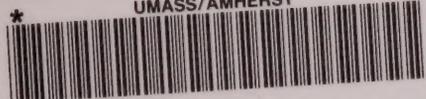


UMASS/AMHERST



312066 0270 8272 7

LIBRARY

OF THE



MASSACHUSETTS
AGRICULTURAL
COLLEGE

635

.08

M 38 p

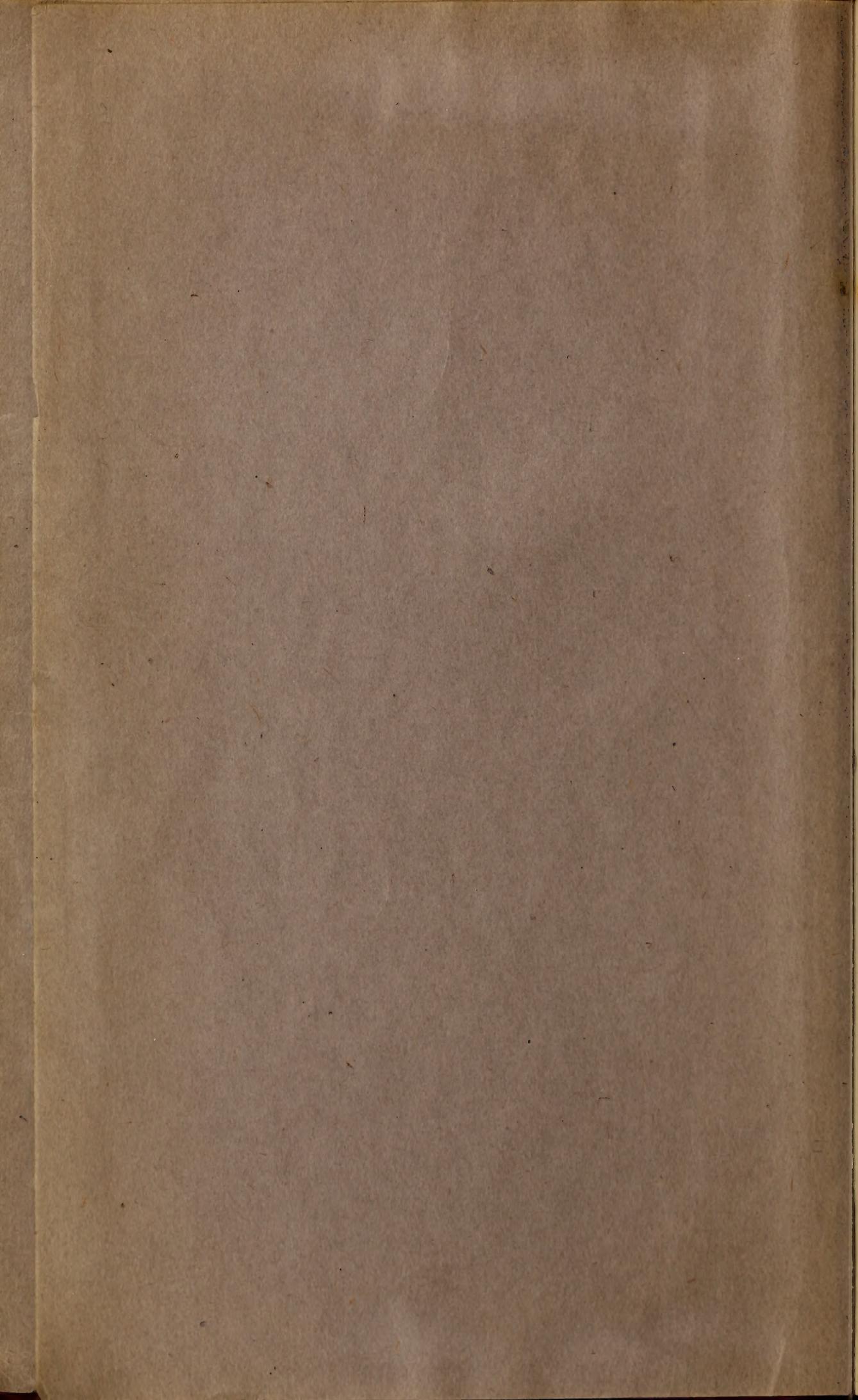
5m-12-'29. No. 7461

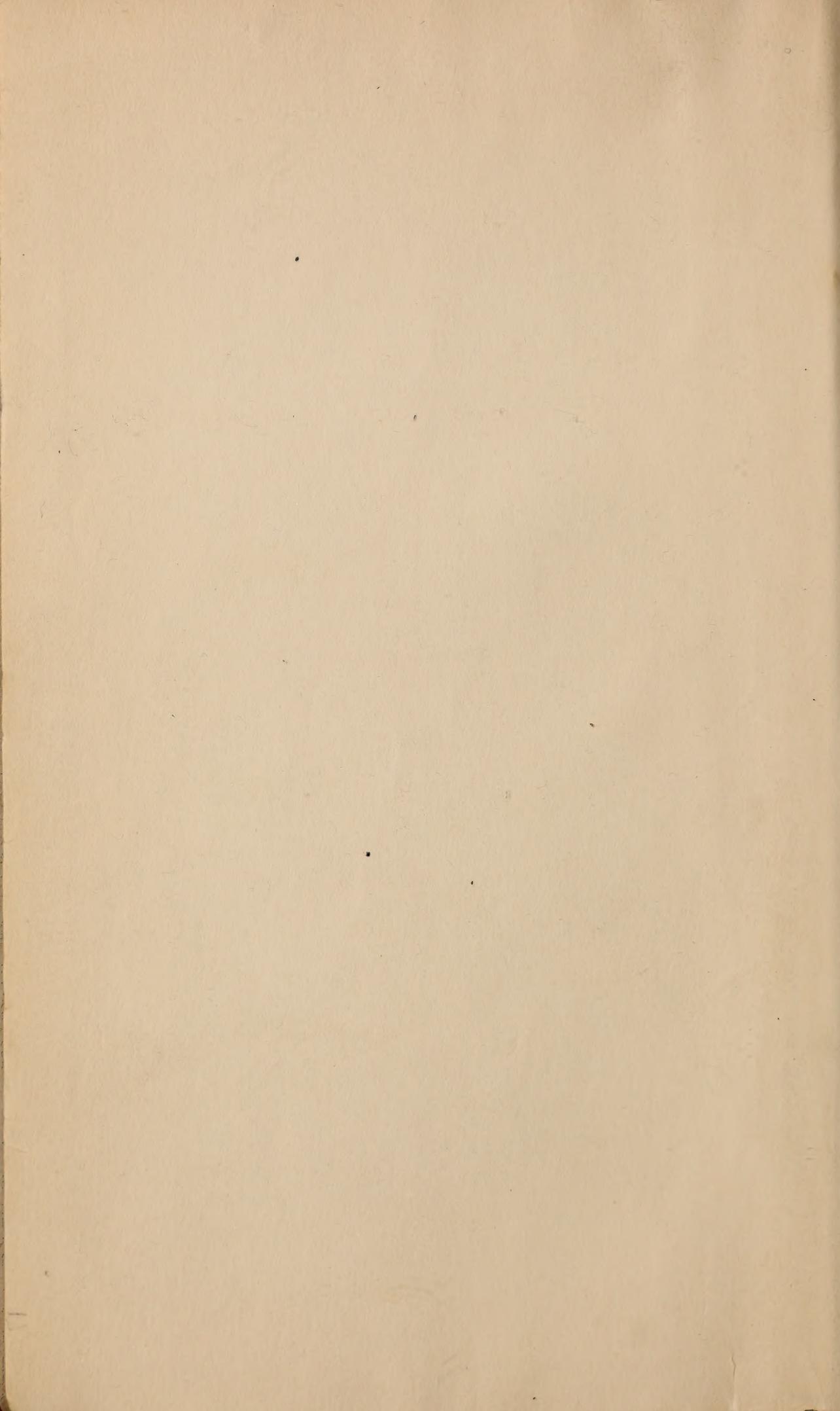
1909-25

GOVERNMENT DOCUMENT
COLLECTION

APR 4 1986

University of Massachusetts
Depository Copy





CONTENTS

1. Forestry in Massachusetts
2. Wood fuel
3. The evergreens
4. We must stop forest fires
5. Parasites of the gypsy and brown-tail moths
6. Massachusetts wood-using industries
7. Wilt disease, or flacherie, of the gypsy moth
- ~~8. Forest trees of Massachusetts~~ ^{MISSING}
9. Chestnut bark disease
10. Artificial use of the brown-tail fungus in Massachusetts.
11. The brown-tail moth.
12. The gypsy moth.
13. Reforestation
14. Forestry in Massachusetts.
15. Improvement thinnings
16. Older forest plantations in Mass.
17. Gypsy moth in Massachusetts
18. Instructions for county forest wardens ^{MISSING}
19. Chestnut bark disease.
20. Forests of Worcester county
21. Utilization of forest products
22. Forests of Plymouth county
23. Massachusetts and her forests
24. Reforestation in Massachusetts
25. Forests of Hampshire county
26. General forest laws
27. Laws relating to gypsy and brown-tail moths
28. Laws relating to forest fires

LIBRARY OF THE
MASSACHUSETTS
STATE COLLEGE

CONTENTS

1. Forestry in Massachusetts
 2. Wood fuel
 3. The evergreens
 4. We must stop forest fires
 5. Diseases of the spruce and brown-tail moth
 6. Massachusetts wood-rain industries
 7. Wild diseases of flaccidities of the spruce moth
 8. Forest trees of Massachusetts
 9. Chestnut bark disease
 10. Artificial use of the brown-tail moth in Massachusetts
 11. The brown-tail moth
 12. The spruce moth
 13. Reforestation
 14. Forestry in Massachusetts
 15. Improvement of forests
 16. Older plantations in Massachusetts
 17. Forestry in Massachusetts
 18. Forestry in Massachusetts
 19. Chestnut bark disease
 20. Forestry of Worcester county
 21. Utilization of forest products
 22. Forestry of Plymouth county
 23. Massachusetts and her forests
 24. Reforestation in Massachusetts
 25. Forests of Hampshire county
 26. General forest laws
 27. Laws relating to spruce and brown-tail moth
 28. Laws relating to forest fires

635.08

M38p

CHAPEL

1909-25

LIBRARY OF THE
MASSACHUSETTS
STATE COLLEGE

①

am

FORESTRY IN MASSACHUSETTS.

PART I.

WHAT IS FORESTRY?

Forestry is technically defined as the science which is concerned with the formation, cultivation, harvesting and utilization of timber, in short, the management of timber as a crop.

True Forestry deals with trees in forest stands as a community and is to be distinguished from arboriculture, the science that deals with trees as individuals, although in practice, the two sciences both go under the name of forestry and are not looked on as distinctive as they should be. Forestry is distinguished from landscape architecture by its point of view. Landscape gardening deals with trees, both as individuals and as groups, but always with the purpose of producing artistic effects, and if any wood or timber is produced, it is merely incidental. We do not mean to say, however, that forestry can always be divorced from the considerations of landscape architecture.

Forestry is chiefly concerned with the economic production of wood or timber, and it aims to do one or more of these things: to produce by cultivation a greater amount of timber than an uncared-for forest, to produce a better quality of timber, or to produce the same amount of timber in a shorter period of time. In other words, it aims to assist and improve on nature in the same way that scientific agriculture cooperates with nature. We will not attempt here to describe how these things are done, for to do so would be to write an elaborate text book on forestry, and that is not in the scope of this bulletin.

The considerations which make forestry desirable, however, are many. They vary somewhat in the different sections of the country and also to some extent in the same section according to local needs and the desires of individual owners of woodland. In steep, mountainous countries, the protection of the soil cover and the maintenance of its ability to store moisture and to equalize the run-off of streams is of more importance than the raising of timber. On the prairies of the central west, the forests have an important influence on climate by reducing the extremes of temperature, while in many places the protection of the natural scenery is often an important consideration. As a rule, if forestry is practised for commercial purposes, i. e., to provide timber, the protective and beautifying functions of the forest will be performed, *per se*.

Back of the prescriptions of forest management is the principle of the "sustained yield." The principle of having the forests of one unit, it may be of one owner, of a township or of a state, so organized that each year there can be harvested an amount of lumber equivalent to the annual increment over the entire forest. This crop can thereafter be harvested each year forever, because the forest capital will be unimpaired. The fact that there are many practical considerations standing in the way of the attainment of this ideal does not prevent it from being the background of the plan of forest management.

IMPORTANCE OF FORESTRY IN MASSACHUSETTS.

The proper management of our forests is of great importance to this Commonwealth for two very evident reasons, first, because we are large consumers of forest products and second, because we are potentially large producers of them.

To consider the first reason let us understand that the people of this state use each year, 900 million feet of lumber, nine-tenths of which comes from outside the

JUN 24 1931

boundaries of the state and three-fourths of which comes from outside of New England. Of the material coming from outside of New England, the bulk is made up of southern pine from the Gulf States and Douglas fir from the Pacific Coast, lumber brought thousands of miles and on which the freight charge alone is more than the entire value of similar native lumber twenty-five years ago.

It is a popular misconception that the bulk of our lumber supply is consumed in building construction. As a matter of fact only 300 million feet of the amount named above is used for construction purposes, while the other 600 million forms the raw material of our manufacturing industries, the three industries most prominent as wood consumers, being box making, furniture and novelties. If these industries ever close down for lack of raw material, much invested capital will become idle and many thousands of workmen will be out of a job.

Year by year the production of lumber in New England grows smaller and our builders and manufacturers go further and further afield for their raw material. Witness in Providence a great terminal for the unloading of timber brought from the Pacific Coast via the Panama Canal, and in Boston harbor steamers loaded with paper pulp manufactured in Sweden and Finland. It seems like "carrying coals to Newcastle" for it is not many years since New England was not only self-supporting in the matter of forest products, but had a comfortable surplus to export outside its boundaries.

In spite of the relatively small area of Massachusetts, the state is potentially a producer of a large yield of forest products. This is due to the high percentage of our forest area which is 60% or 3,000,000 acres. When we say forest area, however, our readers must not imagine a territory covered with high forest, for all of it has been cut over once, most of it several times, much of it has been burned, so that the once valuable forests have been reduced to inferior sprout or scrub lands which produce only 150 million feet of lumber per year, 75 board feet per acre, while under proper conditions this yield should easily be four or five times this amount, and so almost provide us with our annual requirements.

The following table which is based on the results of actual surveys of forest area in five of our counties (Worcester, Plymouth, Norfolk, Hampshire and Essex) give a striking picture of our forest conditions. By way of explanation I will say that of the four sized classes, 1 and 2 might be said to represent merchantable growth, whereas three and four are unmerchantable. Maple and birch refer to grey birch and red maple, species of low value, and so is almost idle forest land. As there are three eastern counties represented to only one western, the table is not an accurate picture of the whole state, even though it covers nearly one-half the total area.

Forest Types.

FOREST TYPES.	4 (Acres).	3 (Acres).	2 (Acres).	1 (Acres).	Total (Acres).	Per Cent.
Pine	44,900	63,300	55,000	28,500	191,700	15
Pine and hardwoods	63,000	77,300	26,000	28,300	194,600	15
Oak	140,000	131,000	73,000	25,000	369,000	28
Hemlock	11,000	20,000	12,000	3,000	46,000	3½
North hardwoods	25,400	20,200	7,400	500	53,500	4
Maple and birch	222,000	114,500	26,500	7,700	370,700	29
Spruce	2,600	2,000	500	-	5,100	½
Pitch pine	47,200	14,700	7,000	2,500	71,400	5
Total	556,100	443,000	207,400	95,500	1,347,900	100
Per cent	48	36	9	7	-	55

Non-Forest.

	Total (Acres).	Per Cent.
Tillage	492,000	20
Pasture	215,000	9
Brush pasture	140,000	6
Brush swamp	50,000	2
Residential	107,000	4
Salt marsh	32,000	1
Water	62,000	3
	2,445,900	45

THE FUNDAMENTAL CONDITIONS.

There are five fundamental conditions that must precede or accompany the permanent development of forestry in any country. The first is the presence of a considerable area of non-agricultural land which is capable of bearing forest growth; the second is a good market for forest products; the third is the presence of good transportation facilities; the fourth is an adequate system of protection from fires; and the fifth is a fair method of taxation of forest lands.

To practice forestry means, on the part of the man who does it the sacrificing of a portion of his present profits for future results, and the forest owner is not apt to do this unless all the conditions are favorable.

1. NON-AGRICULTURAL LAND.

It is not a sound economic proposition to grow trees on land which could earn larger dividends as cultivated land; but in this State we have, as has been said before, nearly 3,000,000 acres which bear forests and are not capable of bearing any other crop, except at great expense. This State, therefore, fulfills the first of these conditions.

2. GOOD MARKETS.

The second condition — that of a good market for forest products — is also fulfilled in this State. Where there is building going on there is a demand for lumber; where manufacturing is going on wood is being used somewhere in the process of manufacture or in crating the product for shipment; where there are railroads there is a demand for ties; where there are telephone and telegraph lines there is a demand for poles; and where farming is going on there is a demand for lumber, fence posts and firewood. The degree to which forest cultivation can be carried on depends largely on the market for forest products, and the market for forest products depends largely on the density and distribution of population. There is only one State in the Union that has a denser population than Massachusetts, and although congested around Boston, there is no large section of the State that is not settled with cities and towns of considerable size. Manufacturing is going on not only in the larger towns but in most of the smaller ones. It is readily seen that a market for wood and lumber is not far to seek in any part of this State; no one has better markets.

3. TRANSPORTATION FACILITIES.

Transportation has an important bearing on forestry. Forest products are as a rule bulky and heavy, and their transportation is consequently a considerable item in the cost of marketing. Whether this or that operation can be adopted in the woods often depends on the question whether the lumber can be carried to the market with a margin of profit. If transportation facilities are good much more intensive forestry can be practiced than otherwise.

The transportation problem here in this State is comparatively simple. A network of railroads puts nearly every section of the State within practical hauling

distance of a shipping point. Our country roads, when compared to those of other States, are excellent, and we have 1,500 miles of macadamized State highway which is being added to each year.

4. PROTECTION FROM FIRE.

Fire is the greatest enemy of the forest. It not only injures and destroys merchantable timber, but it kills young growth upon which our future timber supply must depend. The constant recurrence of fires on large tracts changes them to barren wastes, producing nothing and a burden to the community that contains them. More damaging than the actual loss by fire is the fear of it, which prevents conservative and scientific handling of our woodlands. We cannot condemn the lumberman for skinning the land where we cannot give him reasonable assurance that it will not burn over at any time. We must protect his crop to the extent of making it possible for him to insure it at reasonable rates that do not exceed the growth of the crop. Great progress has been made in the matter of fire protection in this State in the past few years. The forest warden act of 1907 put the matter of fighting forest fires in our towns in the hands of one responsible man and clothed him with sufficient authority. The fire warden acts of 1911 created the office of State Fire Warden, with district deputies to supervise the work of the town wardens and a small appropriation to expend in the work of forest-fire prevention. Under this law the smaller towns have been provided with fire-fighting apparatus, and a system of 40 watch towers has been erected for the early detection of fires.

With all our improvements, however, we are still a long distance from the ideal condition because we still have far too many fires and too many acres of burned land.

5. A FAIR METHOD OF TAXATION.

The system now in vogue of assessing forest lands for purpose of taxation provides not only for the taxing of the land but of the growing crop as well. Not only is the crop taxed once but many times over, and for many years before any returns come in. The only reason that this unjust condition of affairs has not been realized before is that the assessors have purposely undervalued forest lands, and that therefore what is wrong in principle has not been apparent in practice. Indeed, were forest land given its full value and taxed at the prevailing rate, the tax would be nearly equal to the value of the entire annual increment on the woodland. How long could any business last whose entire income had to go to pay taxes? Either the assessor must break the law and undervalue the forest or else he practically confiscates it. Such a system is neither fair to the landowner nor the assessor.

This Commonwealth, which leads in many forms of legislature, is also leading in this matter of forest taxation. As long ago as 1905 a commission was appointed to study the matter, and as a result of their study and the constant agitation in behalf of the reform, the Legislature and the people have adopted a constitutional amendment which allows the Legislature to make a new system of taxation for forest lands. Following this permission the Legislature has passed an act (Chap. 360 Acts 1922) under which growing forest land can be separately classified and thereafter the timber will not be taxed until it is cut.

RECAPITULATION.

As we said before, there are five conditions which are fundamental to a permanent and successful development of forestry: (1) the presence of a considerable area of non-agricultural land that is capable of forest growth; (2) a good market for forest products; (3) good transportation facilities; (4) a good system of fire protection; (5) a fair method of forest taxation. The first three of these conditions we already have, the fourth we are attaining and the fifth we also have, so that we should feel greatly encouraged in our endeavor to establish forestry in this Commonwealth.

PART II.

THE COMMONWEALTH'S FOREST POLICY.

The office of State Forester was established in 1904 with an appropriation of \$5,000 and a force made up of one assistant and a clerk. The increasing interest of the state in its forest problems is shown by the fact that the same department today has about thirty assistants, eight clerks and an appropriation of \$450,000. In 1909 an important addition to the duties of the State Forester was made by abolishing the office of superintendent of moth work and placing the supervision of the gypsy and brown-tail work in the hands of the State Forester. In 1911 the State Forester was given general supervision of the forest fire work in the state acting through an assistant known as the State Fire Warden. In 1914 the Commonwealth decided to adopt the policy of acquiring land for state forests and created for this purpose, the State Forest Commission of three men, of whom the State Forester was one, with a small appropriation for the purchase of land. The outbreak of the European war made it seem unwise to push this work very vigorously so that in its five years existence only 12,000 acres were bought by this commission. In 1919 the general consolidation of all state offices into twenty departments took place and the forest service was placed in the Department of Conservation together with the Division of Fisheries and Game and the Division of Animal Industry. Mr. Wm. A. L. Bazeley was appointed head of the Division of Forestry in the capacity of State Forester and head of the Department of Conservation as Commissioner. In this consolidation of the departments, the State Forest Commission was abolished, but in 1920 the legislature authorized the Commissioner of Conservation to purchase 100,000 acres of land for state forests, these lands to be bought before 1934.

We have given a brief outline of the development of the Commonwealth's forest policy by detailing some of the high lights in its history. Now let us see how this forest policy is at present being carried out in the actual work of the Division of Forestry.

In general one can divide the operations of the Division of Forestry into five lines of work, as follows: Suppression of Gypsy and Brown-tail Moth, Forest Fire Work, Purchase and Administration of State Forests, Forest Nurseries, Educational.

SUPPRESSION OF GYPSY MOTH.

The law provides that each individual town shall care for the suppression of the gypsy and brown-tail moths within the borders through a local superintendent appointed by the selectmen or mayor and approved by the state forester. In carrying out the measures for such suppression, he acts under the direction of the state forester, and his district superintendents. The financing of this work as provided by law is somewhat complicated and complete details are not essential to this account. Suffice it to say that each town has a liability which is one twenty-fifth of one per cent of its valuation. This sum, which amounts to only a few hundreds in small towns, and runs up to \$5,000 in cities, the community must spend from its own funds provided the moth conditions call for it. Where amounts in excess of this liability are spent with the authorization of the State Forester, the whole or a portion of this excess is reimbursed by the State to the towns, the rate depending upon the valuation of the town. This reimbursement may be paid in money or in the form of supplies or both.

In combating insects, the state forester is limited to work against the gypsy and brown-tail moths. As far as other injurious insects are concerned, he can act in only an advisory capacity and if towns wish to combat such pests they must do so at their own expense and through a special appropriation.

The State Forester is superintendent of moth work but assigns this work to a deputy superintendent who supervises the work of six district superintendents.

There is also a business agent who looks after the buying, distribution of supplies used in moth work and who incidentally performs the same service for the other branches of the forestry division. The present appropriation for gypsy moth work is \$150,000, a very substantial reduction from the \$300,000 appropriations made for many years.

FOREST FIRE PREVENTION.

The work of fighting forest fires in each town is in the hands of a local forest warden who is appointed by the selectmen or mayor with the approval of the State Forester. In places having an organized fire department, this office is usually held by the chief. The local fire wardens act under the supervision of the state fire warden and his district deputies. This supervision is limited by law, however, to that of an advisory character. The towns bear the entire expense of fighting fires except in the case of the poorer towns where if the fire fighting expenditures exceed their liability, (1/20 of one per cent of the valuation) the state will reimburse them for 50% of the excess. Also the State Forester can compensate these same towns for 50% of the value of fire fighting equipment which they may purchase. Beside the supervision of the local warden, the efforts of the state fire service are directed towards the prevention and quick detection of forest fires. It is required to enforce the slash law which requires that brush left after the logging, shall be cleared away for a distance of 40' from highways and the boundaries of adjoining woodland and near sawmills. It is also required to see that spark arresters of locomotives are in order and that the railroads keep their rights of way properly cleared. For the quick detection of fires, it maintains forty observation towers in which watchmen are maintained for about six months in the year.

The State Forester as head of the fire service deputizes his powers to a State Fire Warden who has the assistance of seven district wardens and 40 observers.

The funds available for fire work are about \$60,000 of which \$8,000 is a grant from the Federal Government.

STATE FORESTS.

Mention has already been made of the State Forest Commission established in 1914 which acquired five state forests aggregating 12,000 acres and of the larger Purchase & Development Act of 1920 under which the area of state forest land has been increased to 60,000 acres divided into 20 forests and promises to increase at the rate of about 10,000 acres per year. As the law provides that the purchase price shall not exceed \$5 per acre, it follows that the department does not acquire land with any amount of large standing timber although much of it has valuable reproduction. The idea of this act is to purchase cut-over timberlands and abandoned farms and through a policy of fire protection, artificial planting and silvicultural treatment to insure that these lands shall grow valuable timber for the future. When the time arrives that this timber is merchantable, it will be sold to lumber operators who will cut it under forestry regulations. It is hoped that eventually the Commonwealth will own at least 10% of the 3,000,000 acres of forest land in the state. Besides their primary purpose of providing a future reservoir of timber for the citizens of the state, these state forests offer opportunities for recreational use and on several of them, a number of camp sites have been leased to citizens of the state. For purposes of fire protection and convenience, roads and trails are built through the forests and these are, of course, available to the hiker and hunter. They have an important bearing on our hunting conditions for while five of the state forests have been set aside as permanent game sanctuaries, hunting is allowed on the others according to law and in general, it is our policy to keep these forests open to the hunter as long as the privilege is not abused. Fishing in accordance with the general laws is allowed on all the state forests.

The first item in the management of these forests is fire protection and this is largely provided for by opening up of roads and trails, thus dividing up the forest into blocks and making all parts accessible. The second operation is the planting of abandoned fields and pastures and cut-over areas not naturally restocking to

valuable growth, the third will be the improvement of the natural and artificial growth by silvicultural cuttings where possible and the fourth the proper harvesting of the timber crop, which as we have intimated is sometime in the future.

The purchasing and surveying of these lands is in charge of an assistant forester who has several surveyors in the field. The larger forests, are as a rule, under the care of a superintendent who resides on the property, but the smaller forests are placed in the hands of the state fire warden of the district.

The annual appropriation for the purchase and development of state forests is \$150,000.

REFORESTATION LOTS.

These plantations are somewhat analogous to the state forests but for a little different purpose, namely to demonstrate and advertise forest planting. The law provides that the State Forester may purchase scattered tracts not to exceed eighty acres in one lot, suitable for reforestation at a price not to exceed \$5.00 per acre. The law further provides that the original owner of these lots shall have the privilege of redeeming them at any time within ten years by paying back to the Commonwealth the purchase price plus the cost of planting and maintenance. If this option is not made use of in the ten year period, the land becomes the permanent property of the Commonwealth. To date 180 plantations aggregating 7,000 acres have been made under this law and \$10,000 is appropriated annually to carry it out.

FOREST NURSERIES.

To provide the planting stock which must be used in reforesting state forests and reforestation lots, it is necessary to maintain forest nurseries and the department has now three principal nurseries and six transplant nurseries on the state forests. In addition to providing trees for state forests, the law also provides that we shall distribute stock to other state departments free of cost and sell at cost to towns and private individuals. The demands from these outside sources frequently exceed the number planted on state forests. We are working on an estimated demand of 4,000,000 three or four year transplants each year, of which 2,000,000 will be used for department planting, 1,000,000 will be available for sale purposes and the remaining 1,000,000 will be for other state departments and other miscellaneous purposes.

The nursery work is in charge of an assistant forester and three resident superintendents; \$20,000 is the annual appropriation available for this work.

EDUCATIONAL.

As nearly all the work of the forestry department is in its way educational or demonstrational, it is rather difficult to separate any of its activities and call them alone educational, yet there are a few which are exclusively in that class. For instance, the woodland examination service which provides that landowners may have their woodlots or shade trees examined by a forester from the department and advice as to their treatment extended on the ground whether the problem be one of marketing some lumber or of treatment for some insect infestation. The only expense for this advice is a charge for the traveling expenses of the forester making the examination. The growing and care of fruit trees and orchards is not a part of forestry and people who desire information in this line should consult the Department of Agriculture or their county farm extension service.

The department from time to time publishes bulletins on different phases of forestry work which are available for free distribution. A number of members of the department spend considerable time lecturing before various organizations on the forest problems of the Commonwealth and forestry exhibits are frequently made at agricultural fairs and other similar shows.

We consider it important to use all the methods within our means and time to acquaint the people of Massachusetts with the vital importance of the forest problems of the state.

CONCLUSION.

Among these United States the Commonwealth of Massachusetts takes high rank for the completeness and sane progressiveness of its forest policy. This condition is not so much due to the officials in charge as it is due to the intelligent and sympathetic interest which the citizens of this state have for their forests. In focussing this interest the Massachusetts Forestry Association, the Chamber of Commerce through its forestry committee, the State Grange and many local organizations have done excellent work. The state legislature has been in sympathy with forest legislation and appropriations. Let us not in self-satisfaction, however, stop where we are and allow other states to outstrip us. We can enlarge our state forest policy, our cooperation with private owners and strengthen some weak spots in our fire protective system and by so doing bring still nearer the time when Massachusetts will produce within its own borders the timber which is so vital to its economic welfare.

35.08
m 35p

WOOD FUEL

A BULLETIN

To Stimulate the Production and Use of Wood as
Fuel for Patriotic and Economic Reasons
as a War Measure

CONTENTS

	Page		Page
Wood Fuel	3	How to Cut	6
Reasons for Stimulating Wood Production	3	Transportation	8
Wood versus Coal	4	What to Cut	9
Qualities of Woods for Fuel	5	Aid by State Forestry Department	10
		Conclusions	10

By PAUL D. KNEELAND, M.F.
Assistant Forester in Charge Utilization and Operations

Under the Direction of
F. W. RANE, B.AGR., M.S.
Massachusetts State Forester



PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

WOOD FUEL.

Last spring, in a statement issued by the State Forestry Department advising woodland owners to cut cordwood, it was said that the price of wood was mounting so rapidly that soon cordwood might be as valuable property as a gold mine. However picturesquely worded, that statement has been amply borne out by the facts. Many who have cut wood this past year have doubled or even trebled their investment. In many localities prices have approached the coal strike level. But now the production of cordwood has gone beyond the matter of profit; it has become a problem of patriotic endeavor and grim war necessity. There is still the appeal to the purse, but that has become secondary to the need for fuel of all kinds, which can be met in a considerable measure only by substituting the product of the New England woodlot for the coal from the Pennsylvania mines.

Reasons for Stimulating Wood Production.

We have had our flour shortage and our sugar shortage, and, unless all signs fail, we shall have a fuel shortage — if not this winter, then the winter following. This will be felt more in the smaller communities than in the cities, unless cordwood is made to take the place of coal to a large degree. There is no excuse in a man's shivering for lack of fuel if trees and forests grow all about him; at least, that is what those who have the allotting of coal are very likely to say when it comes to a pinch.. So it seems that it will be up to the rural communities, not only to supply their own fuel, but also to help in supplying the larger towns and cities.

Wood is a more primitive fuel than is coal. In the cities its use in normal times, except for kindling, has been confined to the two extremes, — to the well-to-do, who use it for the cheer of the open hearth, and to the poor, who cannot afford a continuous fire. In the country wood has been largely supplanted by coal

for heating purposes, even in the kitchen range. Wood is used only where its lower cost and greater convenience as a summer fuel are factors. However, in these times we shall have to get back to essentials, — wood is better than no fuel at all. We have sufficient quantities of wood close at hand. Coal is not close at hand, and we may not be able to get it. It behooves the prudent man to stock up with wood, and that quickly. It is for the patriotic as well as foresighted man to cut, not only enough wood for himself, but for his neighbor who cannot cut it himself.

Wood versus Coal.

Wood is inferior to coal in convenience of handling, in lasting qualities while burning and in fuel value. Roughly speaking, 1 ton of coal has as much fuel value or heat units as 2 tons of dry wood. A cord of good dry hard wood, such as oak, hickory, hard maple or beech, weighs about 2 tons, and so equals a ton of good hard coal (such as we seldom see nowadays, by the way). But wood has many advantages over coal, which it might be well to point out at this time, to show that its wider use will not be altogether a hardship.

1. It is less wasteful. It consumes completely without waste. It does not burn when not needed.

2. It is cleaner. There are very few ashes and practically no dust, dirt or gas. There are no cinders to sift and dispose of.

3. It is hotter. One can get a hot fire much more quickly than with coal.

4. It is often more convenient. For cooking purposes wood gives a quick hot fire, being next to gas in that respect. In the warm weather it is not necessary to heat up the kitchen, as does a coal fire. For the rapid heating of a room with fireplace or stove, or for "taking the chill off the house" with the furnace, wood comes in very handy.

5. Under many conditions it is a cheaper fuel. The farmer or owner of a wooded estate who can cut wood with his own or hired labor gets fuel at only a fraction of the cost of coal. In most rural districts, and in communities at a distance from the railroad, wood at present prices is cheaper than coal. Even in the larger cities, where, due to high distribution expense, a cord

of wood costs more than a ton of coal, wood if used properly can save more than its cost in coal. In extreme weather by burning wood in fireplaces or stoves, as an auxiliary, it is not necessary to drive the furnace so hard, and thus the excessive use of coal which that entails is avoided. In the fall and spring the house can be kept comfortable by wood alone, burned at morning and night to keep the chill and dampness away. Wood burned part of the time is cheaper than coal burned all the time. Where a continual fire is not needed a great saving can be made by burning wood instead of coal.

Qualities of Woods for Fuel.

Woods vary greatly in their characteristics and value as fuel. In general, the fuel value or caloric content varies directly with the specific gravity. In other words, the heavier the wood the more heat it contains. Hickory, white oak, sugar maple, beech, red oak, ash, yellow and black birch, red maple, white birch, chestnut, gray birch, poplar and willow are the chief hardwoods of this region, and have weights and fuel value about in the order named. Larch, hemlock, spruce, pine and cedar are the chief softwoods, and are chiefly valuable for kindling, since their fuel value is so low, being only about half of that of hickory. The fuel value also varies with the dryness of the wood. It takes considerable heat to evaporate the moisture from green wood, and so leaves less of the heat available for use. Wood dries very rapidly when first cut, and so wood, even three or four months dry, is considerably better than green wood. However, for keeping qualities on the fire green wood is better. It is possible to run the furnace all night with green or partly green wood, and impossible with dry, except very big hunks. Green gray birch and poplar are better than dry. When dry these woods burn almost as rapidly as pine kindling, and so are not very valuable for fuel purposes. When green, however, they last longer on the fire, and so are comparable with the other hardwoods. The fuel value also varies with the size of the stick, as there is more heat in cleft or split wood than in round sticks. This is partly because the split wood dries more rapidly and so contains less moisture, and partly because there is less heat in the bark and sapwood

than in the heartwood. Small round wood has a larger proportion of the bark and sap than the large cleft pieces.

Wood varies in other qualities besides fuel value. Chestnut and hemlock are very snappy, and so are unsuited for extensive fireplace use. Black oak is so slow drying that it never gets really dry, but always hisses and smoulders on the fire. The birches and red maple are free burning and hot, and so make a very cheerful fire in the hearth. Hickory and the oaks ignite slowly, but when thoroughly ignited give a hot, enduring fire. Apple and cherry wood make a beautiful flame. Red cedar gives a pleasant odor.

How to cut.

The methods of producing wood fuel have not advanced considerably since the earliest times. The experienced wood chopper with his axe, cutting by the cord, is still the cheapest way of producing cordwood under most conditions. The matter with him is that he is too few. If we have to depend on experienced cord labor in the present emergency we shall not have nearly enough wood to meet the demand. In many sections wood chopping is a lost art. The lumber and pulp industries, as well as the general manufacturing industries, with their high wages and steady work, have recruited heavily from the already thinned ranks of the wood-choppers. The present price for cutting by the cord varies all the way from \$1.75 to \$3 per cord, depending on the chance, the character of the wood, the need of the owner and the bargaining ability of the chopper. The wages may go even higher. The man hiring wood chopped by the cord has several other things to think of than the exact price he pays. Often a camp has to be provided for the choppers, and even their families, to live in. That adds to the cost. Also wood chopping is a trade requiring skill, and as in many other skilled trades there are many tricks to catch the unwary. Wood is often piled on stumps, cross piled, etc., so as to make less than a cord look like a cord. It is often cut short or not properly split. There is a natural shrinkage in wood when it dries, and this with the improper piling usually makes a 5 to 10 per cent. loss when the wood is sold. The loss to inexperienced operators has often exceeded that.

Wood that is cut by the cord is usually piled in the woods in

4-foot lengths where cut, and when dry hauled out by teams. Before being used it must be sawed up into shorter lengths, and usually split further. This is done either by hand or machine. The wood-sawing machine has come into very general use. Dealers have one in their yards, and in almost every community there is a portable machine with a rotary saw and gasoline power which will cut wood for from 75 cents to \$1.50 a cord, \$1 being the usual price. Such a machine now costs from \$250 to \$500. It will cut from 15 to 20 cords of wood, in 4-foot lengths, into stove wood per day. There are also splitting machines which work efficiently on short lengths.

Many farmers nowadays are cutting their wood in convenient lengths longer than 4 feet, often called sled lengths. These sticks they haul direct to their yards and have cut into stove lengths, usually by machine. This is an improvement over the old method, especially as it allows the use of day labor in cutting instead of cord labor. This is the method we recommend to all farmers and others who cut near-by wood for their own use, or to dealers who supply a local trade. The cost of the method is well within reasonable limits.

Wood in short lengths is much more difficult and expensive to handle dry, and ship any distance, than is wood in 4-foot lengths. With proper conveying machinery it probably can be done economically, but to our knowledge it has never been done yet. Practically all wood which is shipped to the cities or to the wood-using industrial plants comes in 4-foot lengths. The problem that now confronts us, therefore, is to devise methods of economically shipping for considerable distances wood in short lengths, or producing economically, by machinery, wood in 4-foot lengths. We are convinced that machinery in wood production is the only answer in the present emergency. Day labor, largely unskilled in woods work, must be used in wood production. To learn to use an axe as do the French-Canadian wood choppers is impossible except after years of practice. The use of a saw in felling a tree is not so difficult to learn, and by cutting up the tree by machinery we can greatly heighten our production with the labor available. An unskilled woodchopper cannot produce a cord of wood a day, cutting it up in 4-foot lengths in the woods. Probably one-half cord would be an average. Therefore that method

of producing wood is impossible except in the case of the most urgent necessity, or of small operations, or to keep permanent labor busy during the slack times. It is not a commercial proposition, even with the present high price of wood, with unskilled labor costing about \$3 a day.

The shipping of short wood may be successfully done by motor trucks going direct to the consumer from the wood pile. Probably 15 to 20 miles is the limit on that, however. The State Forestry Department is now devising a machine by which it is expected to produce 4-foot wood at about \$3.50 per cord, all yarded out and piled ready for drying and shipment. Others are probably working on the same problem. If this proves successful, similar machines scattered throughout New England can greatly increase the wood production.

Transportation.

There is less difficulty in hiring teams than in hiring wood-choppers this winter. In the spring and summer, when the teams are busy on the farms and roads, it is apt to be hard to get them. The standard price for teams is now, in the slack time, about \$6 per day. Around the cities prices range to \$7 or \$8. Teams should make two trips up to 4 or 4½ miles, and one trip per day up to 9 or 10 miles. On hauls of less than 2 miles three or four trips per day should be possible, especially if extra help in loading and unloading is provided. It is wise to have several teams hauling at once in order to help each other over the hills, and to make help in handling the wood more profitable. The best practice is to use several teams, and have at least one extra man to help load in the woods, and perhaps another at the car or unloading point. A good team will haul a cord and a half of heavy wood, as hickory or oak, except where there are bad hills. Of lighter wood, as chestnut, two cords or more can be hauled. In the winter, on sleds, up to 50 per cent. more can be hauled than the above figures indicate. For motor trucks the wood must be yarded out to a good road at a cost of from 75 cents to \$1.25 a cord. For this reason, motor trucks do not pay except on long hauls, — 6 or 7 miles or more. A 6-ton truck will carry four cords of wood. They can be hired for from \$20 to \$30 a day, which includes the driver. Extra help must be provided for loading and unloading. Seventy-

five miles a day is about the maximum for a heavy truck, but that cannot be attained without quick loading and unloading. Light and fast trucks, which carry a cord or less, can also be used in hauling wood, but care should be exercised not to overload them. However, the heavy trucks will be found more efficient.

What to Cut.

Softwoods, trees of large enough size for lumber, or healthy stands of high future lumber value should not be cut for fuel at this time. Softwood has low fuel value, and should be saved for lumber, pulp, etc., Enough kindling can be obtained from lumbering and sawmill waste and inferior trees. Of course if there are only a few trees of log size in a stand to be cut, it might be advisable to put them into wood with the rest. Large growths should be saved for lumber as the main product, not for wood. Young stands which contain considerable ash, basswood, hard maple, poplar and oak (outside the gypsy moth area) should not be put into wood. The ideal sizes of trees for cordwood are from 4 to 8 inches in diameter. Smaller than that the wood is inferior; larger than that it is usually better suited for logs and is difficult to split. Certain species are best suited for wood and will never make good lumber. Chief among these are the red or swamp maple, gray birch and the oaks in the Cape Cod region and on poor soil in other localities. In many places smaller stands of beech, birch and maple are now of more value as wood than they ever will be for lumber. Chestnut stands of less than tie or pole size can now be advantageously put into wood, as on account of the blight they will probably never mature, and the wood can be disposed of in the present emergency, a thing which may be impossible later.

The present fuel shortage opens an opportunity to the owner of woodland which has never before been presented. He can now thin out inferior trees and poor species from a mixed stand, and so practice forestry and improve his property at a profit. It is hard to get cordwood choppers, paid by the cord, to cut in thinnings. Now, when day labor must be employed anyway, it is just about as cheap to make a thinning. The present demand for wood will make

practically any kind of cordwood salable. In fact, dead wood, as oak, killed by the moths, blighted chestnut and gray birch are rather at an advantage because they can be sold and burned immediately, while most green wood must be seasoned somewhat before it is fit to use. It is strongly urged on owners of woodlands not to spoil the future production of their land by reckless cutting, even in the present emergency. Clear cutting should be done only in maple swamps, in gray birch or infested oak or chestnut areas. In other types of growth, where it is possible to leave something of future lumber value, the best trees should not be cut.

Aid by State Forestry Department.

This department is anxious to aid in the wood fuel situation in all possible ways. We have cut and sold over 30,000 cords of wood within the last four years, and maybe our experiences will be of value at this time. We are willing to help both in the production and the distribution. Any owner can call on us for an inspection of a woodlot where cutting is proposed, and we will give advice, give estimates, mark trees for cutting, etc., without charge. We will help, if possible, in procuring labor to carry on the work, devising special machinery, or getting teams and motor trucks. We will help in selling and disposing of the wood also if desired. This department will also co-operate directly with the owner in cutting wood. If the owner will provide the capital for carrying on the work we will look out for the operation and sell the wood for him without charge (except traveling expenses in some cases). The State Forestry Department is here to help all citizens of the Commonwealth at this time, and we hope they will freely call on us.

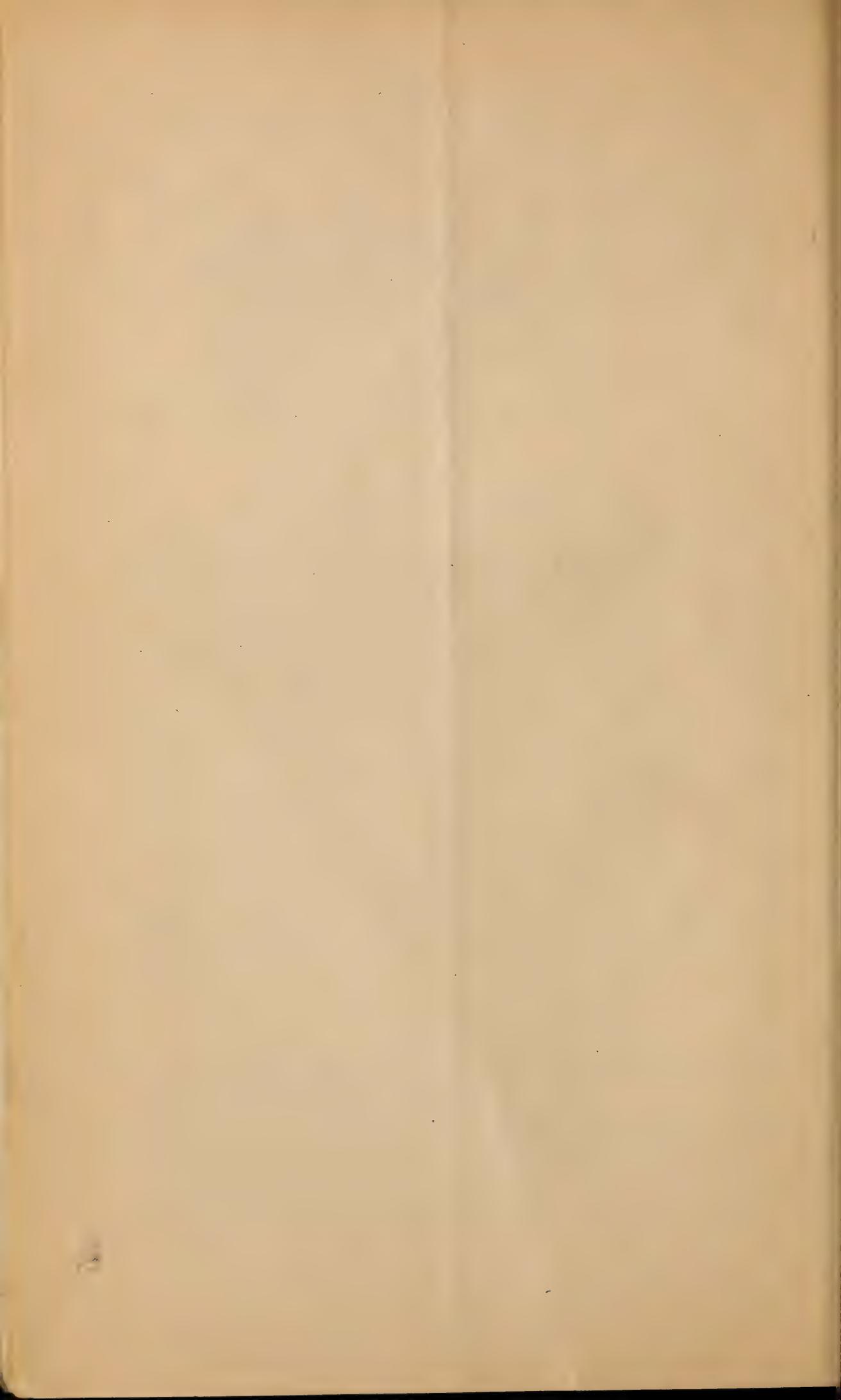
Conclusions.

1. A greatly increased production of cordwood for fuel is necessary at this time as a war measure.
2. Wood, although not as good a fuel as coal, is a very satisfactory substitute, and there is a sufficient supply close at hand, if it is cut.
3. Regular cordwood choppers are hard to find at present, but

their loss can be made up in a large measure by wood-sawing machines.

4. Now is an especially good time to cut and dispose of the dead and inferior trees and to make improvement thinnings.

5. The State Forestry Department should be called upon for help by all interested in producing or obtaining fuel.



WE MUST STOP

FOREST FIRES

IN

MASSACHUSETTS.

- I. A WORD FROM THE STATE FORESTER.
- II. WHAT HAPPENED DURING THE PAST YEAR.
- III. LETTERS FROM TOWNS THAT ARE DOING SOMETHING (READ THEM AND SEE IF YOUR TOWN IS THERE).
- IV. SUGGESTIONS AND EQUIPMENT FOR ALL TOWNS (FOREST WARDENS TAKE NOTICE, AND LET YOUR TOWNS KNOW WHAT THEY SHOULD DO).
- V. OFFICIAL LIST OF MASSACHUSETTS FOREST WARDENS.

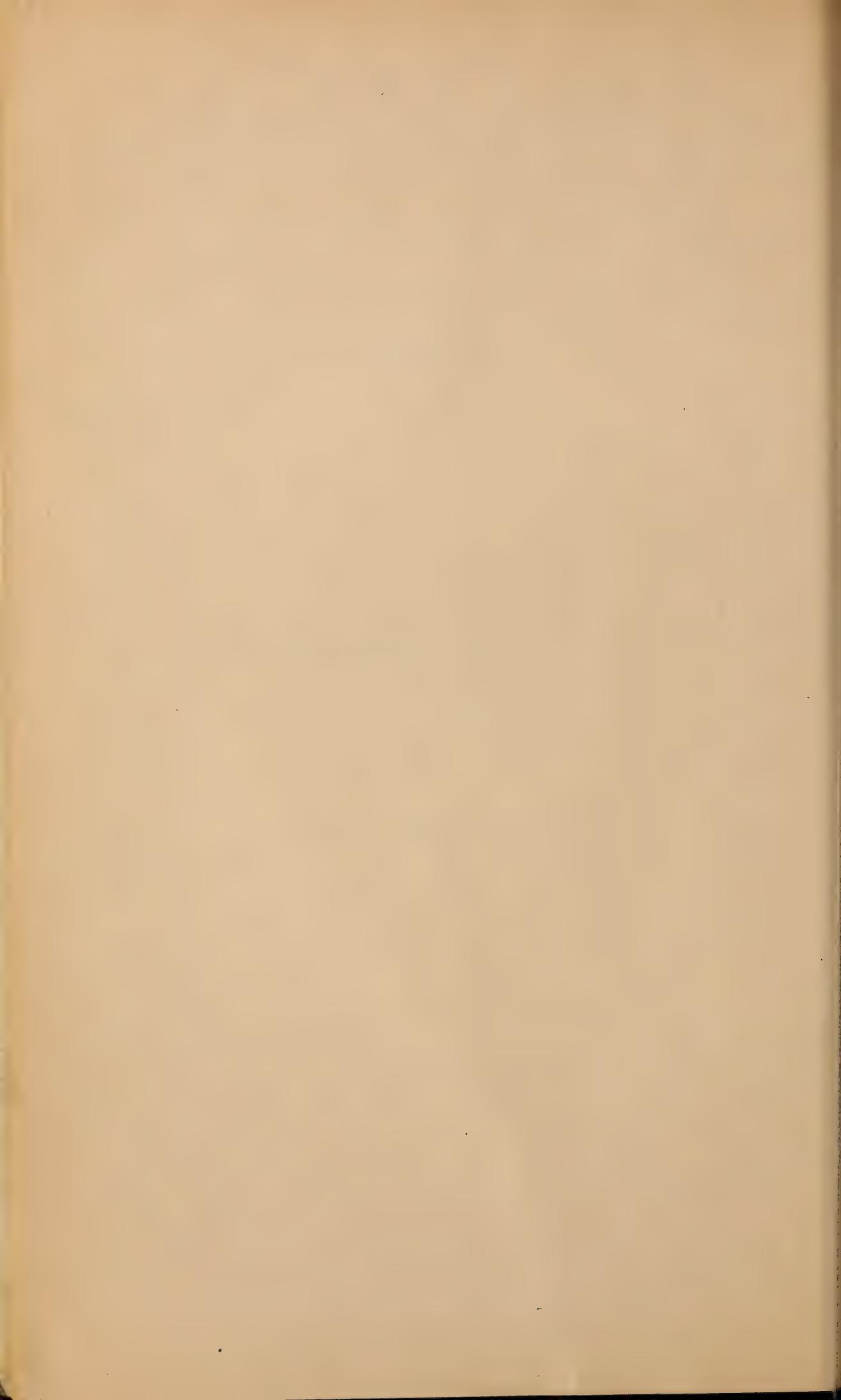


BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1909.

APPROVED BY
THE STATE BOARD OF PUBLICATION.

CONTENTS.

	PAGE
A word from the State Forester,	5
Massachusetts forest fires of 1908,	6
Table on damage by causes,	7
Table on causes by months,	9
Table on acreage and damage by months,	10
Summary of fires by months,	9-13
Fire fighting and protection as carried on by enterprising towns,	14
Forest wardens' letters,	14-23
On forest fire protection and apparatus,	23
Organization and fire lines,	24
Fire patrol,	25-27
Damage by forest fires,	28
Miscellaneous points — extracts from wardens' letters,	29-31
Address list of forest wardens,	32-43



44
709



KINGSTON FIRE, JULY, 1908.

FOREST FIRES IN MASSACHUSETTS.

I. A WORD FROM THE STATE FORESTER.

Do you know, good people of this grand old Bay State, that annually we are allowing fires to run rampant over Massachusetts? We talk about putting out shade trees along our roadsides, in our public squares and about our homes, which is all very good; but forestry or the lumber crop is the only thing that will fill in the background of the painting, that will produce the ideal Massachusetts of the future.

Forest fires have destroyed and are continuing to deplete the very birthright of town after town, and hence the Commonwealth. Take a trip with me throughout the State and see the utter wanton waste and destructiveness of man on every hand. Lands by the thousands of acres are to-day standing idle that but yesterday bore magnificent primeval forests from which it is said the graceful spars of the English navy were cut. These same soils, whether barren, rocky, sandy, hilly or mountainous, the veritable eyesores of the State, are as capable as ever of producing noble forests at our bidding, provided we, as people, rise to the occasion by stifling the fire demon, and educating our present and coming generations to the importance of so grand and beneficial a work as the practice of modern forestry.

The time has come, as a business proposition alone, leaving out the great æsthetic value, when we can ill afford not to establish definite fundamental principles of constructive forestry in this State. Two and one-half million acres of non-agricultural lands, producing a thousand feet board measure of white pine per acre, for example, per year, at stumpage value of \$5 to \$10, would mean an income of \$12,000,000 to \$25,000,000 a year. Is this not worth thinking of?

Was there ever a State more worthy of our endeavors? The eastern part of the State presents one aspect, the beautiful Berkshires another and the grand old Cape country is pathetically in need of our special attention. Every part of Massachusetts is a

natural forest country, and were we to move out of the State, nature would reclothe the whole territory in a relatively short time. This fact alone is suggestive enough, and if we will but stop fires and assist nature we must succeed.

This bulletin on the subject of forest fires is published that our people may realize more fully the exact condition, and especially for the benefit of our forest wardens and their deputies, that they may know what other towns in the State are doing, thereby gaining new ideas and being enabled more intelligently to accomplish good results in their own communities.

The State Forester is proud of the showing that the forest wardens have made in their first year of service, and desires in every way possible to assist and further their public-spirited endeavors.

It certainly is hoped that this bulletin will be made use of and that some good will result therefrom.

II. MASSACHUSETTS FOREST FIRES OF 1908.

The past year has been one of great interest to any one interested in the forest fire situation in Massachusetts.

In the first place, it is the first and trial year of the new system of forest fire fighting. Forest fire work in each town is in charge of an officer called a forest warden, who is appointed by the local authorities, their choice being confirmed by the State Forester. In cities and towns having an organized fire department, the chief is usually the forest warden, or a deputy. The warden does his fire fighting in the interest of and at the expense of the town, but reports the fires, with their extent and damage, to the State Forester. The reports which were sent in this year form the material out of which the following tables were made, and make a valuable contribution to the knowledge of forest fires, concerning their causes and extent, etc.

In the second place, the season of 1908 was one of extraordinary drought, — a condition extremely favorable to the spread of forest fires and to increasing their damage, for when the ground is dry, the fire burns deeply into the soil. This drought, caused by a deficiency of 17 per cent. in the annual rainfall, was intensified at times by more than the usual number of high winds.

We have, then, a new system of fire protection and of collecting the data, started in a year calling for unusual activity. Let us examine the results.

TABLE 1. — *General Table on Damage and Acreage, by Causes.*

	Unknown.	Locomotive.	Burning Brush.	Smokers.	Boys.	Hunters.	Berry Pickers.	Miscellaneous.	Totals.
Number of fires reported.	337	539	96	111	58	18	11	209	1,379
Reports having damage estimated.	\$72,936	\$27,938	\$18,000	\$28,000	\$3,500	\$7,000	\$2,500	\$49,874	\$209,748
Damage on burned acreage not given in reports, estimated.	\$7,749	\$4,369	\$2,913	\$5,040	\$800	\$1,603	\$700	\$7,492	\$40,396
Total damage, . . .	\$90,415	\$32,307	\$20,913	\$33,040	\$4,300	\$8,603	\$3,200	\$57,366	\$250,144
Burned area on which damage was reported (acres), .	6,491	3,840	3,958	5,163	957	957	1,796	4,578	27,740
Burned area on which damage was reported (per cent.).	23.4	13.8	14.2	18.6	3.4	3.4	6.4	16.8	-
Burned area for which no damage was given (acres).	1,638	966	994	1,302	238	238	448	1,176	7,002
Burned area not tabulated by months (acres).	-	-	-	-	-	-	-	-	4,596
Total area reported as not damaged (acres).	-	-	-	-	-	-	-	-	991
Total acreage burned (acres).	-	-	-	-	-	-	-	-	40,327

There are 342 towns and cities in the Commonwealth which have forest wardens, out of which, 234, or 68 per cent., reported that they had 1,379 fires; 15, or 5 per cent., reported that they had no fires; 93, or 27 per cent., sent in no reports. Just how many of this last class had fires to report and neglected to do so it is impossible to state, but it must have been many, because we cannot believe that all these towns were without fires when their neighbors were reporting many. Probably about 20 per cent. should be added to the figures in the table for the number, acreage and damage of fires, to allow for the negligence of these wardens.

The number of acres reported as burned over was 40,327. Estimating the forest area of the State at 2,500,000 acres, — and to do this we have to include all the scrub growth and thinly stocked pasture, — we find that 1 acre in 62 has been burned. Looking at it in another way, it means that the entire forest area of the State might be burned over every sixty-two years. Taking the entire land area of the State, it is 1 acre in 123. On the United States national forests it is 1 in 10,000 acres, and in Germany 1 in 15,000 acres which are annually burned.

The average damage per acre was \$6.20, and the total damage \$250,000. To this should be added 20 per cent., or \$50,000, for towns not reporting, making a total estimated damage caused by forest fires in 1908 of \$300,000. Even with the allowances made we do not arrive at the true damage caused by forest fires, because, for reasons which will be discussed in another chapter, it is exceedingly difficult to reduce the damage to terms of dollars and cents, and, indeed, some of it cannot be so estimated. The damage caused by fire in woodlands is in the long run greatly underrated.

In the following table, which is not quite complete, because it was made up before all the reports came in, we have the number of fires arranged by causes and months. We find a great variety of causes, 26 in all, not including the large number in the column headed unknown.

Railroads are the largest producers of forest fires, with nearly 40 per cent. of the total. Next comes the unknown, with 25 per cent. Then there is 8 per cent. caused by smokers and 7 per cent. from burning brush. If some of the unknown fires could be traced out, probably smokers would figure more heavily in the total. Incendiary and boys setting fires maliciously, which we imagine is much the same thing, together make 11 per cent.

It ought to be noted that of all the 1,299 fires, 5, or .3 per cent., which were set by lightning, were the only ones which were absolutely not preventable. The rest in large part could have been prevented if people would go to the same lengths that they do in cities. A small city of 25,000 population, with a property valuation of \$20,000,000, spends about \$30,000 a year on its fire department, or an expenditure of \$1.50 per \$1,000 of the valuation. Information collected in 1906 by the State Forester showed that in 1905 311 towns spent \$30,000 for fighting fires. The forested area of the State can be roughly valued at \$50,000,000, which makes the expenditure on forest fires about 60 cents per \$1,000 of their valuation. With proper care and safeguards we could attain such a condition as that in Prussia, where in twenty-five years only 1,400 acres were burned over on the average each year, or .02 of 1 per cent. In Bavaria, during five years it averaged only .007 of 1 per cent. of the total forest area. Compare this with an enlightened Commonwealth of Massachusetts, with an average of 1 per cent. or more.

TABLE 2.—*Fires by Causes and Months.*

CAUSES OF FOREST FIRES.	March.	April.	May.	June.	July.	August.	September.	October.	November.	Totals.	Per Cent.
Berry pickers,	-	-	-	-	9	1	-	1	-	11	-
Blasting fuse,	-	-	-	-	-	1	-	-	-	1	-
Boys setting fires maliciously, .	1	28	11	3	-	-	1	12	2	58	4.0
Burning brush,	-	53	21	3	3	2	2	6	-	90	7.0
Campers' fires,	-	1	-	-	-	-	-	-	-	1	-
Carelessness,	1	3	2	6	-	-	1	2	1	16	-
Children playing with matches,	1	2	3	1	-	-	1	4	1	13	1.0
Coals dumped by locomotives and others.	-	2	-	2	-	-	-	-	-	4	-
Cranberry pickers,	-	-	-	-	-	-	1	-	-	1	-
Fire balloons,	-	-	-	-	2	-	-	-	-	2	-
Firecrackers,	-	-	-	-	3	-	-	-	-	3	-
Grass fires,	1	6	-	-	-	-	-	4	-	11	-
Gypsy Moth Commission men, .	2	1	1	-	1	-	2	-	-	7	-
Hunters,	-	-	-	-	-	-	1	16	1	18	1.5
Incendiary,	-	48	16	5	4	-	-	16	3	92	7.0
Lightning,	-	-	-	1	4	-	-	-	-	5	.3
Locomotive sparks,	8	199	93	29	65	2	5	68	21	490	38.0
Picnic and May parties,	-	2	-	-	-	-	-	2	-	4	-
Rubbish fire,	-	7	5	1	1	-	-	1	1	16	-
Section men burning railroad ties and brush.	-	3	-	-	-	-	-	-	-	3	-
Smokers' pipes, cigars, cigar- ettes and matches.	3	39	23	10	13	1	5	14	3	111	8.0
Steam portable sawmill,	-	-	6	4	1	-	1	-	-	12	1.0
Tramps setting fire,	-	1	-	-	1	-	-	1	-	3	-
Unknown,	4	105	39	28	35	3	21	74	5	314	25.0
Sparks from burning buildings,	-	-	-	-	3	-	-	2	-	5	-
Sparks from forest fires,	-	-	-	-	2	-	-	3	-	5	-
Wood choppers cooking,	-	-	-	-	-	-	-	2	1	3	-
Totals,	21	500	220	93	147	10	41	228	39	1,299	-

SUMMARY BY MONTHS.

The following is a brief summary of the fires for each month, the object being to show the effect of different seasons on the frequency of forest fires. It may be said in passing that ordinarily the danger season runs from the 15th of March to the 1st of June and from the 15th of September to the 1st of December, but on account of the drought conditions which existed last year the summer season was little different from the spring and fall in its liability to fire.

The following table gives the acreage burned and the resulting damage for each month. It is not quite complete, as some of the wardens withheld their reports until the close of the year, too late to be included with the others, but their number is small and they do not materially affect the comparison.

TABLE 3.—*Acreage and Damage by Months.*

MONTHS.	Acres.	Damage.	Damage per Acre.
March,	236	\$420	\$1 78
April,	16,262	52,731	3 25
May,	5,856	48,506	8 28
June,	1,195	17,824	14 91
July,	6,109	28,783	4 71
August,	1,567	22,320	14 25
September,	1,062	3,140	2 95
October,	7,084	29,960	4 22
November,	301	1,468	4 88
Totals,	39,672	\$205,152	-

March.

Many towns failed to make reports of forest fires during the early days of March, because the new system of appointing forest wardens did not become established in smooth running order until the latter part of the month. The figures for this month are not, therefore, worth analyzing.

April.

During this month woodland conditions were extremely favorable to the spread of forest fires. Not only was the rainfall light, but a succession of strong winds from the northwest blew much of the time. The consequence was that the moisture in the upper soil was quickly dried, leaving the débris on the forest floor in an inflammable condition.

The wardens' reports for Sunday the 26th and Thursday the 23d amounted to 40 fires for each day, the record for the year. Sunday the 5th and the 12th, the latter the date of the Chelsea fire, were next in order. Three Sundays in April show a total of 148 fires, almost one-third the total for the month.

Prominent among the causes were locomotives, equal to 39.8 per cent., and burning brush, 10.6 per cent. Next in order came fires caused by discarded smoking material, equal to 7.8 per cent.

Wardens' returns in April show the largest area burned and the greatest estimated damage for the whole season. As compared with some other months the per acre damage was less, but this may have

been accounted for by the fact that more moisture lay near the surface than later in the season, which prevented the fire burning very deep or long enough in one place to do much damage.

May.

The largest number of fires for any one day in this month came on the 19th, being 25 in all, or 11 per cent. of the total. The principal causes were locomotives, 41 per cent., smokers, 10.4 per cent., and burning brush, 9.5 per cent. Fires set deliberately were 5 per cent. of the total, while the remaining 25 per cent. were due to unknown or scattering causes.

Most of the spring rains this year came in May and gave the grass and verdure a good start, nevertheless it did not prevent the fires in May from being more destructive than those in April, their per acre damage being \$8.28, as against \$3.25 for the previous month.

June.

According to expectations June reveals a marked reduction in point of number of fires. May showed a falling off over April, and June has 127 less fires than May.

The dry weather continued, with a showing of 31.2 per cent. for locomotive fires, a reduction from May and April of nearly one-fourth, due probably to the infrequency of high winds. Smokers with 11 per cent. and 5 per cent. for boys are about the same as the average of the previous months.

The acreage burned in June was 4,661 less than that of May and the damage \$30,682 smaller.

July.

The lack of rain in June produced a drought in July, which dried up the growing vegetation so that fire ran through the green leaves almost as freely as through the dead débris of previous years.

Forest warden reports reveal an increase of 54 fires over June, whereas a decrease in the number would ordinarily be expected.

The most prolific source of fires was again the railroads, with 44.2 per cent., an increase of 13 per cent. over the figures for the previous month. Smokers maintain their average with 8.8 per cent. Fires escaping from persons burning up brush while clearing land, either because insufficient aid was at hand to keep them in check or because they were left overnight unattended, amounted to only 2

per cent. of the whole number, while in April, which is the brush-burning season, such fires were the second largest cause.

It may be here remarked that fires from this cause are exceedingly reprehensible, because they are quite unnecessary when proper precautions are observed. Such fires cannot be classed as purely accidental.

August.

Fires in August were the least in point of numbers of any month of the season. To offset this advantage, however, they proved quite destructive and burned over a large area.

Locomotives lead the list of causes, with 20 per cent. of the month's total. Burning brush also foots up to 20 per cent., which points to a complete disregard of responsibility on the part of persons starting such fires at an unseasonable time of the year and in the face of a severe drought. Smokers furnished 10 per cent.

The fires of August were more extensive than usual, for although July had fourteen times as many fires, their area was only three times as great. The reason for this is not apparent.

September.

A marked increase in the number of fires appears for September over August, the numbers being as 41 is to 10. August was unique in having more than its normal rainfall, but September was not so blessed.

An examination of the prominent causes shows that locomotive fires drop to 12.2 per cent., which is far below the average. Smokers were responsible for a like amount. The reports which gave cause unknown made up 51 per cent., far too great an amount.

The estimated damage and acreage of the fires were small considering the conditions, which were as favorable to the spread of fires as were those of some other months that show greater totals. It is probable that much of the land particularly liable to fire, especially along the railroads, had by this time been burned over, and was immune for the rest of the year.

October.

The second drought of the year 1908, which commenced in September, was by this time in full swing, so that the woodlands were again abnormally dry. Fires of considerable extent raged, particularly in the Berkshires, which up to this time had not suffered a great deal. The acreage burned was the second largest of the sea-

son, although it was less than half as great as the record month of April.

A greater loss was prevented by the timely arrival of rain during the latter part of the month.

Locomotives, with 30 per cent. of the fires to their credit or discredit, still lead, although below their yearly average. Hunters appear, as we might expect at this time, and are the cause of 7.7 per cent. of the fires. Smokers, whom we imagine are often hunters, fall a little below their average, and into third place, 6 per cent. Mischievous boys were responsible for 5.3 per cent., which indicates that the young generation need some sharp lessons to instil in them a decent regard for other people's property and the value of forest land.

November.

This is the tenth and last month of the season of 1908, and the number of fires and their damage falls abruptly. The figures for this month are not quite complete on account of delayed reports, but they give some clew to the fire damage which we should expect under ordinary conditions. The figures for November are below those of the summer months. When given average conditions, we should expect more and serious fires in the fall, when the ground is covered with fallen leaves.

Locomotives run high this month, with 54 per cent. of the fires, and smokers hold to their usual average, with 7.6 per cent. Fires set by boys amounted to 5.1 per cent.

ADDENDA.

There were three fires resulting in a severe financial loss so much greater than the average that they are worthy of mention. On May 19 sparks from a portable sawmill set fire to a stack of lumber valued at \$10,000. A similar loss of lumber was reported from Carlisle June 28, caused by a lightning bolt. The heaviest single loss was reported from Orleans, July 15, which amounted to \$15,000. Dwellers in large cities are accustomed to fires causing far greater loss than these, but in small country towns such sums are very considerable.

During the present season no less than nine men have been arrested for unlawfully starting fires, which arrests resulted in the payment of a fine or imprisonment or both.

At Clinton one forest fire fighter was burned to death and in Franklin a man died of heart disease while fighting fire. So far as known these were the only casualties.

III. FIRE FIGHTING AND PROTECTION AS CARRIED ON BY ENTERPRISING TOWNS.

The best information on forest fire fighting should logically come from those men who are doing this work, and we have therefore included abstracts from letters of various wardens who have kindly contributed their ideas. It is recognized that conditions vary over the State, and that a method of forest fire fighting used in one town may not be feasible in another. Again, this office, by publishing these letters, does not by that act endorse the ideas and views contained therein, but offers them so that the readers may draw their own conclusions. The selection of reports has been made so as to include some from towns with an organized fire department as well as some without.

EXTRACTS FROM LETTERS OF FOREST WARDENS.

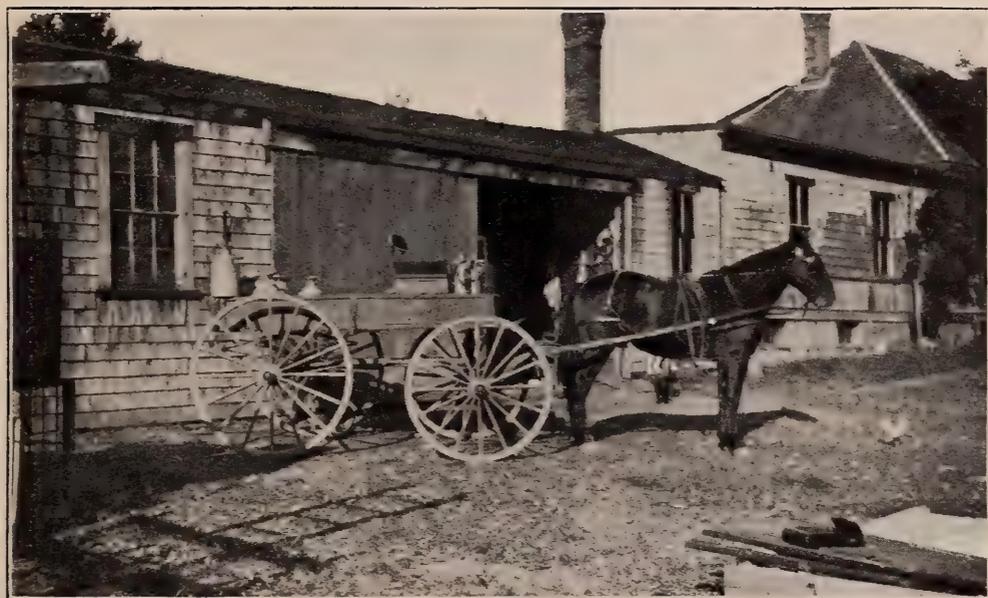
James W. Cutting, Forest Warden, Braintree.

Fire fighting here depends largely on general conditions and extent of the territory, the topography and the wind. Fires are usually discovered by a lookout on the cliff or the mill tower.

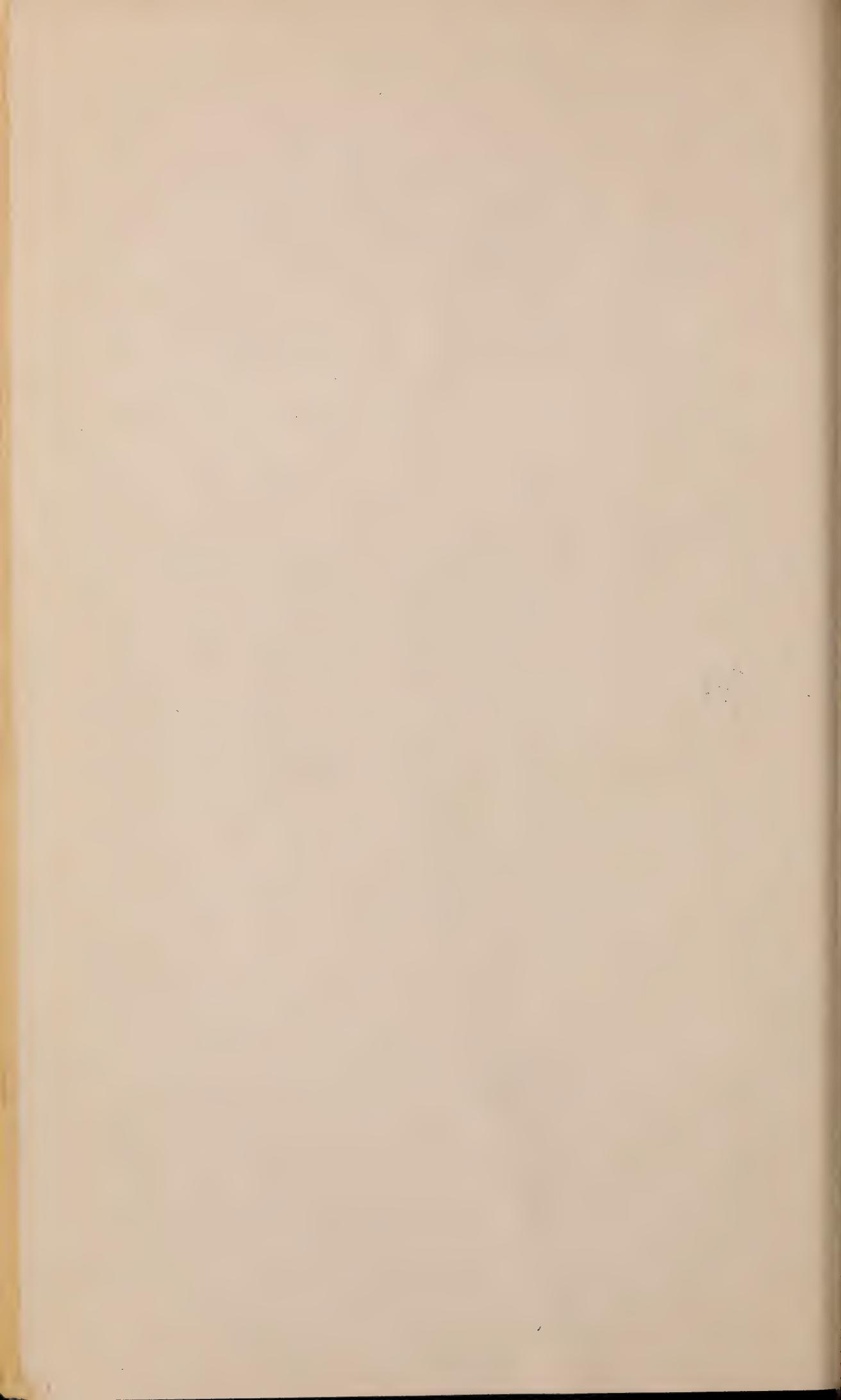
A wagon is at once driven as near the scene as possible. One man takes an extinguisher and goes along the line, deadening the flames, while three others follow, one of whom carries the soda pail and acid box while the other two carry a can of water each. As soon as the cans are emptied they are returned to the wagon and full ones are taken to the front by one of the men, while the other takes the five empty cans for a new supply. Men with shovels and rakes follow after the extinguisher to beat out any remaining fire. Back fires are only resorted to in cases of particular emergency.

