U. S. DEPARTMENT OF AGRICULTURE.

REPORT

OF THE

CHIEF OF THE DIVISION OF FORESTRY

FOR

1892.

BY

B. E. FERNOW.

FROM THE REPORT OF THE SECRETARY OF AGRICULTURE FOR 1892.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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CONTENTS.

REPORT OF THE CHIEF OF THE DIVISION OF FORESTRY.

SIR: I have the honor to submit my seventh annual report upon the work of the Division of Forestry, together with separate and more extensive discussions of such subjects as have had the special attention of the division during the year 1892.

Very respectfully,

B. E. FERNOW,
Chief.

Hon. J. M. RUSK,
Secretary.

THE WORK OF THE YEAR.

During the past year the correspondence of the division in regard to general and specific subjects has grown to such an extent as to so engross the attention of the writer that the editorial work has been delayed and a large amount of accumulated material remains unprinted. While this condition of things is an acceptable exhibit of the increase of interest, as well as an appreciation of the value of information that may be derived from the Division of Forestry, it suggests at the same time the necessity of additional means to meet this kind of demand, and the need of an increased office force in the direction of experts who can give advice in technical matters. The diversity of the subjects which come before this division for consideration and reply was pointed out in my report for 1889, in which I gave a classified list of subjects, technical in many instances as well as statistical and of a general nature. The means for acquiring the information, which should be legitimately ascertained and given out, are entirely insufficient. There are but few people engaged in pursuits related to forestry matters whose experience can be made available for such use, and it becomes necessary, therefore, to train specialists in order to supply the demand. In addition to the correspondence by bona fide inquirers, there are also constant demands for newspaper articles, addresses before associations, etc., that require attention from this office, which suggest a dearth of acceptable private writers on the subjects regarding which the information is sought. It is, therefore, fair to infer that quite a number of students of forestry, who are well versed in its various aspects, now find a field for the practical application of their knowledge and remunerative employment at least by providing the public and technical press with reading matter. There are, as shown in a former report, several colleges which have introduced the subject into their courses. In addition, the Division of Forestry may claim to be sufficiently equipped with literature, collections, and expert advice to furnish a desirable place at which students can acquire the elementary knowledge needed; but while these facilities may properly be placed at the disposal of students who come here for the purpose of acquiring knowledge, it would not be proper to employ their services while they are learning, as has been suggested, nor would the funds at the disposal of the division warrant any such policy.

As during the year 1891, so during the one just passed, the funds of the division have been mainly employed in pushing the test work undertaken and described last year. Bulletin 6, on "Timber Physics," which was promised in my last annual report, has been issued during the year, and the extensive call for this publication has necessitated at once the printing of a second edition. It contains a history and description of the work in hand and also a historical review of the work that had been done by others in this direction. Since there seems still to exist misapprehension of what the main object of these timber examinations is, I may repeat my explanation from last year:

> While the testing of the timbers appears as the most conspicuous part of the work, and the more careful determination of average values expressing the strength of our wood materials is looked for with eagerness by architects, builders, engineers, and consumers of wood, these features constitute in reality the smaller part, and by no means the ultimate object of the undertaking. This object is a twofold one, namely, first, to find out in what relation the mechanical properties of timber stand to its structure and physical conditions, and thereby to find for the practice means of judging the mechanical properties from the simple microscopic or macroscopic examination; and, secondly, to find out in what relation structure, physical conditions, and mechanical properties stand to the conditions under which the tree is grown, and thereby to obtain knowledge for the forest-grower as to the kinds of timber which will yield the best results in given soil and climatic conditions.
>
> The correlation of results of these two directions of study as cause and effect is the aim of this work, and in general of the science, which I have called timber physics. Timber physics, in short, has to furnish all necessary knowledge of the rational application of wood in the arts, and, at the same time, by retrospection, such knowledge will enable us to produce in our forest growth qualities of given character.
>
> Conceived in this manner, it becomes the pivotal science of the art of forestry, around which the practice both of the consumer and producer of forest growth moves.

It is very gratifying that this first venture of original investigation by the Division of Forestry has found general favor, not only in a part of this country, but has also been highly commended by the technical press of the Old World. The calls for special investigations into the qualities of the timbers in various sections of the country have grown very numerous, and it is to be regretted that the scant appropriations made for this work will not allow an expansion, such as might furnish at least preliminary knowledge in regard to all the timbers which appear on the market. There is a special demand for the tests of such kinds as are still more or less unknown, they being now drawn upon to eke out the deficiency of supply of the better-known kinds. The Douglas spruce, the cedars, the sugar-pine of the West, the bald cypress of the South, and other conifers ought to be tested without delay. If Congress had appropriated the necessary funds which were asked for in the special bill introduced during the last session, it was the intention to establish a test laboratory at San Francisco, and another one at Washington. In this way the cost of transportation of material would be decreased, since it can not be expected that the railroad companies will in all cases be willing to furnish free transportation. Not less than $40,000 per annum should be employed in this direction for two or three years in order to secure sufficiently rapid progress at the most economical rate. The economy secured to the country at large by this work may be best comprehended from the statement that by the simple demonstration of the value of "bled" timber for building purposes an increase in the price of the product of nearly 1,000,000 acres in the Southern States has been secured, involving in the assumed appreciation at least 2,000,000,000 feet, B. M., of lumber, which, if appreciated by only $1 per 1,000 feet, represents a saving of $2,000,000 in value.

The collections for test material have now reached a total of 234 trees. The collections this year have been from Missouri, Arkansas, Texas, and Louisiana. It was aimed to complete the collections of longleaf pine, but, in addition, shortleaf pine and loblolly-pine have been collected, together with some oaks, as the opportunity of the collector permitted. I have again to record the generosity and active interest which the railroad companies, along the lines of which the collecting was done, have shown by furnishing free transportation to collectors and for the collected material. Our thanks are due especially to the management of the Iron Mountain Railroad and to the Southern Pacific Railroad Company. As soon as it is possible to complete the tests of the longleaf pine collected, it is proposed to publish the results in a preliminary bulletin, which may possibly reach the public before the issue of this report. At the present writing no less than 6,800 tests of various kinds have been made in the test laboratory, in charge of Prof. J. B. Johnson, of St. Louis, and it is expected that at an early date all the longleaf pine material will be tested and examined, and the results will be embodied in the forthcoming bulletin. The collections then will have comprised the whole western field of the geographical distribution of this one species, from five different sites. This material may be considered sufficient for an exhaustive discussion of the properties of this species, unless additional tests be made on timber collected from the eastern field of its distribution, in order to see whether any difference of development due to difference of climatic conditions is observable.

In the line of special investigations a series of tests and examinations of bled and unbled timber was carried on in order to ascertain whether the practice of taking the resin from the trees had any influence upon its quality. Some thirty trees, boxed, and cut after being abandoned a varying number of years, were so examined. The results seem to show that there is no determinable influence on the mechanical properties of the tree, and hence the prejudice of Northern engineers and architects against the use of this bled timber seems to have no foundation. A preliminary report of the results of these tests was published in Circulars 8 and 9 of this division, but the final discussion is expected to be embodied in the next bulletin on Timber Physics. The discovery of the fact that the quality of timber is not impaired by the bleeding process removes the cloud of suspicion from one of the most important articles of the Southern lumber markets. In connection with this work a study of the methods of turpentine gathering was undertaken, the results of which are embodied in this report, and embrace a description of the process of turpentine orcharding as practiced in this and in other countries to serve as basis for a change from the present wasteful methods to more rational ones. While our tests and examinations show that the removal of the resin does not directly affect the quality of the timber, it does, if not carried on with care, affect the life of the tree and invite other destructive influences, such as fire and fungus growth.

The turpentine industry, like the lumber industry, is carried on in this country on the "robbing system," simply taking off in the most crude and rapacious manner what nature has provided. It is now time to substitute a "management system," which shall utilize the remaining resources more exhaustively yet more carefully, by avoiding all unnecessary waste. If our turpentine orchardists will study the rational methods used in France, they will perhaps find it to their advantage to modify their present destructive methods.

In order to arrive at a conception of what the bleeding of timber means to the physiology of the tree, and of the manner in which the draining of the resin from the tree proceeds, a special study of the distribution of resin in bled and unbled timber has been undertaken, and the results obtained by Mr. M. Gomberg, the chemist, showing that no change in the heartwood due to bleeding can be established, will be discussed in the forthcoming bulletin.

In connection with the collecting of test material, the collector, Dr. Charles Mohr, of Mobile, Ala., has also accumulated a considerable amount of information regarding the general forest conditions of the States through which he traveled, and in regard to the biology of the tree species which he has collected, which will eventually be of special advantage. Mr. Filibert Roth, of Ann Arbor, Mich., who has most assiduously continued the investigations of physical and structural properties of the test material, was also sent into the field through the Southern forests, for the purpose of gaining knowledge of the appearance and of the methods of handling the timber of the longleaf pine, especially as to the condition of the market in reference to bled timber. Several other investigations of technological character have also been inaugurated.

In coöperation with the Division of Chemistry, an inquiry has been begun to determine the tannin contents and their distribution within the trees of the wood of such timber as will presently be used more extensively for making tan extracts. With the waning supply of tanbarks, it is to be presumed that the use of extracts made from such woods as the chestnut and the various oaks will soon assume large proportions, and such use promises to open a new and profitable field of forest exploitation and should be properly directed.

In coöperation with the Division of Vegetable Pathology, an inquiry has been instituted into the cause and possible preventives of the "bluing" of timber, which occasions much trouble and loss, especially in the Southern mills, affecting the sapwood of pines, tulip poplar, and other soft woods. A preliminary examination has shown the blue spots to be due to a fungus growth, which develops in warm, moist weather so rapidly that even careful piling to expedite rapid seasoning and, under some circumstances, kiln-drying can not entirely obviate its growth.

The life history of the fungus being still unknown, it would be premature to discuss remedies. It appears that even the dry kiln (at least some forms), the introduction of which alone made it possible to handle the shortleaf pine to advantage, is not entirely successful in destroying the fungus.

But for the mechanical impossibility, in view of the very pressing office work, of editing and preparing them for the printer, the monographs on the various conifers, which have been promised from year to year, would have been published during the past year. The delay in their publication may not be considered altogether unfortunate, as during the time which has elapsed since their first preparation additional knowledge has accumulated which will make the work much more valuable.

REVISION OF NOMENCLATURE.

The botanist of the division, Mr. George B. Sudworth, has finished the revision of the nomenclature of our arborescent flora, and the same would have been published by this time if the recent action of the botanists of the country, with reference to the laws of nomenclature, had not made it desirable to delay its publication, in order to await their decision as to what principles should guide the reviser. Some of the principles which were adopted at the meeting of the botanists at Rochester during the month of August of this year were in contradiction to those adopted by the Division of Forestry, and since an international congress had been called at Genoa, in order to establish such principles as might be adopted internationally, it was proposed to await the decision of this congress. Unfortunately, the very points of controversy were not reached by this congress, and remain unsettled. It is, therefore, now proposed to publish the revision in such a manner as readily to permit corrections when an international agreement may have been reached. In order to bring more quickly before those interested in this work the results of the revision, a list of the more important changes made, with annotations, is embodied in this report.

A NATIONAL ARBORETUM.

In my last report I suggested the desirability and excellent opportunities afforded for the establishment of a national arboretum in or near the city of Washington, D. C. I pointed out that the climate of this city is exceptionally favorable for the propagation of a very large range of species, exceeding that of even the celebrated Kew Gardens in England, and that as a means of instruction, such an arboretum would not only be superior to an herbarium, but it would also give opportunity for trials and experiments in acclimation; it would permit the study of form, rate of growth, and effect upon one another of the different species, and thus furnish additional means of instruction for forestry experts, whose education sooner or later will become a necessity. Since it can not be expected that action will soon be taken on such a proposition, I have utilized the means at hand for the purpose aforesaid. In connection with the botanist, I have made a list of the many species found in the public reservations and plats of this city, amounting to not less than from four to five hundred, endemic and exotic; their position has been indicated by numbers, on plats of the various reservations, 200 in number, so that the specimen can be found by inspecting the list and the corresponding number of the plat. This work, not entirely germane to the Division of Forestry, was undertaken with the assistance of funds from the National Museum, of which institution the writer is an honorary curator. The results will soon be published in a bulletin containing not only the enumeration, but additional notes of interest respecting the various kinds found.

With the same object in view, namely, to enlarge the facilities for the study of forest flora at the capital, the writer accepted a call from the Governing Board of the Soldiers' Home, the largest and most beautiful park of the city (excepting only the new National Rock Creek Park), to superintend the cutting and planting of trees in that park. In this connection an attempt will be made not only to call attention to the fine specimens of rare and beautiful trees now in existence and to keep them in condition, but also to extend their number so as to introduce all the varieties which will thrive in this climate.

During the summer the War Department availed itself of the information to be derived from the Division of Forestry, by inviting the writer to inspect the Chickamauga National Park, for the purpose of advising the commissioners of the park how to manage the forest growth of the reservation. Since this is a subject which may again and again, under different conditions, become a matter of inquiry, I have reproduced my remarks in regard to it in this report.

FORESTRY LECTURES.

As usual during the year many calls for addresses were made upon the writer and attended to. Among these may be mentioned a special forestry day at the Pennsylvania Chautauqua, attendance at various farmers' institutes in western New York, a forestry convention in Minneapolis, and others.

SEED AND SEEDLING DISTRIBUTION.

The usual distribution of seeds to an amount proportionate to the appropriations has been made. As heretofore, this distribution has been mainly of coniferous kinds, 5,000 packages having been distributed. From the stocks in the grounds there have also been distributed many varieties of osier willows. With the assistance of the Maryland Experiment Station it was also found possible to introduce some cork oak seedlings. Six bushels of cork-oak acorns were imported and put under ground last spring. Unfortunately quite a number spoiled on account of inattention in keeping. Nevertheless, a sufficient number came up and, but for the damage done by grubs, a larger number of seedlings could have been distributed. The actual result has been a distribution of sixteen packages, containing thirty seedlings each, mostly to the experiment stations situated in climates where promising experiments of acclimation might be made with this species. Further information regarding this species is given in a special chapter in this report.

FOREST-PLANTING EXPERIMENT.

The experiment in forest planting on the sand hills of Nebraska, described in last year's report, has been continued by supplying the deficiencies on the three plats numbered 1, 2, and 3. Plat 4, which was planted on plowed ground, plants spaced 3 by 4 feet and cultivated, showing only 5 per cent of plants living at the end of the first season, was abandoned. This poor success, under the conditions of soil, climate, and treatment, had been anticipated, yet it would be unfair to judge the method from this one experiment. A repetition of the method this year was impracticable for various reasons. We may infer, nevertheless, that on sandy soil, which is apt to blow out, dense planting without plowing or cultivating is preferable. The soil should be stirred as little as possible and the plants preferably be set with a dibble by hand. Cultivation on such soils may do harm instead of good; the percolation of the water is hardly improved by the cultivation, while the capillary condition of the sand even when packed is such as to prevent rapid evaporation from the lower strata, the upper sand strata acting as a mulch. That this is the case was indicated by the experiment of mulching one-half of each plat with hay. The report is that no difference was noticed between the mulched and unmulched plats. Hence, for improvement of water conditions plowing and cultivating are not required. The question, then, remains whether the keeping down of weed growth or preventing the sand from blowing is the more important matter. We believe that the loss of tree growth due to the choking by weeds is rather to be endured than the loss by the shifting of the sand, and that under the conditions here met the soil should be disturbed as little as possible.

For the fail places that had occurred on the first three plats there were provided 3,000 Scotch and 675 Austrian pines, received in good condition and planted on May 3 and 4; 1,880 catalpas received in very poor condition, and 900 black cherries, with a few honey locust mixed in, received in good condition; these were planted on May 5 and 7, the weather being very favorable, cool, cloudy, and moist, with occasional showers.

It might be proper to remark here that probably half the failures in tree-planting everywhere, as was the case also in this experiment, arise from the fact that the plant material was not properly cared for before the planting. A large percentage is half dead or doomed to die before the tree is put into the ground, through inattention to proper treatment of the roots. This inattention seems often to begin at the nurseries during the packing; it then continues in transit—by delays in trains and at railroad stations—and finally culminates in the hands of the planter, who treats the tender seedlings as he would potatoes or turnips. There are some trees, like fruit trees, catalpas, and black locust, that will survive such carelessness, but most forest trees, and especially conifers, succumb readily when their root system is dried out, and have poor chance for recovery.

With the additions the number of plants on the three plats was brought up from 7,036—reported living in October, 1891 (none being reported lost during the winter)—to almost 13,500, which at the end of October, 1892, showed a loss of 28 per cent, so that 9,700 remain on the three plats, or at the average of 6,470 per acre. It will be observed that all the trees living last year are reported as living after the second season, the losses being presumably entirely in the new planting, which gives countenance to the opinion that the loss occurs before and during the planting.

The following tables will exhibit the progress and condition of the planting:

Tree-planting experiments in Nebraska.

PLAT 1.

Species.	Number planted.	Number living Oct. 15, 1891.	Per cent living Oct. 15, 1891.	No. planted in 1892.	No. living in November, 1892.	Per cent living in November, 1892.
Bull-pine	306	139	45.4	....	139	100.0
Banksian pine	2,362	2,055	87.0	....	2,055	100.0
Scotch pine	1,350	23	1.7	2,380	916	38.1
Austrian pine	300	134	44.7	379	274	53.4
Red pine	375	54	14.4	....	54	100.0
Douglas spruce	200	53	17.7	....	53	100.0
Arbor-vitæ	225	110	48.9	....	110	100.0
	5,118	2,568	49.2	2,759	3,601	....

Tree-pl, *nting experiments in Nebraska*—Continued.

PLAT 2.

Species.	Number planted.	Number living Oct. 15, 1891.	Per cent living Oct. 15, 1891.	No. planted in 1892.	No. living in November, 1892.	Per cent living in November, 1892.
Bull-pine	459	144	31.4	....	144	100.0
Austrian pine	450	187	41.6	253	237	53.8
Scotch pine (added 1892)	....	....	....	268	52	19.4
Black locust	1,809	1,604	88.7	....	1,604	100.0
Box-elder	1,800	109	6.1	....	109	100.0
Hackberry	450	212	47.1	....	212	100.0
Black cherry	450	34	7.6	749	596	76.1
Hardy catalpa	....	....	....	1,676	436	26.0
	5,418	2,290	42.3	2,946	3,390	....

PLAT 3.

Species.	Number planted.	Number living Oct. 15, 1891.	Per cent living Oct. 15, 1891.	No. planted in 1892.	No. living in November, 1892.	Per cent living in November, 1892.
Bull-pine	288	91	39.9	....	91	100.0
Austrian pine	222	99	44.6	....	99	100.0
Black locust	2,191	1,903	86.9	....	1,903	100.0
Scotch pine	228	1	.4	348	319	91.4
Douglas spruce	222	30	13.5	....	30	100.0
Oak	41	7	17.1	....	7	100.0
Box-elder	25	3	12.0	....	3	100.0
Hackberry	50	44	88.0	....	44	100.0
Hardy catalpa	....	....	....	204	52	25.9
Honey locust	....	....	....	60	48	80.0
Black cherry	....	....	....	160	120	75.0
	3,267	2,178	67.9	772	2,716	....

PLAT 4.

Species.	Number planted.	Number living Oct. 15, 1891.	Per cent living Oct. 15, 1891.	No. planted in 1892.	No. living in November, 1892.	Per cent living in November, 1892.
Bull-pine	1,017	111	10.9		Discontinued.	
Red pine	74	8	10.3			
Scotch pine	666	1	.2			
Box-elder	675	3	.4			
Oak	159	8	5.0			
	2,591	131	5.1			

Summary of tree-planting experiments in Nebraska.

Plat No.	How planted.	1891. No. planted.	1891. No. living.	1891. Per cent living.	1892. No. replanted.	1892. No. living.	1892. Per cent living of two years planting.
1	Pines and other conifers 2 feet apart, in sod, one-half mulched	5,118	2,568	49.2	2,759	3,601	45.7
2	Bull-pine with deciduous trees 2 feet apart, in sod, one-half mulched	5,418	2,290	42.3	2,946	3,390	40.5
3	Pines and deciduous trees, 2 by 3 feet apart, in sod, one-half mulched.	3,267	2,178	67.9	772	2,716	67.2
4	Mixed planting on plowed ground, 3 by 4 feet apart, to be cultivated (the last planted, and during very dry weather)	2,591	131	5.1	Abandoned.		
		16,394	7,167	43.7	6,477	9,707	42.4

The expectations from the jack pine seem to be sustained, this species being reported in the lead with a growth of 12 to 14 inches during the summer. It must also be remembered that these plants were dug from the forest, while the others are nursery grown.

The conifers are all doing well, especially those of plat 1. The deciduous trees are reported as only living; even the black locust "seems to be losing its grip, and all have apparently made no growth this past summer."

Unless unforeseen losses occur it is believed that the planting may be considered concluded, and the plantation established, and no further attention to it will be necessary, except to keep out cattle and fire. It seems already to have proved what was intended, namely, that in the sand-hill region of Nebraska coniferous growth, especially of pines planted closely, is the proper material and method.

It is to be regretted that the Division of Forestry is not in better condition to enlarge in this direction of forest experiments. The present experiment was possible only by the voluntary donation of land and labor on the part of Mr. Hudson Brunner, of Swan, Holt County, Nebr. On account of the inaccessibility from railroads and absence of personal superintendence, many drawbacks were encountered which could be avoided if the funds and organization of the division permitted.

PUBLICATIONS.

A bulletin (Bulletin No. 7) on Forest Influences is now in the hands of the printer. As long as Government action in regard to forest resources is asked, upon the ground that the forest bears a relation to climatic and cultural conditions, it will be of interest to know how far such a relation can be established. In this bulletin are reviewed the systematic observations at the forest-meteorological stations, specially established for the purpose of determining the forest influence in Austria, Switzerland, and Germany. There are twenty-two stations in all, equipped in such a manner that one set of instruments is placed within a forest area, and another set in the open field not far from the forest station. The observations are made daily, and have been recorded now for from eighteen to twenty years, furnishing a large amount of material for the discussion of this question. The bulletin also will contain a discussion of the influence which forests have upon waterflow and upon the sanitary conditions of the air, together with other matter pertaining to the subject.

A report on the Charcoal Industry and the use of wood in this industry has also been brought up to date by Mr. John Birkinbine, a well-known expert, and is expected to be published soon.

THE WORLD'S FAIR.

Much time has been spent in the preparation of an exhibit for the World's Fair. The exhibit of the division must of necessity, owing to lack of space and lack of means, be entirely inadequate to the interests which it represents. When it is considered that the value of products derived from our forest resources, and which it is the object of the existence of this division to have husbanded and properly managed, amount in value to more than $1,000,000,000 annually and is surpassed in the value of annual product by no other single industry, excepting agriculture itself, it will be understood that an exhibit of such a vast interest can not be properly placed within a space of 2,000 feet. It is to be hoped that in the special building devoted to the general exhibit of forestry interests, there will be brought before the public not only the rich material of our forest resources, but also some suggestions as to the manner in which they should be managed in order to yield continuous supplies.

THE SITUATION.

This division has now been in existence for more than a decade, during which time it has been engaged in an endeavor to teach the people of this country that the present methods under which our forest resources are managed are uncivilized, undesirable, and destructive not only to the resources themselves but to many other interests depending upon the material as well as upon the indirect influence of the forest. Although there seems to exist a considerable amount of public interest in the subject, we can nevertheless feel no great satisfaction at the result of the work. There must be some strong reason, which is antagonistic to a change of methods, for the fact that the slaughter of timber lands without any regard to the future, and the burning of square miles without any reference to the destruction of values, continue. Remedies have been suggested and discussed to satiety, but of practical application we have as yet had but little. It seems, therefore, proper that we should once more look over the field, investigate the situation, and find the reasons for a continued absence of more rational treatment of our woodlands; in fact, make a review in this centennial year of what we have done with and for our forest resources, state what their present condition is, and what we hope for the future.

ORIGINAL CONDITION OF FOREST AREAS.

When Columbus discovered America the territorial distribution of forest areas in the United States, and indeed on the whole continent, could be divided with more or less precision into three grand divisions:

(1) The Atlantic forest, covering mountains and valleys in the East, reaching westward to the Mississippi River and beyond to the Indian Territory and south into Texas, an area of about 1,361,330 square miles, mostly of mixed growth, hard woods and conifers; with here and there large areas of coniferous growth alone—a vast and continuous forest.

(2) The mountain forest of the West, or Pacific forest, covering the higher elevations below timber line of the Rocky Mountains, Sierra Nevada, and coast ranges, which may be estimated at 181,015 square miles, almost exclusively of coniferous growth, of enormous development on the northern Pacific coast, more or less scattered in the interior and to the south.

(3) The prairies, plains, lower elevations, and valleys of the West, with a scattered tree growth, on which, whether from climatic, geologic, or other causes, forest growth is confined mostly to the river bottoms or other favorable situations, an area of about 1,427,655 square miles, of which 276,965 square miles may be considered under forest cover of deciduous species east of the Rockies and of coniferous and deciduous species in the west of this divide.

Until the present century, and in fact until nearly the last half of it, the activity of man on this continent has practically been confined to the eastern portion, which, as stated, was originally covered with a dense or at least continuous forest. The substructure of the entire civilization of the United States was hewn out of these primeval woodlands.

Out of the vast virgin forest area of the eastern half of the country there have been cleared for farm use during this time 250,000,000 acres, or 400,000 square miles, leaving about 961,330 square miles covered actually or nominally with forest growth, or waste.

Timber being a great obstacle to the settlement of the land, and the market for it until recently being confined and limited, a large amount had to be wasted and disposed of in the log pile, where the flames made quick work of the scrub as well as of the finest walnut trees. The settlement of the western mountain country, although emigration to Oregon began in 1842, assumed proportions of practical importance only when the gold fever took many travelers over the plains and mountains to California in 1849 and the following years.

If only the legitimate need of the population of this region for cleared land and for timber had made drafts upon the forest resources, the change in forest conditions would have been insignificant, but the recklessness which the carelessness of pioneer life and seemingly inexhaustible resources engender has resulted in the absolute destruction by fire of many thousand square miles of forest growth and the deterioration in quality and future promise of as many thousands more.

The third region, the so-called "treeless area," has experienced, since the advent of the white settlers and the driving out of the Indians, changes which are almost marvelous. The prairies were reached by settlers in any considerable number only as late as the third and fourth decades of this century, but they and their successors have not only occupied a farm area of 80,000,000 productive acres, but they have also dotted the open country with groves, smaller or larger, either by planting them or, by keeping out fire and cattle, aiding the natural reforestation.

CAUSES OF REDUCTION IN FOREST AREAS.

While the requirements of the settlement of agricultural lands have necessitated the removal of forests, their principal destruction has come from two other causes—fire and wood consumption. The latter has assumed proportions which no other country of the earth can equal, for the annual consumption of wood in the United States for all purposes reaches the enormous amount of over 22,000,000,000 cubic feet,* or about 350 cubic feet per capita, as against 12 to 14 cubic feet per capita in Great Britain or about 40 cubic feet in Germany.

The present sawmill capacity (inclusive of shingle mills) of the United States is between 140,000,000 and 270,000,000 feet B. M. daily, which would indicate, at the very lowest, an annual product of about 30,000,000,000 feet B. M. (requiring 4,000,000,000 cubic feet of forest-grown material)—an increase of over 35 per cent in the last five years. Only a small proportion of this is exported either as lumber, timber, or manufactures, namely, less than 150,000,000 cubic feet, or hardly 6 per cent of the total output of lumber; and since we import about 95,000,000 cubic feet of wood material (less than 1 per cent of our consumption) outside of fine cabinet woods (of which we import about $1,500,000 worth), the consumption of sawed-wood products is over 40 cubic feet per capita. If we add the consumption of hewn timber and that used in railroad construction the requirements for sizable timber increase readily to 50 cubic feet per capita. To produce such amounts the annual growth of not less than 500,000,000 acres of well-managed forest in good condition would be necessary, while the consumption in mining, fences, and especially for firewood, for which in this country

*The largest part of this consumption is for firewood; according to the Census of 1880 the consumption of firewood must then have been 280 cubic feet per capita (figuring 100 cubic feet solid to the cord), and this amount has probably not been reduced during the last decade. This firewood is not, as in older countries, made up of inferior material, brush and small fagots, but is, to a large extent, split body wood of the best class of trees.

body wood, hardly inferior to saw timber wood, is chiefly used, would swell the necessary acreage to more than double that amount.