The town of Braintree owns an express wagon, 6 extinguishers, an acid box containing 100 charges, 30 water cans and 18 rakes and brooms. The soda pails are provided with hinged covers, to keep out the dirt. The water cans have covers which prevent slopping over and pitcher mouths for ease in filling extinguishers and to stop waste. The Star extinguishers have been used with good results. The soda is not added to the water until reaching the fire. In case the fire is very hot an extra charge of soda is used, to throw the stream further. The Star will stand this extra pressure. Soda should be sifted if lumpy, because it will not dissolve quickly otherwise. A copper wire should be carried with each extinguisher, to clean out the tube. To prevent the brooms from taking fire they should be saturated with salt water. The hose should be covered with a covering of electric tape, to prevent its being shrivelled by the heat.

On an alarm of fire our wagon picks up the men along the way. If more men are needed than the warden's force, the fire alarm is rung, but no man receives pay unless put to work by the warden. The rate prescribed by the town is 30 cents per hour.



BRAINTREE WAGON.



Those communities provided with an electric alarm system are in a position of advantage, as they can use a special call for forest fires, with a resulting economy of time which is of great importance.

Experience in Braintree has shown that 6 extinguishers are sufficient for a small crew. This would be on a basis of four men to a crew. The supplies needed consist of 2 pails of soda and 1 of acid, in addition to 50 bottles in the carrier, 12 cans of water and 4 shovels.

The town uses the Star and Holloway extinguishers. Any reversible extinguisher is unreliable, according to Mr. Cutting, after having been shaken about in the wagon. Those charged by refilling the acid bottles take up too much time. The Holloway works by the breaking of the bottle. The water cans have proved very handy, rendering good service. They are made of galvanized iron, cover attached with a chain, and with a bail handle for ease in carrying in the woods.

John Breagy, Forest Warden, Dover.

Sometime ago the town purchased a fire wagon. As Dover has no water system, the wagon was equipped with ladders, two or three dozen milk cans, 18 Bric't hand pumps and 6 hand chemical extinguishers.

The cans cost \$9 per dozen, while the pumps were \$54 per dozen and the extinguishers were \$14 apiece. The wagon without equipment cost \$500. Two 54-gallon barrels filled with water were also placed on the wagon. The force pumps threw a stream 30 feet.

*E. A. White, Chief of Fire Department and Forest Warden,
Foxborough.*

The town has its own horses and a regular wagon equipped for forest fires. The outfit consists of 8 extinguishers, 20 4-gallon milk cans, 2 tanks holding 50 gallons, and 12 shovels. A 50-pound keg of soda and 100 bottles of acid are carried along to recharge the extinguishers. The Holloway extinguisher is used.

Foxborough has an alarm system, and when the warden or one of the engineers is notified of a woods fire he sounds an alarm, which consists of three strokes three times repeated. This calls out twelve men, picked for forest fire work. If the required number do not appear within five minutes a second alarm is given which calls the entire department.

At the fire four men use the extinguishers and four men follow with a couple of cans of water each, and two men bring the soda and the acid. Other men armed with shovels come behind to finish all remaining blaze. In times of necessity a back fire is set, but only rarely.

Forty cents an hour is the rate prescribed by the town, and no one outside of the regular force is hired unless the fire is extremely severe, and then they must be well-known, good men.

The new law in regard to setting fire without a permit between April and December was adopted by the town last year and has proved a great

success. A printed form is used for the permits, and no one receives one unless he can satisfy the warden that he can protect himself and others against the spread of fire.

Edward R. Farrar, Forest Warden, Lincoln.

In Lincoln, whoever sees a forest fire notifies the nearest fire company by telephone. There are three wagons, located in separate districts.

Besides the above-mentioned apparatus, Mr. Chas. Francis Adams has a light express wagon which he keeps loaded with 8 extinguishers and 20 milk cans filled with water, which is always offered when needed.

On the estate of Major Higginson, near by, 12 extinguishers are kept for a similar purpose, and 12 more may be obtained if necessary. Many other citizens have extinguishers to be had in time of need.

When fighting forest fires we send men ahead with extinguishers and cans of water, and behind these follow careful men with shovels, to put out the remaining fire.

Jas. J. Shepard, Forest Warden, Pembroke.

A definite plan of operation at forest fires is followed in Pembroke. When the apparatus arrives at the fire a man starts along the blaze with an extinguisher. He does not stop to extinguish everything, as another man or more follow on to put out the fire left by the first. Generally a man or two with extinguishers can deaden the fire so that men with shovels can complete the job. Meanwhile I set one man at work refilling extinguishers and bringing supplies of water. Cans are preferred to tanks, as they can be carried into the woods, whereas a tank must remain in one place and the extinguishers be carried to it.

During the drought this year I issued an order through our local paper stating that permits for fires would not be issued until rain came. A request was also published asking for the co-operation of the people. Fortunately we escaped the infliction of the severe fires which some of our neighbors suffered from.

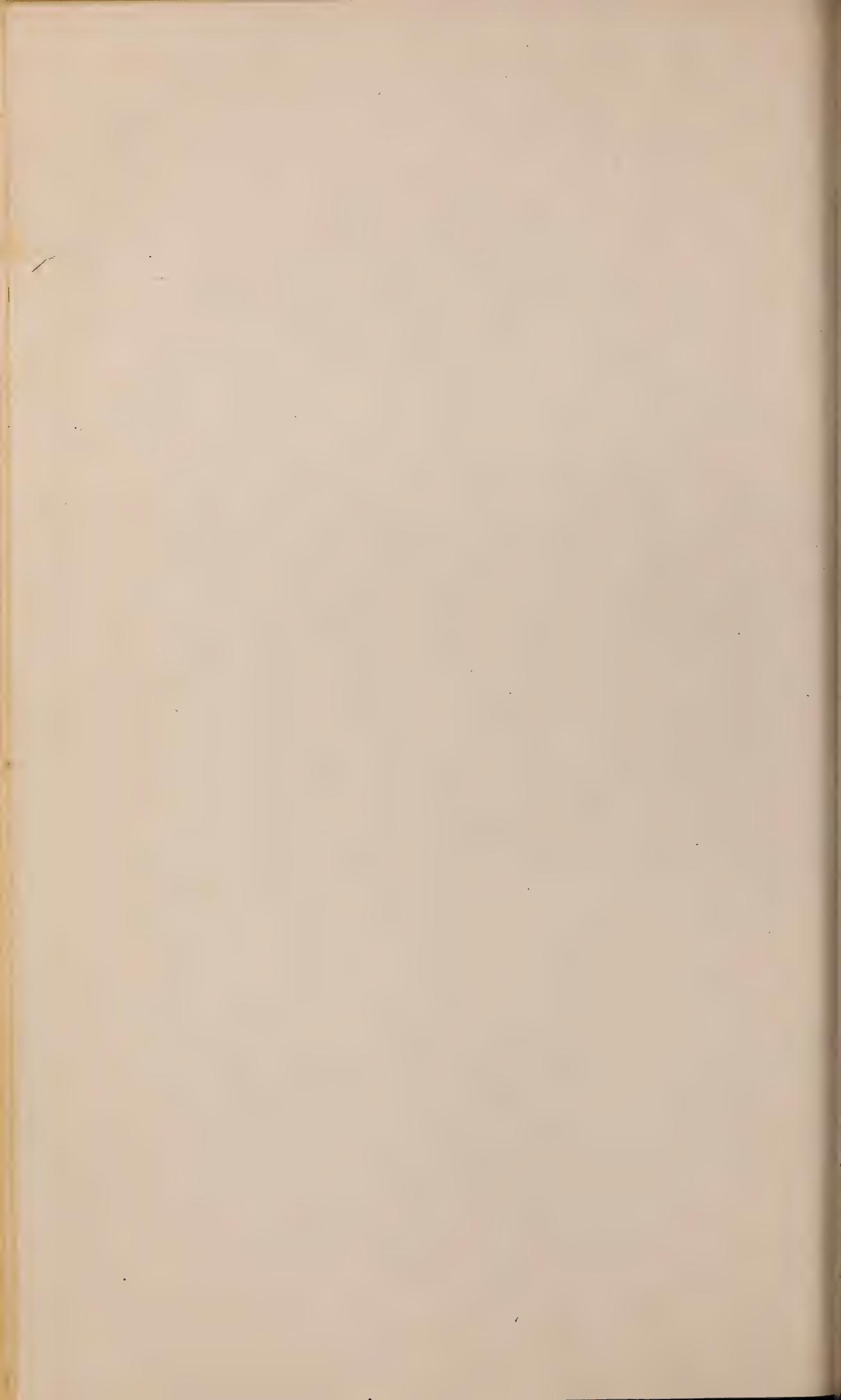
One of our wagons went to a fire located in a large house, while directly across the road were three more buildings with the wind blowing towards them. Our men went out on the roofs with the extinguishers, and as fast as the shingles caught put them out. All the buildings were saved. It was three miles from the place where the wagon was kept to the fire, but the driver got there in eighteen minutes from the time the telephone message was received. The above merely shows that the wagons serve the town in more than one capacity.

The cost of our three wagons and equipment, consisting for each wagon of 14 Standard extinguishers supplied with extra heavy cover and a patent shutoff, 2 axes, 9 shovels, 2 lanterns, a large gong, 10 water cans, each holding enough for two charges, a brass rail along the sides, and under the driver's seat 60 charges of acid and soda, was about \$400 each.

Doubtless this is a more expensive wagon than others rendering similar service. The bare wagon, fitted with pole, nicely painted and lettered, cost without freight in Indiana \$135. The outfitting was done here by local men. Each extinguisher stands by itself in a case, so that there

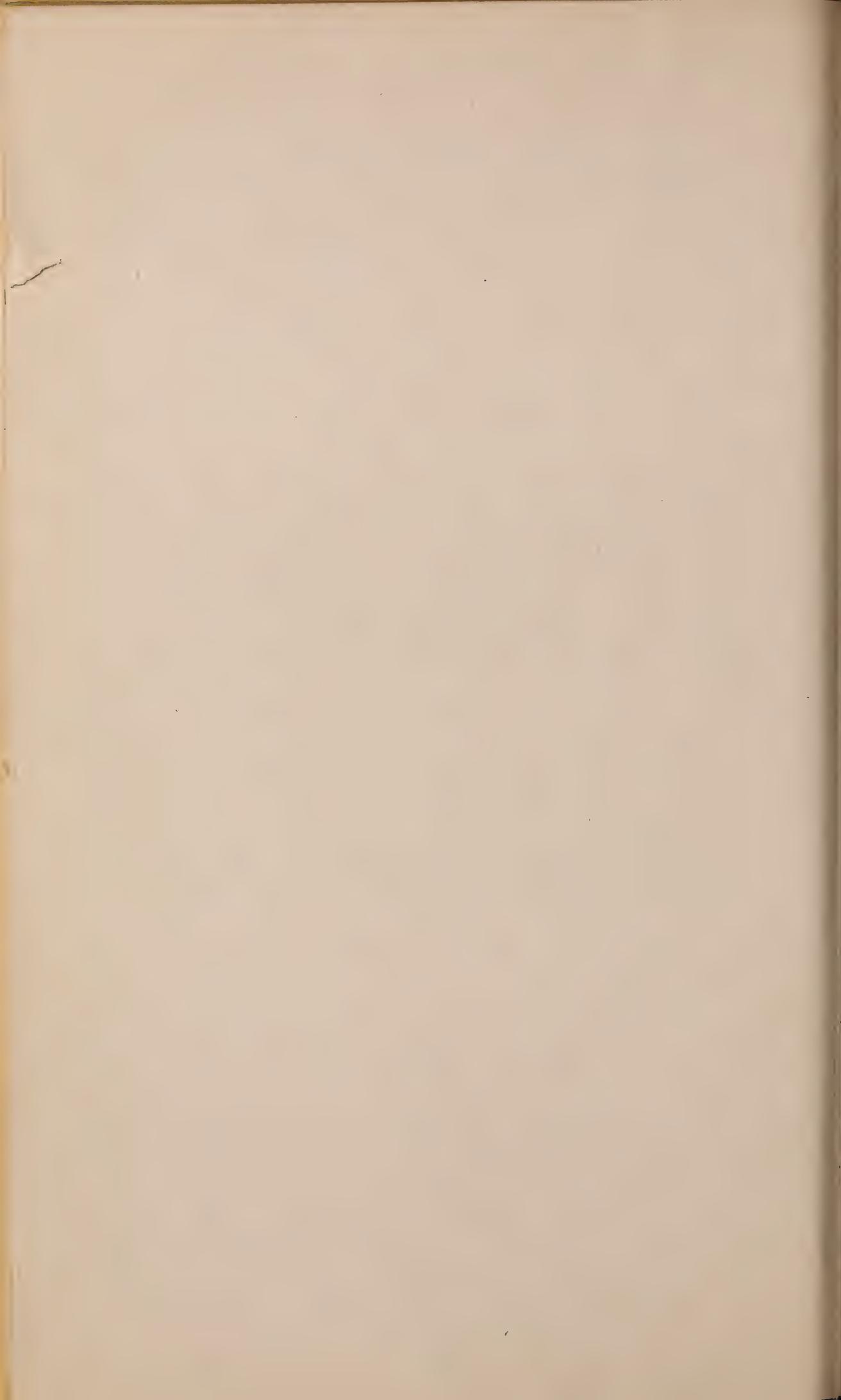


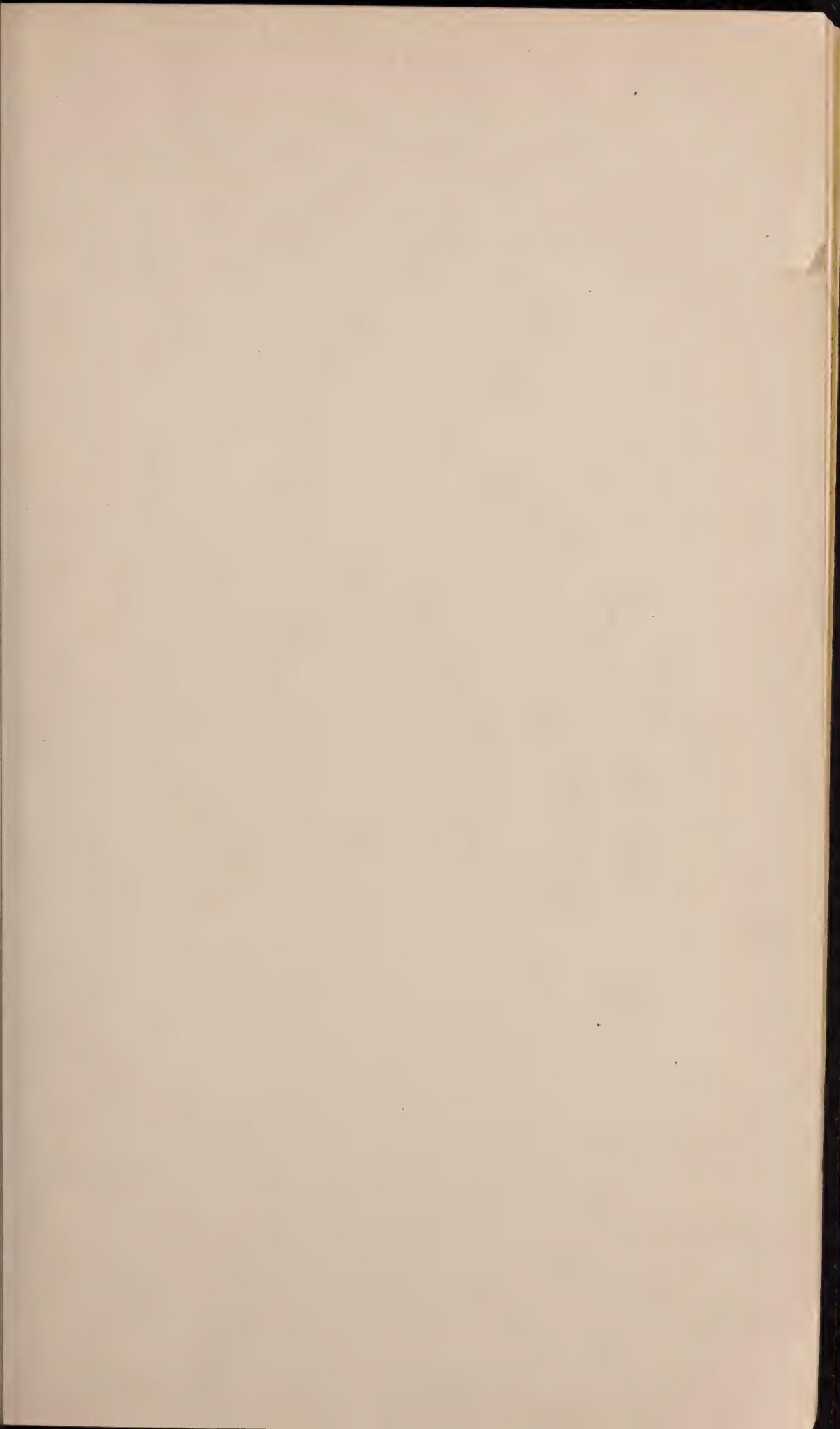
LINCOLN WAGON.





PEMBROKE FOREST WARDEN APPARATUS.







WILMINGTON FOREST FIRE WAGON.

can be no chafing against each other. The water cans are also inside a wooden case, where their slop will not wet the chemicals.

I presume a wagon might be fitted up, less the price of the extinguishers and water cans, for \$150.

Thomas Maher, Chief of Fire Department and Forest Warden, Milford.

The regular supply wagon of the department is used to carry the forest fire apparatus, which consists of 6 extinguishers, shovels and brooms. The forest fire alarm consists of 5 strokes, and all the men report at the station. From six to ten men are taken along on the wagon and they are paid 25 cents per hour.

Mr. Maher also says that back fires may be required in some instances, but they are often more disastrous than the original ones.

S. T. Parker, Forest Warden, Wakefield.

Wakefield has furnished apparatus for forest fires valued at \$1,400. This apparatus consists of 268 Johnson pumps of the double acting variety, 500 buckets and a few cans. Forty oil barrels were purchased and sunk in the ground in the woods, at a cost of \$1 each, for a reserve supply of water.

When a man receives a pump he signs a receipt for it, agreeing to report at any fire within half a mile. Failing in this he gives up the pump. The pumps may be used for other purposes, but they must be kept in condition for immediate use.

Very little time is lost before men are working at the fire, and it seldom burns more than three or four hours. When the fire is too hot in front work is confined to the flanks, and the fire is gradually narrowed down until put out. In a dry season a trench is dug and water turned in to prevent the fire from running under ground.

Water for the pumps is found in brooks and ponds, with which Wakefield is well supplied, and from the water barrels mentioned before.

Every fire is investigated and the cause is usually discovered. If boys set fire their parents are notified, and if they are caught again they are brought before the Board. The warden keeps a record of every fire, its extent, cause and damage.

J. M. Hill, Chief Fire Department and Forest Warden, Wilmington.

The town has two single express wagons which are equipped with 20 10-quart cans with stoppers attached, 6 Johnson pumps, 6 shovels and 3 brooms each. The wagons are kept at opposite ends of the town.

Men report voluntarily, and if the fire is a small one the warden or deputy takes the wagon with two or three men and goes to it. If more men are needed the fire alarm is sounded. The signal is one blast followed by the box number sounded thrice.

Mr. Hill thinks that good results are obtained with water and hand pumps, especially in his section, where on account of the rocky soil there is little chance of using a shovel. Quickness in reaching the fire he considers is paramount. He resorts to back fires when a large number of men are at hand, and then only when necessary.

Herbert Morrissey, Forest Warden, Plymouth.

Fires are controlled by chemical extinguishers, and after the flames have been deadened, men with shovels finish the work by throwing on sand. Close watch is kept on fires, the men remaining overnight if necessary. The area burned is patrolled at least once the next day. When the fires are too hot to combat from the front this work is carried on at the flanks, gradually narrowing in the line until it is all put out by the men meeting in the middle of the line.

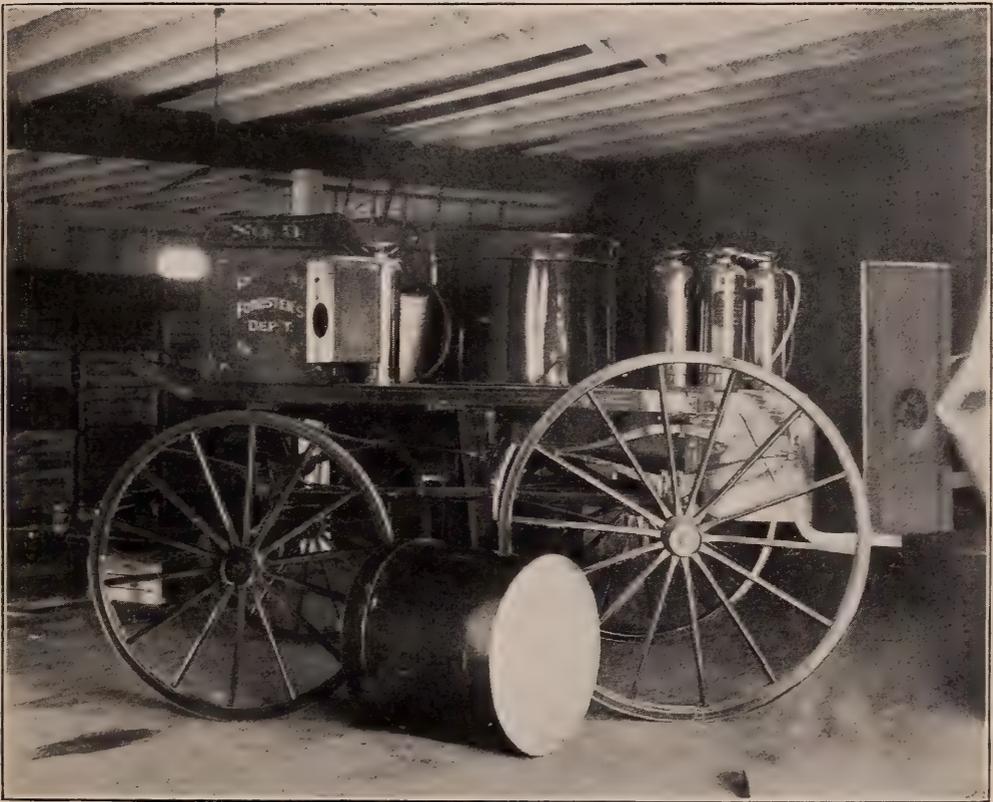
The town owns about 100 extinguishers and has three especially equipped wagons. Two of these wagons carry 12 extinguishers each and the other 14. The wagons are also equipped with tanks holding 50 gallons and covers holding an equal amount, which are put on the ground and the tanks emptied into them, the wagons then going for a new supply. Compartments of acid and soda are fitted into the wagon, and shovels, hoes and brooms are provided.

Two men remain at the wagon to refill the empty extinguishers as they are brought in. Besides the extinguishers on the wagons, each of the twenty deputy wardens have 4, which they bring to the fire with them. All the extinguishers have straps, so that they may be slung on a man's back. One extinguisher will deaden the fire on a line from 50 to 100 yards in length on one charge.

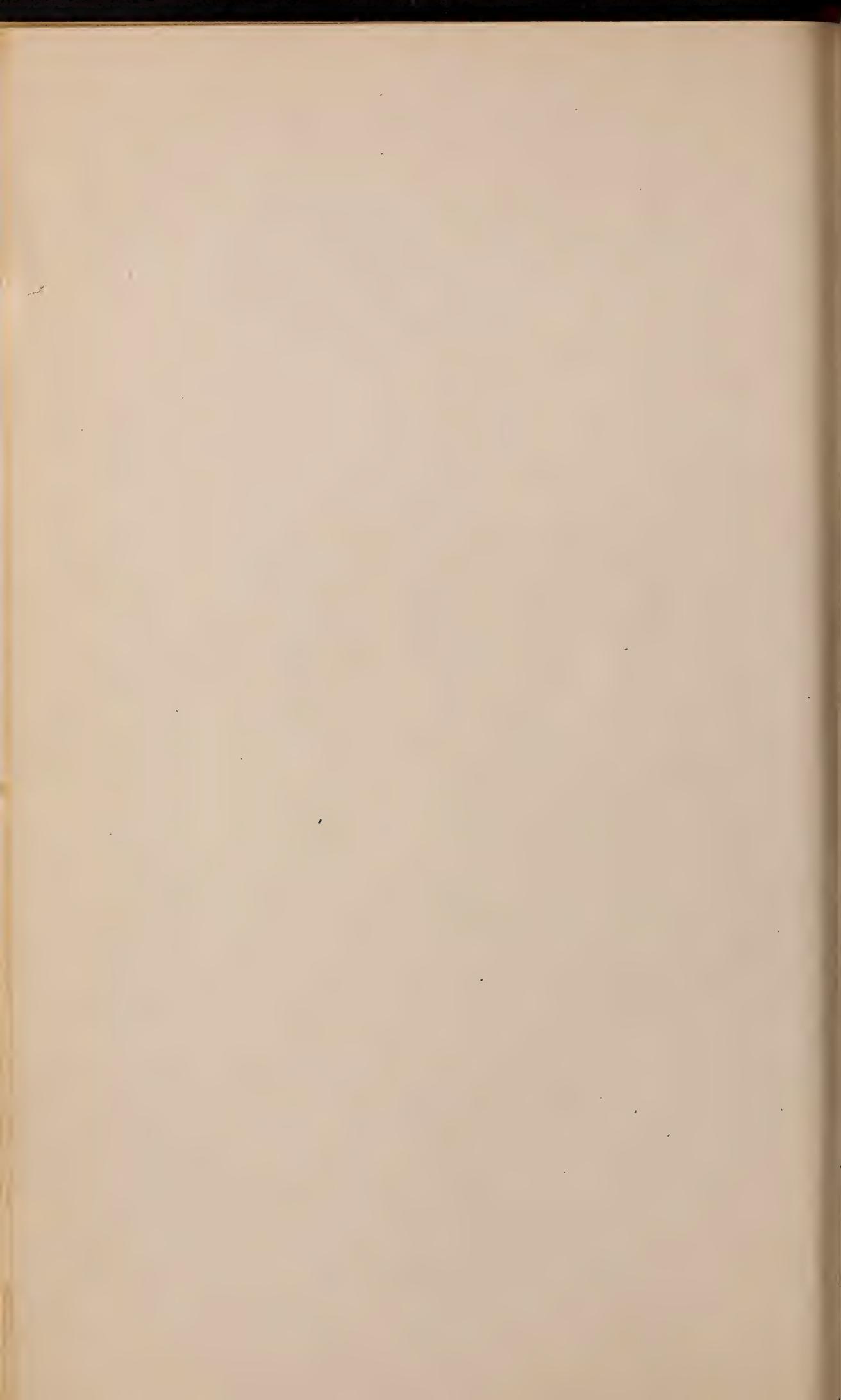
Plymouth is, we believe, unique in having an iron watch tower on one of the highest hills in the town, for the detection of forest fires. The tower is of steel lattice work construction, similar to that of a windmill, and with a sheet-iron cabin at the top. The tower is 85 feet tall, the hill 165 feet above the sea, so that gives the watchman a total elevation of 250 feet. It is connected by telephone with Mr. Morrissey's house. The watchman who stays up here during the dry seasons has a strong glass and thus is given a clear view over many miles of country.

When fires are severe and the situation critical Mr. Morrissey does not hesitate to use back fires, which are handled as follows:—

The warden places his men along a road, if convenient, or along a line of freshly dug earth extending across the face of the fire. A man with a torch goes along the road setting the back fire. Men with shovels are stationed at short intervals along the road, ready to deaden the flames or to stop them from jumping the road to the

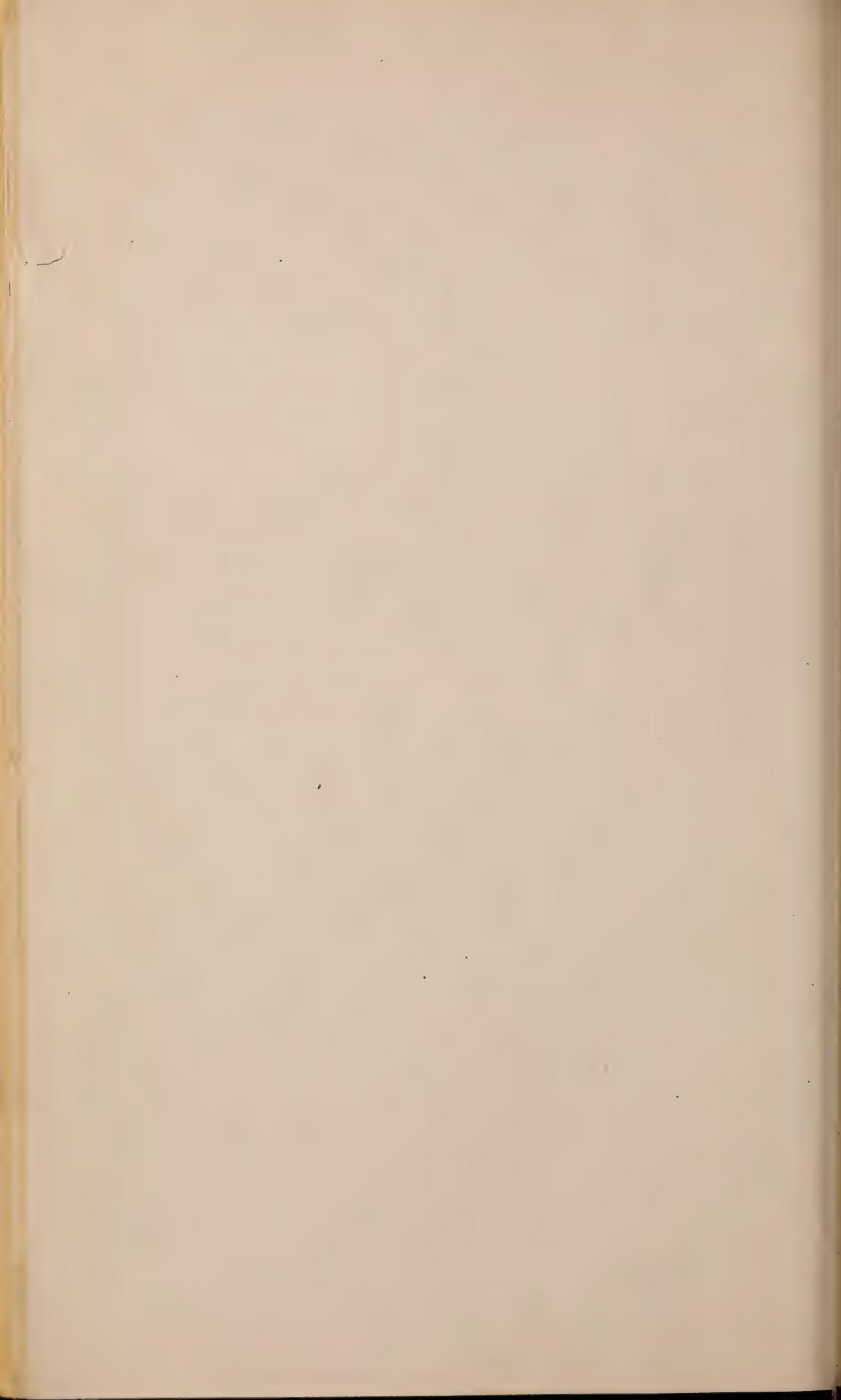


ONE OF THE WAGONS OF THE PLYMOUTH FOREST WARDEN.

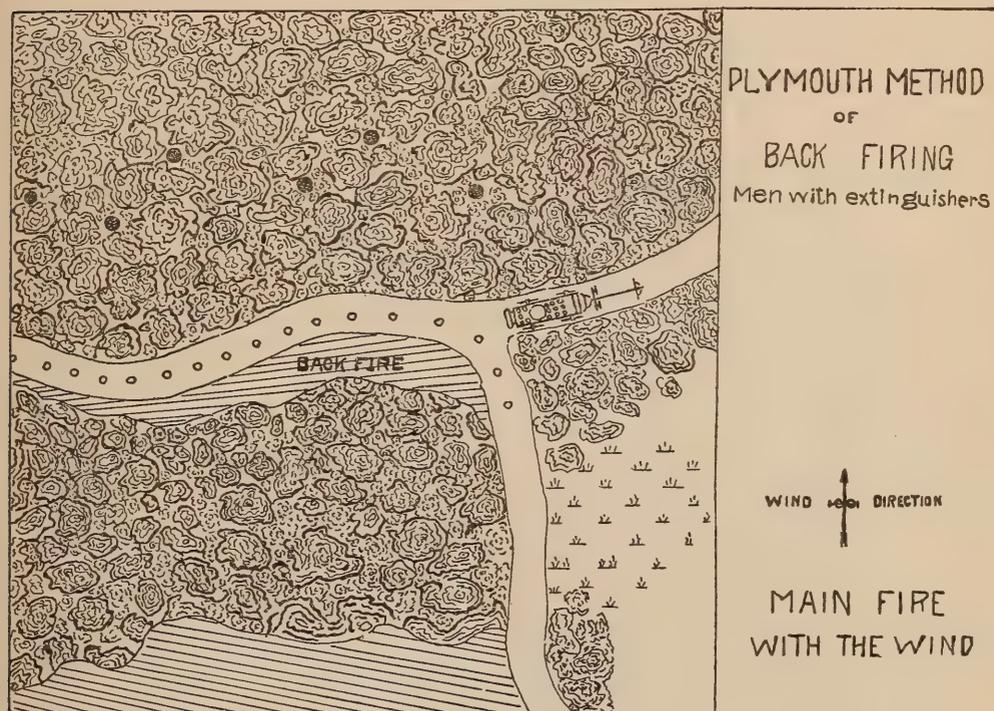




OBSERVATION POST OF FOREST FIRE DEPARTMENT ON RESER-
VOIR HILL, PLYMOUTH, 248 FEET ABOVE MEAN SEA LEVEL.



woods behind. Within these woods are stationed men with extinguishers, indicated in the diagram by large black dots. These men stand ready to put out all incipient fires lighted by flying sparks, and hasten forward to the aid of the men on the line when called.



In Plymouth fires set by locomotives are usually put out by the section men, but when the forest warden is called the railway company reimburses the town for the expense.

Permission to build fires in the open must be obtained from the warden. Cranberry bog owners are treated with leniency when obliged to build smudge fires to protect their crops from frost. All fires for clearing up brush are guarded by a wagon and crew, the owner of the property paying the charge for the protection.

C. H. Trowbridge, Forest Warden, Oakham.

When a forest fire breaks out the warden telephones all persons having fire extinguishers to turn out, and then, taking what men and extinguishers he can muster, he hastens to the fire at once.

At the fire it is the custom of the warden to have three or four men follow him along the line to pass forward loaded extinguishers and take back empty ones for recharging.

Water for recharging the extinguishers is brought in cans from the nearest supply. Much of the advantage of extinguishers over a chemical wagon is that they may be carried with their cans to inaccessible places in the woods.

Oakham owns 34 extinguishers, which have been placed in private houses throughout the town. Many more persons applied for them than could be supplied. Next year the town intends to buy enough to supply the demand. The first ones cost \$18, but a substantial reduction was obtained by ordering a large quantity. While there are many kinds of extinguishers, those most effective at woods fires are provided with an arrangement which cuts off the stream by means of a valve which stops the flow of acid. Such a device saves the remainder of the soda charge, so that it may be used at intervals when needed. Those chemicals using the whole charge are useful in buildings. Every small town should have some such protection as this of Oakham. Many houses have been saved here by extinguishers when a bad fire seemed inevitable.

J. A. Healy, Forest Warden, Westford.

I will give you the list of the fire tools of the town of Westford: 30 shovels, 30 hand pumps, 12 extinguishers, 60 pails.

Enclosed find picture of fire wagon.

F. B. Knapp, Forest Warden, Duxbury.

Our woodland area covers about two-thirds that of the town, and produces cord wood, box boards and some better lumber. It forms part of a continuous forest extending into adjoining towns, but is split up by roads, ponds and open spaces. There are numerous isolated farms liable to damage from forest fires.

Our liability to fire is considerable. A railroad runs the length of the town, many strangers come for mayflowers in the spring and cranberry bogs are in process of construction. The soil is light and the woods get very dry.

The town is liberal in its appropriation and appreciates our efforts. Telephones are pretty common, and the men turn out well. We are in close touch with the railroad people and co-operate with them.

The forest warden and fire departments are technically distinct, but work together. I am chief of the fire department, and all of the engineers are deputy wardens. One commissary looks after all of the apparatus.

We have 2 60-gallon hand combination fire engines (used for forest fires when specially called out), 4 forest fire wagons, and several private ones used at times, 100 3-gallon Standard extinguishers scattered throughout the town, shovels, mattocks, etc.

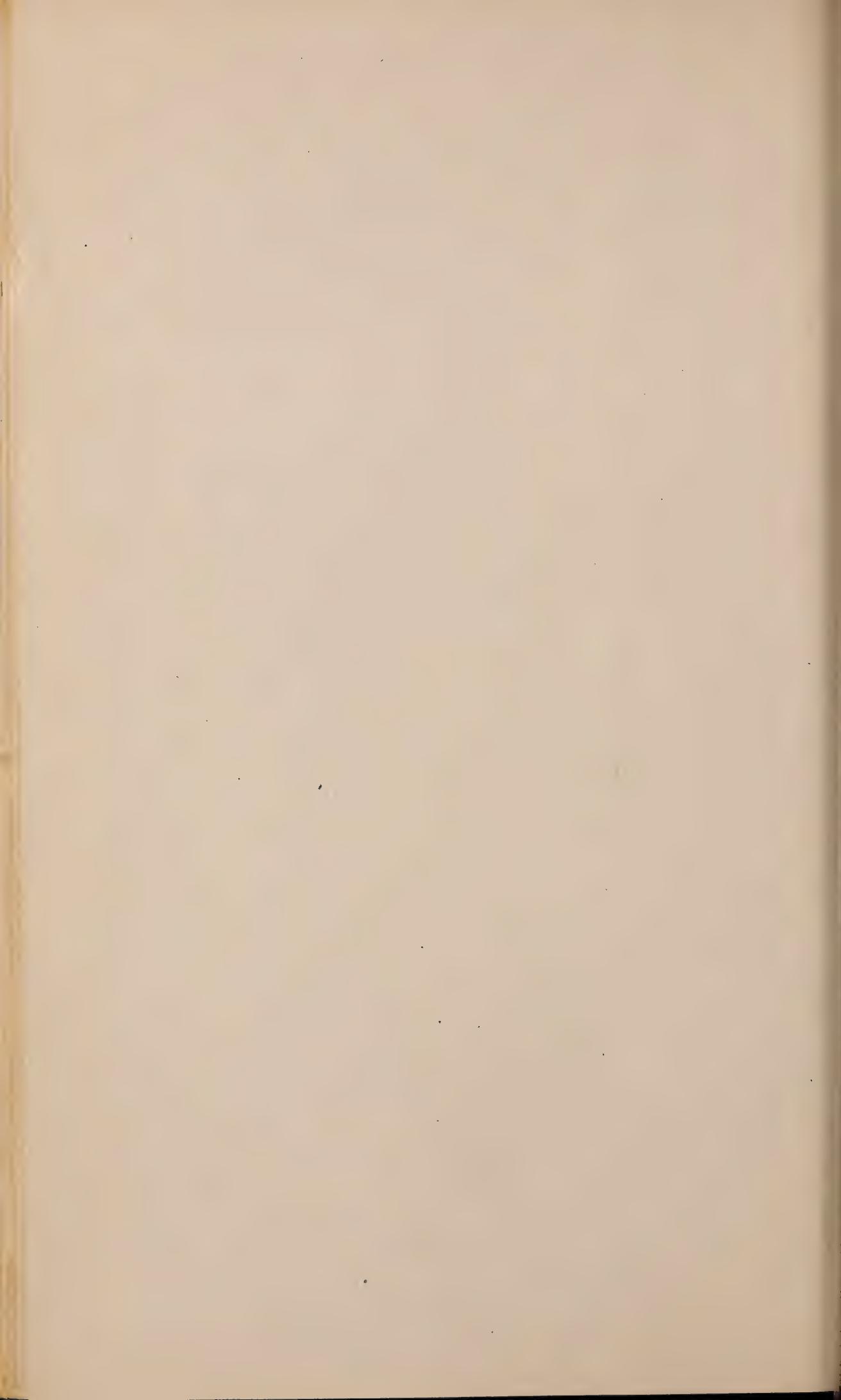
The fire wagons vary, but this one is typical: A light, one-horse express wagon, 4 extinguishers, 6 boxes, each with 6 charges of chemicals, 16 3-gallon Marshfield cans, not completely filled (on account of weight), 10 shovels, 2 mattocks, 2 axes, 2 lanterns, torches.

We spread the alarm of fire by direct telephoning and by bells. In times of great danger a man is stationed in a church belfry.

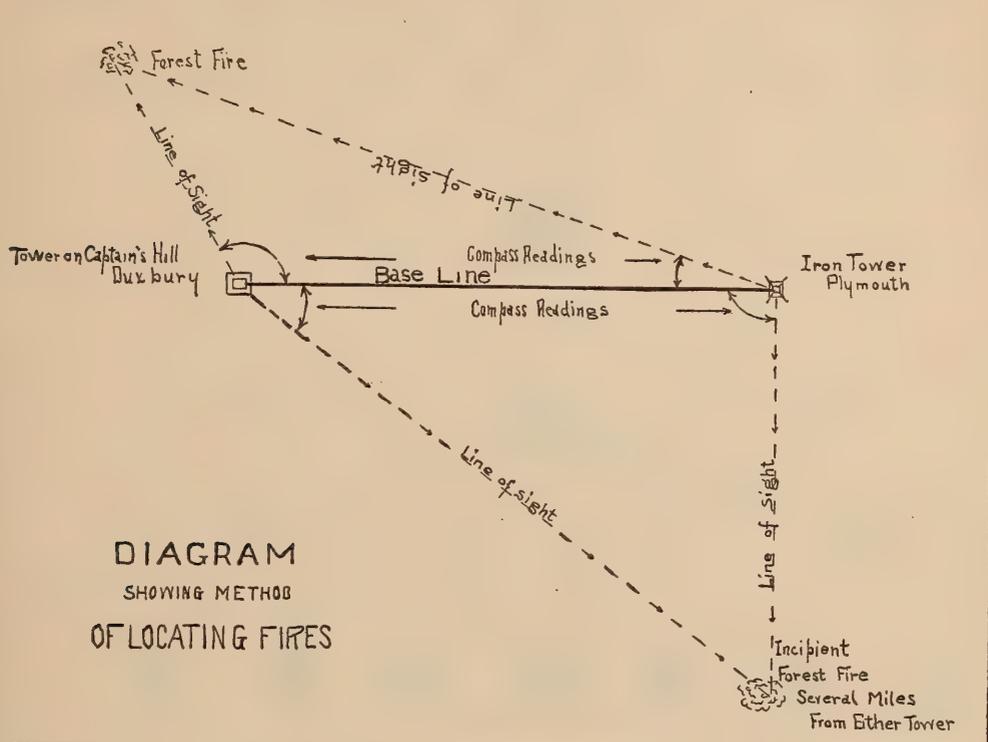
We are inaugurating a system of outlooks in conjunction with the Plymouth fire tower. Our tower is the Standish monument, on Captain's Hill. From these two points the compass bearings of an incipient fire can be read and telephoned to a central station. These lines are then run out on the United States geological survey map, allowance being



WESTFORD FIRE WAGON.



made for the difference between the true and magnetic north. If the compass readings are correct the intersection of the two lines gives the position of the fire.



At a small fire we do not attempt any thorough organization, but we organize at serious fires as follows. All are familiar with the organization, either through experience or printed instructions.

Chief.—The forest warden or deputy of the district. Does not stay at any one point, but overlooks the whole line. Informs himself carefully as to the extent of the fire and picks out the critical points. If the attack on one line is unsuccessful he draws the men back to another.

Aids.—Messengers for the chief.

Deputy Wardens.—Act for section as chief does for whole, or, at smaller fires, are simply foremen.

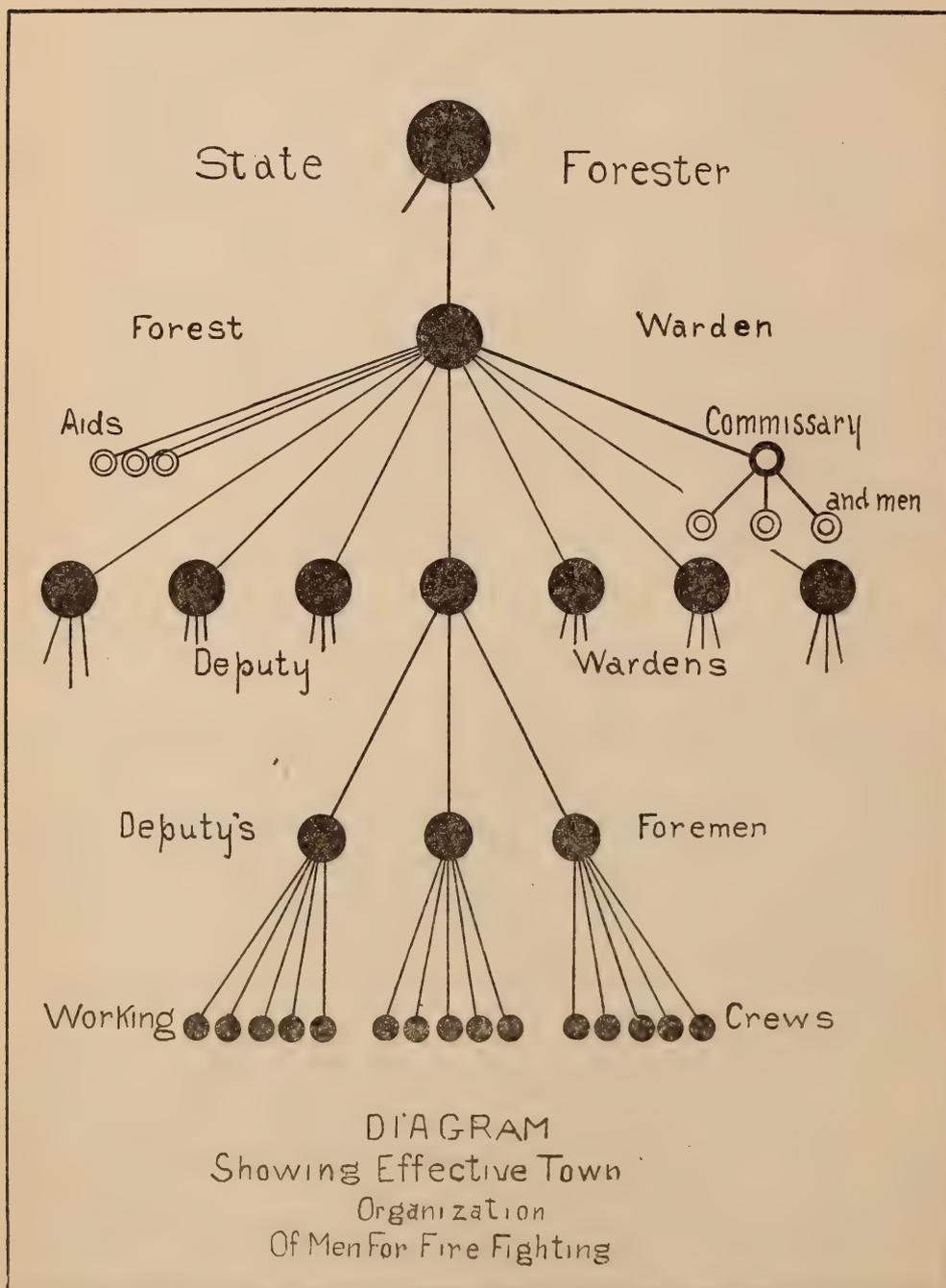
Foremen.—Each has from four to six men, who stay with him until the fire is out. Each foreman and his crew form the units for fighting. As, for instance, one crew might be put to work refilling extinguishers, another at carrying them, another at guard duty, to prevent fresh outbreaks after the fire is apparently out.

Commissary.—Takes care of the apparatus, and at the fires sees that the men are supplied with food and other supplies.

[The diagram on page 22 gives this organization in graphic form and is remodelled from one sent in by Mr. Knapp.]

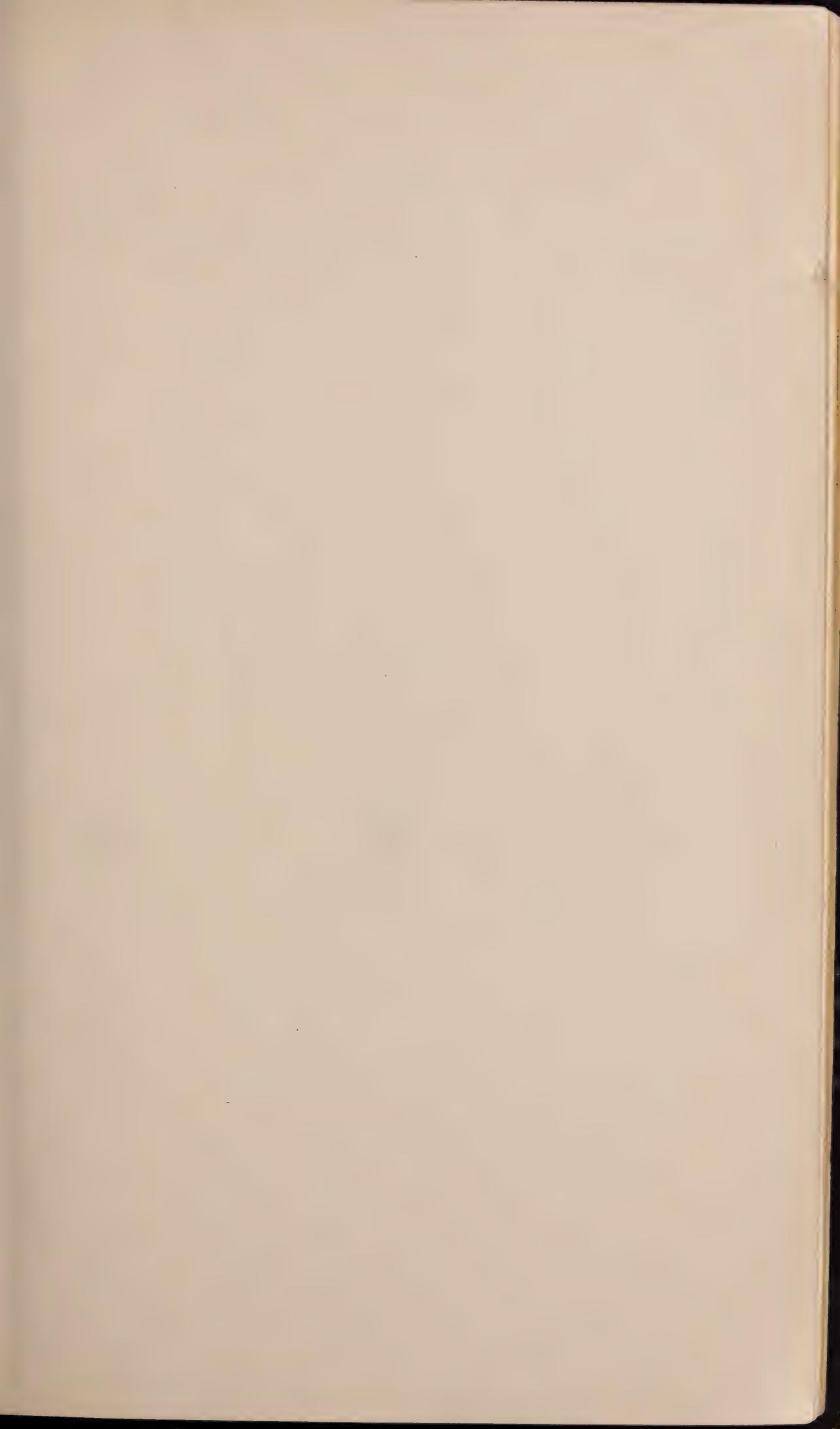
It is essential that the work of forest fire fighting should be done as systematically as possible, and that the directions of the leaders should be faithfully carried out. The failure of a single man to do the part assigned to him may make useless a whole lot of hard work and cause a new start to be made.

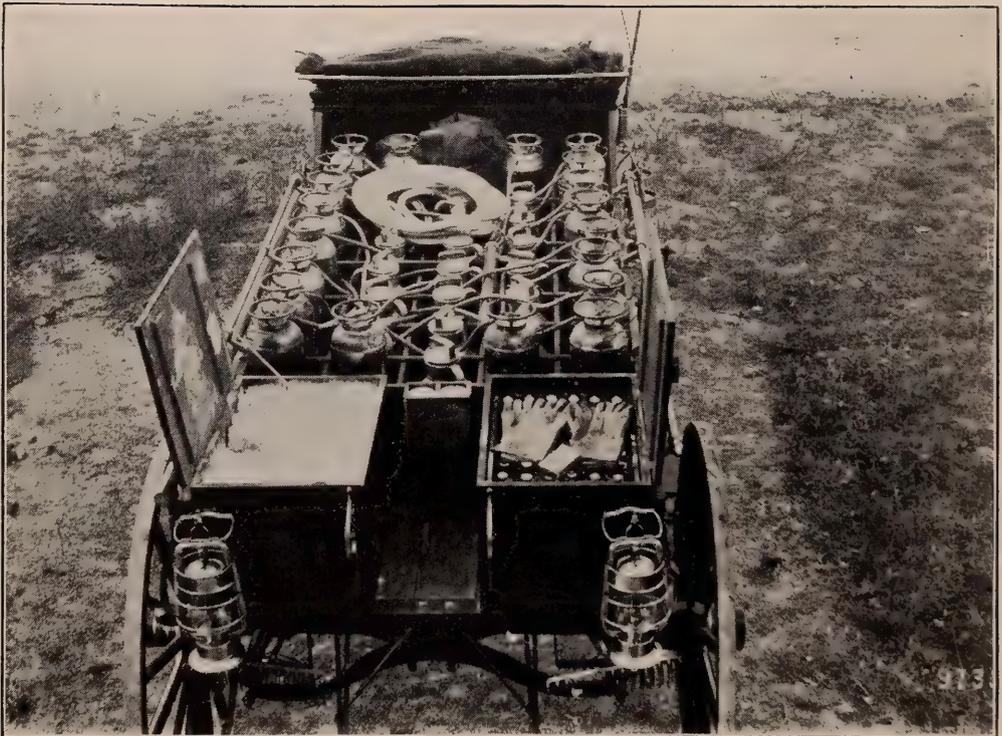
If the force is too small to attempt to stop it across its whole front, we start to windward and work down both flanks, narrowing to the front. One crew with extinguishers pushes ahead and deadens the flames, and is followed by a second crew consisting of one man with a mattock and



four with shovels, and a reserve man. If very dry a second shovelling crew follows this one. Then come the guards with shovels and extinguishers, who patrol the whole line.

With a force strong enough to attack in front, back firing is used. A back fire must be set on a natural line, such as a road, but, failing in this,





INTERIOR OF WELL-EQUIPPED WAGON.

one can be plowed. For this purpose use a strong plow drawing a narrow furrow and pulled by two horses set tandem. Set a back fire as rapidly and continually as possible, the men with torches being followed by shovellers to put out fire spreading on the leeward side of the line. Other shovellers and extinguisher men are stationed some distance back in the woods to put out sparks as they fly over.

Our work is still in the experimental stage and just at present we are trying to get the fire fighters more systematic, and are getting into closer relations with neighboring towns.

The preceding letters were selected so as to give as wide a range of conditions as possible. There are letters from wardens who are at the same time the chiefs of organized fire departments, letters from wardens who have an organization distinct from the fire department and letters from wardens in towns which have no fire department. The apparatus used varies in value from \$300 to \$3,000. There are towns which have done as much or more than some of those mentioned above, but the fact remains that a large majority have made no provision for fighting forest fires. The cities also are as indifferent as the towns. It is not to be supposed that all the towns represented by the letters have done the best thing possible under the circumstances, but they have done something.

IV. WHAT IS YOUR TOWN DOING ?

ON FOREST FIRE PROTECTION.

Apparatus.

Every town having 1,000 acres or more of forest land should have some form of apparatus, its amount depending, of course, on the financial ability of the town, the acreage of forest land and the value the inhabitants set upon it. Cities and towns having organized departments should see that special provision is made for combating forest fires, whether the warden is a member of the fire department or not.

The equipment best suited to various localities will, of course, vary in detail, but a practical outfit will include the following essential things:—

1. A stout express wagon. Gold paint and brass work are not necessary to its practicability, and a second-hand wagon in good condition would fulfill all requirements.
2. Five or 6 chemical extinguishers of a reputable make, and costing from \$12 to \$20 each.
3. A dozen or more cans, with attached covers, and filled with

water in which soda has been dissolved ready to recharge the extinguishers. Large milk cans are often used, but cannot as a rule withstand hard service.

4. Extra charges of soda and acid carried in proper receptacles.

5. Shovels, mattocks, axes, rakes, hoes and brooms, as many as the wagon will conveniently carry.

Such an outfit will cost from \$300 up.

Organization.

Each warden should have some kind of organization, although the exact form will depend a good deal on local circumstances. The warden and each deputy should have a small crew of men whom he can call quickly and upon whom he can rely. No others should be taken to the fire unless its size makes it imperative. Such a plan will stop irresponsible people from setting fires in the woods merely to get a job at putting them out.

Fire Lines.

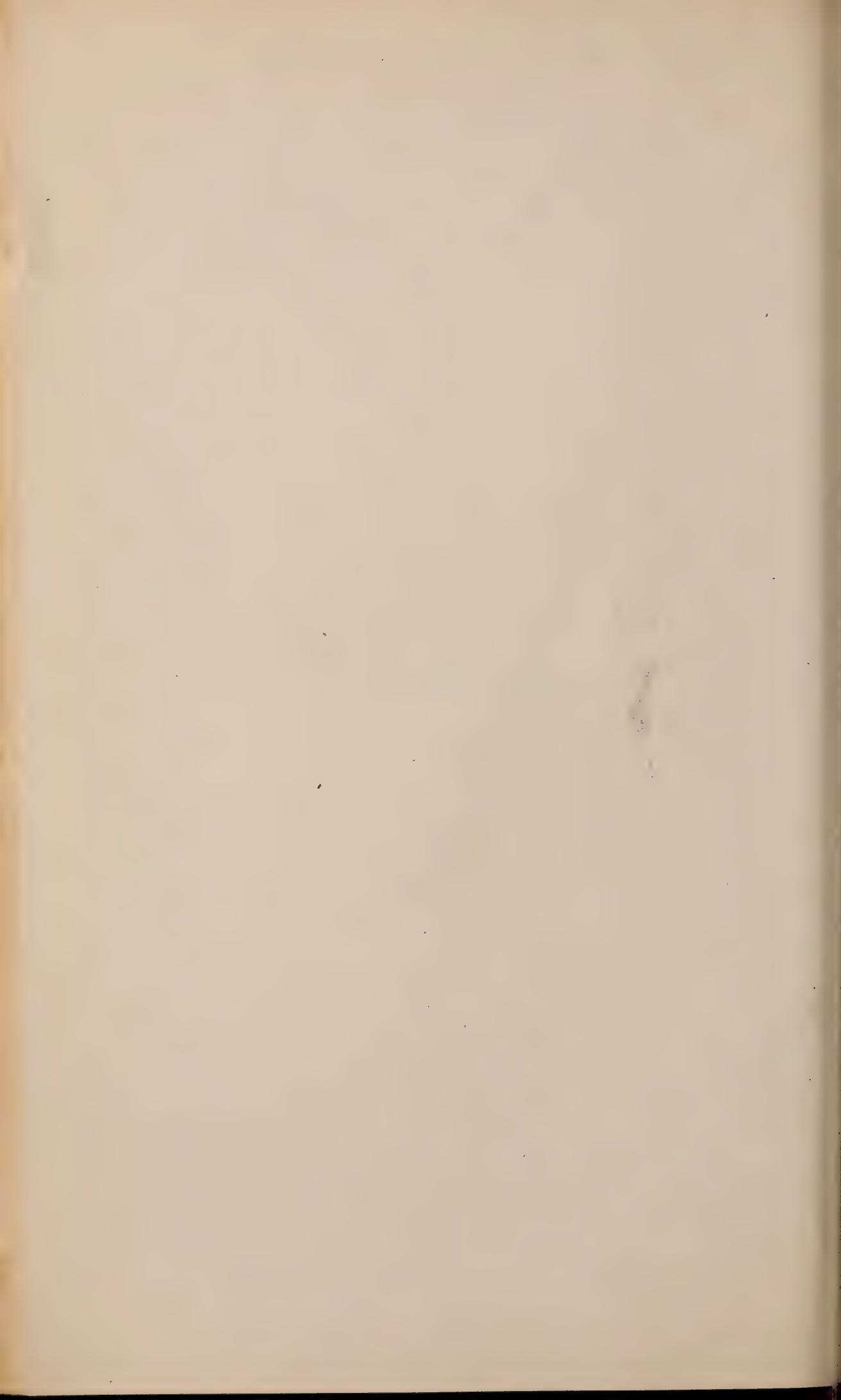
This subject is a rather unsatisfactory one to discuss, because although more or less has been written on it, there have never any real tests been made.

A fire line as ordinarily described is a strip through the woods from which all the growth has been removed. Some people acting on this description have made fire lines which were veritable traps. They cleaned out all the trees and undergrowth and there left it. Consequently during the next year it came up to sprouts and brambles. To keep such a line clear it must be mowed and burned over every year, although of course as time goes on grass will take the place of brambles and sprouts, and this can be easily burned over. The cost of such a line made for the Metropolitan Water Board at the Wachusett Reservoir was \$150 a mile.

What appears to be a very efficient fire guard is to be found on the estate of Mr. Charles Francis Adams, Esq., in Lincoln. It consists of a trench 6 feet wide and dug down to mineral soil (about 2 feet), paralleling the railroad track at a distance averaging 60 feet from the center of the right of way. We are of the opinion that if the distance had been 100 feet there would be less likelihood of cinders blowing over it. Between this ditch and the track the underbrush has been cut and the dead leaves are annually burned. The large trees are left undisturbed, and serve as a screen to catch the flying sparks. Except in the case of a very high wind this line is fireproof. It is two miles long.

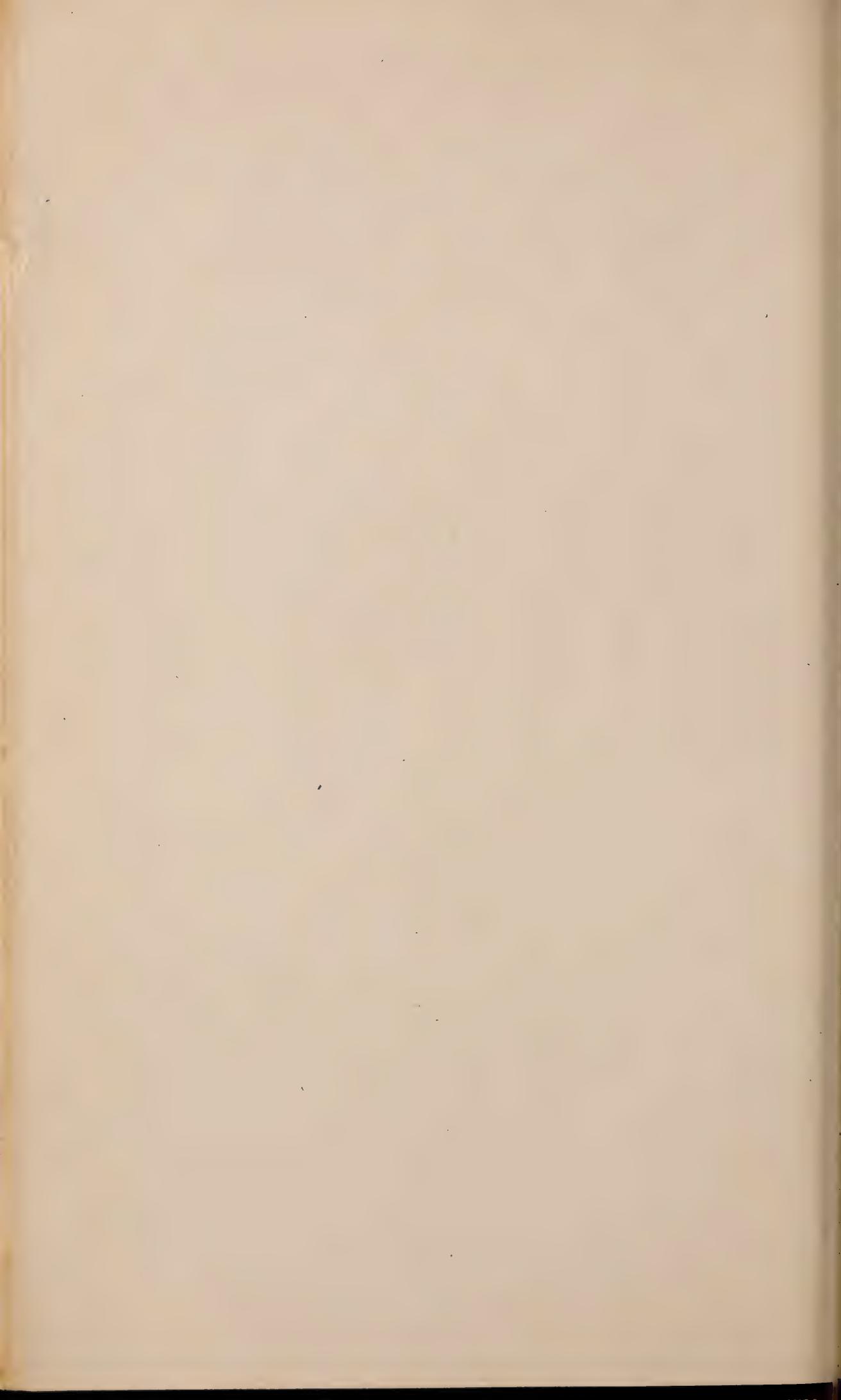


**FIRE LINE, METROPOLITAN WATER BOARD RESERVATION,
BOYLSTON.**





FIRE LINE. ADAMS ESTATE, LINCOLN
(WINTER SCENE).



A similar but cheaper line could be made by running a few furrows with a plow instead of digging a trench. Mr. Knapp contemplates the use of a rotary disk plow followed by a drag to smooth over the ground. A plowed line of this sort would not be sure to keep a fire from running under ground while the trench would.

Just a word of protest should be inserted here against the common practice of cutting brush along the side of country roads, where it lies, making fuel for the first match that is thrown into it.

One of the best natural fire lines is the old wood road. These roads are more or less common, and often ground fires run up and skirt them and there terminate. Were these old roads kept cleaned and widened, with an idea of usefulness as a fire line as well as for getting out forest products, they could be made to serve both purposes.

Forest wardens will do well to emphasize the importance of having all large forest tracts and even relatively small areas subdivided by fire lines, and thus be able to concentrate forces on definite units. System and forethought will put out many fires before they even occur.

Old stone walls relieved of débris, as leaves, brush, etc., also may be utilized as splendid fire protectors. Fires will run up to and skirt these old walls without crossing them if these walls are cared for.

Patrol.

The old saw concerning the stitch in time which saves nine ought to be changed to nine thousand when applied to fire. The quickest and surest way to handle a forest fire is to be on the watch for it. We have seen in the report of Warden Morrissey of Plymouth how that town handles the situation with its tower. This idea is worthy of wider application. Where the topography admits it, several towns could combine to maintain such a station. The Forest Commissioner of Maine maintains several watchmen, who are stationed on some of the highest mountains in the forest region of the State.

The first place to start a patrol would be along the railroads, for, relative to the territory covered, far more fires are started there than elsewhere. Imagine a small car mounted on the rails, run by gasoline, capable of carrying one man, a couple of extinguishers and other tools and geared to a speed of 35 miles an hour. A man so provided could cover a 50-mile stretch of track five times a day. The dangerous season for which a patrol would be needed usually extends from the 15th of March to the 1st of June and from the 15th of September to the 1st of December, — 150 days in all.

The expense for wages and supplies would be \$500 per man. The machines might cost \$500 each. Let us imagine ten such patrols distributed as follows and see how well they cover the danger points. We do not mean by this that ten men are adequate; but they are enough for an experiment.

NEW HAVEN RAILROAD.

Plymouth Division.

Brockton to Provincetown, 100 miles, two men, \$1,000.

Braintree to Plymouth (main line) and Middleborough Branch, 40 miles, one man, \$500.

Midland Division.

Norwood Central to Douglas, 40 miles, one man, \$500.

BOSTON & ALBANY RAILROAD.

Main Line.

Westfield to Pittsfield, 40 miles, one man, \$500.

Ware River Branch, 50 miles, one man, \$500.

BOSTON & MAINE RAILROAD.

Fitchburg to Greenfield, 65 miles, two men, \$1,000.

Central Massachusetts, Hudson to Belchertown, 50 miles, \$500.

CENTRAL VERMONT RAILROAD.

Miller's Falls to Monson, 50 miles, one man, \$500.

Total cost: New Haven, \$2,000; Boston & Albany Railroad, \$1,000; Boston & Maine Railroad, \$1,500; Central Vermont Railroad, \$500.

These figures do not allow for the cost of the machines, which would double them for the first year. No allowance is made for patrols at night, for as a rule comparatively few forest fires start at night, as there is little wind and the ground is covered with dew.

Another scheme is suggested which would make it compulsory along certain sections of track for the section men to detail one of their crew to follow all trains over their section. A crew of five men near Marshfield is said to have spent 50 per cent. of its time during certain weeks of last summer in fighting fire. It would have been real economy for the railroad if one man, or 20 per cent. of the force, had been detailed to patrol the track and put out the fires when they first started.

The advantage of this last scheme is that it is more elastic than the first one, because it can be put in operation when needed and drawn off when not, regardless of months. It also fits into

the ordinary manner of administering the right of way. It would take five men to cover the ground which one could under the first plan, so the annual cost would undoubtedly average more.

That the railroads can afford to expend something on the patrolling of their tracks will be plain from the following list of damage claims paid by railroads in Massachusetts. If the figures of 1908 were at hand it is probable that increases of 200 per cent. would be found. It will be seen that the patrol only has to stop about 10 per cent. of the fires in order to justify the expense.

TABLE 4. — *Forest Fire Damages paid by Railroads in Massachusetts.*

New London Northern:	
For three years ending June 30, 1906,	\$8,339 36
Boston & Albany:	
Nov. 1, 1903, to Nov. 1, 1904,	4,699 33
Nov. 1, 1904, to Nov. 1, 1905,	8,450 60
Nov. 1, 1905, to July 20, 1906,	7,244 62
Boston & Maine:	
1903,	34,859 15
1904,	19,426 36
1905,	35,560 89
New York, New Haven & Hartford:	
Year ending June 30, 1902,	13,658 49
Year ending June 30, 1903,	19,107 79
Year ending June 30, 1904,	19,395 55
Year ending June 30, 1905,	26,311 20
Year ending June 30, 1906,	45,112 96

In addition to patrolling by the railroads along their line, the State should be ready in emergencies to put on a patrol in other sections. The Forest Commissioner of Maine has an emergency appropriation of \$20,000 which he can use for such means. His average annual expenditure from this fund has been \$9,000, but last year he exhausted the entire amount before the 1st of September. For a State of the area of Massachusetts probably \$5,000 would constitute an ample emergency fund. The burden of patrol work is put not on the towns but on the State, because the saving of the forests is a problem which the State as a whole is interested in, and the expense of it should not be borne by the towns, which are forced now to pay the entire cost of fire fighting. As a rule, those towns having the largest area of forest land are the least able, from the financial standpoint, to protect it. In the States of New York and Minnesota one-half the expense of fighting fires is borne by the State; in Michigan it is one-third; in New Jersey one-half, and in Connecticut one-fourth is paid by the State and

one-fourth by the county. Massachusetts is one of the few States having an organized forest fire fighting force in which the Commonwealth is not specifically obliged to assume part of the expense.

ON DAMAGE BY FOREST FIRES.

There are many ways in which a fire injures the woods, some of which are well known and fully appreciated, but several of the most important are not usually considered when the cost of a fire is estimated.

First. — A fire may kill the standing timber. This is always the case when a top or crown fire occurs. In some cases such fire-killed timber can be utilized, but it does not bring a good sale value on the market and only a part of the loss can be recovered.

Second. — A light fire may run through a stand and kill a tree here and there. In this case the damage is not so apparent as when all the trees are killed, but a close examination of the woodlot through which surface fire has gone reveals the fact that other trees do not escape without injury. It may be a slight scorching of the bark, or the roots near the surface of the ground may be damaged. Such trees die later on, because in this weakened condition they are no longer able to withstand the attacks of insects and fungi. Chestnut is a tree peculiarly susceptible to fire scorch.

Third. — The vegetable part of the soil, or humus, as it is called, is consumed by a fire as well as the leaves and other litter which would make a future supply of humus. The destruction of the humus affects the fertility of the soil in a marked degree. The elements which tend to conserve the soil moisture are thus destroyed.

Fourth. — A forest fire may result in a change in the composition of the stand of trees. It is often followed by a growth of poplars, birches, scrub oak and blueberry, which growth has little or no value and is hard to get rid of.

Fifth. — Owing to the moisture-conserving elements which have been destroyed and the rank new growth which succeeds the fire, land which has been burned over is made more liable to fire, so that each successive fire means danger of another.

Sixth. — The young growth or reproduction is nearly always killed. In the long run this is probably the greatest injury of all, although it is seldom counted when the loss through a forest fire is being reckoned.

When one comes to estimate the damage caused by fire in terms

of money he finds it a hard proposition. Allowance must be made for all injuries that can possibly be expressed in dollars and cents, which, except in case of mature growth which has been entirely destroyed, a rare case, calls for a lot of judgment. By mature growth we do not mean that the trees have stopped growing in volume, but that their rate of increase does not keep pace with the interest on their value. For a pine stand this age would be from fifty to sixty years; chestnut sprouts, forty to fifty years; sprout oak, thirty to forty years. To find the value of these stands before they are mature, their expectation value at that age should be discounted to the present date at 6 per cent. The expectation value of these three types of stands at maturity could be averaged as follows, although of course a great deal would depend on the situation of the stand. Pine, \$250 per acre; sprout chestnut, \$60 per acre; and mixed sprout hardwoods, \$30 per acre. At ten years of age, and discounted at 6 per cent., the value per acre would be as follows:—

TYPE.	Mature Age (Years).	Expecta- tion Value.	Taxes and Interest.	Value at Ten Years.
White pine,	50	\$250	\$50	\$19 40
Sprout chestnut,	40	75	25	8 70
Sprout hardwoods,	30	30	15	1 70
Gray birch,	20	20	10	55

The above values, it must be remembered, take no account of the injury to the soil. It must also be remembered that a severe injury to a young tree amounts to total destruction, since there would be little chance of its reaching merchantable size and much less financial maturity.

EXTRACTS FROM WARDENS' LETTERS.

These paragraphs from wardens' letters were selected because they contained miscellaneous points of interest. Most of the letters which contained information on fire fighting have been given under that heading.

A. E. Travis, Deputy Forest Warden, Barre.

The fires of the 24th were set by a locomotive. The two larger fires were set at 9.30 A.M. between mile posts 29 and 30; the smaller fire was started at 2.30 P.M. on the return trip, near mile post 29.

No section men came to any of these fires and as far as I can make out no fire call was sounded by the locomotive.

Our fire department was called, but all that saved us from a severe loss was the wind.

T. B. Tubman, Warden, Brewster.

I write you this letter hoping that you will do something about these abominable railway fires. The railroad will not give the section foreman a man to follow the trains, nor does it seem possible that they inspect their screens as they should. Can you not influence the company to remedy this evil so their engines will run over the road without burning up all the woodland?

I have been a fire warden for about ten years, but have never known anything like the number of locomotive fires during April, except one day last summer when the Boston train set thirteen fires.

A. P. Baker, Forest Warden, Dennis.

Woods fires reported from South Dennis are set by locomotives. As the same engines do not pass over the road every day, it is impossible to report them for the inspection of their spark arresters.

Fires are of almost daily occurrence some weeks. Thus far I have been able to get to them very soon after they start, thus preventing much damage.

Ralph Earle, Forest Warden, Dighton.

I am reporting the only fire which the town has had this year. This I feel is due to our excellent fire laws being well advertised among the people.

E. E. Chapman, Forest Warden, Ludlow.

I have issued to fourteen different persons permits to set fire.

I have had two fires to date where I called out a large number of men. They were extinguished by back firing from a plowed furrow across the face of the fire.

H. J. Montgomery, Forest Warden, North Adams.

The warning notices printed on cloth, calling attention to the fire laws, and sent out by the State Forester, have been a very effective check on forest fires here this season.

A. F. Howlett, Forest Warden, Spencer.

The selectmen think that the railroad company should at least pay half the expense that it costs this town to fight the numerous brush fires set by locomotives.

A. C. Warner, Forest Warden, Sunderland.

We have been for the past two days fighting the worst fire that we have ever had in Sunderland. It was started by a locomotive of the Central Vermont Railroad. I believe the fire covered more than 200 acres

of valuable timber land. I have had 125 men out and think that it is under control, but shall maintain a watch on it for a few days.

This fire is only one of a number set in the same locality by the Central Vermont.

Alvarado Henry, Forest Warden, Upton.

Please send me more blue books with the forest laws as I have appointed nine deputies.

I have had extracts of the forest laws printed on postal cards, which I sent to every voter in the town, so that all may know its mandates.

E. A. Young, Forest Warden, Hubbardston.

There have been many small fires along the railroad which have been taken care of by the section men and of which I have no account. No timber of consequence has been destroyed.

In this unusually dry year adjoining towns have all suffered severely from fires. I believe that the small loss and light cost of fighting fires in Hubbardston have been due to:—

First.—The enforcement of the law against setting fires without a permit.

Second.—The co-operation of citizens with the forest warden and his deputies to prevent fires of careless origin, and the prompt reporting of fires where observed.

During the danger period of the past year special warnings were posted and all citizens were requested to extinguish or report small fires.

ON THE WORK OF GAME WARDENS.

This book may well close with a short tribute to the work of the deputies of the Fish and Game Commission. Of the nine arrests and convictions made for violations of the fire laws, seven were brought about by these two men, Deputy H. A. Bent of Franklin, four men, and Deputy T. L. Burney of Lynn, three cases. The Lynn offenders were boys. Twelve other deputies reported to the commission that they had seen and aided in extinguishing nearly fifty fires. The reports of a few of them are here appended.

Walter A. Larkin, Andover.

I have put out three fires since I have been here; one in Haverhill, set by fishermen; one at Foster Pond, Andover, and one recently in Bedford. The fishermen at Foster Pond set the fire to drive away mosquitoes. I have spoken to them and no more have been set.

Allen A. David, Taunton.

As to forest fires, I have put out ten of them last year. Nine out of ten were along the railroad track and the other in the woods. Three fires did not do much damage, on account of being put out before they got much headway.

Irving O. Converse, Fitchburg.

Fires found and extinguished alone, 2; fires found and department called out, 3; fires found and section hands notified, 3; fires found and farmers called upon.

William H. Leonard, East Foxborough.

I have, with the assistance of one man, put out two woods fires, one in North Attleborough and one in Foxborough. I called out the fire department in the latter town and also notified the chief in Blackstone of a forest fire.

Strange to say, many of the towns in the district have been quite immune compared with former years.

In travelling along the railroad line in Bellingham and Blackstone one is astounded at the vast acreage of woodland forever destroyed by fires.

While in Kingston in October I was told that a fire there in July last cost the town hundreds of dollars just to fight it (\$1,500).

D. E. Wansey, Montague City.

Sunday I saw a forest fire and went out with my son and fought it all the afternoon.

Francis B. Osborne, Hingham.

Number of forest fires extinguished, 5. All of these were in the first stages and help was required only in one. I think that the cause of them was in at least two cases locomotives.

V. , LIST OF FOREST WARDENS.

TOWN OR CITY.	Badge No.	Warden.
Abington, . . .	287	B. Ernest Wilkes, chief fire department.
Acton, . . .	181	William H. Kingsley.
Acushnet, . . .	275	Geo. T. Parker, selectman.
Adams, . . .	7	John Clancy.
Agawam, . . .	93	Edward M. Hitchcock.
Alford, . . .	24	John H. Wilcox.
Amesbury, . . .	228	James E. Feltham, chief fire department.
Amherst, . . .	67	G. E. Stone, tree warden.
Andover, . . .	212	J. H. Playdon, tree warden.
Arlington, . . .	193	Walter H. Pierce, chief fire department.
Ashburnham, . . .	104	William D. Miller.
Ashby, . . .	158	Henry A. Lawrence.

V. LIST OF FOREST WARDENS — Continued.

TOWN OR CITY.	Badge No.	Warden.
Ashfield, . . .	50	Chas. A. Hall.
Ashland, . . .	200	H. H. Piper.
Athol, . . .	105	Jas. A. Dunbar.
Attleborough, . . .	265	Hiram Packard, 3 Hope Street, chief fire department.
Auburn, . . .	123	J. Fred Searle.
Avon, . . .	259	E. Walter Packard, constable.
Ayer, . . .	169	Henry E. Sanderson.
Barnstable, . . .	315	Henry C. Bacon, P. O. Hyannis.
Barre, . . .	142	D. H. Rice.
Becket, . . .	23	Elmer D. Ballou.
Bedford, . . .	179	Chas. E. Williams.
Belchertown, . . .	73	James A. Peeso, constable.
Bellingham, . . .	326	L. F. Thayer, town treasurer.
Belmont, . . .	194	John F. Leonard, chief fire department.
Berkley, . . .	271	Gideon H. Babbitt.
Berlin, . . .	139	Walter Cole, constable.
Bernardston, . . .	39	E. E. Benjamin.
Beverly, . . .	220	Levi K. Goodhue, chief fire department.
Billerica, . . .	173	Geo. C. Crosby, chief engineer fire department.
Blackstone, . . .	114	Thomas Reilly.
Blandford, . . .	81	Stephen Bodurtha.
Bolton, . . .	146	Frank A. Powers, tree warden.
Bourne, . . .	311	Emory A. Ellis, P. O. Bournedale.
Boxborough, . . .	182	M. L. Wetherbee, selectman.
Boxford, . . .	218	Harry L. Cole, selectman.
Boylston, . . .	138	Chas. S. Knight, metropolitan watchman.
Braintree, . . .	244	James M. Cutting, special police, P. O. South Braintree.
Brewster, . . .	318	T. B. Tubman, highway surveyor, P. O. North Brewster.
Bridgewater, . . .	293	Edwin S. Rhoades.
Brimfield, . . .	99	Edward J. Prindle.
Brockton, . . .	286	Harry C. Marston, chief fire department.
Brookfield, . . .	120	David N. Hunter

V. LIST OF FOREST WARDENS—Continued.

TOWN OR CITY.	Badge No.	Warden.
Brookline, . . .	237	Geo. H. Johnson, chief fire department.
Buckland, . . .	49	William Sauer, P. O. Shelburne Falls.
Burlington, . . .	178	Walter L. Skelton, tree warden.
Canton, . . .	249	Laurence Horton, fire engineer, P. O. Ponkapoag.
Carlisle, . . .	171	Herbert P. Dutton, selectman.
Carver, . . .	304	Eugene E. Shaw.
Charlemont, . . .	42	Fred D. Legate.
Charlton, . . .	115	Carlos Bond.
Chatham, . . .	320	Geo. H. Eldredge.
Chelmsford, . . .	172	Ralph P. Adams.
Cheshire, . . .	11	Chas. D. Cummings.
Chester, . . .	80	William H. Babb.
Chesterfield, . . .	63	Chas. A. Bisbee, P. O. Bisbee.
Chicopee, . . .	87	John H. Pomphret, chief fire department.
Chilmark, . . .	308	Ernest C. Mayhew.
Clarksburg, . . .	3	Robert Lanfair, B. F. D. No. 1, P. O. North Adams.
Clinton, . . .	145	Daniel W. Goss, 40 East Street.
Cohasset, . . .	246	Wm. J. Brennock, captain fire department.
Colrain, . . .	37	Wm. H. Davenport.
Concord, . . .	180	G. E. Morrell, chief fire department.
Conway, . . .	51	Chas. Parsons, tree warden.
Cummington, . . .	60	W. S. Gabb, ¹ P. O. Swift River.
Dalton, . . .	14	William M. Colton, forester, Flint Stone Farm.
Dana, . . .	147	Elmer A. Collier, chief fire department, P. O. North Dana.
Danvers, . . .	210	Thos. E. Tinsley, tree warden.
Dartmouth, . . .	278	John W. Howland, P. O. North Dartmouth.
Dedham, . . .	241	Everett J. Winn, chief fire department, P. O. Box 96.
Deerfield, . . .	52	Wm. L. Harris, selectman.
Dennis, . . .	317	Alpheus P. Baker, constable, P. O. South Dennis.
Dighton, . . .	272	Ralph Earle.
Douglas, . . .	112	W. L. Church, county commissioner.
Dover, . . .	240	John Breagy.

¹ Proprietor of the Elm Tree Inn.

V. LIST OF FOREST WARDENS — Continued.

TOWN OR CITY.	Badge No.	Warden.
Dracut,	163	Adelbert P. Bryant, 790 Pleasant Street.
Dudley,	110	F. A. Putnam.
Dunstable,	161	Dexter Butterfield.
Duxbury,	303	Fred B. Knapp, master Powder Point School.
East Bridgewater,	298	Loren A. Flagg, chief fire department, P. O. Elmwood.
Eastham,	322	W. Horton Nickerson, road surveyor.
Easthampton,	77	Frank P. Newkirk, tree warden.
East Longmeadow,	95	Henry Ashley.
Easton,	264	John Baldwin, chief fire department, P. O. North Easton.
Egremont,	29	Frank W. Bradford, Great Barrington, R. F. D. No. 3.
Enfield,	74	Chas. W. Felton.
Erving,	46	Ch. H. Holmes, selectman, P. O. Farley.
Essex,	233	Otis O. Story, tree warden.
Fairhaven,	276	Henry T. Howard.
Fall River,	280	William Bayard, tree warden.
Falmouth,	312	J. M. Watson.
Fitchburg,	157	Geo. H. Hastings, superintendent, local superintendent gypsy moth.
Florida,	5	Fred R. Whitcomb, P. O. Hoosac Tunnel.
Foxborough,	261	Ernest A. White, chief fire department and constable.
Framingham,	197	James Stalker, P. O. South Framingham, assistant tree warden.
Franklin,	255	Edward S. Cook, dealer in wood and lumber.
Freetown,	274	Andrew M. Hathaway, P. O. Assonet.
Gardner,	153	Theodore W. Danforth.
Gay Head,	343	Leander B. Smally, Menemsha, Mass.
Georgetown,	224	Clinton J. Eaton.
Gill,	45	Lewis C. Munn.
Gloucester,	234	M. A. Walton.
Goshen,	61	Sidney F. Packard, P. O. R. F. D. No. 2, Williamsburg.
Gosnold,	344	Harold S. Veeder, P. O. Cuttyhunk.
Grafton,	125	Sumner F. Leonard, overseer of the poor.
Granby,	79	C. N. Rust, P. O. South Hadley.
Granville,	91	Laurence F. Henry, selectman.

V. LIST OF FOREST WARDENS — Continued.

TOWN OR CITY.	Badge No.	Warden.
Great Barrington,	25	Daniel W. Flynn.
Greenfield,	44	William A. Ames, tree warden.
Greenwich,	327	William H. Walker, P. O. Greenwich Village.
Groton,	167	James B. Harrington, chief fire department.
Groveland,	225	Sidney E. Johnson, 311 Center Street.
Hadley,	66	Edward P. West, tree warden.
Halifax,	299	Edwin H. Vaughan, assessor.
Hamilton,	222	Fred Berry, P. O. Essex, R. F. D.
Hampden,	97	John S. Swenson.
Hancock,	9	Chas. F. Tucker.
Hanson,	296	Albert L. Dame, tree warden, P. O. South Han- son.
Hanover,	295	Chas. E. Damon, P. O. Box 113, North Hanover.
Hardwick,	141	Myron N. Ayers, constable.
Harvard,	152	Benjamin Priest.
Harwich,	319	John Condon.
Hatfield,	65	John M. Strong, P. O. West Hatfield.
Haverhill,	216	John B. Gordon, chief fire department.
Hawley,	48	Ernest R. Seare, tree warden, P. O. Charlemont.
Heath,	36	S. G. Benson.
Hingham,	289	Geo. Cushing, chief fire department.
Hinsdale,	15	Lewis B. Brague, tree warden.
Holbrook,	247	E. W. Austin.
Holden,	136	J. W. Rice.
Holland,	101	O. F. Howlett, P. O. Southbridge, R. F. D. No. 2.
Holliston,	202	Waldo A. Collins.
Holyoke,	85	Chas. C. Hastings.
Hopedale,	328	Walter F. Durgin, constable, superintendent of parks.
Hopkinton,	201	R. D. Frail.
Hubbardston,	149	Ernest A. Young, tree warden.
Hudson,	199	Fred W. Trowbridge, chief fire department.
Hull,	329	Smith F. Sturges, tree warden, P. O. Allerton.
Huntington,	70	Daniel B. Mack, constable.

V. LIST OF FOREST WARDENS—Continued.

TOWN OR CITY.	Badge No.	Warden.
Hyde Park, . . .	330	Harry Higbee.
Ipswich, . . .	223	Augustus J. Barton.
Kingston, . . .	301	Thos. W. Bailey, selectman.
Lakeville, . . .	283	Nathan F. Washburn, P. O. Middleborough.
Lancaster, . . .	151	Everett M. Hawkins, chief fire department.
Lanesborough, . . .	10	King D. Keeler, constable.
Lawrence, . . .	214	Chas. G. Rutter, chief fire department.
Lee, . . .	22	James W. Bossidy.
Leicester, . . .	122	Walter E. Sprague.
Lenox, . . .	18	Geo. W. Fitch.
Leominster, . . .	155	William K. Morse, chief fire department, P. O. North Leominster.
Leverett, . . .	57	Orman C. Marvel, assessor.
Lexington, . . .	188	Azor P. Howe.
Leyden, . . .	38	Herman W. Severance, Bernardston.
Lincoln, . . .	187	Edward R. Farrer, tree warden.
Littleton, . . .	170	Chas. F. Johnson, town clerk.
Longmeadow, . . .	94	Oscar C. Pomeroy.
Lowell, . . .	165	Edward S. Hosmer, chief fire department.
Ludlow, . . .	88	Edward E. Chapman, constable.
Lunenburg, . . .	156	Clayton E. Stone.
Lynn, . . .	331	Nathan M. Hawkes, park commissioner.
Lynnfield, . . .	209	Thos. E. Cox, P. O. Wakefield R. F. D.
Malden, . . .	191	Frank Turner.
Manchester, . . .	236	Frederick Burnham.
Mansfield, . . .	263	Herbert E. King.
Marblehead, . . .	332	William H. Stevens.
Marion, . . .	306	Isaac E. Hiller.
Marlborough, . . .	198	Chas. H. Andrews, chief fire department.
Marshfield, . . .	292	Edward E. Ames.
Mashpee, . . .	313	Joseph A. Peters.
Mattapoissett, . . .	281	Everet C. Stetson.
Maynard, . . .	184	Arthur J. Coughlan, room 17, Maynard's block.

V. LIST OF FOREST WARDENS — Continued.

TOWN OR CITY.	Badge No.	Warden.
Medfield,	252	Waldo E. Kingsley, chief fire department.
Medford,	192	Chas. Bacon, chief fire department.
Medway,	254	Clyde C. Hunt, captain fire department.
Mendon,	119	Albert W. Gaskell.
Merrimac,	227	Edgar P. Sargent.
Methuen,	213	Alfred H. Wagland, tree warden.
Middleborough,	284	C. W. Weston.
Middlefield,	342	Thos. H. Fleming, P. O. Bancroft.
Middleton,	211	William W. Richardson.
Milford,	127	Thos. F. Maher, chief fire department.
Millbury,	124	William E. Horn.
Millis,	253	Chas. La Croix.
Milton,	242	Nathaniel T. Kidder, park commissioner.
Monroe,	34	S. R. Tower.
Monson,	98	Omer E. Broadway.
Montague,	53	Fred W. Lyman, lumber dealer.
Monterey,	28	Andrew J. Hall.
Montgomery,	82	Frank C. Preston, P. O. Huntington.
Mount Washington,	30	Fred Porter.
Nantucket,	333	Albert R. Coffin.
Natick,	204	William E. Daniels.
Needham,	238	Howard H. Upham, captain fire department.
New Ashford,	6	Henry B. Baxter.
New Bedford,	277	Edward F. Dahill, chief fire department.
New Braintree,	131	E. L. Haven.
Newbury,	231	William P. Bailey.
Newburyport,	230	David Kent, 26 Arlington Street.
New Marlborough,	32	Dennis Hayes, P. O. Mill River.
New Salem,	55	Ransen King, P. O. Cooleyville.
Newton,	205	Walter B. Randlett, chief fire department, P. O. West Newton.
Norfolk,	256	C. Albert Murphy.
North Adams,	4	H. J. Montgomery, chief fire department.

V. LIST OF FOREST WARDENS—Continued.

TOWN OR CITY.	Badge No.	Warden.
Northampton, . . .	72	Fredrick E. Chase.
North Andover, . . .	215	Geo. A. Rea.
North Attleborough, . . .	262	Harvey W. Tufts, chief fire department.
Northborough, . . .	140	T. P. Haskell.
Northbridge, . . .	117	W. E. Beemap, P. O. Whitinsville.
North Brookfield, . . .	129	H. S. Lytle, chief fire department.
Northfield, . . .	40	Fred W. Doane.
North Reading, . . .	175	Irving F. Batchelder.
Norton, . . .	266	Alden G. Walker.
Norwell, . . .	290	John Wahlen.
Norwood, . . .	250	J. Fred Boyden, chief fire department.
Oak Bluffs, . . .	334	Samuel N. Kidder.
Oakham, . . .	135	Chas. H. Trowbridge.
Orange, . . .	47	Chas. E. Lane.
Orleans, . . .	321	Chas. F. Poor.
Otis, . . .	27	Wilbur L. Strickland.
Oxford, . . .	335	A. W. Stafford, North Oxford.
Palmer, . . .	89	James Summers, chief fire department.
Paxton, . . .	130	Geo. W. Van Wyke.
Peabody, . . .	219	Michael V. McCarthy, Forest Street.
Pelham, . . .	68	E. P. Bartlett, P. O. Amherst.
Pembroke, . . .	294	Jos. J. Shepard.
Pepperell, . . .	160	Geo. G. Tarbell, P. O. East Pepperell, Room 17, Aldine block.
Peru, . . .	16	Clarence W. Hathaway.
Petersham, . . .	148	George P. Marsh.
Phillipston, . . .	106	*William C. Goddard.
Pittsfield, . . .	13	Lucien D. Hazard.
Plainville, . . .	59	Harlie E. Thompson.
Plainfield, . . .	309	Lestan E. Parker.
Plymouth, . . .	302	Herbert Morrissey.
Plympton, . . .	300	Thomas W. Blanchard.
Prescott, . . .	69	Waldo H. Pierce, P. O. Greenwich Village.

V. LIST OF FOREST WARDENS — Continued.

TOWN OR CITY.	Badge No.	Warden.
Princeton, . . .	150	J. Heyden Stimpson.
Provincetown, . . .	325	James H. Barnett.
Quincy, . . .	243	Peter J. Williams, chief fire department.
Randolph, . . .	248	Chas. A. Wales, chief fire department.
Raynham, . . .	270	John V. Festing.
Reading, . . .	176	Herbert E. McIntire.
Rehoboth, . . .	268	Silas A. Pierce.
Richmond, . . .	17	T. B. Salmon.
Rochester, . . .	282	William N. Smellie.
Rockland, . . .	288	John H. Burke, water commissioner.
Rockport, . . .	235	A. J. McFarland, P. O. Box 91.
Rowe, . . .	35	Solomon Granger, P. O. Zoar.
Rowley, . . .	232	Daniel O'Brien, agent Gypsy Moth Commission.
Royalston, . . .	102	Willard W. White, P. O. South Royalston.
Russell, . . .	83	Sidney F. Shurtleff, highway surveyor.
Rutland, . . .	143	Henry Converse, chief fire department.
Salisbury, . . .	229	Wm. H. Evans.
Sandisfield, . . .	33	Lyman H. Clark, P. O. New Boston.
Sandwich, . . .	314	John F. Carlton, P. O. Spring Hill.
Saugus, . . .	207	Eugene Stephens.
Savoy, . . .	8	Herbert H. Fitzroy, ¹ P. O. Savoy Center.
Scituate, . . .	291	Percival S. Brown, tree warden.
Seekonk, . . .	267	John L. Barker, P. O. Attleborough, R. F. D. No. 4.
Sharon, . . .	251	John G. Phillips.
Sheffield, . . .	31	Geo. G. Peck.
Shelburne, . . .	43	Samuel Oates, P. O. Shelburne Falls.
Sherborn, . . .	203	Milo F. Campbell, constable, South Sherborn.
Shirley, . . .	168	Melvin W. Longley, assessor.
Shrewsbury, . . .	132	Wm. E. Rice.
Shutesbury, . . .	58	Emmons J. Spear.
Somerset, . . .	336	James Wilson, fish and game warden.
Southampton, . . .	76	Geo. W. Tyler.

¹ Proprietor Grand View Farm.

V. LIST OF FOREST WARDENS — Continued.

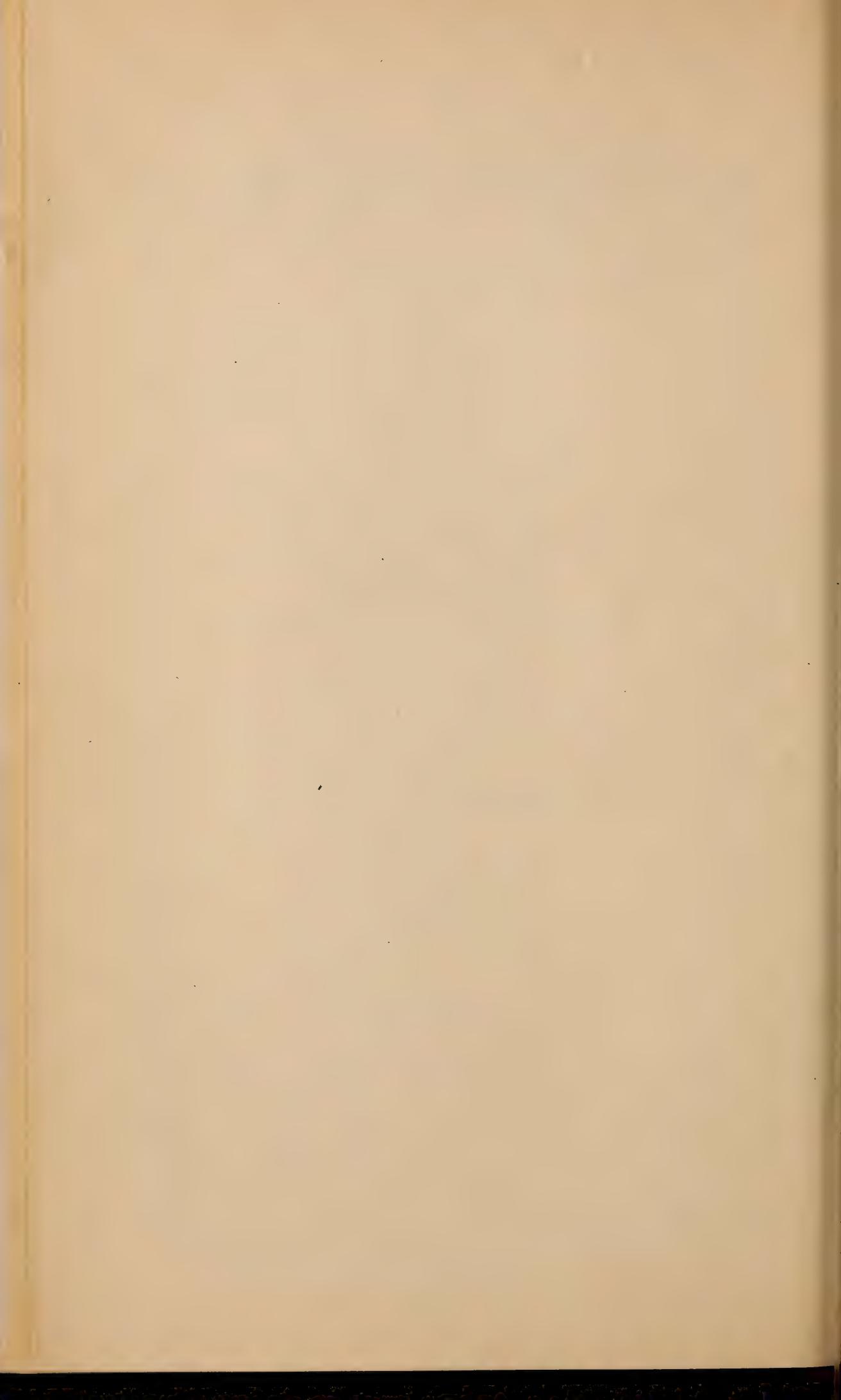
TOWN OR CITY.	Badge No.	Warden.
Southborough, . . .	337	Harry Burnett, tree warden.
Southbridge, . . .	109	Aimee Langevin, Olney Avenue.
South Hadley, . . .	78	Joseph Beach, P. O. South Hadley Falls.
Southwick, . . .	92	Edward Gillett, tree warden.
Spencer, . . .	121	A. F. Howlett.
Springfield, . . .	86	Burton Steere, assistant fire chief.
Sterling, . . .	144	G. F. Herbert, assessor.
Stockbridge, . . .	21	Geo. Schneyer, selectman, P. O. Glendale.
Stoneham, . . .	190	Geo. E. Sturtevant, chief fire department.
Stoughton, . . .	258	Jesse E. Smith.
Stow, . . .	183	William H. Parker, P. O. Gleasondale.
Sturbridge, . . .	108	Chas. M. Clark, P. O. Fiskdale.
Sudbury, . . .	185	F. E. Bent.
Sunderland, . . .	338	A. C. Warner.
Sutton, . . .	116	Ransom W. Richardson.
Swampscott, . . .	339	Geo. P. Cahoon, chief fire department.
Swansea, . . .	273	Thos. L. Mason, constable, P. O. R. F. D. No. 2.
Taunton, . . .	269	Fred A. Leonard, chief fire department.
Templeton, . . .	107	Henry H. Seaver, P. O. Baldwinville.
Tewksbury, . . .	164	Herbert W. Pillsbury.
Tisbury, . . .	310	Albert Rotch, P. O. Vineyard Haven.
Tolland, . . .	90	Eugene M. Moore.
Topsfield, . . .	218	Isaac B. Young, selectman.
Townsend, . . .	159	F. J. Piper, chief fire department.
Truro, . . .	324	Manuel F. Corey.
Tyngsborough, . . .	162	Otis L. Wright.
Tyringham, . . .	26	H. E. Moore.
Upton, . . .	126	Alvarado Henry, chief fire department.
Uxbridge, . . .	113	Arnold S. Allen, constable and chief fire department.
Wakefield, . . .	208	Samuel T. Parker
Wales, . . .	100	W. W. Eager.
Walpole, . . .	340	N. Emmons Winslow, chief fire department.

V. LIST OF FOREST WARDENS — Continued.

TOWN OR CITY.	Badge No.	Warden.
Waltham, . . .	195	Geo. L. Johnson, chief fire department.
Ware,	75	L. S. Charbonneau, P. O. Box No. 25.
Wareham, . . .	305	Arthur B. Savary.
Warren,	119	Joseph St. George, constable.
Warwick,	41	Chas. H. Williams.
Washington, . . .	19	John B. Watson, R. F. D., Becket.
Watertown, . . .	206	John C. Ford, tree warden.
Wayland,	196	Clarence S. Williams, Cochituate.
Webster,	111	Arthur B. Patterson.
Wellesley,	239	Fletcher M. Abbott, tree warden.
Wellfleet,	323	Edwin P. Cook.
Wendell,	54	Geo. A. Lewis.
Wenham,	221	Jacob D. Barnes, tree warden.
Westborough, . . .	133	James H. McDonald, chief fire department.
West Boylston, . . .	137	Frank H. Baldwin, agent Metropolitan Water Board.
West Bridgewater, . .	285	Octave Belmore, tree warden.
West Brookfield, . . .	128	Robert M. Carter, P. O. Box 135.
Westfield,	84	Geo. H. Byers, chief fire department, P. O. address, Arnold Street.
Westford,	166	John A. Healey, P. O. Graniteville.
Westhampton,	71	Levi Burt.
Westminster,	154	John C. Goodridge, chief fire department.
West Newbury,	226	Silas M. Titcomb, P. O. Byfield.
Weston,	186	Edward P. Ripley.
Westport,	279	Frank Whalon, North Westport.
West Springfield, . . .	341	A. A. Sibley.
West Stockbridge, . . .	20	Bernard Manning.
West Tisbury,	307	William J. Rotch.
Westwood,	251	Chas. Dean, P. O. Islington.
Weymouth,	245	J. Rupert Walsh, P. O. East Weymouth.
Whately,	56	James A. Wood.
Whitman,	297	Clarence A. Randall, tree warden.
Wilbraham,	96	Henry I. Edson, P. O. North Wilbraham.

V. LIST OF FOREST WARDENS — Concluded.

TOWN OR CITY.	Badge No.	Warden.
Williamsburg, . . .	64	C. S. Damon.
Williamstown, . . .	2	Daniel Russell.
Wilmington, . . .	174	Jos. M. Hill, chief fire department, P. O. North Wilmington.
Winchendon, . . .	103	Arthur L. Brown, chief fire department.
Winchester, . . .	189	Irving L. Symmes, chief fire department.
Windsor,	12	H. Ward Ford, tax collector.
Woburn,	177	Frank E. Tracy, chief fire department.
Worcester,	131	H. Ward Moore, Winnefred Avenue.
Worthington,	62	Chas. E. Clark.
Wrentham,	260	Chas. E. Brown, chief fire department.
Yarmouth,	316	Seth Taylor, constable.



PARASITES

OF THE

GYPSY AND BROWN-TAIL MOTHS

INTRODUCED INTO

MASSACHUSETTS.

WHERE THEY COME FROM.
WHAT THEY ARE DOING.
A GENERAL SURVEY OF THE WORK.

By W. F. FISKE,

Agent and Expert, Bureau of Entomology, U. S. Department of Agriculture.

UNDER THE DIRECTION OF

F. W. RANE, STATE FORESTER.

BOSTON:

WRIGHT & POTTER PRINTING CO., STATE PRINTERS,

18 POST OFFICE SQUARE.

1910.

APPROVED BY
THE STATE BOARD OF PUBLICATION.

CONTENTS.

	PAGE
Introductory,	5
Acknowledgments,	6
Nature of insect parasitism,	7
Natural control of the gypsy moth,	9
Parasite introduction in theory and practice,	10
Sequence of parasites,	13
Parasites of the gypsy moth in Japan,	15
Parasites of the gypsy moth in Europe,	18
Parasites of the gypsy moth in America,	20
Parasites of the egg,	23
<i>Anastatus bifasciatus</i> ,	23
<i>Schedius kuvanae</i> ,	25
Parasites of the caterpillar,	28
<i>Glyptapanteles fulvipes</i> ,	28
<i>Blepharipa scutellata</i> ,	33
<i>Compsilura concinnata</i> ,	36
<i>Tachina larvarum</i> and <i>Tricholyga grandis</i> ,	38
<i>Zygobothria gilva</i> and <i>Carcelia gnava</i> ,	39
Parasites of the pupa,	40
<i>Theronia</i> sp.,	40
<i>Chalcis flavipes</i> ,	41
<i>Monodontomerus aereus</i> ,	43
Progress of the parasites in Massachusetts,	46
When will the parasites become effective?	50
The work in 1910,	52
Parasites of the brown-tail moth,	53

dition and more promising from actual results at the present time than ever.

The State Forester cannot refrain from saying also that what Massachusetts is doing in this work is indirectly as important to the nation generally; for what is here accomplished will ultimately result in equal value throughout New England and finally elsewhere.

ACKNOWLEDGMENTS.

The work of writing and compiling the data in this bulletin was done by Mr. W. F. Fiske, agent and expert, Bureau of Entomology, United States Department of Agriculture, in charge of directing the technical work of introducing the parasites and predatory enemies of the gypsy moth and the brown-tail moth into Massachusetts. The headquarters for this work are at the State laboratory at Melrose Highlands.

When it was determined by the State Forester that the information contained in this bulletin would be appreciated by our people, a conference with Dr. L. O. Howard, the United States Government Entomologist, who has been our chief adviser in expending the State's money for this work, resulted in his delegating Mr. Fiske to the task. Mr. Fiske's manuscript was examined and approved by Dr. Howard.

We are therefore under obligations to both of the above-named gentlemen for their hearty co-operative efforts in our behalf.

F. W. RANE,
State Forester.

6 BEACON STREET, BOSTON, MASS., March 15, 1910.

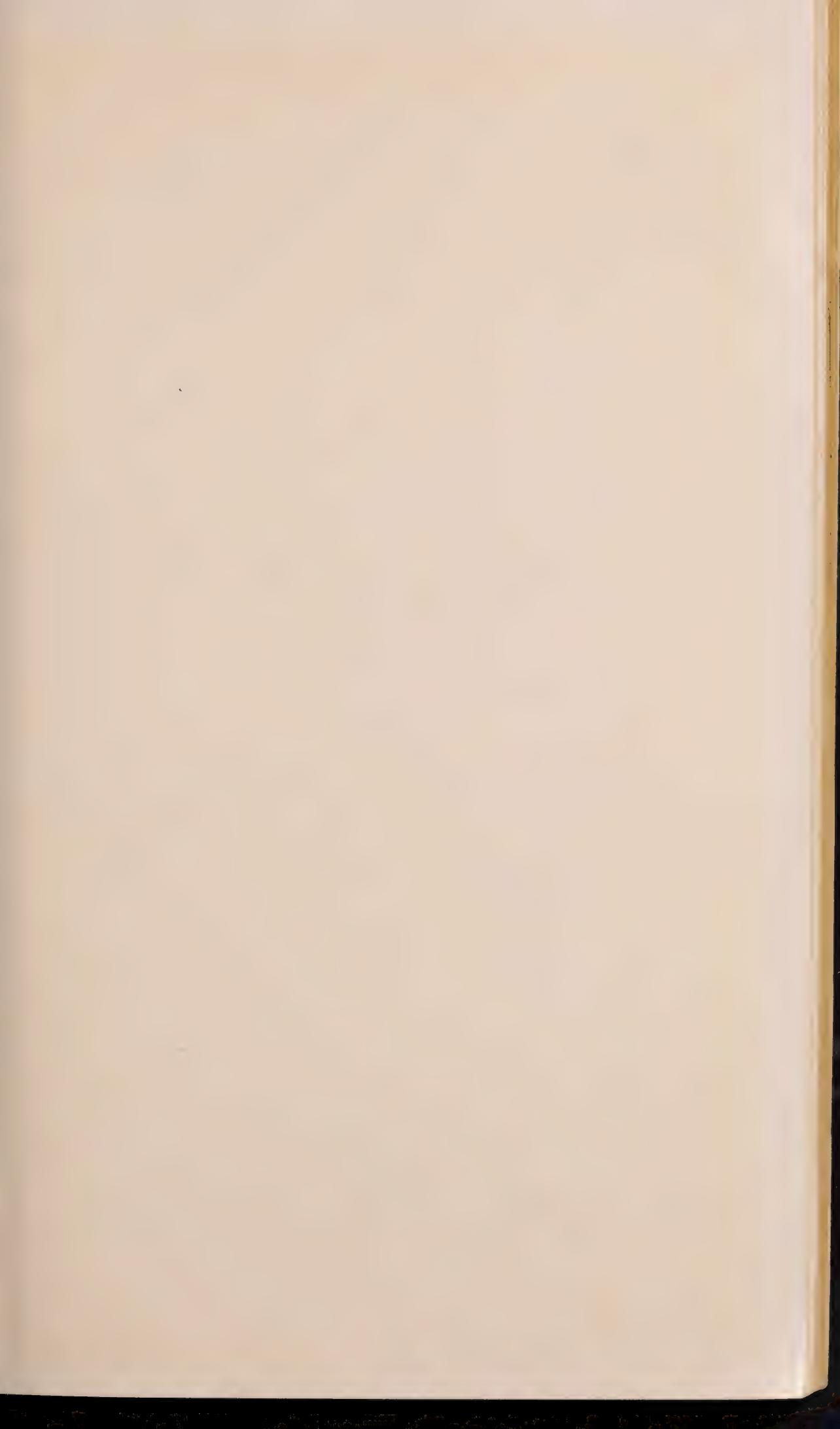


PLATE I.



Grounds of the Gypsy Moth Laboratory, showing Temporary Structures used in rearing Parasites of the Gypsy Moth and Brown-tail Moth.



Interior of One of these Structures, showing Trays for feeding Caterpillars.

PARASITES OF THE GYPSY AND BROWN-TAIL MOTHS.

NATURE OF INSECT PARASITISM.

It is probable that the total number of different species of insects which are native to Massachusetts is not far short of 10,000, if indeed it does not exceed this number. A large proportion of these are plant feeders, some of them sucking the sap, others eating the foliage, and others still boring in the roots, seeds or stems. A great many feed upon dead vegetable matter, or upon the lower plants, such as mushrooms and other fungi.

Several thousand, possibly half of the total, feed upon animals or upon dead animal matter, and by far the larger part of these prey upon other insects, — principally, but by no means exclusively, upon those which are plant feeders. It is largely through this continuous warfare that the plant-feeding insects are held in check, and prevented from increasing to such numbers as to become a menace to vegetable life in general.

The insects which subsist upon other insects may roughly be divided into two classes, according to the methods of their attack. The predatory, like the other predatory animals, wander about, attacking and devouring the weaker species or individuals. For the most part they are very catholic in their tastes, and will attack almost any other insect which they may chance to encounter in their favored haunts. The parasitic, on the contrary, are in most instances very closely restricted in the choice of their prey, and have a very different method of attack.

Instead of falling upon and devouring a weaker insect, they frequently attack and destroy those which are much larger and stronger in every way than themselves. This is accomplished by the deposition of an egg, or in some instances a living maggot, within or upon the body of the selected victim, or upon its food, or in some other situation. The young larva, hatching from the

egg (or deposited by the female parasite, for in quite a large number of them the eggs hatch within the body of the parent), ultimately becomes established within or upon the body of the other insect, which serves as host; and, although there is considerable variation in the ways by which this is accomplished, the end is the same.

Having become established, the young larva proceeds to feed upon the less vital portions of its victim, usually upon the fatty tissues, until it is nearly or quite full grown; then, from its point of vantage inside the body of its host, it kills it, devours all or such portions of its body as it desires, and later transforms to a pupa, which in turn produces an adult similar to that which made the original attack.

There is hardly a plant or shrub or tree which is not attacked in some portion by one or more species of plant-feeding insects. Some trees, like the oak and pine, support a very great variety, which are widely diverse in their habits, and each of which confines its attack to a limited portion of the tree. Those which bore in the bark, for example, are always different from those which feed upon the foliage or which are nourished by the seed. Similarly, there is hardly a single plant-feeding insect which is not attacked by one or more different parasites, each of which is limited in its attack to some stage in the development of the particular species which serves as host. The parasites which attack the caterpillars of a plant-destroying insect, like the gypsy moth, never attack the pupæ or the eggs; but there are other parasites which do attack these stages.

Plant-feeding insects very rarely attack more than a few sorts of plants or trees. Some, like the gypsy moth, are very general feeders, and will eat the foliage of pine and fir as well as of oak and birch; but the number which feed upon both pine and oak are very few, and even the gypsy moth displays a strong preference for the foliage of broad-leaved trees. There are a great many which will feed upon nothing but oak, and there are many which are even more restricted, and which are never found on more than one kind of oak. Exactly the same is true of the parasites: some are general feeders, and will attack a great variety of hosts; others are extremely particular in this respect, and will not attack, or, if they are forced to attack, their young

cannot develop upon, more than a very limited number of hosts. The great majority are thus closely restricted in their host relations, and the parasites which are most effective in controlling the increase of plant-feeding insects are generally of this character. It is on account of this that the many hundreds of different parasites of native caterpillars do not, and cannot, attack and control an insect like the gypsy moth, which is different in many respects from any native American insect.

NATURAL CONTROL OF THE GYPSY MOTH.

With the exception of the parasites, nearly every, and probably every, controlling agency which works to keep the gypsy moth within bounds in Europe and Japan is present in America. Mortality through catastrophic causes, such as storms and climatic changes, is heavy here, as it is abroad. It is probable that the birds, which destroy so many of the caterpillars, pupæ and moths, are equally effective in both Europe and America. Disease, induced through overpopulation, is more prevalent in some parts of Massachusetts than in those countries where overpopulation is not so apt to occur; and a multitude of predatory insects, notably, the bugs described by Mr. Kirkland in the report on "The Gypsy Moth," by Forbush and Fernald, render great assistance. So effective are these various agencies, that, taking the older infested section as a whole, the gypsy moth is practically at a standstill so far as permanent increase in numbers is concerned. Its numbers cannot be said to decrease to a noticeable extent, except as the immediate result of artificial repression, and it has reached its maximum possible abundance. If it had continued to increase at a rate of only twofold annually, it would by 1909 have been thirty-two times as common as it was in 1904 in tracts of woodland where artificial suppression could not be economically employed. This is obviously not the case.

Even in newly infested territory, where the controlling effect of starvation and disease is hardly or not at all apparent, an increase of six-fold annually¹ during the first few years is about all that is expected; and when it is considered that the number of eggs deposited by one female is frequently in excess of 500, it is at once evident that natural causes are responsible

¹ Forbush and Fernald: "The Gypsy Moth," p. 94.

for the destruction of a tremendous percentage. Five hundred eggs, developing into an equal number of males and females, would result in the deposition of 250 egg masses the summer following, or an increase of two hundred and fifty-fold. If only a six-fold increase in the number of egg masses results, it is evident that 244 of the females must be destroyed at some time during their life; in other words there is an approximate mortality of no less than 97.6 per cent. annually in Massachusetts, due to natural causes.

So, to reduce the number of survivors as to permit of *no* annual increase, on the average, in territory where the gypsy moth is not sufficiently abundant to become a pest, is the hope and aim of the work of parasite introduction. As already stated, there is no steady increase of the moth in the central most badly infested sections of the area of infestation; but the control brought about by famine and plague within this area is so exclusively dependent upon overpopulation, which is to say, upon a superabundance of the moth, as to make very probable a continuation of the present conditions for an indefinite period, unless some other factor becomes operative.

PARASITE INTRODUCTION IN THEORY AND PRACTICE.

If, as is believed by those who have the matter most at heart, the only important controlling agency which is lacking in America is the presence of the parasites which are such effective factors in its control abroad, the introduction of these parasites into America and their establishment here is all that is necessary to bring about the reduction of the gypsy moth from its present pre-eminence as a destructive pest to that of an innocuous or rarely noxious insect. The problem at first sight seems simple, but, like most undertakings, it develops complications in its practical solution.

Long before the work of parasite introduction was begun, all of the published records of European parasites and other enemies were well known to the Bureau of Entomology, which for years had been keeping track of such observations, and had accumulated a card catalogue with more than 20,000 references. As soon as work was begun, additional information concerning gypsy and brown-tail parasites was secured from European and

Japanese entomologists, who were most generous in their offers of assistance and advice. At the same time, it must be admitted that the sum total of available and absolutely reliable information was far from adequate. Long lists of parasites had been compiled¹ but these records were based upon the notes and observations of entomologists who were not particularly interested in the possible practical side of the question, and very frequently their records amounted to little more than the bare fact that a certain parasite had been reared in connection with the gypsy moth or the brown-tail moth. Furthermore, the same parasite was sometimes referred to by different entomologists under different names, or different parasites were considered to be the same, and on this account hardly any dependence could be placed on many of the records, and the doubt was reflected upon others. With very rare exceptions, nothing was published which gave any clue to the relative importance of the different species, and in several instances a secondary parasite was recorded as attacking the gypsy moth itself.

The work in the beginning was largely experimental, being an effort to determine ways and means for securing the parasites in a living and healthy condition. This accomplished, it became necessary to make a critical study of the various species secured, to determine, first of all, whether they were truly primary enemies of the moth, or whether they were present in some other connection. If they proved to be primary parasites and true enemies of the gypsy moth, they were liberated as rapidly as they could be imported and reared. As the work progressed, the various species were studied in greater and greater detail, and were ranked according to their relative importance in the countries to which they were native, and according to their methods of attack. Every effort was made to learn the main facts in the life and habits of each, and to become familiar with the conditions necessary to insure the establishment of each species in Massachusetts.

Upon numerous occasions knowledge of this character has been of the greatest value in suggesting the methods of importing, handling and colonizing the parasites, and in some instances it was essential to success. The work has been seriously handi-

¹ Howard: "Insect Life," vol. 2, p. 210. Forbush and Fernald: "The Gypsy Moth," pp. 377 and 387.

capped through the practical necessity of entrusting the actual work of collection and shipment in foreign countries to others than those most familiar with the nature and needs of the various parasites. The several trips which Dr. Howard has made abroad, wholly or in part in the interest of this undertaking, has enabled him to meet the foreign agents, and to enter into explanations which were infinitely more satisfactory than any which could be effected through correspondence. At the same time, it has been impossible to convey to these agents the detailed information which would enable them to work to the best advantage, nor would it be possible for them to acquire this in any manner short of actual experience in the laboratory. In particular has it been handicapped by the very short period during which work upon any particular parasite could be carried on in any one year. Parasites of the pupa, or of certain stages of the caterpillars, could be collected in Europe or Japan only during the season when pupæ or caterpillars in those particular stages occurred in the open in those countries; and the aggregate period during which it has been possible to work with some parasites in the five years since the inception of the work does not exceed as many months.

In all, there have been received at the laboratory in a living condition between 40 and 50 species of parasites of the brown-tail moth and of the gypsy moth. Of these, about 30 attack the gypsy moth, but only about two-thirds of that number can be considered as at all important. The others seem always to be rare in the countries to which they are native, and never to become so abundant as to affect the increase of the moth. No parasite, however rare it might seem to be, has been ignored, once it was demonstrated to be a primary upon the gypsy or the brown-tail. A great deal of time has been spent in attempting to discover the probable reason for apparent inconsequence in so many instances; and a great deal of work has been done to demonstrate that this was due to other causes than defective methods in the collection and subsequent handling of the parasite importations.

One by one, as material has been imported under different conditions and from different countries, different species of parasites have been added to the list, until it has exceeded in

gross numbers any list of parasites of the gypsy moth which has ever been published. One by one, as these parasites have been received and studied, they have been rated according to their habits and importance in the countries from which they came, and those which have failed to show promise of ever becoming of value in America have been eliminated. One by one, different species have been liberated in America under the most favorable conditions which could be provided for their establishment, until at the present time there are only 3 or 4 out of a total of 20 (which may be considered as including all of the promising parasites of the gypsy moth in Europe and Japan) which have not been liberated here, or which are not on hand ready for liberation as soon as the proper season shall arrive. The others, tentatively considered as of possible value, are very rarely common in any country; and partly on this account, and partly on account of the extraordinary difficulties which stand in the way of their successful importation, it has been impracticable to determine whether they are to be ranked as promising, or not. It is very likely that they will prove to be of a distinctly minor importance when they shall have been thoroughly investigated.

SEQUENCE OF PARASITES.

There is one very important factor which must be taken into consideration and thoroughly understood before it will be possible intelligently to discuss the work which has been accomplished in the importation of parasites of the gypsy moth. Briefly stated, it is that no one parasite is capable of effecting the necessary amount of control in an insect of the character of the gypsy moth, and capable of a similarly rapid rate of increase when unchecked by parasites; but a sequence of parasites, which will attack the insect in different stages of its development, and all the component members of which will work together in harmony, is absolutely necessary before the best results may be expected.

It has already been stated that the different parasites of one host are limited in their attack to certain stages in the development of this host. In the case of the gypsy moth, there are some which attack the egg, others the young caterpillars or the

older and larger caterpillars, and those which form still another group reserve their attack until such time as the caterpillars have spun up preparatory to their transformation into pupæ, or until after this transformation has taken place. It is confidently believed that representatives of each of these three or four groups will have to be established in America before any marked results of a practical nature can be expected.

There are two exceedingly good reasons for believing this, which may be mentioned here besides others equally good, but less easily expressed in non-technical language. One of these is the fact that in not a single instance has one species of parasite been found sufficiently abundant abroad to bring about the percentage of destruction which will certainly be necessary in order to offset the six-fold rate of increase of the gypsy moth, which it is the consensus of opinion exists in newly infested territory in America at the present time. The other is, that there is not a single species of defoliating caterpillar, similar in habit to the gypsy moth, of which the parasites have been studied, and which is controlled by them to any extent, which does not support a sequence of parasites similar to that which it is proposed to establish for the gypsy moth.

If the theory as to the necessity of a sequence of parasites be accepted as a general rule, its importance cannot be overestimated. Success in the work of parasite introduction will then depend entirely on whether or not a sufficient variety of parasites can be established in America, and cannot obtain until all of the species which go to make up a natural and effective sequence are established, and have increased to a sufficient abundance to make each of the chain effective in its own particular field. The predaceous beetles alone can never bring about the desired end, neither can the egg parasites, nor those of the pupæ, nor, it is believed, can all these three groups together. The parasites of the caterpillar, in addition to these others mentioned, ought to bring about the desired end. The *Calosoma* beetles bid fair to assist the native predatory enemies materially in the good work which they are doing, and their establishment will make that which is expected of the parasites easier and more certain of accomplishment.

It ought to be stated, in this connection, that this principle,

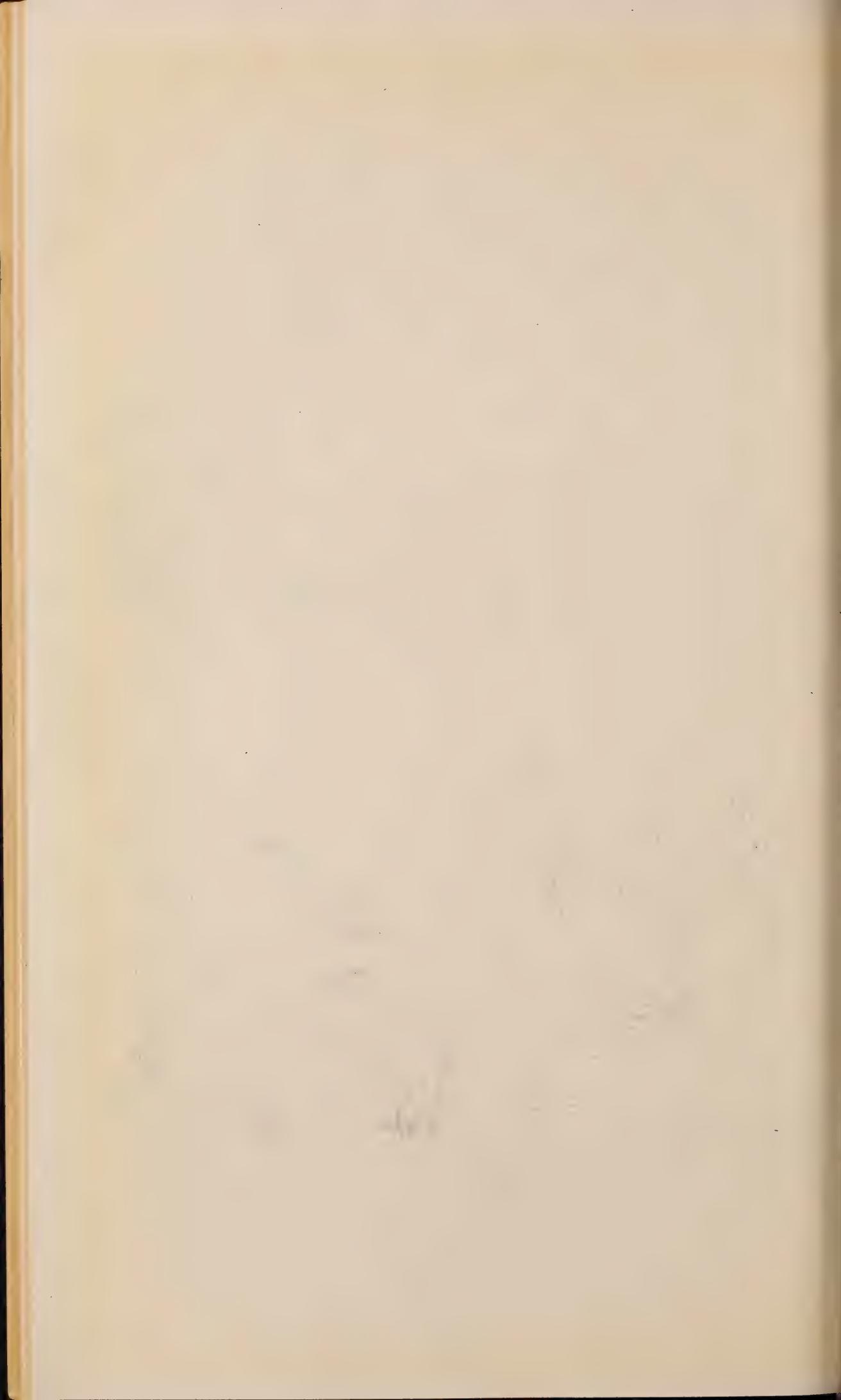
PLATE II.



Large Shipment of Parasite Material received in 1909 from France.



Gypsy Moth Laboratory, Exterior. Lot of Packages of Parasite Material just received.



while it has been recognized as one applicable in many instances, has been established much more firmly than ever before, as a result of the work which has been done at the laboratory. It would be impossible to speak with so much assurance had it not been for a series of investigations upon the parasites of several native insects, similar in certain important respects to the gypsy moth. These investigations have seemed sometimes to be outside of the main point at issue; but their value in establishing, as they have, this and certain other general propositions, has justified many times over the relatively small expenditure necessary to carry them on.

PARASITES OF THE GYPSY MOTH IN JAPAN.

The Japanese race of the gypsy moth is larger and stronger and in certain other respects different from that found in Europe or in America. One important characteristic is its greater fecundity, the number of eggs in a mass being from one-fourth to one-third greater, on an average, than in the egg mass of the typical European variety. This is indicative of greater powers of resistance to natural controlling factors, and, conversely, of the existence of more effective controlling agencies in Japan than in Europe. It is very significant that it is not at all an important pest in Japan, and that, in the opinion of the native entomologists and of every American entomologist or otherwise trained observer who has had opportunity to acquire first-hand information, the parasites are very effective in its control.

Thirteen species of primary parasites have been reared from eggs, caterpillars or pupæ of the gypsy moth from Japan, but only 7 of these can be considered as of importance in bringing about its control. The others have been consistently rare, and some of them have never been recorded as parasites by the Japanese themselves.

These parasites, in every instance but one, are either identical in all respects, or, if not absolutely the same, exceedingly similar to the parasites in Europe. It is unfortunately necessary to refer to them by their technical names, since none of them have been considered as of general interest hitherto, and other than such names there are none. They are listed in Table 1.

TABLE 1. — *The Gypsy Moth. — Sequence of Parasites in Japan.*

PARASITES.	Egg.		LARVAL STAGES.					PUPAL STAGES.					
	Fresh, 10 Days.	Old, 280 Days.	First, 7 Days.	Second, 7 Days.	Third, 7 Days.	Fourth, 7 Days.	Fifth, 7 Days.	Sixth, 7 Days.	Seventh, 7 Days.	Pre- pupa, 2 Days.	Fresh, 3 Days.	Old, 7 Days.	Adult.
Anastatus bifasciatus,
Schedius kuvanæ,
Glyptapanteles fulvipes,
Crossocosmia sp.,
Tachina japonica,
Theronia atalanta,
Chalcis obscurata,

First Generation

Second Generation

How they work in effecting the control of the moth in their native country is best indicated in the table, which, while it needs explanation, tells the story much plainer than it would be possible to tell in words. Opposite the name of each parasite, extending across a certain number of the vertical columns, is a dotted and a solid line. The vertical columns indicate different stages in the development and transformations of the gypsy moth, as egg, caterpillar and pupa, and these are still further divided into caterpillars of different sizes and eggs and pupæ of different ages and conditions. At the head of each column is stated the approximate number of days during which the individual gypsy moth remains in that particular stage.

The dotted line following the name of the parasite indicates those stages in the life of the gypsy moth during which it is liable to be attacked by the parasite in question, and it will be seen that in a number of instances, as, for example, *Chalcis* and *Theronia*, this period is exceedingly short. The solid line indicates the stages in the life of the gypsy moth during which it is likely to contain the parasite in its body. This, it may also be noted, varies considerably. *Crossocosmia*, for example, gains lodgment in the active caterpillar while it is only about half grown, and the extension of the solid line across all of the columns which stand for the later caterpillar stages, as well as for all of the pupal stages, indicates that the larvæ of this parasite do not leave the host caterpillar until after it has transformed to a pupa, and until the moth would naturally have emerged had the pupa remained healthy and unparasitized.

The main fact, which it is particularly desired to emphasize, is that every stage in the transformations of the gypsy moth, from the time the eggs are first deposited until the caterpillars are full grown and transformed to pupæ, is subject to the attack of one or more parasites. It is also liable to attack at any time throughout this period except during the cold weather in the winter, when there is no insect activity. This is exactly what is meant by the sequence of parasites, and, in the opinion of those most thoroughly informed, it is the condition which it is absolutely necessary to bring about in America before complete control can be effected.

PARASITES OF THE GYPSY MOTH IN EUROPE.

Table 2 is similar in construction and illustrates the parasitism of the gypsy moth in Europe. There are at least 22 species, and possibly one or two more of slight importance, known to attack the moth in various European countries, and of these, 15 are considered to be important. Of the 22, 2 are identical in all respects with 2 which occur in Japan, and are considered to be the same species. Six or 7 are quite distinctly different from any which have yet been received from Japan, and it is impossible to separate the remainder from the Japanese species by habit and method of attack alone. The most of them, however, appear to be different in their final appearance as adults, and are considered, for the present, as representing different species.

There are several reasons why there should be a longer list of European than of Japanese parasites, principal among which is the greater variety of climate represented by the different European countries. Some of the parasites are confined almost exclusively to the Mediterranean region, others to Russia and eastern Europe generally, while others are more common in the northern, central and western portions. It is almost certain that other parasites will be found in other parts of the Japanese empire from which small quantities of parasite material have been received, but it is very doubtful if any of importance will be added to the list from European sources.

It will be noted, if the table is scrutinized, that exactly the same conditions as regards the sequence of parasites obtain in Europe as in Japan. As in the table first given, every stage of the moth from the newly deposited egg to the pupa is open to attack by one or more species of parasite, and the sequence is perfect.

TABLE 2. — *The Gypsy Moth. — Sequence of Parasites in Europe.*

PARASITES.	EGG.		LARVAL STAGES.						PUPAL STAGES.			Adult.	
	Fresh, 10 Days.	Old, 280 Days.	First, 7 Days.	Second, 7 Days.	Third, 7 Days.	Fourth, 7 Days.	Fifth, 7 Days.	Sixth, 7 Days.	Seventh, 7 Days.	Pre-pupa, 2 Days.	Fresh, 3 Days.		Old, 7 Days.
Anastatus bifasciatus,
Apanteles solitarius,
Glyptapanteles fulvipes,
Blepharipa scutellata,
Compsilura concinnata,
Zygobothria gilva,
Carcelia gnava,
Tricholyga grandis,
Tachina larvarum,
Parasetigena segregata,
Ichneumon disparis,
Theronia atalantæ,
Chalcis flavipes,
Monodontomerus aereus,
Calosoma sycophanta,

First Generation

Second Generation

Oakham owns 34 extinguishers, which have been placed in private houses throughout the town. Many more persons applied for them than could be supplied. Next year the town intends to buy enough to supply the demand. The first ones cost \$18, but a substantial reduction was obtained by ordering a large quantity. While there are many kinds of extinguishers, those most effective at woods fires are provided with an arrangement which cuts off the stream by means of a valve which stops the flow of acid. Such a device saves the remainder of the soda charge, so that it may be used at intervals when needed. Those chemicals using the whole charge are useful in buildings. Every small town should have some such protection as this of Oakham. Many houses have been saved here by extinguishers when a bad fire seemed inevitable.

J. A. Healy, Forest Warden, Westford.

I will give you the list of the fire tools of the town of Westford: 30 shovels, 30 hand pumps, 12 extinguishers, 60 pails.

Enclosed find picture of fire wagon.

F. B. Knapp, Forest Warden, Duxbury.

Our woodland area covers about two-thirds that of the town, and produces cord wood, box boards and some better lumber. It forms part of a continuous forest extending into adjoining towns, but is split up by roads, ponds and open spaces. There are numerous isolated farms liable to damage from forest fires.

Our liability to fire is considerable. A railroad runs the length of the town, many strangers come for mayflowers in the spring and cranberry bogs are in process of construction. The soil is light and the woods get very dry.

The town is liberal in its appropriation and appreciates our efforts. Telephones are pretty common, and the men turn out well. We are in close touch with the railroad people and co-operate with them.

The forest warden and fire departments are technically distinct, but work together. I am chief of the fire department, and all of the engineers are deputy wardens. One commissary looks after all of the apparatus.

We have 2 60-gallon hand combination fire engines (used for forest fires when specially called out), 4 forest fire wagons, and several private ones used at times, 100 3-gallon Standard extinguishers scattered throughout the town, shovels, mattocks, etc.

The fire wagons vary, but this one is typical: A light, one-horse express wagon, 4 extinguishers, 6 boxes, each with 6 charges of chemicals, 16 3-gallon Marshfield cans, not completely filled (on account of weight), 10 shovels, 2 mattocks, 2 axes, 2 lanterns, torches.

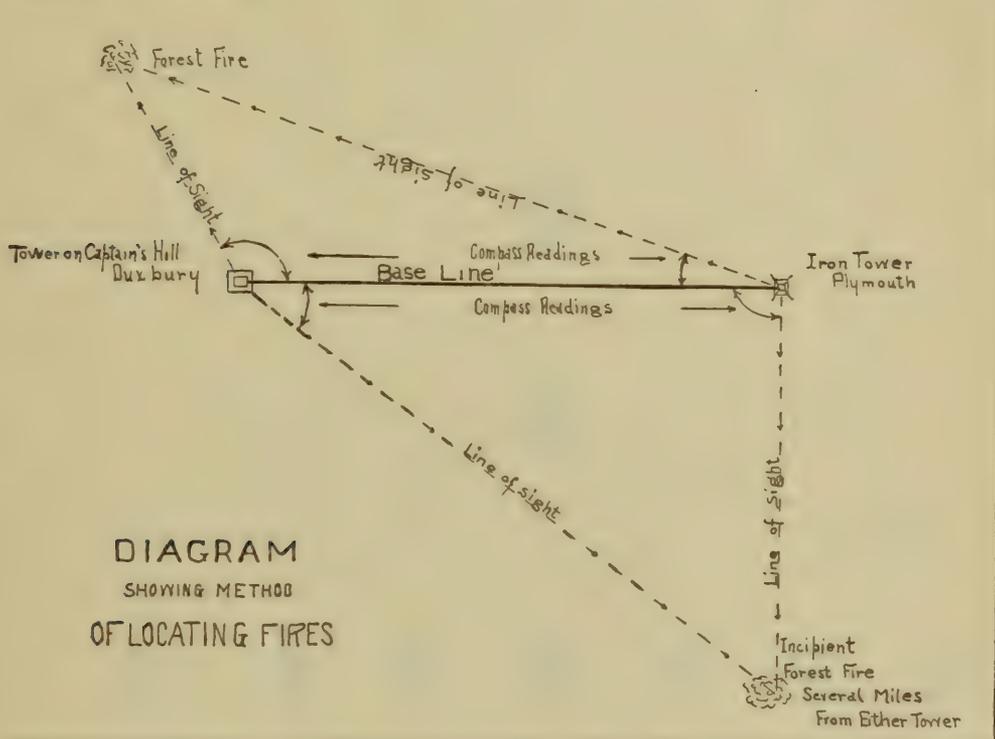
We spread the alarm of fire by direct telephoning and by bells. In times of great danger a man is stationed in a church belfry.

We are inaugurating a system of outlooks in conjunction with the Plymouth fire tower. Our tower is the Standish monument, on Captain's Hill. From these two points the compass bearings of an incipient fire can be read and telephoned to a central station. These lines are then run out on the United States geological survey map, allowance being



WESTFORD FIRE WAGON.

made for the difference between the true and magnetic north. If the compass readings are correct the intersection of the two lines gives the position of the fire.



At a small fire we do not attempt any thorough organization, but we organize at serious fires as follows. All are familiar with the organization, either through experience or printed instructions.

Chief.— The forest warden or deputy of the district. Does not stay at any one point, but overlooks the whole line. Informs himself carefully as to the extent of the fire and picks out the critical points. If the attack on one line is unsuccessful he draws the men back to another.

Aids.— Messengers for the chief.

Deputy Wardens.— Act for section as chief does for whole, or, at smaller fires, are simply foremen.

Foremen.— Each has from four to six men, who stay with him until the fire is out. Each foreman and his crew form the units for fighting. As, for instance, one crew might be put to work refilling extinguishers, another at carrying them, another at guard duty, to prevent fresh outbreaks after the fire is apparently out.

Commissary.— Takes care of the apparatus, and at the fires sees that the men are supplied with food and other supplies.

[The diagram on page 22 gives this organization in graphic form and is remodelled from one sent in by Mr. Knapp.]

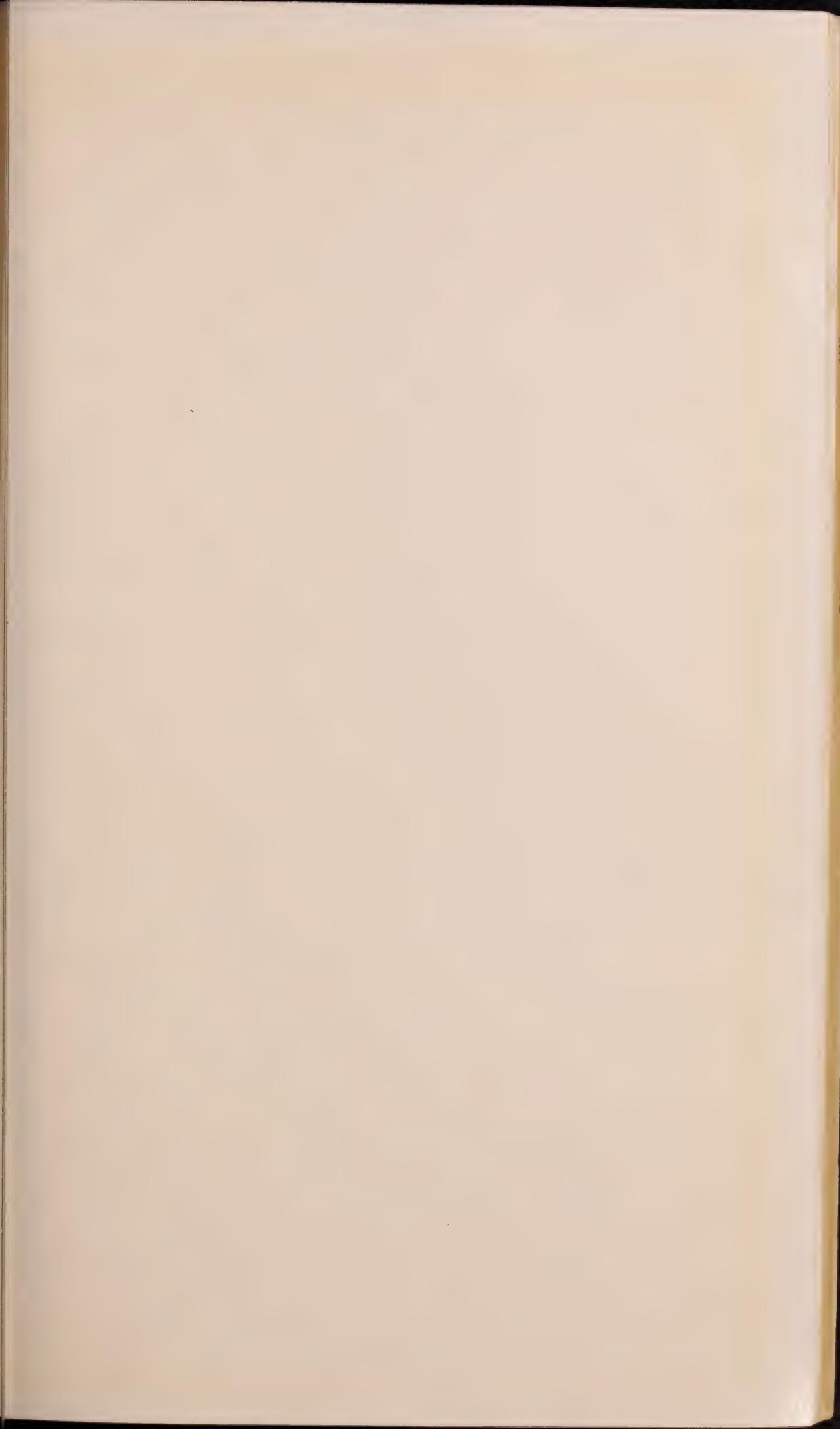
It is essential that the work of forest fire fighting should be done as systematically as possible, and that the directions of the leaders should be faithfully carried out. The failure of a single man to do the part assigned to him may make useless a whole lot of hard work and cause a new start to be made.

It is not by any means assured that all of these parasites are established here, but it is possible that they are, or that they will be before another season passes. Some that are known to be living in the field, and which are apparently in a very good way toward becoming permanent fixtures in the American fauna, have had their freedom for less than one year; and there is no assurance that a species is established until it has completed at least one cycle of the seasons unprotected in the open. A few of them, as will be shown later, will be the better for artificial assistance in dispersion, etc. One, *Chalcis*, ought to be imported in larger numbers, but with this one possible exception, each that is listed has been liberated under the most favorable circumstances which it is possible to provide.

Especial attention is called to the fact that the sequence is complete as it stands. Every stage of the moth is provided with a parasite which will attack it, if given the opportunity, and in every respect the table compares favorably with that illustrative of the Japanese parasites or of the European. It represents, in this most important respect, the climax of the endeavors of the past five years, and it has been accomplished only during the past five months. If the writer were assured of the firm establishment of each of the species listed, and that each would become as efficient in Massachusetts as it is in the countries from which it came, he would state without reservation that the work of parasite introduction was successfully accomplished.

The reader must not confuse the accomplishment of parasite introduction with the accomplishment of the end which it is desired to achieve. It goes without saying, when the habits of the parasites are taken into consideration, that the few paltry thousands, which it has been possible to secure through methods of importation which were the best which experience could devise, must be allowed sufficient time to increase to the millions and billions necessary to cope with the tremendous quantities of gypsy moths which are everywhere in evidence throughout the infested district, wherever the expensive methods of hand suppression have not been employed.

Fortunately, this increase, if it follows colonization, will be by geometrical progression, exactly as has been the case with the gypsy moth; and it will, most fortunately, be much more rapid



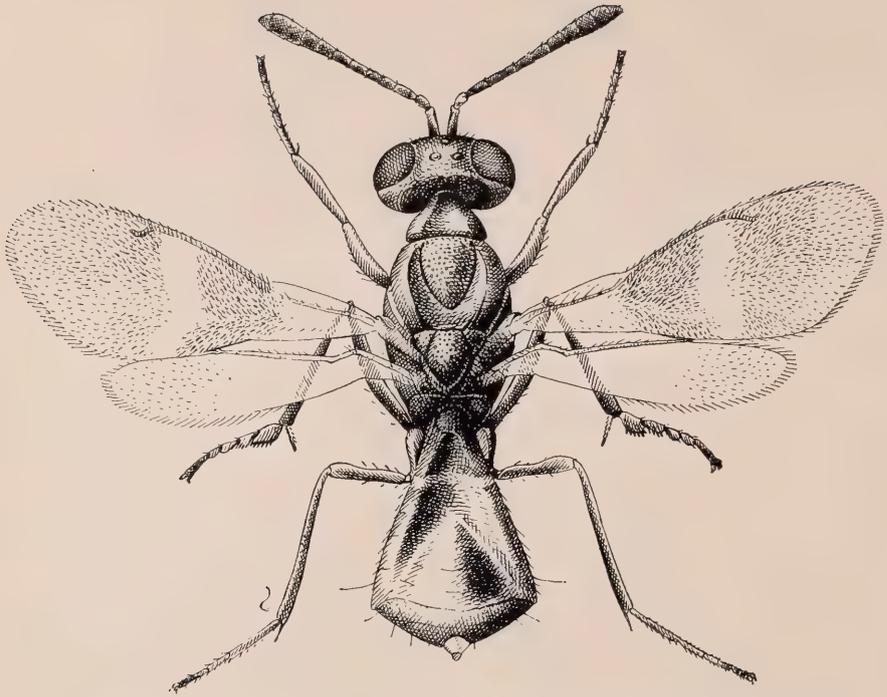


FIG. 1. — *Anastatus bifasciatus* : gypsy moth egg parasite, adult female, greatly enlarged.