The following table shows the value of exports of forest products, crude, or only slightly enhanced in value by manufacture:

Value of exports of forest products, 1860–'92.

Year.	Value.	Total exports of domestic products.	Year.	Value.	Total exports of domestic products.	Year.	Value.	Total exports of domestic products.
		Per cent.			Per cent.			Per cent.
1860	$10,299,959	3.26	1880	17,321,268	2.11	1887	21,126,273	3.01
1870	14,897,963	3.27	1881	19,486,051	2.20	1888	23,991,092	3.51
1875	19,165,907	3.43	1882	25,580,264	3.50	1889	26,997,127	3.70
1876	18,076,668	3.04	1883	28,636,199	3.56	1890	29,473,084	3.49
1877	19,943,290	3.14	1884	26,222,959	3.62	1891	28,715,713	3.29
1878	17,750,396	2.55	1885	22,014,839	3.03	1892	27,957,423	2.75
1879	16,336,943	2.34	1886	20,961,708	3.15			

We have now less than 500,000,000 acres in forest growth, but even that is neither in good condition nor well managed. We have, therefore, long ago begun to use more than the annual growth, and are cutting into the capital which we inherited at a rate which must sooner or later exhaust it unless we adopt recuperative methods.

These figures are approximate and without fine distinctions, but they will be found by those who study the subject conservative rather than extravagant.

A computation by one of the journals representing lumbermen's interests makes the amount of timber standing in the United States 1,200 billion feet B. M., and the present annual consumption 10,000,000,000 feet; or one-third of the above figures. There exists, to be sure, no reliable basis for such computation, but even with these figures the supply would be exhausted in less than one hundred years, for our consumption during the last three decades has increased at the rate of about 30 per cent, as follows:

Estimates of value of forest products used in 1860, 1870, and 1880.

[Including all raw, partially manufactured, wholly manufactured wood products, fuel, and naval stores; estimated upon the basis of census figures, and other sources of information.]

Articles.	1860.	1870.	1880.
Mill products, rough, and partly finished	$155,000,000	$340,000,000	$400,000,000
Cut on farms for home use	45,000,000	52,000,000	55,000,000
In manufactures using wood	50,000,000	100,000,000	110,000,000
Railroad building	6,000,000	14,000,000	30,000,000
Fuel	135,000,000	210,000,000	328,000,000
Total	*391,000,000	716,000,000	923,000,000

* Probably 25 per cent underestimate.

While there are still enormous quantities of virgin timber standing, the accumulations of centuries, the supply is not inexhaustible. Even were we to assume on every acre a stand of 10,000 feet B. M. of saw timber—a most extravagant average—we would, with our present consumption, have hardly one hundred years of supply in sight—the time it takes to grow a tree to satisfactory log size.

Certain kinds of supplies are beginning to give out. Even the white-pine resources, "which a few years ago seemed so great that to attempt an accurate estimate of them was deemed too difficult an undertaking, have since then become reduced to such small proportions that the end of the whole supply in both Canada and the United States is now plainly in view."

The annual product of this pine from the sawmill has reached the enormous total of over 8,000,000,000 feet B. M., which, if we assume a pine stumpage of 5,000 feet to the acre—a high average—would require the culling of 1,600,000 acres annually of their white-pine supplies. Since the three white-pine States (Michigan, Wisconsin, and Minnesota) have a total reported forest area of altogether 60,000,000 acres, it is evident that even if we allow two-thirds of that area to be in the white-pine belt, and consider this area fully stocked—which it is not—twenty-five years would suffice to practically exhaust the supplies. These figures, crude though they be, leave no doubt that the end of this staple is practically much nearer than we have supposed; all opinions to the contrary may be set down as ill-founded.

It is one of the peculiarities of the development of our country that prices of the manufactured article do not give a clue to the condition of the supplies of raw material. The opening of new territories and the improvement of machinery and methods of handling have a tendency to keep the prices of manufactures low. This is especially noticeable in the lumber trade, prices for lumber having hardly changed in the average for the last twenty years.

It is different, however, with land values and with the value of stumpage of such staples as the white pine. In this respect the table given on page 309, as compiled from the report of the Saginaw Board of Trade, is most instructive, showing a sixfold appreciation of stumpage and almost stationary prices for lumber.

The extent and distribution of the sawmill business through the States is, perhaps, best illustrated by the following statement of the number of the various classes of mills and their daily capacity as compiled from the Directory of the Northwestern Lumberman:

Number of mills, logging railroads, and daily capacity of mills.

[Compiled from data published in Northwestern Lumberman, 1892.]

United States.	Sawmills.		Shingle mills.*	Staves and heading mills.	Logging railroads.	Daily sawmill capacity.		Daily shingle-mill capacity.	
	Stationary.	Portable.				Lowest.	Highest.	Lowest.	Highest.
						Feet B.M.	*Feet B.M.*	*Number.*	*Number.*
Maine	355	6	292	61	3	4,686,000	8,730,000	3,208,000	6,275,000
New Hampshire	270	7	158	40	....	2,530,000	4,720,000	972,000	1,860,000
Massachusetts	282	20	78	16	1	1,452,000	3,095,000	390,000	775,000
Rhode Island	10	2	6	......	....	48,000	100,000	42,000	75,000
Connecticut	56	7	22	1	....	342,000	710,000	114,000	215,000
Vermont	349	20	129	10	1	2,851,000	5,525,000	716,000	1,515,000
New England States	1,322	62	685	128	5	12,909,000	22,880,000	5,442,000	10,715,000
New York	738	42	255	44	10	6,670,000	12,680,000	2,266,000	4,535,000
Pennsylvania	887	96	266	39	92	14,597,000	27,190,000	2,814,000	5,415,000
New Jersey	73	3	11	......	....	174,000	540,000	36,000	90,000
Delaware	46	4	2	5	....	252,000	535,000	....	5,000
Maryland	39	6	5	1	2	470,000	900,000	12,000	40,000
Middle Atlantic States	1,785	151	539	89	104	22,163,000	41,845,000	5,128,000	10,085,000
Virginia	100	58	31	8	29	1,602,000	3,260,000	168,000	330,000
North Carolina	140	21	26	2	34	1,932,000	3,605,000	162,000	355,000
South Carolina	70	16	9	2	21	840,000	1,580,000	369,000	475,000
Georgia	144	17	57	17	44	3,086,000	5,495,000	816,000	1,470,000
Southern Atlantic States	454	112	123	29	128	7,460,000	13,940,000	1,515,000	2,630,000
Atlantic coast	3,561	325	1,347	246	237	42,532,000	78,665,000	12,085,000	23,430,000

* Shingles may be averaged 5,000 to the 1,000 feet B. M

Number of mills, logging railroads, and daily capacity of mills—Continued.

United States.	Sawmills.		Shingle mills.*	Staves and heading mills.	Logging railroads.	Daily sawmill capacity.		Daily shingle-mill capacity.	
	Stationary.	Portable.				Lowest.	Highest.	Lowest.	Highest.
						Feet B.M.	*Feet B.M.*	*Number.*	*Number.*
Florida	123	13	48	4	20	2,036,000	3,665,000	890,000	1,575,000
Alabama	141	13	20	6	36	2,514,000	4,505,000	812,000	1,655,000
Mississippi	152	13	18	2	34	2,740,000	5,015,000	282,000	505,000
Louisiana	106	3	29	1	15	1,926,000	3,405,000	1,536,000	2,945,000
Gulf States	522	55	115	13	105	9,216,000	16,590,000	3,520,000	6,680,000
Texas	150	2	30	......	61	3,602,000	6,370,000	890,000	1,525,000
Michigan	847	52	391	101	79	21,630,000	42,045,000	12,356,000	25,680,000
Wisconsin	477	32	265	26	20	14,724,000	27,585,000	8,706,000	15,865,000
Minnesota	103	2	67	2	2	4,182,000	8,965,000	2,700,000	4,740,000
Northern lumbering States	1,427	86	723	129	101	40,536,000	78,595,000	23,762,000	46,285,000
Ohio	576	78	30	82	9	3,856,000	7,820,000	162,000	310,000
Indiana	549	68	32	51	....	4,192,000	8,130,000	300,000	540,000
Illinois	109	41	9	9	1	1,158,000	2,770,000	264,000	445,000
Northern agricultural States	1,234	187	71	142	10	9,206,000	18,720,000	726,000	1,295,000
Lake States	2,661	273	794	271	111	49,472,000	94,315,000	24,488,000	47,580,000
West Virginia	136	93	14	33	40	1,425,000	2,595,000	770,000	1,490,000
Kentucky	218	117	34	37	10	3,146,000	5,970,000	306,000	590,000
Tennessee	332	111	29	32	20	4,018,000	7,695,000	180,000	360,000
Arkansas	284	33	56	27	45	5,030,000	9,615,000	1,074,000	1,920,000
Missouri	184	41	15	9	10	2,016,000	3,820,000	214,000	355,000
Central States	1,154	395	148	138	125	15,635,000	29,695,000	2,544,000	4,715,000
Iowa	42	6	19	2	....	1,400,000	3,655,000	900,000	1,785,000
North Dakota	1	......	......	......	....	....	....	....	....
South Dakota	18	1	14	......	....	186,000	360,000	186,000	365,000
Nebraska	4	......	......	......	....	12,000	25,000	....	....
Kansas	......	......	......	......	....	....	....	....	....
Prairie States	65	7	33	2	....	1,598,000	4,040,009	1,086,000	2,150,000
Interior States	1,219	402	181	140	125	17,233,000	33,735,000	3,630,000	6,865,000
Montana	24	3	11	......	1	438,000	1,000,000	162,000	310,000
Wyoming	10	......	7	......	....	60,000	110,000	96,000	170,000
Colorado	34	17	29	......	....	420,000	820,000	318,000	620,000
New Mexico	15	1	8	......	3	222,000	405,000	108,000	210,000
Indian Territory	17	......	1	......	....	180,000	350,000	12,000	25,000
Eastern Rocky Mountain region	100	20	56	......	4	1,320,000	2,685,000	696,000	1,335,000
Idaho	37	9	20	......	....	306,000	580,000	150,000	315,000
Nevada	6	......	2	......	1	212,000	380,000	24,000	50,000
Utah	31	5	9	......	....	102,000	285,000	48,000	95,000
Arizona	10	1	2	......	1	146,000	310,000	24,000	50,000
Western Rocky Mountain region	84	15	33	......	2	766,000	1,555,000	246,000	510,000
Rocky Mountain region	184	35	89	......	6	2,086,000	4,240,000	942,000	1,845,000
California	159	3	64	2	33	3,446,000	6,105,000	2,202,000	4,010,000
Oregon	184	7	25	......	11	2,722,000	5,225,000	380,000	715,000
Washington	178	16	83	......	28	2,850,000	5,500,000	2,114,000	3,645,000
Pacific coast	521	26	172	2	72	9,018,000	16,830,000	4,696,000	8,370,000
Total	8,818	1,118	2,728	672	717	133,159,000	250,745,000	40,251,000	96,295,000

*Shingles may be averaged 5,000 to the 1,000 feet B. M.

Prices for lumber and stumpage of white pine.

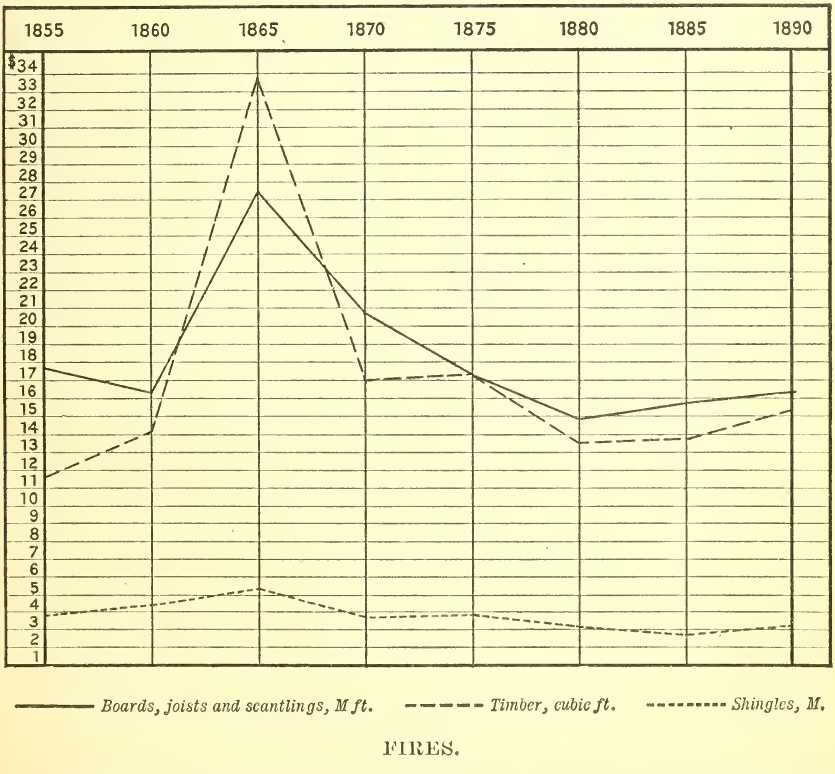
[Compiled from report of Saginaw Board of Trade.]

Year.	Lumber, per 1,000 feet B. M.	Stumpage, per 1,000 feet.	Year.	Lumber, per 1,000 feet B. M.	Stumpage, per 1,000 feet.
1866....	$11.50 to $12.00	$1.00 to $1.25	1877...	$9.25 to $9.75	$2.25 to $2.75
1867....	12.00 12.50	1.25 1.50	1878...	9.50 10.00	2.25 2.75
1868....	12.00 12.50	1.50 1.75	1879...	10.50 11.00	2.50 2.75
1869....	12.50 13.00	2.00 2.50	1880...	11.50 12.00	2.75 3.00
1870....	12.00 12.50	2.00 2.50	1881...	12.50 13.00	3.00 4.00
1871....	12.50 13.00	2.00 2.50	1882...	14.00 14.50	3.50 4.50
1872....	13.00 12.00	2.00 2.50	1883...	13.50 14.00	4.00 5.00
1873....	11.50 11.00	2.00 2.50	1884...	12.50 13.00	4.00 5.00
1874....	10.50 10.00	2.00 2.50	1885...	12.50 13.00	4.50 6.50
1875....	9.50 10.00	2.25 2.75	1886...	12.50 13.00	4.50 6.50
1876....	9.00 9.50	2.25 2.75	1887...	12.50 13.00	4.50 6.50

The following diagram of export prices for lumber shows also comparative stability, with the exception of war time:

DIAGRAM 1.—*Export prices of lumber from 1855 to 1890.*

[The prices given represent market value at time of exportation in the ports whence the lumber was exported averaged for all ports.]



FIRES.

Regarding the loss by fire no adequate conception can be formed. Fires are of such general occurrence that only the larger conflagrations are noticed and it is difficult to obtain reports as to their extent and destructiveness.

In the South the foolish custom of annually burning off the old grass in order to gain a fortnight's earlier pasturage still prevails and gives rise to widespread destruction, which is increased by the coniferous composition of the larger part of these areas and the additional danger occasioned by turpentine orchards. In the West carelessness of campers seems to be the principal cause of fires, which, owing to the dryness of the climate and absence of population interested in stopping the conflagrations, assume frightful dimensions and often not only destroy square miles of timber, but endanger the lives and property of settlers.

From locomotives, without spark-arresters or carelessly handled at the ash-pit, comes the greatest danger in the East. To estimate even the direct loss or damage from this source is well-nigh impossible, much less the indirect loss, which consists in the destruction of the forest floor, the handing over of the ground to worthless brush, brambles, and inferior tree growth, or, as happens in some regions, the burning of the soil down to the rock, leaving an irredeemable waste. Thus the accumulation of centuries—it takes from three to five centuries to make a humus soil 1 foot in depth—is destroyed in one brief season by carelessness.

In the Census of 1880 an attempt was made to ascertain the extent of the fires and the consequent loss in money value. Upon unsatisfactory and partial returns a total of over 10,000,000 acres was reported burned with a loss of over $25,000,000 in value.

A canvass made by the Division of Foresty for the last year, which was highly unsatisfactory in its returns, these being vague and reporting only very partially, shows that in the districts reporting more than 12,000,000 acres of woodland were burned over during 1891. The report showed log timber killed 473,387,000 feet, B. M., and damage from forest fires to other than forest property to the extent of $503,590, besides injury to valuable forest growth difficult to estimate. What proportion of the actual destruction these reports represent it is impossible to tell. They show, however, that in spite of the growing sentiment against such useless waste the nuisance has hardly abated in the last ten years. The loss from prairie fires to crops, tree growth, buildings, and other property was reported by the same correspondents at $1,633,525.

In comparison with our figures of bona fide consumption the direct loss in material is but a small matter, perhaps 2 to 3 per cent of the total value of forest products, but the indirect loss can hardly be overestimated. This lies, not only in the destruction of the fertility of the soil, but in discouraging more conservative forest management on the part of forest owners, while the constant risk from fire is an incentive to turn into cash as quickly as possible what is valuable in the forest growth, leaving the balance to its fate.

There is a crying need in the United States for economic reform in this matter of playing with fire. If the fire nuisance could be reduced to the unavoidable proportion, half the forestry problem would be solved.

FIRES SET BY RAILROADS.

The railroads are probably responsible for as much loss of forest growth by fire escaping from their locomotives as results from any other cause of fire. Yet, if we expect to carry on profitable forest management, we can not dispense with these instruments of transportation, and the development of the country can not be retarded, even at this expense in devastated forest growth. Strange as it may appear to the average railroad man and to the public accustomed to conflagrations from locomotive sparks, it is possible to use locomotives without any special risks from fires. That this is a fact is shown by the following statistics: In the Prussian Government forests during the years 1882 to 1891, there have been 156 larger conflagrations. Of these 96 originated from negligence, 53 from ill-will, 3 from lightning, and only 4 from locomotives. Seven years out of the ten are without any record of fire due to this last cause. When we consider that the larger part of the Prussian forest property, namely, 56 per cent, is stocked with pine mostly on dry, sandy soils, this fact increases in significance.

How is this danger so reduced? In the first place, by ordinances which are enforced regarding the use of spark-arresters and regulations for the cleaning of ash-pits, as well as by frequent patrols of the guards. But with all these precautions the object could hardly be attained effectively if other preventive measures were not adopted. These are fire-safety strips. These safety strips, running along the right of way of railroads, are variously constructed and utilized. An ideal form is described and illustrated on Plate VI.

Wherever this system has been adopted, the clearing having been attended to in spring with reasonable watching during the dangerous season, fires from locomotives have been of no significance. The wooded safety strip acts as a screen, preventing the sparks from being thrown into the growth beyond the ditch.

Such a system would be applicable in many cases in our own country, and while it would not be necessary for the railroad company to acquire title to the right of way for a breadth of 200 feet the company should at least be under obligation to keep the safety strip in order. It would be perfectly feasible and in the end profitable in many cases for the company to grow their tie timber on the safety strips, using for this purpose such thin-foliaged rapid growers as the locust, catalpa, etc. Should it be found impossible to compel the railroad company to provide such protection, owners of valuable timber land may at least find a hint in this system for protecting themselves and reducing the danger from fire by cleaning out and keeping free from inflammable material the ground near the tracks.

FOREST-FIRE LEGISLATION.

Against other causes of fire, watchfulness alone will protect. This, in more densely settled communities, is best secured by the methods of the Pennsylvania or Maine laws. Special fire wardens are appointed for districts not too large, who have sheriff's power, whenever a fire is started, to call out a posse and put out the fire, charging the cost to the county treasury. They are also to find out the originator and bring him to trial, he to pay damages and suffer criminal punishment as provided by law. In this way carelessness at least will soon be more or less eradicated.

In less settled communities, and on large territories, where lumbermen are interested, the Canadian system, which has worked satisfactorily for nearly ten years, is to be recommended. It consists in having fire patrols appointed by the government on recommendation by the limit holders, who contribute one-half the expenses of this service.

There exist some legislative provisions regarding forest fires in almost every State, but they are rarely if ever carried into execution for lack of proper machinery. The most comprehensive fire legislation is that enacted in Maine in 1891, which creates a forest commissioner and organizes a protective service. The first report of the forest commissioner, Mr. Cyrus A. Packard, of Augusta, Me., containing a copy of the law and other valuable matter, is recommended for the perusal of all interested in this most important matter of fighting forest fires. With this legislation as a basis, the following suggestions for the drafting of forest-fire legislation are made, which, with appropriate modifications to suit the special conditions in each State, should be enacted.

The principles most needful to keep in view when formulating legislation for protection against forest fires are—

(1) No legislation is effective unless well-organized machinery for its enforcement is provided. The damage done by forest fires being in many cases far-reaching beyond the immediate private personal loss, the State must be prominently represented in such organization.

(2) Responsibility for the execution of the law must be clearly defined and ultimately rest upon one person, and every facility for ready prosecution of offenders must be at the command of the responsible officer.

(3) None but paid officials can be expected to do efficient service, and financial responsibility in all directions must be recognized as alone productive of care in the performance of duties as well as in the obedience to regulations. In the case of corporations the officer most directly responsible for any damage must be amenable to law in addition to the corporation itself.

(4) Recognition of common interest in the protection of property can also be established only by the creation of financial liability on the part of the community and all its members.

The following is the draft of a bill which embodies the principal features of the desired legislation:

AN ACT FOR THE PROTECTION OF FOREST PROPERTY.

FOREST COMMISSIONER.

Section 1 creates a forest commissioner, whose office may be either an enlargement of some existing office or, much better, a separate one, with adequate compensation in either case, to be appointed by and reporting directly to the governor.

Section 2 prescribes the duties of the forest commissioner, namely, to organize, supervise, and be responsible, under the provisions of this act, for the protection of forest property in the State against fire. In addition he is to collect statistics and other information regarding the forest areas in the State, and the commerce of wood and allied interests, especially such information as will explain the distribution, condition, value, and ownership of the woodland; this information and the results of the operation of this act, together with suggestions for further legislative action, to be embodied in annual reports.

Section 3 provides for the giving of a bond by the forest commissioner for the faithful performance of his duties, and fixes fines for such neglect in performing the duties of the office as may be proven, and explains the manner of imposing and collecting such fines.

ORGANIZATION OF FIRE SERVICE.

Section 4 constitutes the selectmen of towns, or the sheriffs, deputies, constables, supervisors, or similar officers as fire wardens. If preferred, special fire commissioners may be appointed by the forest commissioner, with the advice of county commissioners, or both methods of providing firewardens may be employed together. The towns are to be divided into fire districts, the number and boundaries to be governed by the exigencies in each case, and each district to be under the charge and oversight of one district firewarden. One of these should be designated as town firewarden, to take command in case of large conflagrations. The town firewarden and at least 50 per cent of the district firewardens should be property owners in the county, unless a sufficient number of such can not be found or residents refuse to serve. A description of each district and the name of its firewarden are to be recorded with the forest commissioner and the town clerk or similar officer.

Section 5 provides for employment of special fire patrols in unorganized places in any county and during the dangerous season, especially in lumbering districts, and for coöperation of forest-owners. Wherever unorganized places exist in a county or so far distant from settlements as to make discovery of fires and speedy arrival of regular firewardens impossible, or wherever forest-owners whose property is specially endangered require, the forest commissioner may annually appoint special fire patrols, to be paid at daily rates, the owner paying one-half the expense and the State the other half; such patrols to be under the regulations of this law and to report to the nearest firewardens. The manner of appointment and the matter of compensation and duties are to be formulated by the forest commissioner.

Section 6 defines the power and duties of firewardens: To take measures necessary for the control and extinction of fires; to post notices of regulations provided in this law and furnished by the forest commissioner; to ascertain the cause of fires and prepare evidence in case of suits; to report each fire at once to the forest commissioner on blanks furnished, giving area burned over, damage, owner, probable origin, measures adopted, and cost of extinguishing; to have authority to call upon any persons in their district for assistance, such persons to receive compensation as determined by the selectmen or county commissioners at the rate of not to exceed 15 cents per hour and to be paid by the town or county upon certification by the forest commissioner.

Persons refusing, when not excused, to assist or to comply with orders, shall forfeit the sum of $10, the same to be recovered in an action for debt in the name and to the use of the town or county, or for the fire protection fund.

Firewardens shall be paid $10 a year as a retainer besides day's wages at the same rates as sheriffs or similar officers for as many days as they are actually on duty, and shall be responsible for prompt extinction of fires and be amenable to law for neglect of duty. The district firewarden shall call on the town firewarden in case of inability to control fires, and the town firewarden shall have sheriff's power to enlist assistance, as is provided in case of a mob.

FIRE-INDEMNITY FUND.

Section 7 provides for the creation of a fire-indemnity fund, each county to pay into the State treasury $1 for each acre burnt over each year, the special fund so constituted to be applied in the maintenance of the system provided by this act and for the payment of damages to those whose forest property has been burned without neglect on their part or on that of their agents.

The burned areas shall be ascertained by the county surveyor and shall be checked from the reports of firewardens by the forest commissioner. All fines collected under the provisions of this law shall also accrue to the fire fund.

JURISDICTION AND LEGAL REMEDIES.

Section 8 establishes jurisdiction and legal proceedings in each case of prosecution of incendiaries and adjustment of damages, and imposes upon every district judge the duty in charging the grand juries of his district to call special attention to the penal provisions of this act and of any similar acts providing for offenses against forest property.

Section 9 charges the forest commissioner to issue and publish, by posters and otherwise, reasonable regulations regarding the use of fires; such regulations to contain special consideration of campers, hunters, lumbermen, settlers, colliers, turpentine men, railroads, etc., and to be approved by the governor.

Section 10 makes it a misdemeanor to disobey the posted regulations of the forest commissioner, or to destroy posters, or to originate fires by neglect of the same; provides that the prosecution shall be prepared by the forest commissioner, and imposes fines and imprisonment in addition to damages. Fines should be double the actual damages, one-half to go to the fire fund, one-half to the damaged person.

Section 11 makes it a criminal act, subject to indictment, to willfully set fires, and imposes fine and imprisonment.

Section 12 provides that any person whose forest property is damaged by fire, not originated by his own neglect, and who is able to prove neglect on the part of the firewarden, may call on the forest commissioner for award of damage, whereupon the forest commissioner, in conjunction with the county authorities, shall investigate the case and refer his findings to the judicial officer of the district, who shall charge the grand jury to indict any offender against this act and adjudge any neglectful firewarden or other officer, or any person refusing to act upon orders of the firewarden.

Any neglect on the part of the forest commissioner to investigate and find in each case within one year from the appeal of the owner shall be followed by dismissal unless reasonable cause for failure be shown.

LIABILITY OF RAILROADS.

Section 13 charges railroad companies to keep their right of way free from inflammable material by burning under proper care before certain dates to be established by the forest commissioner. Failure to do so, upon notification by the commissioner, to be followed by the arrest of the superintendent of the section, who shall be liable prima facie to procedure under section 10.

Section 14 provides for the use of spark-arresters—failure to comply with this provision to be followed by arrest of the superintendent or other officer in charge of the motive power and by procedure under section 10.

Section 15 declares that fires originating from the tracks of a railroad company shall be prima facie evidence of neglect on the part of the company—the engineer and fireman to be liable to arrest and procedure under section 10.

Section 16 declares that in all cases where a fire originates through neglect of a railroad company or its agents, both the company and its officers shall be liable for damages under the provisions of section 12.

Section 17 establishes special liabilities for damage by fires in case of railroads under construction.

FIRE INSURANCE AND STOCK LAWS.

Section 18 provides for incorporation of forest fire insurance companies. In States where cattle are allowed to roam, provisions to stop this practice should be enacted.