FIG. 2. — *Anastatus*: egg, greatly enlarged.

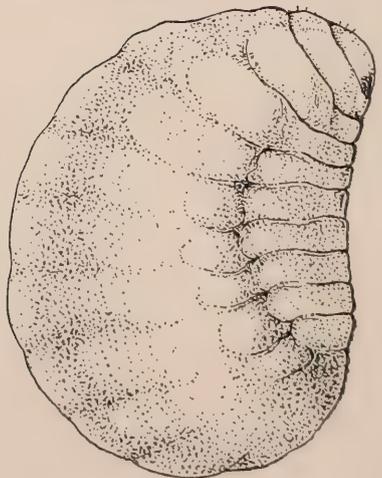


FIG. 3. — *Anastatus*: hibernating larva from gypsy moth egg, greatly enlarged.

than it was in the case of the gypsy moth, owing to the greater dispersive powers of nearly all of the parasites. With one exception, they more nearly resemble the brown-tail moth in this respect, being gifted with the power of flight; and, as is well known, the territory covered by this insect is much more extensive than that covered by the gypsy moth, although the latter was introduced into America more than twenty years earlier.

Another enormous step in advance, which has marked the progress of the work the present season, is the accumulation of certain valuable data which throw much-needed light upon the subject of parasite dispersion, and which have tended more than anything which has come about since the earliest beginning to encourage those who have been charged with direction of the work. For the first time it is possible to calculate, with some foundation upon fact, the probable outcome of the undertaking. It is difficult to do this on the small amount of absolutely authentic information at hand, and to vouch for the accuracy of the conclusions with any degree of assurance; but the attempt has been made, and will appear in the concluding paragraphs.

First, in order to make more clear the ground which supports these conclusions, a brief account of each of the introduced parasites of the gypsy moth will be given. No attempts have been made to go into technical detail concerning the lives and habits of these several species, further than is necessary to give a general idea of their methods of attack, and of the hopes and fears which are felt for the future of each.

PARASITES OF THE EGG.

Anastatus bifasciatus.

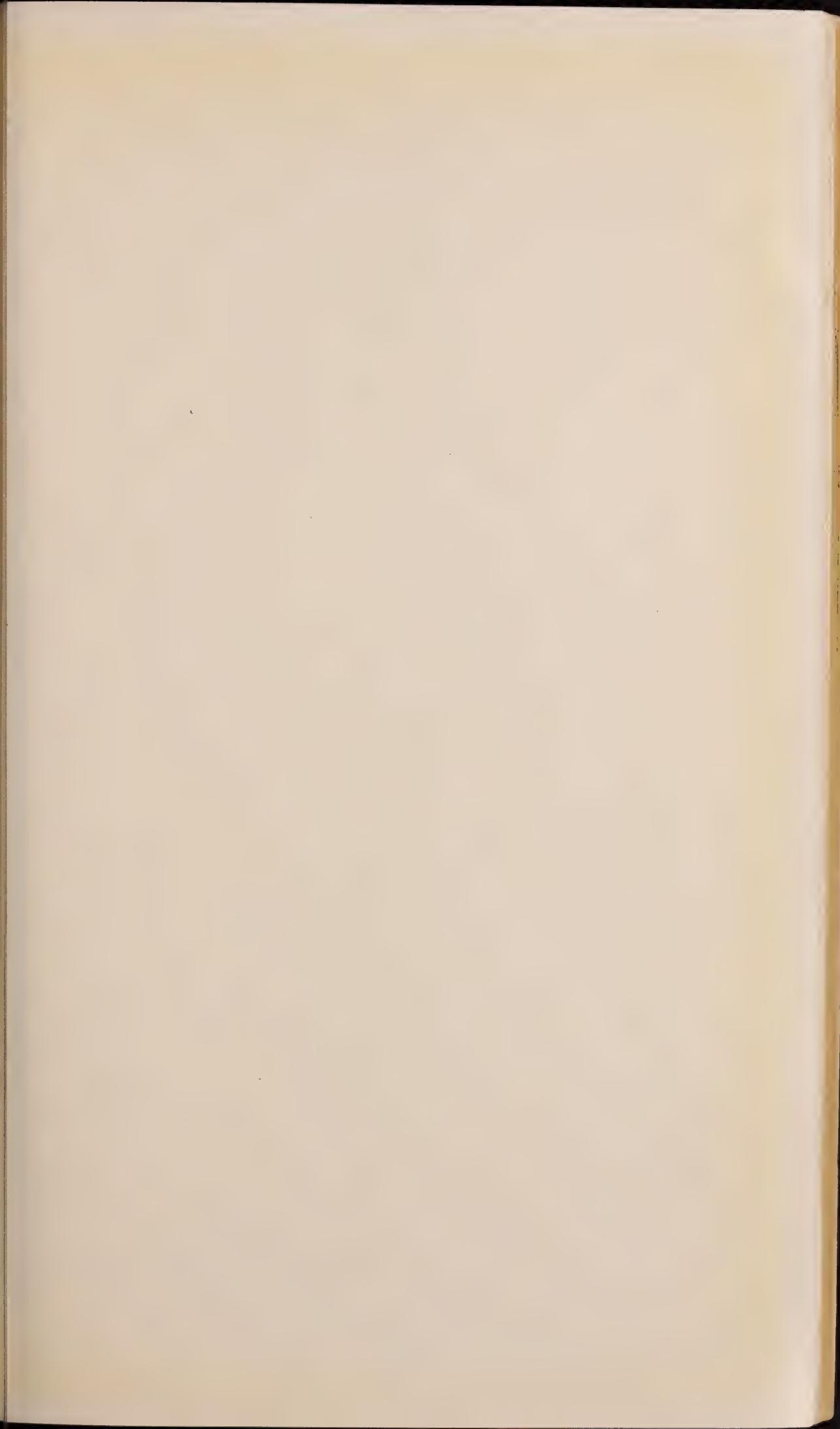
This minute parasite (Fig. 1) attacks the newly deposited eggs of the gypsy moth during the brief interval which elapses before the embryonic caterpillars develop. Its eggs (Fig. 2) are deposited singly, one in each individual egg of the host, and its larvæ feed upon the substance of the host eggs and become full fed in about three weeks. They then enter on a long resting stage, snugly ensconced within the limited confines of the

shell (Fig. 3), and do not resume activity until the middle of the following summer, ten months later. The transformations to pupa (Fig. 4) and adult (Fig. 1) follow in the course of two or three weeks, the latter emerge, and in a few days are ready to deposit eggs for another generation within the newly deposited eggs of the next generation of the gypsy moth. There is thus but one generation of the parasite each year, and its life cycle, which corresponds to the annual cycle, is correlated exactly with that of the insect which serves as its host.

It is a native of both Europe and Japan, and is sometimes a common and effective parasite in either country. It is very unevenly distributed, however, especially in Europe, and a great many lots of eggs have been received which did not contain any of the parasite. For two years large numbers of egg masses were imported from various European and Japanese localities, and not a single specimen was secured. Finally, in the spring of 1908 it issued almost simultaneously from Russian and from Japanese eggs, and was soon determined to be a primary parasite. About 500 individuals were liberated that summer, but under conditions which were unsatisfactory in many respects, and no reproduction in the field resulted, so far as has been determined.

Encouraged by the knowledge that there was an egg parasite which could be secured through the winter importation of eggs, — a fact which was far from being established up to the rearing of the first specimens of *Anastatus*, — larger importations from numerous localities were made during the winter of 1908–09. As before, only a part of these shipments were productive, but among them was one consisting of five sacks of about 1,000 egg masses each, from Professor Jablonowski of Budapest, which were collected in five different Hungarian localities. From three of these only an insignificant quantity of parasites was secured, one lot being entirely unparasitized. From two, however, was secured by far the largest number of egg parasites ever received from any source, there being more than 80,000 all told. It illustrates very well the uneven distribution of the species in Europe.

These, together with some others from other sources, were liberated in five colonies, in quite widely separated localities



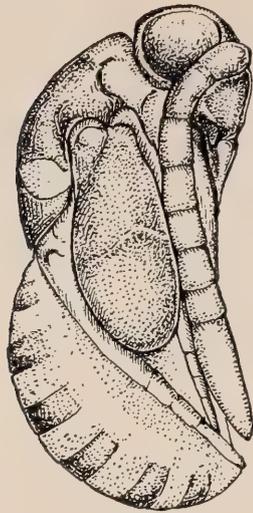


FIG. 4. — *Anastatus*: pupa
from gypsy moth egg,
greatly enlarged.

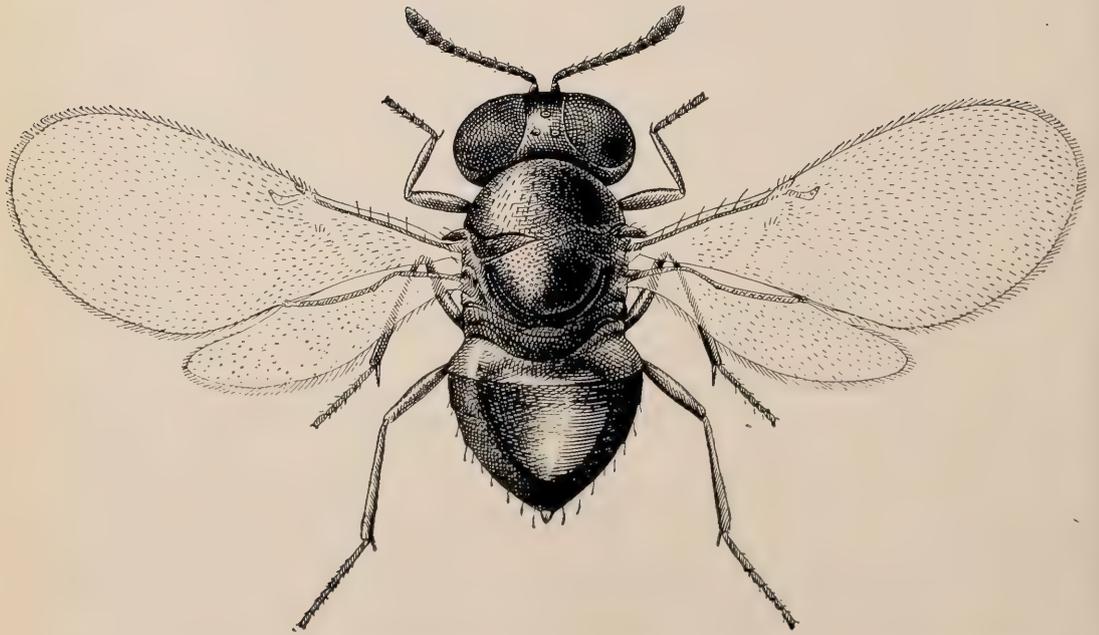


FIG. 5. — *Schedius kuranae*: Japanese parasite of gypsy moth eggs, adult female, greatly enlarged.

within the infested area. In every instance they attacked the freshly deposited eggs of the moth with avidity, and reproduction in the field under perfectly natural conditions resulted. At the present time there are many thousands of the larvæ of the parasite hibernating in the open in the immediate vicinity of the colonies, exactly as they would do in their native land, and there is hardly room to doubt that they will issue next summer in the normal manner.

In one respect only is the insect disappointing. It appears to resemble the gypsy moth, in that the females do not fly. The utmost endeavors have been made to determine accurately the distance to which it travelled from each of the points where it was liberated, and the results indicate that 100 feet is about the limit. This is a rate of dispersion slower than that of the gypsy moth itself, and it would take a great many years for the parasite to spread over the entire infested area. Additional importations will be made during the present winter, and it is hoped that a large number of colonies will be established next summer, but no immediate benefits can be expected.

Schedius kuvanæ.

Most fortunately it is not necessary to depend exclusively upon the *Anastatus* as a parasite of the eggs of the gypsy moth, for in Japan there is another (Fig. 5) with similar habits, in so far as the object of its attack is identical; outside of this fact, it is different in many important particulars. Instead of confining its attack to the freshly deposited eggs, it rather prefers those in which the embryonic caterpillars have developed, and, since these caterpillars are fully formed, and so far as appearances go ready to hatch within three weeks after the eggs are deposited in the summer, *Schedius* is actually a parasite of the unhatched caterpillar, rather than of the egg. Instead of requiring a full year to complete the life cycle from egg to adult, it completes a generation once every three or four weeks during the warmer part of the summer, or in the winter if kept in rooms properly warmed. It is thus able to go through at least two generations during the fall, after the eggs of the moth have been deposited, and before cold weather puts a stop to its activity.

The history of its introduction into America is most interesting, and, except for the fact that it was so long delayed in execution, forms one of the most satisfactory episodes in the entire work of parasite introduction.

As long ago as the spring of 1907 a few dead adults were secured in an importation of gypsy egg masses received during the winter from Japan, but none were living on receipt. During the winter next following larger importations were made, and many thousands of eggs, from which some parasite had issued, were found, but not a single living specimen was obtained. It was evident that it completed its transformations and issued in the fall, and that, if it hibernated in the eggs, it was warmed to activity while the packages were in transit to America, and the adult parasites either died or escaped en route.

In the fall, winter and spring of 1908-09 a large quantity of eggs of the gypsy moth were received from Japan, the shipments beginning early in the fall and continuing until nearly time for the caterpillars to hatch in the spring. The first, received in September, contained hundreds, possibly thousands, of the parasites, which had issued from the eggs en route, and all of which, as usual, had died; not a single living individual was received. Specimens were referred to Dr. Howard, who found that they represented an entirely new and hitherto undescribed species, which he named after Professor Kuwana, who collected and sent the eggs from which they had issued. A single pair of living specimens rewarded the careful attention which was lavished upon the importations received later in the fall and during the winter, and it was not until April, 1909, that a mated pair could be secured. During that month a total of 11 individuals issued from cages containing Japanese eggs recently received.

This small number served as the beginning of a series of experiments in propagation, which succeeded so well that in August several thousands were available for liberation in the field. In September and again in October additional colonies were established, and during the fall, some 50,000 in all were given their freedom.

After September the bulk of those reared were kept for extensive propagation work in the laboratory, and at the present time (February 1) a conservative estimate of the number in various



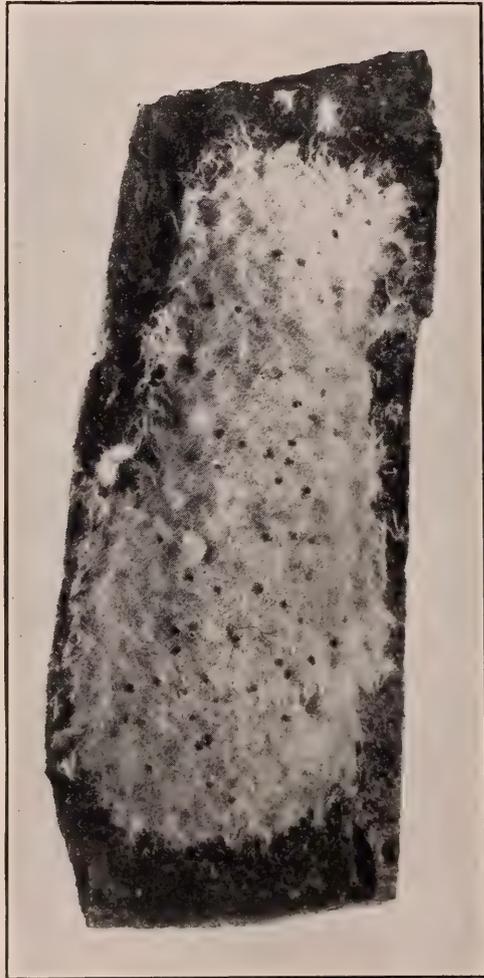


FIG. 6. — Gypsy moth egg mass, showing exit holes of *Schedius*, enlarged about four times.

stages in the reproduction cages is 2,000,000. It is by no means sure that the species will go through the winter in the open as successfully as is hoped will be the case; but no obstacle threatens to prevent the liberation of several millions of the parasite during the summer of 1910.

The reproduction of the parasite in the field, as a result of the earlier attempts at colonization, has been far in excess of expectations. The rate of reproduction in the laboratory, which averages only about ten-fold each generation, was greatly exceeded, and hundreds of thousands of eggs were known to be parasitized in the immediate vicinity of the colony sites. In the one colony which has been most carefully watched the parasitized eggs (Fig. 6) average some 30 to the mass everywhere within a radius of 50 yards, and the masses in a few places are so thick as to hide the bark on the trees. Beyond 50 yards the numbers fall off very rapidly; but the species has been found several hundred yards from the point of liberation, in striking contrast to *Anastatus*, which traveled only 100 feet.

It is hoped that a strong colony will be established in every town in the infested district during the coming summer; and if the same rate of dispersion indicated during the past fall continues, and the parasite demonstrates its ability to exist under American conditions during the entire year, it should be generally established throughout the infested area in two or three years more.

It must not be forgotten, however, that it has not yet proven itself adaptable to American conditions at all seasons. Like the other egg parasite, *Anastatus*, the only known host is the gypsy moth; but, unlike that species, its life is not correlated to that of its host. It is not known how it passes the winter, and, although living adults issue within a few days from egg masses brought in from the vicinity of the colonies in December, it is possible that they will not survive the cold weather which is bound to follow in January and February.¹ There is also a possibility that in Japan there is some other sort of egg subject to its attack, in which it passes a generation during the early

¹ This statement was written in December. It has since been found that all of the larvæ and pupæ of the parasites perished during the cold weather in January, but that adult parasites, of which there are known to be many in the field, lived through it. Whether they will survive the remainder of the winter is yet to be demonstrated.

summer, before the eggs of the gypsy moth are available, and that there will be no native insect which will give what may prove to be some such necessary aid to its continued existence.

PARASITES OF THE CATERPILLAR.

Glyptapanteles fulvipes.

Although this was almost the first parasite of the gypsy moth which attracted any attention in Massachusetts, and the first which it was attempted to import after the beginning of active work, it was one of the last to be liberated under satisfactory conditions, and its establishment in America is not yet certain. Extraordinary methods were necessary to bring it to America living and healthy, and it was not until Prof. Trevor Kincaid, who was selected by Dr. Howard as the best available man for the purpose, visited Japan, and personally superintended the collection and shipment of the cocoons, that success was achieved. The story of Professor Kincaid's experiences and of the difficulties which he met and overcame is interesting. He was accorded great and material assistance by the Japanese entomologists, and the work inaugurated by him in 1908, was continued with even greater success in 1909.

The adult parasite (Fig. 7) deposits a number of eggs beneath the skin of the active caterpillars, and any stage, from the first to and possibly including the last, may be attacked. The larvæ, hatching from the eggs, become full grown in from two to three weeks, and then work their way out through the skin of the still living caterpillar (Fig. 8) within the body of which they fed. Each spins for itself immediately afterward, for its better protection during its later stages, a small white cocoon. The number of parasites nourished by a single host varies in accordance with its size. There may be as few as 2 or 3 in very small caterpillars, or 100 or more in those which are nearly full grown.

The unfortunate victim of attack does not, as a rule, die immediately after the emergence of the parasite larvæ and the spinning of their cocoons, but it never voluntarily moves from the spot. Its appearance, both before and after death, surrounded by and seeming to brood over the cocoons, is peculiar and characteristic, and once seen can never be mistaken (Fig. 9).



FIG. 7. — *Glyptapanteles fulripes*: Japanese and European caterpillar parasite, adult, greatly enlarged.



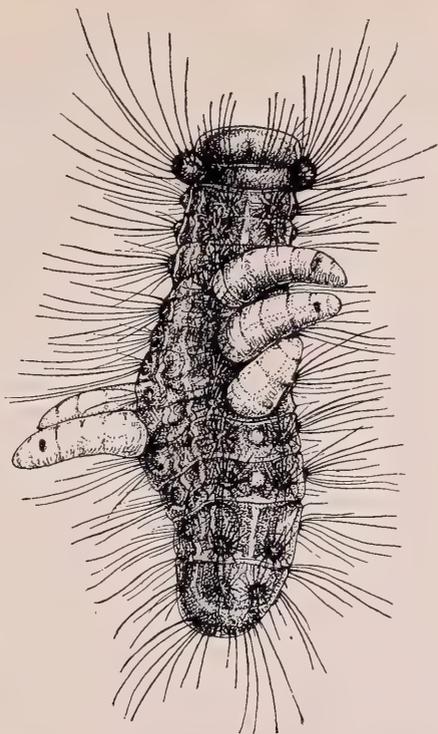


FIG. 8.—Glyptapanteles: larvæ leaving gypsy moth caterpillar, enlarged.

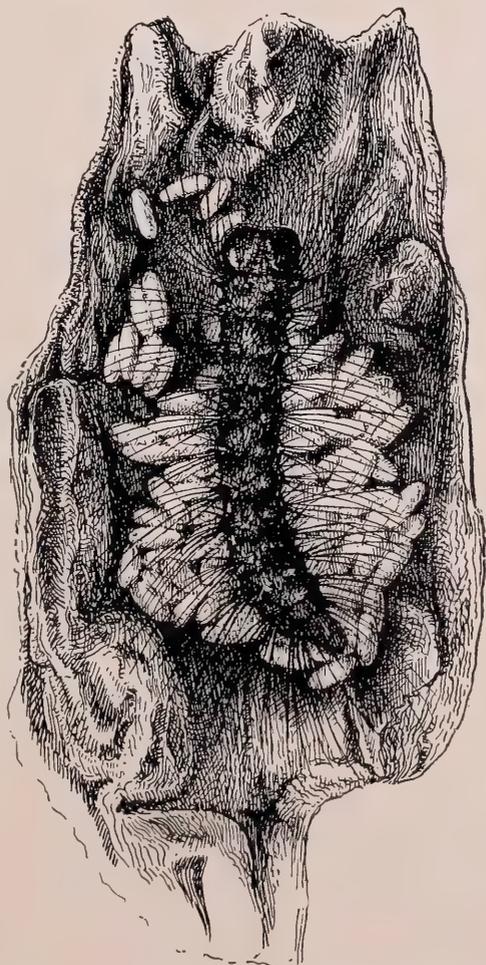


FIG. 9.—Glyptapanteles: dead gypsy moth caterpillar surrounded by cocoons of parasite, slightly enlarged.



There is ample opportunity for two generations of the parasite annually upon the caterpillars of one generation of the gypsy moth. This is the rule in the countries to which it is native, and is to be expected in America.

The parasite was described from Europe more than seventy-five years ago, and has been known to be a parasite of the gypsy moth for a long time. Later it was described under a different name from Japan, and the Japanese parasite was for a time considered to be different from the European. Absolutely no differences in life and habit which can serve to separate the two are known, and, as the adults are also indistinguishable in appearance, they are considered to be identical.

It has been the subject of frequent mention under the name of *Apanteles*, as well as of *Glyptapanteles*, in the various reports of the superintendent of moth work, from the first to the fourth; and Dr. Howard, in the account of his first trip to Europe in the interests of parasite introduction, tells of its occurrence in the suburbs of Vienna. Largely on account of the fact that it is much more conspicuous than many of the other parasites, it has attracted more general attention. The Rev. H. A. Loomis, a missionary, and resident of Yokohama, was the first to call attention to its importance in Japan, and made several unsuccessful attempts to send it to America. Dr. G. P. Clinton, mycologist of the Connecticut Agricultural Experiment Station, who visited Japan in 1909, observed the parasite at work, and reported most favorably upon its efficiency as a check to the moth. Numerous other attempts on the part of European and Japanese entomologists, including one elaborate experiment, which involved the shipment of a large wire-screened cage containing a living tree with gypsy caterpillars and the parasite, were made, but with uniformly ill success. Upon every occasion the parasites all emerged from their cocoons and died en route.

When every other means failed, Professor Kincaid, as already stated, was deputed to visit Japan, and to make all necessary arrangements for the transportation of the parasite cocoons in cold storage to America. The arrangements which he perfected provided for continuous cold storage, not only en route across the Pacific, but during practically every moment from the time

the cocoons were collected in the field in Japan until they were received at the laboratory in Melrose. Events justified the adoption of every precaution, and, with all the care, only a small part of the very large quantity of cocoons which he collected reached their destination in good condition. Hundreds of thousands were collected and shipped, and less than 50,000 were received alive, — nearly all in one shipment in July.

The season in Massachusetts was early, and nearly all of the gypsy caterpillars had pupated by that time, so that there was no opportunity for the parasite to increase in the field upon this host that season. In 1909 the sites of the colonies were frequently visited, but not a single parasitized caterpillar was found which could be traced to colonizations of the year before. Keen disappointment was at first felt, but later developments have tended to throw a more encouraging light upon the situation.

In 1909 importations were continued, through the magnificent efforts of Prof. S. I. Kuwana of the Imperial Agricultural Experiment Station, at Tokio, with much more satisfactory results. In 1908 the season in Japan was very late, and it was not practicable to send any of the cocoons of the parasite until June and July; while in America the season was early, and by that time all of the caterpillars, as has already been stated, had pupated. In 1909 the season was rather early in Japan and correspondingly late in America; and besides, through special effort, Professor Kuwana was enabled to send a few thousands of the cocoons of the first generation, which reached the laboratory early in June. About 1,000 adults emerged from these cocoons after receipt, and the most of them were placed in one colony in a cold situation on the North Shore, where the caterpillars were greatly retarded, and where there were still some in the first stage. The remainder were colonized in warmer localities, where the caterpillars were one stage farther advanced.

Immediate success followed the planting of these colonies. Within three weeks cocoons were found in each, and the number of parasitized caterpillars was gratifyingly large. A very careful investigation was conducted, to determine the proportion which was attacked by native secondary parasites; and, while this was so very large in one instance as seriously to jeopardize

the success of the experiment, it was not so large in the others.

There were several thousands of this first generation known to have developed in the open upon American soil, which issued from the cocoons some four or five weeks after the colonies were established, but in only that one on the North Shore, where the caterpillars were in the first and second stages when the parasites were liberated, was there a full second generation. Here the larger caterpillars were again attacked, and an abundant second generation of the parasite followed.

Meanwhile, additional shipments of cocoons of the second Japanese generation were received early enough to permit of a generation in the open upon the native caterpillars, and several other colonies were successfully established. It is known that there were many thousands of the parasite issuing in at least five different localities during August, but immediately thereafter they were completely lost to sight, and it is futile to hope to recover traces of them before another spring.

Until the late summer of 1909 nothing occurred to indicate that this parasite would be likely to fly for any great distance from the point of its liberation; and, as has been already stated, it was looked for in vain in the summer of 1909 in the immediate vicinity of the colonies of the year before. In July, 1909, a strong colony was planted in an isolated woodland colony of gypsy moths in the town of Milton. It was rather confidently expected that it would attack these caterpillars so extensively as to destroy the major portion; but it was the cause of some surprise, when the locality was visited after the parasites of the new generation had mostly issued from the affected caterpillars, to find a smaller number of cocoons than there were individuals liberated in the first place, and only about one-fourth, perhaps less, of the caterpillars attacked. The circumstance was as discouraging as anything which had gone before, and for a few days nothing happened to change its complexion. Then, to the intense surprise of the writer, Mr. Charles W. Minott, field agent of the central division, sent to the laboratory a *bona-fide* example of the parasite, which had been collected in the Blue Hills reservation, upwards of a mile away. There was no possible source except the Milton colony, and a spread of upwards of a mile in something under a week was indicated beyond dis-

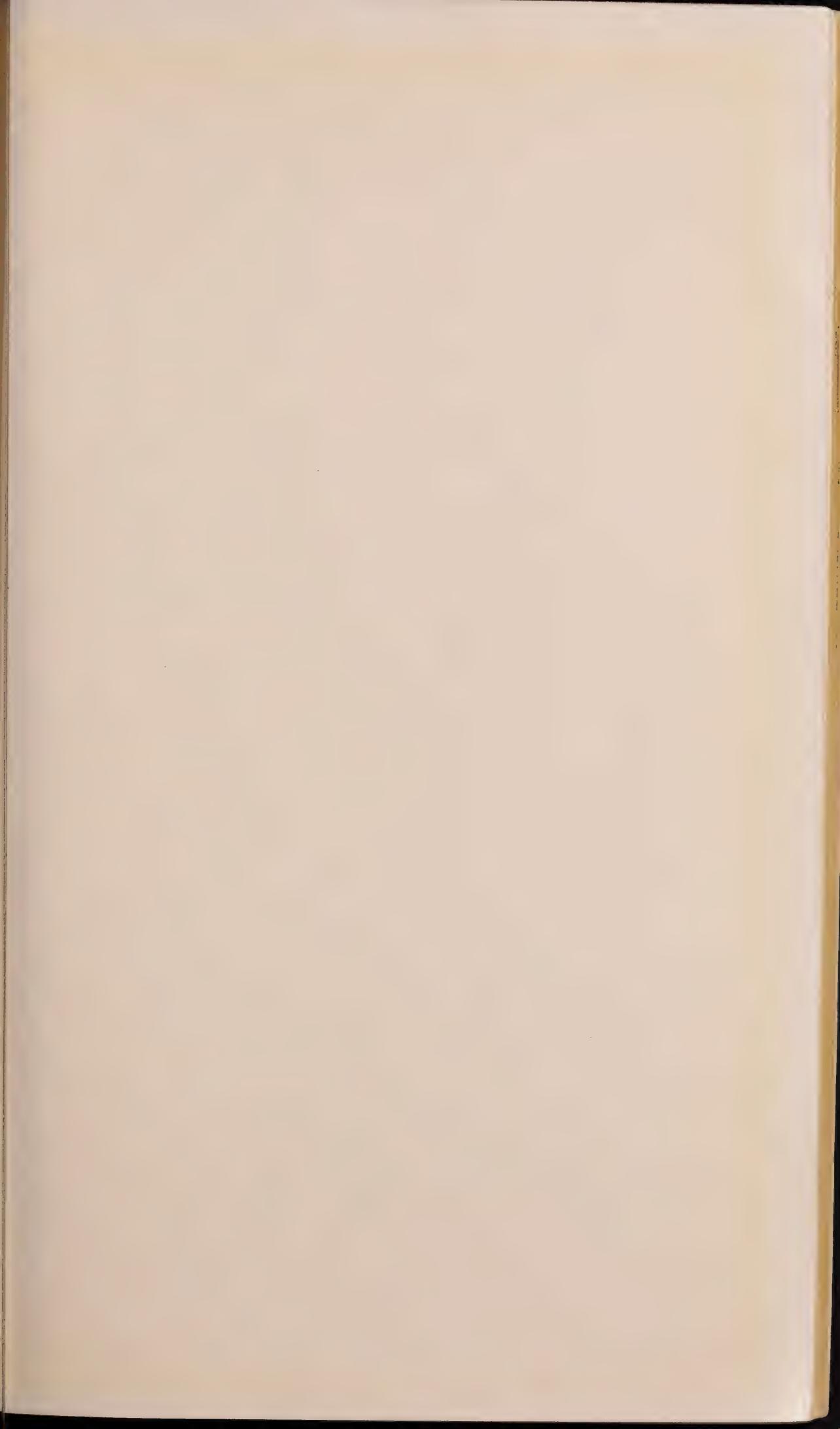
pute. At almost the same time the brood of *Monodontomerus* was found for the first time in pupæ of the gypsy moth in the field; and when the history of this species is considered, in the connection which it bears toward the circumstances surrounding the recovery of the *Glyptapanteles* so far from the point where it was liberated, the whole situation is altered.

Granted that the parasite disperses at the rate of one mile in each week of activity, and that it is able to adapt its life and habits to the climate and conditions in America, the chances are, that, instead of looking for it in the immediate vicinity of the points of colonization, it is quite as likely to be found almost anywhere in the infested area within 25 miles of Boston. If it is thus generally distributed, very large numbers in the aggregate may exist, and it may increase at a rate as rapid as that of *Monodontomerus*, and at the same time escape detection until the summer of 1911 or 1912.¹

This is not only possible, but probable, unless a number of careful observers assist in the recovery of the parasite next season; and if any one should chance, at any time during the summer, to discover parasite cocoon masses similar to those figured, and will collect them and forward them in a small box to the gypsy moth laboratory, Melrose Highlands, Mass., the service will be greatly appreciated. There are a great many native parasites of native caterpillars which are very similar and in some instances indistinguishable from those of the *Glyptapanteles*, but none of these have ever been recorded as attacking the gypsy moth.

The one great fear in connection with the introduction of this most important parasite is that it will not find all of the natural conditions necessary for its continued existence in Massachusetts. Its life during the fall and its whereabouts during the winter are equally a mystery; and even the Japanese entomologists, who are the keenest of observers, resident in a country where it is a relatively common insect, are wholly unable to suggest a reasonable solution. It has been recorded upon a variety

¹ The occurrence of the cocoons in the near vicinity of the colony sites immediately following the liberation is most natural, and in perfect harmony with the wide dispersion. The female parasites as soon as they emerge are ready to deposit a small part of the eggs which they will eventually deposit if they live and have opportunity. After the deposition of this part, it is necessary for them to wait an appreciable time before they are ready to deposit any more.



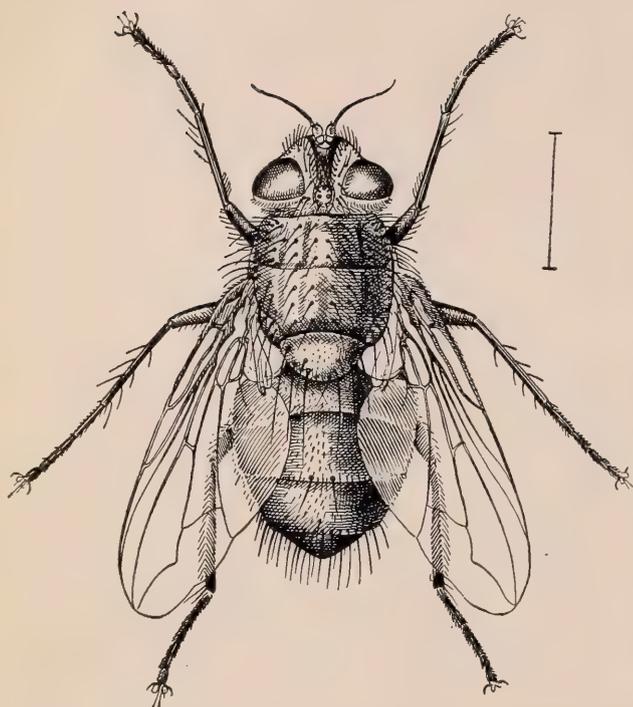


FIG. 10. — *Blepharipa scutellata*: important European parasite of gypsy moth caterpillar, adult, enlarged.



FIG. 11. — *Blepharipa*: full-grown larva from gypsy moth pupa, enlarged about six times.



FIG. 12. — *Blepharipa*: puparia, slightly enlarged.

of other caterpillars in Europe, but these records are known to be erroneous in part, and all are likely to be so. As stated just above, there are numerous other species which are easily confused with it, but none of them appear to attack the gypsy moth; and, *vice versa*, absolute proof that the *Glyptapanteles* of the gypsy ever attacks any other host is at present lacking.

It is one of the most important parasites, perhaps the most important, and fills a gap in the sequence which it will be exceedingly hard to fill should it fail to become established. If it demonstrates its ability to live in America, it is safe to say that the greatest and most-feared of all of the obstacles to success will prove to be nonexistent.

Blepharipa scutellata.

Blepharipa belongs to a different order of insects, the *Diptera*, which consists of the true flies, while the egg parasites and *Glyptapanteles* belong to the order *Hymenoptera*, and are more nearly related to the bees and wasps. The latter are characterized by four membranous wings, while *Blepharipa* has but two wings, and is the first of the several parasites which will be mentioned which belongs to the family *Tachinidæ* of order *Diptera*. The *Dipterous* parasites of the gypsy moth and of the brown-tail moth are all members of this family, and will frequently be referred to as the *Tachinid* parasites, in contradistinction to the *Hymenopterous* parasites.

The *Tachinid* parasites, as a class, differ markedly in their manner of life from the *Hymenopterous*, but not all of them to quite the extent of the one under consideration (Fig. 10). It attacks the gypsy moth during several of the caterpillar stages, but instead of depositing its eggs within the body of the host, they are deposited upon leaves of trees infested by the caterpillars. They are exceedingly minute, black and shining, and one fly can lay many thousands. When eaten by a caterpillar big enough not to crush them in the process they hatch almost immediately into tiny maggots, which pierce the walls of the alimentary canal and lodge themselves in the fatty tissue of the caterpillar's body. They grow slowly, and invariably, if parasitism is successful, the caterpillar pupates. When the moth would have been about ready to issue, had the pupa been healthy,

the *Blepharipa* maggot (Fig. 11) reaches maturity and works its way out of the now empty shell. It then drops to the earth and burrowing its way several inches below the surface, transforms to a puparium (Fig. 12), an oval, dark body, formed of the hardened skin of the larva, and containing the true pupa. This pupa remains unchanged during the winter, and produces the perfect fly in the late spring following.

Blepharipa is a very important parasite of the gypsy moth in Europe, and in western Europe appears to be very much more destructive than does the *Glyptapanteles*. It is represented in Japan by another very similar species (*Crossocosmia* sp.), the adults of which have not yet been reared at the laboratory.

The difficulties which have stood in the way of the successful introduction of this parasite into America have been different from any that have hindered the work with any other species. Importation of the full-grown caterpillars or freshly formed pupæ of the gypsy moth resulted in 1905 in securing a considerable number, several hundred at least, of the hibernating puparia, but not a single fly issued the following year. The cause was not obvious at the time, but was later determined to be due to the drying up of the pupæ within the puparium. Death did not immediately ensue, but eventually the fly would die when it was nearly ready to issue. A great many different methods of hibernating these puparia have been attempted, and with very variable but uniformly unsatisfactory results. During the winter of 1907-08 the puparia were kept in moist earth, and a 10 per cent. emergence from a total of 5,000 was secured. The year before it was less, hardly equalling 3 per cent., and the year following much less, hardly amounting to 1 per cent. These tremendous losses were unexplained until the summer of 1909, when large numbers of gypsy caterpillars were received in a living condition from Hyeres, France, through the magnificent efforts of M. René Oberthür of Rennes, and as a direct result of Dr. Howard's trip to Europe that year. (Plate II.) They came in better shape, in many respects, than any other similar lot of material ever received, having been shipped in cold storage on fast transatlantic liners.

For the first time since the inception of the work, large numbers of living pupæ containing the immature maggots of

the parasites were received at the laboratory, and it was possible to allow the formation of the puparia under natural conditions in the earth. Each preceding year the maggots had reached their maturity, and formed, or attempted to form, puparia in the boxes in transit. They were often injured, and the puparia were always thoroughly dried when received.

A very large number of the parasites were secured in this manner (25,000, as a conservative estimate), and several thousands of the maggots were allowed to enter the earth in the open in forests infested by the gypsy moth. Examination has demonstrated the fact that these maggots pupated in a perfectly natural manner, and the condition of the pupæ at the present time is far and away more satisfactory than it has ever been before at this season of the year. It is almost impossible to conceive of conditions which will prevent the emergence of these flies in large numbers in the open the coming spring.

The remainder of the maggots were allowed to go into the earth in a variety of containers, principally sunken wire screen cages in the laboratory grounds. They, as well as those in the open, are in the best of condition, and it will be a severe disappointment if a large number of the flies are not reared and colonized, as a result.

The parasite was colonized as adults in small numbers and under satisfactory conditions in the spring of 1907, and in somewhat larger numbers in 1908. No results have been secured to date, nor are immediate results expected from these early colonies. The fly is very strong, and it is to be expected that it will fly for long distances during the considerable period of its activity in the spring. Unlike *Glyptapanteles*, *Schedius*, etc., it is not ready to deposit its eggs for something like three weeks after it issues in the spring, and during this time it is likely to traverse considerable distances. It is a source of great regret that it has not been liberated in large numbers much earlier in the course of the work; but it was not until after numerous experiments had been made, through which it was hoped to remedy the obvious defects in methods of importation and handling, and all modifications proven to be useless, that the extraordinary methods of last season were adopted. There is not a single other one amongst the numerous species of

Tachinid parasites, except the Japanese *Crossocosmia*, which is nearly so difficult to handle.

Multiplication of this parasite in the open, under favorable conditions, which it is believed the present season offers, ought to be exceedingly rapid. As in so many other instances, the year to come is crucial, and will likely demonstrate the ability of this species to become Americanized.

Success with *Blepharipa*, and its rapid acclimatization in America, is looked for more especially on account of the close correlation which exists between the parasite and host. Like *Anastatus*, this correlation is perfect, and the parasite is able to continue its existence from year's end to year's end, independent of any other insect. This, in connection with its extraordinary powers of multiplication, make it one of the most promising of the parasites studied at the laboratory, and perhaps the most promising of all.

Compsilura concinnata.

Only a very few of the introduced parasites are equally important as enemies of both the gypsy moth and the brown-tail moth, although a number of them are known to attack both to a varying degree. One of the few which are important enemies of both is *Compsilura*, a Tachinid fly like *Blepharipa*, but differing from that species in a great many important particulars. Instead of depositing eggs on the foliage, to be eaten by the caterpillars, the eggs hatch in the body of the parent female, and the minute maggots are thrust beneath the skin of the host after a fashion somewhat comparable to the manner in which *Glyptapanteles* deposits its eggs in the active caterpillars. Usually only one parasite develops in one host.

The maggots begin to feed at once, and in a very short time (less than two weeks in the summer) are full fed, and have caused the death of the host caterpillar. They then work their way outside of its body, drop to the earth and transform to puparia, from which shortly after the adult flies issue.

Since the parasite has been secured in both brown-tail and gypsy moth parasite importations, the numbers which have been received and liberated have been considerable. The first colonies were planted in 1906, and in each year since, but particu-

larly in 1909, new colonies have been located in various parts of eastern Massachusetts. There is no better method for the recovery of the parasite from the field than the collection of gypsy or brown-tail caterpillars and their confinement in cages, where they can be fed, and where the parasite can be secured in case it is present and emerges. This is a tedious process, involves a large amount of labor, and in the case of the brown-tail caterpillars entails much discomfort in its execution; and attempts to determine the distribution of the parasite in the field have not been as thorough as it is intended that they shall be in 1910. Nevertheless, it was recovered from the field upon several occasions in the course of the summer of 1909, and there seems not to be any question that it is thoroughly established and widely distributed in Massachusetts at the present time. Its rate of increase, if the widespread distribution is taken into account, is wholly satisfactory, and, as indicated by the field collections, is as great as of *Calosoma* and perhaps as of *Monodontomerus*. It must be remembered, in this connection, that there is no simple means of determining its distribution, as is the case with both of the other species mentioned; and furthermore, that, although it was liberated in 1906, it was not until so late in the season as to make a generation upon the gypsy or brown-tail caterpillars improbable during that year. It was not until 1907 that it can be considered as having had its first good opportunity for reproduction in America, and the fact that it was found to be generally distributed the third season in the field is indicative of a particularly satisfactory progress.

It is not a very important parasite of either the gypsy or the brown-tail moth in Europe. It has never been received from Japan, and it is not expected that it will become of more than relatively minor importance in either connection here, as compared with *Blepharipa* and *Glyptapanteles*. At the same time, it has points in its favor not possessed by any other parasite, notably, its ability to pass one generation upon the brown-tail caterpillars and another immediately after upon those of the gypsy; and it is likely to gain in effectiveness, in this manner, a part of what it loses through its probable inability to complete its seasonal cycle without the assistance of an alternate native host. It is very democratic in its choice of hosts, and

has been reared in the laboratory from a considerable variety of native caterpillars, including such common species as the fall web worm and the *Datana* caterpillars, which are frequently so abundant upon various trees and shrubs in the fall.

Tachina larvarum and *Tricholyga grandis*.

These two species of Tachinid parasites are exceedingly similar in many respects and are so difficult to separate in their various stages as to have been confused under the name of *Tachina larvarum* during the first three years of the work. On this account, considerable confusion exists concerning the early history of both in America.

Tachina (Fig. 13), like *Compsilura*, is a parasite of both the brown-tail and the gypsy caterpillars, while *Tricholyga* is principally confined to the last-mentioned in its host relations. Both deposit large flattened eggs upon the body of the larger caterpillars, and the minute maggots hatching from these eggs burrow into the body of their host, where they grow rapidly. The larva of *Tachina* usually leaves its host and completes its transformations upon or just beneath the surface of the earth. That of *Tricholyga* may do this, or it may remain attached to the host and never drop to the ground at all. Both species usually kill the host caterpillars before pupation, but not always.

Several thousands of one or both species were liberated in various localities in 1906 and 1907. Both were colonized in small numbers in 1908, and in very large numbers in 1909. It was not known that either species had established itself until late in the summer of 1909, when *Tricholyga* was recovered from the field as a parasite of the gypsy moth from the near vicinity of a very small and unsatisfactory colony of the year before. There seems to be every reason to believe that it has succeeded thoroughly in establishing itself, and that it is a mere matter of time until it shall become so common as to be of active assistance in the control of the gypsy moth.

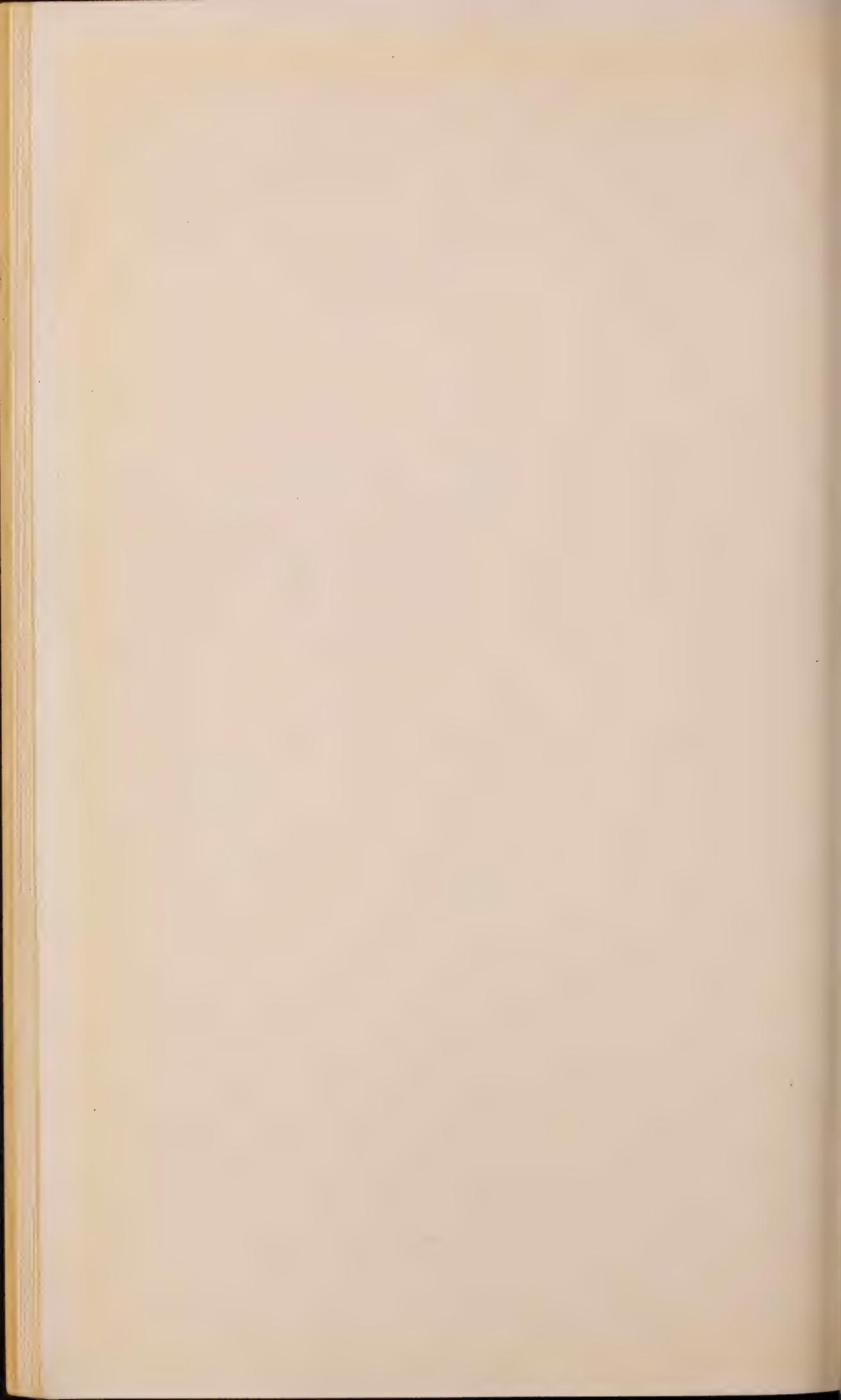
The *Tachina*, strangely enough, is scarcely distinguishable as an adult, or in any other way than by its behavior as a gypsy moth parasite, from a native American species which has upon rare occasions been reared as a parasite of the gypsy moth. The native species is probably the one which deposits its conspicuous



FIG. 13. — *Tachina larvarum* : European parasite of gypsy and brown-tail moth caterpillars, adult, enlarged.



FIG. 14. — *Chalcis flavipes* : European parasite of gypsy moth pupæ, adult, greatly enlarged.



white eggs upon the larger caterpillars of the gypsy moth in certain localities each year so abundantly as periodically to attract attention; but the identity of these eggs cannot be determined, since the maggots which hatch from them rarely go through to maturity. The reasons for this extraordinary state of affairs have not been accurately determined, but in some way the caterpillars of the introduced insect are not fitted to the needs of the maggots of the native parasite.

It has been stated that the native species occasionally completes its growth and transformations upon the gypsy moth, and, since it is impracticable to separate the adults with certainty, there will be no way of following the progress of the imported species in America until it shall become a great deal more common than the native in this connection. It is unquestionably too soon to look for such conditions at the present time, but it is rather confidently expected that within a few years *Tachina larvarum* will become an efficient link in the sequence of parasites which it is hoped to establish.

There is a species of *Tachina* in Japan, indistinguishable in habit from the European species, and apparently rather more effective. The adults are different, however, and quite easily distinguished from either the American or the European. A small number have been liberated, and it is possible that they will be heard from in the future. It is also expected that a larger number will be imported and liberated the coming season, so that, if the European species for any reason should fail to come up to expectations, the position which it might otherwise occupy will not remain vacant.

Zygobothria gilva and *Carcelia gnava*.

Through the efforts of M. René Oberthür of Rennes, very large shipments of gypsy caterpillars and pupæ were received from France in 1909 in much better condition than any considerable shipments ever received before. Largely because of the satisfactory condition of the material on receipt, and partly because the two parasites named above are more common in the Mediterranean region than in northern or central Europe, several thousands of each were imported and colonized under the happy circumstances which accompanied nearly all of the

colonizations in 1909. Both had been received before, and both had been colonized, but in insignificant quantities and under conditions which left much to be desired. It is considered, therefore, that the first satisfactory and possibly the first effective colonization of these parasites was accomplished last year.

Both are Tachinids, and similar in many respects to *Tachina*, *Compsilura*, etc., but differ from all others and from each other in many minor particulars in their life and habits. In relative importance, as determined by the frequency of their occurrence abroad, they are about equal in rank, and compare favorably in France with any other Tachinid parasites except *Blepharipa*.

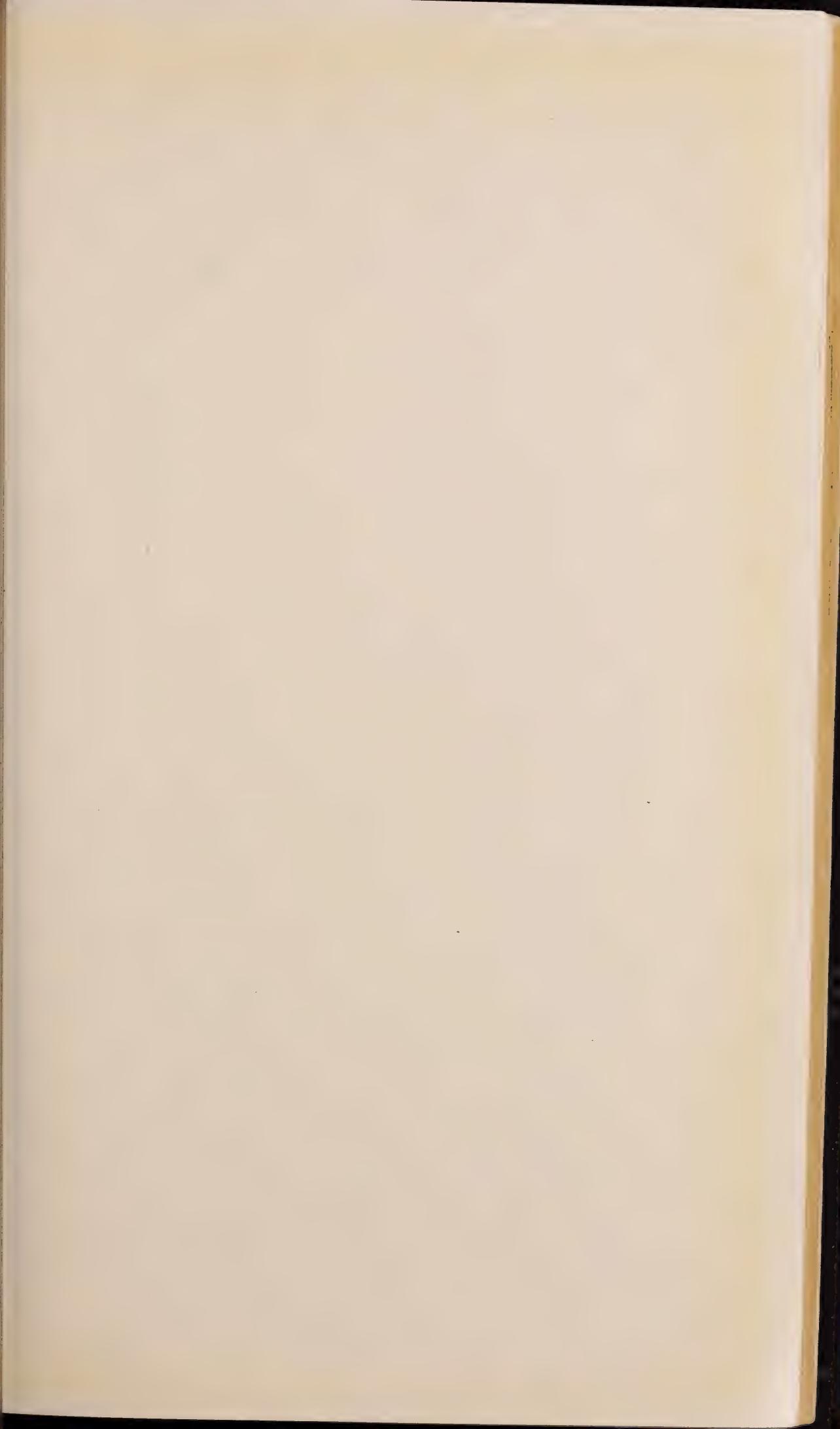
It is hoped that both will establish themselves in America, but their ability to do so remains to be proven, and it is hardly to be expected that either will be recovered before 1911 or 1912, unless some of the earlier and relatively very unsatisfactory colonizations should have resulted more favorably than is now believed to be the case.

PARASITES OF THE PUPA.

Theronia sp.

There are at least 10 species of large, wasp-like parasites which attack the freshly formed pupæ of the gypsy moth, and the caterpillars just previous to their transformation, and which belong to the genera *Pimpla* and *Theronia*. All of them are very general in their host relations, and will attack the pupæ of almost any moth which they encounter under the proper conditions; but none of them, with the exception of the several varieties or species of the genus *Theronia*, have ever occurred so abundantly in any lots of imported gypsy pupæ as to justify a position among the important parasites of the gypsy moth. As parasites of the brown-tail, the several species of *Pimpla* are quite effective both in Europe and America; and *Theronia* is also a brown-tail parasite, but of relatively less importance.

There are three species or varieties of *Theronia*, inhabiting respectively Europe, Japan and America, and all are very similar in appearance and habits. The American species, *Theronia fulvescens*, appears to have reached its maximum effectiveness



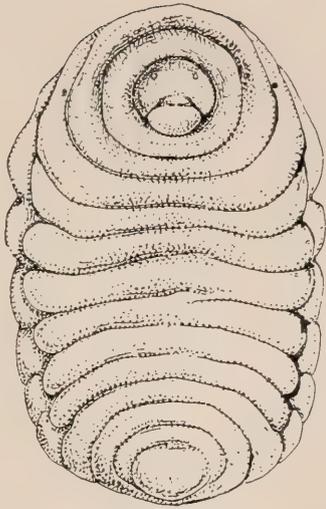


FIG. 15.—Chalcis: full-grown larva from gypsy moth pupa, greatly enlarged.

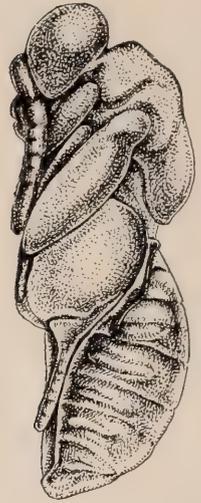


FIG. 16.—Chalcis: pupa from gypsy moth pupa, greatly enlarged.



FIG. 17.—Chalcis: gypsy moth pupae, showing exit hole of the parasite, enlarged.

in America, and without exceeding in this respect the Japanese or the European species in their respective countries. A few of the European *Theronia atalantæ* have been liberated in America, but nothing more is expected of it than of *Theronia fulvescens*; and, as a matter of fact, it will be difficult to determine whether it is established or not, owing to the very close resemblance between the two.

Theronia will help a little in the ultimate control of the gypsy moth in America, but it is not to be expected that it will ever become of greater efficiency than it is at present. It is generally distributed throughout the infested area.

Chalcis flavipes.

One of the most effective parasites of the tussock moth in certain more southern localities is a native species of *Chalcis* (Fig. 14) which is not very common in any connection in New England. If, as is altogether probable, the gypsy moth extends its southern distribution into the range of *Chalcis* as a common parasite, it is not at all unlikely that it will be attacked by it.

In southern Europe and in Japan are other species of *Chalcis* similar to the native species in appearance and habits, and sometimes quite effective parasites of the pupæ of the gypsy moth. They are always solitary, and notwithstanding that there is substance enough in an average gypsy pupa to nourish several individuals, there is no record of more than one ever emerging from one host. The eggs are deposited in the freshly formed pupa, and apparently the individual host is open to attack for a period of only about three days in the course of its life. The larva (Fig. 15) feeds upon as much of the contents of the pupal shell as it desires, and then transforms to a pupa (Fig. 16). The adult emerges later through a large, ragged hole gnawed through the pupal shell. (Fig. 17.)

The European species, *Chalcis flavipes*, was imported in some numbers in 1905, but at that time was supposed to be an enemy of the Tachinids which were primary parasites of the moth, and none were liberated. In 1906 and 1907 none were received, and no opportunity arose to investigate the relations existing between the moth and the parasite. It was not known that it was so closely confined in its geographical distribution at that

time, and since no gypsy moth pupæ were received in good condition from any of the Italian or French collectors, its importance was not recognized.

In 1908, for the first time since 1905, a quantity of gypsy moth pupæ was received from Italy, through the courtesy of Professor Leonardi of the School of Agriculture, Portici, and from them quite large numbers of the parasite were reared. At first, with the recorded secondary parasitism of the species in mind, considerable care was exercised to prevent the escape of any of the specimens until their true relation to the gypsy moth should be established. At last, after a rather tedious series of microscopic studies, supplemented by dissections of the parasitized pupæ, it was definitely demonstrated that the *Chalcis* which issued from the Tachinid puparia were different from those which came from pupa direct; in other words, there were several species of the genus *Chalcis*, closely resembling each other in their appearance, but differing entirely in their habits. One of them was, beyond further dispute, a primary parasite of the gypsy moth, and was immediately liberated in the field, while the others were destroyed as fast as secured.

In 1909 a few more were received in importations of gypsy pupæ from Italy and France, and another small colony was established. It is known definitely that reproduction in the field followed immediately after, but there is insufficient assurance that the species is acclimatized in America, since it has not been recovered a full year after its colonization. If it disperses as rapidly as do most of the parasites, it will be some years before it is again recovered as the result of the last summer's colonization. During this period it is hoped that additional importations will make it possible to establish larger and stronger colonies of what, if it can exist here, is very likely to become a parasite of some importance.

In both 1908 and 1909 *Chalcis flavipes* was carried through all of its transformations in gypsy moth pupæ in the laboratory; and, but for the fact that a supply of host pupæ cannot be provided except during a very limited season each year, it would be practicable to institute propagation work similar to that which has been so successful with *Schedius* and *Calosoma*. Only about one month is required for the complete life cycle from





FIG. 18. — *Monodontomerus aereus* : European parasite of gypsy and brown-tail moth pupæ, adult female, greatly enlarged.

egg to adult. It is very probable that the adults live for a long time, like those of *Monodontomerus*, and they may hibernate.

Monodontomerus aereus.

The females (Fig. 18) deposit their eggs (Fig. 19) in the freshly formed pupæ of the gypsy moth and of the brown-tail moth, several in each individual host. The larvæ (Fig. 20) feed and subsequently undergo all of their transformations within the pupal shell, of which they usually consume the entire contents. (Fig. 21.) A little later than the time when the moth would have issued, had the parasitized pupa remained healthy, the *Monodontomerus* adults escape through a small hole in the dried pupal shell. (Fig. 22.) From 5 or 6 to 15 or 20 come from each. The males die soon after, but the females live all winter, and are not able to deposit eggs for another generation until the summer following. When cold weather approaches they seek the shelter afforded by the hibernating webs of the brown-tail caterpillars, and remain well protected in the silken chambers during the winter. They come forth in the spring as soon as the weather becomes warm enough to stir them into activity, and in the course of the period intervening between their resumption of activity and the pupation of the brown-tail and gypsy, they develop their eggs and are ready for the attack.

A considerable number of the adults of this parasite, all, without exception, fertilized females, issued from the large number of brown-tail hibernating nests which were imported from various European countries during the winter of 1905-06. A part were given their freedom in the spring, but as it was soon found that the species were not in any way an enemy of the hibernating brown-tail caterpillars, and as their parasitism of the pupæ of the gypsy moth and brown-tail moth was not indicated at that time, their liberation was discontinued. In 1906 and 1907 small numbers were reared from imported cocoon masses of brown-tail, but under conditions which told nothing concerning their host relations. Upon several occasions small numbers have been reared from the puparia of Tachinid parasites of the gypsy moth, and it was feared that the parasite might prove to be habitually secondary, instead of primary.

Like *Chalcis*, *Monodontomerus* is more common in southern

Europe, and the small quantities of gypsy and brown-tail pupæ which were received in 1906 and 1907 from those countries where it was most abundant made any attempts to investigate its life and habits difficult of execution. The females would never evince any interest in gypsy or brown-tail pupæ in the laboratory, and all of the many reproduction experiments which were made failed utterly. This was subsequently found to be due to the fact that their eggs were undeveloped, and it was not until a careful series of microscopic dissections were made that this insuperable obstacle to success was discovered.

In 1908 the same importation of gypsy moth pupæ from Italy which served to establish the host relations of *Chalcis* served also to establish the primary character of the parasitism by *Monodontomerus*. It was reared from the gypsy moth pupæ direct, and in such numbers as to indicate that it was a parasite of considerable importance; and great regret was felt that it had not been liberated in larger numbers upon the first opportunity. It was hardly considered probable at that time that the small number liberated during the early spring of 1906 would succeed in establishing themselves.

In the winter of 1908-09, large numbers of the hibernating nests of brown-tail were collected from various localities, as they had been each winter since the beginning of the work, and from these nests issued a very few hibernating females of *Monodontomerus*, exactly as they had previously issued from nests similarly collected in Europe. The circumstance was as unexpected as it was gratifying, and indicated that the parasite had multiplied rapidly in the field, because similar collections of even larger quantities of brown-tail nests had not produced the parasite the year before. Steps were immediately taken to determine the distribution of the parasite, and the surprise was greater when it was discovered to be sparingly but generally distributed over an area of approximately 500 square miles, extending in nearly every direction, but farthest to the west, from the original point of liberation.

In the summer of 1909, when the proper season had arrived, it was recovered for the first time as a parasite of the gypsy moth in the field. Although it was not very common, it was found to be generally distributed, exactly as indicated by the collections



FIG. 19. — Monodontomerus: egg, greatly enlarged.

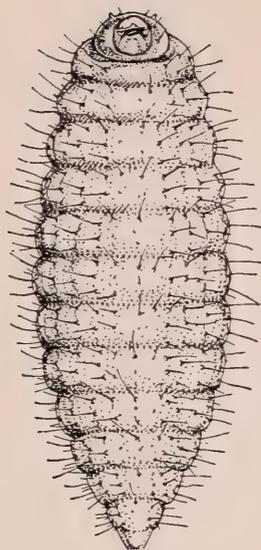


FIG. 20. — Monodontomerus: larva from gypsy moth pupa, greatly enlarged.

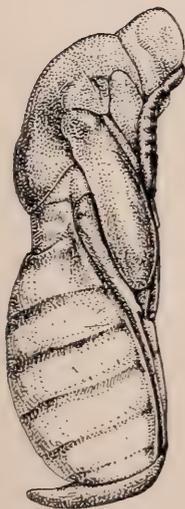


FIG. 21. — Monodontomerus: pupa from gypsy moth pupa, greatly enlarged.

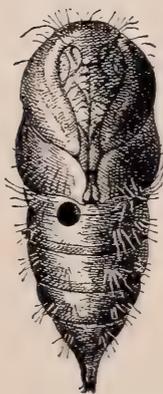


FIG. 22. — Monodontomerus: gypsy moth pupa, showing exit hole left by parasite, greatly enlarged.



from brown-tail nests the winter before. The percentage of the gypsy pupæ destroyed was negligible; but the fact remained that the parasite was on the increase, since exactly the same methods employed in previous years had produced no such results.

Great curiosity was felt as to the probable character of the results of winter work in the recovery of the hibernating females in the winter nests of brown-tails in the fall of 1909, as this would provide the first opportunity to determine the rate of annual increase and of dispersion. The work was begun as soon as practicable, and, while the results are not yet complete, they are more favorable than was at any time anticipated. In brief, the insect is now known to be distributed over an area of approximately 3,000 square miles. Every portion of the Commonwealth north and east of Boston to the New Hampshire line, and as far west and southwest as Leominster, Shirley and Dover, is included in this territory. It is certain to be in New Hampshire, but to date none have been received from that State, and the western limits of its distribution have not been determined.

Everywhere in the area which was not included in its known distribution last year it is about as common as it was in any place the winter before. Within the limits of the territory in which it was known to occur a year ago it has increased at least twenty-five-fold during the year. At this rate, if unchecked, it would be abundant enough to destroy *all* of the gypsy and brown-tail pupæ in three years more. Since this, for various reasons, is highly improbable, it is likely that it will reach its maximum effectiveness within the centrally infested areas by that time. Judging from the best which it is known to do abroad, this will be the destruction of something like one-fourth of the gypsy and brown-tail pupæ. It is not abroad, and cannot be expected to become in America a parasite of as great importance as *Glyptapanteles* or *Blepharipa*, provided these species become as thoroughly acclimatized; but it promises to become a very valuable parasite, occupying, as it does, a position in the sequence of parasites which would otherwise be vacant except for the ineffective *Theronia* or the less certainly efficient *Chalcis*.

PROGRESS OF THE PARASITES IN MASSACHUSETTS.

Before it is possible accurately to predict the progress of an insect in a new country, it is necessary to know, first, the average rate of increase under the new conditions; and, second, the average rate of dispersion. Neither may be determined otherwise than by actual observation in the field. In the countries to which the insect in question is native, the rate of increase is balanced more or less perfectly, and, although it always fluctuates somewhat in relative abundance from one year to another, there is no permanent gain or loss. The dispersion of an insect in a country where it is native and generally distributed is impossible of determination; the progeny of any given parent or of the parents within a given area are at once confused with the progeny of parents in any part of the surrounding country into which they may chance to spread.

The introduction of an insect into a new country is usually followed by a steady increase, which is sustained until it has established a balance with the native insects; or by a steady decrease, which results in its final extinction.

There are a few instances on record in which the progress of an introduced insect has followed neither path. The Chinese lady-bird (*Chilchorus similis*) was introduced into Georgia in 1902 as an enemy of the San José scale, and for one year increased at a very rapid rate, and spread over a considerable territory from the point where it was liberated. It passed the first winter successfully, and for a time bade fair to become so numerous as to be of valuable assistance in the fight against this scale; but in 1904 its numbers showed a decided decrease, and at the present time it appears not to be at all common. The causes for this are very obscure, and no satisfactory explanation has ever been advanced.

The history of the Oriental moth in Boston, where a few years ago it appeared to have become firmly established, is another case in point. At the present time it is far from common, and it is very possible that eventually it will become extinct.

It will never be known how many insects have been introduced into America from abroad, but the number is undoubtedly far

in excess of those which have become temporarily or permanently abundant enough to attract attention.

It has never been expected that all of the parasites and predatory enemies of the gypsy and brown-tail moths which have been introduced into Massachusetts would continue to exist here. It has always been expected that certain of them would do so, and the only cause for uneasiness as to the ultimate success of the work has been the fear that not enough different kinds of parasites could be secured for colonization, or, if colonized, that not enough to form a natural and effective parasitic sequence would be able to continue to exist. At the present time there is no parasite of the gypsy moth, and only one or more of the brown-tail, of which it can be said that the progress is unsatisfactory. Just what the progress is, or whether there is any actual progress, is not known in every case; but, as will be shown, it may be very satisfactory, and at the same time inconspicuous.

In the beginning it was expected that increase, if it followed colonization, would be rapid; but it was not thought that many of the several species would be likely to fly very far from the point of liberation until they had increased for several generations. Had these expectations been fulfilled, practical results would have been apparent, locally, within three or four years.

So far as it is possible now to state, the rate of multiplication has generally been gratifyingly rapid; but it has been accompanied by a rate of dispersion so much greater than was expected as to materially change the aspect of the situation. It is now evident that, if success follows the work of parasite introduction, the parasites will become practically effective over a considerable portion of the infested area, and possibly throughout its whole extent, at about the same time.

In order better to illustrate this point, a theoretical example may be taken of an insect introduced into a new country, where it increases at the rate of twenty-five-fold annually, and spreads from the point of liberation at the rate of about 10 miles annually. It is supposed that 1,000 individuals are liberated in a territory where they can be spread in every direction, and where their increase will be unhampered for a period of six years.

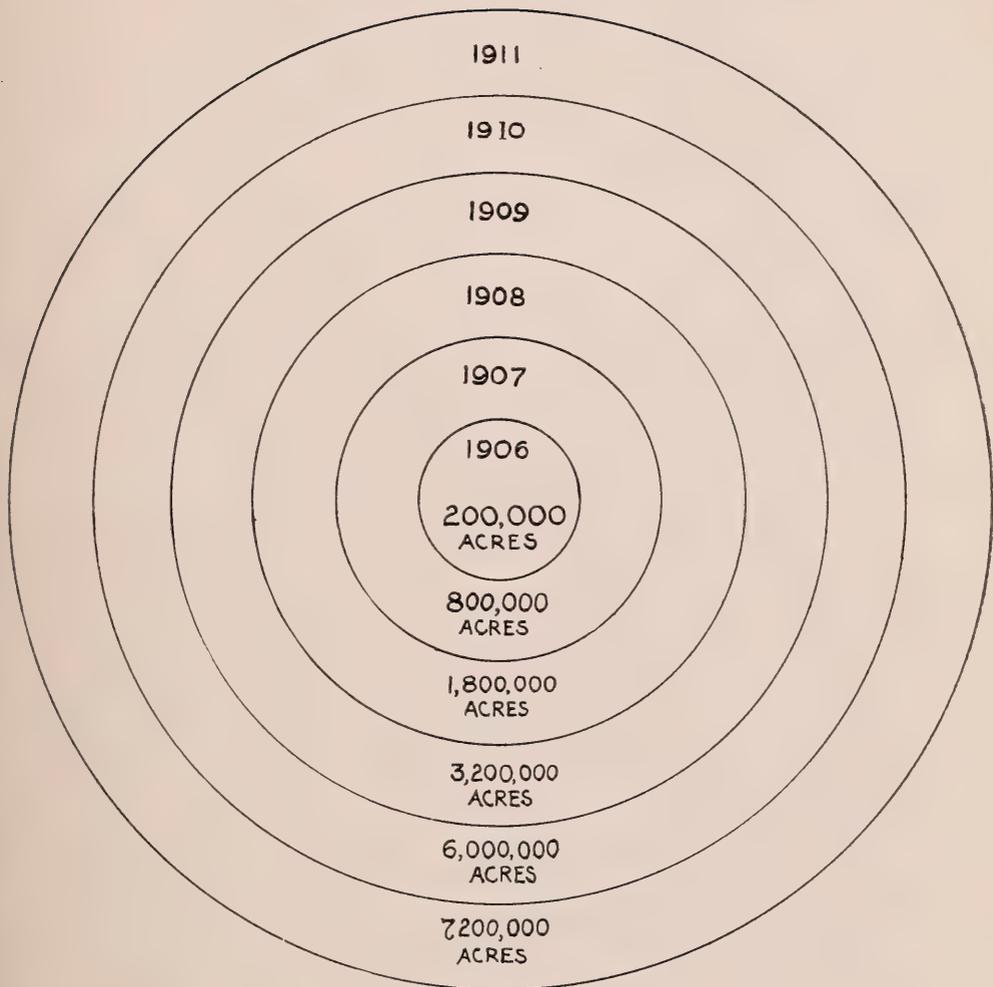


DIAGRAM I.—Illustrating the dispersion of an introduced insect for six years, at the rate of approximately ten miles per year.



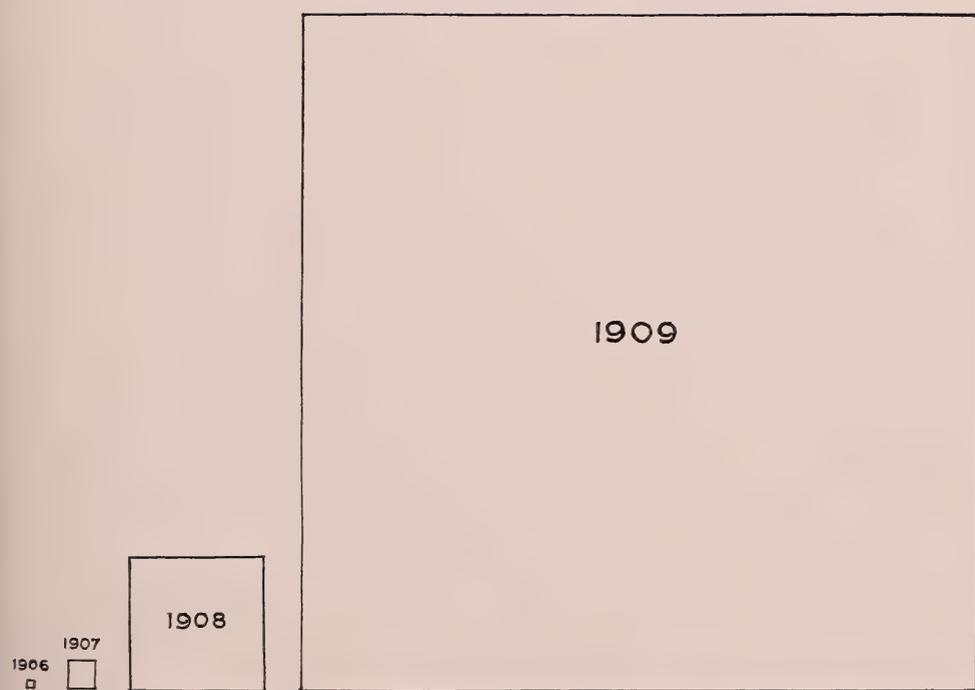
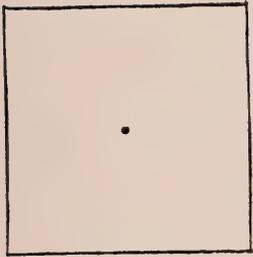
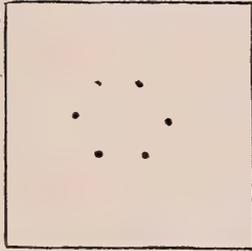


DIAGRAM II. — Illustrating the numerical increase of an introduced insect for four years, at the rate of twenty-five-fold each year.

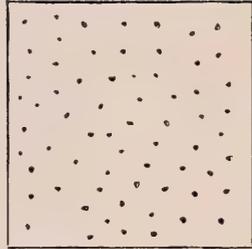




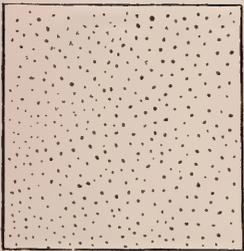
1906.
1 individual to 200
acres.



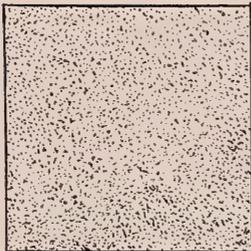
1907.
5 individuals to 200
acres.



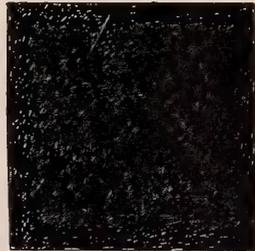
1908.
69 individuals to 200
acres.



1909.
976 individuals to 200
acres.



1910.
15,625 individuals to 200
acres.



1911.
270,156 individuals to 200
acres.

DIAGRAM III.—Illustrating the increase in average abundance of an introduced insect which disperses as indicated by Diagram I. and increases at the rate indicated by Diagram II.



Increase in the average abundance of the insect from year to year over the area included in its range would be comparatively slow at first, but would later become much more rapid, on account of the rate of increase being so much greater than that of dispersion. An attempt has been made to illustrate it in Diagram III., in which each square represents an area of 200 acres. The number of the insects (*Monodontomerus* in this instance) which are to be found within a territory of this extent is indicated by the black dots. It becomes impossible to crowd a sufficiently large number into the limited space available to indicate accurately the proportionate abundance which will result in 1910 and 1911, if the rate of increase continues without diminution.

The parasites are generally very inconspicuous, and when not common are difficult to find. *Monodontomerus*, as has been stated, is particularly easy to find, owing to its hibernating habits, and it is partly on this account that so much is known of its progress. The only methods which may be employed for the recovery of the most of them is the collection of a quantity of the caterpillars or pupæ of the gypsy moth, which are confined in the proper form of cage in the laboratory until the parasites issue from the affected individuals after destroying them. To collect all of the gypsy caterpillars or pupæ over a territory as large as 1 acre is out of the question when the insect is abundant. It is therefore impracticable to follow systematically the progress of an insect which would be so uncommon as to be represented by only a single individual in an area of this extent. It is small wonder that no trace of certain of the parasites which have been liberated has been found during the first few years following.

It was not until the summer of 1909, the fourth after its establishment, that *Monodontomerus* was first recovered as a parasite of the gypsy moth in the field; and if a parasite can increase at such a rate and remain unnoticed for three years, there is good foundation for hoping that other species may be doing as well.

The *Calosoma* beetles, which were also liberated for the first time in 1906, in time to attack the gypsy moth caterpillars that year, have ever since increased at a less rapid but at the same time a very satisfactory rate. Their rate of dispersion is also much less, and probably does not exceed a mile or two per year.

It will be several years before they will reach the abundance at present held by *Monodontomerus*.

These two insects, *Monodontomerus* and *Calosoma*,¹ were the only enemies of the gypsy moth which were liberated in 1906 in time to attack the gypsy caterpillars that year. A number of other parasites were given their freedom during the late summer or fall, after the caterpillar season was nearly or quite over, and the first opportunity which they had to attack the gypsy or the brown-tail caterpillars was in the year following. Of these parasites, one, *Compsilura*, has been recovered in the past summer in numbers in every way as large as could be expected, if its rate of dispersion is as rapid as that of *Monodontomerus*. A greater rapidity of dispersion and multiplication, sustained over a period of years, has not been expected of any of the introduced insects.

WHEN WILL THE PARASITES BECOME EFFECTIVE?

This question, which has been asked so frequently, has always been avoided, especially since it became apparent that the dispersion of the parasites was going on at an unexpectedly rapid rate, making their recovery difficult except in the immediate vicinity of the colony and immediately after colonization. It was obviously impossible, under such circumstances, to determine what their actual progress was; and the only results which were apparent to those in charge of the work were so technical in their nature as to be of little significance to any one not thoroughly familiar with entomology.

During the past few months considerable data have been accumulated, uniformly satisfactory in character, which bears upon the rate of dispersion or of multiplication of certain of the parasites. It is very insufficient, but if it is reliable, and if the progress of the first among the parasites and predators to be liberated may be taken as a criterion of what is to be expected of the others, it is possible to make a fair estimate of the length of time required for the parasites to become sufficiently abundant and so generally distributed as to bring about an effective natural control of the gypsy moth. The different species differ

¹ *Calosoma inquisitor*, another predaceous beetle, was also liberated in 1906, but in rather small and unsatisfactory numbers. It has not been recovered.

in so many particulars, however, as to make such an estimate at the present time largely speculative.

In Table 4 are listed all of the parasites of the gypsy moth which have been liberated in America under conditions in every way satisfactory. The dates when the first satisfactory colony of each was established will be found in the second column. When, as so frequently happened, the parasite was secured too late in the season to make its attack upon the caterpillars possible until another year, the circumstance is indicated in the third column. The fourth column indicates when the parasite was first recovered from the immediate vicinity, and the fifth when it was found to be generally distributed. On the supposition that the progress of the parasites later liberated will be comparable with that of the earlier, the dates when each of the species listed can be expected to become effective in their respective rôles of egg, caterpillar or pupa parasites, are indicated in the last column.

TABLE 4. — *Showing Date of Liberation and Subsequent Progress of the Parasites of the Gypsy Moth in Massachusetts.*

PARASITES.	First liberated under Satisfactory Conditions.	First Opportunity to reproduce as a Parasite or Enemy of the Gypsy Moth.	First recovered from Immediate Vicinity of Colony.	First recovered at a Distance from Colony Site.	Will probably become Effective.
<i>Theronia fulvescens</i> , ¹	-	-	-	-	-
<i>Monodontomerus aereus</i> ,	1906	1906	- ²	1909	1911
<i>Calosoma sycophanta</i> ,	1906	1906	1907	1909	1911
<i>Compsilura concinnata</i> ,	1906	1907	1907	1909	1912
<i>Tachina larvarum</i> ,	1906	1907	- ³	- ³	1912
<i>Tricholyga grandis</i> , ⁴	1906 ?	1907 ?	1909 ?	1909 ?	1912 ?
<i>Glyptapanteles fulvipes</i> ,	1908	1909	1909	-	1914
<i>Anastatus bifasciatus</i> ,	1909	1909	1909	-	- ?
<i>Schedius kuvanæ</i> ,	1909	1909	1909	-	1912
<i>Chalcis flavipes</i> ,	1909	1909	1909	-	1915
<i>Blepharipa scutellata</i> ,	1909	1910	-	-	1916
<i>Zygobothria gilva</i> ,	1909	1910	-	-	1916
<i>Carcelia gnava</i> ,	1909	1910	-	-	1916

¹ A native parasite, of slight relative importance.

² First recovered at a distance from colony.

³ Adults indistinguishable from a native species, which is rarely parasitic on the gypsy moth.

⁴ It is not known positively when *Tricholyga* was first liberated, owing to its very close resemblance, in appearance of adult, to *Tachina*. The recovery from the field in 1909 may have been the result of colonization in 1908, or equally well of that of earlier years.

Earlier in this paper an attempt was made to point out the necessity of establishing a sufficient number of parasites to form a natural sequence, which would attack each stage of the moth, from egg to pupa. Every parasite necessary to make an effective sequence is represented in the list given, but there are several, including at least one of considerable importance (*Blepharipa scutellata*), which may not become effective before 1916. Since the chain is no stronger than its weakest link, the sequence of parasites will not become fully effective until each necessary component of the sequence has reached the necessary abundance. It will be 1916 before the complete control of the gypsy moth in New England can reasonably be expected, and, unless the writer is mistaken, this control, when it is effected, will be general over all of the infested area.

THE WORK IN 1910.

The year 1910 will be crucial in one respect, since it will give ample opportunity to prove or disprove a number of the premises which have been used as a basis for the above calculation. It ought to be possible to follow the progress of several parasites very exactly, and their progress must be proportionate to the distance which they must travel if they are to become effective in their respective rôles by the time set. Should the actual developments of this season fall short of what is considered to be a necessary amount of progress, the disappointment of those in charge of the work will be very great.

It is hoped that *Monodontomerus* will increase at about the same rate which has prevailed in the past, but a slight falling off is rather expected. In like manner increase in the numbers of and in the territory covered by *Calosoma* ought to be commensurate with the progress of this species during the past year. *Compsilura* ought to be recovered with ease, and it should be possible to determine more accurately its rate of increase and of dispersion. *Tachina* ought to be recovered for the first time, and *Tricholyga* may or may not show decided increase, owing to the doubt which exists concerning its early history in America. It is hardly expected that *Glyptapanteles* will be found at all. If it were, the circumstance would be more encouraging than anything which has happened: first, because it would allay the

doubts which have been felt as to its ability to exist here; and second, because it would indicate an increase beyond what could be reasonably expected. The egg parasites, *Anastatus* and *Schedius*, and the Tachinid *Blepharipa*, must demonstrate their ability to survive the New England winters. It is hardly to be expected that *Carcelia*, *Zygobothria* and *Chalcis* will be recovered. Should any or all of them be found, it would be considered as particularly encouraging.

PARASITES OF THE BROWN-TAIL MOTH.

The brown-tail moth is generally and with justice considered to be the less injurious of the two imported pests, and largely on this account the major part of the space in this bulletin is devoted to the consideration of the gypsy moth and its parasites. It must not be concluded from this, however, that the parasites of the brown-tail moth have been treated with less consideration in the laboratory. They have received their full share of attention, and work upon them, which naturally begins in the winter, at a time when very little can be done on the parasites of the gypsy moth, is largely completed by the end of June, before the larger and more important importations of gypsy moth material are received.

The brown-tail is generally more common and more frequently injurious than the gypsy moth in Europe, and appears to be less completely controlled by its parasites. It is attacked by a greater variety, but more of the species are of distinctly minor importance.

There are at least six parasites native to America which attack the brown-tail moth as freely as the native *Theronia* attacks the gypsy moth. One of these, *Diglochis*, is apparently the same as the European *Diglochis omnivorus*. All but one of the remainder are very similar in habit to European species, as may be seen by reference to Table 5.

All of the European parasites known to be of importance abroad have been imported and liberated in some numbers; but in a few instances we have not been able to secure a sufficiently large number to establish strong colonies. Several of the European species, on account of their very close resemblance to American forms which attack the brown-tail in this country,

cannot be considered as of much promise; and two (*Trichogramma* and *Pteromalus*) have been given every opportunity to prove their worth, but have not responded at all satisfactorily.

There are, however, ten or twelve European parasites different from any known to attack the brown-tail in America, and which include several of great promise, which will be of material assistance in reducing the present prevailing abundance of their host, if they prove adaptable to American conditions.

In Table 5 are listed all of the known parasites of the brown-tail moth which play any considerable part in effecting its control. The names of the native American species are in black-faced type; those of European species which have been imported in satisfactory numbers and colonized under favorable conditions are in Roman type; while those of the European species which have not yet been received under satisfactory conditions are italicized.

Nearly all of the introduced species have been recovered from the field, but not all of them are known to be firmly established. Three of them, *Monodontomerus*, *Tachina* and *Compsilura*, are promising parasites of the gypsy moth also.

TABLE 5. — *Brown-tail Moth.* — *Sequence of Parasites.*

PARASITES.	Egg.	LARVAL STAGES.						PUPAL STAGES.			Adult.		
		FALL STAGES.			Winter Stages.	SPRING STAGES.			Pre-pupa.	Fresh.		Old.	
		First.	Second.	Third.		First.	Second.	Third.					Fourth.
<i>Trichogramma</i> sp.,												
<i>Trichogramma pretiosa</i>,												
<i>Telenomus phalænarum</i> ,												
<i>Apanteles viminetorum</i> ,												
<i>Meteorus versicolor</i> ,				Fall Generation								
<i>Zygodotria nidicola</i> ,												
<i>Pteromalus egregius</i> ,												
<i>Parexoriata chelonix</i> ,												
<i>Dexodes nigripes</i> ,												
<i>Compsilura concinnata</i> , ¹												
<i>Eupeletoria magnicornis</i> ,												
<i>Zenillia libatrix</i> ,												
<i>Pales pavidâ</i> ,												
<i>Tachina larvarum</i> ,												
<i>Anomalon exile</i>,												

¹ Attacks young caterpillars before hibernation, but larvæ apparently fail to mature.

A STUDY
OF THE
MASSACHUSETTS
WOOD-USING INDUSTRIES

BY HU MAXWELL, EXPERT

United States Forest Service

UNDER THE DIRECTION OF

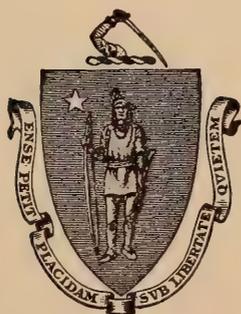
PROF. F. W. RANE

State Forester, Commonwealth of Massachusetts

AND

H. S. SACKETT

In Charge of Wood Utilization, United States Forest Service



BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
18 POST OFFICE SQUARE
1910

APPROVED BY
THE STATE BOARD OF PUBLICATION.

TABLE OF CONTENTS.

	Page
Introduction	5
Massachusetts Wood-manufacturing Industries	7
Kinds and Quantities of Woods used (Table 1)	8
Prices paid for Woods by Different Industries (Table 2)	10
Boxes and Crates	10
Furniture	12
Steam and Electric Cars	14
Musical Instruments	15
Interior Finish and Stair Work	16
Lasts and Fillers	18
Cooperage and Tanks	18
Shuttles, Spools and Bobbins	19
Ships and Boats	20
Refrigerators	21
Horse Vehicles	22
Garden and Farm Implements	23
Automobiles	24
Whips	25
Cabinets, and Store and Office Fixtures	26
Baskets	26
Toys	27
Handles	28
Brushes	28
Miscellaneous	29
List of Wood Manufacturers	30
Uses by Species	34

F
th
e
b
e
v
o
b
z
v
i
s
l
i
i
s
v
e

INTRODUCTION.

The Bureau of the Census, in co-operation with the United States Forest Service, compiles and publishes statistics annually, showing the output of sawmills by States and for the whole country. The cut in Massachusetts in 1908 was 384,526,000 feet B. M., reported by 610 sawmills. This did not include pulpwood, tanbark, tanning extracts, cross-ties, telegraph and telephone poles, or cooperage and veneer stocks.

After lumber leaves the sawmill it serves many purposes. Some of it passes through no further process of manufacture, but goes into buildings with only the cutting and fitting which carpenters give it. Another part is further manufactured before it is used. Wood-working machines of many kinds change its form, and it is cut, joined and fitted by skilled labor, becoming, partly or wholly, a finished product, — boxes, frames, doors, sash, vehicles, boats, shuttles, spools, lasts, baskets, musical instruments, furniture, handles, toys, brushes and many more. This study has to do with that part of lumber only which undergoes further process of manufacture after it leaves the sawmill.

Heretofore, lumber has not been very carefully followed after it leaves the saw, to ascertain what becomes of it, what is made of it, and into what commodities it enters. In a general way it has been known that some of it is used in its rough form, and some passes through further process of manufacture. The present study of the wood-manufacturing industries of Massachusetts was undertaken to supply information concerning the lumber which is not used in its rough form. The work has been done in co-operation by the United States Forest Service and the State of Massachusetts. Industries which manufacture commodities wholly or partly of wood were asked to furnish data along their special lines, and this report is based on their replies, supplemented by independent investigations throughout the State.

Statistics thus collected and published are expected to be useful to both growers and manufacturers of wood. It is shown what part

of the total demand, and of the demand for each species, is met by forests and woodlots in the State, and what part is supplied from without. The kinds of wood demanded by the various industries are shown, together with the amount of each species used, the prices paid at the factory, and into what product each wood is manufactured. With this information before them, the woodlot owners who are looking to the future can determine what kinds of timber promise best returns, and can give preference to those kinds. Those who have timber or lumber to sell can form an intelligent opinion as to where the best market may be found for what they have to offer. On the other hand, the manufacturer who is in the market for woods of certain kinds will have the means to determine whether he can buy near home, or whether he must look beyond the State; and a study of average prices paid by others will show whether or not he has been buying on an equal footing with others. A closer acquaintance between buyer and seller, with a better understanding of what one has to sell and what the other wishes to buy, will be of mutual benefit.

A history of lumber operations and of past uses and markets in the State was not undertaken, though it would have brought out many interesting facts. It was deemed sufficient if present conditions were shown, thereby making it possible to formulate an intelligent policy for future operations.

MASSACHUSETTS WOOD-MANUFACTURING INDUSTRIES.

Manufacturers in Massachusetts convert approximately 550,000,000 feet of rough lumber a year into finished products. The total quantity of wood used annually in the State is not shown by these figures, — certainly not half of it, — but only that portion of it which, after it leaves the sawmills, is further worked by machinery, or, at least, by the expenditure of considerable labor upon it. The mere cutting off of beams, planks and boards to fit them in house frames, bridges or trestles, or the mortising or joining in rough construction, does not constitute sufficient manufacture to bring the product within the scope of this study. Neither are railroad ties, poles, shingles and clapboards included. No attempt has been made to ascertain how much wood of all kinds and for all purposes is used in this State, nor to show what the market value is when the products take their final form. Finished commodities shipped into the State ready for use are not included in the tables and totals which follow. This distinction excludes a great deal of planed and matched flooring, siding and interior finish, which is fully manufactured before it is shipped into Massachusetts. The same consideration excludes much furniture and many wheeled vehicles which come into the State ready to assemble, or partly assembled. Though sold in Massachusetts, they are not manufactured here.

A painstaking effort has been made to keep species separate. They have not been grouped as "oak," "pine," "hardwoods," etc., but as white oak, red oak, yellow oak, white pine, longleaf pine, black gum, red gum, etc. The identification and listing of species was perhaps not successful in all cases; and in other instances, where use is confined almost exclusively to one species, though the genus includes others, a common term, as "ash" or "maple," was deemed sufficient. In Table 1, which follows, all the kinds of wood reported are brought together, except a few for which no figures showing the amount used yearly could be procured. All the species, together with the uses reported for each, will be found in the part of this report dealing with uses by species, beginning on page 34. Fifty-four woods are listed in the following table: —

TABLE 1. — *Kinds of Wood used, Quantity of Each, with Total Cost, and the Per Cent. grown in the State and out.*

SPECIES.	Feet used B. M.	Cost at Factory.	Grown in Massa- chusetts. (Per Cent.).	Grown outside of Massachu- setts (Per Cent.).
White pine	296,787,000	\$5,061,821	44	56
Spruce	45,772,400	882,491	17	83
Hemlock	31,557,000	547,151	17	83
Maple	30,252,300	578,837	11	89
Longleaf pine	27,368,500	776,391	-	100
White oak	24,287,700	936,492	12	88
Fir	14,999,100	277,511	10	90
Yellow poplar	14,806,400	656,765	10	90
Chestnut	11,753,000	163,781	34	66
Beech	9,873,000	193,436	18	82
Sweet birch	9,846,400	227,244	20	80
White birch	5,665,000	93,766	28	72
Basswood	4,166,500	106,487	3	97
North Carolina pine	4,115,000	162,410	-	100
Ash	3,440,300	140,114	11	89
Elm	2,698,500	107,493	1	99
Mahogany	2,025,400	298,253	-	100
Hickory	1,564,500	112,060	5	95
Cypress	1,252,000	65,860	-	100
Pitch pine	887,000	16,605	83	17
White cedar	795,500	15,477	11	89
Yellow birch	757,000	16,352	8	92
Black walnut	743,100	73,452	1	99
Douglas fir	655,000	26,723	-	100
Cherry	611,250	26,639	1	99
Western cedar	603,500	24,245	-	100
Black gum	475,000	22,032	-	100
Red oak	398,000	14,548	20	80
Redwood	356,100	13,610	-	100
Norway pine	250,000	5,000	-	100
Cottonwood	137,000	5,178	-	100
Sugar pine	68,600	4,392	-	100
Red gum	45,000	2,825	-	100
Dogwood	40,000	7,000	-	100
Persimmon	40,000	7,000	-	100
English walnut	35,000	4,200	-	100
Teak	33,000	7,196	-	100
Red cedar	27,000	1,655	-	100
Butternut	25,000	1,800	-	100
Sycamore	21,000	1,047	-	100
Holly	20,000	2,000	-	100
Circassian walnut	15,000	1,620	-	100
Applewood	13,800	166	100	-
Loblolly pine	8,000	192	-	100
Hazelwood	8,000	496	-	100
Yellow oak	8,000	320	100	-
African walnut	6,000	720	-	100
English oak	3,370	367	-	100
Spanish cedar	1,500	300	-	100
Italian walnut	1,212	242	-	100
Hackmatack	1,000	40	-	100
Prima vera	300	75	-	100
Rosewood	300	225	-	100
Ebony	112	28	-	100
Total	549,319,644	\$11,692,130 ¹	30	70

¹ The average price per M. for all the wood reported was \$21.29.

It is evident that Massachusetts is still a white pine State. It has always been that. The original forests contained some of the finest white pine ever cut in America; but the virgin stand was felled long ago, and the second, third and perhaps the fourth growths are now being drawn upon. How well the demand is met is indicated

by the fact that the present cut of this wood greatly exceeds the combined cut of all others in the State. Manufacturers last year used 133,276,000 feet of home-grown white pine, and only 33,172,923 feet of all the other State-grown species, — 4 to 1 in favor of white pine. Yet Massachusetts is not now producing half the pine demanded by home factories. Fifty-six per cent. of the total quantity comes from other States, some of it from as far west as Michigan. Large areas of vigorous young growth are coming on, and, with better protection from fire than formerly, there is promise of substantial gain.

The State grows only two woods in sufficient amounts to supply its manufacturers, and these are little-used species, — yellow oak and applewood. Pitch pine makes the next nearest approach to supplying the home market, and falls 17 per cent. short. But this is not an important wood; rated by quantity, it is twentieth on the list.

The amount of black walnut reported is disappointing, and of the small quantity used the State grows only 1 per cent., — less than 8,000 feet. It was once a popular wood for furniture, but available statistics indicate that Massachusetts now puts more of it into brush backs than into furniture. Its principal uses now are for musical instruments and gun stocks.

INDUSTRIES.

The articles made wholly or partly of wood are so many that a complete list is practically impossible, but a general division into industries is practicable. It becomes necessary, however, to decide somewhat arbitrarily at times as to the divisions in which certain commodities belong, and under what industry a certain manufacturer should be placed. For example, the distinction between "finish" and "fixtures" is clear enough at times, and at times not; and the dividing line between other industries is occasionally obscure. It is necessary, however, if figures are to be presented and useful comparisons made, that the division of the whole into separate parts must be insisted upon.

In the present study the wood manufacturers of Massachusetts have been listed under twenty heads, the twentieth being "miscellaneous," which includes everything not clearly belonging elsewhere. Care was exercised to make the divisions as distinct as possible, but doubts as to the proper listing of a commodity were not always cleared away. Table 2 names the industries, and likewise shows the average

price which each paid for wood at the factory, and the comparative quantity used by each. The amount of lumber used by all was 549,319,644 feet, and the average price was \$21.29 per thousand. If these figures are borne in mind, the table will show at a glance which industries paid more and which less than the average, and the comparative amount of lumber used by each will likewise be shown.

TABLE 2. — *Wood-using Industries, Average Prices paid for Lumber at the Factories, and the Per Cent. which each Industry used of the Total Quantity.*

INDUSTRIES.	Average Price paid for Lumber at the Factory per 1,000 Feet B. M.	Apportionment of the Total Quantity of Lumber among the Industries (Approximate Per Cent.).
Boxes and crates	\$16 02	64.00
Furniture	28 36	8.68
Steam and electric cars	27 80	5.40
Musical instruments	35 71	5.00
Interior finish and stair work	34 15	3.78
Lasts and fillers	16 99	2.39
Cooperage and tanks	14 06	1.33
Shuttles, spools and bobbins	18 83	1.02
Ships and boats	50 51	.72
Refrigerators	35 93	.59
Horse vehicles	58 85	.56
Garden and farm implements	25 02	.40
Automobiles	60 79	.34
Whips	21 38	.33
Cabinets, and store and office fixtures	67 92	.29
Baskets	14 47	.27
Toys	14 92	.17
Handles	17 94	.14
Brushes	27 07	.12
Miscellaneous	23 73	4.47

BOXES AND CRATES.

In quantity of wood used and in total cost, boxes and crates head the list. These items, and others, will be fully set forth in Table 3. It is worthy of remark that the State demands 351,941,350 feet of lumber for boxes. This is seven times as much as any other wood-

manufacturing industry requires, and almost twice as much as all the others combined. It is clear that the making of boxes and crates is preëminently the leading business in the State among those who manufacture wood. Box makers paid four times as much for their raw material — considering wood as raw material when it reaches the factory — as was paid by any other of the listed industries. The nearest approach was by the furniture makers, both in amount of lumber used and the cost. Twenty-three woods are on the list of box materials. The manufactured product ranged from the grossest crates, such as serve for shipping marble slabs or nursery stock, to the finest sample cases for commercial travelers, and receptacles for confectionery, toilet articles and jewelry. The cheapest wood reported, averaged for the whole, was cottonwood, at \$9 a thousand, cut in Massachusetts and received as logs at the factory. The most costly was mahogany, at \$251 per thousand, — a higher average price than was reported by any other industry in the State. Only one wood more costly was reported by any industry, — rosewood, at \$750 per thousand, for pianos. It is therefore apparent that box makers supply a wide range of customers and send their wares to many markets.

One-third of the manufacturers of wood in the State make boxes. It is a side line with many, who thus utilize what otherwise would be waste. Others, whose chief business is in other lines, perhaps not directly connected with wood, make boxes and crates for shipping their own products. Less than 38 per cent. of the reported box material is grown in the State. The largest importation is of white pine, spruce next. If no outside lumber were obtainable, boxes alone would consume 94 per cent. of the State's whole lumber cut.

Though some very fine and costly boxes are made, the bulk of them are of cheap lumber. It generally reaches the factory as wane-edge, unplaned boards, with bark on the edges, due to sawing small logs through and through without slabbing the four sides. Some factories saw, plane and match box boards, making shooks of them, and selling them to the users, who nail them up, but operate no wood-working machinery. Others do all the work, from the log — perhaps from the tree on the stump — to the finished box. In some instances a factory makes boxes for one purpose only, perhaps shoe boxes; while others manufacture many sizes, shapes and kinds.

TABLE 3. — Boxes and Crates.

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Ash	8,800	\$26 76	\$235 45	1,000	\$19 00	7,800	\$27 75
Applewood	13,800	12 00	165 60	13,800	12 00	-	-
Basswood	605,500	26 99	16,342 75	100,000	21 50	505,500	28 08
Sweet birch	27,800	53 00	1,473 40	-	-	27,800	53 00
Cherry	5,000	26 80	134 00	4,000	16 00	1,000	70 00
Chestnut	2,362,000	16 10	38,021 00	782,000	16 36	1,580,000	15 96
White cedar	700,000	18 50	12,950 00	-	-	700,000	18 50
Cottonwood	22,000	9 00	198 00	22,000	9 00	-	-
Elm	854,000	38 90	33,221 00	-	-	854,000	38 90
Fir	14,879,700	18 28	272,398 57	1,461,400	18 08	13,436,300	18 31
Hemlock	27,394,000	17 31	474,207 50	4,278,500	17 01	23,115,500	17 37
Maple	350,000	20 57	7,201 00	75,000	11 33	275,000	23 09
Mahogany	12,000	251 00	3,012 00	-	-	12,000	251 00
White oak	55,000	12 00	660 00	-	-	55,000	12 00
Red oak	56,000	40 00	2,240 00	-	-	56,000	40 00
White pine	263,443,700	16 85	4,439,163 95	121,855,600	15 90	141,588,100	17 66
Longleaf pine	1,591,000	15 31	24,365 00	-	-	1,591,000	15 31
Pitch pine	600,000	15 93	9,560 00	448,000	16 33	152,000	14 76
North Carolina pine	251,000	19 57	4,911 00	-	-	251,000	19 57
Yellow poplar	6,723,800	24 00	161,350 60	1,465,000	17 95	5,258,800	25 68
Spruce	31,972,000	17 57	561,775 25	2,677,700	17 42	29,294,300	17 58
Sycamore	10,000	25 00	250 00	-	-	10,000	25 00
Walnut	250	144 00	36 00	-	-	250	144 00
	351,941,350	\$16 02	\$5,637,872 12	133,273,000	\$16 01+	218,668,350	\$16 03

FURNITURE.

Furniture makers report the use of 23 woods, ranging in price from \$152.70, the average paid for their mahogany, to \$11.31 for hemlock. The average price for all, as shown in Table 4, was \$28.36. The State produced 20 per cent. of its furniture wood, and drew the balance from many parts of the world, the mahogany coming from Mexico, Central and South America, and different parts of Asia and Africa. The showing for mahogany is high not only for furniture, but in other industries. Massachusetts used about 5 per cent. of the mahogany imported into the United States in 1908, and paid approxi-

mately 14 per cent. of the total value of the imported wood. It appears from that fact that the grade bought by Massachusetts manufacturers was very much above the average.

Furniture makers paid for wood grown in the State an average price of \$20.64, and for that brought from without \$30.37. One-third of all was white oak, and Massachusetts supplied 11 per cent. of it, and 21 per cent. of the maple, 14 of the sweet birch, beech 16, chestnut 47. A large part of all the lumber used went to chair factories, but the exact ratio between that made into chairs and that used for other kinds of furniture can not be stated. The bulk of the chair wood was beech, sweet birch and maple.

TABLE 4. — Furniture.

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
White pine . . .	2,686,000	\$20 38+	\$54,735 00	1,840,000	\$18 30	846,000	\$24 89
White birch . . .	50,000	19 30	965 00	40,000	19 87	10,000	17 00
Maple	8,563,000	20 29	173,775 00	1,763,000	18 40	6,800,000	20 78
Ash	900,000	24 62	22,157 00	48,000	22 81	852,000	24 72
Sweet birch . . .	6,388,000	21 30	136,099 00	926,000	17 15	5,462,000	22 01
Spruce	555,000	16 38	9,094 00	195,000	15 42	360,000	16 63
Chestnut	4,849,000	24 51	118,846 00	2,284,500	24 56	2,564,500	24 46
White oak	16,722,500	34 59+	578,485 00	1,838,500	25 18	14,884,000	35 76
Yellow poplar . .	319,500	34 77+	11,110 00	-	-	319,500	34 77
Basswood	408,000	19 80	8,006 00	20,000	20 00	388,000	19 60
Beech	4,943,000	20 09	99,304 00	812,000	15 99	4,131,000	20 89
Mahogany	762,000	152 70	116,350 00	-	-	762,000	152 70
Black walnut . .	20,000	121 40	2,428 00	-	-	20,000	121 40
Hemlock	163,000	11 31	1,843 50	119,000	11 05	44,000	12 00
Black gum	61,000	43 47	2,652 00	-	-	61,000	43 47
Elm	348,000	31 49	10,906 00	-	-	348,000	31 49
Cherry	148,000	79 39	11,750 00	-	-	148,000	79 39
Sugar pine	100	100 00	10 00	-	-	100	100 00
Sycamore	1,200	78 33	94 00	-	-	1,200	78 33
Yellow birch . . .	250,000	24 00	6,000 00	-	-	250,000	24 00
African walnut . .	3,000	120 00	360 00	-	-	3,000	120 00
Hazelwood	2,000	80 00	160 00	-	-	2,000	80 00
Cypress	1,000	80 00	80 00	-	-	1,000	80 00
	48,143,300	\$28 36	\$1,365,209 50	9,886,000	\$20 64	38,257,300	\$30 37+

STEAM AND ELECTRIC CARS.

Table 5, presenting statistics of car manufacturing, shows that southern yellow pine greatly surpasses all other woods in quantity used and in value. The two species, the longleaf and the North Carolina, constitute 80 per cent. of the total and 78 per cent. of value. A distinction between longleaf and shortleaf pines is not always recognized after they are made into lumber. Manufacturers reported much more of the former than of the North Carolina species, but it is not improbable that a good deal of the latter appears in the lists as longleaf. Massachusetts grows less than 6 per cent. of its car timber, and four-fifths of this small amount is white oak. The cheapest timber reported by car builders was hemlock, averaging \$19, and only a small quantity was used. Mahogany was the most costly, and a comparatively large quantity was used. It is employed as finish for passenger coaches and electric cars. Sixteen species in all are listed, as the following table sets forth in detail:—

TABLE 5.—*Steam and Electric Cars.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUTSIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Ash	370,000	\$43 05	\$15,925 00	9,000	\$35 00	361,000	\$43 24
Basswood	29,000	30 00	870 00	9,000	30 00	20,000	30 00
Sweet birch	28,000	50 00	1,400 00	5,000	50 00	23,000	50 00
Maple	17,000	29 90	508 00	5,000	20 00	12,000	34 00
Mahogany	185,000	144 32	26,700 00	—	—	185,000	144 32
White oak	2,176,000	33 73	73,397 50	141,000	30 67	2,035,000	34 43
Longleaf pine	24,610,000	25 61	630,000 00	—	—	24,610,000	25 61
North Carolina pine	600,000	33 00	19,800 00	—	—	600,000	33 00
White pine	635,000	22 00	13,970 00	—	—	635,000	22 00
Spruce	230,000	20 00	4,600 00	—	—	230,000	20 00
Yellow poplar	517,000	60 00	31,020 00	—	—	517,000	60 00
Cherry	13,000	125 00	1,625 00	—	—	13,000	125 00
Chestnut	7,000	22 00	154 00	—	—	7,000	22 00
Hemlock	6,000	19 00	114 00	—	—	6,000	19 00
Norway pine	250,000	20 00	5,000 00	—	—	250,000	20 00
	29,673,000	\$27 80	\$825,083 50	169,000	\$30 91+	29,504,000	\$27 78

MUSICAL INSTRUMENTS.

The makers of musical instruments reported the use of 27 kinds of wood. The largest quantity went into pianos, but organs, including pipe organs, used the greatest number of woods. Twenty-two species grow in the United States, but only seven were supplied wholly or in part by Massachusetts, and they made less than 5 per cent. of the total. Seventy-four per cent. of all the black walnut reported by manufacturers in the State was used for musical instruments. None of the instrument walnut was State-grown. Yellow poplar is an important wood in this industry. Three woods were reported by makers of musical instruments and not reported by any others; they were red gum, prima vera and rosewood.

TABLE 6. — *Musical Instruments.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUTSIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Ash	91,000	\$43 27	\$3,938 00	10,000	\$11 00	81,000	\$47 26
Basswood	40,000	32 38	1,295 00	40,000	32 38	-	-
Beech	2,115,000	21 83	46,172 50	10,000	11 00	2,105,000	21 83
Sweet birch	1,904,000	23 52	44,801 50	10,500	12 62	1,894,000	23 53
Butternut	10,000	45 00	450 00	-	-	10,000	45 00
Cherry	1,000	52 50	52 50	-	-	1,000	52 50
Chestnut	3,838,000	24 23	93,012 00	300,000	23 33	3,538,000	24 31
Ebony	12	250 00	3 00	-	-	12	250 00
Elm	1,355,000	43 66	59,163 75	-	-	1,355,000	43 66
Fir	101,400	50 41	5,112 00	-	-	101,400	51 41
Black gum	320,000	44 13	14,120 00	-	-	320,000	44 13
Red gum	45,000	62 78	2,825 00	-	-	45,000	62 78
Hazelwood	6,000	56 00	336 00	-	-	6,000	56 00
Mahogany	663,900	138 45	91,917 00	-	-	663,900	138 45
Maple	4,101,800	28 33	116,201 10	248,000	24 64	3,853,800	28 57
White oak	926,500	78 20	72,453 00	-	-	926,500	78 20
White pine	3,935,000	27 86	109,775 00	694,500	30 26	3,240,500	27 39
North Carolina pine	602,500	35 10	21,150 00	-	-	602,500	35 10
Sugar pine	33,500	73 34	2,457 00	-	-	33,500	73 34
Yellow poplar	4,354,500	39 94	173,927 00	-	-	4,354,500	39 94

TABLE 6. — *Musical Instruments* — Concluded.

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Prima vera . . .	300	\$250 00	\$75 00	-	-	300	\$250 00
Redwood . . .	1,500	60 00	90 00	-	-	1,500	60 00
Rosewood . . .	300	750 00	225 00	-	-	300	750 00
Spruce . . .	2,367,700	24 45	57,885 60	-	-	2,367,700	24 45
Black walnut . . .	552,000	104 96	57,937 00	-	-	552,000	104 96
Circassian walnut . . .	12,000	100 00	1,200 00	-	-	12,000	100 00
Cottonwood . . .	85,000	48 00	4,080 00	-	-	85,000	48 00
	27,463,412	\$35 71+	\$980,657 95	1,313,000	\$26 48+	26,150,412	\$36 17+

INTERIOR FINISH AND STAIR WORK.

Stair building is sometimes considered distinct from interior finish, but in this study it was not practicable to present separate statistics. The combined industries stand fifth in the list, on the basis of amount of lumber used. They head the list in the number of species. Twenty-eight appear, only three of which are foreign, and one of them, Italian walnut, appears in no other industry. Massachusetts supplied 20 per cent. of the wood reported, and 78 per cent. of it was white pine. This species constitutes 38 per cent. of all the lumber manufactured into interior finish and stair work. Some of the woods were of high grade, as indicated by the average prices shown in Table 7. This applies particularly to beech, mahogany, black walnut, cherry, sycamore and black gum. However, the average price paid for all the woods employed in this industry was considerably less than averages paid by makers of boats, horse vehicles, automobiles, cabinets and store and office fixtures.

The total number of feet shown in the table is clearly not the total used in the State for finish and stair work, — certainly not one-tenth of it. The table shows that part only which was manufactured in Massachusetts. This study, as was explained on a preceding page, was not concerned with products fully manufactured before they reached the State. The largest item in that class is flooring, of which a single firm reported the sale of 200,000,000 feet, all of which was manufactured ready for use before it came into Massachusetts, and

of course could not be included in this study. In several other instances, and for similar reasons, large amounts of finish, frames, sash and doors were excluded from consideration, though used by Massachusetts builders.

TABLE 7. — Interior Finish and Stair Work.

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
White pine . . .	8,059,000	\$26 95	\$216,859 00	3,478,000	\$22 21	4,581,000	\$30 48
Yellow poplar . .	1,655,500	49 29	81,603 00	-	-	1,655,000	49 29
Sweet birch . . .	838,600	36 65	30,735 00	500,500	32 02	338,100	43 51
North Carolina pine	2,628,500	40 73	107,064 00	-	-	2,628,500	40 73
Longleaf pine . .	962,000	36 07	34,696 00	-	-	962,000	36 07
Redwood	1,000	62 00	62 00	-	-	1,000	62 00
Cypress	1,165,000	52 25	60,888 00	-	-	1,165,000	52 25
Spruce	2,654,000	22 62	60,037 00	-	-	2,654,000	22 62
Hemlock	1,036,000	18 64	19,311 00	60,000	13 50	976,000	18 95
Ash	456,000	56 54	25,783 00	-	-	456,000	56 54
Mahogany	56,350	160 05	9,019 00	-	-	56,350	160 05
Black walnut . . .	7,800	124 55	971 50	-	-	7,800	124 55
Redwood	1,000	80 00	80 00	-	-	1,000	80 00
Cherry	5,250	80 77	424 00	-	-	5,250	80 77
White oak	652,000	66 57	43,403 00	19,000	26 31	633,000	67 77
Sycamore	9,000	78 11	703 00	-	-	9,000	78 11
Maple	442,500	37 64	16,654 00	13,000	31 39	429,500	37 82
Black gum	4,000	65 00	260 00	-	-	4,000	65 00
Chestnut	338,000	21 94	7,416 00	310,000	20 13	28,000	42 00
White cedar	53,000	25 60	1,357 00	53,000	26 60	-	-
Basswood	501,000	33 21	16,637 00	-	-	510,000	33 21
Douglas fir	1,000	53 00	53 00	-	-	1,000	53 00
Sugar pine	35,000	55 00	1,925 00	-	-	35,000	55 00
English oak	1,370	210 00	287 70	-	-	1,370	210 00
Italian walnut . .	1,212	200 00	242 40	-	-	1,212	200 00
Beech	160,000	39 84	6,375 00	-	-	160,000	39 84
Red oak	1,000	30 00	30 00	1,000	30 00	-	-
White birch	75,000	19 00	1,425 00	-	-	75,000	19 00
	21,795,357	\$34 15	\$744,303 60	4,434,500	\$23 13	17,360,857	\$36 96+

LASTS AND FILLERS.

Table 8 presents statistics of the manufacture of lasts and fillers for the shoe trade. Fillers, which are also known as shoe forms or stretchers, are made of yellow poplar and basswood. The number is about 10 per cent. of the number of lasts. Only four woods were reported for this industry. Maple and beech supply the material for lasts, maple constituting 99 per cent. of the total. The most of it is cut in Michigan, with Pennsylvania as a second. The last industry stands sixth in the State for quantity of wood used, and it is worthy of note that the reports do not show that one foot of the wood was grown in Massachusetts. The manufactured product goes to every important country of the world where leather or rubber shoes are made. Lasts for rubber shoes and boots constitute a considerable trade, but they are not separately listed in the table. Only three lines of manufacture reported woods of lower average price than last makers use. These were toys, baskets and cooperage and tanks, statistics for which are shown respectively in Tables 9, 18 and 19. Last wood is selected with great care, is seasoned during two or more years, and is worked by machinery as true as skill can make it.

TABLE 8. — *Lasts and Fillers.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Maple	11,850,000	\$16 39	\$194,220 00	—	—	11,850,000	\$16 39
Basswood	982,000	23 51	23,085 00	—	—	892,000	23 51
Beech	40,000	11 50	460 00	—	—	40,000	11 50
Yellow poplar	160,000	22 50	3,600 00	—	—	160,000	22 50
	13,032,000	\$16 99	\$221,365 00	—	—	13,032,000	\$16 99

COOPERAGE AND TANKS.

Table 9 presents statistics of an industry which cannot be clearly defined, but its principal products are pails and buckets for confectionery and articles of that nature, tubs, keelers, churns, caddies, firkins, kits, tanks, vats and wooden receptacles of many kinds. No barrels or kegs for beer, molasses or spirituous liquors are included. The average price of the wood employed was lower than for any other

industry, being \$14.06 per thousand. White pine made 87 per cent. of it. Massachusetts furnished approximately 66 per cent. of all the wood reported. This was a percentage of home supply larger than for any other industry except toys (Table 19). Eleven species of wood were reported, and all are grown in Massachusetts except cypress, though the State seems to have supplied none of the white cedar. All the beech, white birch, chestnut, hemlock, maple and pitch pine were cut in the State, and 65 per cent. of the total amount used was home-grown. The average price of State-grown woods was higher than for those shipped in.

TABLE 9. — *Cooperage and Tanks.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Beech	40,000	\$8 00	\$320 00	40,000	\$8 00	-	-
White birch	40,000	8 00	320 00	40,000	8 00	-	-
White cedar	25,000	38 00	950 00	-	-	25,000	\$38 00
Chestnut	110,000	15 00	1,650 00	110,000	15 00	-	-
Cypress	50,000	52 50	2,625 00	-	-	50,000	52 50
Hemlock	50,000	10 00	500 00	50,000	10 00	-	-
Maple	40,000	8 50	340 00	40,000	8 50	-	-
White oak	90,000	18 33	1,650 00	40,000	18 75	50,000	18 00
Pitch pine	277,000	25 00	6,925 00	277,000	25 00	-	-
White pine	5,933,000	13 14	77,961 00	3,770,000	13 80	2,163,000	11 99
Spruce	160,000	16 00	2,560 00	100,000	10 00	60,000	26 00
	6,815,000	\$14 06	\$95,801 00	4,467,000	\$14 29	2,348,000	\$13 64

SHUTTLES, SPOOLS AND BOBBINS.

Statistics of the manufacture of shuttles, spools and bobbins were compiled with difficulty, because much of the material is partly or wholly manufactured outside the State, and is received in small pieces difficult to measure and reduce to feet. Table 10 presents available data, but the total amount of wood used in the State is probably more than the table shows. The highest-priced material was dogwood, used exclusively for shuttles, and worth \$175 per thousand feet, — which was above the average for mahogany. It reaches the factory in blocks of many sizes. Tennessee and Kentucky supplied the most of it.

White birch was the principal spool wood, and Maine was the chief source of supply, but Massachusetts grew one-tenth. Eleven per cent. of all the wood employed in this industry grew in the State, and its average cost per thousand was 72 per cent. of the cost of that shipped from without. In every reported instance the price paid for outside wood in this industry was above the price of that grown in Massachusetts.

TABLE 10. — *Shuttles, Spools and Bobbins.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Dogwood . . .	40,000	\$175 00	\$7,000 00	—	—	40,000	\$175 00
Basswood . . .	897,000	21 83	19,581 50	100,000	\$13 50	797,000	22 88
White birch . . .	2,080,000	16 41	34,142 50	220,000	14 77	1,860,000	16 61
Beech	928,000	16 48	15,298 00	100,000	13 50	828,000	16 84
Maple	1,157,000	16 28	18,827 50	100,000	13 50	1,057,000	16 53
Yellow poplar . . .	102,000	13 73	1,400 00	100,000	13 50	2,000	25 00
Yellow birch . . .	412,000	23 07	9,504 00	—	—	412,000	23 07
	5,616,000	\$18 83	\$105,753 50	620,000	\$13 95	4,996,000	\$19 44

SHIPS AND BOATS.

Twenty-one woods are used in boat building. White pine heads the list, with 28 per cent. of all. Longleaf pine furnished nearly as much. Only five species were supplied in part by Massachusetts, and the amounts were very small, the aggregate being less than 2 per cent. of the total. The State once supplied white pine masts for the largest ships. The whole quantity of this species obtained in the State by boat builders was only 5,800 feet in 1908, which was scarcely the equivalent of two or three first-class masts. Four foreign woods were reported, — Spanish cedar, mahogany, English oak and teak. They made finish for yachts, canoes and steamboats. Teak was the highest priced and basswood the cheapest of the timbers reported for this industry. The average price of all was \$50.51, which was exceeded by only three industries. Loblolly pine, an abundant southern timber, was reported for this industry only. A large number of boats are in use in Massachusetts, and the comparatively small quantity of lumber reported for boat building indicates that the State is not supplying

the home market, and that considerable numbers of boats ready made are shipped in. Available statistics do not, however, confirm or disprove this assumption.

TABLE 11. — *Ships and Boats.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Ash	35,000	\$75 00	\$2,625 00	-	-	35,000	\$75 00
Basswood	365,000	17 00	6,205 00	-	-	365,000	17 00
Butternut	15,500	87 10	1,350 00	-	-	15,500	87 10
Red cedar	27,000	61 30	1,655 00	-	-	27,000	61 30
Oregon cedar	3,500	70 00	245 00	-	-	3,500	70 00
White cedar	12,500	60 00	750 00	1,500	\$60 00	11,000	60 00
Spanish cedar	1,500	200 00	300 00	-	-	1,500	200 00
Cypress	24,500	68 16	1,670 00	-	-	24,500	68 16
Douglas fir	74,000	72 70	5,380 00	-	-	74,000	72 70
Elm	10,000	35 00	350 00	-	-	10,000	35 00
Maple	11,000	34 55	380 00	-	-	11,000	34 55
Mahogany	44,000	151 48	6,670 00	-	-	44,000	151 48
English oak	2,000	40 00	80 00	-	-	2,000	40 00
White oak	274,700	54 97	15,099 00	60,000	46 67	214,700	57 28
Red oak	5,000	90 00	450 00	-	-	5,000	90 00
White pine	1,106,300	78 94	87,330 00	5,800	72 41	1,100,500	78 97
Longleaf pine	1,071,500	36 82	39,453 25	-	-	1,071,500	36 82
Loblolly pine	8,000	24 00	192 00	-	-	8,000	24 00
North Carolina pine	15,000	35 00	525 00	-	-	15,000	35 00
Spruce	792,700	26 10	20,691 00	11,700	34 27	781,000	25 98
Teak	33,000	218 06	7,196 00	-	-	33,000	218 06
	3,931,700	\$50 51	\$198,596 25	81,000	\$46 80	3,850,700	\$50 59

REFRIGERATORS.

Massachusetts grows none of the timber which supplies its manufacturers of refrigerators. White pine exceeds in quantity all other woods combined in their construction. Yellow poplar furnishes the least, but its price is highest. Refrigerators are like furniture, in the fact that many sold in the State are made elsewhere. This does not apply to large sizes, constructed in place and not meant to be moved. The greater portion of the 3,240,000 feet of lumber reported is used for large refrigerators.

TABLE 12. — *Refrigerators.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Spruce	145,000	\$27 24	\$3,950 00	—	—	145,000	\$27 24
Ash	35,000	42 00	1,470 00	—	—	35,000	42 00
White oak . . .	255,000	40 86	10,420 00	—	—	255,000	40 86
White pine . . .	2,300,000	23 91	55,000 00	—	—	2,300,000	23 91
Sweet birch . . .	220,000	18 00	3,960 00	—	—	220,000	18 00
Yellow poplar . .	20,000	65 00	1,300 00	—	—	20,000	65 00
North Carolina pine	30,000	50 00	1,500 00	—	—	30,000	50 00
Red oak	30,000	60 00	1,800 00	—	—	30,000	60 00
Beech	155,000	18 00	2,790 00	—	—	155,000	18 00
Elm	50,000	38 00	1,900 00	—	—	50,000	38 00
	3,240,000	\$35 93	\$84,090 00	—	—	3,240,000	\$35 93

HORSE VEHICLES.

Vehicles to be drawn by horses and those operated by power are distinct so far as manufacturing is concerned. The number of wagons, carts, drays, carriages and conveyances of that kind is apparently as large as ever, notwithstanding the increase in number of automobiles. Table 13 shows what was done in Massachusetts the past year in the manufacture of vehicles for horses. The number of vehicles is not shown, but the woods used are listed. These woods are generally high in price, the average being \$58.85 per thousand. Massachusetts furnishes only 14 per cent. of this, and the average price is \$25.98 lower than for imported timber. Except red oak, every wood from without cost more than the same species grown at home. Red oak was the same for both. A number of firms which formerly did their own manufacturing reported that they no longer do so, but buy vehicles ready to sell, or nearly ready, and now act as selling agents or merchants. They generally buy in the middle west. Others buy wooden parts dressed and fitted, and complete the work by putting the irons on and doing the painting. In this industry, as in many others, the manufacturing shows a tendency to move toward the source of supply for the raw material. A considerable part of the wood listed in Table 13 was used in repair work.

TABLE 13.—*Horse Vehicles.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Ash	289,500	\$36 60	\$10,597 50	82,500	\$33 15	207,000	\$38 00
White oak	1,364,500	53 86	73,500 00	308,500	40 66	1,056,000	57 72
Hickory	969,500	79 96	77,525 00	6,500	64 61	963,000	80 07
White pine	60,000	31 66	1,900 00	60,000	31 66	—	—
Yellow poplar	74,000	86 08	6,370 00	6,000	70 00	68,000	87 50
Elm	25,000	16 00	400 00	25,000	16 00	—	—
North Carolina pine	8,000	40 00	320 00	—	—	8,000	40 00
Sweet birch	8,000	40 00	320 00	—	—	8,000	40 00
Maple	6,000	35 00	210 00	—	—	6,000	35 00
Spruce	10,000	48 00	480 00	—	—	10,000	48 00
Redwood	3,000	7 00	210 00	—	—	3,000	70 00
Mahogany	1,000	180 00	180 00	—	—	1,000	180 00
Yellow oak	8,000	40 00	320 00	8,000	40 00	—	—
Chestnut	3,000	40 00	120 00	3,000	40 00	—	—
Red oak	250,000	35 00	8,750 00	50,000	35 00	200,000	35 00
	3,079,500	\$58 85	\$181,202 50	549,500	\$37 50	2,530,000	\$63 48

GARDEN AND FARM IMPLEMENTS.

Of the thirteen woods listed in Table 14, nine were supplied wholly or in part by Massachusetts, but what the State furnished was only 27 per cent. of the total. The average price paid at home was only 70 per cent. of that paid for imported lumber. It is of interest to note that one of the cheapest woods listed in this industry was black walnut, and that the whole supply came from Massachusetts. The quantity was not large, however, and that fact probably accounts for the low price. A small lot of home-grown yellow poplar was bought for \$13 a thousand, which was about one-fourth the usual price. This suggests a complaint sometimes made by woodlot owners and farmers who have a few trees. They say it is not always easy to sell small lots of logs, — three or four trees, perhaps, — because purchasers do not care to buy that way; they want carload lots. The owner probably cannot cut that many, and so he must sell at a low price, or not at all. Cases have been reported of farmers burning

logs that would have made good lumber. Mill men would make no offer on lots so small, though the general demand in the State for logs is far greater than the supply.

TABLE 14. — *Garden and Farm Implements.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
White oak . . .	711,000	\$19 52	\$13,879 00	266,000	\$20 89	445,000	\$18 70
Maple	270,000	17 28	4,665 00	50,000	13 00	220,000	18 25
Black walnut . . .	8,000	16 50	132 00	8,000	16 50	—	—
Ash	145,000	24 11	3,495 50	57,000	24 18	88,000	24 06
Spruce	101,000	18 25	1,843 30	30,000	18 00	71,000	18 35
Chestnut	50,000	15 00	750 00	50,000	15 00	—	—
White pine	224,000	17 80	3,988 00	145,000	18 24	79,000	17 00
Hemlock	108,000	18 00	1,944 00	—	—	108,000	18 00
Yellow poplar . . .	4,600	39 56	182 00	2,000	13 00	2,600	60 00
Elm	2,500	13 00	32 50	2,500	13 00	—	—
Longleaf pine . . .	434,000	45 50	19,747 00	—	—	434,000	45 50
North Carolina pine	117,000	27 00	3,159 00	—	—	117,000	27 00
Black gum	70,000	33 75	2,362 50	—	—	70,000	33 75
	2,245,100	\$25 02	\$56,179 80	610,500	\$19 17	1,634,600	\$27 24

AUTOMOBILES.

Manufacturers of automobiles predict that the use of wood in their industry will not increase in proportion to the increased output of the factories. Aluminum is taking the place of yellow poplar, mahogany, walnut and other expensive woods in the construction of bodies. The industry is so new that figures are not available to show the rate at which wood is being replaced by metal. Frames, however, are of wood, and apparently will continue to be. Of the 1,894,000 feet used, 1,279,000 feet were hickory and ash, and went into frames. Massachusetts-grown timber constituted 2 per cent. of quantity and less than 1 per cent. of value. Nine American woods and two foreign were listed in this industry.

TABLE 15. — *Automobiles.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Yellow poplar	527,000	\$65 34+	\$34,435 00	-	-	527,000	\$65 34+
Ash	778,000	57 36+	44,630 00	3,000	\$90 00	775,000	57 24
Mahogany	21,500	144 54	3,107 50	-	-	21,500	144 54
Cherry	500	125 00	62 50	-	-	500	125 00
White pine	25,000	18 00	450 00	25,000	18 00	-	-
Spruce	24,000	28 50	684 00	10,000	18 00	14,000	36 00
Hickory	501,000	60 15	30,135 00	-	-	501,000	60 15
Basswood	2,000	15 00	30 00	-	-	2,000	15 00
Black walnut	10,000	110 00	1,100 00	-	-	10,000	110 00
Circassian walnut	3,000	140 00	420 00	-	-	3,000	140 00
Sweet birch	2,000	40 00	80 00	2,000	40 00	-	-
	1,894,000	\$60 79	\$115,134 00	40,000	\$24 50	1,854,000	\$61 57

WHIPS.

Four woods only are listed as whip material in Table 16. Massachusetts grew 58 per cent. of all, but the average price for its share was little more than half the average paid for woods grown in other States. The measurement in feet of wood used by whip factories is difficult, because it reaches the factory in various forms and sizes. Some of it, too, is so far manufactured when it arrives as to exclude it from the scope of this study. The table which follows presents the available statistics for 1908:—

TABLE 16. — *Whips.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Beech	521,000	\$19 33	\$10,070 00	251,000	\$13 42	270,000	\$24 81
Birch	555,000	21 06	11,690 00	351,000	16 44	204,000	30 00
Maple	733,000	22 13	16,225 00	458,000	17 41	275,000	30 00
Hickory	18,000	60 00	1,080 00	-	-	18,000	60 00
	1,827,000	\$21 38	\$39,065 00	1,060,000	\$16 15	767,000	28 62+

CABINETS, AND STORE AND OFFICE FIXTURES.

The manufacturers of cabinets and of fixtures for stores and offices paid a higher average price for their lumber than was paid by any other wood-using industry in the State. The cheapest reported for this industry was hemlock, and its average was \$25. The average for mahogany was \$149.05. Much high-grade white oak, basswood and maple were reported. The dividing line between cabinets and fixtures is frequently difficult to define, and no attempt to do so has been made here. Of the lumber used, the State grew 10 per cent., but it received little more than 5 per cent. of the total price. For three of the woods, however, the State-grown product commanded higher prices than the same species grown elsewhere. These woods were chestnut, white oak and yellow poplar.

TABLE 17. — *Cabinets, and Store and Office Fixtures.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Ash	22,000	\$50 00	\$1,100 00	-	-	22,000	\$50 00
Basswood	186,000	58 49	10,880 00	-	-	186,000	58 49
Sweet birch	64,000	27 81	1,780 00	-	-	64,000	27 81
Cherry	47,000	41 17	1,935 00	-	-	47,000	41 17
Chestnut	50,000	35 40	1,770 00	10,000	\$65 00	40,000	28 00
Cottonwood	30,000	30 00	900 00	-	-	30,000	30 00
Elm	27,000	32 78	885 00	-	-	27,000	32 78
Hemlock	3,000	25 00	75 00	-	-	3,000	25 00
Mahogany	262,000	149 05	39,050 00	-	-	262,000	149 05
Maple	20,000	47 50	950 00	5,000	20 00	15,000	56 67
White oak	379,000	80 18	30,390 00	3,000	95 00	376,000	80 06
White pine	260,000	34 22	8,896 00	138,000	32 78	122,000	35 84
Yellow poplar	131,000	53 24	6,975 00	6,000	75 00	125,000	52 20
Spruce	105,000	20 38	2,140 00	-	-	105,000	20 38
	1,586,000	\$67 92	\$107,726 00	162,000	\$37 25	1,424,000	\$71 41

BASKETS.

Next after the woods used for cooperage and tanks, presented in Table 9, basket makers paid the lowest average price for their lumber. Much of it came to them as logs, and they did all the manufacturing. In other cases it was partly manufactured when it reached them. In this industry the average price for home-grown material was lower than for the imported, but the State furnished less than one-fourth of the total.

TABLE 18. — *Baskets.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Ash	264,000	\$22 61+	\$5,971 00	138,000	\$21 67	126,000	\$23 66
Beech	310,000	10 32+	3,200 00	10,000	20 00	300,000	10 00
White birch	320,000	10 62+	3,400 00	20,000	20 00	300,000	10 00
Elm	25,000	17 00	425 00	25,000	17 00	-	-
Maple	379,000	10 52+	3,990 00	20,000	20 00	359,000	10 00
Red oak	40,000	23 89	955 00	13,333	23 89	26,667	23 89
White oak	130,000	24 61+	3,200 00	125,000	23 00	5,000	65 00
Rattan	-	-	-	-	-	-	-
Willow	-	-	-	-	-	-	-
	1,468,000	\$14 47	\$21,141 00	351,333	\$21 67	1,116,667	\$12 11

TOYS.

Massachusetts grows 77 per cent. of the wood worked in the toy factories of the State. A proportion so great of home-grown wood is not found in any other industry embraced in this study. The average price of the home-grown timber was 8 per cent. higher than for that grown elsewhere. Among the articles listed as toys are sleds, wagons, barrows, hobby horses, swings, games, menageries, villages, furniture, railroads and equipments, soldiers and small articles of many kinds.

TABLE 19. — *Toys.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUT-SIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Chestnut	158,000	\$13 14	\$2,076 00	158,000	\$13 14	-	-
Hemlock	190,000	13 00	2,470 00	-	-	190,000	\$13 00
Red oak	16,000	20 00	320 00	16,000	20 00	-	-
Cherry	2,000	30 00	60 00	-	-	2,000	30 00
Maple	6,000	13 50	81 00	6,000	13 50	-	-
White birch	256,000	14 97	3,831 00	256,000	14 97	-	-
Basswood	30,500	19 93	608 00	10,500	16 00	20,000	22 00
Yellow poplar	12,000	16 00	192 00	12,000	16 00	-	-
Beech	193,000	15 00	2,895 00	193,000	15 00	-	-
White oak	20,000	20 00	400 00	20,000	20 00	-	-
White pine	50,000	20 00	1,000 00	50,000	20 00	-	-
	933,500	\$14 92	\$13,933 00	721,500	\$15 19+	212,000	\$14 01

HANDLES.

The handles represented by Table 20 are chiefly for buckets, packages, boxes, knives, shovels, tools and articles which do not require tough woods. Ax and hammer handles are of another kind. They account for the 25,000 feet of hickory listed in the table. Massachusetts grew all the hickory, and its price was higher than that of any other wood. Cherry was supplied wholly by the State, but its price was lowest. As in the case of toys, the average price of State-grown wood was above that of the imported lumber.

TABLE 20. — *Handles.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUTSIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Ash	5,500	\$29 00	\$159 50	5,500	\$29 00	-	-
Beech	175,000	15 69	2,745 00	105,000	18 48	70,000	\$11 50
White birch	292,000	19 71	5,755 00	82,000	17 68	210,000	20 50
Cherry	40,000	13 63	545 00	40,000	13 63	-	-
Hickory	25,000	45 00	1,125 00	25,000	45 00	-	-
Maple	212,000	14 60	3,095 00	142,000	16 13	70,000	11 50
White oak	21,000	18 86	396 00	21,000	18 86	-	-
	770,500	\$17 94	\$13,820 50	420,500	\$18 80	350,000	\$16 90

BRUSHES.

The manufacture of brushes calls for a variety of woods, ranging in price from beech at \$10.53 per thousand feet to ebony at \$250. All the holly reported for the State was taken by the brush makers. It grew in North Carolina. It is worked into backs and handles for toilet brushes. The same use is made of rosewood, mahogany, black walnut and ebony. Cheaper woods serve as backs and handles of clothes brushes, blacking brushes, scrub brushes and others of similar kind. The purpose was to include under "Handles" (Table 20) all woods made into handles, as separate from the article as a whole; but it is probable that some of the woods listed under "Brushes" (Table 21) was made into handles for paint, varnish, whitewash and shaving brushes. The average price of home-grown woods was 30 per cent. under the average for outside material.

TABLE 21. — *Brushes.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUTSIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
White birch . . .	393,000	\$18 58	\$7,304 00	115,000	\$11 56	278,000	\$21 52
Ebony . . .	100	250 00	25 00	-	-	100	250 00
Yellow poplar . . .	5,000	48 00	240 00	-	-	5,000	48 00
Black walnut . . .	25,000	78 00	1,950 00	-	-	25,000	78 00
Maple . . .	80,000	12 87	1,030 00	60,000	10 50	20,000	20 00
Holly . . .	20,000	100 00	2,000 00	-	-	20,000	100 00
Rosewood . . .	10,000	150 00	1,500 00	-	-	10,000	150 00
Mahogany . . .	20,000	100 00	2,000 00	-	-	20,000	100 00
Beech . . .	55,000	10 53	580 00	55,000	10 53	-	-
Yellow birch . . .	40,000	11 00	440 00	40,000	11 00	10,000	75 00
Ash . . .	10,000	75 00	750 00	-	-	-	-
	658,100	\$27 07	\$17,819 00	270,000	\$11 28	388,110	\$38 07

MISCELLANEOUS.

Table 22 is made up of odds and ends which could not properly be listed under any of the special industries. The articles from which the table was compiled were usually small, but the aggregate reached nearly 25,000,000 feet, or more than 4 per cent. of all the wood reported by the manufacturers of the State.

TABLE 22. — *Miscellaneous.*

SPECIES.	Quantity used annually (Feet B.M.).	Average Cost at Factory per M (f. o. b.).	Total Cost at Factory (f. o. b.).	GROWN IN MASSACHUSETTS.		GROWN OUTSIDE MASSACHUSETTS.	
				Feet.	Average Cost per M (f. o. b.).	Feet.	Average Cost per M (f. o. b.).
Ash . . .	30,500	\$33 11	\$1,010 00	15,000	\$20 00	15,500	\$45 81
Basswood . . .	90,000	32 57	2,947 50	-	-	90,500	32 57
Beech . . .	238,000	13 56	3,228 00	238,000	13 56	-	-
White birch . . .	1,959,000	20 65	31,372 00	849,000	15 47	1,110,000	27 22
Sweet birch . . .	18,500	43 51	805 00	-	-	18,500	43 51
Yellow birch . . .	55,000	7 50	412 50	55,000	7 50	-	-
Western cedar . . .	600,000	40 00	24,000 00	-	-	600,000	40 00
White cedar . . .	30,000	14 00	420 00	30,000	14 00	-	-
Cherry . . .	1,200	42 50	51 00	1,000	25 00	200	130 00
Chestnut . . .	98,000	16 49	1,616 00	98,000	16 49	-	-
Cypress . . .	12,500	54 16	677 00	-	-	12,500	54 16
Douglas fir . . .	580,000	36 71	21,290 00	-	-	580,000	36 71
Elm . . .	7,000	30 00	210 00	-	-	7,000	30 00
Black gum . . .	100,000	50 00	5,000 00	-	-	100,000	50 00
Hemlock . . .	2,607,000	17 91	46,680 00	938,000	17 73	1,669,000	18 00
Hickory . . .	51,000	43 04	2,195 00	42,000	35 12	9,000	80 00
Mahogany . . .	1,650	150 00	247 50	-	-	1,650	150 00
Maple . . .	1,014,000	25 67	26,024 50	463,000	18 90	551,000	31 35
White oak . . .	510,500	55 90	28,538 00	110,000	12 95	400,500	67 70
White pine . . .	9,070,000	21 04	190,793 00	3,215,000	17 93	5,855,000	22 71
North Carolina pine . . .	131,000	32 83	4,301 00	-	-	131,000	32 83
Pitch pine . . .	10,000	12 00	120 00	10,000	12 00	-	-
Yellow poplar . . .	210,000	43 83	9,205 00	-	-	210,000	43 83
Redwood . . .	350,600	37 79	13,248 00	-	-	350,600	37 79
Spruce . . .	6,656,000	23 55	156,751 00	1,860,000	21 36	4,796,000	24 40
Walnut . . .	120,050	75 03	9,008 00	-	-	120,050	75 03
English walnut . . .	35,000	120 00	4,200 00	-	-	35,000	120 00
	24,587,000	\$23 73	\$583,450 00	7,933,000	\$18 29	16,663,000	\$26 31

WOOD MANUFACTURERS.

Below is a list of Massachusetts manufacturers who supplied data on which this report is based. The names are grouped by industries. If a name appears under more than one industry, it indicates that the firm manufactures more than one commodity. Occasionally, for example, a firm makes its own shipping boxes, though its principal business is in other lines, and it is listed under both industries.

AUTOMOBILES.

S. R. Bailey & Co. . . .	Boston
The Biddle & Smart Co. . .	Amesbury
Briggs Carriage Co. . . .	Amesbury
Currier Cameron Co. . . .	Amesbury
James N. Leitch & Co. . .	Amesbury
Quinsler & Co.	Boston
Sargent & Ham Co.	Boston
Chauncey, Thomas & Co. . .	Boston
Archibald Wheel Co.	Lawrence
Bartlett, Stevenson & Co. . .	Leominster
J. B. Judkins Co.	Merrimac
C. S. Pease & Sons	Merrimac
Knox Automobile Co.	Springfield

BASKETS.

M. E. Ballou & Sons	Becket
Bailie Basket Co.	Boston
D. S. Bridgman	Northampton
Williams Mfg. Co.	Northampton

BOATS.

The Atlantic Co.	Amesbury
D. D. Kelly & Son	Boston
George Lawley & Son	Boston
Rood Bros.	Fall River
Union Spar Co.	Gloucester
Stearns & McKay	Marblehead
H. Manley Crosby	Osterville
Fore River Shipbuilding Co.	Quincy
The Baker Yacht Basin	Quincy
E. H. Brown	Taunton

BOXES, CASES AND CRATES.

Blanchard & Gould	Acton
Acushnet Saw Mills Co.	Acushnet
Henry W. Cushman Co.	Acushnet
George W. Bryant	Amesbury
L. W. Love	Amesbury
N. E. Angus	Amherst
William O. Loveland	Ashby
The Diamond Match Co.	Athol
Smith & Rice Co.	Barre
George H. Allen	Beverly
A. W. Copp & Co.	Beverly
American Box & Lumber Co.	Boston
Dexter Box, Shook & Lum- ber Co.	Beverly

BOXES, CASES, AND CRATES — CON.

Frost Box Co.	Beverly
A. Ceppi & Co.	Boston
Conant Bros. Co.	Boston
A. H. Davenport Co.	Boston
F. C. & E. B. Gammons	Bridgewater
E. L. Bonney	Brockton
Mackie Bros. Co.	Brockton
F. L. Woodbridge,	Brockton
Doten Dunton Desk Co.	Cambridge
National Casket Co.	Cambridge
George G. Page Box Co.	Cambridge
A. B. Holden	Caryville
Frank B. Ford	Charlemont
Putnam Bros.	Charlton
Atwood & McManus	Chelsea
Parsons Mfg. Co.	Chelsea
Belcher & Taylor Agr. Tool Co.	Chicopee Falls
J. Stevens Arms & Tool Co.	Chicopee Falls
F. W. Purrington	Colrain
Cadwell & Glazier	Cooleyville
Flansburgh & Hardiman	Dalton
Crane & Co.	Dalton
F. J. Derry	Danvers
Woodman Bros. & Ross	Danvers
National Casket Co.	E. Cambridge
Joseph Lunan & Sons	Fall River
Isaac Varney & Sons	Fall River
Lynde Bros. Box Co.	Farley
Webber Lumber Co.	Fitchburg
Charles W. Welder	Fitchburg
E. S. Cook	Franklin
O. F. Metcalf & Sons	Franklin
F. E. & H. E. Chase	Freetown
Collier Keyworth Co.	Gardner
Perkins Box Co.	Gloucester
George A. Stevens	Gt. Barrington
New England Box Co.	Greenfield
Charles R. Field Mfg. Co.	Greenfield
Robert Darhurst	Halifax
E. H. Vaughan	Halifax
W. S. Simmons	Hanover
John Foster Co.	Hanson
O. S. Currier & Son	Haverhill
Haverhill Box Co.	Haverhill
C. H. Hayes Corpn.	Haverhill
Hazen L. Foss	Haverhill
Island Park Box Co.	Haverhill

BOXES, CASES, AND CRATES — CON.

Doane & Williams	Holyoke
Green Mountain Lumber Co.	Holyoke
Holyoke Box & Lumber Co.	Holyoke
C. J. Sawyer	Hudson
N. G. Tripp	Hudson
A. F. Purce	Huntington
H. E. Stanton	Huntington
Williams & Bridges Co.	Hopkinton
Ipswich Mills	Ipswich
Hook & Hastings Co.	Kendal Green
George W. Dinsmoor	Lawrence
Weld Bobbin & Spool Co.	Lawrence
Whitney Reed Chair Co.	Leominster
Beaman, Marvell & Co.	Leverett
Richardson Piano Case Co.	Leominster
Otis Allen & Sons Co.	Lowell
A. L. Brooks & Co.	Lowell
George L. Cady & Sons	Lowell
Frank G. Cummings	Lowell
T. W. De Long & Co.	Lowell
James A. Thompson	Lowell
Crossman Box Co.	Lynn
Littlefield & Plummer Corp'n.	Lynn
John Owens & Co.	Lynn
A. G. Potter	Lynn
Samuel E. Vaughan	Malden
Geo. L. Metcalf Wood & Paper Box Co.	Marblehead
Howe Lumber Co.	Marlborough
H. H. Oakman	Marshfield
Bolles Bros.	Mattapoisett
T. C. Tinkham	Mattapoisett
Edwin V. Mitchell Co.	Medfield
M. A. Ritchie	Medfield
Medway Box Co.	Medway
A. T. Savery	Middleborough
S. A. Eastman Co.	Milford
C. J. Billings & Sons	Montague
L. P. Churchill Co.	Myricks
Natick Box Co.	Natick
D. S. Bridgman	Northampton
Henry W. Warner	Northampton
T. M. Cole	No. Carver
William P. Proctor Co.	No. Chelmsford
L. S. Crafte	No. Hatfield
Bullard & Sons	No. New Salem
Gilbert H. West	No. Pembroke
A. H. Sweet & Son	Norton
W. D. Turner	Norwell
The New Home Sewing Machine Co.	Orange
Chaffee Bros. Co.	Oxford
Lemuel Lefurgey	Pembroke
North Dana Box Co.	Prescott
Paper, Lumber & Box Co.	Princeton
Myron F. Chickering	Raynham
Otis P. Symonds & Sons	Reading
Judah Hathaway	Rochester
Alden Rounseville	Rochester
C. N. Atwood & Son	Rock
Gideon Studley	Rockland
Amos C. Maynard	Savoy

BOXES, CASES, AND CRATES — CON.

Sharon Box Factory	Sharon
G. M. Ballou	Shirley
The Horton & Hubbard Mfg. Co.	Somerville
Charles Hyde	Southbridge
United States Spring Bed Co.	Springfield
F. M. West Box Co.	Springfield
Charles R. Richmond	Taunton
Conrad H. Gale	Tully
A. A. Flint	Tyngsborough
Heywood Bros. & Wakefield Co.	Wakefield
E. L. Needham	Wales
Ware Lumber Co.	Ware
G. M. Wheeler & Co.	Warwick
Cochituate Box Co.	Wayland
J. D. Putnam Son Co.	Webster
Blanchard & Gould	W. Acton
Bartlett Box & Lumber Co.	Westborough
H. E. Lowe	W. Boylston
S. A. Healy & Sons	W. Chesterfield
W. J. McCarthy	Westfield
Edwin B. Hedges	Westfield
New England Whip Co.	Westfield
Lot Phillips Co.	W. Hanover
J. C. Goodridge	Westminster
Upton Mfg. Co.	W. Acton
Reuben Loud & Sons	Weymouth
Atwood Bros.	Whitman
G. M. Bradford	Williamsburg
Williams & Bridges Co.	Worcester
Baker Box Co.	Worcester
W. D. Smith	Wrentham

BRUSHES.