FURTHER DUTIES OF FOREST COMMISSIONER.

Section 19 defines minor duties of the forest commissioner, namely, to coöperate with superintendents of schools and other educational institutions in awakening an interest in behalf of forestry and rational forest use.

Section 20 provides for salary and other expenses of the office of forest commissioner, which should be liberal in proportion to the responsibility of the office.

Section 21 repeals all acts and parts of acts inconsistent with provisions of this act.

EXTENT OF FOREST AREA.

In consequence of the various destructive agencies described, not only has the forest area dwindled down to less than 480,000,000 acres, but a large part of this area believed to be under forest is in a more or less devastated condition. If, therefore, the map of the State of Massachusetts, by the U. S. Geological Survey, for instance, exhibits over 50 per cent of the area of the State in forest, this has but little meaning for the question of future supplies, for fully one-third or more of this so-called forest is useless brush and waste land, which will not be productive in this or the next generation.

An exact census of the forest area in existence has never been made. The figures given have been approximations from various sources of information, more or less reliable, and hence much larger areas have been claimed to be in existence by those who deny the necessity of a conservative forest policy. It will, however, be found that, deducting the so-called treeless area—which does not contain forests of extent or value—the farm area not in forest, and as large a per cent of waste land as is reported in farms from the total area of the United States, the area that could possibly be in forest will not exceed 850,000,000 acres. Any-one familiar with the condition of the culled-over and burnt-over forest areas, and at the same time cognizant of what the lumber-producing capacity of a growing woodland may be, will readily admit that 50 per cent of this area may, to all intents and purposes of lumber production, for the next generation at least, be considered unavailable. It may then be safely assumed that we have hardly 25 per cent of our area in producing forest—a proportion that is reported for Germany; but our drafts on it for material exceed the consumption of Germany at least eightfold.

OWNERSHIP.

The ownership of the forest area is for the most part in the hands of private individuals. The policy for the single States or the United States to own lands, except for building, etc., and for eventual disposal, has not been germane to the spirit of the institutions of this country.

School lands, indemnity lands, swamp lands, and other lands which the General Government has given to the States, or which they have owned otherwise, have never been held for an income, except by their sale. The State of New York seems to be the first to make an exception, having set aside an area of nearly 1,000,000 acres in the Adirondack and Catskill mountains as a forest reserve; and a movement to extend this reserve over a larger area—3,000,000 acres, more or less—is strongly advocated. The administration of this reserve is, however, confined to protection without utilization, and forest management in any sense does not as yet exist, although the staff of the three forest commissioners includes, besides a secretary with assistants, a superintendent with assistant, inspectors, and surveyor, eleven foresters, who constitute, in fact, however, only a police force.

The General Government has also within the last two years been committed to a change of policy by the enactment of a law permitting the reservation of forest areas for permanent ownership by the Government. This policy will be discussed further on. Before this enactment several areas of public lands besides the Indian reservations had been reserved as military, timber, and water reservations, and as national parks; the former for temporary occupancy by troops to supply them with fuel, the latter for permanent ownership on account of natural wonders and scenery for the benefit of pleasure-seekers, or for health resorts, but not with the express purpose of preserving and improving forest conditions. These parks are at present—

	Acres.
Yellowstone National Park, Wyoming	2,288,000
Yosemite National Park, California	960,000
Sequoia National Park, about	100,000
General U. S. Grant National Park, about	3,000
Hot Springs Reservation, Arkansas	2,529

The area of the permanent forest reservations, proclaimed by the President of the United States will, before the close of the present administration, amount to nearly 13,000,000 acres, while the total area of public lands, classed as timber lands, may be in the neighborhood of 50,000,000 acres, the last estimate made in 1883 making the area 73,000,000 acres.

There are three classes of private forest owners: The farmers who have wood lots connected with their farms; the speculators, among whom may be included all those who hold forest property temporarily for the purpose of selling it to obtain the "unearned increment" from the third class, namely those who develop and utilize the forest resources—lumbermen and manufacturers.

The first class should be considered a safe and conservative one, holding forest property to the extent of from 35 to 40 per cent, and we might feel safe regarding the fate of this part of the forest area. Whatever attempt at rational forest management exists in the United States is found among the farmers. It is probable, however, that a large part of their forest property is held only for speculative purposes, and the opportunity of paying off indebtedness by sacrificing the wood lot is not unfrequently embraced. The forest land is not treated in a conservative manner, which arises from lack of conception of the true value of this part of the farm.

The speculators are harmless as far as forest conservancy goes—perhaps even an advantage to the country in keeping their holdings from utilization until a change in market conditions may make a more rational exploitation of the forest practicable. It is, then, the lumbermen, or those who make it a business to exploit the forest resources, to whom we must look for a forest policy. Here, again, we must distinguish between those who supply the raw material to others, engaged only in logging, and those who supply themselves, their mills, manufactures, charcoal kilns, etc. The latter might be expected to have conservative tendencies, and to some extent they do exhibit them in the care of their forest property; but their foresight usually does not reach beyond a few years, certainly not to the length of a "rotation"—the length of time it takes to mature trees; and, as to application of real forest management, the writer is not aware of any attempts worthy of notice.

Altogether, the general speculative spirit prevailing in all classes of society and business breeds instability, and is detrimental to anything that depends on decades and centuries for results, as does a forest growth. Those engaged in the logging business, purchasing only stumpage from others, are the ones that have the least regard for the future—the most wasteful and reckless methods of exploitation are theirs; after them, fire or the deluge.

To induce any forest owner to adopt rational and conservative forest management we should have to show him that it is directly profitable—profit, we must never forget, is the only incentive for private enterprise. Now, from the foregoing statements regarding market conditions and fire risks, it will have appeared that this is difficult, almost impossible, to do in a general way, and it is questionable whether in many, perhaps in most, localities forest management for the present can be shown to be profitable. The wanton waste and destruction, to be sure, is not profitable—certainly not to the nation at large—but forest management means more than abstaining from wantonness. It is not only a negative but a positive business. It means application of knowledge; it means expenditure for a manager and other requisites of an organized management; expenditures for protection; curtailment of present profits for the sake of a continued revenue; expenditure in the present for the sake of gain in the future.

There are two main objections on the part of forest owners to such expenditures; the first is, the hazard to which their property is exposed under our poorly administered laws, especially against damage from fire; the second is, that as long as forest supplies from virgin growth compete in the market with only the cost of harvesting and transportation placed upon them, there seems no money in the business, at least for the present, if there is an additional cost of production in the shape of expenditure for management to be placed upon it.

The lumberman, accustomed to carry on his business like the butcher, slaughtering his herd and finding his profit in the difference of the price he paid for the cattle and the price he got for the meat, is not readily turned into a forester, who like the breeder finds his profit in the sale of the young increase, treating his herd as the capital. Additional difficulty results from the absence of educated foresters, competent to advise and carry on a management under such difficult economic conditions. So that, even if the forest owner were willing to try the experiment, he would not be able readily to secure the manager.

The result of all these considerations is, that profitable exploitation of our forest resources and forest conservation or conservative forest management are at present more or less incompatible. At best, any scheme of introducing forest management would be an experiment, which few private forest owners would be willing to risk. Hence, where the preservation of forest conditions is of importance to the community, the community alone will be able to insure their preservation, for the community alone can afford to forego the immediate profits arising from conservative exploitation for the sake of an indirect object, that of favorable soil and water conditions. The community, or rather government, State or Federal, can alone afford to establish such an experiment, and after it has shown the methods to be employed, after it has offered the opportunity for the education in theory and practice of forest managers, there will be more inclination for private enterprise to follow suit.

THE FORESTRY MOVEMENT.

Having thus briefly sketched the conditions of the forest areas and the difficulties in the way of their rational use and management, it behooves us to inquire what methods have been pursued to bring about a more rational policy in regard to the same, and to interest people and governments in the art of forestry.

Although from early colonial times voices were heard, and occasionally enactments were made by legislatures, in behalf of a more conservative forest policy, and with a recognition of a special value in timber lands, it is only within the last twenty years that this recognition has become more general, as when the law of March 3, 1873, the so-called timber-culture act was passed by Congress, by which the planting to timber of 40 acres of land in the treeless territories conferred the title to 160 acres of the public domain. This law was not in existence ten years when its repeal was demanded, and finally secured in 1891, the reason being that, partly owing to the crude provisions of the law and partly to the lack of proper supervision, it had been abused and given rise to much fraud in obtaining title to lands under false pretenses. It is difficult to say how much impetus the law gave to bona fide forest-planting and how much timber growth has resulted from it. Unfavorable climate, lack of satisfactory plant material, and lack of knowledge as to proper methods, led to many failures; so that while the entries made during the years 1873 to 1878 comprised 3,821,843 acres, ten years from the last date (in 1888) the final acreage proved up was not more than 779,582 acres, or about 20 per cent, representing perhaps 175,000 acres planted; and if the same proportion had prevailed since, the acreage of groves originated under the timber-culture law might now be estimated at about 2,000,000 acres.

The encouragement given to timber-planting in the prairie States by legislative means (Minnesota, 1871; Illinois, 1874, offering bounty; Iowa, 1872, exemption from tax; Dakota, 1877, bounty and exemption from tax) has been of only indifferent success. Private interest of homesteaders and settlers, without State aid, has probably been as effective. In this direction the establishment of Arbor days through the States has perhaps been as stimulating as any other measure. From its inception by Governor J. Sterling Morton, and first inauguration by the State Board of Agriculture of Nebraska, in 1872, it has become a day of observance in nearly every State, until its adoption as a national holiday may be shortly expected. While, with the exception of the so-called treeless States, perhaps not much planting of economic value is done, the observance of the day has been everywhere productive of increased interest in tree growth and forest preservation.

The following table exhibits the condition of the Arbor-day movemen at the present time:

Arbor-day observance in the United States.

States and Territories.	First observed. Date.	First observed. By whose appointment.	When legally established.	Legal holiday.	Date of annual observance.	By whom fixed.
Alabama	1887	Supt. of Education.			Feb. 22	
Arizona	1890-'91	Legislature	1891	Yes	1st Fri. after Feb. 1.	Legislature.
Arkansas						
California	1886	Gen. Howard and others.			Variable	
Colorado	1885	Governor	1889	For schools.	3d Fri. in Apr.	Do.
Connecticut	1887	....do	1886		In spring	Governor.
Florida	1886	Governor			Jan. 8	Do.
Georgia	1891	Legislature	1890	For schools.	1st Fri. in Dec.	Legislature.
Idaho	1887	....do	1887	Yes	Last Mond. in Apr.	Do.
Illinois	1888	....do	1887			Governor.
Indiana	1884	Supt. of Pub. Instruction.			Oct., usually	Supt. of Pub. Instruction.
Indian Ter						
Iowa	1887	Supt. of Pub. Instruction.			Variable	Do.
Kansas	1875	Mayor of Topeka.			Apr., usually	Governor.
Kentucky	1886	Legislature	1886			Do.
Louisiana	1888-'89	State Supt. of Schools.			Option of parish boards.	
Maine	1887	Legislature	1887			Do.
Maryland	1889	....do	1884		Apr.	Do.
Massachusetts	1886	Village Imp. Soc.	1886		Last Sat. in Apr.	Legislature.
Michigan	1876	Governor	1885			Governor.
Minnesota	1876	State Forestry Assoc.				Do.
Mississippi	1892	State Board of Education.	1892			State Board of Education.
Missouri	1886	Supt. of Schools.	1889	For schools.	1st Fri. after 1st Tues. Apr.	Legislature.
Montana	1887	Legislature	1887		3d Tues. Apr.	Do.
Nebraska	1872	Board of Agric.	1885	Yes	Apr. 22	Do.
Nevada	1887	Legislature	1887	For schools.		Governor.
New Hampshire	1886	....do	1885			Do.
New Jersey	1884	....do	1884		Apr.	Do.
New Mexico	1890	....do	1891	For schools.	2d Fri. in Mar.	Legislature.
New York	1889	....do	1888		1st Fri. after May 1.	Do.
North Carolina	1893	....do	1893			Do.
North Dakota	1884	Governor			May	Governor.
Ohio	1882	....do	1882		Apr.	Do.
Oklahoma	1892	Supt. of Pub. Instruction.			Feb. 22	Supt. of Pub. Instruction.
Oregon	1889	Legislature	1889		2d Fri. in Apr.	Legislature.
Pennsylvania	1887	....do	1887			Governor.
Rhode Island	1887	....do	1886		Variable	Do.
South Carolina	(*)	Individual action.				
South Dakota	1884	Governor				Do.
Tennessee	1875	Normal College.	1887		Nov	County Supt.
Texas	1890	Legislature	1889	Yes	Feb. 22	Legislature.
Utah	1892	....do	1892	Yes	1st Sat. in Apr.	Do.
Vermont	1885	Governor				Governor.
Virginia	1892	Village Imp. Soc.				
Washington	1892	Agric. College				
West Virginia	1883	Supt. Pub. Instruction.			Fall and spring.	Supt. of Schools.
Wisconsin	1889	Legislature	1889			Governor.
Wyoming	1888	....do	1888	Yes		Do.

* Uncertain.

Private efforts in the East in the way of fostering and carrying on economic timber-planting should not be forgotten, such as the prizes offered by the Society for the Promotion of Agriculture, the planting done by the private landholders at Cape Cod, in Rhode Island, Virginia, and elsewhere. Altogether, however, these efforts have been sporadic and unsystematic and not on any scale commensurate with the destruction of virgin-forest resources.

Interest in the preservation and conservative use of our natural rest areas may be said to have been first systematically aroused when r. George B. Emerson and Dr. Franklin B. Hough, in 1873, engaged he attention of the American Association for the Advancement of cience to the subject, and a memorial from that association to Conress led to the appointment, in the centennial year of our existence, f Dr. Hough to make a detailed report on forestry, which was pubshed in 1877, followed by three other reports, and finally by the stablishment of a permanent Division of Forestry in the U. S. Deartment of Agriculture, for the purpose of investigating, experienting, and reporting upon forestry. While this was the first official ecognition of the importance of the subject, private interest associated self in the American Forestry Congress, which was convened at incinnati in 1882, called together by patriotic citizens, incited thereto y the representations of Baron von Steuben, a Prussian forest official, hen visiting this country on the occasion of the centennial celebraion of the surrender of Yorktown.

The association then formed has labored to arouse public interest in orestry matters and to influence Government action, and during the ecade of its existence has given impetus to many other private efforts n behalf of better forest management.

Thus State forestry associations were formed under its direct or indiect influence. The most thriving of these, the Pennsylvania Forestry Association, founded in 1886, maintains a useful periodical in the interst of forestry. State forestry associations exist also in Minnesota established as early as 1876), Colorado, Ohio, Kentucky, and New York, nd associations less comprehensive as to title, but not less active, xist in California, Dakota, South Carolina, and Maine, while several f the State horticultural societies make forestry a subject of discusion in their meetings and reports. Several of the State agricultural olleges have introduced the subject in their curriculum and have proessors of forestry, usually in connection with botany. In the absence f employment for forestry experts, the instruction in forestry proper, o be sure, can be only of very general nature.

Official recognition has been given to the subject in several States ot only by sending official delegates to the meetings of the American Forestry Association, but also by the appointment of forest commissions. These have been mostly commissions of inquiry, of temporary nature, o make reports on desirable legislation. Such commissions were apointed in New York in 1884, in New Hampshire in 1881 and again in 889, now endeavoring to commit the State to a purchase of the forest over of the White Mountains; in Vermont in 1884, in Michigan in 887, and in Pennsylvania in 1888.

The Forestry Bureau of Ohio, which has been continued since 1885, s also of an advisory and educational nature, and publishes biennial reorts. So is the office of superintendent of irrigation and forestry of North Dakota (1890), while the forest commissioner of Colorado (1885) nd the State Board of Forestry of California (1885) were charged with xecutive duties. The former was only poorly provided with the means of executing his official duties, which were mainly to organize a service or the protection of forests against fire and to keep alive an interest n forestry matters; while the latter, with ample means, should have been able to do much for the forestry interests of the State.

The forest commissioner of Maine is charged principally with the execution of the forest-fire laws enacted in 1891, which may be conidered the best effort in that direction.

The State of New York alone since 1885 has, as stated before, an a ministrative forest commission with forests to manage, having charge the Adirondack and Catskill Forest Reserves. There is, however, s far but little application of the art of forestry within the power of th commission. The reports of these various commissions have done muc to stimulate interest in forestry matters.

Finally, I should mention two attempts known to me of private er terprise having in view the introduction of forest management. Th one in the Adirondacks, contemplated by the Adirondack League Clul in which over 100,000 acres of excellent virgin timber land are to b brought under systematic management, has not yet progressed fa enough to speak of it as a fact; the other, begun in the mountains o North Carolina by a rich private owner, lacks, unfortunately, the op portunities of serving the contemplated purpose, namely, to be an ob ject-lesson of the profitableness of forestry. Being applied to a fores area severely culled and away from markets, that might take inferio material, such demonstration can hardly be expected in the near future

Altogether, as I have pointed out elsewhere, profitableness in fores management is rarely immediate, but lies in the future rather than in the present. Where, therefore, the maintenance of forest cover for it influence on water and soil conditions is of importance, the community alone which can forego or wait for profits can be successful. It is fo this reason that I consider as the most important step toward a proper forest policy the plan inaugurated March 3, 1891, and followed up by the present Administration in a statesmanlike manner, establish ing forest reservations in the public timber lands. Under this policy fourteen reservations, aggregating 13,000,000 acres, have been estab lished, while a number of other locations have been temporarily with drawn from the market and subjected to examination prior to their final permanent reservation.

The year 1892, the quadro-centennial year of the discovery of this continent, during which most of these reservations were at least prepared, will, therefore, in the forestry annals of the future, mark a new era for this country.

The reservations so far established by proclamation of the President are as follows:

In Arizona.—Grand Cañon Forest Reserve, in Coconino County, containing about 1,851,520 acres.

In California.—San Gabriel Timber Land Reserve, in Los Angeles and San Bernardino counties, containing 555,520 acres; Sierra Forest Reserve, in Mono, Mariposa, Fresno, Tulare, Inyo, and Kern counties, containing about 4,096,000 acres; San Bernardino Forest Reserve, in San Bernardino County, containing 737,280 acres; Trabuco Cañon Forest Reserve, in Orange County, containing 49,920 acres.

In Colorado.—White River Plateau Timber Land Reserve, in Routt, Rio Blanco, Garfield, and Eagle counties, containing 1,198,080 acres; Pike's Peak Timber Land Reserve, in El Paso County, containing 184,320 acres; Plum Creek Timber Land Reserve, in Douglas County, containing 179,200 acres; The South Platte Forest Reserve, in Park, Jefferson, Summit, and Chaffee counties, containing about 683,520 acres; Battlement Mesa Forest Reserve, in Garfield, Mesa, Pitkin, Delta, and Gunnison counties, containing 858,240 acres.

In New Mexico.—Pecos River Reserve, in Santa Fe, San Miguel, Rio Arriba, and Taos counties, containing 311,040 acres.

In Oregon.—Bull Run Timber Land Reserve, in Multnomah, Wasco, and Clackamas counties, containing 142,080 acres.

In Washington.—The Pacific Forest Reserve, in Pierce, Kittitas, Lewis, and Yakima counties, containing 967,680 acres.

In Wyoming.—Yellowstone National Park Timber Land Reserve, lying on the south and east of the Yellowstone National Park, containing 1,239,040 acres.

NOTE.—The areas given are the estimated aggregate areas lying within the exterior boundaries of the reservations. The lands actually reserved are only the vacant, unappropriated public lands within said bounderies.

While the primary object of these reservations is to insure favorable water conditions in the regions which depend for their fertility upon irrigation, ultimately it will not be practicable to exclude such areas and their resources from use.

When, therefore, the immediate necessity of providing for the special protection of these permanent Government reservations against fire and depredation has been satisfied, there will have to be developed methods for the rational use and management in perpetuity of their timber resources and other useful material, which must ultimately lead to the well-regulated forest administration contemplated in the bill now before Congress (S. 3235), which the American Forestry Association has advocated.

We may, then, before the end of the century expect to see the first phase of the history of forestry development in the United States ended by having the Government fully committed to a sound forest policy. Such a policy will induce imitation on the part of smaller communities, and finally of private landholders, especially as with the settlement of the country greater stability will lead to permanent investments and induce conservative management, when also with the rapid destruction of virgin supplies the profitableness of forest management will have become more apparent.

Imports of wood and certain wood products for home consumption during the years ending June 30, 1891 and 1892.

Articles.	1891.		1892.	
	Quantity.	Value.	Quantity.	Value.
Free of duty.				
Firewood....cords..	171,762	$360,090	198,850	$411,482
Logs and round timber	....	1,272,427	....	1,188,797
Railroad ties....number..	2,287,411	399,207	748,520	131,295
Shingle and stave bolts	....	89,198	....	44,387
Handle and head bolts	....	72,530	....	59,573
Ship timber	....	81,159	....	31,721
Ship planking	....	30,761	....	79,622
Hop poles	....	11,562	....	18,412
Wood for pulp-making	....	130,747	....	230,959
Charcoal	....	56,669	....	48,395
Cabinet woods; cedar, ebony, mahogany, etc	....	1,802,703	....	2,234,003
Corkwood or bark	....	1,219,008	....	1,368,244
Hemlock bark....cords..	57,251	274,426	53,018	256,346
Bamboos, rattans, canes, etc	....	1,080,859	....	1,198,813
Briar root or briar wood, and the like, only partially manufactured	....	15,141	....	39,185
Ashes	....	42,624	....	54,855
Fence posts	....	30,779	....	31,351
Tar and pitch of wood....barrels..	2,981	12,597	768	3,352
Turpentine, spirits of....gallons..	2,889	1,219	9,337	3,470
Turpentine, Venice....pounds..	70,185	8,138	36,642	3,992
Pitch, Burgundy....do....	212,627	3,520	281,430	4,386
Total free	....	7,025,364	....	7,442,640
Dutiable.				
Wood, unmanufactured, not specially provided for..	....	13,616	....	32,655
Timber—				
Used for spars, wharves, etc....cubic feet..	1,207	153	12,295	2,301
Hewn and sawed....do....	556,969	34,852	445,804	54,570
Squared or sided, not specially provided for.do....	117,782	35,947	14,036	1,392
Lumber—				
Boards, planks, deals, and other sawed lumber....M feet..	373,373	4,240,145	482,339	5,588,948
Sawed lumber, not otherwise specified....do....	325,967	3,576,638	150,184	1,416,331
Sawed boards, planks, deals—cedar, ebony, etc..	176	6,602	222	5,117
Clapboards....M..	5,558	88,254	6,259	99,187
Hubs, posts, laths, and other rough blocks	....	50,828	....	29,823
Laths....M..	293,142	345,602	259,157	328,359
Pickets and palings....M..	15,856	66,597	3,157	22,679
Cedar poles, posts, and railroad ties	450,216	72,535	2,115,986	259,583
Shingles....M..	259,897	553,274	362,551	731,299
Shooks	....	107,586	....	62,981
Staves	....	438,063	....	551,575

Imports of wood and certain wood products for home consumption, etc.—Continued.

Articles.	1891.		1892.	
	Quantity.	Value.	Quantity.	Value.
Dutiable—Continued.				
Manufactures, all other—				
Barrels or boxes containing oranges, lemons, etc., apart from contents		522,364		467,514
Casks and barrels, empty		1,545		919
Chair cane or reeds, manufactured		235,773		181,337
Cabinetware and household furniturd		453,041		411,712
Osier or willow, prepared for manufacture		93,207		82,633
Osier or willow, manufactures of		223,335		123,820
Wood pulp ... pounds	94,786,416	1,895,677	92,155,840	1,831,231
Veneers of wood		884		8,264
Bark extract, for tanning ... pounds	772,020	15,187	12,973	408
Sumac ... do	13,811,325	312,611	12,724,703	294,744
Corks and cork bark, manufactured		432,055		321,480
Matches		88,066		83,157
Frames and sticks for umbrellas		91,758		92,437
All other manufactures of wood or of which wood is the component of chief value		901,501		1,277,644
Total dutiable		14,897,696		14,364,100
Total imports		21,923,060		21,806,740

Exports of wood and certain wood products during the year ending June 30, 1892, by districts of country whence exported.

	Districts.*				
	I.	II.	III.	IV.	Total.
Raw materials:	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Boards, deals, planks, etc	3,089,115	2,220,327	2,962,732	1,400,319	9,672,493
Joists and scantling	16,953	157,136	43,739	10,685	228,513
Hoops and hoop poles	74,626	13,465		131	88,222
Laths	2,337	75	620	14,685	17,717
Palings and pickets	76	1,183	293	4,707	6,259
Shingles	5,841	39,671	13,171	29,309	87,992
Shooks	691,867	46,052	1,899	41,719	781,537
Staves	946,210	709,952	551,578	3,976	2,211,716
All other lumber	657,304	29,651	250,687	113,755	1,051,397
Timber (sawed)	37,235	259,653	1,844,333	531,933	2,673,154
Timber (hewn)	242,770	57,986	682,818		983,574
Logs and other round timber	875,371	740,502	268,985	38,746	1,923,604
Firewood	1,604				1,604
Rosin	652,777	2,755,811	8,123	1,748	3,418,459
Tar	38,534	12,078	226	1,679	52,417
Turpentine and pitch	15,965	2,217	38	116	18,336
Spirits of turpentine	445,249	4,050,533	429	4,510	4,500,721
Bark and bark extract	84,268	155,440			239,708
Total raw materials	7,878,102	11,251,732	6,621,671	2,198,018	27,957,423
Manufactures:					
Agricultural implements	3,682,784	19,042	65,753	27,404	3,794,983
Carriages and horse cars	1,799,344	550	73,954	70,322	1,944,170
Cars, passenger and freight	1,145,473	95,419	56,565	22,808	1,320,265
Matches	48,657	76	3,395	21,537	73,666
Organs	748,938	19,970	1,573	2,101	772,582
Doors, sash, and blinds	191,045	633	12,124	92,116	295,918
Moldings, trimmings, etc	169,623	14,592	1,423	16,951	202,589
Hogsheads and barrels, empty	281,533	326	5,162	3,092	290,113
Household furniture	2,751,111	48,114	112,261	178,660	3,090,146
Wooden ware	326,991	27,197	2,289	76	356,553
All other wood manufactures	1,551,013	134,626	54,647	87,182	1,827,470
Total manufactures	12,696,514	360,545	389,146	522,249	13,968,455
Total exports	20,569,217	11,612,277	7,010,817	2,720,267	41,925,878

* District No. 1 includes all of the United States north of Baltimore and east of the Rocky Mountains. District No. 2 includes the territory having its outlet by the South Atlantic ports. District No. 3 includes the territory adjacent to the Gulf ports. District No. 4 embraces that portion of the United States bordering on the Pacific Ocean.

Exports of wood and wood products from the United States for the twelve months ending June 30, 1891 and 1892.

Articles.	1891.		1892.	
	Quantity.	Value.	Quantity.	Value.
Agricultural implements:				
Mowers and reapers		$1,579,976		$2,372,938
Plows and cultivators		596,728		597,735
All other, and parts of		1,042,426		1,021,310
Bark and extract of, for tanning		241,382		239,708
Carriages and horse cars, and parts of		2,015,870		1,944,170
Cars, passenger and freight, for steam railroads ... number	3,902	2,885,250	1,680	1,320,265
Ginseng ... pounds	283,000	959,992	228,916	803,529
Matches		73,220		73,666
Organs ... number	14,498	954,507	11,856	772,582
Rosin ... barrels	1,790,251	3,467,199	1,950,214	3,418,459
Tar ... barrels	17,265	39,094	22,377	52,417
Turpentine and pitch ... barrels	8,541	17,180	8,739	18,336
Turpentine, spirits of ... gallons	12,243,621	4,668,140	13,176,470	4,500,721
Firewood ... cords	2,061	7,026	423	1,604
Boards, deals, and planks ... M feet	613,406	9,916,945	592,596	9,672,493
Joists and scantling ... M feet	11,324	155,114	16,131	228,513
Hoops and hoop poles		60,502		88,222
Laths ... M	7,976	20,799	7,893	17,717
Palings, pickets, and bed slats ... M	1,352	13,479	640	6,259
Shingles ... M	42,463	116,868	31,198	87,992
Shooks:				
Box		199,674		195,618
Other ... number	316,242	450,492	412,308	585,919
Staves and headings		2,404,213		2,211,716
All other lumber		886,133		1,051,397
Timber:				
Sawed ... M feet	214,612	2,549,411	235,550	2,673,154
Hewn ... cubic feet	6,990,073	1,227,960	6,736,446	983,574
Logs and other timber		2,274,102		1,923,604
Doors, sash, and blinds		338,263		295,918
Moldings, trimmings, and other house finishings		140,670		202,589
Hogsheads and barrels, empty		240,430		290,113
Household furniture		2,956,114		3,090,146
Wooden ware		387,823		356,553
All other wood manufactures		1,924,022		1,827,470
Total		41,811,004		42,729,407

REPORT ON CHICKAMAUGA NATIONAL PARK.