A. V. Stevens	Cummington
Charles H. Ball	E. Windsor
Florence Mfg. Co.	Florence
Willis H. Bean	Lowell
Samuel E. Jordan Brush Co.	Malden
Florence Mfg. Co.	Northampton

BUILDERS' FINISH.

Clinton W. Schwamb & Co.	Arlington
N. Sarsfield	Ashburnham
H. M. Peckham	Athol
Arthur F. Tyler Co.	Athol
Smith & Rice Co.	Barre
Dexter Box, Shook & Lumber Co.	Beverly
John R. Atkins	Boston
Boston Floor Co.	Boston
George H. Carter	Boston
A. Ceppi & Co.	Boston
Louis Cohen & Co.	Boston
Charles A. Freeman Mfg. Co.	Boston
Graham & Cameron	Boston
Irving & Casson	Boston
A. E. Jones & Co.	Boston
P. W. Merrill Co.	Boston
Perkins Woodworking Co.	Boston
Dean-Penney Company	Brockton

BUILDERS' FINISH—Con.

Hayward Screen Mfg. Co.	Brockton
Henderson Bros.	Cambridge
John Quinn & Son.	Cambridge
W. M. Pratt	Charlemont
E. R. Marshall	Chelmsford
Webber Lumber Co.	Fitchburg
K. L. Haskins	Greenfield
N. S. Cole & Sons	Haverhill
Messenger Wood Works	Haverhill
F. P. Stanton	Huntington
Doane & Williams	Holyoke
Robertson & Larkin	Hudson
S. F. Canney	Ipswich
William H. Bean	Lowell
J. B. Goodwin	Lowell
W. E. Hatch	Lowell
W. C. Miles & Co.	Medford
C. W. Maxim	Middleborough
A. W. Allen Co.	New Bedford
Greene & Wood	New Bedford
Tripp & Thorpe	New Bedford
L. R. Washburn & Son	New Bedford
Edward Perkins Lumber Co.	Newburyport
John E. Fales	Norfolk
S. B. Dibble Lumber Co.	No. Adams
William P. Proctor Co.	No. Chelmsford
Patten & Bond	Palmer
E. J. Faxon	Salem
Milton P. Locke & Son	Salem
J. A. Richmond & Sons	Shelburne Falls
George N. Gates	Shrewsbury
Springfield Lumber Co.	Springfield
The Ide Lumber Co.	Southbridge
J. K. & B. Sears & Co.	So. Hyannis
Lawrence M. Yale	Stockbridge
P. H. Pickens	Taunton
P. Jacobus	Turners Falls
Bartlett Box & Lumber Co.	Westborough
J. W. Bishop Co.	Worcester
Henry Brannon	Worcester
L. C. Clark Co.	Worcester
Flexible Door & Shutter Co.	Worcester
Hatch & Barnes	Worcester
J. W. Loring & Son	Worcester

CABINETS AND STORE AND OFFICE FIXTURES.

C. H. Bangs Druggist Fix- ture Co.	Boston
Eastern Showcase Co.	Boston
Charles P. Whittle Mfg. Co.	Boston
Doten Dunton Desk Co.	Cambridge
Library Bureau	Cambridge
A. W. Allen Co.	New Bedford
L. R. Washburn	New Bedford
E. W. Coffin	Worcester
J. W. Loring & Son	Worcester

COOPERAGE AND TANKS.

L. E. Flint	Ashby
New England Tank and Tower Co.	Boston
A. Bachelder & Co.	Lowell
T. M. Cole	No. Carver
S. W. Farrar & Son	Royalston

COOPERAGE AND TANKS—Con.

George A. Thayer	Spruce Corner
Charles R. Richmond	Taunton
B. & A. D. Fessenden Co.	Townsend
George P. Morse	W. Wareham
Wm. Brown & Son	Winchendon
M. H. Parks Co.	Winchendon

FURNITURE.

William O. Loveland	Ashby
Albert M. Wilder	Ashby
L. Morse & Sons	Athol
Smith, Day & Co.	Baldwinville
Waite Chair Co.	Baldwinville
Smith & Rice Co.	Barre
Oliver L. Briggs	Boston
J. E. Came Co.	Boston
A. H. Davenport Co.	Boston
Paine Furniture Co.	Boston
Irving & Casson	Boston
Shales & May	Boston
Allen Chair Co.	Concord Junction
Cadwell & Glazier	Cooleyville
T. T. Greenwood	E. Templeton
George W. Travers Co.	E. Templeton
Washburn & Haywood Chair Co.	Erving
Haywood Bros. & Wakefield Co.	Gardner
S. Bent & Bro.	Gardner
Brown Bros. Co.	Gardner
Collier Keyworth Co.	Gardner
Conant Ball & Co.	Gardner
P. Derby & Co.	Gardner
J. A. Dickerman	Gardner
Greenwood Bros. & Co.	Gardner
Kelly Bros.	Gardner
E. H. Mahoney Chair Co.	Gardner
Nichols & Stone Co.	Gardner
S. K. Pierce & Son	Gardner
L. B. Ramsdell Co.	Gardner
Charles R. Field Mfg. Co.	Greenfield
Merriam Hall & Co.	Leominster
Whitney Reed Chair Co.	Leominster
French & Heald Co.	Milford
H. E. Cummens	No. Brookfield
J. N. Crowe & Co.	Salem
Brown & Simonds Co.	Somerville
Derby Desk Co.	Somerville
Alfred H. Whitney	So. Ashburnham
W. B. Pierce	So. Ashburnham
United States Spring Bed Co.	Springfield
Heywood Bros. & Wakefield	Wakefield
E. J. Crandall	W. Hawley
Mather & Pierce Co.	Westminster
Kennedy Bros. & Watkins	Weston
C. Dodge Furniture Co.	Winchester
Carter & Campbell	Winchendon
Vocalion Organ Co.	Worcester

GARDEN AND FARM IMPLEMENTS.

Belcher & Taylor Agr. Tool Co.	Chicopee Falls
Samuel H. Houghton	Harvard
L. S. Crafte	No. Hatfield

GARDEN AND FARM IMPLEMENTS — Con.

H. J. Carnes & Co. . . . Ludlow
 Ames Plow Co. . . . Worcester
 Richardson Mfg. Co. . . . Worcester
 Zoar Mills Co. . . . Zoar

HANDLES.

H. G. Reed Conway
 The Mossman Wood Turning
 Co. Fitchburg
 Bolles Bros. Mattapoisett
 J. H. Russell Melrose
 S. A. Healy & Son No. Chesterfield
 Paul Wheeler Rutland
 Amos E. Maynard Savoy
 George A. Thayer Spruce Corner
 F. T. Crosby Williamsburg
 C. A. Brooke Winchendon

HORSE VEHICLES.

S. R. Bailey & Co. . . . Amesbury
 Wm. O. Loveland Ashby
 E. A. Gillett & Sons Boston
 Henderson Bros. Cambridge
 W. L. Payne Charlemont
 Archibald Wheel Co. . . . Lawrence
 E. Teel & Co. Medford
 George L. Brownell estate New Bedford
 William E. Mann Norfolk
 Pike & Whipple Co. . . . Peabody
 G. N. Sampson Plymouth
 A. M. Eames & Co. . . . So. Framingham
 Smith & Hubbell Springfield
 Brownell & Burt Taunton
 John J. Grothe Woburn
 Henry Jerome Worcester

LASTS AND FILLERS.

F. W. Stuart & Co. . . . Beverly
 Boston Last Co. . . . Boston
 Brockton Last Co. . . . Brockton
 Mawhinney Last Co. . . . Brockton
 Woodward & Wright Brockton
 Goodwin Bros. Lynn
 Thomes W. Gardiner Lynn
 George P. Cox Last Co. . . . Malden
 Middlesex Last Co. . . . Malden
 Marlborough Last Co. . . . Marlborough
 George E. Belcher Last Co. . . . Stoughton
 Golbert Last Co. . . . Worcester
 S. Porter & Co. . . . Worcester

MISCELLANEOUS.

Wm. O. Loveland Ashby
 The Diamond Match Co. . . . Athol
 The Atlantic Works Boston
 Boston & Lockport Block Co. . . . Boston
 Oliver L. Briggs & Sons Boston
 Josiah Cunningham & Sons Boston
 New England Trunk Co. . . . Boston
 J. Rush Green Boston

MISCELLANEOUS — Con.

Sanitas Mfg. Co. . . . Boston
 Hayward Screen Mfg. Co. . . . Brockton
 F. L. Woodbridge Brockton
 National Casket Co. . . . Cambridge
 Standard Turning Works Cambridgeport
 Horatio Bisbee Chesterfield
 C. S. Damon Chesterfield
 A. G. Spalding & Bros. . . . Chicopee
 J. Stevens Arms & Tool Co. . . . Chicopee Falls
 W. A. Fuller Clinton
 E. F. Hodgson Dover
 F. J. Smith & Co. . . . Fitchburg
 Webber Lumber Co. . . . Fitchburg
 Florence Furniture Co. . . . Florence
 George C. Tarr Gloucester
 Samuel H. Houghton Harvard
 H. F. Purce Huntington
 S. F. Canney Ipswich
 William K. Aldrich Co. . . . Lowell
 Willis H. Bean Lowell
 H. Carver & Co. . . . Ludlow
 M. E. Killam Lynn
 J. H. Russell Melrose
 Norwood Engineering Co. . . . Northampton
 John D. Ondréss Otis
 G. N. Sampson Plymouth
 J. N. Crowe & Co. . . . Salem
 The Horton & Hubbard Mfg.
 Co. Somerville
 C. W. H. Moulton Co. . . . Somerville
 Charles Hyde Southbridge
 S. N. Farrar & Son So. Royalston
 E. A. Jordan W. Cummington
 E. J. Crandall W. Hawley
 F. T. Crosby Williamsburg
 J. W. Loring & Son Worcester
 William C. Sampson Worthingto
 C. W. Bryant Zoar

MUSICAL INSTRUMENTS.

The Theo. Schwamb Co. . . . Arlington
 A. M. McPhail Piano Co. . . . Boston
 Briggs Piano Co. . . . Boston
 Everett Piano Co. . . . Boston
 Hallett & Davis Piano Co. . . . Boston
 Mason & Hamlin Co. . . . Boston
 Merrill Piano Mfg. Co. . . . Boston
 Vose & Sons Piano Co. . . . Boston
 Ivers & Pond Piano Co. . . . Cambridge
 Seaverns Piano Action Co. . . . Cambridge
 Standard Action Co. . . . Cambridge
 Ernest M. Skinner Co. . . . Dorchester
 Edmund Cole Piano Co. . . . Fall River
 Trowbridge Piano Co. . . . Franklin
 J. H. Locky Piano Case Co. . . . Leominster
 F. G. Smith Leominster
 Wellington Piano Case Co. . . . Leominster
 A. Merriam Co. . . . So. Acton
 J. W. Stine & Son Organ Co. . . . Springfield
 E. W. Lane Waltham
 Beckwith Bros. & Co. . . . Westfield
 Emmons Howard Westfield
 Hook & Hastings Weston

MUSICAL INSTRUMENTS — Con.

Simplex Piano Player Co.	Worcester
A. Stevens & Sons	Worthington

RAILWAY AND STREET CARS.

The Laconia Car Co. Works	Laconia
Keith Car & Mfg. Co.	Sagamore
Osgood Bradley & Sons	Worcester

REFRIGERATORS.

D. Eddy & Sons Co.	Boston
A. D. Hall & Son	Boston
A. E. James Co.	Boston
O. M. Whitman & Co.	Boston
F. A. Atherton	Worcester

SHUTTLES, SPOOLS, BOBBINS, ETC.

Frary Mfg. Co.	Charlemont
Chester Mfg. Co.	Chester
Dana S. Courtney	Chicopee
W. L. Parker	Lowell
Union Shuttle Co.	Lawrence
Weld Bobbin & Spool Co.	Lawrence
The Hall Bobbin Co.	No. Adams

SHUTTLES, SPOOLS, BOBBINS, ETC. — Con.

M. H. Parks Co.	Winchendon
Winchendon Spool & Bobbin Co.	Winchendon

Toys.

Frary Mfg. Co.	Charlemont
Noble & Cooley branch of Hardware and Woodenware Mfg. Co.	Granville
American Toy Mfg. Co.	Salem
Mason & Parker	Winchendon

WHIPS.

Horatio Bisbee	Chesterfield
A. F. Purce	Huntington
H. E. Stanton	Huntington
W. J. McCarthy	Westfield
New England Whip Co.	Westfield
W. C. Sampson	Worthington
United States Whip Co. (American Whip Co. branch)	Westfield
H. M. VanDeusen Whip Co.	Westfield

USES BY SPECIES.

The manufacturers in Massachusetts report the use of 54 different woods. The principal purposes for which each is employed are shown in the list which follows: —

AFRICAN WALNUT.

Furniture
Interior finish

ASH.

Automobile bodies
Baby carriages
Balusters
Banjos
Baskets
Boat frames
Brush backs
Cabinet work
Car finish
Car frames
Carriage bodies
Castors
Dowels
Drums
Furniture
Go-carts
Gymnasium goods
Harps
Hobby horses
Measure rims
Molding
Newel posts
Piano cases

ASH — Con.

Picker sticks
Pipe organs
Pung frames
Rakes
Refrigerators
Sieves
Shipbuilding
Shovel handles
Showcase frames
Sleds
Sleighs
Snow plows
Snow shovels
Stair rails
Tambourines
Tennis rackets
Wagon gears
Wheel rims
Woolen mill cabinets

APPLEWOOD.

Boat knees
Box handles
Engraving blocks
Wooden type
Yacht ribs

BALSAM FIR.

Boxes
Clothboards
Crates
Frames
Shoe cases

BAMBOO.

Reaper whip handles

BASSWOOD.

Baby carriages.
Barrel heading
Boat templets
Bobbins
Boxes for confectionery
Car roofing
Crates
Cupboards
Drug store fixtures
Drums
Fillers
Hollow lasts
Kitchen tables
Medicine cabinets
Molding
Penholders
Picture frames

BASSWOOD — Con.

Piano skeletons
 Pipe organs
 Pyrography wood
 Reed ribs (in cloth mills)
 Shirt-waist boxes
 Shoe frames
 Showcase tables
 Skewers
 Spirit levels
 Spools
 Toys
 Trunks

BEECH.

Balls
 Baskets
 Bobbins
 Brush backs
 Bucket handles
 Children's cradles
 Cores for veneering
 Crochet hooks
 Furniture
 Interior finish
 Lasts
 Novelties
 Piano posts
 Plane stocks
 Rolling hoops
 Round boxes
 Skewers
 Slack cooperage
 Soap sticks
 Spools
 Swings
 Tool handles
 Toys
 Turned wood
 Whip stocks
 Valve handles

BIRCH (SWEET).

Banjos
 Billiard tables and fixtures
 Boring machine frames
 Brush backs
 Cabinets
 Carriage bodies
 Children's cribs
 Counters
 Druggists' fixtures
 Drums
 Flooring
 Furniture
 Gymnasium goods
 Harps
 Interior finish
 Keys for musical instruments
 Molding
 Panels
 Piano cases and hammers
 Picture frames

BIRCH (SWEET) — Con.

Platforms for scales
 Posts
 Refrigerators
 Showcases
 Soda fountains
 Spindles
 Stair rails
 Stools
 Tambourines
 Tennis rackets
 Trim for passenger cars
 Turned toys

BLACK GUM.

Agricultural implements
 Furniture
 Gun stocks
 Interior trim
 Panel work
 Piano trusses
 Pipe organs
 Porch posts

BLACK WALNUT.

Balusters
 Brushes
 Carpenters' tools
 Furniture
 Interior finish
 Mantels
 Molding
 Organs
 Package handles
 Pianos
 Picture frames
 Pipe organs
 Railing
 Stair work
 Tennis rackets

Boxwood.

Plumbers' wood
 Plumbers' tools
 Billiard material

BUTTERNUT.

Boats
 Piano cases
 Pipe organs

CHERRY.

Automobile bodies
 Boats
 Cabinets
 Car finish
 Carriage panels
 Furniture
 House finish
 Molding

CHERRY — Con.

Organ panels
 Penholders
 Pianos
 Picture frames
 Sample-case boxes
 Spirit levels
 Stair work
 Tool handles
 Yacht trim

CHESTNUT.

Agricultural implements
 Billiard tables and fixtures
 Boxes
 Cars
 Children's cradles
 Crates
 Furniture
 Gymnasium goods
 House finish
 Molding
 Mission furniture
 Piano cases
 Picture frames
 Pipe organs
 Showcase doors
 Slack cooperage
 Stable floors
 Stair work
 Tool chests
 Toys

CIRCASSIAN WALNUT.

Cabinets
 Furniture
 Interior finish
 Musical instruments

COCOA.

Tree sticks (used in shoe factories)

COTTONWOOD.

Boxes
 Showcases
 Musical instruments

CYPRESS.

Balusters
 Boats
 Cabinets
 Cranberry separators
 Doors
 Furniture
 Interior finish
 Molding
 Picture frames
 Porch posts
 Screen frames
 Showcases

CYPRESS — Con.

Stair work
Weatherboarding
Weather strips

DOGWOOD.

Shuttles
Golf goods

DOUGLAS FIR.

Flooring
Gutters
Interior finish
Masts
Molding
Organs
Porch columns
Portable houses
Spars

EBONY.

Brush backs
Gavels
Handles
Organ keys
Pedals
Society goods

ELM.

Agricultural implements
Baskets
Boxes
Crates
Hoops of many kinds
Hubs
Parts of furniture
Parts of pianos
Refrigerators
Showcase tables
Slack cooperage
Soda fountains
Trunk slats
Wheel rims

ENGLISH OAK.

Interior finish
Tables

FIR.

Boxes
Crates
Packing cases
Slack cooperage

HACKMATACK.

Boat building

HAZELWOOD.

Piano legs

HEMLOCK.

Boxes
Cloth boards
Crates
Mill cabinets
Organs
Siding
Stair work

HICKORY.

Automobile gears
Baskets
Carriage poles
Golf clubs
Gymnasium goods
Handles
Heel cutter's mallets
Rims for measures
Rolls
Screens
Shafts
Trunk slats
Wagons
Wheels

HOLLY.

Brush backs

ITALIAN WALNUT.

Furniture
Interior finish

LIGNUM VITÆ.

Boat finish
Bowling balls
Castor wheels

LOBLOLLY PINE.

Boats

LONGLeAF PINE.

Boats
Flooring
Freight cars
Inside finish
Molding
Parts of machines
Passenger cars
Pipe organs

MAHOGANY.

Automobile bodies
Actions for piano players
Canoe trim
Counter tops
Drugstore fixtures
Furniture
House finish
Molding
Newel posts
Organs
Passenger car finish

• MAHOGANY — Con.

Piano cases
Picture frames
Showcases
Stair work
Tennis rackets
Yacht finish

MAPLE.

Agricultural implements
Athletic goods
Balusters
Banjos
Baskets
Bobbins
Boxing machine frames
Boxes
Brush blocks
Brush handles
Butter printers
Candlepins
Car finish
Carriage bodies
Children's cradles
Church organs
Clamp jaws
Cottage organs
Crates
Cutter frames
Die blocks
Drums
Flooring
Furniture
Games
Go-carts
Gymnasium goods
Handles
Harps
Interior finish
Lasts
Meat blocks
Pianos
Piano player actions
Railing
Rolls
Skewers
Slack cooperage
Soap sticks
Spools
Swings
Tambourines
Tennis rackets
Ten pins
Toys
Turnery
Whip butts
Wire mattress frames

NORTH CAROLINA PINE.

Blinds
Boxes
Cloth boards
Crates

NORTH CAROLINA PINE — Cop.

Doors
Flooring
Freight car siding
Gymnasium goods
Interior finish
Pipe organs
Refrigerators
Sash
Screens
Stair work
Snow plows
Wagons

NORWAY PINE.

Freight car siding
Walking planks

PERSIMMON.

Billiard cues
Golf stick heads
Mallets
Shuttles

PITCH PINE.

Boxes
Crates
Heading for barrels
Staves

PRIMA VERA.

Musical instruments

QUASSIA.

Quassia chips
Quassia cups

RATTAN.

Furniture

RED CEDAR.

Boats
Furniture
Interior finish
Yacht trim

RED GUM.

Piano skeletons

RED OAK.

Baskets
Boat finish
Furniture
Interior finish
Refrigerators
Rolling hoops
Snow plows
Stair work
Wagons

REDWOOD.

Carriage bodies
Cupboards

REDWOOD — Con.

Flooring
Furniture
Gutters
Molding
Pianos
Wagon tops

ROSEWOOD.

Brush backs
Gavels
Piano cases
Society goods
Tool handles

SPANISH CEDAR.

Boats
Furniture
House finish
Yacht trim

SPRUCE.

Agricultural machines
Barrel bungs
Blinds
Bobbins
Boxes
Butter cases
Car roofing
Cloth boards
Crates
Doors
Furniture
Hobby horses
Interior finish
Mill cabinet work
Organs
Piano skeletons
Plugs
Refrigerators
Sash
Screens
Shoe racks
Slack cooperage
Sounding boards
Spars and yards
Spruce oil
Stair work
Stakes

SUGAR PINE.

Blinds
Interior finish
Pipes for church organs

SYCAMORE.

Boats
Furniture
Interior finish
Pipe organs

TEAK.

Boats
Bowling balls

WESTERN CEDAR.

Yachts

WHITE CEDAR.

Boats
Panels
Piazza columns
Tanks
Tennis rackets
Tubs and pails
Wedges

WHITE BIRCH.

Baby carriages
Balls
Baskets
Bobbins
Brush backs
Children's chairs
Coffin handles
Doorknobs
Dowels
Novelties
Package handles
Penholders
Screens
Skewers
Slack cooperage
Spindles
Spools
Tackle blocks
Toys
Turnery
Wagons
Whip butts
Wire mattress frames

WHITE OAK.

Agricultural machines
Baskets
Billiard tables
Boats
Bungs
Cabinets
Church organs
Church pews
Cottage organs
Die blocks
Doors
Flooring
Freight cars
Furniture
Gymnasium goods
Handles
Hobby horses
Interior finish
Measure rims
Molding
Panels
Parquetry
Passenger car finish
Pianos
Picture frames

WHITE OAK — Con.

Plow beams and handles
 Plugs
 Pulpits
 Refrigerators
 Screens
 Showcases
 Showcase tables
 Snow shovels
 Soda fountains
 Stair work
 Tight cooperage
 Toys
 Trunk slats
 Turnery
 Wagon wheels and gears

WHITE PINE.

Agricultural machines
 Automobile bodies
 Baby carriages
 Barrel heads and bungs
 Blinds
 Bottoms for measures
 Bottoms for showcases
 Brackets
 Boxes
 Carriage bodies
 Children's wheelbarrows
 Chocolate boxes
 Church organs
 Cloth boards
 Crates
 Cutting boards
 Doors
 Egg carriers
 Freight cars
 Furniture
 Golf goods
 Hobby horses
 Hothouse sash
 Matches
 Mill cabinets
 Pails

WHITE PINE — Con.

Patterns
 Penholders
 Piano cases
 Piano keys and key beds
 Refrigerators
 Sash
 Screens
 Showcases
 Showcase tables
 Shoe racks
 Snow plows
 Soda fountains
 Tanks
 Tobacco cases
 Toys
 Trunks
 Wagon bodies
 Warehouse car bottoms
 Weather strips
 Window frames
 Woodenware
 Yacht decks

WILLOW.

Baskets
 Furniture

YELLOW BIRCH.

Baskets
 Bobbins
 Brushes
 Chairs
 Go-carts
 Handles
 Interior finish
 Skewers
 Slack cooperage
 Soap sticks
 Spools
 Stretchers
 Swings
 Toys
 Turnery

YELLOW OAK.

Furniture
 Snow plows
 Wagons

YELLOW POPLAR.

Actions in piano players
 Agricultural implements
 Automobile bodies
 Balusters
 Billiard tables
 Boats
 Bobbins
 Boxes
 Brackets
 Brushes
 Cabinets
 Car finish, roofing and siding
 Carriage panels
 Chocolate boxes
 Crates
 Church organs
 Doors
 Drums
 Fillers
 Frames
 Furniture
 Gymnasium goods
 Hobby horses
 Interior finish
 Molding
 Newel posts
 Panels
 Penholders
 Pianos
 Railing
 Refrigerators
 Screens
 Shelving
 Showcase doors
 Spools
 Stair work
 Steamboat finish
 Weather strips

THE "WILT DISEASE," OR "FLACHERIE,"

OF

THE GYPSY MOTH.

BY

WILLIAM REIFF,

BUSSEY INSTITUTION OF HARVARD UNIVERSITY.

UNDER THE DIRECTION OF

F. W. RANE, STATE FORESTER.



BOSTON :

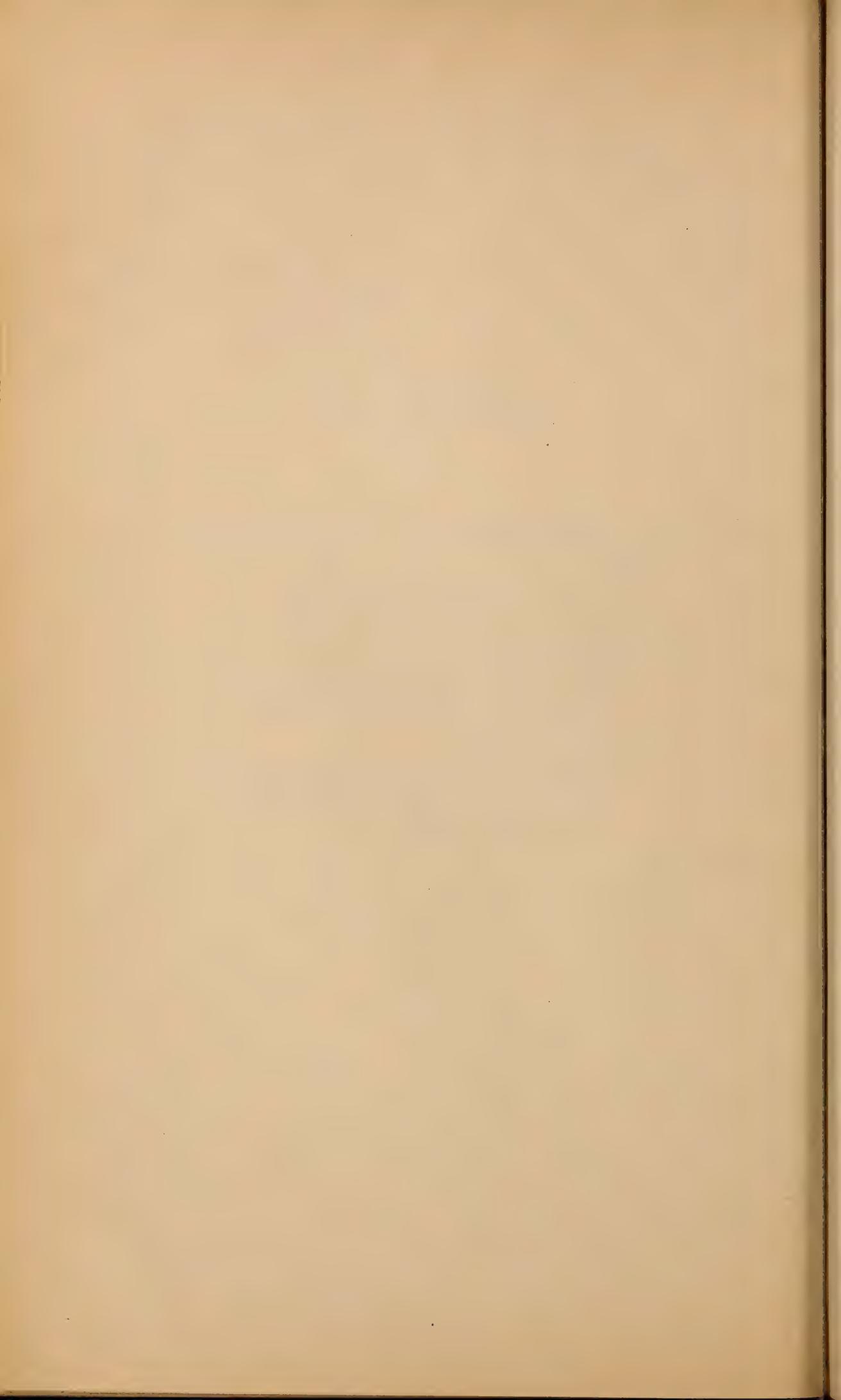
WRIGHT & POTTER PRINTING COMPANY, STATE PRINTERS,
18 POST OFFICE SQUARE.

1911.

APPROVED BY
THE STATE BOARD OF PUBLICATION.

CONTENTS.

	PAGE
Introductory,	5
I. Caterpillar Diseases in General, Common Diarrhoea; Bead Disease; Muscardine; Pébrine; Flacherie.	7
II. Résumé of Some Experiments with Flacherie in 1909,	12
III. Flacherie Experiments in 1910,	14
A. General,	14
Acknowledgments; General Points of the Work; Con- trol Experiment.	
B. The Single Experiments,	20
Concord, North Carver, Boxford, West Bedford, Haver- hill, Marshfield, Kingston, Brockton, Beverly, Co- hasset, Hingham, Byfield.	
IV. Summary,	53
V. Final Conclusions,	55



INTRODUCTORY.

Anything that offers promise of being effective in our warfare against the gypsy moth is hailed with delight by our Massachusetts people.

It is with pleasure that the State Forester is able to offer this publication, setting forth the work with the "wilt disease," or "Flacherie," of the gypsy moth, which has been carried on during the past two years by Mr. William Reiff, under the supervision of Prof. W. M. Wheeler of the Bussey Institution of Harvard University. Professor Wheeler's co-operative interest in the moth-suppression work in the State is highly appreciated by the State Forester, and the results shown in this bulletin will prove, we are sure, of great interest generally.

This bulletin is a companion, in a way, to that issued on parasites, in that it is another method of attacking our foe. We desire to have as many strings as possible to our bow in fighting this pest. That this "wilt disease" is a most hopeful remedy there is little question. We anticipate carrying on even more extensive work with it the coming season.

Upon reading this bulletin it will be readily apparent that any one can easily assist in furthering this work at little, if any, expense; and it is to be hoped that many will not only acquaint themselves with the methods employed, but experiment on their own initiative. If the State Forester can assist you in any way do not hesitate to call upon him.

ACKNOWLEDGMENTS.

The experimental work and writing up of the data in this bulletin was done by Mr. William Reiff of the Entomological Laboratory of the Bussey Institution of Harvard University.

The State Forester decided that the work undertaken by Mr. William Reiff during the season of 1909 was well worthy

of being continued upon a much larger scale, and co-operative plans were happily agreed upon with Dr. Wheeler, with the results as outlined in this bulletin.

Besides Professor Wheeler and Mr. Reiff, there are the field agents and local superintendents of the regular moth staff, who made it possible to get results. To these we are also under obligations for their loyal support and co-operation.

F. W. RANE,

State Forester.

BOSTON, MASS., March 21, 1911.

THE "WILT DISEASE," OR "FLACHERIE," OF THE GYPSY MOTH.¹

I. Caterpillar Diseases in General.

The production of diseases is one of nature's methods of quickly checking the overproduction of living things. Animals, including man, and plants all have their own specific infectious diseases, which usually appear whenever a species becomes so numerous that it menaces the prosperity of the coming generations. In the animal kingdom the possibility of overproduction is especially apt to occur in insects, since they form by far the largest portion of the world's fauna, and have a high rate of reproductivity. Insects, small though they are individually, form in their totality an immense mass of living matter. Of this mass we can get only a slight conception, even when we consider that insects are everywhere present, not only as a few scattered individuals, but in such enormous numbers that they constitute, as it were, a world in themselves. We may say without hesitation that among all the conditions which arise from and are caused by animals, there is none more widely distributed, more many-sided and which interferes more deeply with life on our planet than that which is brought about by insects. As Graber says:—

Man may unwisely neglect these creatures — as he does many things; but their power for evil crushes him the more; indeed, it may destroy him if he persists in his neglect.

Now, such a power may be checked by nature by one of the most efficient means which she possesses, — the infectious diseases.

Owing to the profound influence which insects exert upon us and our culture, attention has been drawn to their diseases. A close study has been made of some of these; especially of

¹ Contributions of the Entomological Laboratory of the Bussey Institution, Harvard University, No. 36.

those known to occur in the silkworm (*Bombyx mori*) and in the "nun" moth (*Psilura monacha*), which latter destroys the forests of Central Europe.

The first scientific knowledge which we have of caterpillar diseases we owe to the valuable investigations of the French scientist Pasteur. Since his time many other investigators have been engaged in this study, among them the Germans Standfuss and Emil Fischer, the Italians Verson and Bolle, and the Americans Snow and Forbes. By their experiments and investigations we are now able to recognize the character of the more common caterpillar diseases.

We may mention some of those diseases with which the lepidopterist will come in contact in the course of a few years.

A very frequent disease of caterpillars is the *common diarrhœa*, which is produced in most cases by too juicy or too wet food. This is shown by the unusually wet excrement, the fluid part of which is green. If the disease is of longer standing, the excrement does not cling together, but is voided as a pulpy mass, in which the single vegetable particles swim around undigested. This disease in itself is not dangerous, since it is not infectious, but it may prepare the way for the attack of other infectious diseases, which will be mentioned further on.

In another disease, which has no popular name as yet, and which I shall call *bead disease*, the excrement masses hang from the body like a string of beads. This intestinal disease is probably due to unhealthy food, but the specific cause has not been determined. Apparently this disease, too, is not infectious.

Of much greater importance is the disease known as *muscardine*. This is really a collective name for a series of fungous diseases, which convert the infected caterpillar in a short time into a stiff, swollen mass, with the skin invested with a grayish-white coating. Very hairy caterpillars are especially susceptible to muscardine, but in extremely wet years even smooth caterpillars suffer from fungous diseases. It is easy to determine whether muscardine is present in a given locality because the diseased caterpillars crawl toward the exposed tops of grass blades, poles or stems, and remain there after death, thus be-

coming visible for a considerable distance. On a trip which I made in June, 1910, to Raymond, N. H., I saw thousands of brown-tail moth caterpillars dead from muscardine, and commonly hanging in this characteristic manner. Since these fungous diseases are extremely infectious, and propagate with incredible swiftness, and since healthy caterpillars are much inclined to gnaw at dead ones, the artificial production and propagation of muscardine has been hopefully considered during the last few years as a means of destroying the brown-tail moth.

There are two fungi, especially, which are responsible for the death of most caterpillars; these are *Botrytis bassiana* Bals and *Entomophthora aulicae* Reichhardt. Experiments with fungous diseases of the brown-tail moth are being conducted by Mr. A. T. Speare, under the direction of Dr. R. Thaxter of Harvard University.¹

The *pébrine* or *pebrina*, which has become so notorious through the great damage it has caused to the silk industry, is the caterpillar disease which has been studied so far most thoroughly. Caterpillars with this disease always have a wet anus, and if they are hairy, the hairs on this region of the body stick together. Smooth caterpillars also change their color considerably; for instance, green caterpillars turn yellowish, and are often mottled with dark, irregular spots; gayly colored caterpillars lose their brilliancy. This disease does not kill in a few hours or days, but the infected caterpillars languish slowly, lose their appetite, and become transparent and ill-nourished. They then shrink more and more, till finally at death only the flabby dry skin remains. Pébrine appears preponderatingly in wet years, and its cause seems to be lack of nourishment. The specific cause, however, the disposition, has not yet been absolutely determined. The carriers of the disease are known under the name *Corpuscoli di Cornalia*, and have been described by Lebert² as the fungus *Panhistophyton ovatum* (*Micrococcus ovatus*). Here it might be of interest to cite from a review in "Deutsche Entomologische

¹ "Seventh Annual Report of the State Forester of Massachusetts," 1910, pp. 98-101.

² "Berliner Entomologische Zeitschrift," 1858, p. 170.

National "Bibliothek," No. 3, Jahrg. II., 1911, where it is stated that the botanist Naegeli described the carrier of the pébrine, as early as 1857, as *Nosema bombycis*. This review, moreover, mentions the fact that W. Stempell (38. Jahresber. Zool. Sekt. Westf., Prov. Ver. f. Wiss. u. Kunst, 1909-10, p. 37) has made artificial infection experiments with this parasite, and found that it develops with extreme rapidity and great virulence, not only in caterpillars of the silkworm, but also in caterpillars of several local species of the same family. Thus Stempell reached the conclusion that this susceptibility of the individuals towards the pébrine parasite might be used practically in combating injurious caterpillars. He further mentions that his researches on this and other *Microsporidia* are of biological interest, since it would seem that there must be organisms so minute that they cannot be seen, even with our most modern optical instruments. In several infectious diseases the carriers of the disease have not yet been optically demonstrated, and it may be that these carriers are such small organisms. These little oval shining bodies are now no longer regarded as plant organisms, but as belonging to the *Psorospermii*, a group of Protozoa. Pébrine is extremely infectious, and is carried over, as Pasteur has proved, from generation to generation in the eggs, with increasing destructiveness.

We come now to the last and probably most important of all the common caterpillar diseases, the disease called *Flacherie*, *Flaccidenza* or *caterpillar cholera*, and in America known also under the name "wilt disease." This disease is characterized as follows: a caterpillar suffering from it soon stops eating, becomes weak and lazy, and usually crawls up on some object, as the trunk of a tree, a fence, a wall, or other vertical surface, where it remains without motion. In a few hours there drops from its mouth and anus a dirty, blackish, foul-smelling liquid; the caterpillar becomes more and more flaccid, one leg after the other loses its support, and finally the creature, reduced to a black skin, hangs dead, still holding on with one or two of its false feet or with the anal claspers. The slightest touch now suffices to break the skin, and a thin, dark, offensive-smelling

liquid flows out. Flacherie kills the older more quickly than the younger caterpillars. Young caterpillars, indeed, often live several days before they are killed by the disease. It is not positively known what organisms produce Flacherie. The bodies of caterpillars which have died of this disease show extremely small bacilli, innumerable schizomycetes, and, more particularly, many small strings of micrococci; but which of these micro-organisms, if any, is the real carrier of the disease is still unknown to specialists.¹ To the investigations of Dr. E. Fischer, in Zürich, Switzerland, we owe considerable information regarding the primary causes leading to Flacherie, and the manner in which the disposition to this disease may be induced. He has pointed out that a decrease in the nutritive value of the food of the caterpillars, which induces a disturbance in their metabolism, is the first condition leading to the contraction of the disease. As a result of these disturbances the organisms responsible for the disease immediately find conditions suitable for their growth. One of the main causes of the disease is therefore to be sought in the predisposition of the caterpillars, while the specific infection of Flacherie is to be regarded as coming more or less secondarily; in other words, without this predisposition infection cannot take place, and the predisposition can be brought about artificially by insufficient nourishment.² Flacherie seems to be influenced by climate and weather conditions less than any other caterpillar disease. We meet with it both in the old and the new world, in wet, in dry and in normal weather. As a result of its comparatively great abundance and its extremely easy infection, Flacherie has become the "guardian angel" of the Central European forests. When the "nun" (*Psilura monacha*) makes its appearance in some places in Europe in vast numbers, man with his wit and the powerful means at his command is quite unable to stop the destruction, but Flacherie always comes to his assistance. Although this disease has been much studied, it has not yet been positively

¹ Very recently C. Sasaki, in Tokyo, Japan, found that there were also polyhedral corpuscles present in caterpillars which were sick from Flacherie ("Deutsche Entomologische National-Bibliothek," Jahrgang II., 1911, No. 1, Referat). Since polyhedral corpuscles, however, are found chiefly in caterpillars which have been infected by the pébrine, a close relationship of these two diseases is highly probable.

² See Fischer's detailed accounts in the "Biologisches Centralblatt," Band XXVI., No. 13-16. Leipzig, 1906.

established whether it is hereditary or not. There is at present no argument that can be brought against the heredity of the disease, while there are some important facts which indicate its heredity. These will be considered later.

II. *Résumé* of Some Experiments with Flacherie in 1909.

Fischer called attention, in his excellent paper, already mentioned, to the manner in which Flacherie can be artificially developed. He says that the disposition to the disease is secured by giving the caterpillars food which has been placed in water and renewed only every three or four days. This treatment apparently causes an injury to the leaf protoplasm, due to the presence of too much water, and there is a concomitant increase in the acidity of the leaves.¹ If, now, a caterpillar eats such leaves, the alkalinity of its digestive fluid, which is very strong in healthy individuals, decreases, and in this manner the first susceptibility to the disease is given. Before the visible outbreak of Flacherie, Fischer could recognize as an early symptom a characteristic sweet odor in the breeding cages, which could be compared best to that of somewhat withered lilac blossoms. Whenever this odor was noticeable Flacherie soon made its appearance, and as it progressed the odor increased proportionately. Fischer recommends the artificial production of Flacherie among the caterpillars of the "nun" ("die Nonne" of the Germans) by intentionally giving the larvæ this kind of food as soon as an abundance of the pest is noted in any particular locality.

Bearing in mind the close relationship existing between the "nun" and the gypsy moth, I attempted during the summer of 1909 to put Fischer's conclusions regarding the artificial production of the wilt to a practical test. These experiments were published in detail in the entomological journal "Psyche," Vol. XVI., No. 5, October, 1909. There appeared also a German translation of the paper in the "Societas Entomologica," Jahrgang XXIV., pp. 178-181, Zürich, Switzerland. The main facts in these experiments are here noted. Up to 70 per cent. of the caterpillars were killed by artificially produced

¹ See the experiments which Sasaki performed on mulberry trees in Japan, "Zeitschrift für Pflanzenkrankheiten," XII. Band, Jahrgang 1902, 4. Heft, pp. 203-226; 5. Heft, pp. 258-278.

Flacherie, while all caterpillars which were kept apart for control remained healthy. From these results I was therefore led to believe that the artificially produced Flacherie might be utilized as a valuable aid in the destruction of gypsy moth caterpillars. If the disease appears in nature during normal weather conditions, the caterpillars are in most cases almost full grown when attacked; but the farther the weather conditions of the year differ from the normal, the earlier in their life will the disease affect them. The fact that I succeeded in rendering the caterpillars susceptible to the wilt before the third molt suggested that this may be of importance in the practical use of the disease, since by artificially inducing Flacherie, relief might be had weeks sooner than happens in nature.

Better to understand the conclusions drawn from the last experiment, which was performed on trees on which a considerable number of gypsy moth caterpillars occurred naturally, the following account is given: A group of oak and another of willow trees were infested with about 5,000 caterpillars each. Shortly before their fourth molt, upon each of these two groups of trees 100 sick and 50 dead caterpillars were distributed. The disease spread with amazing rapidity, and even on the following day many freshly killed caterpillars could be counted. By the time of pupation about 4,000 caterpillars on each group of trees had succumbed to the disease. Two conditions which did not enter into my previous experiments united to cause this unusual result. In the first place, the two groups of trees had been badly infested and injured by gypsy moth caterpillars the previous season, as was evidenced by the unhealthiness of the leaves during the summer of 1909, and the caterpillars had probably become predisposed to the disease on account of the resulting decrease in the value of their food. As a second very important factor may be mentioned the dry weather, which by its desiccating effect upon the leaves served to render the food for the caterpillars still less nutritious. Hence, from the beginning there was a decreased vitality in the tissues, and digestion was early disturbed. In short, the caterpillars were already very susceptible to the disease at the time I introduced it

among them, and conditions were therefore most suitable for the spread of the wilt. Always in the places that have been injured by gypsy moth caterpillars in previous years, there is a predisposition on the part of caterpillars of the following year toward Flacherie. The heavy defoliation checks the normal metabolism of the attacked vegetation, which causes a weak and sickly development of the shoots, and these therefore do not furnish the caterpillars sufficiently wholesome nourishment. It should be remembered that these facts, in the long run, mean a self-protection of the vegetation. If at this time dead and sick material is introduced among the caterpillars in such a locality, the organisms of the disease will act readily upon the individuals present. Infection will take place even in cases where a locality is badly infested by the caterpillars for the first time, because one can always find a large number of weak and therefore susceptible specimens. Then, as the disease progresses, it acquires such virulence that even the previously healthy specimens become infected.

In the article mentioned I called attention to other ways in which the caterpillars advance the infection among themselves, that is, during the resting period, during the feeding time, etc., and how easily the disease may be carried over by the caterpillar to its pupal stage. The great probability of an economic value in Flacherie for destroying the gypsy moth was suggested, but it was thought that the experiments of only a single year had better not be taken as a comprehensive method for the practical use of the wilt, and that further experiments should be undertaken on a larger scale to substantiate the obtained results.

III. Flacherie Experiments in 1910.

A. GENERAL.

In the spring of 1910 the author was requested, by the State Forester of Massachusetts, to make similar experiments on a large scale in different parts of the State.¹ These experiments were undertaken with the help and kind encouragement of Prof. W. M. Wheeler. I would also express my indebtedness

¹ Cf.: "Sixth Annual Report of the State Forester of Massachusetts," 1909, p. 86.

to all those from whom I have received advice and actual assistance. My thanks are also due to State Forester Frank W. Rane and Assistant Forester L. H. Worthley for much help; and to their division agents, Norman Souther of Bridgewater, and Francis C. Worthen of Georgetown, and to Mr. H. P. Richardson, local moth superintendent of Concord, for their support in the field work. Last but not least, I owe, through correspondence, several valuable hints to Dr. E. Fischer, Zürich, Switzerland, who, through his investigations on insect diseases, is to be regarded the proper instigator of these experiments.

In the beginning of the work each of the division agents was asked by letter to suggest convenient localities in which to conduct the experiments. Three of the division agents stated that they had no suitable places in their districts. In the remaining divisions 29 places were chosen, but at the end of my investigations unfortunately 13 of these could not be used, since some of the local moth superintendents had not followed instructions, and other places had been sprayed with arsenate of lead. Isolated forest districts, varying from small areas to several acres, were chosen for the experiments. The isolation was for the purpose of making easier a control of the place, since in such a locality an eventual increase or decrease of the caterpillar mass by migration was less probable. The local superintendents of the different places were instructed not to use any artificial means for destroying caterpillars in the selected woods. I was, however, obliged to use some localities in which, during the preceding winter, some of the egg clusters had been killed by creosote. According to the size of the various places, the local superintendents were requested to collect a corresponding mass of gypsy moth caterpillars shortly before their second molt. These amounted to from 50 to 100 individuals per acre. Where many egg clusters were present but few caterpillars had to be collected, and *vice versa*. Hence, the number of caterpillars to be collected was decided in advance for each locality. The reason for this is that an infection spreads more easily and rapidly in a heavily infested district than in places less damaged by caterpillars. In a

badly infested forest of 10 acres or more the average number of caterpillars to be collected was placed at less than 50 specimens per acre, since the disease spreads best in such localities.

The local superintendents had been instructed to feed the collected caterpillars daily with oak leaves, or with apple leaves where oak leaves could not be secured. These leaves were not to be removed from the twigs, and were to be placed in water for at least four days before feeding. A special emphasis was laid on not giving as food leaves of trees which had been sprayed with arsenate of lead. As breeding cages common wooden boxes were used, to which the entry of air was provided for by means of gauze coverings. Further, the local superintendents, who were not familiar with the wilt, were taught the character of this disease and its manner of appearance, and were instructed to communicate with me at once on the first appearance of Flacherie in their breeding cages. The local superintendents were asked to attend to this part of the work, since at that time it was not convenient to rear several thousand gypsy moth caterpillars in one place, and also in order that their interest might be awakened in the experiments.

As soon as the wilt was determined to be present in a brood the whole material was transplanted upon the previously chosen places, with the help of the respective superintendents. This was done as follows: a piece of clean cloth, burlap, for instance, about 2 feet long by 1 foot wide, was hung in dense foliage between the limbs of a tree, or from one tree to another close by (Fig. 1). In this hammock-like bag were placed, besides the dead and still living caterpillars of the brood, also all food remaining in the breeding cage, since such remains might also be supposed to contain organisms of the disease. No means were used to prevent the escape of the sick but still crawling caterpillars, in order that they might disseminate the organisms.¹ Where possible, the bag with the material was hung about 6 feet or still higher from the ground, in order that the wind might aid in the spread of the disease. In planting the diseased material the direction of the prevailing wind of the

¹ That this is the case is proved by some experiments which I shall consider particularly later, where only sick caterpillars were transplanted, but no dead caterpillars.

season was taken into consideration. For instance, in localities which had prevailing east winds the infected material was exposed near the eastern border of the forest, but still inside of it, so that the wind, before reaching the larger part of the wood, was forced to strike first the center of the diseased area. It may be mentioned that in some cases, where no convenient cloth was at hand, the breeding cages themselves with the material, after the removal of the cover, were hung between limbs. No difference was observed in the results. The infected material was planted in most of the localities at a time when most of the caterpillars in the field were undergoing the



Fig. 1.—Method of hanging hammock in tree.

third molt. The respective ages of the caterpillars will be mentioned under each experiment.¹

It was important to select places which gave the best guarantee for the health of the growing caterpillars; hence, special attention is called to the fact that in the experimental localities no disease is known to have occurred among the caterpillars of previous years.

¹ I had always planned to plant the disease as soon as it made its appearance in one or the other of the broods. This was, however, frustrated on several occasions by various circumstances. For instance, some local superintendents did not notice the Flacherie till after the disease had prevailed for several days. It was, further, not always possible for me to depart immediately upon receiving a communication concerning the outbreak of the disease. It was also almost impossible for one man to transplant the infected material to all the chosen places during the short time in which the gypsy moth caterpillars were in the third or beginning of the fourth stage. This is the reason why in some localities the disease was planted later, although the caterpillars were already beyond the third molt.

After the eggs were laid in the autumn of 1910 all localities were carefully inspected, and the number of the fresh clusters was determined as nearly as possible. For examination of the single eggs, five clusters, when possible, were collected from each locality. Five clusters from a place in the western part of Concord, Mass., served for control. These eggs must be considered as normal because they come from a place in which positively no disease whatever has occurred. In collecting clusters for examination the first five found were taken; and were not taken at random.

Every single egg of all these clusters was examined microscopically. This, it is true, required very much time, but it was nevertheless indispensable. The eggs were separated into three kinds: first, those that showed no signs of development of the embryo (empty or unfertilized eggs); second, those in which the more or less developed embryo had been killed before its complete development; and finally, those which showed a perfectly developed embryo (normal and supposedly living eggs). In every case in which the egg could not be absolutely assigned to the second series it was counted with the third series.¹

In the details of all the work everything which seemed to suggest the economic value of the wilt has been purposely regarded from the most unfavorable standpoint, for the purpose of meeting any objections. When estimating the egg clusters from the selected localities there was always present either the division agent or the local superintendent, and at that time written notes were made of these estimates before the introduction of the disease. In the spring we made the lowest possible estimate on the number of clusters present, while with the second estimate in the autumn, after the disease had produced its effect, the fresh clusters were estimated as liberally as possible.

The average which resulted from the examination of the single clusters must not be taken as absolutely fixed, since the small number of the clusters examined admits of a variation

¹ The eggs of the control clusters could all be distributed with exactitude into the respective series.

from the mean in both directions. The main purpose of the experiments, however, was not to make mathematically exact calculations, but to find out in what manner and to what degree the gypsy moth may be infected by the wilt. For these purposes the calculations made should be sufficient, and the figures given will not be far from the real average.

As to the control experiment, the average of eggs in a normal cluster was found to be 437. I am not aware that the eggs of a large series of normal clusters have ever been counted in order to establish an accurate average. In published reports the average of eggs in a normal cluster is stated as "400 to 500."

Control Experiment, Concord, Mass.

Five clusters were taken in the western part of this locality, where there certainly did not occur any disease among the gypsy moth caterpillars. These clusters, therefore, must be regarded as normal. The microscopic examination of the eggs of these clusters gave the following results:—

Cluster 1.

Unfertilized eggs,	1	} = .73 per cent., or about 1 per cent.
Eggs with dead embryos,	3	
Eggs apparently alive,	543	=99.27 per cent., or about 99 per cent.
<hr/>		
Total,	547	eggs.

Cluster 2.

Unfertilized eggs,	-	} = .47 per cent., or about .5 per cent.
Eggs with dead embryos,	2	
Eggs apparently alive,	424	=99.53 per cent., or about 99.5 per cent.
<hr/>		
Total,	426	eggs.

Cluster 3.

Unfertilized eggs,	3	} = 1.74 per cent., or about 2 per cent.
Eggs with dead embryos,	4	
Eggs apparently alive,	395	=98.26 per cent., or about 98 per cent.
<hr/>		
Total,	402	eggs.

Cluster 4.

Unfertilized eggs,	1	} = .93 per cent., or about 1 per cent.
Eggs with dead embryos,	3	
Eggs apparently alive,	424	=99.07 per cent., or about 99 per cent.
<hr/>		
Total,	428	eggs.

Cluster 5.

Unfertilized eggs,	-	} = .79 per cent., or about 1 per cent.
Eggs with dead embryos,	3	
Eggs apparently alive,	377	
<hr/>		=99.21 per cent., or about 99 per cent.
Total,	380 eggs.	

The average of these 5 clusters is as follows:—

Dead eggs,	4	= .92 per cent., or about 1 per cent.
Eggs apparently alive,	433	=99.08 per cent., or about 99 per cent.
<hr/>		
Total,	437 eggs.	

The results of this control experiment are used in estimating the departure from the normal of the egg masses in all the other experiments.

B. THE SINGLE EXPERIMENTS.

Concord, Mass.

Division Agent, CHAS. W. MINOT; Local Superintendent, HENRY P. RICHARDSON.

As a suitable place for my experiments, I located, on May 20, 1910, an isolated forest of about $2\frac{1}{4}$ acres, belonging to the estate of Mr. William Brewster. This place is situated in the eastern part of Concord, about half a mile west of the West Bedford railroad station. The forest consists mainly of oaks about twenty years old and of a group of pines about fifty years old, all mixed with brush; and along the border, especially on the northern part, are birches about ten years old.

According to the local superintendent and to the owner, Mr. Brewster, the gypsy moth caterpillars were quite numerous during the summer of 1909. Both are certain that there was no disease among the caterpillars. We estimated this place to contain about 10,000 clusters of eggs in May, 1910.

On June 6 I received notice from the local superintendent that the wilt had appeared among the caterpillars which he had collected and fed according to instructions. Two days later I went to Concord, and found that some 10 caterpillars were already dead and the others were apparently very sick, as they remained motionless even when irritated. The superintendent had begun to feed the caterpillars on May 26, and had noticed the first dead specimen on June 5. Accordingly, he had succeeded in developing the wilt artificially in the course of eleven days.

With the assistance of the local superintendent the whole breeding material was immediately exposed in the western part of the selected forest. The distance from the ground to the material, which was hung between the limbs of a tree, was about 15 feet. The largest number of gypsy moth caterpillars in this locality were at this time in the third molt, or about to pass into this molt. The wilt soon spread over the whole forest, as was seen during occasional visits to the place by Mr. Richardson, Mr. Brewster and myself. On Sept. 7, 1910, the fresh egg clusters were estimated by the local superintendent and myself to amount to about 5,000. Often 4 or 5 of these clusters together would not make more than 1 normal cluster; the actual number of eggs was thus much less than would have been present in the same number of normal clusters.

The examination of 5 clusters which had been collected Sept. 7, 1910, on Brewster's estate showed the following counts:—

Cluster 1.

Unfertilized eggs,	3	} = 9.66 per cent., or about 9.5 per cent.	
Eggs with dead embryos,	11		
Eggs apparently alive,	131		
Total,	145 eggs.		

Cluster 2.

Unfertilized eggs,	2	} = 7.43 per cent., or about 7.5 per cent.	
Eggs with dead embryos,	9		
Eggs apparently alive,	137		
Total,	148 eggs.		

Cluster 3.

Unfertilized eggs,	13	} = 48.06 per cent., or about 48 per cent.	
Eggs with dead embryos,	49		
Eggs apparently alive,	67		
Total,	129 eggs.		

Cluster 4.

Unfertilized eggs,	1	} = 8.64 per cent., or about 8.5 per cent.	
Eggs with dead embryos,	6		
Eggs apparently alive,	74		
Total,	81 eggs.		

Cluster 5.

Unfertilized eggs,	-	} = 6.76 per cent., or about 6.5 per cent.
Eggs with dead embryos,	5	
Eggs apparently alive,	69	
<hr/>		
Total,	74 eggs.	

Averaging these 5 clusters we have:—

Dead eggs,	20	=17.24 per cent., or about 17 per cent.
Eggs apparently alive,	96	=82.76 per cent., or about 83 per cent.
<hr/>		
Total,	116 eggs.	

A normal egg cluster contains on an average 433 eggs (p. 20) which are apparently alive. Since the infested locality averages only 96 eggs which are apparently alive per cluster, $4\frac{1}{2}$ clusters are necessary to equal the size of a normal cluster. The number of the fresh clusters, estimated at 5,000, thus has to be reduced to about 1,100 clusters to compare with the 10,000 clusters present in the spring of 1910. The number of apparently vital eggs, therefore, is decreased to about 11 per cent. through the action of *Flacherie*.

The local superintendent informed me that the disease had also spread into the neighboring forest districts. By an extended walk through about 5 acres of these woods I learned that the wilt had operated in the same manner as in the first locality. He is of the opinion that the number of clusters in this 5 acres has been decreased to about 15 per cent. Adjoining these woods there are about 15 acres of forest, in which the local superintendent found that all egg clusters which had been laid in the summer of 1909, and which had been deposited 1 foot or more above the ground, had failed to produce caterpillars, that is, the eggs had remained unhatched; but the caterpillars had all emerged from those eggs in clusters placed less than 1 foot above the ground. I found that these statements corresponded very closely with the facts. Here and there I noticed a slight exception by occasionally finding either a high-placed cluster from which a few caterpillars had emerged, or I detected close to the ground a cluster from which only a portion of the caterpillars had emerged. These exceptions, however, were insignificant, for they represented in each case hardly more than 10 eggs. I am unable, so far, to find any explanation for this peculiar occurrence. At first I thought that an egg parasite might have exerted its helpful power, but the examination of eggs from several clusters which had remained unhatched showed that almost all eggs contained a fully developed dead embryo, and no signs of a parasite could be found. The moisture of the soil cannot be made responsible, for bor-

dering this forest there is another with exactly the same soil, the same kind of trees and of the same age as the other place, and although these forests are separated only by a very broad road, in the latter wood the caterpillars of almost all egg clusters of 1909 had emerged from clusters that had been placed at any height on the trunks of the trees. There were exceptional cases of clusters, sometimes on the upper, sometimes on the lower part of the trees, from which all caterpillars had not emerged, but there was no evidence of the peculiar condition that characterized the clusters in the place first mentioned. Whether any caterpillar disease has any effect in this occurrence, I cannot now say. The solution of this question may come in the future from careful observations at this particular locality.¹

An extensive forest in the southwestern part of Concord was visited, in which, according to the information of the local superintendent, the wilt had broken out naturally. The peculiar conditions which we found here require a detailed description of the locality and of the manner in which the disease operated. The largest part of the forest, about 20 acres, is situated upon the ridge of a hill. On the east and west the hill slopes to wet meadows. On the north and south the hill gently passes over into level country, and it is bordered here by broad roads. The principal trees on the ridge of the hill are high pines about sixty to eighty years of age; brush is almost absent. The slopes are covered in large part with young oaks, which are much mixed with brush of different kinds. Now, while the forest of the whole ridge, including the northern and southern slopes, suffered considerably from injuries by gypsy moth caterpillars during the summer of 1910, the eastern and western slopes were exempt from this damage. Soon after the caterpillars had passed the third molt Flacherie made its appearance among those feeding on the pines upon the ridge of the hill. The disease developed here so rapidly that probably all caterpillars were killed, for we were unable, even by careful search in these 20 acres, on Sept. 7, 1910, to find a single fresh cluster. The statement, therefore, seems justified that all caterpillars, at least all the females (100 per cent.), were here killed by the wilt. This very high number, however, was restricted to the forest upon the ridge of the hill. On the first trees of the northern and southern slopes fresh egg clusters were found, and the number of these increased as we went toward the plain. But the inspection of such dead caterpillars as were observed showed that the wilt had also operated in the woods of these slopes. The local superintendent looked here for Flacherie, but it did not appear till the caterpillars were in their last stage. The reason for this behavior of the wilt might be that the ridge of the hill, with its high trees, was much exposed to the effect of the wind, and after Flacherie had once developed it could be spread very rapidly along the ridge. On the northern

¹ Similar observations, where eggs have not hatched, were made elsewhere by different persons connected with the moth work, but no definite observations, as at Concord, were reported.

and southern slopes, however, the wind could not strike so hard, and the spreading of *Flacherie* toward the plain, therefore, took place comparatively slowly. Upon the eastern and western slopes, on account of the lack of caterpillars, the conditions necessary for developing the wilt were not present.

A map of the place, sketched by Mr. Richardson (Fig. 2), which may aid in understanding the description, is given herewith.

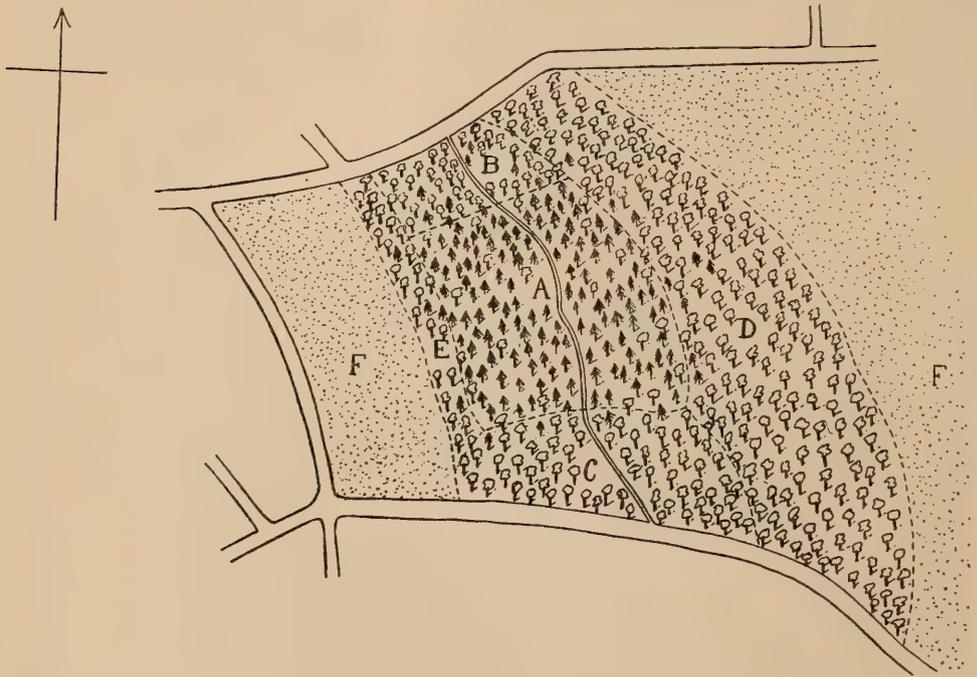


Fig. 2.—Experiment, Concord, Mass. A. Summit of hill, now cleared. B. Northern slope, infested. C. Southern slope, infested. D. Eastern slope, not eaten. E. Western slope, not eaten. F. Meadows.

Five clusters were examined for comparison from the localities in which *Flacherie* developed naturally. These were collected on a walk through the forest district at the southern end of the hill, and from different trees taken at random. The result was:—

Cluster 1.

Unfertilized eggs,	4	} = 12.59 per cent., or about 12.5 per cent.
Eggs with dead embryos,	16	
Eggs apparently alive,	139		= 87.41 per cent., or about 87.5 per cent.
Total,		159 eggs.

Cluster 2.

Unfertilized eggs,	2	} = 5.30 per cent., or about 5 per cent.
Eggs with dead embryos,	6	
Eggs apparently alive,	143		= 94.70 per cent., or about 95 per cent.
Total,		151 eggs.

Cluster 3.

Unfertilized eggs,	1	} = 2.14 per cent., or about 2 per cent.
Eggs with dead embryos,	4	
Eggs apparently alive,	229	=97.86 per cent., or about 98 per cent.
<hr/>		
Total,	234	eggs.

Cluster 4.

Unfertilized eggs,	1	} = 3.17 per cent., or about 3 per cent.
Eggs with dead embryos,	3	
Eggs apparently alive,	122	=96.83 per cent., or about 97 per cent.
<hr/>		
Total,	126	eggs.

Cluster 5.

Unfertilized eggs,	6	} = 12.93 per cent., or about 13 per cent.
Eggs with dead embryos,	32	
Eggs apparently alive,	256	=87.07 per cent., or about 87 per cent.
<hr/>		
Total,	294	eggs.

Averaging these 5 clusters we get this result:—

Dead eggs,	15	= 7.77 per cent., or about 7.5 per cent.
Eggs apparently alive,	178	=92.23 per cent., or about 92.5 per cent.
<hr/>		
Total,	193	eggs.

We notice also that the egg clusters from this place, where the wilt developed naturally, are considerably less than the normal size, about $2\frac{1}{2}$ clusters being equal to 1 normal cluster. This, and the fact that only 7.5 per cent. of the eggs would fail to hatch, while in the experiment 17 per cent. were dead, is probably due to the fact that upon this southern slope Flacherie appeared late and spread but slowly.

North Carver, Mass.

Division Agent, JOHN A. FARLEY; Local Superintendent, HERBERT F. ATWOOD.

This locality was visited on May 9, 1910, with the inspector of the southern districts of the State of Massachusetts, Mr. Norman Souther of Bridgewater, to find suitable places for the intended experiments. The gypsy moth does not occur here in such enormous numbers as in the northern parts of the State, but I wished to have some experiments at places where the gypsy moth has but recently gained a foothold.

An isolated wood of about 2 acres, situated somewhat southwest from Makepeace's cranberry bog, was found to be a suitable place. It consists of pines about forty years old and of oaks about twenty to twenty-five years of age, with considerable brush.

The gypsy moth was discovered here for the first time during the winter of 1909-10, by finding egg clusters. Several of these clusters, unfortunately, had been already killed with creosote before my first visit, but there were present, according to Mr. Souther's and my estimation, about 25 clusters. Whether there was any disease among the caterpillars of the previous year could not be ascertained, but it is highly improbable, considering the youth of the colony and the large size of the clusters.

On June 14, 1910, the local superintendent sent me word that wilt had made its appearance among the caterpillars which he had collected and fed according to instructions. I therefore went to North Carver on June 16, and found that in Mr. Atwood's colony about 3 per cent. of the caterpillars had already died of Flacherie. Most of those still living were very sick. He therefore had developed the wilt artificially after a feeding of about fourteen days.

This same day, with the assistance of the local superintendent, a part of the breeding material was exposed on the western side of the selected place. The bag containing the material was fastened about 8 feet from the ground, between young oak trees. Most of the caterpillars of this locality had just passed the third molt.

On Oct. 7, 1910, an extended search was made by the local superintendent and myself, but only 4 fresh clusters could be found. The microscopic examination of these 4 clusters resulted as follows:—

Cluster 1.

Unfertilized eggs,	5	} = 6.03 per cent., or about 6 per cent.	
Eggs with dead embryos,	21		
Eggs apparently alive,	405		
Total,	431 eggs.		

Cluster 2.

Unfertilized eggs,	3	} = 5.38 per cent., or about 5.5 per cent.	
Eggs with dead embryos,	18		
Eggs apparently alive,	375		
Total,	396 eggs.		

Cluster 3.

Unfertilized eggs,	2	} = 4.65 per cent., or about 4.5 per cent.	
Eggs with dead embryos,	8		
Eggs apparently alive,	205		
Total,	215 eggs.		

Cluster 4.

Unfertilized eggs,	3	} = 13.38 per cent., or about 13.5 per cent.
Eggs with dead embryos,	18	
Eggs apparently alive,	136		= 86.62 per cent., or about 86.5 per cent
<hr/>		
Total,	157 eggs.	

Averaging these 4 clusters we get:—

Dead eggs,	20	= 6.67 per cent., or about 6.5 per cent.
Eggs apparently alive,	280	= 93.33 per cent., or about 93.5 per cent.
<hr/>		
Total,	300 eggs.	

Since, as we have seen, a normal cluster contains on the average 433 eggs with apparently living embryos, the living eggs of these 4 clusters, after the wilt did its work, amount to about 64.5 per cent. The egg clusters which were present in the spring of 1910 were estimated at about 25, while only 4 fresh clusters were found in the autumn of 1910. The total number of all apparently living eggs was decreased in this locality to about 13 per cent., as compared with the number present in the spring of 1910.

Another place for experiments, very similar to the last one, was selected in North Carver. This is a forest district of 3 acres, and is situated east of the cemetery on Wenham Street. The timber and brush here are the same as in the other locality, and the egg clusters of the gypsy moth were also first discovered here during the winter of 1909-10. Unfortunately, several clusters were killed with creosote before my first visit. The clusters still present were estimated by Mr. Souther and myself at about 600. On account of the young age of the colony and the considerable size of the clusters probably no disease had appeared among the caterpillars of the preceding year.

The remaining part of the wilt material was planted among the caterpillars of this locality on the same day and in the same manner as in the first colony. Here, also, most of the caterpillars at this time had just undergone the third molt.

The estimate of the fresh clusters, which was made by the local superintendent and myself Oct. 7, 1910, was about 400, from which the first 5 found were used for microscopical examinations. The result is as follows:—

Cluster 1.

Unfertilized eggs,	-	} = 4.11 per cent., or about 4 per cent.
Eggs with dead embryos,	12	
Eggs apparently alive,	280		= 95.89 per cent., or about 96 per cent.
<hr/>		
Total,	292 eggs.	

Cluster 2.

Unfertilized eggs,	2	} = 17.17 per cent., or about 17 per cent.
Eggs with dead embryos,	38	
Eggs apparently alive,	193	
Total,		233 eggs.

Cluster 3.

Unfertilized eggs,	-	} = 7.38 per cent., or about 7 per cent.
Eggs with dead embryos,	9	
Eggs apparently alive,	113	
Total,		122 eggs.

Cluster 4.

Unfertilized eggs,	1	} = 4.89 per cent., or about 5 per cent.
Eggs with dead embryos,	14	
Eggs apparently alive,	292	
Total,		307 eggs.

Cluster 5.

Unfertilized eggs,	2	} = 2.95 per cent., or about 3 per cent.
Eggs with dead embryos,	9	
Eggs apparently alive,	362	
Total,		373 eggs.

Averaging these 5 clusters we get:—

Dead eggs,	17	= 6.42 per cent., or about 6.5 per cent.
Eggs apparently alive,	248	= 93.58 per cent., or about 93.5 per cent.
Total,		265 eggs.

Since this place, after infection with *Flacherie*, contains on the average only 248 eggs with apparently living embryos per cluster, almost 2 clusters of this locality are necessary to equal a normal cluster. The number of the fresh clusters, estimated at about 400, thus has to be reduced to about 250. The number of apparently living eggs in this locality therefore decreased, after the wilt had operated, to about 42 per cent.¹

¹ This forest was cut down by the owner in the beginning of the winter of 1910-11, and all egg clusters which the forest contained were collected by the local superintendent; 444 clusters were found. Our estimate of the clusters in the autumn, which was 400, therefore was nearly correct. The number of apparently living eggs which remained after *Flacherie* did its work has to be increased 3 per cent., that is to say, to 45 per cent.

Boxford, Mass.

Division Agent, FRANCIS C. WORTHEN; Assistant Local Superintendent, HARRY L. COLE.

Two places were selected in the West Boxford district for the intended experiments. The locality which we shall consider first is situated opposite the almshouse, near the Almshouse Road, and is only about a quarter of an acre in size. This small isolated wood is composed of oaks almost fifty to sixty years of age, and there is no brush. The gypsy moth caterpillars were numerous here in the summer of 1909. No disease had been noticed among them, according to Mr. Worthen and Mr. Cole, nor have any artificial means of destroying the gypsy moth been undertaken here. Mr. Worthen and I estimated the number of egg clusters at the time of my first visit, on May 6, 1910, at about 200.

Mr. Cole was intrusted with raising the caterpillars for the Boxford experiments. Having received no notice of the wilt making its appearance in the brood, on the 14th of June, 1910, I went to Boxford to inspect the material. It was found that Mr. Cole had reared the caterpillars in a very cold cellar, where they were eating but little and were retarded considerably in their development. He was instructed to place the caterpillars immediately in a warmer place in the open air. On June 19, 1910, a letter from him announced that Flacherie had broken out in his brood. On June 21 I went to Boxford to confirm his statement. About 5 per cent. of the caterpillars of this brood had already died of Flacherie, and most of the individuals still living showed all the signs of the disease.

One part of this brood was exposed, with the assistance of Mr. Cole, on the same day in the western part of the selected locality. The bag containing the material was fastened between twigs of oak trees, about 6 feet from the ground. Most of the caterpillars of this locality were at this time about ready for the fourth molt.

The fresh clusters at this place were estimated, on Aug. 26, 1910, by the division agent and myself, to be about 60. The first 5 clusters which were found were collected and examined. The examination resulted as follows:—

<i>Cluster 1.</i>	
Unfertilized eggs,	-
Eggs with dead embryos,	6
Eggs apparently alive,	116
} = 4.92 per cent., or about 5 per cent.	
} = 95.08 per cent., or about 95 per cent.	

Total,	122 eggs.

Cluster 2.

Unfertilized eggs,	1	} = 10.16 per cent., or about 10 per cent.
Eggs with dead embryos,	12	
Eggs apparently alive,	115		= 89.84 per cent., or about 90 per cent.
<hr/>		
Total,	128	eggs.

Cluster 3.

Unfertilized eggs,	3	} = 7.14 per cent., or about 7 per cent.
Eggs with dead embryos,	4	
Eggs apparently alive,	91		= 92.86 per cent., or about 93 per cent.
<hr/>		
Total,	98	eggs.

Cluster 4.

Unfertilized eggs,	8	} = 28.24 per cent., or about 28 per cent.
Eggs with dead embryos,	16	
Eggs apparently alive,	61		= 71.76 per cent., or about 72 per cent.
<hr/>		
Total,	85	eggs.

Cluster 5.

Unfertilized eggs,	-	} = 2.96 per cent., or about 3 per cent.
Eggs with dead embryos,	5	
Eggs apparently alive,	164		= 97.04 per cent., or about 97 per cent.
<hr/>		
Total,	169	eggs.

The average of these 5 clusters gives the following result: —

Dead eggs,	11	= 9.17 per cent., or about 9 per cent.
Eggs apparently alive,	109	= 90.83 per cent., or about 91 per cent.
<hr/>		
Total,	120	eggs.

Since this place, weakened by the wilt, contained only 109 eggs with apparently living embryos to the cluster, almost 4 clusters were necessary to equal the size of a normal cluster. The number of fresh egg clusters, which were estimated at 60, thus must be reduced to about 20 clusters. The number of apparently living eggs was therefore decreased, as the result of Flacherie, to about 10 per cent.