During the year the chief of this division made an inspection of the Chickamauga National Park, and the following is the text of his report:

GENTLEMEN: Pursuant to your invitation, through the Hon. the Secretary of War, and under instructions of the Hon. the Secretary of Agriculture, I have made a cursory inspection of the woodlands which form the Chickamauga National Park, with a view to advising in regard to the most suitable manner of treating the same, and herewith submit to you in brief the result of my inspection and conclusions.

THE CONDITIONS.

The Chickamauga National Park lies on two geologic formations, which predicate a difference of soil. For the larger part it is situated on a limestone base known as the Chickamauga Limestone, the stratification of which is almost horizontal; a smaller part to the west lies on a dolomitic limestone, known as the Knox Dolomite, with a more inclined stratification. The residual soils resulting from these two formations differ in composition and physical conditions. The dolomite furnishes a more fertile and usually deeper soil of red clays mixed with cherty gravel, while the limestone proper disintegrates into a stiff blue clay, which usually does not reach great depth, and hence is less fertile, although here and there capable of a fine tilth and good crop results. Due to the varying depths of the soil on such formations and its physical conditions is a noticeable variation in the character and development of the timber growth.

A further difference may also be noted in the species composing the forest as well as their growth along the few water courses and gulches, where, in addition to greater depth and finer soil, water conditions are also more favorable.

The present condition of the timber growth in general—no attempt has been made to go into details—is not what it was at the time of the battle thirty years ago, and can only be understood by reference to the conditions then prevailing. Before the war these grounds were mostly pasture lands for large herds of cattle and horses; the timber growth was thinned out and the underbrush kept down, only some old timber giving the shade under which the grass thrives in the sunny South. The tramping and browsing of the stock, probably assisted by occasional burning over, kept the woodland in a park-like condition like the so-called oak openings.

The consequence of such treatment is a destruction of the natural vegetable mold, a compacting of the soil, a consequent more rapid dessication and final deterioration of the land, which shows itself in top dryness of the old timber and slow growth of any young timber that may spring up, until the mold has been reëstablished and the evaporation checked by a denser cover.

After the war, the stock-breeding industry being destroyed, an undergrowth started, making more or less rapid growth according to soil and light conditions regulated by the denser or thinner stand of the old timber. The old growth consists mainly of oaks, the black jack and post oak prevailing, with Spanish oak and red oak—the natives confound the two—in spots old loblolly and occasionally shortleaf pines are found scattered through the woods, and the former especially form a large proportion in the young growth which has sprung up in the oak openings. Along the water courses, ravines, and bottoms may be found; in addition, elms, water oaks, willow oaks, sweet gum, beech, maple, etc. While only here and there a few old hickories are found, in the young growth this timber represents quite a fair proportion, together with the oaks and pines.

The old timber for the most part is not of much value, except in a few localities. Much of it is top dry, or with tops broken off, the trunks diseased.

The blackjack, as is well known, is not useful, except for firewood and charcoal; the post oak would furnish at least good railroad timber and fence posts, and the few old pines would furnish fair lumber. Altogether, however, not much of value exists in the old timber, except for home consumption as needed.

The young growth is as thrifty as can be expected under the conditions—absence of a good humus cover and shade from the old timber—only on the thinner and drier portions is it stunted and of little promise A growing prevalence of pine is noticeable in the young growth and abandoned fields are entirely occupied by this kind.

THE PROBLEM.

The objects of the park being primarily to restore and preserve as much as possible the conditions existing during the time of battle and to facilitate the study of topography and military operations, the consideration of the requirements of proper forest management becomes only secondary and subservient to the first object.

To be sure, the maintenance of natural conditions for a length of time can be only partially accomplished, nor would it be rational to attempt it beyond certain limits. Those who remember the field as it was exactly and to whom the exactitude of conditions is a natural matter of sentiment to be gratified, will have ceased to visit the ground within the next twenty-five or thirty years. After that, if only the relation of pasture, field, and forest can be maintained, it will suffice, albeit the character of the forest growth be changed and a better young growth shall have taken the place of the old and worthless, in character and condition worthy of the civilization we expect will then have been attained even in our woodlands.

The problem, then, may be formulated as follows: To gradually improve and regenerate the wood growth making the period of conversion not less than thirty years, preserving the most important strategic points of interest longest in original conditions as regards old growth and opening up the young growth, for the purpose of establishing vistas, as far as absolutely necessary and with a view of its ultimately taking the place of the original growth.

THE SOLUTION.

With the exception of a few places, where replanting is proposed in order to restore forest growth which has been cleared away since war times, the manipulations of the forester will have to be restricted to what may be called improvement cuttings. These should be made in the young growth with the following general principles in view:

(1) It is much easier to cut and destroy than to replace and restore; therefore all cutting should be done with caution and in a conservative manner. It is better to go twice and three times over the same ground with the ax than to thin severely at once, by which operation the soil is deteriorated and the tree growth further stunted, besides undesirable undergrowth is invited. Every consideration urges that the soil should be kept constantly and densely shaded.

(2) It is desirable to restrict and reduce the less valuable and encourage the more valuable kinds, especially the hickories and post oaks and to some extent the pines, which are soil improvers and will form a desirable mixture with the other two. The black jack, on the contrary, should be gradually eradicated; the red and Spanish oak only tolerated where the crown cover necessitates them.

(3) In determining which trees to cut and which to leave, besides the consideration of the species, it is necessary to observe the condition of the crown cover; the endeavor should be not to interrupt this to any great extent, for it is the shade which the interlocking dense leaf canopy exerts that insures improvement of soil conditions and at the same time tends to keep down undergrowth; this is desirable in order to keep the vistas open.

The workmen should therefore be trained to look up to the top and see whether the tree they are about to cut takes any prominent part in making shade. This is quite readily learned, and soon the axmen will themselves classify those trees that are already out of the race with their competing neighbors, being shaded out and of no value in maintaining shade, which may be removed without hesitation; those that form with their tops a part of the general leaf canopy, but not an important one, and which, if of an inferior kind, may also be removed, but if of the favored species and of promising growth may be left, and should be favored by the removal of their overcrowding neighbors, judgment being required in the selection; lastly, those trees which form the principal shade, which should be disturbed only for good reasons, such as misshapen growth, diseased condition, or conditions other than the forest management.

To regulate the cutting by either number of individuals or diameters fails of accomplishing its objects, and is hardly any more readily obtained from the unskilled workman than the judgment in making proper selection.

(4) Vistas are obstructed mainly by the number of stems; they may, therefore, in most cases be opened without disturbing the crown cover by the simple removal of the overgrown individuals. It should also be borne in mind that the near objects obstruct the view to a greater extent than those farther removed, hence along roads and paths the thinning out of the undergrowth may have to be done more severely than is desirable from forestry considerations, while farther in the operation may be more conservative.

(5) Where it is desired to keep the undergrowth down, the cutting is best done in June and July, when the stumps will be killed and sprouting prevented.

The old growth is for the most part an obstruction to the young growth, and would, if forest management were the only consideration, have to be removed wherever sufficient young growth is established to insure regeneration. As it is, its conservation being of historic import, at least for a time, the removal should be restricted to those trees that are positively unsightly and misshapen, and such leaning and spreading trees as are an undue hindrance to the young growth, especially if they are of the inferior kinds. On the portions of the field more remote from the centers of interest, the operations in the old growth might be carried on with greater consideration of improving forest conditions. A regular cutting for regeneration in such places as, for instance, Snodgrass Hill, is a matter of consideration for future years.

Wherever replanting of fields is contemplated, the simplest plan would be to gather hickory nuts and post-oak acorns and sow them in the fall in trenches; loblolly-pines will find their way into such a plantation naturally. Other plans may be suggested if desired.

I need not say anything regarding the necessity of keeping out fire and restricting the running of cattle, which latter compacts the soil undesirably. On the other hand, pigs in moderate numbers are not unwelcome cultivators, being frequently employed as such to open the ground and plant acorns and nuts in the oak and beech forests of Europe.

CONCLUSION.

In conclusion, I would suggest that the policy here outlined, although of a simple nature, can only be properly and successfully carried out by the employment of stable and skillful laborers, who would take an interest in the park and its twofold objects as here conceived and gradually develop into a corps of expert foresters. There is no better opportunity than on the park property to establish such a class from among the tenants of the various farms which constitute part of its area. Since the park is not intended primarily to be managed for revenue, it would be wise to select the tenants with such an object in view, and by low rents induce a desirable class of woodmen to settle on these farms and to devote themselves to the interests of the park and ultimately of rational forest management.

In this way a much-needed object lesson for our people of the manner in which our maltreated woodlands may be recuperated and put into better and more profitable condition could be inaugurated. This would be of even more value to our people than the preservation of war memories, however valuable their influence in educating proper patriotic spirit.

Respectfully submitted.

B. E. FERNOW,
Chief of Division of Forestry.

The COMMISSIONERS OF THE CHICKAMAUGA NATIONAL PARK.

ADDITIONS TO THE FOREST FLORA OF NORTH AMERICA AND NECESSARY CHANGES IN NOMENCLATURE OF IMPORTANT TIMBER SPECIES, WITH NOTES.

By GEORGE B. SUDWORTH, *Botanist of the Division.*

Magnolia fœtida (L.) Sargent, Gard. & For. ii. 615 (1889). MAGNOLIA (BULL BAY).
Syn. *M. Virginiana*, var. *fœtida*, Linn. Spec. Pl. 536 (1753).
M. grandiflora, Linn. op. cit. ed. 2, 755 (1762–'63).

Since *M. fœtida* has been taken up as the oldest specific name for this magnolia, there has been considerable protest against its maintenance. The greatest objection raised thus far, however, is that *fœtida* is inapplicable as a specific name to a sweet-scented species. But the practice of changing regularly published, although unfortunately misapplied, names to those thought to be more suitable in accordance with present knowledge of the species, is dangerous, and threatens stability by sanctioning changes too often dependent upon personal likes or dislikes rather than upon the strict law of priority. *M. fœtida*, founded on Linnæus' *M. Virginiana* var. *fœtida*, is sufficiently characterized to prevent confusion with any other known magnolia, and, as the oldest designation, should be maintained. The subsequent renaming, by Linnæus, to *M. grandiflora* was without authority, and an arbitrary right usurped by Linnæus, at the present time neither in accordance with existing law nor just usage. Once published, a name is common property and inviolable, even by its author.

Magnolia acuminata var. *cordata* (Michx.) Sargent, Am. Jour. Sc. 3d ser. xxxii. 473 (1886).
Syn. *M. cordata* Michx. Fl. Bor. Am. i. 328 (1803).

YELLOW-FLOWERED CUCUMBER TREE.

As existing in cultivation this form is comparatively distinct from *M. acuminata*, notably in the size and form of leaves, color and size of flowers; but as found growing wild it is far less distinct, only occasional variable forms being found differing from *M. acuminata*, and chiefly in its smaller and yellower flowers.

Magnolia tripetala Linn. Spec. Pl. ed. 2, 756 (1762–'63).
Syn. *M. Virginiana*, var. *tripetala* Linn. Spec. Pl. ed. 1, 536 (1753).
M. Umbrella Lam. Encyc. Meth. Bot. iii. 673 (1789).

UMBRELLA TREE.

The long-maintained *M. Umbrella* gives place to Linnæus' older name, *M. tripetala*, which is perfectly recognizable.

TILIACEÆ.

Tilia pubescens Ait. Hort. Kew. ii. 229 (1789).
Syn. *T. Americana*, var. *pubescens*, Loudon, Arb. 374 (1838).

DOWNY LINDEN.

The characters possessed by this plant are found to be sufficiently constant and distinct from those of *T. Americana* to warrant raising it to specific rank.

SAPINDACEÆ.

Æsculus octandra Marshall, Arbustum Am. 4 (1785).
Syn. *Æ. flava* Aiton Hort. Kew. i. 494 (1789).

YELLOW BUCKEYE.

Marshall's *Æ. octandra* belongs clearly to this plant, and, as the oldest, is now maintained in place of the better-known *Æ. flava*.

Var. *hybrida* (*DC.*) Sargent, Silva N. A. ii. 60 (1891).
Syn. *Æs. hybrida* DC. Hort. Monsp. 75 (1813).
Æs. flava, var. *purpurasceus* Gray, Man. ed. 5, 118 (1867).

PURPLE-FLOWERED BUCKEYE.

The original specific name for this form is now maintained in varietal rank, in place of Dr. Gray's *purpurascens*, which seems to have been created without necessity.

Acer Saccharum Marshall, Arbustum Am. 4 (1785).
Syn. *A. saccharinum*, Wang., Nordam. Holz. 26, t. 11, f. 26 (1787), not Linn.
A. barbatum Mx., Fl. Bor. Am. ii. 253 (1803).

SUGAR MAPLE.

We concur with Dr. Britton, who has already taken up, in his Catalogue Plants New Jersey, Marshall's *A. Saccharum*, the oldest name for our sugar maple. Prof. Sargent considers it unsafe, but, aside from Marshall's unscientific description, we can see no reasonable doubt as to the identity of this name.

Var. *nigrum* (Michx. f.) Britton Trans. N. Y. Acad. Sci. ix. 9 (1889).

BLACK MAPLE.

Syn. *Acer nigrum* Mx. f. Hist. Arb. Am. ii. 238, t. 16 (1810).
A. saccharinum Wang., var. *nigrum* T. & G., Fl. N. Am. i, 248 (1838).
A. barbatum Michx., var. *nigrum* Sarg. Gard. & For. iv. 148 (1891).

Var. *Floridanum* (Chapm). FLORIDA MAPLE.
Syn. *Acer saccharinum* Wang., var. *Floridanum* Chapm., Fl. So. States, 81 (1865).
Var. *grandidentatum* (Nutt. MSS. in T. & G.). LARGE-TOOTHED MAPLE.

Syn. *Acer grandidentatum* Nutt. MSS. in T. & Gr., Fl. N. A. i. 247 (1838).
A. barbatum Mx., var. *grandidentatum* Sarg. Gard. & For. iv. 148 (1891.)

Prof. Sargent is followed in reducing *A. grandidentatum* to a variety of the sugar maple, as a careful study of the variable forms to be here referred thoroughly supports this decision.

Acer saccharinum Linn. Spec. Pl. ed. 1, 1055 (1753). SILVER MAPLE.
A. dasycarpum Ehrhart, Beitung. iv. 24 (1789).

There is no doubt as to the identity of the Linnæan name for this maple, and as the oldest, it is maintained in the place of the later *A. dasycarpum*.

Negundo Negundo (Linn.) Sudworth, Gard. & For. iv. 166 (1891). BOX-ELDER.
Syn. *Acer Negundo* Linn., Spec. Pl. ed. 1, 1056 (1753).
Negundo aceroides, Moench, Meth. 334 (1771).

Strict adherence to the law of priority makes it necessary to maintain this duplicate name, a usage already adopted by the zoölogists and by Prof. Sargent in the Silva. The latter author prefers, however, in the case of the box-elder to follow Linnæus in maintaining it in the genus Acer; it is thought, however, that the diœcious habit and compound leaves of these plants furnish abundant ground for keeping up the well-known genus Negundo.

Cladrastis lutea (Mx. f.) Koch, Dend. i. 6 (1869). YELLOW WOOD.
Syn. *Virgilia lutea* Mx. f., Hist. Arb. Am. iii. 266, t. 3 (1813).
C. tinctoria Raf., Neogen. 1. (1825).

There is no question as to the identity of Michaux's *V. lutea*, and Koch is here followed in maintaining the oldest specific name *lutea* under Cladrastis which was neglected by Rafinesque when he applied *C. tinctoria*.

Gymnocladus dioicus (Linn.) Koch, Dend. i. 5 (1869). KENTUCKY COFFEE TREE.
Syn. *Guilandina dioica* Linn. Spec Pl. ed. 1, 381 (1753).
Gymnocladus Canadensis Lam. Encyc. Meth. Bot. i. 773 (1783).

Linnæus' original specific name *dioica*, the oldest applied to this plant, is here maintained as proposed by Koch, who first combined it under Gymnocladus.

Galeditsia * *aquatica* Marshall, Arbust. Am. 54 (1785). WATER LOCUST.
Syn. *G. monosperma* Walter, Fl. Car. 254 (1788).

Marshall's name for this locust has been shown to be the oldest, and being well founded, should be maintained, as already taken up in Gray's New Manual and by Prof. Sargent in his Silva.

CORNACEAE.

Nyssa aquatica Linn. Spec. Pl. ed. 2, 1058 (1753). BLACK GUM.
Syn. *N. sylvatica* Marsh, Arb. Am. 97 (1785).

The establishment of Linnæus' original *N. aquatica*, the earliest name applied to the black gum, is somewhat difficult, in that it includes, by citation of Catesby's t. 60 (Nat. Hist. Carolina, 1731—), another distinct species, *N. uniflora*. But the first two characterizations, in order on the page, upon which Linnæus founds his *N. aquatica* (1st "*Nyssa foliis integerrimis*;" and 2nd "*Nyssa pedunculis multifloris*") may well apply to the black gum, and are sufficient to establish the name, since the first is cited from his own work (Hort. Cliff.). The convenient designation under this name, in varietal rank, of the tree commonly found growing in water at the South is scarcely to be recommended, since there are no good characters to separate the aquatic plant from the upland form, when the numerous connecting forms are carefully studied.

OLEACEÆ.

Fraxinus velutina Torr., Emory's Rep. 149 (1848). LEATHER-LEAVED ASH.
Syn. *F. pistaciæfolia* Torr. Pac. R. R. Rep. iv. 128 (1856).
F. coriaceæ Watson, Am. Nat. vii. 302, in part (1873).
F. pistaciæfolia, var. *coriacea*, Gr., Syn. Fl. N. A. ed. 1, ii. Pt. 1, 74 (1878).

The oldest name applied to a form of this ash is the *F. velutina* of Torrey. Dr. Gray (loc. cit.) considered this particular form a variety of the type of Torrey's *F. pistaciæfolia*, taking up Watson's *coriacea* for it, and citing Torrey's *F. velutina* as a synonym of the variety. But there seems to be no good reason why the older name (*velutina*) should not have been taken up as a name for the variety, which, if this relationship should be tenable, would give *F. pistaciæfolia*, var. *velutina* (Torr.). But from what is at present known of this plant, it seems advisable to maintain it as a species and to unite all the forms under Torrey's older name, *F. velutina*.

Fraxinus Pennsylvanica Marshall, Arb. Am. 51 (1785). RED ASH.
Syn. *F. pubescens* Lam. Encyc. Meth. Bot. ii. 548 (1786).

Koch (Dendrologie ii. 253) has taken up Marshall's name, the oldest applied to the species; and Dr. Gray (Syn. Fl. ii. 1, 75) cites it as a synonym of Lamarck's later *F. pubescens*, so that it appears to have been well acknowledged as an equivalent. Marshall's description of the fruit of this ash, one of the most important characters, is sufficiently definite to indicate that he had in hand our red ash, and it seems therefore advisable to restore his name.

Fraxinus expansa Willdenow, Berl. Baumz. 150 (1796). GREEN ASH.
Syn. *F. viridis* Michx. f. Hist. Arb. iii. 115, t. 10 (1813).

There appears to be no reason for not taking up Willdenow's *F. expansa* for this species, antedating, as it does, Michaux's *F. viridis* by seventeen years.

Fraxinus nigra Marshall, Arb. Am. 51 (1785). BLACK ASH.
Syn. *F. sambucifolia* Lamarck, Encyc. Meth. Bot. ii. 549 (1786).

Marshall's description of the black ash is unmistakable, and as his *F. nigra* was published one year earlier than Lamarck's *F. sambucifolia*, it should replace the latter.

BIGNONIACEÆ.

Catalpa Catalpa (Linn.) Sudworth, Gard. & For. iv. 166 (1891). COMMON CATALPA.
Syn. *Bignonia catalpa* Linn. Spec. Pl. ed. 1. 622 (1753).
C. bignonioides Walter, Fl. Car. 64 (1788).

Strict adherence to the law of priority demands that Linnæus' original specific name *Catalpa* be taken up under the genus Catalpa.

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* Linnæus' uniform spelling of this genus is adopted in preference to the later modification by authors to *Gleditschia* (in honor of Dr. Gleditsch), which is without warrant.

URTICACEÆ.

Ulmus pubescens Walter, Fl. Car. 111 (1788). SLIPPERY ELM.
Syn. *U. fulva* Michx., Fl. Bor. Am. i. 172 (1803).

There is no doubt that Walter's *U. pubescens* refers to our slippery elm, and as the oldest name applied to it should replace the much later *U. fulva* of Michaux.

Ioxylon Rafinesque (1817) = *Maclura* Nuttall (1818).

Ioxylon pomiferum Raf., Am. Month. Mag. ii. 118 (1817). OSAGE ORANGE.
Syn. *Maclura aurantiaca* Nutt., Gen. ii. 234 (1818).

Prof. Greene (Pittonia ii. 120, 1890) has pointed out that Rafinesque's genus Ioxylon is one year older than Nuttall's Maclura and proposes that Rafinesque's name, *I. pomiferum,* should replace the better known *M. aurantiaca* of later date.

Hicoria Rafinesque (1817) = *Carya* Nuttall (1818).

Dr. Britton (Bull. Torr. Bot. Cl. xv. 277, 1888) calls attention to the fact that Rafinesque's Hicoria (his "Scoria," 1808, being supposed to be a misprint for Hicoria) should replace Nuttall's later genus Carya, and has transferred, under their oldest specific names, all the known species to this genus. Dr. Otto Kuntze, ignoring or overlooking Dr. Britton's elaboration, has likewise proposed (Rev. Gen. Pl. ii. 637, 1891) Rafinesque's original spelling, Scoria. There is abundant evidence to show, however, that Rafinesque by later references to his genus did not intend to write Scoria, but Hicoria.

Hicoria Pecan (Marsh.) Britton, op. cit. 282 (1888). PECAN.
Syn. *Juglans Pecan* Marshall, Arb. Am. 69 (1785).
Carya olivæformis Nutt., Gen. ii, 221 (1818).

Hicoria ovata (Miller) Britton, op. cit., 283 (1888). SHAG-BARK HICKORY.
Syn. *Juglans ovata* Mill. Gard. Dic. ed. 8, No. 6 (1768).
C. alba Nutt., Gen. loc. cit. (1818).

Hicoria sulcata (Willd.) Britton, loc. cit. (1888). SHELL-BARK HICKORY.
Syn. *Juglans sulcata* Willdenow, Berl. Baumz., 154, t. 7 (1796).
C. sulcata Nutt., loc. cit. (1818).

Hicoria alba (Linn.) Britton, loc. cit. (1888). MOCKER NUT.
Syn. *Juglans alba* Linn., Spec. Pl. 997 (1753).
C. tomentosa Nutt., loc. cit. (1818).

Hicoria glabra (Mill.) Britton, op. cit., 284 (1888). PIG NUT.
Syn. *Juglans glabra* Miller, Gard. Dic. ed. 8, No. 5 (1768).
C. porcina Nutt., op. cit., 222 (1818).
Scoria glabra O. Kuntze, Rev. Gen. Pl. ii, 638 (1891.)

Hicoria minima (Marsh.) Britton, loc. cit. (1888). BITTER NUT.
Syn. *Juglans alba minima* Marshall, Arb. Am., 68 (1785).
C. amara Nutt., loc. cit. (1818).

Hicoria myristicæformis (Michx. f.) Britton, loc. cit. (1888). NUTMEG HICKORY.
Syn. *Juglans myristicæformis* Mchx. f. Hist. Arb. Am. i, 211, t. 10 (1810).
C. myristicæformis Nutt., loc. cit. (1818).

Hicoria aquatica (Michx. f.) Britton, loc. cit. (1888). WATER HICKORY.
Syn. *Juglans aquatica* Michx. f., op. cit. 182, t. 5 (1810).
C. aquatica Nutt. loc. cit. (1818).

CUPULIFERÆ.

Quercus minor (Marsh.) Sargent, Gard. & For. ii, 471 (1889). POST OAK.
Syn. *Quercus alba minor* Marshall, Arb. Am. 120 (1785).
Quercus obtusiloba Michx., Hist. Ch. Am. No. 1, t. 1 (1801).

There is no doubt as to the identity of Marshall's *Q. alba minor*, and Prof. Sargent has taken up (loc. cit.) this varietal term *minor*, the oldest name for this oak, in place of the later *Q. stellata* and *obtusiloba.*

Quercus platanoides (Lam.). SWAMP WHITE OAK.
Syn. *Q. Prinus platanoides* Lamarck, Encyc. Meth. Bot. i, 720 (1783).
Q. bicolor Willd. in Neue Schrift. Gesell. Nat. Fr. Berl. iii, 396 (1801).

There seems to be little reason for longer neglecting Lamarck's name for this species, as his description (loc. cit.) points unmistakably to it, and being much older than Willdenow's *Q. bicolor*, it should replace the latter. Lamarck's name has reference to the supposed similarity in the exfoliation of the bark of this oak to that of the plane tree.

Quercus Virginiana Miller, Gard. Dic. ed. 8, No. 17 (1768). LIVE OAK.
Syn. *Q. virens* Aiton, Hort. Kew. iii. 356 (1789).

Prof. Sargent has already proposed to take up Miller's name as the oldest for the live oak, and being perfectly identifiable with that species, it should properly replace Aiton's later *Q. virens*.

Quercus velutina Lamarck, Encyc. Meth. Bot. i. 721 (1783). YELLOW OAK.
Syn. *Q. discolor* Aiton, Hort. Kew. iii. 358 (1789).
Q. tinctoria Bartram, Travels, 37 (1791).

It has been shown (Gard. & For. v. 98) that Bartram's *Q. tinctoria* is doubtfully tenable as it is not founded on a description, and no distinctive characters of the species are to be found in Bartram's remarks. The *Q. discolor* of Aiton is, moreover, an older name, and should have had precedence over *Q. tinctoria*; but as there can be no reasonable doubt of the identity of Lamarck's *Q. velutina*, the oldest name applied to the black oak, it has been taken up.

Quercus digitata (Marshall) Sudworth, Gard. & For. v. 98 (1892). SPANISH OAK.
Syn. *Q. nigra digitata* Marsh. Arb. Am. 121 (1785).
Q. cuneata Wang., Am. 78, t. 5. f. 14 (1787).
Q. falcata Michx. Hist. Chen. Am. No. 16, t. 28 (1801).

Marshall (loc. cit.) without doubt describes, under his *Q. nigra digitata*, our "Spanish oak," and being the oldest name for the species, it has been taken up in place of the later *Q. cuneata* and *Q. falcata*.

Castanea dentata (Marshall) Sudworth, Bull. Torr. Bot. Club xix. 152 (1892).
Syn. *Fagus Castanea dentata* Marsh., Arb. Am. 46 (1785).
C. vesca, var. *Americana* Michx. Fl. Bor. Am. ii. 193 (1810).

CHESTNUT.

It has been shown that Marshall's name for this species is the first applied to the American chestnut, and being perfectly identifiable, should be maintained.

Fagus atropunicea (Marsh.) Sudworth, Bull. Torr. Bot. Club. xx, 43 (1893). BEECH.
Syn. *F. sylvatica atropunicea* Marsh. Arb. Am. 46 (1785).
F. ferruginea Aiton, Hort. Kew. iii. 362 (1789.)

It has also been pointed out that Marshall's name for the American beech is the oldest one recorded, and should, therefore, be maintained in place of Aiton's much later *F. ferruginea*.

CONIFERÆ.

Thuya plicata Lambert, Pinus ed. 1, ii. 19 (1824). PACIFIC ARBOR-VITÆ.
Syn. *T. gigantea* Nuttall, Journ. Phil. Acad. vii. 52 (1834).

Lambert's name for this species is ten years older than Nuttall's, and should, therefore, replace the latter's *T. gigantea*.

Chamæcyparis thyoides (Linn.) B. S. P., in Britton Cat. Pl. N. J. 299 (1889).

Syn. *Cupressus thyoides* Linn., Spec. Pl. ed. 1, 1003 (1753).
Chamæcyparis sphæroidea Spach, Hist. Veg. xi. 331 (1842).

WHITE CEDAR.

Dr. Britton (loc. cit.) has very properly restored to this plant its oldest specific name, which was applied by Linnæus in 1753, and should be maintained in place of the later *Ch. sphæroidea*.

Pinus radiata Don, in Trans. Linn. Soc. xvii. 442 (1837). MONTEREY PINE.
? *P. Californiana* Loiseleur, in Nouv. Duham. v. 243 (1812).
? *P. adunca* Bosc, in Poiret suppl. Lam. Enc. Meth. Bot. iv. 418 (1816).
P. tuberculata Don, loc. cit. post *P. radiata* (1837), not Gordon (1849).
P insignis Loudon, Arboretum iv. 2265, f. 2170-2172 (1838).

Prof. J. G. Lemmon has called attention (Gard. & For. v. 64, 1892) to the fact that the Monterey pine does not bear its oldest name, and proposes to take up for it Loiseleur's *P. Californiana* (1812); but as Prof. Sargent remarks, in a note to Prof. Lemmon's revision (loc. cit.), there is much uncertainty as to the actual identity of this name. He therefore advises that this, and *P. adunca*, the next oldest name suspected to belong here, should be passed over, and that the *P. tuberculata* of Don (1837) be taken up. There appears, however, to be no good reason for passing over Don's *P. radiata*, which certainly applies to no other than the Monterey pine, and occurs before *P. tuberculata* on the same page with it.

Pinus attenuata Lemmon, Mining & Scientif. Press, Jan. 16; Gard. & For. v. 65 (1892).
Syn. *P. Californica* Hartweg, in Journ. Hort. Soc. Lond. ii. 189 (1847), not *P. Californiana* Loisel. (1812).
P. tuberculata Gordon, Journ. Hort. Soc. Lond. iv. 218, f. (1849), not Don (1837).

KNOB-CONE PINE.

Prof. Lemmon points out (loc. cit.) that the preoccupation of *P. tuberculata* for the Monterey pine leaves the Knob-cone pine without a name. He proposes to call it *P. attenuata*, in allusion to the tapering cones.

Pinus Virginiana Miller, Gard. Dic. ed. 8, No. 9 (1768). SCRUB PINE.
Syn. *P. inops* Aiton Hort. Kew. iii. 367 (1789).

Dr. Britton (Cat. Pl. N. J. 300, 1889) has already taken up Miller's name for this pine, and being the oldest on record, it properly replaces Aiton's later *P. inops*.

Pinus echinata Miller, Gard. Dic. ed. 8, No. 12 (1768). SHORT-LEAF PINE.
Syn. *P. mitis* Michx. Fl. Bor. Am. ii. 204 (1803).

Dr. Britton (loc. cit.) has also restored to this pine its oldest specific name *Pinus echinata*.

Pinus latifolia Sargent, Gard. & For. ii. 496, f. 135 (1889). BROAD-LEAVED PINE.

Prof. Henry Mayr, of the University of Japan, detected this new species first in 1887, on the southern slopes of the San Rita Mountains, southern Arizona. It is somewhat similar to *P. ponderosa*, but differs in having longer and broader leaves, and by the long, round umbo of the cone scales. Since Dr. Mayr's discovery of this species, it has also been collected (July, 1892) at Fort Huachuca, at an altitude of 6,000 feet, and sent to the National Herbarium for identification, by Mr. J. E. Wilcox. It is said to be a tree of about 60 feet in height.

Pinus divaricata (Aiton) Sudworth, Bull. Torr. Bot. Club xx. 44 (1893). JACK PINE.
Syn. *P. sylvestris*, var. *divaricata* Aiton, Hort. Kew. iii. 366 (1789).
P. Banksiana Lambert, Pinus ed. 1, 7, t. 3 (1803).

It has been pointed out that Aiton's "var. *divaricata*" is the oldest designation for this pine, and being perfectly identifiable with the jack pine, it has been proposed as a specific name, in place of Lambert's later *Banksiana*.

Since the publication (1884) of the Census Catalogue of Forest Trees, the geographical distribution of the jack pine has been found to extend farther southward in Maine, to Frenchmans Bay, on the eastern side, Lat. 44° 20′ (E. L. Rand, in Bull. Torr. Bot. Club xvi. 294, 1889).

Pinus heterophylla (Elliott) Sudworth, in Bull. Torr. Bot. Club xx. 45 (1893)
Syn. *P. Tæda*, var. *heterophylla* Ell., Sk. ii, 636 (1824).
P. Cubensis Griseb., Mem. Am. Acad. viii. Pt. 2, 530 (1863).
P. Elliottii Engelm., Trans. St. Louis Acad. iv. 186, t. 1, 2, 3 (1879).

CUBAN PINE.

Elliott's variety *heterophylla* is the oldest name applied to this southern lumber pine, and now that the insular (*P. Cubensis*) and mainland forms are known to belong to one species, it is proposed to unite them under the oldest name, *P. heterophylla*.

Picea Mariana (Miller) B. S. P., in Britton Cat. Pl. N. J. 310 (1889). BLACK SPRUCE.
Syn. *Abies Mariana* Miller, Gard. Dict. ed. 8, No. 2 (1768).
Picea nigra Link, Linnæa xv. 520 (1841).

We follow Dr. Britton in maintaining Miller's specific name *Mariana*, the oldest for this species, in place of Aiton's later *nigra*.

Picea Canadensis (Miller) Britton, Prelim. Cat. Pl. N. Y. 71 (1888). WHITE SPRUCE.
Syn. *Abies Canadensis* Miller, Gard, Dic. ed. 8, No. 8 (1768).
Pinus alba Aiton, Hort. Kew. iii. 371 (1789).
Picea alba Link, Linnæa xv. 519 (1841).

The oldest specific name for this spruce is Miller's *Canadensis*, taken up by Dr. Britton in 1888, in place of the later *alba* of Aiton.

Picea Breweriana Watson, Proc. Am. Acad. Sci. xx. 378 (1885). BREWER'S SPRUCE.

This spruce was discovered by Mr. Thomas Howell in June, 1884, on the Siskiy Mountains, northern California. Lately (Gard. & For. v. 592) Mr. T. S. Dougl reports it from the summit of the coast range in Oregon, on the divide betwe Canyon Creek and Fiddler's Gulch. It is a very distinct species, and readily d tinguished from other spruces by its long drooping branches.

Pseudotsuga taxifolia (Lamb.) Britton, Trans. N. Y. Acad. Sci. viii. 74 (1889).
Syn. *Pinus taxifolia* Lambert, Pinus ed. 1, i. 51, t. 33 (1803).
Abies Douglasii Lindley, Penny Cycl. i. 32 (1833).
Pseud. Douglasii Carrière, Trait. Conif. ed. 2, 256 (1867).

DOUGLAS SPRUCE.

Lambert's specific name for the Douglas fir is here maintained as already take up by Dr. Britton (loc. cit.).

Pseudotsuga macrocarpa (Torrey) Lemmon, in 3d Bienn. Rep. Cal. B'd For. 134 (1890
Syn. *Abies Douglasii*, var. *macrocarpa* Torr., in Ives's Rep. 28 (1861).
Abies macrocarpa Vasey, in Gard. Month. 22 (1876).
Pseudotsuga Douglasii, var. *macrocarpa* Engelm., in Bot. Cal. ii. 120 (1880).

BIG-CONE DOUGLAS SPRUCE.

There appears to be good reason, as pointed out by Prof. Lemmon (loc. cit.), fo maintaining this as a distinct species, although considered by Dr. Engelmann to b only a variety of the Douglas fir. It differs from the Douglas fir in minor point but chiefly, it seems, in the constant, larger-sized cones and seeds, and is usually smaller tree.

Larix larcina (Du Roi) Koch, Dendrologie ii. Pt. 2, 263 (1873). TAMARAC
Syn. *Pinus larcina* Du Roi, Obs. Bot. 49 (1771).
Larix Americana Michx.. Fl. Bor. Am. ii. 203 (1803).

Koch's restoration of Du Roi's original specific name *larcina* for this species i here followed, as there is no doubt as to the identity of Du Roi's *Pinus larcina* wit our Larch. Dr. Britton (Cat. N. J. Pl. 302, 1889) took up *larcina*. but seems to hav overlooked the fact that it had already been restored by Koch, as the combinatio is accredited to "Britton Sterns & Poggenburg."

THE NAVAL STORE INDUSTRY.

The most important economic result of the work of the Division o Forestry during the year is the establishment, beyond doubt, that th bleeding of the Southern pines for the purpose of gathering naval store does not, as has been generally maintained, affect the quality of thei timber. Even the claim that tapped or bled trees lose their durabilit does not find any support in the chemical analyses made, which seem to prove that there is no change in the condition or chemical constitu tion of the heartwood due to bleeding; that the turpentine collecte must come from the sap, where alone it is found in a condition permit ting it to flow. Nor is there any physiological reason for assumin any change.

Hence it can be stated with absolute assurance that the prejudic entertained by architects and builders against bled timber is withou basis, as determined by tests and analysis, and, as may be gathered from the report of Mr. Roth, cited further on, not even warranted by practica experience. We may, then, consign to the rubbish heap of baseles theory this belief, which has caused much annoyance to the Southern lumber trade and considerable loss in money and valuable material.

But while there is no deterioration of the timber due to the proces of bleeding, it can be said with truth that there is no more destructive agency at work in the longleaf pineries of the South than the turpen tine industry, and that without necessity. The damage and destruc tion do not result directly, although by the boxing of immature trees a nsiderable loss to the future is involved, and by the crude boxing ıch of the most valuable part of the tree is needlessly wasted; but en indirectly from fires, which annually sweep the turpentine orchds and destroy millions of feet of valuable timber, the resin colcted on the scars of the trees rendering them highly inflammable. e trees which are not killed by the fire are soon destroyed by barketles and pine-borers, which find a breeding place in the trees, which, ter the injury by fire, are blown down by the wind. "Hence," says . Mohr, "the forests invaded by the turpentine industry present in e or six years after they are abandoned a picture of ruin and desoion painful to behold, and in view of the destruction of the seedlings d younger growth season after season all hope for the restoration of e forest is excluded."

It appears from the report of Dr. Mohr, agent of this division, that er 2,000,000 acres of pine forest which were in orchard in 1890 ust have been exposed to this danger, and that every year adds beeen 500,000 and 600,000 acres of new orchard.

It seemed, therefore, desirable to study the turpentine industry in conditions and methods with a view of suggesting improvements. e results of this study, based upon reports of special agents and the erature on the subject, follow.

TURPENTINE ORCHARDING.

The most important industry in the United States concerned in the ilization of by-products from the forest is the tanbark industry, and xt to it the turpentine or naval store industry, which is practically nfined to the pineries of the Southern States within a belt of about 0 miles in width along the Atlantic and Gulf coasts from North Carina to Louisiana.

The importance of this latter industry is found not only in the value its products, namely, nearly $10,000,000 worth per year, furnishg the bulk of the naval stores used in all the world, but also in the direct influence which this industry exerts on the condition and fure of one of our richest forest resources.

Owing to the wasteful and careless manner in which this industry is rried on and the disastrous conflagrations that follow in its train, ich destroy thousands of acres of the most valuable timber every ar, while the margin of profit to the turpentine gatherer is comratively small, this industry may be considered the most unprofitable the nation at large in spite of the large aggregate value of its prodts. This is not so by necessity, but due to faulty methods. The ject of this discussion is to create a more general interest in the instry, give information regarding its methods, show its defects, and ve the way toward improvement and more rational procedure.

PRODUCTS OF THE TURPENTINE INDUSTRY.

Naval stores.—Under the name of naval stores are comprised all the sinous products and their derivatives that are gathered from conifers trees. The name comes probably from the fact that the bulk of ese products is or was used in the economy of ship construction and ip management, although now, with iron as a substitute for wood in ipbuilding, other industries may consume perhaps a larger portion. ese products are:

(1) *Resin or crude turpentine.*—This is the crude material obtained by "tapping" "bleeding" the trees, a mixture of resinous material and oil of turpentine, in

which the resins are partly dissolved, partly suspended. According to the spe from which it is obtained, the consistency of the resin varies, depending upon the r tive proportion of hard resin particles and oil: the more oil, the more liquid is resin.

The "fine" turpentine or resin, which comes from larch and fir or balsam tree semiliquid, more or less transparent and clear, and remains clear on exposure to air. The "common" turpentine, which is furnished by the other trees tapped it, is usually not at all transparent or clear, but is semiliquid or hard, the flui being lost by evaporation of the oil on exposure.

Most resins are yellow or brown in color, darkening on exposure; most of t possess a characteristic odor and taste; they have a specific weight of nearly 1, when hard melt readily at low temperatures. They are not soluble in water, readily so in alcohol, ether, or oil of turpentine; they are free from nitrogen, poo oxygen, and rich in carbon, and of somewhat acid reaction. With alkalies the called resin soap is formed.

The best grades of turpentine are usually obtained (not necessarily so) in the pr uct of the first year, known as "virgin dip" or "soft white gum;" in the foll ing years it becomes "yellow dip," being darker colored and less liquid every ye while "scrape" or "hard turpentine" is the product hardened on the tree scraped off. By distillation of the cruded resin are obtained the important resin products of trade.

(2) *Spirits of turpentine or oil of turpentine.*—This is the liquid distillate from the cr resin. When pure it is a mixture of hydro-carbons of the formula $C_{10}H_{16}$; but impure product from the still contains also other hydro-carbons and acids. To rect it, it is mixed with limewater and again distilled; yet, according to the source fr which derived, the oil of turpentine possesses different qualities. Freshly prepa oil of turpentine, especially that from virgin trees worked for the first time, is col less, tasteless, a thin fluid, of peculiar smell, of low specific weight (0.855–0.875), its boiling point at 300–340° F. Most of the oils of turpentine of the trade polar light to the left, but the American oil polarizes it to the right, and may thereby recognized.

The oil evaporates very readily in ordinary temperature, and by oxidation thick until hard, becomes yellow, and shows sour reaction. It burns with a stron sooty flame; it is insoluble in water, but soluble in alcohol. It is a good solvent many resins, wax, fats, caoutchouc, sulphur, and phosphorus. In the arts it is u mainly for the preparation of varnishes, in paints, and in the rubber industry. I also used for illuminating purposes as pine oil, or mixed with alcohol as camphe and under other names. It has a wide use in medicine internally and externally. is often used in the adulteration or imitation of various essential oils.

(3) *Rosin or colophony.*—This is the residue remaining from the distillation of crude turpentine or resin. According to the nature of the crude turpentine, wh depends on the number of seasons the tree has been worked, it shows different prop ties. It is either perfectly transparent, translucent, or almost opaque; in color, fr pale yellow, golden or reddish yellow, through all shades to deep dark brown, alm black; and of different degrees of hardness; some soft enough to take the impressi of a finger nail, and some so hard that only iron will make an impression.

The hard colophony or rosin is almost without smell or taste, of glassy gloss, ve brittle, easily powdered. It becomes soft at about 176° F. and melts between 194° a 212° F. It is soluble in the same solvents as the crude resin; its specific weig is 1.07. Rosin is used in the manufacture of varnish, sealing-wax, putty, soa paper, etc.

In the American market the following grades are distinguished: W G—wind glass; WW—water white, the lightest colored grade, obtained from virgin dippin and under special care at the distillery; N—extra pale; M—pale; K—low pale; good No. 1; H—No. 1; F—good No. 2; E—No. 2; D—good strain; C—strain; E common strain; A—black.

By dry distillation of the rosin are obtained the following three products:

(*a*) Light rosin oil, which is used in the fabrication of varnishes.

(*b*) Heavy rosin oil, which is used in the manufacture of printers' ink, machi oil, axle grease, etc.

These oils, known in commerce as pale oil, pine oil, ink oil, etc., are of a light re dish or brown color, more or less fluorescent, with a specific gravity of 0.98 to 1; slight odor but characteristic taste. The distillation is carried on at a dull, r heat, yielding about 85 per cent of rosin oil. They are composed of a mixture several hydrocarbons of indefinite nature (colophene, heptin, etc.), and contain fr 0 to over 15 per cent of resinous acids. They are insoluble in water, slightly so alcohol, can not be saponified, but form unstable compounds with slaked lime a other bases. The rosin grease made by stirring slaked lime finely suspended water is an excellent lubricant, adapted especially for metal bearings in machine and wagons. Mixed with sweet oil, rape oil, or the denser mineral oils, it is us r the preparation of lubricating oils. These oils are also used in the manufacture varnish, in the preparation of cheap paints used to cover metal, roofs, etc.

(c) *Common pitch.*—This is the residue from the dry distillation of rosin; a glossy, ack, brittle body, which is used in the manufacture of the common ship-chandlers' tch, used for calking of vessels, shoemakers' pitch, and black pigments. Pitch is so obtained by boiling tar down until it has lost about one-third or more of its eight. The navy pitch of commerce has more or less rosin of lowest grades added it. It commands a price of about $1.50 per barrel.

(4) *Brewers' pitch.*—This is used for pitching beer kegs and barrels, and is obtained hen the distillation of the crude turpentine is stopped, before all the oil has been stilled. It therefore contains a certain quantity of oil of turpentine; if too much, e pitch foams when melted and imparts a disagreeable, sharp taste to the beer, hile with too little oil the pitch becomes brittle and does not adhere to the barrel. he best quality of this product is obtained from the larch, and is produced mostly Tyrol, but there is quite an amount of brewers' pitch made in the Southern neries.

(5) *Tar.*—This is not exactly a by-product of the turpentine orchard, but is mostly product of destructive distillation of the wood itself. Most of the tar in the United ates is made in North Carolina, where the industry has been largely carried on om earliest colonial times. In other parts of the Southern coast pine-belt it is nly produced for home consumption. Perfectly dry wood of the longleaf pine—ead limbs and trunks perfectly seasoned on the stump, from which the sapwood as rotted—are cut into suitable billets, piled into a conical stack in a circular pit ned with clay, the center communicating by a depressed channel with a receptacle—hole in the ground—at a distance of 3 or 4 feet from the pile. The pile is covered ith sod and earth, and otherwise treated and managed like a charcoal pit, being fired om apertures at the base, giving only enough draft to maintain slow smoldering combustion. After the ninth or tenth day the flow of tar begins, and continues or several weeks. It is dipped from the pit into barrels of 320 pounds net, standard eight, mostly made by the tar-burner himself from the same pine. From one cord f dry "fat" wood or "lightwood" from 40 to 50 gallons of tar are obtained.

There is but little profit in the business, except that it employs labor in remote istricts at a season (winter) when there is but little else to do. The price of tar, at resent quoted as low as $1.05 per barrel at Wilmington, N. C., has been depressed, specially since considerable quantities of tar are produced incidentally in the destructive distillation of wood in iron retorts for charcoal purposes.

(6) *Oil of tar.*—This is obtained by distillation of the tar. It is a complex mixture f hydrocarbons with some wood alcohol and a small quantity of creosote, often more or less covered by empyreumatic substances, with a density of .841 to .877. It s used as an insecticide and for various external applications in domestic and eterinary practice.

SOURCES OF SUPPLY.

Naval stores are being produced on a commercial scale mainly in Ausria, France, on the island of Corsica, in Spain, Portugal, Galicia, Russia, and the United States. The largest amount of European turpentine comes from the black pine (*Pinus laricio*) and the maritime pine (*Pinus maritima*). The first of the two, which yields the largest amount, is apped especially in Lower Austria, France, and Corsica. The latter, which does not furnish much resin, is tapped especially in France, beween Bayonne and Bordeaux, where about one and a half million acres are covered with it; also in Spain, Portugal, and on the North African coast. In Germany, especially in the Black Forest, the Norway spruce is tapped, but not to any great extent. In Southern Italy and he Italian Alps the larch furnishes resin of excellent quality, although small quantities per tree and year, which is known in trade as Veneian turpentine. Occasionally, and especially in Galicia, Russia, the Scotch pine and fir are tapped; the turpentine from the latter species which is bled in Alsace is known as "Strasburg" turpentine. The Hungarian turpentine, so called, comes from the Carpathian Mounains and is derived from the pine known as *Pinus pumilia*.

In the United States a considerable amount of naval stores used to be collected in colonial times from the pitch pine of the North Atlantic States (*Pinus rigida*); but this species has been so far exhaust and forest conditions so changed that this industry is now practica extinct in the North and the business of turpentine gathering is co fined entirely to the South. There are three pines in the South whi yield resinous products abundantly, the longleaf pine (*Pinus palustri* the loblolly (*Pinus tæda*), and the Cuban pine (*Pinus cubensis*). T botanical features, their distribution, value as timber trees, etc., m be found in the report from the Division of Forestry for the year 18

The loblolly and Cuban pine yield a more fluid resin, rich in volatile c which when distilled leaves a smaller proportion of the solid rosin. T resin of these trees runs so rapidly that it is exhausted during the fi season, and hence it is not considered profitable to work them, althou they are always tapped where they are found intermixed with the lon leaf pine. It is, however, possible, nay probable, that with more ca ful methods, differing from those now employed, these two species m be made more productive and that the compact forests of the loblol in Arkansas, Louisiana, and Texas may still become valuable sourc of naval stores as well as the Cuban pine forests of Florida.

At present the longleaf pine furnishes the bulk of naval stores, n only for the United States, but for the whole world, the production France and Austria, the only other producers of naval stores, furnis ing hardly one-tenth of the total production.

HISTORICAL NOTES AND STATISTICS.

The first production of naval stores from longleaf pine took place i North Carolina. The tapping of the trees for their resin and the pr duction of pitch and tar was resorted to by the earliest settlers as source of income, and during the later colonial times it had risen to profitable industry, which furnished the largest part of the exports the colony. In the three years—1768 to 1770—88,111 barrels of crud turpentine, 20,646 barrels of pitch, and 88,366 barrels of tar were o the average annually exported to the mother country, representing value of $215,000 in our present currency. In its infancy the man facture of naval stores was confined to the district between Tar an Cape Fear rivers, with Wilmington and Newberne for shipping port Most of the turpentine or crude resin was shipped to England. Late the distillation of spirits of turpentine was carried on to a small exten in Northern cities as well as in North Carolina. Up to the year 184 fully one-half of the crude product was subjected to distillation in th latter State, the process being effected in clumsy iron retorts; the in troduction of the copper still in 1834 led to a largely increased yield o volatile oil, and this industry received a strong impetus. The numbe of stills at the ports was increased, and the production grew yet furthe shortly afterward, caused by the new demand for spirits of turpentin in the manufacture of India-rubber goods, and turpentine orcharding was rapidly extended to the south and west of its original limit. As early as 1832 rectified spirits of turpentine was used for an illuminator and for that purpose came into general use in 1842, either alone in the rectified state or mixed with a certain quantity of strong alcohol, unde the names of camphene and burning fluid, furnishing the cheapest light until replaced by the products of petroleum. The large consumption of spirits of turpentine in this way caused such an increase in its production that the residuary product, rosin, was largely in excess of the demand, leading to a great depreciation of this article. The consequent reduction of the profits of the business caused the transfer of the still om the place of shipment to the source of the raw material—the forest. rom that time (1844) dates the great progress made in the expansion this industry to the virgin forests farther south, and the turpentine ills increased rapidly in number in South Carolina, Georgia, Florida, nd the eastern Gulf States.

During the war of secession, when the production in the South was opped, the turpentine industry of France received an impetus and iat country supplied as best she could the deficiency. Prices went up five or six times their former range, namely, $25 to $30 per 100 pounds r spirits, and $9 to $10 for pale yellow grades of rosin, $4 to $5 for in- rior grades. These prices instigated improvement of methods, such the Hugues system, described further on, and more careful treatment the crop.

With the close of the war the industry revived in the United States, ough the demand for turpentine was not as great as formerly, petro- um products of various kinds having been found to take the place of e product of the pine for many purposes. With the general exten- on of arts and manufactures, however, both in this country and abroad, nd new application of the products, there has been an increasing de- and both for spirits of turpentine and resin, the exports of these lone in the year 1891 being $8,135,339 in value.

The following table of exports of naval stores has been compiled with reat care by Charles Mohr from the reports of the boards of trade, e press reports published in the several ports of export, and partly om private information. The amounts given are not claimed to com- rise the total annual production, but will fairly represent the bulk of roduction in each year for the ten or twelve years included.

able of exports of naval stores from the markets of principal centers of production during the period 1880 to 1890.

Year.	North Carolina (Wilmington).		South Carolina (Charleston).		Georgia (Savannah).		Alabama (Mobile).	
	Spirits turpentine.	Resin.	Spirits turpentine.	Resin.	Spirits turpentine.	Resin.	Spirits turpentine.	Resin.
	Casks.	*Barrels.*	*Casks.*	*Barrels.*	*Casks.*	*Barrels.*	*Casks.*	*Barrels.*
379–'80	125,585	663,967	60,000	259,940	46,321	221,421	25,209	158,482
380–'81	90,000	450,000	51,386	231,417	54,703	282,386	25,224	170,616
381–'82	88,376	425,925	69,027	258,446	77,059	309,834	30,937	172,438
382–'83	87,050	483,432	65,914	285,446	116,127	430,548	43,870	200,125
383–'84	78,978	434,367	64,207	264,049	129,835	559,625	41,804	210,512
384–'85	71,145	310,808	44,126	218,979	121,028	401,998	41,713	200,688
385–'86	63,580	324,942	40,375	170,066	106,925	424,490	38,733	175,817
386–'87	71,912	381,335	52,549	171,145	146,925	566,932	40,149	182,955
387–'88	63,473	246,516	40,253	181,886	168,834	654,286	28,725	132,055
388–'89	61,628	351,827	43,127	149,348	159,931	577,990	23,927	106,129
389–'90	70,289	385,523	49,232	217,865	181,542	716,658	21,029	93,906

Exports of tar and crude turpentine from Wilmington, N. C.

Year.	Tar.	Crude turpentine.	Year.	Tar.	Crude turpentine.
	Barrels.	*Barrels.*		*Barrels.*	*Barrels.*
881–'82	56,113	2,323	1886–'87	68,143	24,662
882–'83	75,544	3,188	1887–'88	63,163	21,572
883–'84	85,230	31,966	1888–'89	68,856	18,171
884–'85	70,530	45,966	1889–'90	71,949	19,082
885–'86	69,195	35,290			

Adding to the above records the production reported from Miss sippi and Louisiana, which is said to have averaged, for the last t years, 75,000 barrels of resin and 15,000 casks of spirits, being market in New Orleans, we may estimate the total production at present round:

340,000 casks spirits of turpentine, or 17,000,000 gallons, at 35 cents	$6, 000, (
1,490,000 barrels (240 pounds net)* resin of grades W W to C, or 357,600,000 pounds, at $1.80 average price per barrel or per 280 pounds gross	2, 682, C
	8, 682, C

From the same report we quote the following data regarding the d velopment of the industry in the different States (no regular retur from any district are obtainable regarding the annual production naval stores derived from the longleaf pine previous to 1870):

GROWTH OF THE TURPENTINE INDUSTRY IN THE STATES.