The second place which was selected in West Boxford for experiments with the disease consists of an isolated wood of about half an acre. Most of the trees are oaks about thirty years of age, mixed with underbrush. This locality is situated on Highland Street, between two apple orchards. In the summer of 1909 the gypsy moth caterpillars were relatively more numerous than at the first place. No dis-

ease was noticed among them by Messrs. Worthen and Cole, but it is nevertheless possible that the wilt might have made its appearance. No artificial means for destroying the gypsy moth had been undertaken here. The number of egg clusters present at the time of my first visit in the spring of 1910 was estimated by Mr. Worthen and myself at about 550.

Flacherie, which had been developed artificially by Mr. Cole, was planted in this locality June 21, 1910, in the same manner as in the place first described. The caterpillars were about ready for the fourth molt, as in the first experiment. With the assistance of the division agent the fresh clusters at this locality were estimated on Aug. 26, 1910, to be about 80. The microscopical examination of the first 5 clusters found shows:—

Cluster 1.

Unfertilized eggs,	1	} = 6.67 per cent., or about 6.5 per cent.	
Eggs with dead embryos,	10		
Eggs apparently alive,	154		=93.33 per cent., or about 93.5 per cent.
Total,	165 eggs.		

Cluster 2.

Unfertilized eggs,	1	} = 6.25 per cent., or about 6 per cent.	
Eggs with dead embryos,	5		
Eggs apparently alive,	90		=93.75 per cent., or about 94 per cent.
Total,	96 eggs.		

Cluster 3.

Unfertilized eggs,	2	} = 7.09 per cent., or about 7 per cent.	
Eggs with dead embryos,	7		
Eggs apparently alive,	118		=92.91 per cent., or about 93 per cent.
Total,	127 eggs.		

Cluster 4.

Unfertilized eggs,	3	} = 9.68 per cent., or about 9.5 per cent.	
Eggs with dead embryos,	12		
Eggs apparently alive,	140		=90.32 per cent., or about 90.5 per cent.
Total,	155 eggs.		

Cluster 5.

This cluster proved to be entirely without eggs, and it consisted only of a mass of wool of about 1 square centimeter in size. The female moth, which deposited this cluster, seems to have been absolutely sterile. It started mechanically, it is true, to lay eggs, but of course it could deposit nothing except the hairs from its abdomen.

The average of these clusters gives the following result:—

Dead eggs,	8	= 7.34 per cent., or about 7 per cent.
Eggs apparently alive,	101	= 92.66 per cent., or about 93 per cent.
	109	eggs.

Since this locality, which had been infected with the wilt, showed only 101 eggs with apparently living embryos on the average per cluster, about 4 clusters would be equal to a normal one. The fresh egg clusters, which were estimated at about 80, thus have to be reduced to about 20. The number of apparently living eggs in this infested locality has thus decreased to about 4 per cent.

A third locality in which the wilt appeared naturally was somewhat closely inspected. A small isolated wood of about 3,000 square feet is situated on Main Street, about 500 yards south of Wood's Corner. The trees consist of oaks a hundred years or more of age, and the place is free from underbrush. The gypsy moth caterpillars were very numerous here in the summer of 1909, but no definite statement can be made as to whether or not there was disease among them. If the disease was present, it was doing little harm, as otherwise dead caterpillars in large numbers would have been noticed, without doubt, by the division agent or the local superintendent. Mr. Worthen estimated the number of clusters present in the spring of 1910 at about 400. No artificial means for destroying the gypsy moth were undertaken. Measured in a straight line this place is at least 1 mile from the nearest of the two localities previously mentioned. Flacherie was noticed here at a time when most caterpillars were in the fourth molt. Here, too, the disease worked considerably among the caterpillars. It was hard to find even 50 clusters when Mr. Worthen and I estimated the freshly laid ones, on Aug. 26, 1910. For comparison the first 5 clusters found were collected and examined. They gave the following results:—

Cluster 1.

Unfertilized eggs,	-	} = 11.27 per cent., or about 11 per cent.
Eggs with dead embryos,	8	
Eggs apparently alive,	63	= 88.73 per cent., or about 89 per cent.
	71	eggs.

Cluster 2.

Unfertilized eggs,	1	} = 10.28 per cent., or about 10 per cent.
Eggs with dead embryos,	10	
Eggs apparently alive,	96	= 89.72 per cent., or about 90 per cent.
	107	eggs.

Cluster 3.

Unfertilized eggs, . . .	2	} = 6.94 per cent., or about 7 per cent.
Eggs with dead embryos, . . .	8	
Eggs apparently alive, . . .	134		= 93.06 per cent., or about 93 per cent.
<hr/>		
Total,	144 eggs.	

Cluster 4.

Unfertilized eggs, . . .	-	} = 4.26 per cent., or about 4 per cent.
Eggs with dead embryos, . . .	4	
Eggs apparently alive, . . .	90		= 95.74 per cent., or about 96 per cent.
<hr/>		
Total,	94 eggs.	

Cluster 5.

Unfertilized eggs, . . .	2	} = 8.59 per cent., or about 8.5 per cent.
Eggs with dead embryos, . . .	12	
Eggs apparently alive, . . .	149		= 91.41 per cent., or about 91.5 per cent.
<hr/>		
Total,	163 eggs.	

The average of these 5 clusters gives the following result: —

Dead eggs,	9	= 7.08 per cent., or about 7 per cent.
Eggs apparently alive, . . .	106	= 92.92 per cent., or about 93 per cent.
<hr/>		
Total,	115 eggs.	

Thus in this locality, also, in which the wilt appeared naturally, the egg clusters were far below the normal size. Examination showed that about 4 of these clusters would be necessary to equal a normal one in size. The estimated sum of 50 clusters, therefore, must be reduced to about 14. Hence, the apparently living eggs which remained amount to about 4 per cent.

Finally, a forest of about 30 acres was inspected. This is situated at an angle of 45°, and half a mile distant from the two first localities. In this forest, which consists mainly of large pines and oaks, the gypsy moth caterpillars had been present in considerable numbers during the summer of 1909, and were still more numerous during the first part of the summer of 1910. The owners of this place intended, according to the division agent, to cut down the forest, thus preventing a total stripping and decrease of the value of the wood. A powerful ally came to the support of the owners during the latter part of the summer of 1910, in the guise of *Flacherie*, which cleared up the caterpillars in a manner that left nothing to be desired. It cannot be determined whether the disease appeared naturally or was spread to this

forest from the two localities in which the experiments were performed. However this may be, the wilt had acted at any rate in such a virulent manner that in all these 30 acres of forest not a single fresh egg cluster could be found, notwithstanding the most painstaking search on the part of Mr. Worthen and myself.

Mr. Worthen also undertook, on his own behalf, the breeding of several hundred caterpillars, feeding them according to my instructions. The disease could be noticed in this brood as early as June 14, 1910. Most of these caterpillars had just passed the third molt. Three days later he exposed all the material among the caterpillars of a forest near his home. Soon he observed the "dying off" of the caterpillars which were there present. The number of the dead ones grew astonishingly, but the final result cannot be stated, since, unfortunately, the trees were later sprayed with arsenate of lead.

West Bedford, Mass.

The division agent and the local superintendent in this locality were not requested to perform the experiments. My friend, Mr. L. W. Swett, the well-known specialist in Geometridæ, asked me in the spring of 1910 to undertake an experiment with the wilt upon his estate on Davis Street, northeast of the railroad station, in West Bedford. We inspected the place for this purpose on May 29, and the locality appeared to be a very suitable one for the work. It consists of two isolated strips of wood, which meet at a right angle. One strip comprises oaks about fifty years of age, mixed with some brush; while the other consists of dense birch brush about six years old. The whole locality comprises about three-quarters of an acre. The gypsy moth was first discovered here in 1908, and the place since that time has been under continuous observation by Mr. Swett. He assured me that there were positively no signs of a disease among the caterpillars. During the summer of 1909 the caterpillars were quite numerous. Part of the egg clusters, which were laid in the autumn of 1909, were killed with creosote, but there were still present, according to Mr. Swett's and my estimation at the time of my first visit, about 400 clusters on the oaks and about 100 clusters on the birches.

The caterpillars for this experiment were raised by the author at Forest Hills. They began to die from Flacherie after a continuous feeding of fourteen days, and just as they had passed the third molt. This material was planted, June 22, 1910, in the birch brush, and the bag was fastened about 6 feet from the ground. Most of the caterpillars of this locality were at that time half way between the third and fourth molt. The place was visited again on July 18, 1910, to determine the progress of the disease. Mr. Swett and I found that the caterpillars were dying in considerable numbers, and the percentage of dead individuals was greatest on the shortest brush, and decreased

gradually the higher the vegetation grew. For instance, all the caterpillars which had been feeding on the small willow brushes were already dead. This brush, hardly 3 feet high, occurs here and there in front of the two rows of woods. The dead caterpillars were readily seen, as they were hanging all over the brush. Many of the caterpillars on the birches were dying, but a considerable number of living individuals was still present. In the colony of the high oaks, however, the wilt had

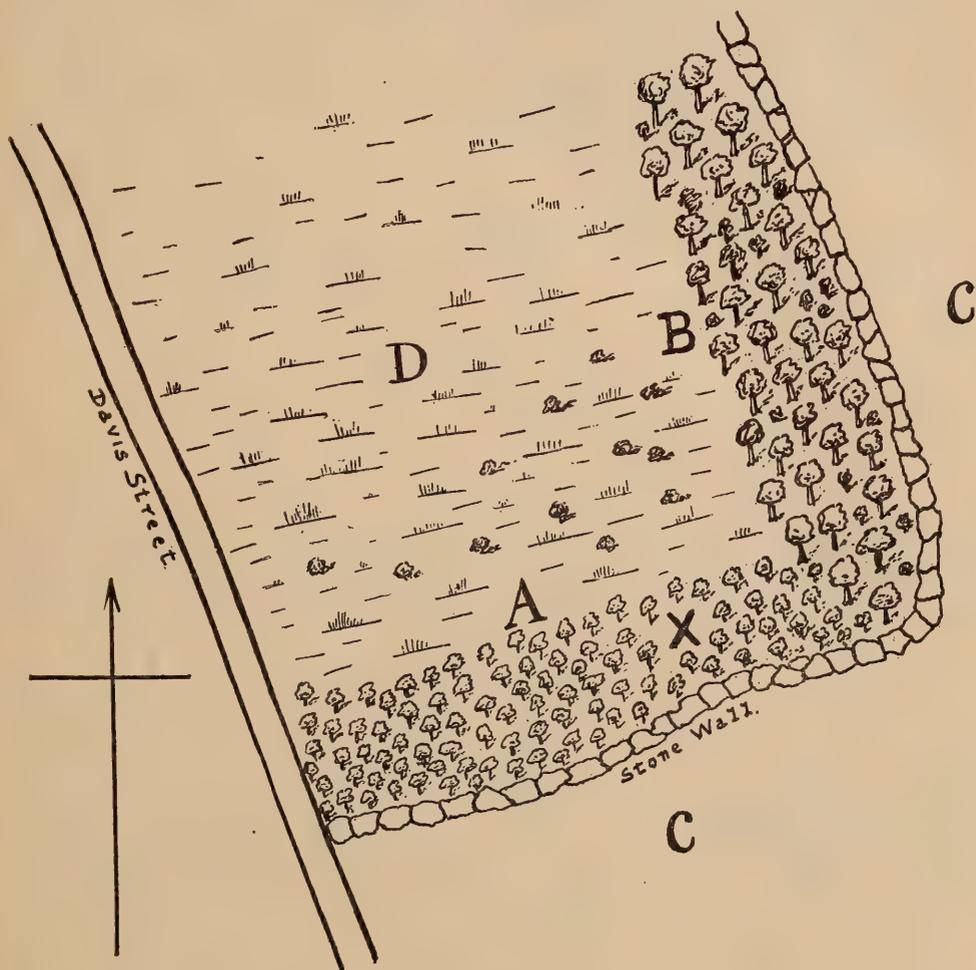


Fig. 3.—Experiment, West Bedford, Mass. A. Dense birches. X. Exposure of disease. B. Oaks and underwood. C. Field. D. Marshy meadow with a few scattered willows.

not spread so much, although dead individuals were found in considerable numbers.

On Sept. 23, 1910, the freshly laid egg clusters were estimated. We made the interesting discovery that there existed no fresh clusters in the row overgrown with birch. Thus, all the caterpillars, at least the females, had been killed by *Flacherie*. To be certain of this fact the crevices of the bordering stone wall were carefully examined, since the gypsy moth female selects with preference such hidden places for oviposition. But no fresh clusters could be found here. The other row with the high oaks, however, proved to have a relatively large number

of fresh clusters, which were estimated at about 150. Mr. Swett later made an examination and confirmed these facts. There is no sufficient explanation so far for the peculiar behavior of the wilt in this locality. Apparently the wind here played a special rôle. The difference in the vegetation may also have had some influence. Does the eating of birch foliage hasten the production of the disposition to Flacherie among the caterpillars?

The accompanying map will complete the description of the West Bedford locality (Fig. 3).

The microscopic examination of the 5 first egg clusters, found on the oaks, gave the following result:—

Cluster 1.

Unfertilized eggs,	-	} = 2.69 per cent., or about 2.5 per cent.
Eggs with dead embryos,	5	
Eggs apparently alive,	181	= 97.31 per cent., or about 97.5 per cent.
<hr/>		
Total,	186	eggs.

Cluster 2.

Unfertilized eggs,	2	} = 2.67 per cent., or about 2.5 per cent.
Eggs with dead embryos,	7	
Eggs apparently alive,	328	= 97.33 per cent., or about 97.5 per cent.
<hr/>		
Total,	337	eggs.

Cluster 3.

Unfertilized eggs,	1	} = 3.25 per cent., or about 3 per cent.
Eggs with dead embryos,	4	
Eggs apparently alive,	149	= 96.75 per cent., or about 97 per cent.
<hr/>		
Total,	154	eggs.

Cluster 4.

Unfertilized eggs,	12	} = 20.65 per cent., or about 20.5 per cent.
Eggs with dead embryos,	58	
Eggs apparently alive,	269	= 79.35 per cent., or about 79.5 per cent.
<hr/>		
Total,	339	eggs.

Cluster 5.

Unfertilized eggs,	1	} = 3.19 per cent., or about 3 per cent.
Eggs with dead embryos,	9	
Eggs apparently alive,	303	= 96.81 per cent., or about 97 per cent.
<hr/>		
Total,	313	eggs.

The average of these 5 clusters gives the following result:—

Dead eggs,	20	= 7.52 per cent., or about 7.5 per cent.
Eggs apparently alive,	246	= 92.48 per cent., or about 92.5 per cent.
	266	
Total,	266	eggs.

Since this locality, in which the wilt has worked, contained only 246 eggs with apparently living embryos in average per cluster, nearly 2 clusters were necessary to equal a single normal cluster. The number of fresh clusters, which were estimated at about 150, must therefore be reduced to about 90. The number of apparently living eggs of that part of this locality which bears the oaks was therefore decreased to about 22.5 per cent. after the wilt had worked, while, as already mentioned, the part with the birches contained probably no living eggs.

Haverhill, Mass.

Division Agent, H. F. ARMSTRONG; Local Superintendent, G. F. MOORE.

With the assistance of the local superintendent a place was selected for the experiment in East Parish, Haverhill; it is situated west of East Broadway and northeast of Millway Pond, and on the Old Country Road. This locality represents almost 50 acres of isolated forest, in which oaks about thirty years old, mixed with underbrush, prevail. Only about 12 acres of this forest are infested with the gypsy moth. The caterpillars were numerous here during the summer of 1909, but no disease was present, according to the local superintendent. On May 18, 1910, our joint estimation gave 1,000 clusters per acre, *i.e.*, altogether about 12,000 clusters. No artificial means of destroying the gypsy moth had been undertaken.

Mr. Moore, owing to lack of time, could not raise caterpillars for the experiment, and he had no reliable man to whom he could entrust the work. Upon the recommendation of Mr. Fitzgerald, the field inspector of the northern divisions, the brother of the local superintendent of Methuen, Mass., Mr. Wagland, was intrusted with the raising of the caterpillars. As no communication was received from Mr. Walter Wagland by June 21, 1910, that his caterpillars showed signs of Flacherie, I went on this day to Methuen, to convince myself of the condition of the insects. The local superintendent, A. H. Wagland, Mr. Walter Wagland's brother, was with me, and we found that all the caterpillars were sick and that several had already died. The reason why I had received no word from Mr. Walter Wagland was that he did not recognize the disease. The planting of the material in the selected place in Haverhill was accomplished the next day. All the material was exposed in a pasteboard box in the western part of the forest, about 6 feet from the ground and between limbs of oak trees.

Most of the caterpillars of this locality were at this time about half way between the third and fourth molts.

The place was visited again Aug. 30, 1910, with the local superintendent of Haverhill, to see how the wilt had operated, and how many fresh egg clusters were present. First it was noticed that the infested portion of the forest was not uniformly infected with Flacherie. While the periphery of the infested area (about 8 to 9 acres) showed a very considerable decrease of the egg clusters in comparison with those of the spring of 1910, the real center of the colony, which covered 3 to 4 acres, had been more resistant to the disease, although here also the number of the fresh clusters had decreased considerably in comparison with the clusters of the previous year. Altogether the number of fresh clusters of the whole colony was estimated by us to be about 3,500. The 5 clusters which served for examination proved to be as follows:—

Cluster 1.

Unfertilized eggs,	8	} = 28.57 per cent., or about 28.5 per cent.	
Eggs with dead embryos,	28		
Eggs apparently alive,	90		= 71.43 per cent., or about 71.5 per cent.
Total,	126		eggs.

Cluster 2.

Unfertilized eggs,	-	} = 3.31 per cent., or about 3 per cent.	
Eggs with dead embryos,	5		
Eggs apparently alive,	146		= 96.69 per cent., or about 97 per cent.
Total,	151		eggs.

Cluster 3.

Unfertilized eggs,	4	} = 5.63 per cent., or about 5.5 per cent.	
Eggs with dead embryos,	13		
Eggs apparently alive,	285		= 94.37 per cent., or about 94.5 per cent.
Total,	302		eggs.

Cluster 4.

Unfertilized eggs,	7	} = 12.36 per cent., or about 12 per cent.	
Eggs with dead embryos,	25		
Eggs apparently alive,	227		= 87.64 per cent., or about 88 per cent.
Total,	259		eggs.

Cluster 5.

Unfertilized eggs,	-	} = 1.95 per cent., or about 2 per cent.	
Eggs with dead embryos,	6		
Eggs apparently alive,	302		= 98.05 per cent., or about 98 per cent.
Total,	308		eggs.

The average of these 5 clusters gives the following result:—

Dead eggs,	19	= 8.30 per cent., or about 8 per cent.
Eggs apparently alive,	210	=91.70 per cent., or about 92 per cent.
	<hr/>	
Total,	229	eggs.

Since a normal cluster contains, on the average, 433 eggs with apparently living embryos, and this locality in which Flacherie had prevailed contained only 210 eggs with apparently living embryos on the average per cluster, 2 clusters were necessary to equal a normal one. The number of fresh clusters, which were estimated to be about 3,500, must therefore be reduced to about 1,750. The number of apparently living eggs had decreased in this locality, after the wilt had operated, to about 14.5 per cent.

Marshfield, Mass.

Division Agent, JOHN A. FARLEY; Local Superintendent, P. R. LIVERMORE.

I did not visit this locality, but the experiment was undertaken by the local superintendent with the assistance of Mr. Joseph Sherman of Marshfield, who raised the caterpillars according to my instructions. On visiting Marshfield on June 24, 1910, it was found that Mr. Sherman's caterpillars, most of which were ready to undergo the fourth molt, were sick with Flacherie. He was instructed to expose the material, with the assistance of the local superintendent, in a forest infested with the gypsy moth. This was done on June 26, 1910, in a forest of 10 acres. On Oct. 25, 1910, the local superintendent sent, upon my request, a number of fresh egg clusters from the locality where the disease had been planted, and he remarked that the number of egg clusters were considerably decreased in comparison with those present in the spring of 1910. Unfortunately, further detailed communications regarding this locality were not received. The first 5 clusters, which were taken from the top of the shipment, were examined microscopically. The result was as follows:—

Cluster 1.

Unfertilized eggs,	1	} = 4.26 per cent., or about 4 per cent.
Eggs with dead embryos,	10	
Eggs apparently alive,	247	=95.74 per cent., or about 96 per cent.
	<hr/>	
Total,	258	eggs.

Cluster 2.

Unfertilized eggs,	8	} = 13.47 per cent., or about 13.5 per cent.
Eggs with dead embryos,	65	
Eggs apparently alive,	469	= 86.53 per cent., or about 86.5 per cent.
	<hr/>	
Total,	542	eggs.

Cluster 3.

Unfertilized eggs,	2	} = 10.59 per cent., or about 10.5 per cent.
Eggs with dead embryos,	41	
Eggs apparently alive,	363	
<hr/>		
Total,	406	eggs.

Cluster 4.

Unfertilized eggs,	1	} = 5.28 per cent., or about 5 per cent.
Eggs with dead embryos,	14	
Eggs apparently alive,	269	
<hr/>		
Total,	284	eggs.

Cluster 5.

Unfertilized eggs,	4	} = 6.64 per cent., or about 6.5 per cent.
Eggs with dead embryos,	9	
Eggs apparently alive,	181	
<hr/>		
Total,	194	eggs.

The average of these 5 clusters gives the following result:—

Dead eggs,	31	= 9.20 per cent., or about 9 per cent.
Eggs apparently alive,	306	= 90.80 per cent., or about 91 per cent.
<hr/>		
Total,	337	eggs.

After the wilt had operated in this locality the size of the egg clusters was not up to the average size of the normal cluster, and the percentage of dead eggs was very high.

Kingston, Mass.

Division Agent, JOHN A. FARLEY; Local Superintendent, C. C. FAUNCE.

With the help of the field inspector, Mr. Norman Souther of Bridgewater, two places were selected for the intended experiments. The locality which we will first consider is an isolated part of the so-called "Rocky Nook," and is situated about 1 mile east of the Kingston-Plymouth car line. This place is about a quarter of an acre in size and mainly overgrown with oaks about twenty-five years of age. The gypsy moths were discovered here in the autumn of 1909 by finding egg clusters. The youth of the colony made it seem improbable that there was any disease among the caterpillars of 1909, and, moreover, the egg clusters had a considerable size. Several of the clusters found had been killed with creosote, but there were still left about 60 clusters, according to Mr. Souther's and my estimate.

The local superintendent was intrusted by Mr. Souther with the breeding of caterpillars. On June 24, 1910, I found the wilt in this brood. The same day, with the assistance of the local superintendent, one part of the material was exposed in the locality mentioned. This brood was thoroughly sick, but the "dying off" of the caterpillars had not begun. The bag containing the material was fastened between twigs about 7 feet from the ground. The caterpillars in this locality were at this time half way between the third and fourth molt.¹

On Oct. 25, 1910, the fresh egg clusters of this locality were estimated by the local superintendent and myself. We found that the place contained almost the same numbers of clusters as in the spring of 1910, with the difference, however, that many clusters had the hairy covering only in part. Several clusters completely lacked this covering. It seems that the disease spread very slowly, and that it did not kill many caterpillars but had merely given them a mild form of the disease, which manifested itself later in the manner mentioned, when the females laid their eggs. The 5 clusters which were first found were examined, like those of other localities. The examination gave the following interesting results:—

Cluster 1.

Unfertilized eggs,	2	} = 3.97 per cent., or about 4 per cent.	
Eggs with dead embryos,	13		
Eggs apparently alive,	363			=96.03 per cent., or about 96 per cent.
Total,	378 eggs.		

Cluster 2.

Unfertilized eggs,	6	} =18.85 per cent., or about 19 per cent.	
Eggs with dead embryos,	92		
Eggs apparently alive,	422			=81.15 per cent., or about 81 per cent.
Total,	520 eggs.		

Cluster 3.

Unfertilized eggs,	2	} =13.48 per cent., or about 13.5 per cent.	
Eggs with dead embryos,	58		
Eggs apparently alive,	385			=86.52 per cent., or about 86.5 per cent.
Total,	445 eggs.		

Cluster 4.

Unfertilized eggs,	1	} =20.98 per cent., or about 21 per cent.	
Eggs with dead embryos,	123		
Eggs apparently alive,	467			=79.02 per cent., or about 79 per cent.
Total,	591 eggs.		

¹ This experiment was intentionally undertaken with sick caterpillars only, and no dead ones, in order to see what effect the exposure of only sick individuals might have upon the healthy caterpillars in the field.

Cluster 5.

Unfertilized eggs,	-	} = 6.06 per cent., or about 6 per cent.
Eggs with dead embryos,	2	
Eggs apparently alive,	31	= 93.94 per cent., or about 94 per cent.
<hr/>		
Total,	33	eggs.

The average of these 5 clusters gives the following result:—

Dead eggs,	60	= 15.23 per cent., or about 15 per cent.
Eggs apparently alive,	334	= 84.77 per cent., or about 85 per cent.
<hr/>		
Total,	394	eggs.

Since this place, in which Flacherie had operated, contained on the average only 334 eggs with apparently living embryos per cluster, the size of these clusters was about one-quarter less than normal. The fresh clusters, which were estimated to be about 60, *i.e.*, the same number which was found in the spring, thus must be reduced to about 45. The number of apparently living eggs of this locality therefore was decreased, after the wilt had worked, to about 77 per cent.

This experiment also shows that the exposure of sick instead of dead caterpillars contributes to the spread of the wilt. As in such cases, however, the disease spreads slowly, the caterpillars, it is true, will not be killed in large numbers, but they will be infected more or less lightly. The result is that a high percentage of the eggs deposited by the females will fail to hatch.

The second place which was selected in Kingston for an experiment is situated on the eastern side of Jones River, opposite the poor farm. This is an isolated wood of about one-eighth of an acre in size, which contains several large oaks and underbrush. The gypsy moth was discovered here also by the finding of egg clusters first in the autumn of 1909. It cannot be stated whether disease was present among the caterpillars of the summer of 1909, but this seems improbable, owing to the youth of the colony. Several of the clusters were killed with creosote, but there were still left, according to Mr. Souther's estimate, about 50 clusters.

The planting of the sick material was accomplished on the same day and in the same manner as in the first locality. Estimating the fresh clusters on Oct. 25, 1910, unfortunately I found that most of these fresh clusters (about 25) had been already killed with creosote by the men working under the local superintendent. Even with the assistance of the local superintendent, only 2 untouched egg clusters could be found. Only 1 of these could be collected, since the second was out of reach. Although, therefore, we are unable to draw any

complete and final conclusions in regard to the work of the wilt in this locality, nevertheless the result of the examination of the single cluster which could be secured may be given:—

Unfertilized eggs,	1	} = 3.52 per cent., or about 3.5 per cent.
Eggs with dead embryos,	12	
Eggs apparently alive,	356		=96.48 per cent., or about 96.5 per cent.
<hr/>		
Total,	369 eggs.	

All we can say concerning this locality is that through the operation of Flacherie, which was introduced by sick material only, the number of fresh clusters seems to have been reduced in comparison with that of the previous year.

Brockton, Mass.

Division Agent, L. W. HODGKINS; Local Superintendent, E. MOLTAN.

The place which, with the assistance of the inspector, Mr. Norman Souther of Bridgewater, was selected for an experiment, is situated near Oak Street, northwest of Brockton Center and east of the Dutchland Farm. The place, of about half an acre, consists of a growth of oaks about forty to fifty years of age; no brush is present. The caterpillars of the gypsy moth were abundant here in the summer of 1909, but no disease was noticed among them. Several of the clusters were killed with creosote during the winter of 1909-10. The clusters which were left were estimated by Mr. Souther and myself to be about 40.

The raising of caterpillars for the intended experiment Mr. Souther intrusted to Mr. Rudolph Marshall, 218 Battle Street, Brockton. On June 24, 1910, the brood was inspected. Several caterpillars had already died from the wilt and the others were found to be sick. This same day the whole material was exposed in the selected place. The bag was fastened between oak limbs, about 8 feet from the ground. Most of the caterpillars of this locality were at this time about half way between the third and fourth molt.

This place was visited again on Oct. 7, 1910, with Mr. Souther, to determine the number of fresh clusters. But in spite of the most strenuous search there were found but 4 clusters; these were collected for examination. They resulted as follows:—

<i>Cluster 1.</i>		
Unfertilized eggs,	2	} = 2.99 per cent., or about 3 per cent.
Eggs with dead embryos,	10	
Eggs apparently alive,	389		=97.01 per cent., or about 97 per cent.
<hr/>		
Total,	401 eggs.	

Cluster 2.

Unfertilized eggs,	13	} = 11.71 per cent., or about 11.5 per cent.
Eggs with dead embryos,	22	
Eggs apparently alive,	264	
<hr/>		
Total,	299	eggs.

Cluster 3.

Unfertilized eggs,	3	} = 5.47 per cent., or about 5.5 per cent.
Eggs with dead embryos,	14	
Eggs apparently alive,	294	
<hr/>		
Total,	311	eggs.

Cluster 4.

Unfertilized eggs,	2	} = 4.81 per cent., or about 5 per cent.
Eggs with dead embryos,	18	
Eggs apparently alive,	396	
<hr/>		
Total,	416	eggs.

The average of these 4 clusters gives the following result:—

Dead eggs,	21	= 5.88 per cent., or about 6 per cent.
Eggs apparently alive,	336	= 94.12 per cent., or about 94 per cent.
<hr/>		
Total,	357	eggs.

Since this place, in which the wilt had operated, contained only 336 eggs with apparently living embryos on the average per cluster, the size of these clusters was about one-fourth less than normal. The number of the fresh clusters, which were found to be 4, must thus be reduced to 3. The number of apparently living eggs of this locality therefore was decreased, after Flacherie had worked, to about 7.5 per cent.

Beverly, Mass.

Division Agent, SAUL PHILLIPS; Assistant, W. F. HOLMES.

With the help of the assistant of the division agent two places were selected for the experiments. The place which we will first consider is situated near Hart Street, north of Greenwood Avenue, Beverly Farms. It is an isolated wood of about 1 acre, mainly overgrown with maple about fifty to sixty years of age, and yellow birch, and has dense underbrush. The gypsy moth caterpillars were very numerous here during the summer of 1909, but no disease was noticed among them. A small percentage of egg clusters was killed with creosote during the

winter of 1909-10. A joint estimate of the egg clusters in this locality made with the assistant of the division agent in the spring of 1910 resulted in finding about 500 clusters.

The rearing of caterpillars was undertaken by Mr. Phillips's assistant. On June 20, 1910, he noticed the first dead individuals in the brood. Three days after the receipt of this communication I went to Beverly to inspect the material. Many of the caterpillars had already died from the wilt. This same day (June 25), with the help of the assistant, one part of the material was exposed in the western portion of the locality mentioned. The bag containing the material was fastened about 6 feet from the ground, between limbs with dense foliage. Most of the caterpillars of this locality had at this time just passed the third molt.

After the wilt had operated all through the summer among the caterpillars of this locality, the place was visited again on Sept. 13, 1910, together with Mr. Phillips's assistant. We estimated the number of fresh clusters present to be about 250. The decrease in the size of the clusters compared with those of the previous year was very striking. The examination of the first 5 clusters which were found gave the following result:—

Cluster 1.

Unfertilized eggs,	5	} = 13.60 per cent., or about 13.5 per cent.	
Eggs with dead embryos,	12		
Eggs apparently alive,	108		= 86.40 per cent., or about 86.5 per cent.
Total,			125 eggs.

Cluster 2.

Unfertilized eggs,	2	} = 5.92 per cent., or about 6 per cent.	
Eggs with dead embryos,	8		
Eggs apparently alive,	159		= 94.08 per cent., or about 94 per cent.
Total,			169 eggs.

Cluster 3.

Unfertilized eggs,	1	} = 7.37 per cent., or about 7 per cent.	
Eggs with dead embryos,	6		
Eggs apparently alive,	88		= 92.63 per cent., or about 93 per cent.
Total,			95 eggs.

Cluster 4.

Unfertilized eggs,	1	} = 5.76 per cent., or about 5.5 per cent.	
Eggs with dead embryos,	7		
Eggs apparently alive,	131		= 94.24 per cent., or about 94.5 per cent.
Total,			139 eggs.

Cluster 5.

Unfertilized eggs,	-	} = 6.45 per cent., or about 6.5 per cent.
Eggs with dead embryos,	4	
Eggs apparently alive,	58	
<hr/>		
Total,	62 eggs.	

The average of these 5 clusters gives the following result:—

Dead eggs,	9	= 7.63 per cent., or about 7.5 per cent.
Eggs apparently alive,	109	= 92.37 per cent., or about 92.5 per cent.
<hr/>		
Total,	118 eggs.	

Since a normal cluster contains on the average 433 eggs with apparently living embryos, and this place, in which Flacherie had operated, contained only 109 eggs with apparently living embryos on the average per cluster, about 4 clusters were necessary to equal the size of a normal one. The number of fresh clusters, which were estimated to be about 250, thus must be reduced to about 65. The number of apparently living eggs of this locality therefore was decreased, after the wilt had worked, to about 15 per cent.

For the second experiment a small isolated group of oaks, about eighty years of age, was selected. This place is situated near the railroad station, Beverly Farms, between the railroad track and the ocean. The caterpillars of the gypsy moth have always appeared here only in small numbers, and there were hardly more than one dozen clusters in the spring of 1910, according to our estimate. It must be mentioned, especially, that this locality is always exposed to very strong winds.

Flacherie, artificially developed by the assistant of the division agent, was planted among the caterpillars at this place on June 25, 1910, in the same manner as in the first locality. Considering the heavy breeze the material was placed in a wooden box, which was then fastened between limbs; thus the wind was not able to carry off the whole material. Most of the caterpillars of this place were about ready at this time to undergo the third molt.

On Sept. 13, 1910, this locality was visited again. The wilt had done very considerable damage to the caterpillars. Although the place was carefully searched with Mr. Holmes's assistance, we could find but 2 fresh clusters. One of these is especially remarkable, as it lacks completely the protecting covering. The microscopic examination of both clusters gave the following results:—

Cluster 1.

Unfertilized eggs,	3	} = 9.17 per cent., or about 9 per cent.
Eggs with dead embryos,	8	
Eggs apparently alive,	109		=90.83 per cent., or about 91 per cent.
Total,		120 eggs.

Cluster 2.¹

Unfertilized eggs,	38	} =87.50 per cent., or about 87.5 per cent.
Eggs with dead embryos,	116	
Eggs apparently alive,	22		=12.50 per cent., or about 12.5 per cent.
Total,		176 eggs.

The average of these 2 clusters gives the following:—

Dead eggs,	83	=55.70 per cent., or about 55.5 per cent.
Eggs apparently alive,	66	=44.30 per cent., or about 44.5 per cent.
Total,		149 eggs.

Since this place, in which Flacherie had operated, contained only 66 eggs with apparently living embryos on the average per cluster, the size of these clusters was about five-sixths less than normal. The number of fresh clusters, which were found to be 2, thus equal together only one-third of a normal one. The number of apparently living eggs of this locality therefore had decreased, after the wilt had worked, to about 3 per cent.

Cohasset, Mass.

Division Agent, F. A. BATES; Local Superintendent, J. E. GRASSIE.

An island, known as Barron's Island, which is situated southeast of Cohasset in the headpart of Bailey's Creek, was selected for the experiment. This island has an area of about 10 acres, and is densely overgrown, mostly with oaks about twenty-five years of age and with underbrush. The gypsy moth was quite numerous here in 1909, but there was no disease among the caterpillars, according to Mr. Grassie's statement. Our joint estimate of the clusters which were present in the spring of 1910 was about 2,000. No artificial means of destroying the gypsy moth had been undertaken here.

Mr. Grassie, who was intrusted with the breeding of the caterpillars, noticed the wilt in this brood after a feeding of about sixteen days. On June 27, 1910, the caterpillars were inspected, and there were found

¹ Without the protecting cover.

about 70 per cent. individuals already dead from the disease.¹ The same day all the material was exposed, with the assistance of Mr. Grassie, in the western part of the selected place, and about 6 feet from the ground. Most of the caterpillars of this locality were at this time about ready to undergo the fourth molt.

On Sept. 26, 1910, the island was visited again, in company of the local superintendent, to determine in what manner the wilt had operated among the caterpillars. An especially considerable reduction of the number of the fresh egg clusters, compared with those of the previous year, had not occurred. According to our estimate there were about 1,500 fresh clusters. The size of each of these clusters, compared with the clusters found in the spring of 1910, was diminished in such a degree, however, that the clusters were often no larger than a bean. The eggs also were often only covered in part with hair. This, as well as the comparatively small mortality and the smallness of the fresh clusters, may be perhaps a consequence of the late planting of the disease. It is true that a number of caterpillars were killed, but most of them only grew slightly sick, the disease again expressing itself at the time of oviposition. The fresh clusters of this locality were also of an abnormally light yellowish color, which was noticed nowhere else.

The examination of the first 5 clusters found gave the following result:—

<i>Cluster 1.</i>	
Unfertilized eggs,	4
Eggs with dead embryos,	7
Eggs apparently alive,	162
	173
Total,	173 eggs.
 <i>Cluster 2.</i>	
Unfertilized eggs,	3
Eggs with dead embryos,	15
Eggs apparently alive,	58
	76
Total,	76 eggs.
 <i>Cluster 3.</i>	
Unfertilized eggs,	1
Eggs with dead embryos,	6
Eggs apparently alive,	50
	57
Total,	57 eggs.

¹ It should be mentioned that Mr. Grassie sent a telephone communication on June 12, 1910, that the wilt had made its appearance among his caterpillars, but by a mistake I did not receive this notice until June 23.

Cluster 4.

Unfertilized eggs,	5	} = 18.31 per cent., or about 18 per cent.
Eggs with dead embryos,	21	
Eggs apparently alive,	116	
<hr/>		
Total,	142 eggs.	

Cluster 5.

Unfertilized eggs,	8	} = 39.15 per cent., or about 39 per cent.
Eggs with dead embryos,	66	
Eggs apparently alive,	115	
<hr/>		
Total,	189 eggs.	

The average of these 5 clusters gives the following result: —

Dead eggs,	27	= 21.26 per cent., or about 21 per cent.
Eggs apparently alive,	100	= 78.74 per cent., or about 79 per cent.
<hr/>		
Total,	127 eggs.	

Since this place, in which Flacherie had worked, contained only 100 eggs with apparently living embryos on the average per cluster, more than 4 clusters were necessary to equal a normal cluster. Thus the number of fresh clusters must be reduced to about 370. The number of apparently living eggs of this locality therefore had decreased, after the wilt had operated, to about 18 per cent.

Hingham, Mass.

Division Agent, F. A. BATES; Local Superintendent, A. W. YOUNG.

For the experiment an island of about 1 acre was selected, very densely overgrown with low wood. This island is situated east of Water Street and south of the railroad track in the so-called Millpond. The wood consists mainly of oaks and birches of five to six years of age, and of underbrush. The gypsy moth was quite numerous here in the summer of 1909, but there was no disease among the caterpillars, according to the statements of the division agent and the local superintendent. Several of the clusters were killed with creosote during the winter of 1909–10. The number of the clusters which still remained was estimated by Mr. Young and myself to be about 100.

The breeding of a series of caterpillars was accomplished exactly according to my instructions by the local superintendent, but unfortunately he omitted to send word when the wilt made its appearance, since he had understood that he was to notify me only after all the caterpillars of the brood had died. To convince myself about the con-

dition of the brood, I inspected the caterpillars July 1, 1910, and found that about 60 per cent. of them had succumbed to Flacherie. The first dead caterpillars were noticed by Mr. Young about fifteen days before. On the same day the whole of the material was exposed, with Mr. Young's assistance, in the southwestern part of the island, about 5 feet from the ground. Most of the caterpillars of this locality had at this time just undergone the fourth molt.

On Sept. 26, 1910, this island was visited, again in company with the local superintendent. We could see that the wilt had done very considerable damage to the caterpillars, for there were only a few scattered clusters. According to our estimate there were hardly 15 fresh clusters present; these, moreover, were much smaller in size than those of the previous year. It was also noticed that the clusters were often only partly covered with hair. All these conditions may well be attributed to Flacherie. The almost full-grown caterpillars had contracted the disease, and the females which then emerged from pupæ produced by these caterpillars were unable to oviposit like healthy moths.

The examination of the first 5 clusters found gave the following result:—

Cluster 1.

Unfertilized eggs,	3	}	= 9.56 per cent., or about 9.5 per cent.
Eggs with dead embryos,	10		
Eggs apparently alive,	123		
Total,	136		eggs.

Cluster 2.

Unfertilized eggs,	3	}	= 8.82 per cent., or about 9 per cent.
Eggs with dead embryos,	12		
Eggs apparently alive,	155		
Total,	170		eggs.

Cluster 3.

Unfertilized eggs,	1	}	= 4.73 per cent., or about 4.5 per cent.
Eggs with dead embryos,	7		
Eggs apparently alive,	161		
Total,	169		eggs.

Cluster 4.

Unfertilized eggs,	2	}	= 10.77 per cent., or about 10.5 per cent.
Eggs with dead embryos,	5		
Eggs apparently alive,	58		
Total,	65		eggs.

Cluster 5.

Unfertilized eggs,	4	} = 9.22 per cent., or about 9 per cent.
Eggs with dead embryos,	9	
Eggs apparently alive,	128		=90.78 per cent., or about 91 per cent.
<hr/>		
Total,	141 eggs.	

The average of these 5 clusters gives the following result:—

Dead eggs,	11	= 8.09 per cent., or about 8 per cent.
Eggs apparently alive,	125	=91.91 per cent., or about 92 per cent.
<hr/>		
Total,	136 eggs.	

Since this place, in which Flacherie had operated, contained only 125 eggs with apparently living embryos on the average per cluster, almost 4 clusters were necessary to equal a normal one. The number of the fresh clusters thus must be reduced to about 5. The number of apparently living eggs of this locality therefore had decreased, after the wilt had worked, to about 5 per cent.

Byfield, Mass.

On June 30, 1910, a letter was received from Mr. James O. Hale of Byfield, in which he stated that he had heard of my Flacherie experiments of 1909, and asked for aid in diminishing the gypsy moth caterpillars by using Flacherie. I therefore visited the locality on July 5, 1910, and took with me sick and dead caterpillars which had been raised at Forest Hills. The forest in question is about 4 to 5 acres in size, and consists mainly of oaks of different ages and some underbrush. It is situated on the border between Rowley and Newbury. It is not isolated, but connected with woods which belong to other persons. At the time of my arrival most of the caterpillars had already undergone the fifth molt, so that it seemed questionable whether the disease would be able to show much success this year. The infected material was exposed in the southwestern part of the forest, about 7 feet from the ground. It proved to be impossible to secure a correct estimate of the caterpillars which were present; all that could be stated was that the caterpillars were quite plentiful.

This locality was visited again with Mr. Hale on Sept. 16, 1910, to determine the results. Mr. Hale gave his opinion that there was, at the least, no increase in the number of egg clusters compared with that of the previous year, although there was no visible decrease in the number of the fresh clusters. However, these fresh clusters were considerably smaller than those of the preceding year.

The first 5 clusters collected gave the following counts:—

Cluster 1.

Unfertilized eggs,	2	} = 8.33 per cent., or about 8 per cent.
Eggs with dead embryos,	6	
Eggs apparently alive,	88	= 91.67 per cent., or about 92 per cent.
<hr/>		
Total,	96	eggs.

Cluster 2.

Unfertilized eggs,	1	} = 3.76 per cent., or about 3.5 per cent.
Eggs with dead embryos,	4	
Eggs apparently alive,	128	= 96.24 per cent., or about 96.5 per cent.
<hr/>		
Total,	133	eggs.

Cluster 3.

Unfertilized eggs,	1	} = 2.75 per cent., or about 2.5 per cent.
Eggs with dead embryos,	5	
Eggs apparently alive,	212	= 97.25 per cent., or about 97.5 per cent.
<hr/>		
Total,	218	eggs.

Cluster 4.

Unfertilized eggs,	2	} = 4.72 per cent., or about 4.5 per cent.
Eggs with dead embryos,	4	
Eggs apparently alive,	121	= 95.28 per cent., or about 95.5 per cent.
<hr/>		
Total,	127	eggs.

Cluster 5.

Unfertilized eggs,	3	} = 5.59 per cent., or about 5.5 per cent.
Eggs with dead embryos,	6	
Eggs apparently alive,	152	= 94.41 per cent., or about 94.5 per cent.
<hr/>		
Total,	161	eggs.

The average of these 5 clusters gives the following result: —

Dead eggs,	7	= 4.76 per cent., or about 4.5 per cent.
Eggs apparently alive,	140	= 95.24 per cent., or about 95.5 per cent.
<hr/>		
Total,	147	eggs.

We notice that the clusters of this locality in which the wilt had operated are far smaller than normal ones, since about 3 clusters are necessary to equal the size of a normal one. The percentage of dead eggs, however, does not attain that of other localities.

IV. Summary.

The artificially developed Flacherie was planted, after the "dying off" of the breeding material had begun, among the caterpillars of the gypsy moth in the following localities, the de-

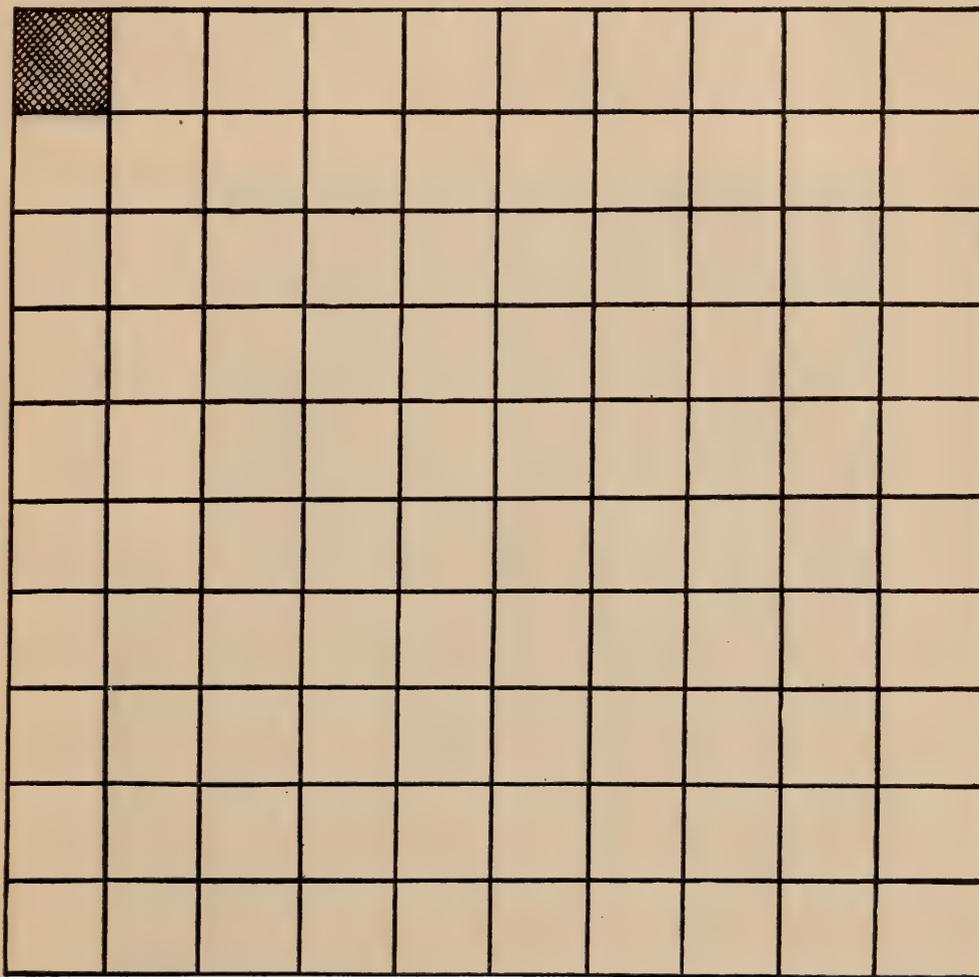


Fig. 4. — Diagram showing percentage of living eggs in healthy colonies.

tails in regard to these experiments being given in the preceding pages. The number of apparently living eggs was reduced to the following percentages: —

	Per Cent.
Concord, Mass. (Brewster's estate),	11
Carver, Mass. (southwest of Makepeace's cranberry bog),	13
Carver, Mass. (on Wenham Street),	45
Boxford, Mass. (near the almshouse),	10
Boxford, Mass. (on Highland Street),	4
West Bedford, Mass. (Swett's estate), 0 per cent. + 22½ per cent. =	11½
Haverhill, Mass. (west of East Broadway),	14½

	Per Cent.
Brockton, Mass. (on Oak Street),	7½
Beverly, Mass. (on Hart Street),	15
Beverly, Mass. (beside railroad track),	3
Cohasset, Mass. (Barron's Island),	18
Hingham, Mass. (island in the millpond),	5

Taking the average of these results, we see that the total number of apparently living eggs has been decreased by introduction of the artificially developed Flacherie to about 14 per cent. This result is shown graphically in Figs. 4 and 5, where

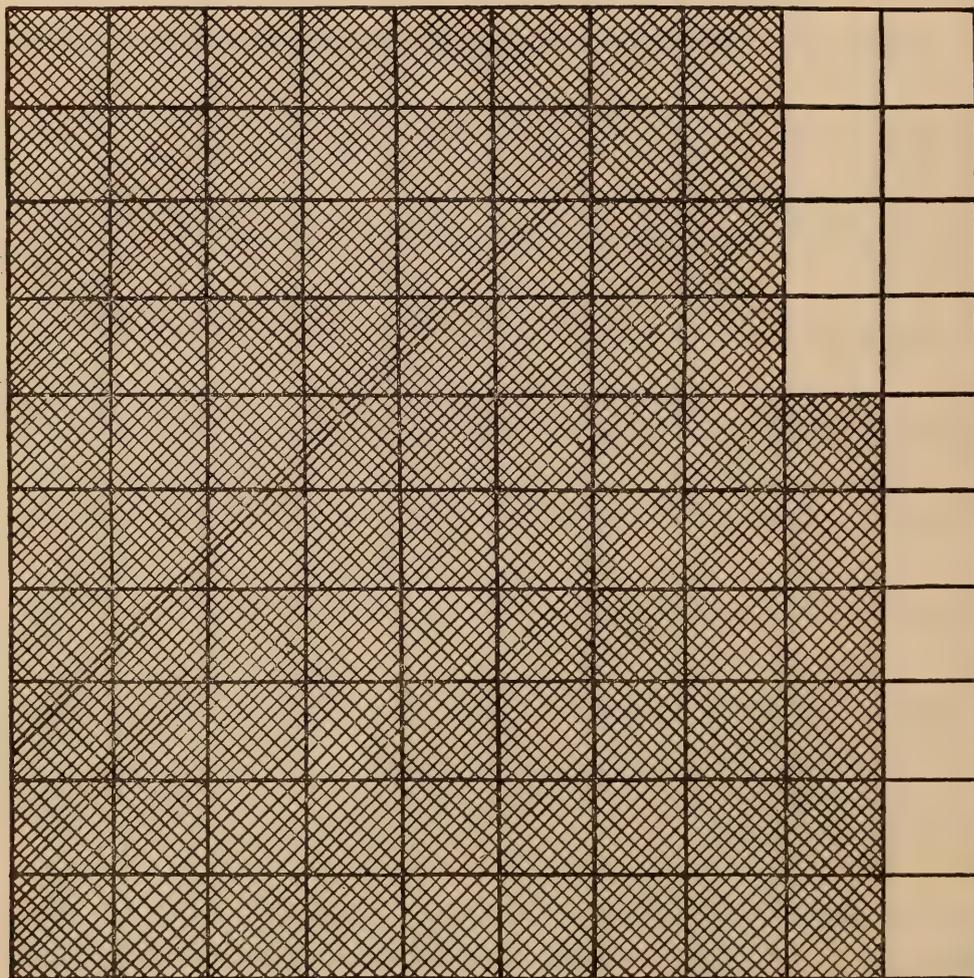


Fig. 5. — Diagram showing average percentage of living eggs after introduction of the disease.

1 per cent. is equal to 1 square, the cross-lined spaces representing the percentage of *dead* eggs.

Only those localities have here been tabulated on which we had complete data from the beginning to the end of the experiment.

V. Final Conclusions.

The foregoing experiments prove conclusively that Flacherie has an injurious influence upon the prosperity of the gypsy moth caterpillars, this influence varying according to the manner and time of the appearance of the disease. There was no difference noticed in the progress of the wilt which broke out naturally and that of the artificially developed Flacherie. The latter, however, is probably the more important factor, for with its help we may be able to introduce the disease among caterpillars of localities in which the wilt, perhaps, would not make its appearance naturally. The infection of a place with *sick* material only seems to be, as regards the "dying off" of the caterpillars, less favorable for the spread of Flacherie than with material which already contains a number of *dead* individuals. In selecting the localities in which the disease is to be introduced, it is unimportant whether the caterpillars of the gypsy moth are present in large or small numbers. It is true the wilt will get a stronger foothold and attain a greater virulence the larger the number of caterpillars. In places, however, which are not badly infested, the disease will also spread to the healthy caterpillars, as was shown by several of the experiments. According to the observations, we are almost inclined to believe that the direction of the wind plays an important rôle in spreading the disease. This opinion is strengthened especially by the observations made in Concord and West Bedford.

Wherever the naturally as well as the artificially developed Flacherie occurs the female caterpillars will always succumb to it more readily than the male. This may perhaps be due to the fact that they require a longer time to mature than the male caterpillars. If, at the flying period of the moth, we visit such a diseased locality, — one in which during the summer the caterpillars were quite plentiful, — we find ourselves surrounded by male moths, which to the superficial observer would indicate that the wilt had caused no considerable diminution. As soon, however, as we begin to search for adult females, we discover that they are present in a decided minority, and

that they are by no means in the same large proportion to the male moths as in localities where the disease has not occurred among the caterpillars. The effective result, then, will be shown at the time of oviposition, in the decrease of the number and size of the fresh clusters, compared with those of the previous year. To be sure, this will not always be the case; for instance, in localities in which Flacherie appears very late. However, places infected early enough, always show as a result a diminution in the number of the fresh clusters, sometimes to 100 per cent. The reduced average size of the clusters also has a close connection with the wilt. Heretofore it has often, but erroneously, been supposed that small clusters were deposited by small female moths, which suffered during their caterpillar stages from lack of food. Certainly such cases are not rare, but the origin of small clusters is capable of yet another explanation. For instance, in localities in which there are few gypsy moth caterpillars, and where there is no lack of food, but where the wilt has worked, egg clusters are found which are no larger than a pea or a bean. Such clusters contain from 4 to 12 eggs, with embryos which are usually incompletely or not at all developed. In such localities it may often be recognized, from the volume of the abdomen, even of the freshly emerged female moths, which were little below the normal size, that the body contained only a small number of eggs. Also, in several cases the interior of the body was examined, and then it was found that the cause of the small circumference of the body was that the ovary was small. Females which had already oviposited and died were examined to see whether they contained more eggs in their bodies. Eggs were always found in females that had laid egg clusters which were only partly, or not at all, covered with hair. But there were sometimes found undeposited eggs in females which had completely covered the cluster with their abdominal hairs. All this must be taken in connection with the wilt, for female moths from healthy colonies deposit all the eggs they contain, as long as they are not interrupted at the time of egg laying, and it does not matter whether the individuals are large or small.

The most important point to be noticed is the fact that the

clusters which are found in localities in which Flacherie operates among the caterpillars contain, on the average, a comparatively high percentage of dead eggs. Hence, Flacherie has a direct effect even upon the next generation. If, however, the number and the quality of the eggs in the female adult are affected by the wilt, is it not then possible that the disease goes directly over to the eggs? Certainly we have no direct proof of this at the present time, but we do know that Flacherie can be carried over from the caterpillar to the pupa, and from the pupa to the adult, and we have seen that the eggs in the ovary of females which come from infected colonies are influenced by the disease in regard to their number and vitality. In spite of the many investigations which have been made by celebrated bacteriologists in both the old and the new world, the carriers of the disease have not yet been determined. This shows what a difficult problem science has before it to solve. Although several scientists accept neither the heredity of the disease, nor believe that it can be carried over to the next generation, there are others (Pasteur, Fischer) who believe in its transmissibility. Perhaps the disease is carried over to the following generation through the adult female only, in a similar manner to the pébrine. Perhaps, moreover, the name Flacherie covers several diseases, which, it is true, make their appearance in the same manner in the infected individuals, but nevertheless are specifically distinct. One of these diseases may be restricted, indeed, to caterpillar and pupa only, while the other disease is carried over to the adult, and might possibly be inherited through the female organism by the descendants. It may be possible to throw some light on these complicated questions by breeding experiments, but only the investigations of the bacteriologist and pathologist can secure the final proof. It would be of the highest importance for the economic value of Flacherie if the inheritance of the disease could be definitely proved. If the wilt proves to be the direct cause for the "dying off" of many embryos of eggs from infected localities, death would be caused by the organisms of the disease themselves, and probably not be a result of the weak constitution of the female moth. The still living embryos of the same cluster will

then contain, without doubt, at least partially, the carriers of the disease, which, according to their number and to the constitution of the embryo, will kill, early or late, the larva after it has hatched. Thus Flacherie will be carried again through the whole ontogeny of the descendants of those individuals which were originally infected by the disease. In this case the wilt would be hereditary, and it would have by far the greatest possible economic value and benefit. If, however, the "dying off" of several of the embryos is only a consequence of the weak condition of the female adult, which perhaps was slightly infected during the caterpillar stage, then of course the guaranty for the wilt is not yet given for the next generation. Among the hatching caterpillars there will always be a considerable percentage of weak individuals which thus possess from the beginning the necessary predisposition to the disease. If, then, the climatic conditions develop favorably for the disease, these weak caterpillars will be attacked first by the wilt, but as it increases in virulence it will attack the stronger and healthier individuals. If the climatic conditions are less favorable for the natural appearance of Flacherie, we hope the introduction of the artificially developed Flacherie in the respective localities will transmit the disease to the weak caterpillars. Then the disease will operate as though it had appeared naturally.

The existence of the wilt does not depend upon climatic conditions as soon as the disease is once established. It is true weather conditions will often be of great advantage in spreading the disease, but not likely to be of considerable harm. Hence, Flacherie, even if its nonheredity should be proved, is a factor of great importance to economic entomology. It will be advisable to work with the wilt against the gypsy moth in large wooded areas of all kinds, and it has the great advantage of cheapness, while the spraying with arsenate of lead or with other poisons is expensive. A very good scheme would be to furnish as many trees as possible with rings of tanglefoot in heavily infested forest districts, and not to kill the caterpillars after they are gathered together under the rings, but to assist in this manner the more rapid spread of the wilt, since the sick and weak individuals thus have a greater possibility of coming

in contact with healthy caterpillars. The effect of this method was observed in one case during the summer of 1910. In company with the division agent, Mr. Worthen, I came in touch with a locality in Boxford where gypsy moth caterpillars were gathered together in considerable numbers under tanglefoot rings. It had been decided to kill the caterpillars with burning oil, but I dissuaded the men from doing this by giving as my opinion that the wilt would make its appearance in all probability in a few days. This assumption was right, for there was seen, after three days, the first signs of the disease, which then spread so quickly that in a few more days the caterpillars had succumbed.

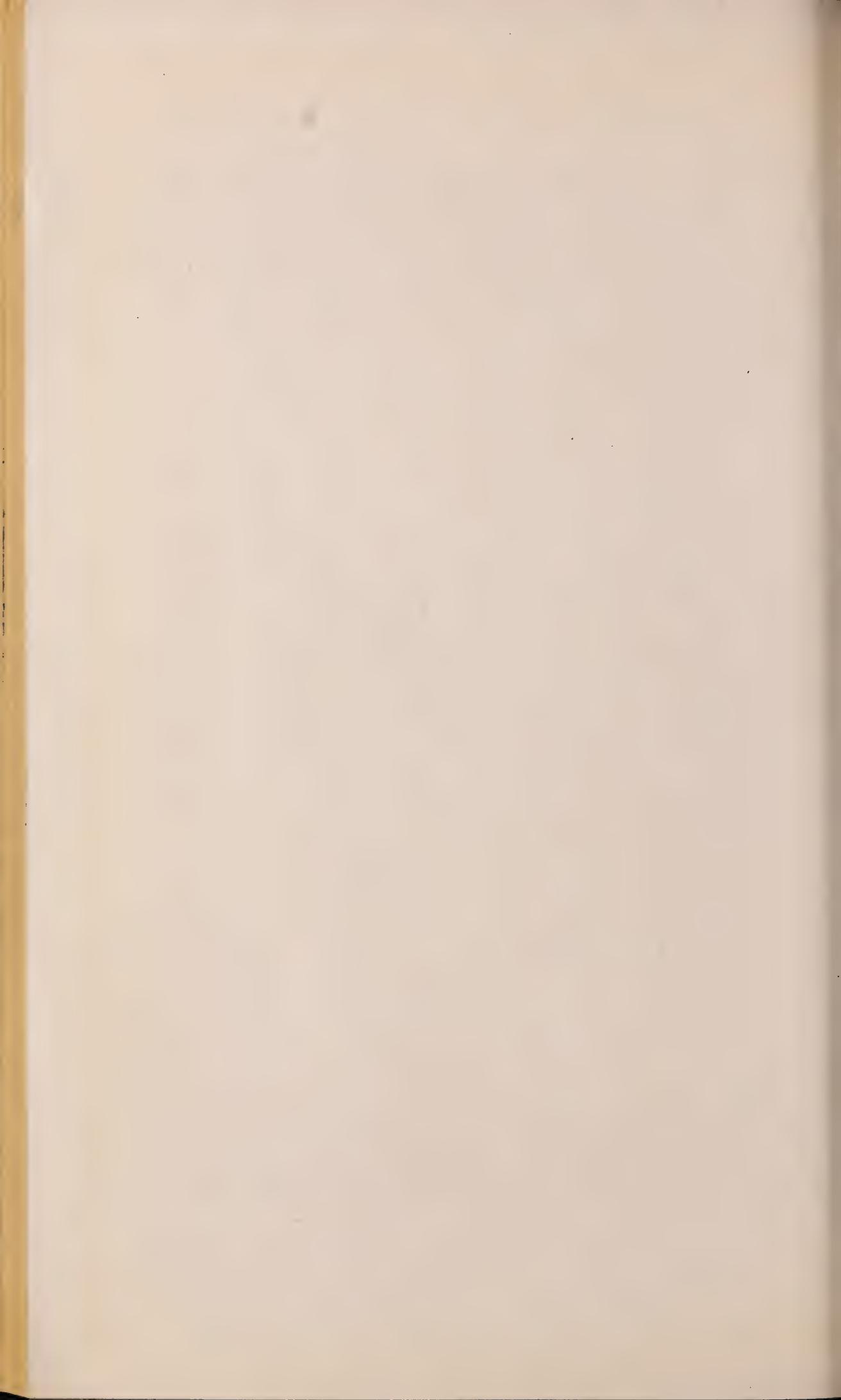
Perhaps it might be worth while to work with the wilt in different ways from those in the experiments described. There is, for instance, the recapitulation of the experiments of 1909 on a large scale. Caterpillars which had been killed by Flacherie were mixed with water in different ways, and the mixture was then either sprayed upon trees or was painted as rings around the trunks. One or the other of these methods may prove to be valuable, but the expense will be quite high, while the use of the simple exposure method incurs but small expense. There might be mentioned still another point; Dr. E. Fischer of Zürich, the discoverer of the predisposition of caterpillars towards Flacherie, wrote me some time ago the following directions for developing Flacherie artificially in the field: cut some of the larger roots of a tree that is infested with a sufficient number of caterpillars, water frequently the ground around the cut surfaces and put into the trunk as much water as possible through a hole bored at an angle of about 45° to the base of the tree. By these means the same unhealthy food is produced on the tree as is otherwise obtained by the placing of twigs in water. It is certain that the wilt can be developed artificially in the manner just described, but such an experiment needs constant attention, and trees thus treated are, of course, destroyed.

I doubt whether the gypsy moth will ever become extinct in America, but the wilt will probably produce, first, a considerable reduction of the mass, and then it is to be hoped that the

insect parasites and other natural enemies will contribute in diminishing the pest to a minimum. I am quite convinced that we can apply the wilt in a systematic manner to the benefit of our forests, and that in so doing we shall come considerably nearer to a solution of the problem of destroying the gypsy moth. In wooded areas mainly much more attention should be given in future to the wilt as an aid in combating the insect, while for street trees, garden trees, etc., which are more easily managed, the eggs and caterpillars of the gypsy moth may be removed according to established methods. The wilt should eventually reduce the pest to a condition in which it can be easily kept in check, and prevent serious outbreaks and damage.



PLATE I. — Egg clusters from a healthy colony.



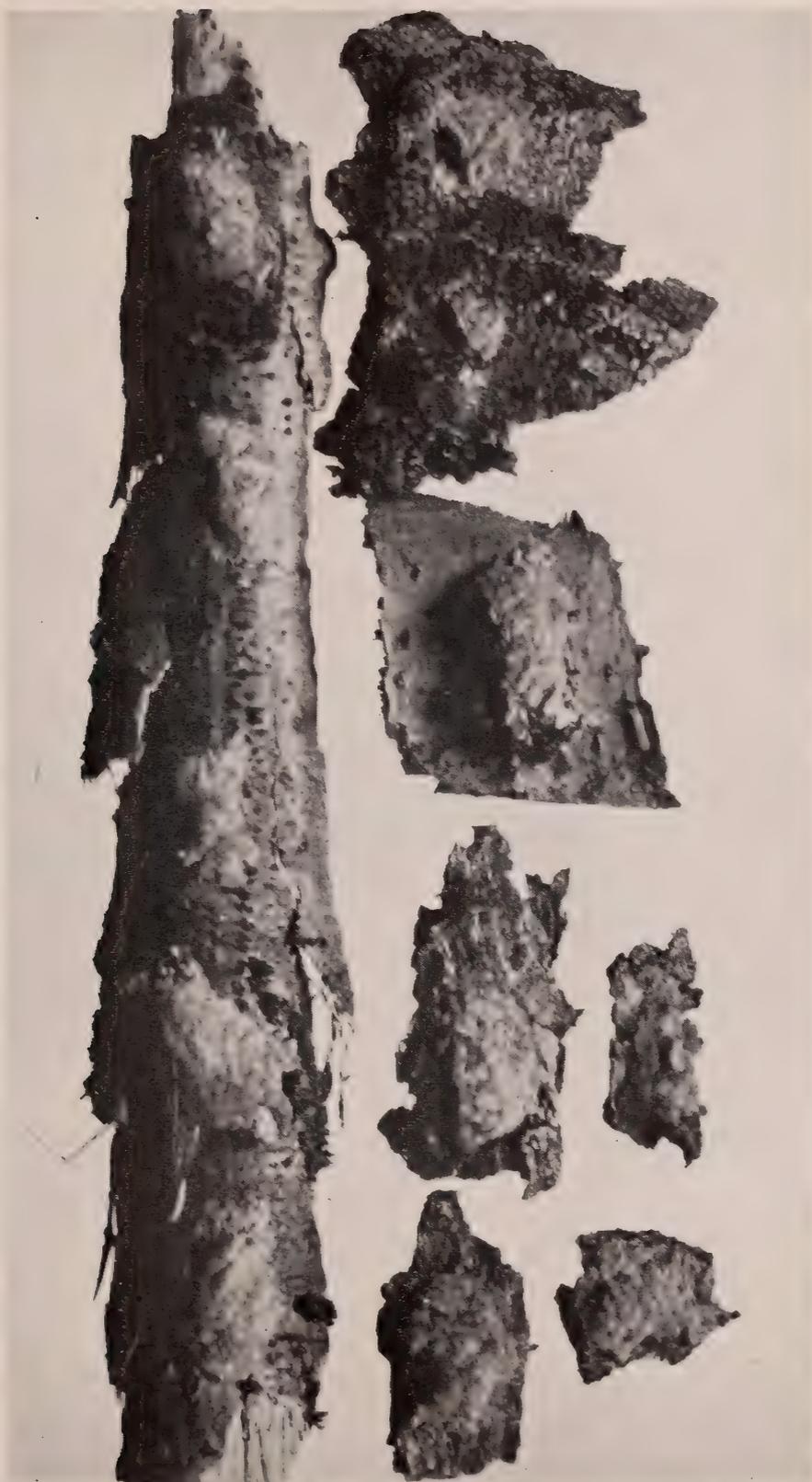
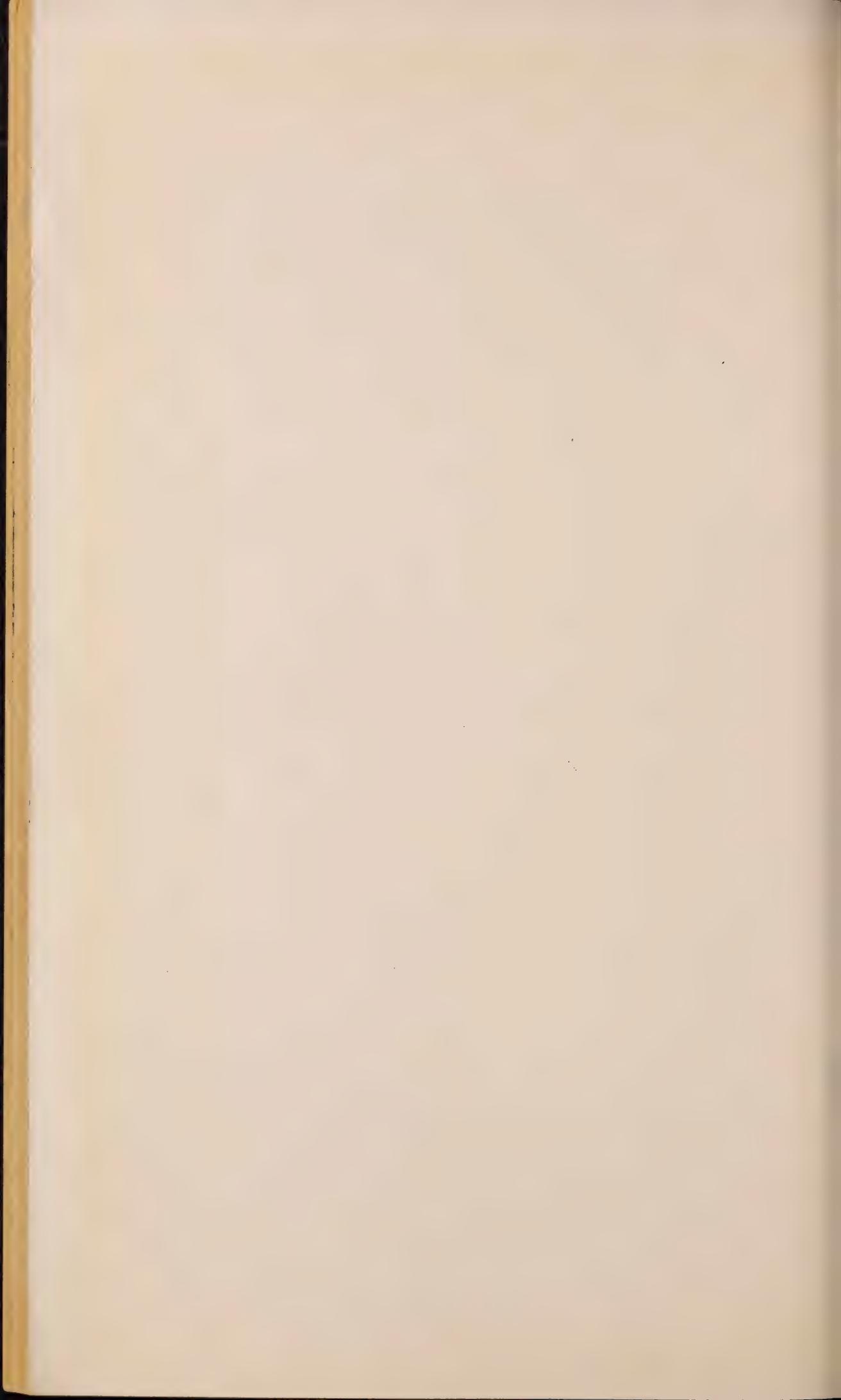


PLATE II.—Egg clusters from a colony where disease was introduced.



The Chestnut Bark Disease



A Grave Danger which Threatens
Our Forest Trees, with
Its Remedy

STATE FORESTER'S OFFICE
BOSTON, MASS.

F. W. RANE, STATE FORESTER



BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
18 POST OFFICE SQUARE
1911

APPROVED BY
THE STATE BOARD OF PUBLICATION.

THE CHESTNUT BARK DISEASE.

THE DISEASE AND ITS METHOD OF ATTACK.

The State Forester wishes to call the attention of the citizens of the Commonwealth to a serious disease of the common chestnut (*Castanea dentata*),— a disease which has been working for some time in the States of New York, New Jersey, Connecticut and Pennsylvania, and which has been found to be slowly gaining a foothold in Massachusetts. This disease is caused by a fungus known botanically as *Diaporthe parasitica* (also as *Valsonectria parasitica*), and grows in and derives nourishment from the tissues of the inner bark of the chestnut tree. The fungus is conveyed from one place to another by means of "spores" or fruiting bodies, which are analogous to seeds in the higher orders of plants. These spores, being small and very light, are easily carried long distances by the wind, and when blown against a chestnut tree find lodgment in any wounds, of which even the healthiest tree often has a great many, that may be in the bark. It makes no difference with the disease whether the spores find a refuge in the tissues of the thick bark of the trunk or the thinner bark of the small twigs,— the fungus develops equally well. It is true that in localities where the disease is rare the spread is slow, but the fact that it can increase to an alarming rate has been proved in our sister States, where it is no exaggeration to say that in certain sections the chestnut is becoming extinct.

GROWTH.

The spores having gained an entrance, the fungus begins to spread by sending out many small fibers, much in the same way that a plant sends out roots. These fibers, pushing about and through the growing cells of the tree to obtain nourishment, form a close network which soon saps the life of the section where they are.

Now, the serious part of this process of growth, looked at from the tree standpoint, lies in the fact that the fungus shows a marked tendency to grow around the infected branch or stem, thus girdling it, and killing all growth above that point. When this happens to the trunk of a tree it is easily seen that it becomes a serious matter.

Furthermore, the trunk of a tree may be infected by spores coming from diseased parts of its own branches, thus multiplying the disease within itself so to speak.