North Carolina.—This State, the oldest site of production, took the lead in this indu try up to the census year 1880. In the census of 1850 the value of these products that year is stated at $2,476,225, and in the census of 1860 at $996,902. The producti in 1870 of 75,990 casks of spirits of turpentine (equal to 37,995,000 gallons) a 456,131,388 barrels of resin valued at $2,337,300, increased in the business year endi 1880 to 125,585 casks of spirits of turpentine and 663,967 barrels of resin of a valu of $3,146,388, showing an increase of 65 per cent in spirits of turpentine and of per cent in resin. From that year to the present a gradual decline has taken plac which, in the year 1888–'89, amounted to 50 per cent in spirits and 48 per cent in t resin. The exports in that year reached a value of only $1,170,932. This decline clearly due to the exhaustion of the natural resources. During the period of t years, from 1879–'80–'89–'90, $2,114,483 worth of spirits of turpentine and resin, c the average, were each year exported. From the returns available it appears th nearly all the tar and crude turpentine shipped to domestic and foreign ports is pr duced in North Carolina. The export of these stores from Wilmington in 1889–' amounted to 71,949 barrels of tar and 19,082 of crude turpentine, at a value of n less than $253,000.

South Carolina.—By the census of 1850, the naval stores produced in that year we valued at $235,836, and in the census of 1860 their value is stated at $205,249.† A cording to the returns made to the census in 1870, 31,647 casks of spirits of turpe tine and 115,945 barrels of resin were produced at a value of $779,077, rising in 188 to 60,000 casks of spirits and 259,940 barrels of resin, at a value of $1,491,853—an i crease of nearly 100 per cent in spirits of turpentine and 124 per cent in resin. Aft a slight check in the succeeding year, the production shows for the next four yea an increase of 10 per cent on the average annually over the production in 188 With the year 1885 a decline took place; the production between that year and th end of 1890 varied between 39,651 casks of spirits of turpentine and 218,962 barre of resin and 49,430 casks and 217,865 barrels. The value of the products in 1888–'8 amounted to $968,761. The average price of resin reached in that year the lowes figure of $1 a barrel. The production of the same year shows a decline of 28 pe cent in spirits of turpentine and 40 per cent in resin compared with the productio of 1880.

Georgia.—In 1850 the naval stores produced reached a value of $55,086, and by th statements of the census of 1870, 3,208 casks of spirits of turpentine, and 13,84 barrels of resin, valued at $95,970, have been produced in Georgia during that year In the course of the following ten years the naval store industry made great progress resulting in 1880 in the export from Savannah of 46,321 casks spirits of turpentin and 221,421 barrels resin, at a value of $1,202,555, followed by a steady increas which, in 1884, exceeded the production of North Carolina during its palmiest days and has been constantly progressing to the present day. In the year closing, 1889 the exports from Savannah reached 159,931 casks spirits of turpentine and 577,99 barrels of resin, valued at $3,616,680, an increase of 227 per cent in spirits turpentin and 161 per cent in resin over the production of 1880. To-day this port is the greates market for these stores in the world.

*Lately the weight per barrel has been greatly increased, so that it now varie from 350 to 450 pounds net.

† F. B. Hough's Report on Forestry to the Department of Agriculture, 1878, IXth, Vol. II, 333.

Alabama.—According to the statements in the census of 1850, the naval stores pro-
lueed in Alabama represented a value of $17,800, which in 1860 declined to $13,575, nd in 1870, by the production of 8,200 casks spirits of turpentine and 53,175 barrels esin, reached a value of $280,203. In 1873 the receipts in the market of Mobile had ncreased fully 50 per cent over those of the previous year, amounting to from 15,000 to 0,000 casks spirits turpentine and from 75,000 to 100,000 barrels resin, besides 1,000 barrels tar and pitch, of a value estimated at $750,000. In 1875 the receipts reached value of $1,200,000, which in the year 1879-'80 was reduced to $739,000. In the ear 1883 the production had increased again to 43,870 casks spirits turpentine and 00,125 barrels resin, with but slight fluctuations to the end of 1887, indicating an ncrease of 59 per cent in spirits turpentine and 21 per cent in resin over the pro-
luction in 1880.

With the beginning of 1888 a decline set in; during that year the receipts at Mobile vere reduced to 28,725 casks and 132,055 barrels, valued at $635,643, and still further, n 1888-'89, to 23,927 casks and 106,129 barrels, of a value of $556,399. The receipts hat year of spirits turpentine fell 47 per cent and of resin nearly 49 per cent below hose of 1883, the year of greatest production, and the returns of the following years how still greater reductions. This decline is to be ascribed to the exhaustion of he forests along the lines of communication by water and by rail, and the conse-
uent reduction in profits caused by the increased expense of transportation of the roducts from the still to the shipping points, ports, or inland markets. The re-
eipts at Mobile include all of these stores produced in eastern Mississippi.

Other States.—In Mississippi and Louisiana this industry has not as yet reached arge dimensions, while it is not known that turpentine orcharding is carried on in he magnificent pineries of Texas. The production along the New Orleans and Northeastern Railroad is reported to have averaged for the last two years 15,000 asks of spirits of turpentine and 75,000 barrels of resin.

PHYSIOLOGY OF RESINS.

All coniferous trees, with the exception of those of the genus *Taxus*, contain in their woody structure passages or pockets, filled with resin, known as resin ducts or resin vesicles. How and under what condi-
tions exactly these ducts and vesicles arise, and how and why the resin forms, are matters still imperfectly understood. Resin passages begin to develop in the young seedling, and even during germination; resin forms in the growing bud, however, only during normal respira-
tion and growth. It is, then, a product of the living plant, formed by and during its life functions in the living parts of the plant; yet as far as we know it is a product of decomposition, which, while perhaps not useless in the economy of the plant, seems to find no further use in the nutrition or growth of its organs.

Resin passages arise from the shrinking away from each other of the walls of neighboring rows of cells; an intercellular space is thus formed and gradually filled up with products of decomposition and secretion, which we call resin. The source of these secretions is also still more or less unexplained. In the first place it comes, no doubt, from a de-
composition of the cellulose of the surrounding cell wall; then the starchy contents of the cells themselves may change into resin, and by oxidation of terpenes, essential oils, the surrounding cells with their contents are liquefied and resorbed, and in this way the resin duct becomes filled and enlarged from a mere intercellular passage to an irregular, smaller, or larger pocket or canal. The number, size, and arrangement of the resin ducts and vesicles differ with different species.

The Cupressus genus all have isolated cells containing resin; some have also ducts, the contents of which give the wood its peculiar odor, but these do not contain sufficient quantities to permit extraction ex-
cept by distillation of the wood itself. One of the Thuya tribe (*Calli-
tris quadrivalvis*) of Algiers, furnishes the white resin, known as san-
darac; and the fruit of the juniper, rich in essential oil, is used in the preparation of gin, the flavor of which is due to the oil.

The wood of the firs (*Abies*) does not contain any resin ducts, only isolated resin cells and vesicles, which are found most amply in th bark, containing an oleoresin very rich in volatile oil, and hence ver liquid. The wood of the spruces (*Picea*) contains few, rather narrow longitudinal ducts, and wider lateral ducts strongly developed. Th larch (*Larix*) contains resin ducts of very large diameter. The larges development of resin passages, however, occurs in the pines (*Pinus* admitting extraction on a large commercial scale.

In these we find longitudinal resin ducts in greater or less abundance according to the species, in all parts of the annual rings, more frequently however, in the summer wood than in the spring wood; hence, in part the darker coloration of the former. Those of the ducts which pas near a medullary ray form lateral extensions along the cells of the rays by means of which the longitudinal ducts are more or less frequently connected. These lateral ducts extend into the bark, where sometime considerable pockets of resin are formed; the longitudinal ducts are however, the most important source of resin supply in the pine.

As we have seen, the production of resin takes place under the lif functions of the tree in the living parts. Whether, and if so how, th resin wanders in the tree is not well known. Small amounts, no doubt remain at the place where they were formed. Larger masses may change their place, following the law of gravity, although the observa tion that leaning trees are richest in resin on the under side does no necessarily predicate a wandering. The collection of resin in the hol lows of trees (frost pits) of the larch may not be due to a wandering o the resin, but an emptying of broken ducts into the open spaces, in which the counterpressures otherwise existing are relieved.

The special investigations undertaken in the Division of Forestry and recorded in Bulletin 8, have shown that the quantitative distribu tion of resin throughout the tree, from top to bottom, follows no law the larger amounts being as often found in the top or middle portions as in the butt-logs. If the claim that the roots and base parts are richest in resin be a fact, this need not be due to a wandering of the resin, but to more abundant production in those parts. The belief tha in trees bled for turpentine a change takes place in the distribution o resin was not sustained in the investigations. It was, however, found that the heartwood of old trees contains invariably more oleoresin than the sapwood, the largest amount relatively being found at the line where heart or sap wood join. This would indicate an infiltration o the heartwood with resin from the sapwood. Before, however, accept ing such a conclusion, in which we would find it hard to explain me chanical difficulties in the wandering of the resin, it would be desira ble to examine trees of different age and note the progress of resinifi cation and also to make further analyses on absolutely fresh wood in which the sapwood is guarded against loss of resinous contents by evap oration and otherwise.

Of practical importance is the demonstration, furnished in these in vestigations, that the resin of the heartwood has lost its fluidity, being probably infiltrated into the cell-wall, and therefore the tapping for turpentine does not involve the resin of the heartwood or produce any change in the same.

Concerning the conditions which encourage abundant resin produc tion we are also in the dark. Trees standing side by side and appar ently under the same conditions show widely different amounts of resin. In general it may be said that light and warmth are prime requisites for abundant resinification, hence this proceeds more rapidly in open groves than close plantations; abundant nourishment and energetic activity of life seem also advantageous to resin production, hence a strong, fresh, warm soil furnishes more resin than a thin and cold soil, trees with full crown and branches more than thin foliaged and densely crowded trees with small crowns; warm and dry summers produce a richer flow than wet and cold ones.

METHODS OF WORKING TREES.

The methods of working trees for turpentine differ with the different species, as also in different countries. According as the resinous contents are found mainly in the bark or in the sapwood or in the heartwood, we may discern various methods.

(1) Chipping; this method consists in making a scar or chip on the tree, which is annually enlarged, and gathering the liquid turpentine at the lower end of the chip or scar in recess (box) cut into the tree; or else, as in France, in vessels; or else by allowing the resin to dry and be scraped, as is done with the Norway spruce.

(2) Bore-holes are applied in the tapping of larch where the turpentine is formed or collected in the heart.

(3) Opening the resin vesicles of the bark and gathering by hand is applied in the case of the balsam.

The yield of resin and turpentine depends upon various circumstances besides the species from which it is gathered, namely: (1) The dimensions of the tree; the larger the tree, of course, *ceteris paribus*, the larger the yield; the yield of trees of small diameter, 7 to 10 inches, may be from one-half to one-third of those of larger diameter. (2) The conditions of site; all elements which further large development of the crown, mainly open and sunny position, south or east exposure, will increase the yield. (3) The weather, and especially the temperature, during the time of gathering; the most favorable weather is changing temperature and humidity; long-continued heat and long-continued cold rains depress the yield, especially a cold spring predicts a poor crop; the flow of turpentine increases from spring to fall. (4) The duration of the bleeding process; in the first two or three years the yield is or ought to be smaller than in the following years. With the Austrian (black) pine the maximum yield seems to be reached in the trees of smaller diameter between the fourth and sixth years; in the trees with larger diameter, over 10 inches, between the seventh and ninth. Trees of these species on proper sites can be utilized for thirty years, but working becomes less profitable after six or eight years for the smaller and ten or twelve years for the larger sizes; the expense of working growing too costly, the foliage becoming thinner, and the yield smaller. (5) The aptitude and care of the workmen, which tells in the manner of making and enlarging the chips and of dipping and scraping.

PRINCIPLES TO BE OBSERVED IN TURPENTINE ORCHARDS.

The principles which should be observed in the chipping process, the one practiced on the largest scale, especially on pines, will now be mentioned.

SIZE OR AGE OF TREES TO BE TAPPED.

There is not sufficient experimental knowledge at hand to determine the most advantageous size of trees for tapping, either as far as greatest annual production of turpentine or safety to the life of the tree is concerned. The experiments on Austrian pine, recited further on, seem to show that trees above 10 inches in diameter yield much mor than smaller trees, almost double the amount of resin, with a higher per centage of spirits of turpentine. It also stands to reason that th safety of the tree, where this is of moment, is better assured the large the tree. Generally speaking, the best time for plentiful production i neither near the beginning nor near the end of the life of the tree, bu when it is in its most vigorous growth, and probably after it has at tained its maximum annual height growth, for then its activity is con centrated upon the development of its interior and diameter develop ment.

If the analyses referred to before exhibit the true amounts of resi formed at the part of the tree from which they are taken, and if ou proposition be true that ordinarily resins do not wander in the tree, bu remain where they are formed, then we could, by analyses of cross sec tions, dividing them into periods and ascertaining the resin contents o each division, approximately determine the period of greatest produc tion. In view of the great variation in resin contents, a very larg number of analyses would be required to allow generalization. From those at hand it would appear that the time of greatest productio falls for the longleaf pine between the seventieth and ninetieth years. Since, however, resin production appears to be a result of vigorous life functions, and since wood production depends upon the same con ditions, we should rather seek a criterion for resin production in the relation of diameter to age $\frac{d}{a}$; that is to say, whenever the largest amount of wood is formed in a given time—whenever $\frac{d}{a}$ reaches its greatest value—then the largest amount of resin is presumably also formed. Investigations in this direction are still wanting.

Another consideration is that of the value of the tree after it has been bled. Since the wood which is formed after the bleeding either on or between the scars is of little value for sawmilling, no trees should be bled—unless they are otherwise unfit for lumber—that will not make good sawlogs from the heartwood; that is to say, they should be at least 14 inches in diameter, so as to furnish a log of at least 8 inches at the small end. If the diameter were allowed to increase to at least 18 or 20 inches, probably the largest value both in resin and lumber might be attained.

In practice, various rules have found acceptance. In France 14 inches, which may be attained in thirty years, is considered a necessary diameter in order to endure continued tapping without injury to life; the lumber value of the maritime pine, being small, enters hardly into consideration. In Austria the tapping is begun with trees as low as 8 inches in diameter, but a diameter of at least 10 inches is preferred. With the spruce, 12 inches is considered a minimum size. In the United States, where no regard to consequences for the tree or lumber is had, the diameter at which a tree might be tapped is gauged by the amount of resin obtained in proportion to the labor expended. Until lately small diameters were avoided, but now any tree capable of carrying a bore is tapped and the ruin of the future of the industry prepared by this malpractice.

SIZE AND NUMBER OF SCARS AND PROGRESS OF CHIPS.

Regard to the life of the tree and the length of time for which it is expected to produce, on one hand, and the rapidity with which the largest amount of resin can be extracted in the shortest time, on the other hand, determine the size and number of scars inflicted simulta-

[…]eously. Although the resin itself is or seems to be of no particular [u]se to the tree in its vital functions, by laying bare a part of the cam[b]ium and young wood, a diminution of the flow of water to the crown, [a]nd of nutritive material downwards, must be induced. As a result [t]he foliage must suffer in proportion, and with it not only the life of [t]he tree, but also the production of additional resin, which is pro[d]uced in quantity only in vigorously growing trees with a luxuriant [f]oliage. Hence both the life of the tree and the total yield of resin may [b]e curtailed by too many and too large scarifications.

Since there is a relation between the amount of active foliage on each [s]ide of the tree and the activity in the cambium on the same side (one-[s]ided crowns produce one-sided annulation), it stands to reason that a [l]arger product can be obtained for a longer time by inflicting a number [o]f smaller scars than by making a large scar on one side of the tree, which is bound to reduce the activity of the foliage on that side, and thereby the production of additional resin; not that the dripping itself increases the production of new resin, as has been sometimes thought, but new resin is formed every year in proportion to the activity of the foliage, and hence by impairing this activity the amount of new resin in the new wood is reduced.

As we have shown, the resin which the orchardist takes from the tree, in the longleaf pine, at least, comes alone from the sapwood, the heartwood being impregnated with nonfluid oleoresin and not contributing toward the flow. The resin tapped is not only that which was deposited in the sapwood in former years, but also that which is formed during the years of tapping by the growth of the tree; hence sufficient amount of active cambium and young wood should be left untouched to permit a plentiful supply of water from the ground and vigorous function of the foliage, and the size of the one scar, or the sum total of all the scars, if several, should stand in a certain relation to the circumference or diameter of the tree.

For the size of the scar three dimensions are to be determined—breadth, depth, and height. Breadth and depth should be determined by the considerations just stated. As far as product is concerned there is nothing gained—at least in our pine—by cutting deeper than the sapwood, since the heart is inoperative. The breadth may be larger or smaller according to whether the tree is expected to yield resin for a long time or is to be depleted as fast as possible. In the former case the scar should not be wider than can conveniently callous over in a few years' rest, so as to permit new scars to be opened after the rest without any diminution, so to say, of conducting cell tissue. In the latter case, *i. e.*, when the largest amount of resin is to be obtained in the quickest time without reference to the life of the tree, only enough cambium need be spared to sustain the tree alive during the period which it takes to carry the chip advantageously to the greatest practical height. In this case, to be sure, only the resin already formed in the sapwood is being drained, no new additions coming from the growth during the years of tapping. The greater the breadth of the chip the greater, no doubt, the momentary discharge. The height of the chip, in the pines at least, should be determined by the following considerations: The resin drains from the longitudinal resin ducts which are cut through, by the law of gravity, until by the volatilization of the solvent oil of turpentine the hardened resin stops the flow, hence regard to plentiful production dictates as low a chip to begin with as is possible to collect from. A high chip at first and rapid chipping afterwards is a useless waste of good material, without any benefit, since the flow depends only upon the number of resin ducts cut through radially.

In practice the French have come nearest a rational size of the scar not allowing it to be more than 4 to 5 inches wide and scarcely one half an inch deep, beginning with a height of not more than 4 inches and progressing afterwards with the greatest care very gradually. With such chips it is possible to bleed the trees without detriment for their whole natural life. In Austria the size is extravagant, namely widening to two-thirds of the circumference, although the height is at first started with only 2 inches. In the United States a waste of 10 inches is at once incurred by "cornering" the box, and the chip is made 12 to 14 inches wide without much reference to the life or size of the tree, and several chips are opened on larger trees.

METHOD OF COLLECTING THE RESIN.

The pocket interest of the orchardist makes it desirable to have the largest amount of "dip," that is, liquid resin, and the smallest amount of "scrape," or hardened resin scraped from the surface of the scar, for the former contains larger amounts of the more valuable oil which has been evaporated from the latter by exposure to the air, as the resin, in a thin layer, runs to the receptacle. It is, therefore, advantageous to reduce as much as possible the distance between the place at which the resin exudes and the receptacle and also to concentrate as much as possible into one channel the flow of resin.

The American practice, it will be seen, is entirely faulty in this respect, and the Austrian not much better, the French alone being rational.

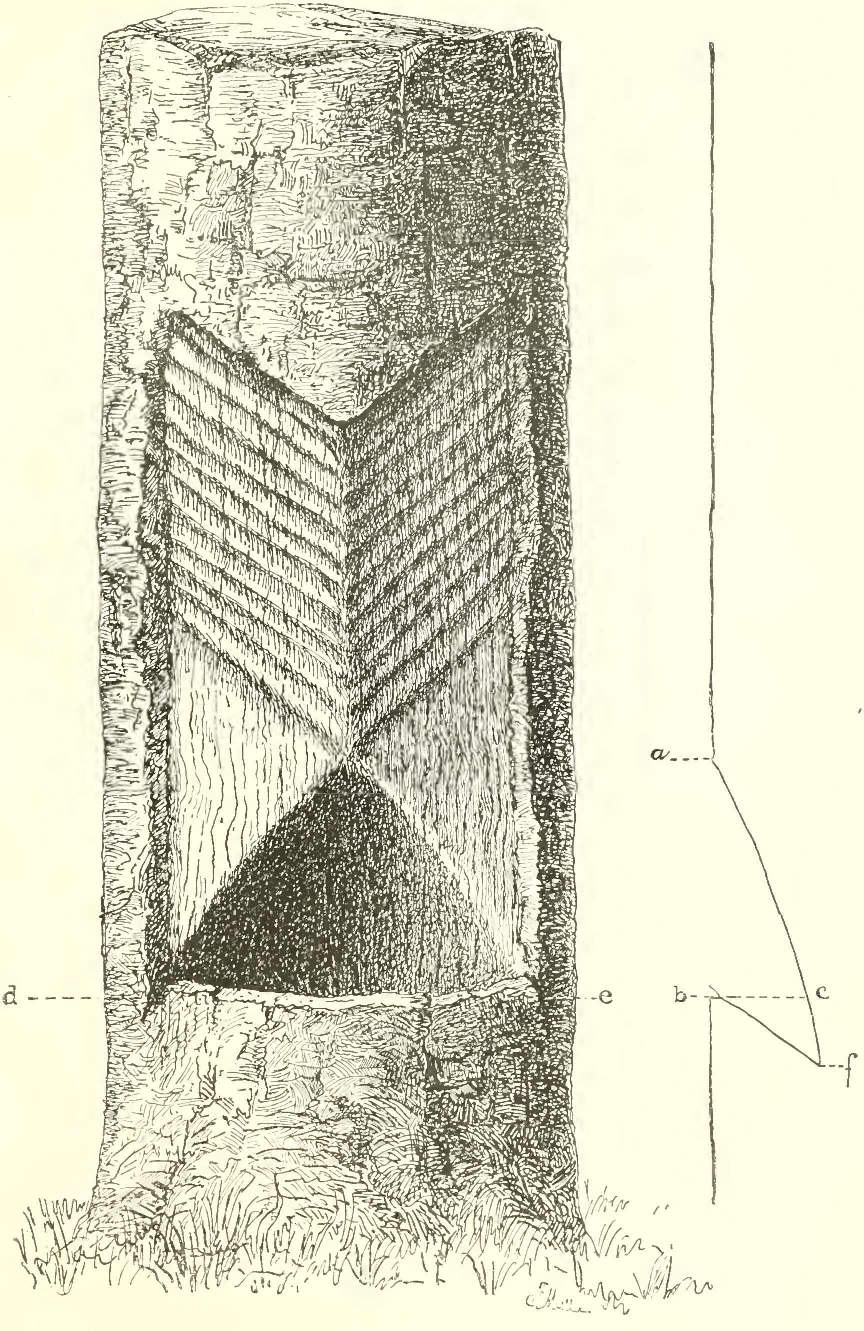
Frequent collection from receptacles at the trees also reduces loss from evaporation. Cleanliness, keeping impurities, sand, chips of bark and wood out of the receptacles is reflected in the better grades of the product. Scraping should be done as rarely as possible, since it injures the tree, and after the resin is once hardened the loss of oil by exposure is only insignificant.

TURPENTINE ORCHARDING IN AMERICA.

The American practice of boxing and chipping is thus described by Dr. Charles Mohr, agent of the Division of Forestry:

In the establishment of a turpentine orchard and still, two points must be considered, namely, (1) proper facilities of transportation to shipping points for the product, and (2) a sufficient supply of water for the condenser connected with the still. The copper stills generally in use have a capacity of about 800 gallons, or to carry a charge of 20 to 25 barrels, of crude turpentine. For such a still to be charged twice in twenty-four hours during the working season not less than 4,000 acres of pine land with a good average stand of timber are required. This area is divided into twenty parcels each of 10,000 "boxes," as the cavities are called, which are cut into the tree to serve as a receptacle of the exuding resin. Such a parcel is termed a "crop," constituting the allotment to one laborer for the task of chipping. The work in the turpentine orchard, as such a complex is called, is started in the earlier part of the winter, with the cutting of the boxes. Until some years past no trees were boxed of a diameter of less than 12 inches; of late, however, saplings scarcely over 8 inches in diameter are boxed. Trees of full growth, according to their circumference receive from two to four boxes; so that the 10,000 boxes can be said to be distributed among 4,000 to 5,000 trees on an area of 200 acres.

The boxes are cut (see Plate I) from 8 to 12 inches above the base of the tree, 7 inches deep (*b–f*) and slanting from the outside to the interior with an angle of about 35; they are 14 inches in greatest diameter (*d–e*) and 4 inches in greatest width (*b–c*) at the top, of a capacity of about 3 pints; the cut above this reservoir forms a gash of the same depth and 6 to 7 inches of greatest height (*a–b*). In the meantime



AMERICAN PRACTICE OF BOXING AND CHIPPING.

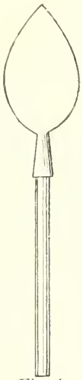


Fig. 1.

Fig. 2.

Fig. 3.

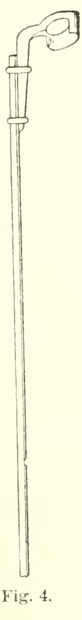


Fig. 4.

Fig. 5.

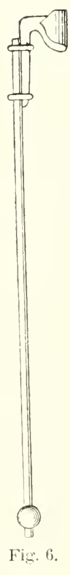


Fig. 6.

TOOLS USED IN AMERICAN PRACTICE OF TURPENTINE ORCHARDING.

ıe ground is laid bare around the tree for a distance of 2½ or 3 feet, and all combus- ible material loose on the ground is raked in heaps to be burned in order to protect ıe boxes against the danger of catching fire during the conflagrations which are frequently started in the pine forests by design or carelessness. This work of aking around the trees is also done to give the chipper in the performance of his ask a firmer foothold on the ground than could be obtained when covered with the lippery pine straw. The employment of fire for the protection of the turpentine rchard against the same destructive agency necessarily involves the total destruc- ion of the smaller tree growth, and, left to spread without control beyond the proper imits, carries ruin to the adjoining forests, in many instances over areas many miles n extent. The tools used are illustrated on Plate II, and are described as follows: Fig. 1, chipper; Fig. 2, pusher; Fig. 3, open hacker; Fig. 4, closed hacker; Fig. 5, craper; Fig. 6, puller.

With the first days of approaching spring the turpentine begins to flow and "chip- ing" is begun, as the work of the scarification of the tree is termed, by which its sur- ace above the box is laid bare just beyond the youngest layers of the wood scarcely to a depth of an inch from the outside of the bark. To effect this, first a strip 2 inches wide is removed, extending vertically from the corner of the box to the height of about 10 inches ("cornering"), and then the surface between these strips is laid open. The removal of the bark and outermost layers of the wood, the "chipping" or "hacking," is done with a peculiar tool, the "hacker" (Plate II, Figs. 3 and 4), a strong knife with a curved edge, fastened to the end of an iron handle bearing on its lower end an iron ball about 4 pounds in weight, in order to give increased momen- tum to the force of the stroke inflicted upon the tree, and thus to lighten the labor of chipping. As soon as the scarified surface ("chip") ceases to discharge turpentine freely, fresh incisions are made with the hacker. The hacking or chipping is repeated every week from March to October or middle of November, extending generally over thirty-two weeks, and the height of the chip is increased about 1½ to 2 inches every month. The resin accumulated in the boxes is removed to a barrel for trans- fer to the still by a flat, trowel-shaped dipper ("dipping"). In the first season, on the average, seven dippings are made (from six to eight) the 10,000 boxes yield at each dip about 40 barrels of dip or soft turpentine, or ("soft gum") as it is called in Alabama; of 240 pounds net or 280 pounds gross weight. The flow is most copious during the hottest part of the season, July and August, diminishes with the advent of cooler weather, and ceases in October or November. As soon as the exudation is arrested and the crude resin begins to harden, it is carefully scraped from the chip and the boxes with a narrow, keen-edged scrape attached to a wooden handle ("scraping"). The product so obtained, called scrape or hard turpentine, or hard gum, is of a dingy white color, more or less mixed with woody particles and dust, and contains only half of the quantity of volatile oil obtained from the dip or soft turpentine.

In the first season the average yield of the dip amounts to 280 barrels and of the scrape to 70 barrels. The first yields 6¼ gallons of spirits of turpentine to the bar- rel of 240 pounds net, and the latter 3 gallons to the barrel, resulting in the produc- tion of 2,000 to 2,100 gallons spirits of turpentine and 260 barrels of resin of higher and highest grades. The dippings of the first season are called "virgin dip" when almost without color, and white virgin dip, from which the finest and most highly priced quality of resin is obtained perfectly white, transparent, showing but the faintest tint of straw color, which enters the market under the grades of "water white" WW, and window glass WG. The next grades of resin obtained by the distillation of the turpentine dipped during the latter part of the same season, the "second virgin dip," are of a decided straw color and designated by the letters N. M. K., (See Grade, page 344.)

In the second year from five to six dippings are made, the crop averaging 225 bar- rels of soft turpentine; the scrape is increased to 120 barrels, making altogether about 2,000 gallons of spirits. The rosin, of which about 200 barrels are produced, is of a lighter or deeper amber color, and perfectly transparent, of medium quality, includ- ing grades "I," "H," "G." In the third and fourth year the number of dip- pings is reduced to three. With the slow flow over a more extended surface the tur- pentine thickens under prolonged exposure to the air and loses some of its vol- atile oil partly by evaporation and partly by oxidation. To the same influence, no doubt, the deeper color of the crude turpentine is to be ascribed. In the third season the dip amounts to 120 barrels, the scrape to about 100 barrels, yielding about 1,100 gallons of spirits of turpentine and 100 barrels of rosin of a more or less dark-brown color, less transparent, and graded as "F," "E," "D."

In the fourth and last year three dippings of somewhat smaller quantity of dip than that obtained the season before and 100 barrels of scrape or hard turpentine are obtained, with a yield scarcely reaching 800 gallons of spirits and 100 barrels of rosin of lowest quality from a deep brown to almost black color, opaque and heavier in weight, classed as "C," "B," "A." After the fourth year the turpentine is generally abandoned.

Owing to the reduction in the quantity and quality of the raw product, resul ing in a smaller yield of spirits and of lowest grades of rosin, it is not considere profitable by the larger operators to work the trees for a longer time. In Nort Carolina the smaller land owners work their trees for eight to ten successiv seasons and more, protect the trees against fire, and after giving them rest for series of years apply new boxes on spaces left between the old chips ("reboxing" with good results.

Distillation.

The process of distillation requires experience and care in order to prevent los in spirits of turpentine, to obtain the largest quantities of rosin of higher grades and to guard against overheating. After heating the still somewhat beyond th melting point of crude turpentine, a minute stream of tepid water from the top o the condensing tub is conducted into the still and allowed to run until the end o the process; this end is indicated by a peculiar noise of the boiling contents of the still and the diminished quantity of volatile oil in the distillate. On reaching this point the heating of the still and the influx of water has to be carefully regulated. After all the spirits of turpentine has distilled over, the fire is removed, and the contents of the still are drawn off by a tap at the bottom. This residuum, the molten rosin, is first allowed to run through a wire cloth and is immediately strained again through coarse cotton cloth, or cotton batting made for the purpose, into a large trough, from which it is ladled into barrels. The legal standard weight of the commercial package is 280 pounds gross, no tare being allowed.

The finest grades of rosin are largely used in the manufacture of paper, for sizing, of soaps, and of fine varnishes; the medium qualities are mostly consumed in the manufacture of yellow soap, sealing wax, in pharmacy, and for other minor purposes, and the lower and lowest qualities are used for pitch in ship and boat building, brewer's pitch, and for the distillation of rosin oil, which largely enters into the manufacture of lubricating agents.

A turpentine distillery, on the basis of twenty crops, can be said to produce, during the four seasons the boxes are worked, about 2,400 casks, or 120,000 gallons, of spirits of turpentine and from 11,500 to 12,000 barrels of resin, or 2,800,000 pounds (the lowest grade BA excluded), at a value of about $60,000 at average prices. The prices of spirits of turpentine vary from 28 cents to 40 cents a gallon, even during the same season, according to supply and demand in the market. The quotations on December 31, 1892, at Wilmington, were 28 cents for spirits and $1.91 for resin in the average down to grade C. The prices for different grades were per barrel: WG, $3.65; N, $3.10; M, $2.85; K, $2.15; I, $1.45; H. $1.15; G, $0.92; F, $0.85; E. D. C, $0..82.

Cost of establishment of plant and of working the crop.

Lands with the privilege of boxing the timber for the term of four years are rented at the rate of $50 per crop of 10,000 boxes (about 200 acres with 4,000 to 5,000 trees). The establishment of plant for the working of twenty crops requires an investment of about $5,000, including the still, houses, sheds, tools, wagons, and working animals, mostly mules.

The following statement, made by an operator of many years' experience, exhibits the actual expenses incurred for the working of one crop during four years; the work is for the greatest part done by the job:

Chopping 10,000 boxes	$125.00
Inspecting and tallying the same	15.00
Cornering 10,000 boxes	12.00
Raking around the trees, at $10 per season	40.00
Chipping boxes during 111 weeks, at $5 per week	555.00
Dipping crude resin, 650 barrels, and scraping 460 stands, at 30 cents	333.00
Hauling dippings and scrapings, at 30 cents per barrel	333.00
Distilling, at 20 cents per barrel	222.00
Spirit barrels, 122, at $2.80	305.00
Making and filling 795 barrels resin, at 30 cents	238.50
Superintendence of the crop	80.00
Total working expense of one crop	2,258.50
Rent of land for one crop	50.00
Cost of one crop	2,308.50

'otal expense of operating a plant of 20 crops during four years:

oor,* rent, and materials	$46,170.00
erest on capital invested, $5,000, at 6 per cent	1,200.00
ss by depreciation of plant, 10 per cent per year for four years	2,000.00
xes and incidentals	630.00
	50,000.00

'ield.—It appears that the yield of the crop of 200 acres distributes itself about follows:

	Dip.	Scrape.	Total crude turpentine.	Total yield.	Scrape.	Spirits.		Rosin.
	Pounds.	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*	*Gallons.*	*Per cent.*	*Barrels.*
st year	67,200	16,800	84,000	30.9	20.0	2,100	34.4	260
ond year	54,000	28,000	82,800	30.5	34.8	2,000	32.8	200
rd year	28,800	24,000	52,800	19.5	45.5	1,100	18.0	100
rth year	28,000	24,000	52,000	19.1	46.1	900	14.8	100
	178,000	93,600	271,600	100.0	29.0	6,100	100.0	669

f we assume that 4,500 trees produce these amounts in four years, the yield per e in crude turpentine is about 60 pounds. The result at the still would indicate t each tree furnishes between 1¼ and 1½ gallons of spirits and one-eighth of a rrel, or 30 pounds, of rosin of better grade, or at best 75 cents' worth of product ring the four years, which it has cost 55 cents to produce, leaving 5 cents net per e per year, or from $1 to $1.25 per acre.

'rom the fact that 4,000 acres of timber land (20 crops of 200 acres each) during r years' working produce 120,000 gallons of spirits of turpentine, or 7½ gallons acre and year, it follows that to produce the 17,000,000 gallons reported as the nual product, not less than 2,250,000 acres must be in orchard; and since the yield the first year represents 35 per cent of the total annual yield, at least 800,000 es of virgin forest are newly invaded annually to supply the turpentine stills in eration.

INSPECTION LAWS RELATING TO RESINOUS PRODUCTS.

In several of the Southern States, laws have been passed regulating e inspection of turpentine, etc., and defining its grades. The prin- oal of these are as follows:

'irginia.—Barrels to be full of good, clean, sound, and merchantable tar, pitch, turpentine, and to hold 31½ gallons.

North Carolina.—Soft turpentine barrels to weigh 280 pounds gross, and hard tur- ntine 240 pounds; pitch, 32 gallons to the barrel. Turpentine, tar, or pitch to be e from fraudulent mixtures. Casks to be of good seasoned staves, three-fourths an inch thick, and not over 5 inches wide; not less than 30 nor over 32 inches ng. Heads not less than 1 nor more than 1½ inches thick. To have 12 hoops to a sk, except hard turpentine, which may have 10 hoops. Water is declared not a udulent mixture of tar. Tar and turpentine barrels not limited as to weight, but weight to be marked and certified. Turpentine to be branded "S," or "H," for t or hard, and to show the initials of the maker's name. The inspector of naval ores at Wilmington is to gauge all spirits of turpentine.

South Carolina.—A barrel of crude turpentine to weigh 280 pounds gross.

Georgia.—Inspectors of turpentine, etc., may be appointed by cities, and their ties prescribed. Soft turpentine to be put up in barrels, as in North Carolina, and be branded "V," for virgin turpentine; "S," for yellow dip, and "H," for hard.

Florida.—The governor may appoint inspectors of tar and turpentine. Makers quired to brand their initials on the barrels. Inspectors are to mark the products at come under their notice as follows: "V," for pure virgin dip; "D," for pure llow dip; "S," for pure scrape. If the first two of these be impure or mixed, the

*Laborers are paid $1 to $1.25 per day; one man chips 10,000 to 12,500 boxes per ek by the job. A saving is made now in most localities in the matter of barrels d freight, by using kerosene tanks on cars, holding 3,500 gallons, into which the irits are filled directly from the still.

"V" or "D" is to be inclosed in a circle. If the scrape is not passable, it is ma with an "X" in a circle.

Allowances and deductions are to be made on turpentine with reference tc following particulars:

(1) When virgin dip is dipped from burnt boxes, or contains burnt cinders or s

(2) When virgin dip is mixed with chips, bark, or other impurities.

(3) When virgin dip is mixed with yellow dip, or scrape.

(4) When yellow dip is mixed, or contains chips, straw, bark, scrape, or sanc other impurities.

(5) When scrape contains more chips than are absolutely necessary to get it or dirt, or other impurities.

(6) When yellow dip, virgin dip, scrape, or tar contains water, or there is an cess of wood in the barrels containing it, or it is injured by long standing or leak

(7) When tar or turpentine of any class is contained in insufficient or unmerch able barrels.

The size of barrels is fixed at 30 to 32 inches in length, and the weight 280 pou gross, for turpentine and 320 for tar. Allowance is to be made for deficiencies, records are to be kept, but inspection is not obligatory upon the producers of and turpentine in this State.

Alabama.—Inspectors are to be appointed by the cities, and their duties prescri by municipal law.

TURPENTINE ORCHARDING IN EUROPE.

AUSTRIAN PRACTICE.

In Austria it is the black pine (*Pinus laricio*, var. *austriaca*) whicl tapped for turpentine. The method is very similar to the Americ In the spring, just before the sap rises (usually in March), a box (qu del) is cut into the tree about 1 foot above the ground (quandel). T box has about 3 inches depth and a breadth of from one-fourth to o third of the circumference of the tree. From the corners of this b two upward diverging channels are notched, from the ends of wh continues the scar or chip (sache). This is made with a carved hoe, inches in width, by taking all the bark and the youngest two to f year old wood. The chip is at first made only about 2 inches high a increased very gradually, reaching during the first year 14 to 16 inches height.

In the first year the chip is increased every week; in later yea oftener, every four or five days. If the chipping is delayed longer t yield is smaller, since the resin thickens and incrustates the surfa The chipping is continued during eight to twelve seasons, and the cl increases every year at the rate of from 14 to 16 inches. The bread remains even, and must never be more than two-thirds of the circu ference of the tree. The time of chipping is from April to the beginni or the middle of October. In the first year most of the resin is liqu and flows into the box. Later, when it has to run a longer distance, much of the volatile oils evaporates that the exudation thickens a must be scraped off the chip. So far this method does not differ fro the American method, except as to the rapidity with which the chip increased and the length of time the tree is worked. In order, howeve to reduce the surface from which the volatile oils may evaporate, channel is formed near the place where the exudation occurs by maki two converging cuts and inserting two pieces of wood, which condu the resin into a narrower channel down to the box. Otherwise the seems to be no difference in the two methods.

Yield.—In experiments regarding the yield, the following resul were obtained on sixteen trees, from 90 to 110 years old, under vario conditions. During nine years of chipping there was obtained of resi (per tree and year) the amounts given in the statement following.

	Minimum.	Maximum.	Average.
	Pounds.	*Pounds.*	*Pounds.*
Small trees below 10 inches	2.9	6.18	4.64
Large trees over 10 inches	5.7	9.8	8.4

Fhe last figure gives 75 pounds per tree altogether, or 25 per cent re than the average product in American practice. An 80-year-old owth, which was rented for twenty years, furnished in the tenth year orcharding still a net rent of $12 to $18 per acre.

The scrape contains less spirits of turpentine, is mixed with chips of od, and therefore obtains only two-thirds of the price paid for the). The amount of scrape depends, in the first place, on the surface the chip; also on the temperature during the fall, warm weather oducing more dips.

During the nine years of experimental chipping there were obtained each 100 pounds of dip the following amounts of scrape:

	Minimum.	Maximum.	Average.
	Pounds.	*Pounds.*	*Pounds.*
Small trees below 10 inches	40.2	72.4	57.7
Large trees over 10 inches	38.9	62.9	47.3

From the gathering to the distillation of the resin a loss averaging out 3 per cent was experienced by the evaporation of the oil of tur- ntine. No other resin seems to be so rich in turpentine as that of e black pine, 100 pounds of resin yielding 14 to 20 pounds of spirits d 60 pounds of rosin.

During the same experiment, in the course of nine years, the follow- g percentages of loss in the trees by death or windfalls occurred:

	Minimum.	Maximum.	Average.
Small trees below 10 inches	4.0	42.3	10.4
Large trees over 10 inches	1.3	27.3	8.3

Trees from 50 to 100 years old are tapped ten or twelve years before ey are to be cut. The business is carried on upon a rent system per tree d year, under contract prescribing the dimensions and gradual exten- on of the chip and the time for chipping (usually till September 30) and raping (not later than October 30), with heavy penalties in case of mage or excess of conditions. The total production in 1880—which s probably not materially changed since—was estimated at 13,288,000 unds of resin, producing 9,260,000 pounds of rosin, 2,425,000 pounds spirits, with an aggregate money value of, about, $300,000.

FRENCH PRACTICE.

Turpentine orcharding in France is carried on with more care than any other country. The first difference between the industry in the nited States and in France is that in the latter it is largely practiced in ung plantations specially planted and protected for this particular isiness. The maritime pine (*Pinus pinaster* L. synon., *P. maritima*), which has been used in the celebrated plantations on the sand du along the coast and in the Landes of Gascony for over 2,000 squ miles, furnishes the bulk of naval stores produced in France. T boxing or tapping is begun when the trees are 20 to 25 years old a is continued for a great many years. Trees have been known to ha been boxed for more than two hundred years.

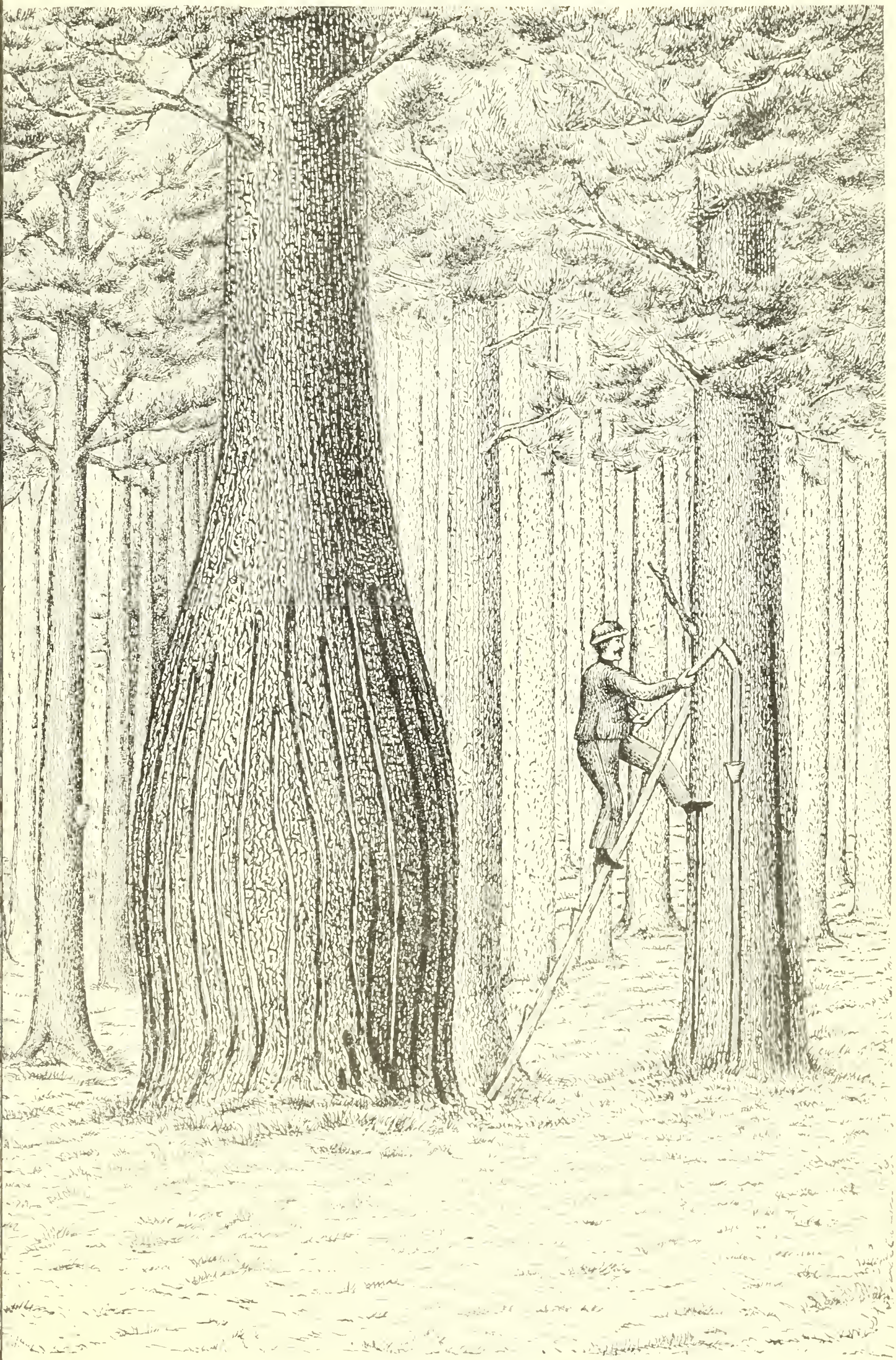
Two methods of boxing are practiced, which are known as *gemmag morte* and *gemmage a vie*, or "bleeding to death" and "bleedi alive." The difference lies in the number of scars inflicted simulta ously. The bleeding to death is applied to trees which are to be c out in the thinnings of a regular forest management and to those wh are at the end of their usefulness. The illustration (Plate III), h reproduced from Prof. L. Boppe's work on Forest Technology, rep sents a pine 200 years old, with more than fifty scars or chips, wi out apparently any ill effects on the life of the tree.

The "bleeding alive" is practiced on those trees which are to gr on, and hence must not be injured too much. They receive, therefo one chip at a time. When this, after five seasons' working, has tained a height of about 12 feet, the tree is allowed a rest of seve years, and then another chip is opened, 6 or 8 inches from the o one, or else on the opposite side of the tree. In this way in time t whole circumference is chipped in alternating periods of bleeding a of rest until the trees are to be cut for lumber, when 100 to 125 yea old or more. Sometimes exceptionally vigorous trees receive more th one chip at a time, but these are opened at different heights.

This successful continued bleeding can, however, be carried on on by corresponding care in the manipulation. The important differen between French and American practice consists in this, that the former more careful in the chipping, and proceeds more slowly in enlarging t chip, which is made only 3 to 5 inches wide instead of 12 or 14. Furthe in collecting the products with more care, the deep box cut into the tr in American practice is dispensed with and a lip and pot substitute

The chipper begins his work in February or March by removing wi a scraper from the whole portion of the tree that is to be chippe during the season, about 2 feet in height by 4 inches wide, the out bark nearly to the wood. This is done to obviate the falling of ba chips into the pot, thus securing a cleaner product, and also to sa the chipping tool. In the first week of March the chip is opened at t foot of the tree by making a triangular incision 3 to 4 inches wide an about $1\frac{1}{4}$ inches high, and not deeper than two-fifths of an inch. (No the small size of the opening.) This chip is made with a specially an curiously fashioned hatchet, having a curved blade and a curved handl difficult to make and use. (Plate IV, Fig. 1.) The chip is enlarge (chipping piquage) without increasing the width or even decreasing i The art of the chipper consists in taking off just as thin a peel of woo as possible, and at each chipping he freshens up the old scar by r moving another peel, taking care not to go deeper than two-fifths of a inch altogether. This chipping is repeated forty to forty-five time during the season, and during following seasons the chip is carried highe until it reaches 12 to 13 feet in height, namely, 70 inches the first seaso 30 inches each the following three seasons, and 38 inches the las season, when the tree is left to rest, and the wound heals up by th formation of new layers of bark and wood.

The cross-sections of trees bled through several periods twenty-fou to twenty-seven years and more (shown on Plate V) exhibit the manne in which the chips are distributed through the various seasons aroun the tree, and the manner in which the scars heal over. To be sure,



Turpentine Orcharding in France.

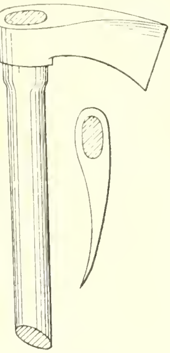


Fig. 1.

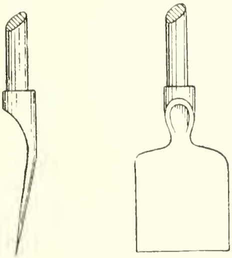


Fig. 2.

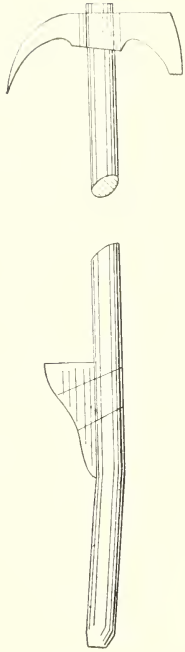


Fig. 3.

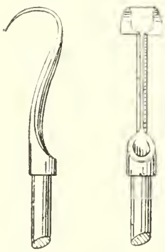


Fig. 4.

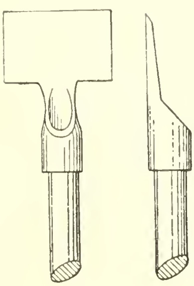


Fig. 5.

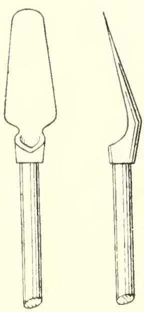


Fig. 6.

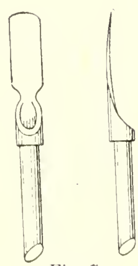


Fig. 7.

TOOLS USED IN FRENCH PRACTICE OF TURPENTINE ORCHARDING.

vood formed on the chips is irregular and, therefore, not service- for anything except fuel.

n experiment made in Austria on the black pine with the Hugues em (Plate VI) produced more dip and less scrape, and that purer, with less work, owing to the greater capacity of the vessel and the ler surface to be scraped being confined to the chip of the year. des, quantity and quality of the spirits and resin were superior, ely, 78.5 pounds distilled gave—

	Common method.		Pot gathered.	
	Pounds.	*Per ct.*	*Pounds.*	*Per ct.*
turpentine	14.7 or	18.78	17.6 or	22.41
	47.3	60.22	52.9	67.37
	10.6	13.44	5.3	6.72
	1.5	1.96	....	......
y evaporation	4.4	5.60	2.7	3.50
	78.5	100	78.5	100

eld.—In a growth of 45 years of age, each tree produces from 6 to ounds of resin each season, more than we obtain from old trees yield per acre varies, of course, according to the age and the ber of trees bled "to death" and bled "alive," as well as on the re of the soil—the sand soil of the dunes produces more than the el and limestone soil. The weather and the care of the workman influences the yield, so that the product per acre vacillates be- n 200 pounds of resin in younger (30 to 35 years old) growths to pounds in older growths. The yield is said to be greatest in trees t 16 inches in diameter. If bled "to death," 200 to 250 pines, 8 es in diameter, will yield about 500 pounds each year for three s. M. Bagneris mentions a pine about 50 inches in diameter which 10 chips working simultaneously, and yielded 12 to 14 pounds of annually. The men are paid by the cask of 517 pounds from $6 7, which allows them to earn about 80 cents to $1 per day. The of the crude turpentine varies considerably from $8 per cask of pounds. It reached the enormous figure of $58 during the Ameri- civil war. Orcharding in France is usually carried on on half es between timber-land owner and orchardist.

EXPLANATION OF PLATES.

PLATE IV.—Tools used in French practice.

e tools employed in the French method of orcharding are: An ax (la cognee) for ng trees and for removing the course for the chip and for opening the lower An ax with a concave blade and a curved handle (l'abchot); this is the ipal tool of the orchardist, and it serves exclusively for the opening of the s. The blade is razor-like in order to make a sharp and smooth cut through the ducts. The irregular form of its handle and of its sharp edge make it an instru- difficult to manufacture and particularly difficult to use, and it is only after a apprenticeship that it can be used with exactness and dexterity. (Fig. 1.)

scoop (la pelle) is made of iron, with an edge of steel. It is fixed at the end of oden handle of about 3 feet in length. This serves to clean the bottom part of hip and particularly to draw out the resin from the reservoirs. (Fig. 2.)

e barker (la barrasquite) has a blade, steel-plated, narrow, and curved, and is ished with a handle 5 feet long. This instrument is used for barking the trees e highest point where it is impossible to use the ax, and for gathering the from such places. (Fig. 4.)

other kind of barker (le rasclet) much edged, having a handle 6 feet long, which rnished with a step, is used in certain regions to continue the chip above the ht of a man. Often the orchardist holds on by the handle of the "rasclet" and ks with the hatchet. (Fig. 3.)

A third form of scraper (la pousse), having a handle 8 feet long, used for the sa purpose, has the blade so bent as to permit the worker to stand at a distance from t tree, thereby avoiding, while working, the falling bark and dripping resin. (Fig.

A shorter scraper (le palot) with a handle only 3 feet long replaces the scoop ever where where the Hugues system does away with the dirt; it is used for cleanin and is also used like a dibble at planting time for planting the acorns. (Fig. 6.)

A ladder made by cutting steps into a pine sapling, each step being held by a na to prevent breaking, is used to reach the higher points.

The products are gathered from the chips or pots, to a reservoir established in t forest, in a sort of basket with a capacity of about 20 quarts. It is formed by cylinder of rough cork surrounded with wood, the bottom being a round slab, ma fast with pegs, the handle is of willow.

A spatula (l'espatula) is used to remove the resin that adheres to the sides of t pots or transporting vessels. (Fig. 7.)

PLATE V.—Cross-sections through bled timber.

This plate shows cross-sections of trees bled through several periods of years; al the manner in which chips are distributed, and healed scars.

PLATE VI.—Turpentine gathering—Hugues system; fire-safety strip.

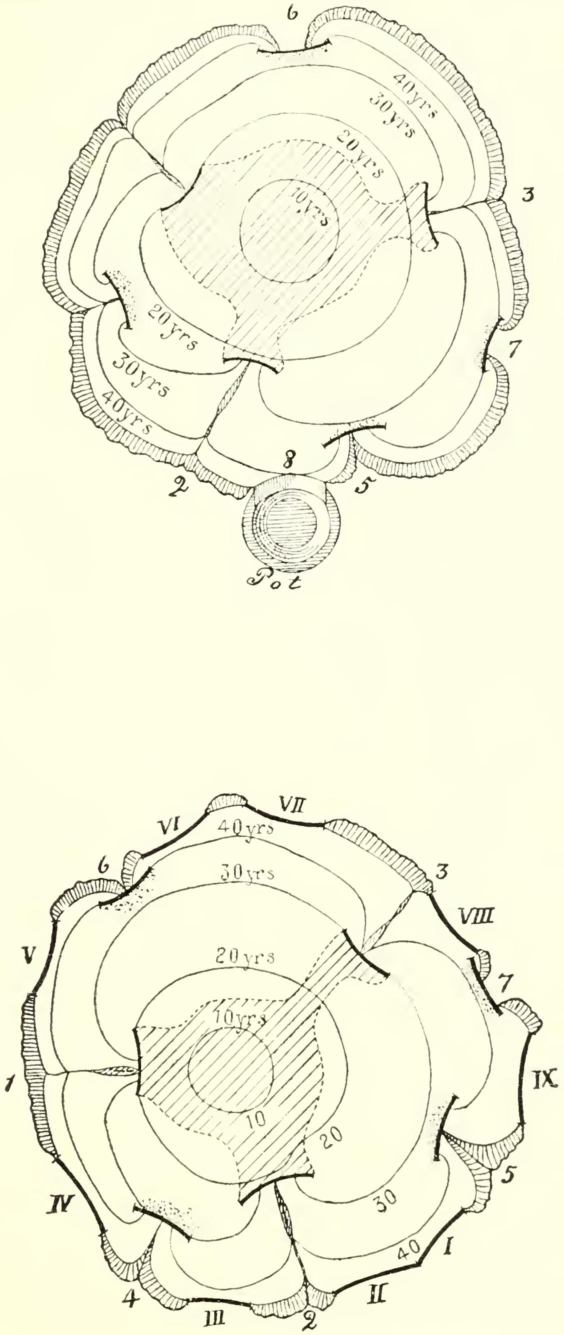
In this plate Fig. 1 exhibits the method of gathering turpentine by the Hugu system, and the use of the till and pot. While formerly the resin was allowed to ru into a hole in the sand at the foot of the tree, since 1860, when the production wa stimulated by the closing of the American sources of supply, an improvement on th crude method of collecting came into use. It consists in fixing a bent zinc collar o gutter cut from sheet zinc 8 inches long and 2 inches wide, with teeth (see figure across the chip, which acts as a lip, and conducts the liquid resin into a glaze earthen pot or a zinc vessel of conical shape suspended below the lip. The pots ar 6 inches high, 4½ inches at the opening, and 3 inches at the bottom, and hold about quart. At first placed on the ground they are fastened each season above the old chi by means of a nail through a hole or otherwise (see figure). In this way, by shorten ing the distance over which the resin has to flow, the evaporation of the oil is re duced, and there is less liability of impurities to fall into the receiver. A cover ove the pot is also sometimes used. The pots are emptied every fifteen or twenty day with the aid of a spatula (see Plate IV, Fig. 7). The scrape is collected only twic in the season, in June and November.

Another improvement which reduces the amount of evaporation and assures cleane resin consists in covering the chip with a board. This improvement (Hugues system is said to yield more and purer resin, the yield is claimed to be about one-third larger and the difference in price, on account of purity, 80 to 90 cents a barrel, while th cost per tree per year is figured at about 1 cent, besides the proportion of scrape i considerably reduced. This (called galipot) is collected by hand, except the hardes impure parts (called barras), of which there is hardly any in this system of collection Not more than 17.9 per cent of scrape is expected, as againt 29 in the America practice.

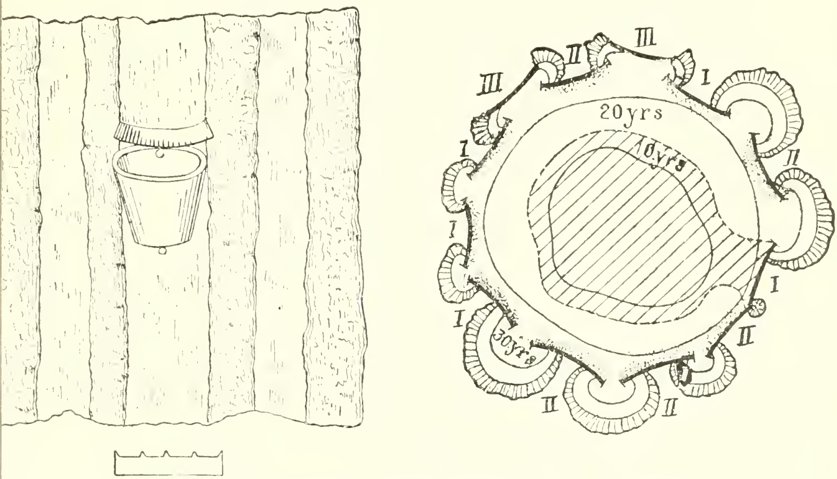
Fig. 2 shows safety fire strip along railroad; *a* is the elevated roadbed, *b* is a stri of ground about 25 feet wide, which is cleared of all inflammable material. Along side of this the wooded safety strip about 50 to 60 feet wide; *e* is a ditch 5 to 6 fee wide, a foot or so deep, the soil being thrown toward *d*. Cross ditches are mad through the safety strip every 300 feet. The total width of the whole system of th road on either side is, therefore, 80 to 90 feet. The strip *b* may be used for agricul tural purposes if fit for it; strip *c* remains wooded, but the forest floor is cleare out and freed of all inflammable material.

MANAGEMENT OF TURPENTINE PINERIES.

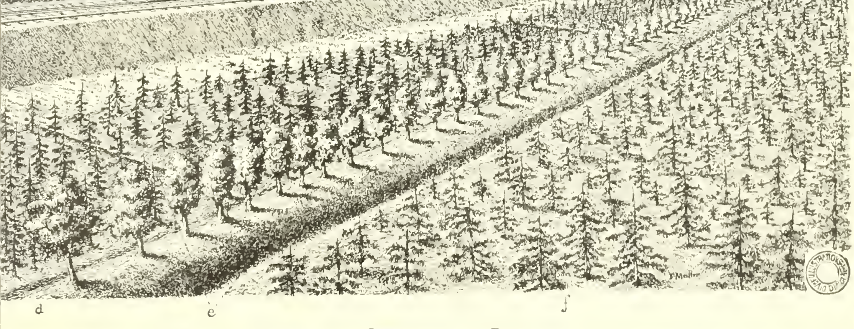
When the yield of turpentine falls below a certain minimum, the time has arrived when the growth must be regenerated. All trees are then bled "to death" and cut as they give out, and the openings are seeded with pine seed and the reproduction is completed in four or five years. The young forest grows up uniformly, densely, and quickly, and when 10 or 12 years old it becomes necessary to thin out and to repeat the operation every five or six years, so that at the age of 20 the pines are nearly isolated. Then there are about 250 to 280 trees per acre, and bleeding "to death" is commenced at the rate of, say, 80 or 85 trees which are to be taken out during the next four or five years. At



CROSS SECTIONS THROUGH BLED TREES—FRENCH METHOD.



TURPENTINE GATHERING (SYSTEM HUGUES), TILL AND POT.



FIRE-SAFETY STRIP ALONG RAILROAD.

the age of 25 another 80 are subjected to the operation, and at the age of 30 there may be left 100 to 125 trees per acre. At this age, when the trees are about 1 foot in diameter, bleeding "alive" is commenced on all trees. At the age of 60 to 80 years this number has dwindled down by casualties to 80, or even 65. If well managed, these trees may last 120 to 130 years; otherwise, if bled too much, they will succumb in half the time. A rest of a year or more every fifth year is necessary to recuperate the trees. When the circumference of the tree has been all chipped, the old chips may be opened again.

In order to produce resin abundantly the trees must stand isolated, their crowns well exposed to the sunlight, but it is only necessary that the crowns should just touch, when the trees are sufficiently isolated.

The best producers are the short, stout trees, with well-developed crown and well set with branches. To endure tapping without injury, they should be at least 14 inches in diameter, with a bole of 20 to 26 feet to the first limb on the dunes and 40 to 50 feet in the landes. There is no definite relation between volume and resin production. In fact, there is but little known as to the conditions and physiological processes which give rise to the formation of resin, except that full active foliage and heat seem to be essential factors.

GATHERING OF SPRUCE TURPENTINE.

The wood of the spruce contains few and rather narrow longitudinal resin ducts, but wider lateral ducts, which are strongly developed in the liber or new wood fibers. It is these that furnish the flow. Hence the methods of extraction used on the pines must be modified. In growths of 80 to 100 years old the yield is about 127 pounds of scrape and 40 pounds of dip per acre. Here the scrape is the purer material, and, therefore, more expensive, the dip being more or less impure. The operation is harmful to the trees, as it is apt to induce red rot. The pitch known as Burgundy pitch is derived from the resin of this species.

The resin of the spruce has also the property of hardening very quickly on exposure to the air; therefore it does not flow readily enough from the chip to permit the methods used in the pines. In May or June two chips are made at the same time, 3 to 3½ feet in height and only half an inch in breadth, on opposite sides of the tree. They are cut with a specially curved sharp knife, and deep into the sapwood. In order to prevent stagnant water from collecting at the bottom this is made pointed. The sides of the chip soon callous, which would prevent the flow, and, therefore, the sides must be renewed every two or three years, or yearly, gradually widening the chip, so that after a series of years only two small strips of bark remain between the two chips. The renewing of the sides is done in summer, so that they may protect themselves before winter sets in by forming new callous. In some localities alternate chips are made every two years, instead of enlarging the original one. The bleeding is continued for ten to fifteen years, and the yield per tree and year averages 1 pound scrape and 1½ pounds of dip.

GATHERING OF LARCH TURPENTINE.

The larch contains resin ducts of very large diameter, and the resinous contents are found mainly in the heartwood. The trees very often contain frost splits in the heart, in which the resin collects. The trees are bored into about a foot above the ground in horizontal direction. The bore-hole, being 1 inch in diameter and reaching into the center is closed with a wooden stopper. This hole fills up during the summer and the resin is taken out with a half-cylindrical iron and then closed up. One tree will furnish per year one-fourth to three-eigths of a pound (120 to 180 grams) of resin. If the bore-holes were left open from spring to fall the yield could be increased to 1 pound, but the resin would be impure, would contain less spirits of turpentine, and the tree would be damaged. One bore-hole suffices for the whole period of orcharding, which is usually carried on for thirty years. With small amount of work and with a price two to three times that of the black pine turpentine, and no injury to the trees, this industry is quite profitable in spite of the small yield.

GATHERING FIR TURPENTINE.

The resin of the firs occurring mainly in isolated resin vesicles or cells and most abundantly near the bark (blisters), this is gathered by means of an iron pot with sharp-pointed till, with which the vesicles are pierced. From the European fir in this way the Strasburg turpentine used to be gathered; now the practice is nearly abandoned. The Canada balsam is gathered similarly from our own fir, *Abies balsamea.*

EFFECTS OF TURPENTINE ORCHARDING ON TIMBER, TREE, AND FOREST, AND SUGGESTIONS FOR IMPROVEMENT ON AMERICAN PRACTICE.

The turpentine industry can be carried on, but usually is not, without detriment to the value of the timber, to the life of the tree, and to the condition of the forest. The present practice, however, in the United States is not only wasteful, but highly prejudicial to present and future forestry interests.

EFFECT ON THE TIMBER.

As far as the timber of bled trees is concerned, it has been shown by the work of the Division of Forestry that the heartwood, the only part of the tree which is used for lumber, is in no way affected directly by the process of tapping. Not only has its strength been shown to be in no wise diminished, but since the resin of the heartwood does not participate in the flow, being nonfluid, the durability of the timber, as far as it depends on the resinous contents, can not be impaired by bleeding. Indirectly, however, by the boxes and large-sized chips, a considerable loss of timber in the best part of the tree, the butt log, occurs, which is avoidable. The parts surrounding the scar are furthermore rendered somewhat harder to work by an excess of resin which accumulates on and near the wound, tending to "gum up" tools. Indirectly, also, a considerable proportion of boxed timber becomes defective if not used at once or, if left on the stocks exposed for a series of years to destructive agencies, such as fires, followed by fungus growth and attack of beetles. The larvæ of large capricorn beetles bore their way through the soft wood formed in the shape of callous surrounding the borders of the chip and through and beyond the sapwood. Through the innumerable fissures which are caused by repeated fires, air and water charged with spores of fungi find entrance into the body of the tree, causing decay, the damage increasing every year, so that from this cause alone the timber from a turpentine orchard abandoned for ten or fifteen years was at the sawmill found damaged to the extent of fully 20 per cent.

Another prospective loss in timber is occasioned by the tapping of undersized trees which are not ready for the saw. Even if the trees survived all the changes of the years following the bleeding and healed over the wound, the timber formed after the process, at least in the portion of the tree which carried the chip, is inferior and not fit for sawmill purposes on account of malformations and change of grain. The loss of timber by fire is also only an incidental effect of careless management.

EFFECT ON TREES.

No doubt the normal life of the tree is interfered with by bleeding; not that the resin is of any physiological significance to the life of the tree, but the wound inflicted in the tapping, like any other wound, interferes with and reduces the area of water-conducting tissue. This interference may be so slight as practically to have no effect, or so great as to kill the tree sooner or later if other conditions are unfavorable. The experience in France shows that with care (narrow chips and periods of rest, which permit callousing of the scar) trees may be bled for long periods and attain old age (see p. 348); it also shows how fast a tree may be bled to death, if this is desired. (See Plate III.)

While the exudation of the resin covering the excoriated surface and the accumulation of resin in the wood near the surface act as an efficient antiseptic and firm protection against atmospheric influences, access of fungi and of insects to the interior of the tree—superior to any callous—it also endangers the life of the tree if exposed to fire, since the resin is highly inflammable, and the heat produced by its flame is capable of killing the trees outright. It is, therefore, again, this indirect effect which exposes the trees of the turpentine orchard to extra risk, even though the operation was carried on with due care and consideration for the vitality of the tree.

EFFECT UPON THE FOREST.

What has been said regarding the effects upon timber and trees applies naturally to the forest as a whole. With proper methods and proper care the turpentine industry need not be detrimental to the full and profitable utilization or the successful regeneration of the forest. In France the turpentine orchard is generally as well managed—with exceptions, of course—as any other forest property. Unfortunately, the ignorance and carelessness of our turpentine gatherers, as well as of the entire community regarding forestry matters, lead to most disastrous results.

The coarse, irrational manner of cutting boxes into the tree for gathering the dip, while reducing the yield of the valuable oil, weakens the foot of the tree, and those receiving more than one box or being of smaller size are generally sooner or later blown down; the broad chips out of proportion to the size and vitality of the tree cause many to die before they have yielded what they could; the same charge of wastefulness may be made against the methods of chipping and of collecting the resin, both of which reduce the yield considerably. But the greatest loss is that occasioned by the fires, carelessly handled by the orchardist himself in trying to protect himself against it, and still more carelessly allowed by the community to rage over large areas one season after another. In the orchard their destructiveness is increased by the broad resinous surfaces at the butt of the trees by the blown-down trees and the débris of the dead trees standing or lying on the ground. Dr. Mohr observes—

The trees which have not been killed outright by the fire, or have altogether escaped this danger, are doomed to speedy destruction by bark beetles and pine-borers, which find a breeding place in the living trees blown down during the summer months, the broods of which rapidly infest the standing trees, which invariably succumb to the pest in the same season. Hence, the forests invaded by the turpentine men present, in five or six years after they are abandoned, a picture of ruin and desolation painful to behold; and in view of the destruction of the seedlings and younger growth, and of the vegetable mold, season after season, all hope for the restoration of forest life is excluded.

SUGGESTIONS FOR IMPROVEMENT.

No radical improvement or existing practice can, of course, be expected until the turpentine orchardists themselves can see that present conditions and methods are detrimental to their business, and can persuade the community that it is to the mutual interest of both community and orchardist to allay the fire nuisance.

Forestry—that is, rational use and management for perpetuity of our forest resources—will never succeed in our country until our communities discountenance the habits of the savages in the use of fire and learn that civilization consists in making nature do more than she voluntarily gives; in fact, that it consists in management, not in destruction, of natural resources.

It is the duty as well as the self-interest of the community to do all in its power to make rational management for continuity practicable, and the first step is to insure protection of individual property against loss, be it by depredation or by other preventable causes. Hence, protection against fire is a *conditio sine qua non*, if we would have rational and systematic management of our forest resources; for so long as forest property is made extra hazardous by lack of proper protection against fire, the inducement to rob it of its best parts in the shortest time and then abandon it to its fate is too great.

I would refer here to another part of this report, in which the general legislation for fire protection has been outlined (p. 310). In the States or portions of States in which turpentine orcharding is practiced, additional provisions would be necessary.

Regarding the practice in the technical operation of tapping, legislative regulations are probably out of question, the spirit of our institutions being against interference in the use of private property, except where such use is directly injurious to other persons. Otherwise it would be desirable for the indirect benefit of the community, and especially its future, to prescribe lowest size of trees to be tapped and broadest chip permissible.

The orchardist's own interest, if he owns the forest and proposes to make the most of it, or the owner's interest, if he leases it for turpentine orchard, would dictate the following considerations, which I have formulated into a set of instructions:

(1) Attend to the firing of the brush, when preparing for orcharding, at a season and time when a smoldering fire can be kept up which will not kill young growth and will not consume to ashes the vegetable mold.

(2) Abandon the "boxing" system and substitute the movable pot with cover and lip. (See Plate VI.) By this the tree is less injured or

liable to injury, and a larger amount of valuable dip and a smaller proportion of scrape is insured. The cost of making and cornering boxes—a wasteful operation—averages about $1\frac{1}{2}$ cents per box, while the cost of pots is very much higher (heavy tin or zinc iron pots might be used more cheaply); but if the orchard is worked for longer time, as proposed in the following, the cost per year will be reduced and amply repaid by better yield.

(3) Tap only trees large enough to make a good saw log, not less than 12 inches at the butt. Not only will such trees yield in better proportion to the labor expended, but the younger trees when left, after the saw timber fit for the saw has been taken, will assist in the reforestation by shedding their seed, and will in a few years have grown to proper size both for profitable tapping and profitable lumbering.

(4) Reduce the chip in breadth to not over 3 inches, and rather work more chips at a time on the same tree, if good sized; not more, however, than one for each foot in circumference simultaneously, so that a tree 1 foot in diameter would carry, say, three of these narrow chips, evenly distributed. Thus the tree will be kept in full activity and yield more turpentine for a longer time.

(5) Before starting the chip remove the rough bark down to a thin (reddish) skin for the breadth of 4 inches and, say, 2 feet in height, or a little wider than the chip is to be, and as high as it is to be worked for the season; this is for the purpose of keeping your pots clean of bark particles. Start the chip with as small an opening and as low down at the foot of the tree as is practicable for attaching the pot, and cut it triangular at the base, so as to allow any water to readily flow off, preventing its collection and consequent fungus growth.

(6) Do the chipping as gradually as possible, remembering that the flow depends mainly upon the number of longitudinal ducts cut through transversely and kept open. A rapid increase in height of the chip is a useless waste; the chipping is done simply to remove the clogged-up ends of the ducts; the removal of one-fourth to one-third, or at most one-half inch, of new wood every five to eight days, according to the weather, will accomplish this end. As to depth, it is useless to cut deeper than the sapwood, since the heart does not yield any resin. Whether the French method of deepening the chip gradually and only to a depth of one-half inch at most or a cut through the entire sapwood at once is, on the whole, more profitable, comparing labor and yield, remains to be ascertained by trial. Where trees are not to be managed for continuous bleeding, but are to be exhausted prior to their cutting for saw logs, it would appear proper to cut at once through the entire sapwood, using perhaps a sharp chisel for the work of chipping. When we have arrived at a time when the orcharding is done in young plantations managed for the purpose the more careful chipping of the French may be indicated.

(7) Do not collect the scrape more than once a year, in August or September, or early enough to give the trees a chance to protect their scars before winter sets in, but reduce the amount of scrape by using pots and lips and keeping these as close as practicable to the top of the chip. In this way the superior yield will pay for the greater care.

(8) Remember that it is more profitable to prepare for operating a given area for ten to fifteen years instead of three to four years, since many necessary expenditures remain the same whether the operation is carried on for the shorter or longer period, and hence in the latter case are distributed through a longer term. With the above methods and proper care an orchard may be worked profitably four or five times

as long as under present methods, and hence many precautions, especially against fire, such as ditches, roads, etc., to arrest the fire, too expensive if the orchard is soon to be abandoned, may be employed with advantage.

(9) If present methods must prevail and protection against fires can not be had, because the community is still too uncivilized or blind to its interests, do not subject your valuable timber to turpentine orcharding, unless you can dispose of it to a sawmill immediately after the orchard is abandoned. Otherwise the loss of timber by fire is apt to wipe out all profits made by the orchard.

In closing this long and yet not exhaustive paper on a subject of vital importance to Southern forestry interests of the present as well as of the future, I feel that more knowledge based on experiment is wanted before we can with assurance determine the most profitable and least injurious practice for the turpentine industry.

ADDITIONAL NOTES ON THE TURPENTINE INDUSTRY.

By Charles Mohr.

IMPROVEMENTS IN THE DISTILLATION OF THE CRUDE TURPENTINE BY THE APPLICATION OF STEAM.

In the ordinary way, the distillation of the crude turpentine yielding the largest quantity of spirits of turpentine and finest quality of rosin can not be carried to the total extraction of the volatile oil without impairing the quality of the residuary product. The higher grades of rosin are still retaining a considerable amount of spirits. To prevent such loss distillation by steam has been resorted to. This innovation seems, however, not to have received the deserved attention. From the latest information it appears that this method has proved completely successful at a turpentine distillery in New Orleans; there, by its introduction, an increase of fully 30 per cent is claimed over the yield of spirits of turpentine obtained by distillation by the open fire, the grade of rosin remaining unaffected.

PRODUCTS OF THE DESTRUCTIVE DISTILLATION OF THE WOOD OF THE LONGLEAF PINE.

The air-dried wood of the longleaf pine in its normal condition has been found to contain from 2 to $2\frac{3}{4}$ per cent of volatile oil, taking the specific gravity of spirits of turpentine at 0.87 and the weight of 1 cubic foot of the air-dried wood at 43 pounds. The spirit is obtained by subjecting the wood to the action of superheated steam in the same retorts in which its destructive distillation is carried on, a process with which its production direct from the wood is invariably connected, and of which it forms the first step. The quantity of spirits of turpentine obtained varies largely. As stated by one operator, it differs all the way from 5 to 18 per cent, according to the wood being fresh cut or dry, and to the different parts of the tree from which it is taken. From the results of numerous experiments made on a large scale in different parts of the longleaf pine region, it can be assumed that one cord of wood, green and of different degrees of dryness, yields, on the average, about 15 gallons of an impure spirits of turpentine. Owing to the presence of empyreumatic substances of yellow color it becomes darker on exposure to air and of an empyreumatic odor. It is easily freed from its impurities by redistillation; thus rectified the product is perfectly clear, colorless, and almost odorless, save a faint woody smell, answering all the purposes for which the spirits of turpentine obtained from the rosin is used. In 1881 Mr. William Mepan, of Georgia, secured a patent for the utilization of the wood wasted at the sawmills, of the refuse left on the ground in the logging camp and in the turpentine orchard, for the production of spirits of turpentine, pyroligneous acid, tar, and charcoal. By the operation of the apparatus of the patentee, on exhibition at the Atlanta International Exposition (in 1882), 600 pounds of dry, highly resinous wood, so-called lightwood, yielded—

	Pounds.
Spirits of turpentine	21¼
Pyroligneous acid	95
Heavy oils and tar	150
Charcoal	127
Water and gas	206¾
Total	600

Amounting to a yield by the cord of 24 gallons of spirits of turpentine, 88 gallons of pyroligneous acid, 120 gallons tarry and heavier oily products, and 56 bushels of charcoal.*

In several experiments made at the same place slabs taken from the sawmill yielded (to the cord) from 12 to 14 gallons of spirits of turpentine, 200 to 250 gallons of weak pyroligneous acid, from 64 to 108 gallons of tar and heavier oils, and from 50 to 60 bushels of charcoal. The operations subsequently carried on by the same parties in retorts of a capacity of about 6 cords of wood showed similar results. In the attempt made at Mobile by Mr. Maas, about fifteen years past, in connection with a sawmill, soon abandoned, however, the results were about the same. From a cord of green slabs 12 gallons of turpentine were distilled and 150 gallons of tarry and oily substances. The rectified spirits of turpentine was found not to differ sensibly from the product of the rosin. At the works of the Yellow Pine Wood Distilling Company at New Orleans, worked under the patent and superintendence of Mr. E. Koch, every kind of mill refuse, pine knots, stumps, branches, etc., are used. The patentee has kindly furnished the following information about the apparatus employed and the way it is being worked: The material is cut in short pieces, loaded in iron cars, which are run into steel retorts, 20 feet long and 8 feet in diameter, provided with rails and holding 3 cords of wood; doors are closed tight, superheated steam is let in and at the same time a moderate fire is started in the furnace. The distillation proper of the spirits begins in about six hours at a temperature of 300°, increasing during the next four hours to 350°, until the distillate ceases to run; at this stage the steam is shut off and the destructive distillation by the open fire is proceeded with; under the gradual increase of the temperature from 350 to 900 degrees the distillation is continued through the following fifteen hours, the whole operation consuming about twenty-four hours. The residue in the retort is a charcoal of good quality. The quantity of spirits of turpentine obtained from 1 cord varies from 5 to 18 gallons, of heavier oils and tarry products known as dead oil or creosote from 60 to 100 gallons, and of stronger acid (of a specific gravity 1.02) 60 gallons, or of weaker acid 120 gallons. The gas produced is used for fuel. The capacity of this plant is 6 cords of wood in twenty-four hours. By the increase in the value of dead oil that has taken place during the past five or six years the destructive distillation of the wood of the longleaf

*Report of awards at the Atlanta International Exposition in 1882.

pine is placed financially on a more promising basis than ever before. If the enormous amount of raw material be considered, which has heretofore gone to waste at the sawmills and in the forest, but by this process may be turned to a profitable use, this industry is capable of the widest extension and can not fail to add other resources of income to those already derived from the forests of longleaf pine.

With the augmenting demand for the mixture of heavier hydrocarbons and chryselic (phenylic) compounds known in the trade as dead oil, creosote, or pine oil for the impregnation of timber for the purpose of preventing its decay and destruction by the teredo, the distillation of the wood of the longleaf pine is at present carried on with the main object of securing the largest yield of dead oil. According to the statements of Mr. Franklin Clark, of Columbia College, N. Y., made in his paper on the subject, for this purpose the most resinous wood is preferred with which the retorts are charged.

These retorts, cylindrical in shape, made of wrought-iron or steel plates, and about three times as long as they are wide, are of a capacity to receive little over a cord of the perfectly air-dried wood. The distillation is effected by the open fire and the condensation of the distillate by the ordinary worm condenser. The light oils running over first at a temperature of from 350 to 500 degrees of a specific gravity of 0.88 to 0.90 are of a dark-red color; as soon as their density has increased to the latter figure they are caught separately. After twelve or fifteen hours, when the temperature has reached 600 degrees and the density of the oil is 0.98, with the formation of the chryselic compounds, the aqueous distillate at this stage shows a higher percentage of acetic acid, increasing with the rise of the specific gravity of the oil. The operation is generally finished at a temperature not exceeding 900 degrees. The process is terminated at the end of twenty-four hours.

The charge of the retort averaging 4,575 pounds of resinous, air-dried wood (little more than a cord) yields—

Light oil (of spec. grav. 0.875 to 0.95)	gallons	13
Heavy pine oil or dead oil (spec. grav. 0.95 to 1.04)	do	73½
Pyroligneous acid (spec. grav. 1.02)	do	185

Or a mean yield of:

Pyorligneous acid (spec. grav. 1.02)	1,527 pounds,	or 31.37 per cent.
Total of oily products	729 pounds,	or 15.94 per cent.
Charcoal	1,511 pounds,	or 33.04 per cent.
Gas	761 pounds,	or 16.64 per cent.

On settling, the pine oil—that is, the whole of the oily products of the wood—separates from the acid as a black or red oil, with a specific gravity from 0.907 to 1.30. For the purpose of creosoting it is subjected to a process of partial distillation, by which the separation of the lighter oil is effected, and the percentage of the phenylic compounds and of the heavy hydrocarbons to which the creosoting process owes its merits is increased.

The pyroligneous acid is of a yellowish or reddish color and contains 4 per cent of hydrated acetic acid. In its crude state it serves for the manufacture of pyroligneate of iron, the so-called black dye, and for the preparation of acetate of lime, acetate of lead, and pure acetic acid. The light oil is used for dark paints, fit to cover metals and stone. It does not work well, however, for wood.