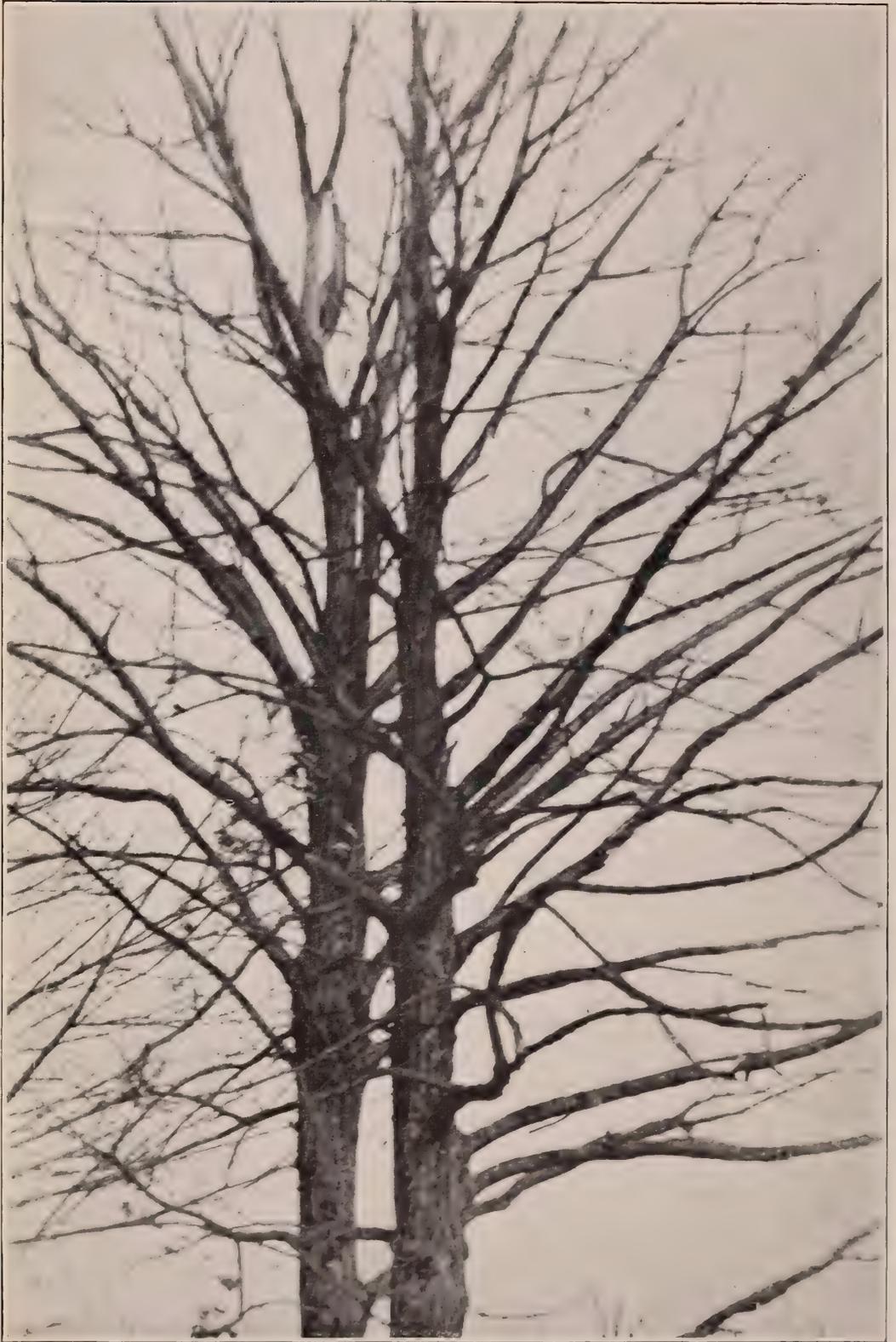
APPEARANCE OF DISEASED PARTS.

The following features are characteristic of the external appearance of the diseased tree. The outer bark over the diseased part is of a slightly reddish tinge, more so than the rest of the bark, and as the disease progresses this reddish area becomes covered with yellowish, brownish, or orange-colored pustules. Further, in damp weather or damp situations the spores are often extruded in the form of greenish-yellow "strings." The bark splits open up and down the length of the infected spot and often shows a swelled appearance. The cracks are filled with twisted and criss-crossed fibers of a slightly yellowish color. Among the smaller branches the cracks are of course less visible, but they still occur.

It should be here stated that these same characteristics may be the result of the work of other species of fungi than the one in question, and therefore, in order to be sure, specimens should be sent to a botanist for a microscopic examination. Such identification will be gladly made by the Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C., or by the Massachusetts Agricultural College, Amherst, Mass.

TIME FOR MAKING OBSERVATIONS.

The best time for seeing the evidences of the work of this fungus is the season now approaching, viz., in the spring, when the leaves begin to appear. The reason for this is not that the disease does the greatest amount of damage at this time, but because trees that have been injured the previous season by having much of their live tissue destroyed, instead of putting forth



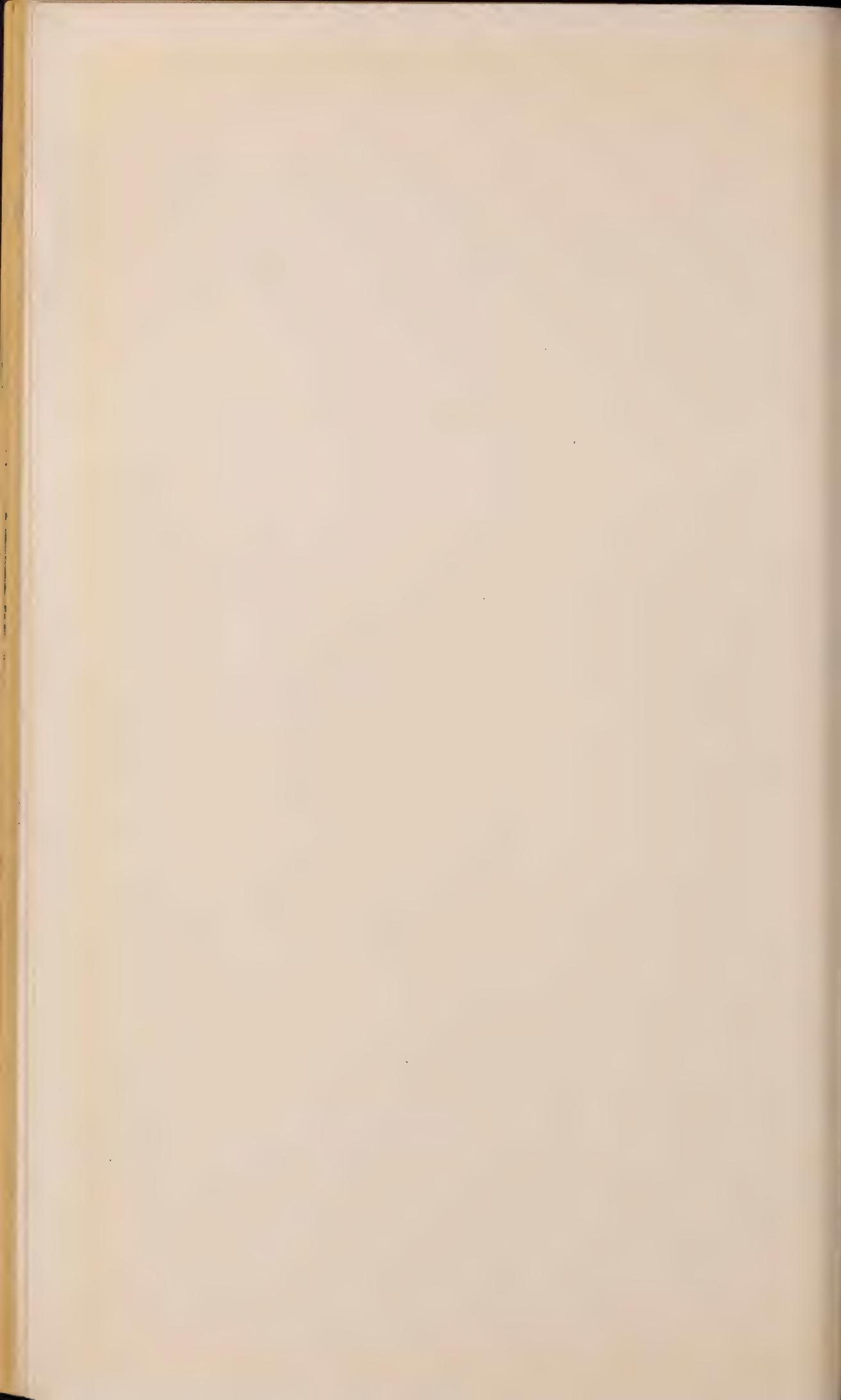
Two trees killed by the disease. Note the dilapidated or shreddy appearance of the bark and the few persistent dead leaves; also, portion of upper part of left-hand tree, where bark is falling off. (All photographs taken at Wilbraham, Mass., Feb. 23, 1911.)



Infested stem. The fungus tends to girdle the diseased portion rather than to extend up and down. "x" and "y" are diseased sections.



Infested trunk, showing how bark splits open. (This is a nearer view of section marked "y" in photograph to the left.)



healthy new leaves can produce only sickly and stunted foliage, the extent of the blighted area depending on whether the main stem or only a branch was attacked.

METHODS OF CONTROL.

It should be understood that there is no known method of curing the disease, or of saving woodland once it has become thoroughly infested. The experience of other States has proved this. Nor is it possible to save single trees, if badly diseased, except at great expense, and even then the chance for failure is great, owing to the impossibility of locating all the infected spots.

VIGOROUS MEASURES NEEDED IN EARLY STAGES.

To check its spread at the beginning of its entrance into a locality is, therefore, the only hope, and this hope is considered a strong one by those who have studied the disease most.

Dr. Haven Metcalf, who is the pathologist in charge of investigating this blight for the government Bureau of Plant Industry, and who has spent a great deal of time in this work, states that "in all cases we know of where the disease has been carefully eradicated, in localities where it has just appeared, the work has been very successful; so that we feel warranted in advising a very considerable outlay of energy to eradicate the disease at the outset."

METHODS OF ERADICATING.

Inspection of Nursery Stock.

There are several ways of going about the eradication of the blight. All chestnut nursery stock should be carefully inspected for signs of the disease, as such stock has heretofore apparently been one of the chief agencies of spreading the fungus. This precaution should be taken by nurserymen and purchasers alike.

Prompt Destruction of Diseased Trees.

A careful inspection of trees for evidences of the disease should be made by all owners of chestnut woodland during the months of May and June, and any tree found infected should at

once be cut down, the wood put into marketable form, and all brush, and if possible all patches of diseased bark, burned at the first opportunity. If this is not done, the down tree merely becomes a center of infection for the rest of the woods, as it is known that the fungus may live on dead bark for at least six months after cutting.

In answer to the question as to whether sprouts from the stumps of infected trees that have been cut will also themselves be infected, it should be said that for the first year at least they will not be, but after that they should be carefully examined for signs of the disease.

TREATMENT OTHER THAN CUTTING.

Spraying.

Experiments have shown it to be a matter of doubt as to whether the spraying of infected trees is of any avail against this fungus. It is possible, however, that in the case of valuable shade trees very frequent sprayings might have a tendency toward preventing infection.

Broken limbs, wounds, cracks and crotches of branches are fruitful sources of attack, and the fungus should be looked for at these points.

Local Cutting of Infected Spots.

The other method of individual treatment that has proved successful, though only in the case of valuable trees, where the expense was warranted, is the one of cutting and removing all patches of diseased bark and carefully protecting the exposed surface with a coat of tar or paint. This treatment must be thorough, and even then it will do no good if the disease has progressed too far. Infected branches should be removed altogether, at a good distance below the point of infection, and any bark cutting should be done at least an inch beyond and outside of the discolored area, which shows the location of the fungus.

A tree that has been already girdled should be cut down at once, and trees under treatment should be inspected frequently, say about June 1, July 15 and September 1, or oftener in wet weather.

CO-OPERATION NECESSARY.

It is believed that by carefully following the foregoing instructions the disease can be kept under control in Massachusetts, with the constant hope that some natural enemy will appear to assist in the work. No controlling enemy, however, is known at present. All persons are therefore urged to do their utmost, either by reporting cases to this office or by actively using some of the above measures of control, to aid in checking this enemy of one of our best timber trees.

BIBLIOGRAPHY.

Reference is made to the publications of the United States Department of Agriculture on this subject, especially Bulletin 141, Part V., of the Bureau of Plant Industry, from which several extracts, including quoted passages in this pamphlet, have been taken (those who are interested are advised to obtain a copy of this bulletin); also to a report of the Main Line Citizens' Association of Haverford, Pa.

CONCLUSION.

Lest the serious results of this disease be underestimated, the following instances of its work in other localities are cited: —

“A survey of the Forest Park, Brooklyn, showed ‘that 16,695 chestnut trees were killed in the 350 acres of woodland in this park alone. Of this number, about 9,000 were between 8 and 12 inches in diameter, and the remaining 7,000 or more were of larger size.’”

“In a recent publication Dr. W. A. Murrill estimates the financial loss from this disease ‘in and about New York City’ at ‘between five and ten million dollars.’”

With this loss in a city it can readily be seen what an enormous loss would occur should the disease become prevalent in the woodlands.

It becomes a question, therefore, as to which is the better economy, — to do nothing, and lose our chestnut trees, or to do our utmost at this early stage, with a fair chance of saving them.

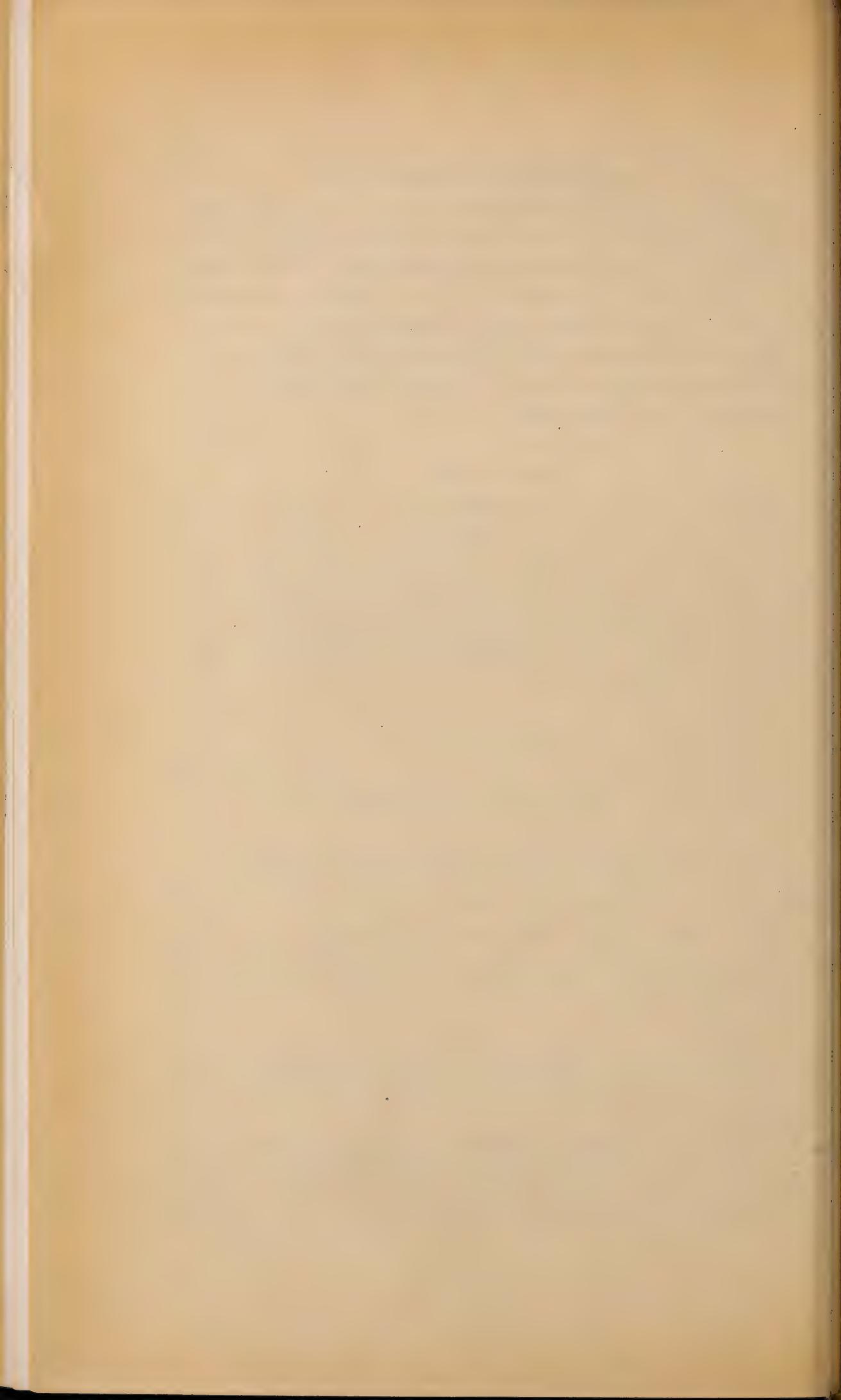


PLATE I.



A winter nest with young larvæ dead from the disease scattered all over the surface.

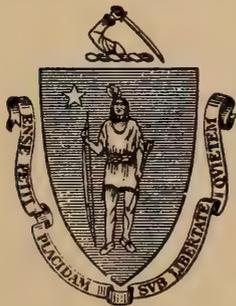
7

THE ARTIFICIAL USE OF THE BROWN-TAIL FUNGUS *IN MASSACHUSETTS*

WITH PRACTICAL SUGGESTIONS FOR
PRIVATE EXPERIMENT, AND A BRIEF
NOTE ON A FUNGOUS DISEASE OF
THE GYPSY CATERPILLAR

BY A. T. SPEARE, ASSISTANT PATHOLOGIST
HAWAIIAN SUGAR PLANTERS' ASSOCIATION
AND R. H. COLLEY, AUSTIN TEACHING
FELLOW IN BOTANY, HARVARD UNIVERSITY

UNDER THE DIRECTION OF
F. W. RANE, STATE FORESTER
OF MASSACHUSETTS



BOSTON: WRIGHT & POTTER PRINTING COMPANY
STATE PRINTERS - - 18 POST OFFICE SQUARE

1912

· APPROVED BY
THE STATE BOARD OF PUBLICATION.

INTRODUCTORY.

This report is published in order to acquaint our people with the beneficial results to be derived from utilizing a fungous disease in destroying the brown-tail moth, which is so destructive to our deciduous trees and also so obnoxious to our people on account of the rash incident upon the contact of its hairs with the human skin.

The report is based on a manuscript of Dr. G. P. Clinton, on the manuscript and notes of Mr. A. T. Speare and on personal observation and experiment by Mr. R. H. Colley, and was suggested by the apparent success of experiments made by Dr. Roland Thaxter of Harvard University at Kittery Point, Me., in the summer of 1907.¹ At this time former Superintendent Kirkland of the Moth Commission became interested in the matter, and on the advice of Dr. Thaxter the services of Dr. G. P. Clinton of the New Haven Agricultural Experiment Station were secured, and preliminary experiments were continued under his supervision from May 12 to July 11, 1908. Dr. Clinton was assisted during June and July by Mr. A. T. Speare, who was later employed permanently by the State Forester to succeed Dr. Clinton, and who had immediate charge of the investigation from July, 1908, until February, 1911, while during the past year it has been in charge of Mr. R. H. Colley. All of the laboratory experiments connected with this work have been conducted in the cryptogamic laboratories or at the Botanic Garden of Harvard University.

ACKNOWLEDGMENTS.

The State Forester and all concerned in the work wish to acknowledge their indebtedness to Professor Thaxter for suggestions as to experimental methods and for general direction and advice. Through the courtesy of Dr. G. L. Goodale and Mr. Oakes Ames, the directors of the Botanic Gardens, the successful propagation of the disease through the winter and the

¹ See Professor Hitchings's report in Maine Dept. Agri. Bur., 3, 20, 1908.

preparation of infection material on a large scale, have been rendered possible.

Thanks are also due Mr. Worthley, assistant in moth work, Messrs. Fiske and Burgess of the parasitic laboratory at Melrose Highlands, and to the division and local superintendents of the regular moth staff for their co-operation, and for courtesies rendered.

For the work on the fungus of the gypsy caterpillar, which has not as yet developed so satisfactorily as that on the brown-tail, we are wholly indebted to Harvard University through its friends in financing the expedition to Japan, where the disease was secured. The kindly offices of Harvard University, through Dean Sabine and his colleagues in assisting the State Forester in making this work possible, are herewith heartily acknowledged.

F. W. RANE,

State Forester.

BOSTON, March 22, 1912.

THE ARTIFICIAL USE OF THE BROWN-TAIL FUNGUS IN MASSACHUSETTS, WITH PRACTICAL SUGGESTIONS FOR PRIVATE EXPERIMENT, AND A BRIEF NOTE ON A FUNGOUS DISEASE OF THE GYPSY CATERPILLAR.

SOME FUNGOUS DISEASES WHICH HAVE BEEN USED ARTIFICIALLY.

The conditions governing the artificial spread of a fungous disease among insects vary according to the type of fungus used and the characters and habits of the pest to be attacked. All classes of insects have their fungous enemies, — some, like the *Entomophthoræ*, the species of *Cordyceps* and its *Isaria* condition, as well as other forms belonging to the *Fungi Imperfecti*, often causing serious epidemics, while others, like the *Laboulbeniales*, may be comparatively harmless. The idea of using fungous diseases in a practical manner to control the ravages of noxious insects is not a new one, and as early as the middle of the last century De Bary, Tulasne and others called the attention of agriculturists and orchardists to the importance of white muscardine, *Isaria densa* Link., as a natural check on destructive insect pests. Since the time this suggestion was originally made there have been numerous more or less successful attempts to use fungous diseases artificially, among which the following may be mentioned.

Metchnikoff (1878) cultivated *Metarhizium anisopliæ* (Metch.) Sorokin, the so-called green muscardine, and infected *Anisoplia* with the spores. Krassiltschik (1884) founded a laboratory at Smelk in order to raise green muscardine in large quantities, and the spores, spread on the beet fields to infect *Cleonus punctiventris*, the beet weevil, started an artificial epidemic which is said to have killed from 50 to 80 per cent of these destructive beetles. Rorer (1910) has also used the spores of the same fungus, mixed with flour, in spraying sugar cane in Trinidad to control the froghopper, with some success.

Cordyceps melolonthæ Tul. has been employed against the white grub, *Melolontha vulgaris*, in Europe, and Giard (1893) records an attempt to use *Isaria densa* against the same insect in France, contrasting the results obtained with those of certain American investigators. Buisson (1892) used *Botrytis tenella* Sacc. against the same pest.

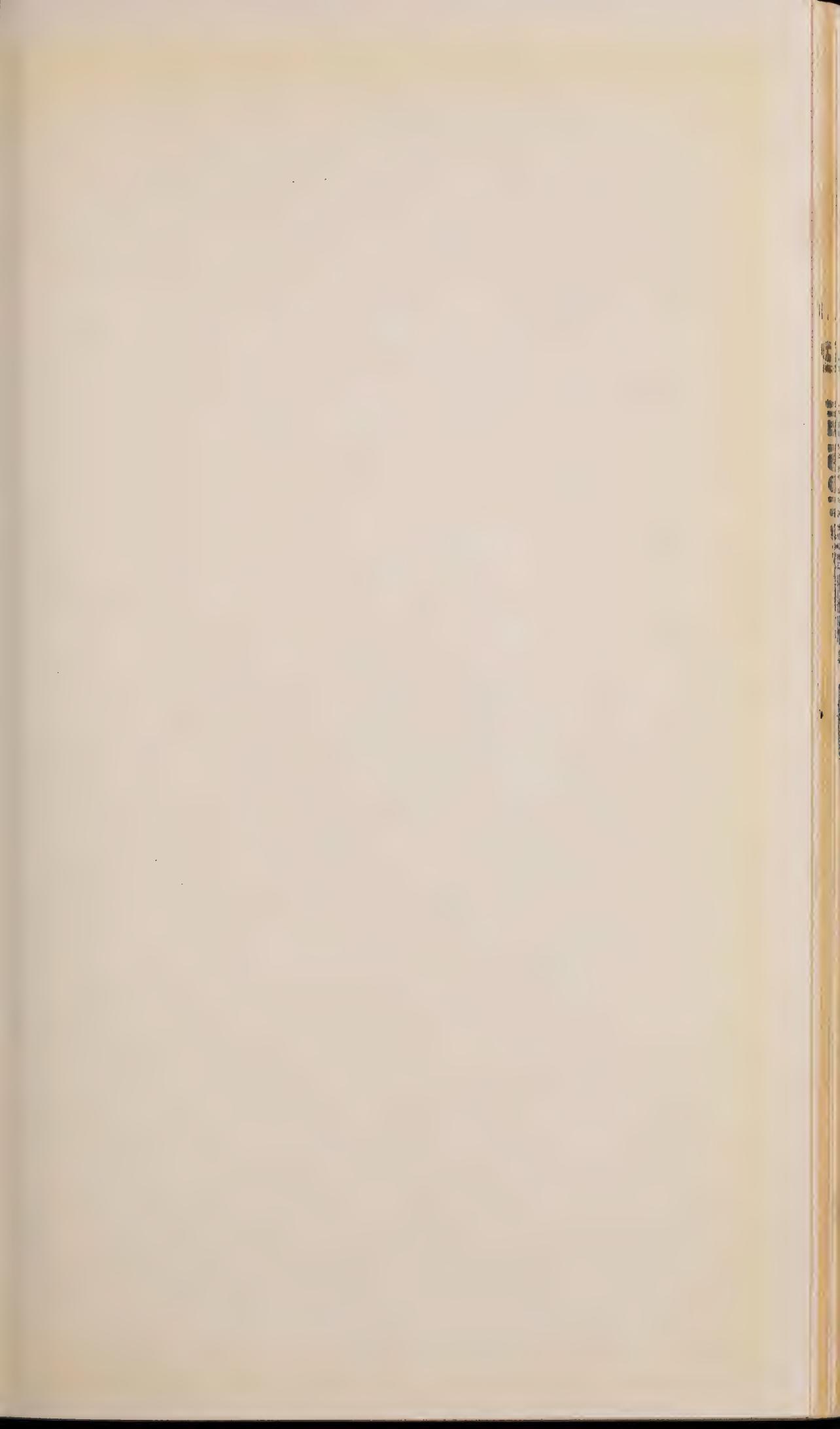
Sporotrichum globuliferum Speg. has been used by Snow (1889), Forbes (1888), Brunner (1902) and others on the chinch bug in this country, but although various opinions have been expressed as to the success of this work, the more recent experiments of Kelly and Parks (1911) lead them to the conclusion that, although under certain conditions the fungus may be very destructive in nature, its artificial propagation is not to be recommended, an opinion in which Messrs. Billings and Glenn (1911) also concur. Brunner has also used it on the migratory locust in the Argentine Republic, and reports its use in the fight against the same pest in Sterling, Col.

Sphærostilbe coccophila Tul., *Microcera* sp. and *Ophionectria coccicola* E. and E. have been successfully employed (Rolfs, 1907, and Fawcett, 1908) against the San José and purple scale of orange trees in Florida. During the last three or four years the use of *Aschersonia aleyrodis* Webber, *Aschersonia flavocitrina* P. Henn and *Ægerita Webberi* Fawcett (Fawcett, 1908, Rolfs, 1908, and Berger, 1910) has been very successful in checking the white fly in the citrus groves of Florida, a region especially well adapted for such experiments, owing to the fact that here these fungi grow naturally out of doors more or less continuously throughout the year.

Of the *Entomophthoreæ*, although the group contains some of the most destructive forms attacking economically important insects, the brown-tail fungus appears to be the only form which has been used artificially. That more of these forms have not been used is probably due to the fact that their cultivation and propagation is usually attended with the greatest difficulty.

THE BROWN-TAIL FUNGUS.

The fungus which causes the disease of the brown-tail caterpillar is a microscopic plant known technically as *Entomophthora Aulicæ* Reich, which has been long known in Europe





a

b

c

Fig. 1.

FIG. 1.—*a*, gypsy moth larva from Japan killed by an *Entomophthora* disease; *b*, a tent caterpillar, and *c*, three brown-tail larvæ killed by *Entomophthora Aulicæ*. The latter were kept in a dark chamber to develop an external growth of the fungus.



Fig. 2.

FIG. 2.—This photograph gives some idea of the number of spores discharged. The branch, crowded with dead and dying caterpillars, was laid on a sheet of glass in a still room, and the white color is entirely due to the thousands of spores which fell on the glass during the night.

and was first reported from this country by Dr. Thaxter in 1888. It has not only produced natural epidemics among the brown-tails since they were first introduced, but it attacks various other native species of insects, which are enumerated below. It is closely allied to *Entomophthora muscæ* Cohn, a fungus that attacks the common house fly, which may often be seen dead on a window pane or mirror, where it becomes surrounded by a white halo or whitish patch, due to the large number of

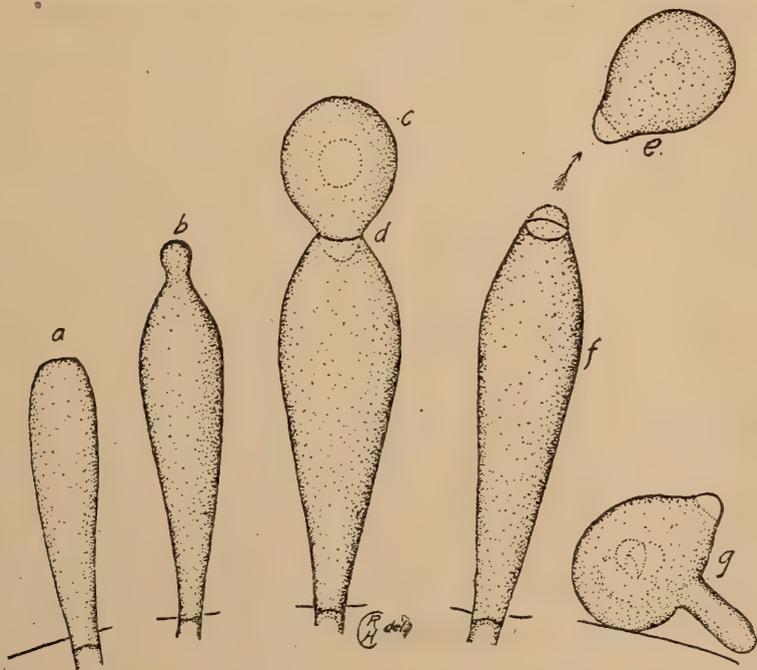


FIG. 1. — Diagram to illustrate the development and discharge of spores.

At the tip of the club-shaped conidiophore *a* a rounded bud *b* develops into the pear-shaped spore *c*. This spore is torn away at the collar *d* when mature by internal pressure, and shot off from the conidiophore *f*, as indicated by the arrow at *e*. Spores produced and discharged in this manner are called conidia. At *g* is shown a germinating spore with its young germ tube.

spores discharged on the glass. (Plate II., Fig. 2.) These spores, called conidia, which are the fruit of the fungus, and correspond in function to the seeds of higher plants, are ovoid to pear-shaped (Plate VII., Figs. 1-4), with a papillate base, and measure 25 to 35 by 28 to 40 thousandths of a millimeter. If a spore comes in contact with a healthy caterpillar under favorable conditions of moisture, germination takes place immediately; that is, the spore sends out a thread-like germ tube. (Fig. 1, *g*; Plate VII., Figs. 5-7; Plate VIII., Fig. 32.) This germ tube pierces the integument and continues to grow

within the body of its victim for about five days after infection. Germination may also take place on any moist surface, but in such cases growth is usually very limited, and may result in the production of secondary conidia (Plate VII., Fig. 8) exactly similar to the primary conidia, which may be discharged when mature and have the same power of infecting a healthy larva. The conidia retain their power of germination for about seventy-four hours after their discharge. In nature the caterpillar is not visibly affected by the presence of the fungus in its body until the afternoon of the fifth or sixth day, when, after a brief period of nervous activity, its movements become sluggish or cease altogether. By this time the branches from the original germ tube have become broken up into irregular chunky "hyphal bodies," which more or less completely fill the body cavity. Just before death, which usually comes toward evening, the caterpillar is almost always impelled to climb to the highest point on the leaf or twig on which it has been resting; the forelegs then lose their power, and the fore part of the body droops backward or to one side in a position so characteristic as to be easily recognized. (Plate VI.) As soon as the caterpillar is dead, or even just before death, the hyphal bodies within it send out stout germ tubes. (Plate VIII., Figs. 28-31.) The ultimate branches of these germ tubes break through the integument in pustules (Plate VIII., Fig. 26), which may eventually cover the whole body with a creamy white mass of fungous growth, especially if the atmosphere is moist. At the tip of each of the club-shaped branches, called conidiophores (Fig. 1, *a*, *b*; Plate VII., Fig. 10), a rounded bud develops into the pear-shaped spore (Fig. 1, *c*, *e*), which is shot off with considerable force when mature by a mechanism specially developed for this purpose. Air currents may carry the spores for miles, or if they fall on the backs of other caterpillars the movement of the latter may perhaps further aid in their distribution, especially where the caterpillars are closely congregated. The number of spores which may be discharged from a single diseased larva is very large, probably reaching hundreds of thousands in the case of a full-grown caterpillar, and every spore has the power to infect another caterpillar, provided that it strikes in a favorable position for penetration

under favorable conditions of moisture. It is interesting to note that nature has provided for the wider dissemination of these spores by impelling the dying caterpillar, as already mentioned, to climb upward, thereby placing its body in a more elevated position, from which the falling spores will be distributed over a large area. In the field the dead caterpillars are found most often on the shady under side of the limbs, near the crotches of the branches, but one may find them with little trouble on any part of the tree or on adjacent walls and fences. (Plate III.)

Resting Spores.

Besides the type of "air spores" or "conidia" just described, the fungus produces another type, formed internally, known as "resting spores," which are extremely resistant to changes of heat and cold, and which, although their germination has not been observed, undoubtedly serve to tide the fungus over winter. They are commonly formed by the rolling together of the contents of large, irregular, fungal elements (Plate VII., Figs. 12-18) into spherical bodies, which later become enclosed in very thick walls. Spores of this type are comparatively rare, and the conditions which lead to their formation, whether they be due to internal causes, or to the effect of weather, or other external influences, are not clearly understood.

Encysted Hyphal Bodies.

In the fall the hyphal bodies may themselves also become surrounded with heavy walls, which on germination split and let out the contents in the form of stout germ tubes. (Plate VIII., Figs. 22, 23.) The latter branch freely, and give rise eventually to pustules (Plate VIII., Fig. 25), as in the case of the ordinary hyphal bodies. These encysted hyphal bodies are also instrumental in wintering over the fungus.

General Conditions governing the Artificial Spread of the Fungous Disease of the Brown-tail Moth Caterpillar.

In the case of the brown-tail caterpillar there are two periods in its life history when the *Entomophthora* under consideration may be effectively used, namely, in the spring and early sum-

mer, when the larvæ have left their nests to feed on the young leaves, and in the autumn for several weeks before the webs of the new broods are closed for the winter. During both of these periods the rapid spread of the disease is largely dependent on weather conditions, and when these conditions — warm nights and damp atmosphere — favor the growth of the fungus, artificial distribution yields truly satisfactory results, and may bring about enormous and widespread destruction; but it should be understood clearly that, even under these conditions, although the disease is evidently very important as a powerful check, it cannot be regarded as a “cure-all.” In the spring, when the caterpillars are scattered all over the trees, it is comparatively easy to place the infected larvæ in among them, but in the autumn, when they are localized, feeding in the immediate vicinity of the nest, it is necessary to infect individual webs. Experience seems to point to the autumn, however, as the more advantageous time to start the artificial epidemic.

Early Reports of the Disease among Brown-tails.

Mention has been made in previous State reports of the occurrence of the disease in spring and fall epidemics. The dead larvæ on the outside of the webs (Plate I.) were first noticed during the early winter months ¹ of 1902 and 1903, and the frosty appearance of the nests, due to hundreds of thousands of discharged spores, led to the popular belief that the young caterpillars had been lured out of the webs by the warm mid-day sun and had been frozen to death before they could return. The susceptibility of the brown-tail to this disease was first noticed by Dr. Thaxter in Maine, just after the caterpillars made their initial appearance there. He had made a series of experiments in artificial infection previous to the experiments at Kittery Point, Me., in 1907, which were reported by Professor Hitchings, and the apparent success of which led to the engagement of Dr. Clinton to carry on a preliminary investigation in Massachusetts.

¹ See Fernald and Kirkland's Report of Brown-tail Moth Commission, 1903.

Preliminary Experiments of 1908.

Dr. Clinton concluded from his preliminary experiments in the spring of 1908 that the use of the disease as a check would be of practical value if (1) the fungus were planted in territory where the natural disease was not in evidence, and (2) if the plantings were made in the field before the natural disease could develop under ordinary weather conditions, thereby giving the introduced disease an opportunity to develop more generations, and consequently infect more larvæ than the later-starting natural epidemic. He was hampered in his investigation by the fact that he was unable to begin operations until the season was well advanced, and the time available was so short that he was unable to make extensive experiments. His results, however, again demonstrated that the propagation of the disease in the field could be successfully accomplished.

Autumn of 1908.

Dr. Clinton being unable to continue the work after July of this year, it was taken in charge by Mr. Speare, and the first fall infection was made in the autumn of 1908, when about 500 diseased caterpillars were distributed over a limited area on low shrubbery at North Andover, Mass. As nearly as could be estimated about 35 per cent. of the young larvæ on the hillside where the planting had been made died as a result of this artificially induced epidemic.

Cultivating the Fungus through the Winter of 1908-09.

The *Entomophthora* from the fall infection was cultivated and kept alive through the winter months so that the spring planting could be made as early as possible, without the delay incident to spring collection and forcing of the disease. In order to accomplish this, webs were cut open and placed on a layer of filter paper over damp moss in ordinary culture dishes. A glass cover kept the atmosphere in the dishes moist and favorable to the growth of the fungus. Infected larvæ were placed in the cut nests, and in this manner the disease was transmitted to the healthy larvæ, and the fungus kept alive through successive generations. Some practice was necessary

before the optimum moisture conditions were determined, but the chief difficulty encountered was the hostile action of other fungi, which grew very rapidly under culture-dish conditions. The worst enemy, *Sporotrichum globuliferum* Speg., sometimes threatened to choke out the *Entomophthora* entirely.

Spring of 1909.

The fungus having been propagated through the winter of 1908-09 at the Botanic Garden, about the first of March two bushels of webs were brought from cold storage and placed in two boxes, which, for the sake of convenience, will be called the "disease box" and the "rearing box." Both boxes were of the same type, their dimensions being 11 by 27 by 27 inches, and by leaving the bottoms open the contents were directly in contact with the moist earth. A two-inch rim of ordinary commercial tanglefoot served to keep the caterpillars confined. Dead and dying larvæ from the winter culture dishes were turned into the disease box, together with fresh webs containing healthy caterpillars, for the purpose of starting a general infection as soon as the latter emerged. In order to favor the spread of this infection as much as possible the atmosphere was kept moist by covering the box with a damp mat. Without attempting to force the growth of the larvæ in either box, they were fed just enough to keep them alive, so that the disease might be carried along through successive generations on a little larger scale than was possible with the culture dishes.

About April 1 larvæ from four bushels of cold-storage webs were placed in five rearing boxes, and the intention was to feed them to the limit of their capacity, so that they would be large enough for infection and distribution by the 25th of the month. Owing, however, to the nature of the only food which was available, the rearing of the caterpillars was attended with the greatest difficulty, as it was almost impossible to make them feed. Willow twigs forced under glass were not acceptable; lettuce worked fairly well but was expensive, and the larvæ did not thrive on it, so that little or no active growth occurred until a supply of fresh food became available out of doors as the season advanced.

Feeding Methods.

The larvæ were fed by two methods: (a) by placing leafy twigs in jars sunken in the earth, or (b) by throwing small quantities of stripped leaves directly on the clean earth. In the first method the leaves remained fresh for some time, but in handling the wet twigs, when changing the food or the water, the boxes often became too damp and favorable to the growth of the fungus, which, when once it gained a foothold, threatened to kill off the entire supply of caterpillars. The second method has proved to be the better for general use, because the supply of food can be easily regulated by throwing in just enough leaves to keep the caterpillars eating all the time. The boxes were kept clean and sanitary by removing the dried and half-eaten leaves as soon as the larvæ crawled on fresh ones.

General Methods of Infection.

All investigators on fungous diseases of insects have experienced more or less trouble in transmitting the disease to healthy larvæ in the laboratory. In most cases it seems very difficult to imitate exactly the conditions under which the infection naturally occurs. What is true of other fungous diseases is in general true of the brown-tail disease, and it often happened that the fungus would get a start in the rearing boxes, where it was not wanted, and attack the larvæ with the virulence of an epidemic, while in the disease boxes, where the conditions were supposed to be at an optimum for its growth, it appeared only in scattered spots. The three methods used for general infection may be outlined as follows:—

(a) *Infection by the "Crate Method."*—A crate 5½ by 30 by 30 inches, with a mosquito netting bottom, was fitted tightly over a second crate of similar dimensions, in which the healthy larvæ were placed. Caterpillars dying from the disease or those already dead and ready to discharge spores were placed at short intervals on the netting bottom of the upper box, so that the spores from their bodies would drop through the meshes of the netting upon the healthy larvæ below.

(b) *Infection by the "Spray Method."*—Dead caterpil-

lars were placed in an atomizer bottle so that all of the spores discharged would be caught on the glass. After spore discharge had ceased, and the bodies of the caterpillars had been removed, the bottle was filled with water, the spores were dislodged from the sides and bottom with a soft camel's-hair brush, and the "spore water" was then sprayed over healthy caterpillars in an ordinary rearing box.

(c) *Infection by the "Natural Method."* — Infected larvæ were mixed with healthy ones all over the twigs and leaves in a rearing box. Following their natural instinct to climb, the diseased caterpillars placed their bodies in such elevated positions as the tips of the twigs and sides of the box just under the rim of tanglefoot, so that the spore discharge was directed against the bodies of the healthy caterpillars and in every direction over the leaves.

By taking lots of 100 at random from these boxes, after they had been exposed to the spray or spore discharge for three or four days, placing them in small trays and counting the number which died from the disease within nine days, it was found that the maximum infection was hardly more than 40 per cent.¹ The last method appeared to be the most favorable, and was adopted for the infection of all of the material sent into the field.

General Methods of Distribution.

After trying several schemes for distributing the infected larvæ it was concluded that the method first used by Dr. Clinton could not be bettered for general use, because of its simplicity and comparatively low cost. The method in brief is as follows: From 20 to 30 caterpillars which had been exposed to the spore discharge were placed in a quarter-pound paper bag, the neck of which was wound tightly with a 10-inch strand of No. 26 iron wire. The bag was then hung in the tree as near the web as possible, or near the masses of feeding caterpillars, and its side ripped open to allow the infected larvæ to escape. In addition to this bag method, wherever it was possible the sick caterpillars were placed directly in the feeding masses, thus practically insuring an infection.

¹ This maximum was increased by a combination of methods to 75 per cent. in 1911.



Fig. 1.

FIG. 1.— Showing dead larvæ on the top of an old stone wall at South Billerica.

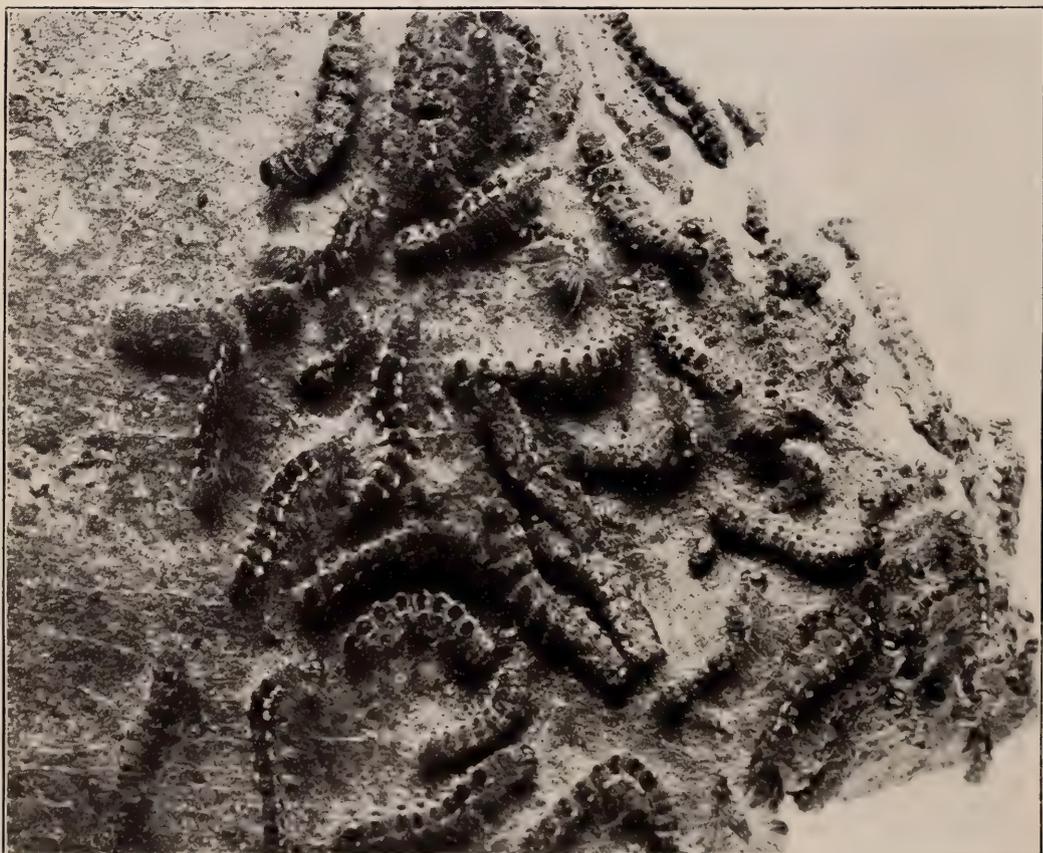


Fig. 2.

FIG. 2.— A view of a single stone of the above wall. All of the larvæ shown are dead from the *Entomophthora* disease.

The plantings¹ of the spring of 1909 were made by the two methods just described. In nearly every case the larvæ crawled out of the bag in a few minutes, but in the first two plantings made in late April, the cold rendered their movements so sluggish that they died before they could escape. The last three plantings were made so late in the season that they could not have been very effective. The season's work proved that artificial spread before May 1 is useless, because the irregular cold weather of late April inhibits the growth of the fungus, and that it is extremely difficult to estimate the effectiveness of plantings made after May 25 on account of the prevalence in the field at this season of spontaneous epidemics. In the territories of Rowley and West Newbury, where the disease worked very successfully, the final mortalities among the prepupæ and pupæ ranged from 80 to 90 per cent., and in localized plots of intense infection it was impossible to find a single live individual.

On May 14 the number of caterpillars dead from the disease on the territory at North Andover, planted the previous fall, was estimated at 50 per cent., and on May 28 at 95 per cent. The epidemic had apparently spread about equally well in all directions. Inspection of the estate of Mr. William Brewster at Concord, where a natural infection had occurred in the fall, showed that the caterpillars were practically annihilated by the 24th of May. It seemed probable that the epidemic in the North Andover territory had been started by the diseased caterpillars planted there in the fall of 1908, since there was no indication of the fungus in that locality previous to their introduction, and in both cases the early appearance of the disease in the spring, and the intense destruction wrought by it, seemed to point to the conclusion that the fungus had wintered over in the nests, and begun its attack as soon as the young larvæ emerged.

Autumn of 1909.

In the autumn of 1909, the supply of webs in cold storage being insufficient, only three plantings were made, two of which were effective in killing off 20 to 30 per cent. of the larvæ, thus

¹ See page 26 for list of localities planted.

confirming the results of the preceding fall; the other was spoiled for observation because the infected webs were cut from the trees and burned by the owner of the property.

Spring of 1910.

The fungus was carried over the winter of 1909-10 in culture dishes by the method already outlined, and a general infection started in the disease boxes in the usual manner. A disastrous epidemic of *Sporotrichum globuliferum* Speg., which killed off a large number of the larvæ and threatened to choke out the *Entomophthora* altogether, was controlled only with the greatest difficulty. In spite of this hindrance, however, a sufficient quantity of infected material was ready for planting on the 1st of May. The diseased caterpillars were distributed over a solid block of territory about twelve square miles in extent, running along the railroad track from Ipswich to within one mile of the New Hampshire line, and also in six scattered plantings on private estates. Weather conditions were favorable, and regular inspection at intervals during late May and early June revealed a mortality estimated at about 35 per cent., with the disease universally distributed through the planted areas. The virulence of the epidemic gradually increased until the larvæ began to spin up, about the middle of June, when the per cent. of those visibly affected rose so high that only 80 out of 1,000 pupæ and prepupæ collected from all over the planted territory matured moths.

It might be stated here that the word per cent. as used above should not be taken in its literal sense, as it is impossible to arrive at an absolutely correct determination of the work of the fungus at any given moment. The reasons are obvious. Only those caterpillars visibly affected with the disease at the time of inspection can be used in the calculation, which means that all larvæ which have died and dropped from the trees, as well as those infected but not yet dead, must be inevitably overlooked. Moreover, at the time of inspection the disease may be at a very low ebb, due to adverse weather conditions or some other cause, and the inspector will get the impression that the fungus is not working at all. Territories in which the disease ap-

peared to be working to perfection in May often exhibit only scattering evidence of the destruction wrought when inspected in June, and in other territories the June death rate may be the highest of the season. Since the conditions in the field are so variable, careful inspections and estimates must be made at intervals throughout the entire season in order to arrive at even an approximate estimation of the total work that the fungus has done.

Autumn of 1910.

Seventy bushels of webs were brought from cold-storage on the 25th of July to furnish the larvæ for the fall infection of this year. The caterpillars were placed in long rearing boxes out of doors under favorable conditions for their growth, but an attack of the disease, which started from one box in which there must have been a few infected webs, and spread rapidly to all of the others, killed off 90 to 95 per cent. before the 20th of August. The few that survived were evenly distributed in five disease boxes, and with them were mixed healthy larvæ from the webs in the field. Although this meager supply of diseased material was unsatisfactory, about forty plantings were made, with the co-operation of the State agents and superintendents, on low shrubbery in eastern Massachusetts. A new method of sending the caterpillars to the field, in mailing cases, was tried in connection with these plantings, and proved to be satisfactory, except in those instances where the cases were delayed in the mails until the larvæ were dead when they arrived at their destination. In making the plantings all the nests that could be conveniently reached were ripped open, so that a few of the infected caterpillars could be inserted directly among the healthy occupants. The bag method was also used successfully. Where the contour of the country permitted, the plantings were made at 50-foot intervals, and the whole planted territory divided into plots of convenient size for careful observation. A count of all of the nests in a selected plot was recorded at the time of planting, so that the spread of the disease might be checked up at each inspection. The reports of the inspectors showed that the disease became evident after ten days in every plot, and that the number of dead larvæ on

the outside of the nests increased very rapidly, first in the immediate vicinity of the infected web, and then in scattered spots all over the territory. The following typical report from two inspections of a planting made August 13 at Clinton gives some idea of the rapid death rate. One bag, containing 15 to 20 diseased caterpillars, was hung in the middle of each plot, and the plots so chosen that the bags were about 50 feet apart.

PLOTS.	Total Number of Webs in Plot.	Webs Infected September 10.	Dead Larvæ September 10.	Webs Infected September 15.	Dead Larvæ September 15.
I., . . .	12	4	67	10	231
II., . . .	10	3	46	9	340
III., . . .	23	6	149	15	410
IV., . . .	20	6	78	13	177

The area of each plot was between 400 to 500 square feet. The same results were reported from the other plantings, which were practically all successful, resulting in the infection of 35 to 50 per cent. of the webs in the planted areas.

Spring of 1911.¹

Following the same general methods in rearing, infecting and distributing the caterpillars used in previous experiments, the work of the spring of 1911 was continued on a still larger scale. The only change in the rearing and disease boxes was the use of heavy wire screening with a quarter-inch mesh on the bottoms, to retain a thin layer of earth and prevent the escape of the larvæ whenever the boxes had to be moved. The late spring, and consequent late opening of the foliage, made the work of early rearing very difficult, and it was necessary to draw on a supply of raspberry leaves, grown in the greenhouse and intended for use in raising gypsy larvæ, until the willow and cherry trees came out. Beside the extensive plantings made by two men employed especially for the purpose during the month of May, a general distribution of infected caterpillars was made possible with the help of the State agents. Ship-

¹ Mr. Colley took full charge of the work in February, 1911.

PLATE IV.



Fig. 1.

FIG. 1.—Long rearing boxes under the trees at the Botanic Garden, used to force the larva for the infection experiments of the fall of 1910.

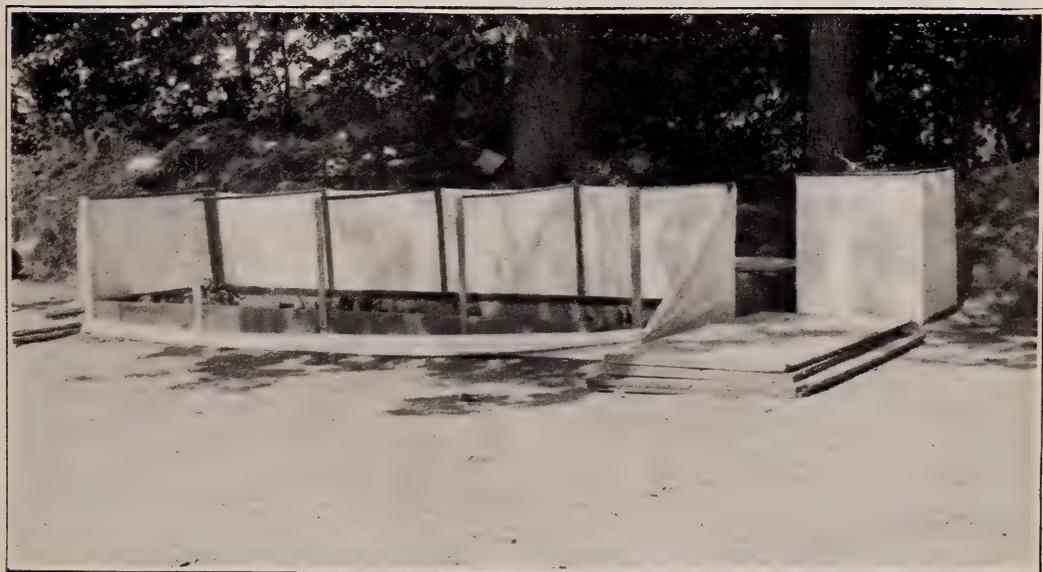
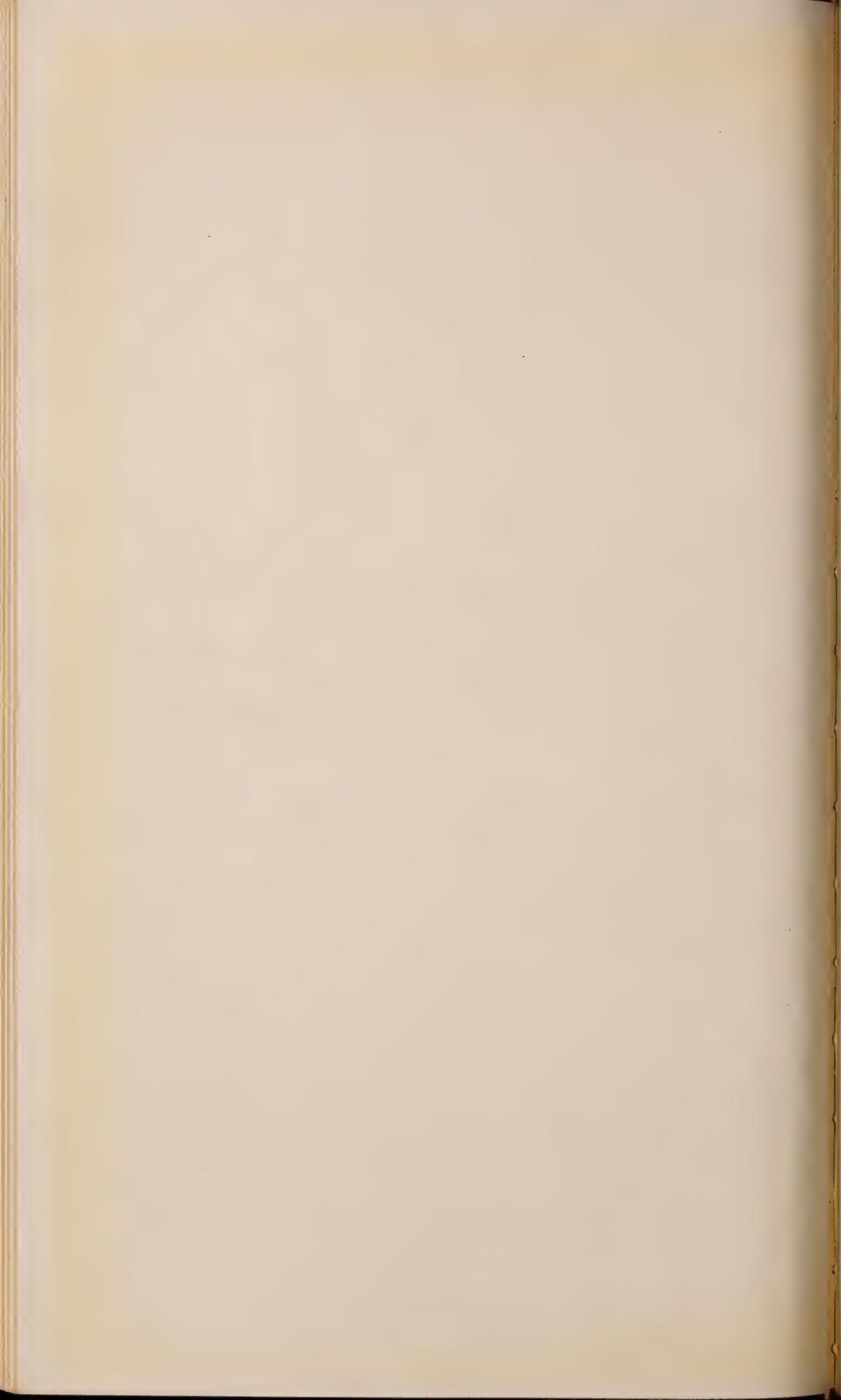


Fig. 2.

FIG. 2.—Rearing boxes protected by cotton drilling to prevent the spread of an epidemic of the disease in the fall of 1910. It was thought that the cotton cloth would stop spores from being blown in from the infected boxes.



ments were made also to interested persons all over the State for private experiment, as long as the material lasted.

The extreme dryness of the month of May hindered the growth of the fungus to a very large extent, so that the final results were not as good as those of the preceding spring, but toward the end of the season there was a general infection all over the planted territory. In and around Ayer the number of caterpillars visibly affected with the disease on the 27th of June was estimated at 60 to 70 per cent., and the trees in which the fungus had been planted were not nearly so badly stripped as those in which the caterpillars had been unmolested. In contrast to this condition a badly infested scrub growth of oak and cherry in Roberts, where no fungus had been planted, was completely defoliated, and the natural disease, though evident on one or two bushes, was not present in epidemic form.

Early inspection of the plantings made in the autumn of 1910 showed that the infection was general, but was not spreading far from the planted areas, except in one or two instances. In spite of this fact the defoliation in these areas was noticeably less than in areas where no fungus had been distributed. As in the spring of 1910, the death rate after the 15th of June increased very rapidly, and in Georgetown, where an excellent infection was started the previous September, the caterpillars in the planted territories were almost completely annihilated. The territory between Ipswich and Rowley, which is damp nearly all the time, on account of the proximity of the ocean and salt marshes, was found to be practically cleared of brown-tails by the disease.

Autumn of 1911.

In preparation for the fall infection the larvæ were brought from cold storage on the 15th of August, three weeks later than in previous seasons, and fed wholly on cherry. Fortunately, the disastrous results which attended our efforts to force the caterpillars in July and August, 1910, were not repeated, so that ten bushels of webs furnished an abundant supply of larvæ about one-half inch long by the 1st of September. It was found advisable to cover the bottoms of the rearing boxes

with a thin layer of coarse gravel, which was a great aid in keeping the boxes clean. Two disease boxes had been run all summer, and from them infection was started in seven others. The latter were all arranged as shown in Fig. 2, and by a combination of the "natural method" and the "spray method" a comparatively high per cent. of infection was obtained. The following table shows the results obtained in five test experiments. In each case the caterpillars were picked at random from the disease boxes and packed in mailing cases for several hours, as if they were to be shipped to agents in the field, to imitate the normal conditions of distribution, before being placed in the observation trays.

TRAYS.	Number of Larvæ placed in Tray.	Number of Larvæ dying within Nine Days.	Approximate Per Cent.
I.,	180	97	53
II.,	253	204	80
III.,	219	183	83
IV.,	144	109	75
V.,	129	97	75

Planting was commenced on the 1st of September and ended on the 12th, during which time approximately 100,000 caterpillars were distributed, a great increase over the number distributed in the fall of 1910. The caterpillars, packed in mailing cases as before, were delivered by automobile, a method which assured their reaching the agents in good condition, because by its use unnecessary delay in transit was avoided. With one or two exceptions all of the infected caterpillars were planted directly in the nests.

About the middle of October an inspection of all the nests on plotted areas in plantings in Waltham, Stow, Marlborough and Hudson showed a general infection, about half of the nests examined being diseased.¹ In all of this autumn's work only three cases of naturally infected webs were observed, a fact which led to the conclusion that the epidemic in these areas

¹ The number diseased was 763 out of 1,623, by actual count.

was due to the infection started by the introduced caterpillars. There is every indication that, with favorable weather conditions, the work of the fungus will be evidenced in the spring of 1912 by a more or less complete annihilation of the brown-tails in and around the territories where the plantings were made this last autumn.

In summing up the results of the investigations covering the four seasons 1908-11, it may be said that it has been found possible to propagate the disease in the laboratory, and to infect caterpillars in the field successfully, both in the spring and in the fall. Under favorable weather conditions the artificially induced spring epidemics have resulted in many cases in the practically complete destruction of the larvæ in the planted areas. In the fall epidemics the number of nests infected at the end of the season has ranged from 30 to 50 per cent., and these nests have apparently formed the starting point of early spring infections. The fall plantings have, therefore, a two-fold efficiency, in that they not only result in the destruction of one-third to one-half of the caterpillars in the autumn, while they are small and comparatively harmless, but also, by establishing the disease in the nests, enable an epidemic to get started much earlier in the spring than any natural infection could develop under ordinary weather conditions. The last three or four years have not been particularly favorable for natural epidemics or for furthering the spread of the introduced disease, and it seems reasonable to suppose that the fungus would have been far more effective if the weather, especially during the spring months, had been warmer, with a larger rainfall. It has, of course, been impossible to plant all of the infested territory with diseased caterpillars, and in many cases areas cleared of brown-tails by the fungus in the spring have been invaded by moths from uninfected localities, with the result that they were infested as badly as ever in August. This condition of affairs is unavoidable, since we are dealing with a moth that may fly, or be blown, for some distance, and it is therefore impossible to guarantee that the fungus will clear any territory of moths so that it will remain free for any length of time. The presence of the disease does not ren-

der a territory immune to future immigrations, but it certainly will reduce the amount of damage that the invading moths may do. The determination of the distance to which the disease may spread is extremely difficult. Undoubtedly the spores are often blown for miles, and in such cases the epidemic might jump from one territory to another widely separated from it, but there would be no means of telling just where the spore or spores which started the second epidemic came from. As can be seen from the table on page 18, one bag of 20 to 30 diseased caterpillars is sufficient to infect an area of approximately 625 square feet; any further spread of the disease would be variable, and dependent upon weather conditions.

Webs in Cold Storage.

Before giving general directions for private experiment it seems advisable to mention the advantages of having a supply of webs in a cold-storage warehouse, or packed in a dry box in an icehouse where the temperature does not go over 35 degrees, to furnish the proper amount of material at short notice for spring or fall work. It is difficult to collect larvæ just when they are needed in the spring, for the caterpillars have usually started to feed, and it is impossible to collect them in the summer in time for the fall work, for they do not emerge from their eggs until the middle of August. Care should be taken that such webs as are selected for this cold-storage supply are not infected with the disease at the time of collection, for if they are it will become epidemic when the nests are brought out into the warmer air, and completely destroy the larvæ in the rearing boxes.

Directions for Private Experiment.

With such a supply of webs to draw from, persons wishing to make private experiments might proceed something as follows:—

Two boxes should be constructed after the manner shown in Fig. 2, and set in two frames (Plate V., Fig. 2) some distance apart, one for rearing the caterpillars and one for forcing the disease. The bottoms of both boxes should be covered with a

PLATE V.



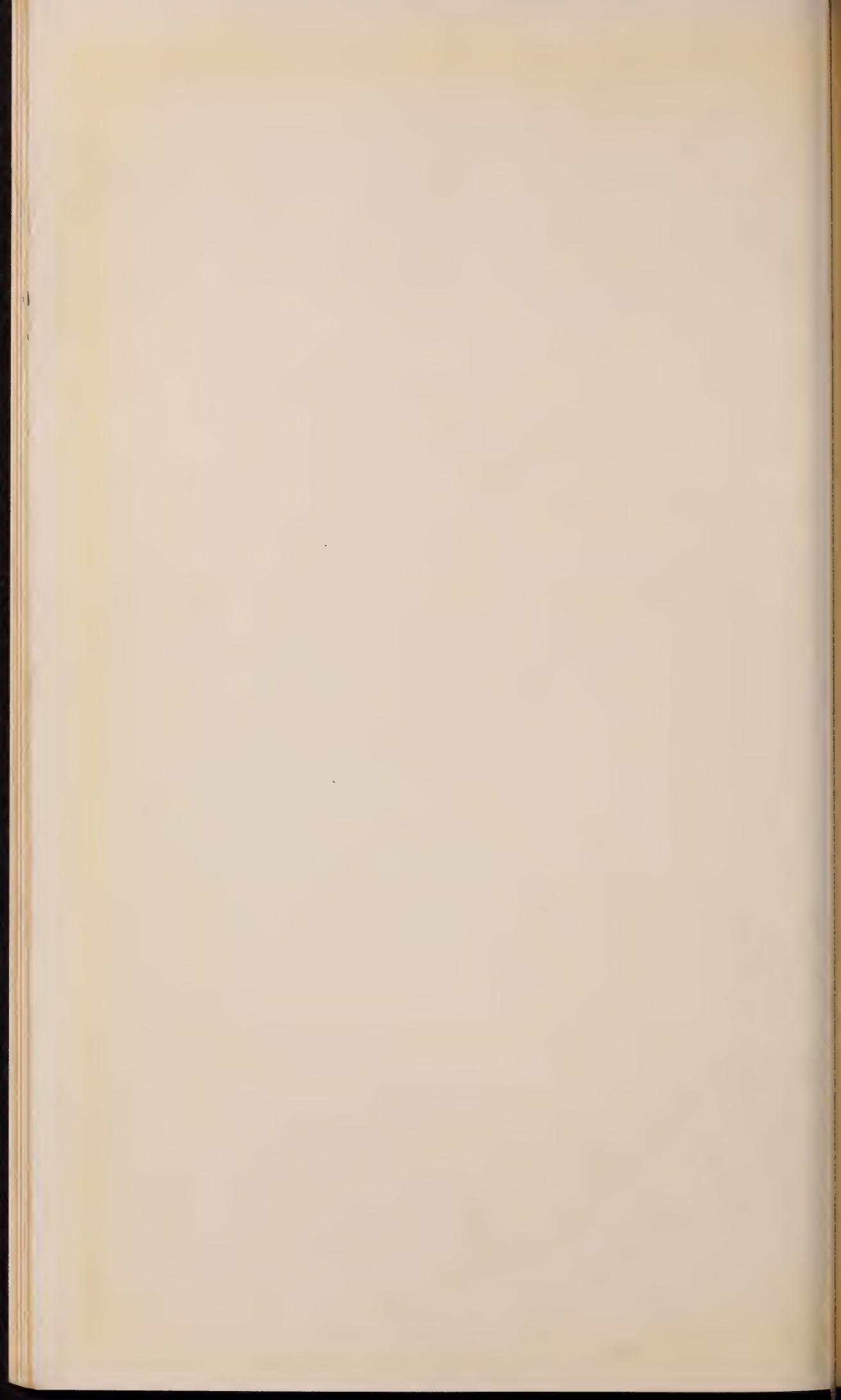
Fig. 1.

FIG. 1.—Showing the proper method of hanging the bag containing the infected caterpillars close to the nest.



Fig. 2.

FIG. 2.—A cheap but efficient frame and disease box for private experiment.



thin layer of gravel. About April 1, 200 stored or freshly cut webs should be placed in each box, and in addition to this number the box chosen for the disease box should also receive two or three dozen infected webs from some locality where the disease is known to be present.

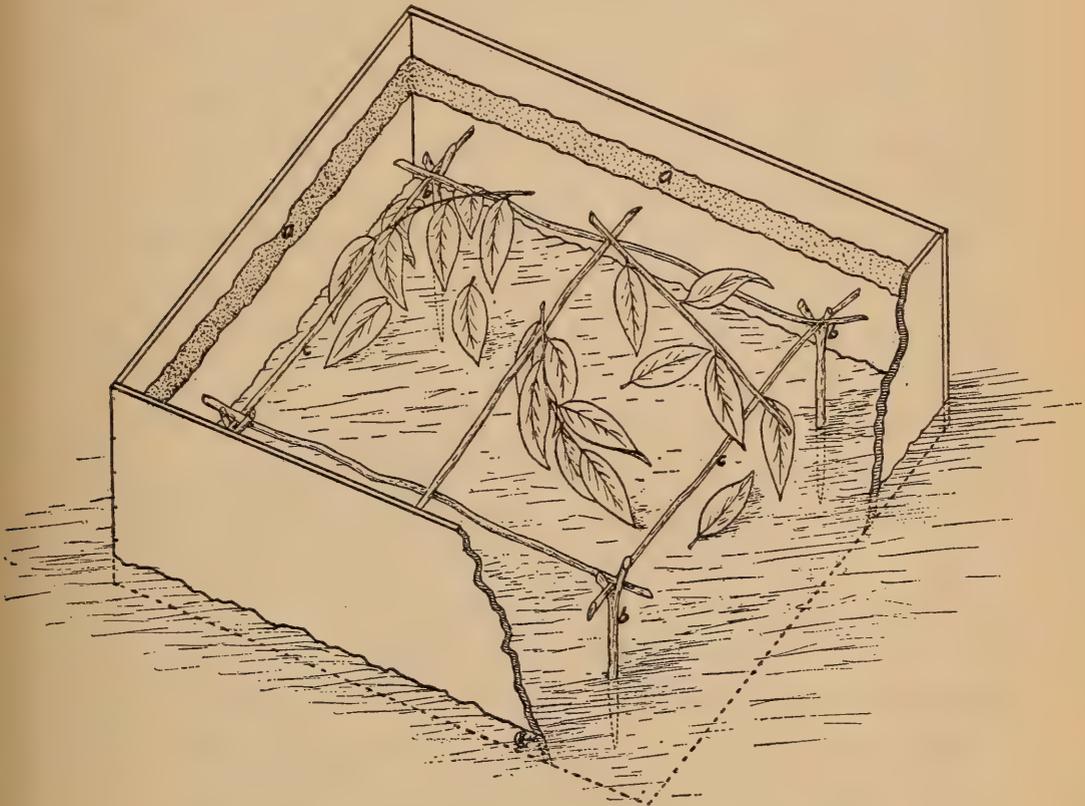


FIG. 2.—Diagrammatic view of the interior of a rearing or disease box. Forked sticks *bbb* driven into the ground support crosspieces *cc*, on which leafy twigs may be hung. Other leaves should be scattered on the ground beneath the crosspieces. Infected caterpillars will usually crawl up the forked sticks and along these crosspieces, so that the spores from their bodies will fall on the healthy larvæ feeding below. A two-inch rim of tanglefoot in the position indicated by *aa* will keep the caterpillars confined.

In the matter of food, sanitation, heat and shade experience is the only reliable guide, but in general, young buds, stripped from oak or cherry trees, make the best material for early feeding; the boxes, especially the rearing box, should be kept as clean as possible, and the shade should be arranged so that the temperature does not go much over 80 degrees. The disease box should be kept dark and moist most of the time by covering with a damp mat, but here again the rule is not without excep-

tion. The rim of tanglefoot, indicated in Fig. 2, should be frequently combed.

After about ten days, by which time the disease should have made its appearance, the disease box should receive constant attention. Each night and morning the dead and dying caterpillars should be evenly distributed among the other larvæ in the box, in order to make the infection as general as possible. The "spray method" outlined on page 13 should be used in conjunction with this "natural method." Furthermore, it is particularly important, in the attempt to hasten the general infection, that the number of larvæ in the disease box should be kept nearly constant, by transferring healthy caterpillars from the rearing box to replace those killed by the disease. Broad-pointed forceps should be used in handling the caterpillars.

Planting should be commenced about the first of May, and can be continued to advantage until the first of June. Twenty to 30 of the caterpillars which have been exposed to the spore discharge in the disease box should be placed in a quarter-pound paper bag, the neck of which should then be tightly wired with a convenient strand of No. 26 iron wire, or other suitable material. The bag, when it has been hung as near as possible to the masses of feeding larvæ or to the nests (Plate V., Fig. 1), should be ripped open to allow the escape of the infected caterpillars.

For successful autumn planting a supply of cold-storage webs is absolutely necessary, because the fungus must be kept alive through successive generations during the summer months in the disease box, and to do this one must have a few webs on hand all the time. Moreover, as stated before, the larvæ in the field are not large enough for convenient handling in the fall experiments. The rules given for spring rearing and infection hold in general for the autumn work, except that it is not necessary to keep the boxes under glass. Autumn planting should be direct, that is, infected caterpillars should be placed directly into nests conveniently reached, a method which insures an infection and which is simpler than the bag method. Pliable branches may be pulled down with a hooked pole. Where there are a number of nests on a small bush the central nest may be

directly inoculated and the surrounding nests tied up to it with a piece of heavy cord, which may be cut at the first inspection, after the infection has spread. Another method, devised by Dr. Thaxter, is as follows: cut, infect and bind together half a dozen or more nests. To one end of a string of convenient length attach a small stone, throw the stone over the infested tree and pull the bunch of webs attached to the other end of the string up into the topmost branches, where the nests are usually crowded and the infection will do most good. All of these suggestions can be varied to suit conditions of moisture, contour and shrubbery on the territory which is to be planted. Where it is convenient the nests which have been cut from fruit trees may be piled in an open field or in swampy pasture land and the infection started in the pile. Such a method will result in the practically complete destruction of the caterpillars, will allow the escape of insect parasites which would be killed by burning, and will establish the starting point for an epidemic which should spread to the surrounding bushes and trees. It has been found advantageous in some cases to burlap the trees in which the fungus has been planted, especially in the spring, as the caterpillars, in crowding together under the burlap, easily transmit the disease to one another.

Conclusions.

The artificial propagation and use of the brown-tail fungus has been clearly shown to be an effective means of destroying the caterpillars of this insect in great numbers and over considerable areas.

Although the success of this artificial use is variable, owing to the fact that the degree of warmth and moisture most favorable for the growth of the fungus, and dependent on weather conditions, cannot be controlled, the introduced disease can in general be depended on to kill from 60 to 100 per cent. of the caterpillars in the planted areas.

Plantings of the infected caterpillars should be made preferably in localities where the natural disease is not known to be present, in the spring from May 1 to June 1, and in the autumn from August 25 to September 10.

The fungus usually lives over winter from the autumn infec-

tion, and does effective work, as is evidenced by the early appearance of the disease and the reduction of the spring defoliation in localities where it was introduced the preceding fall, and for this reason fall infection is doubly effective.

Artificial distribution is most easily accomplished in sprout woodlands and pastures where the ordinary methods of control, such as spraying and cutting, are not employed, and where the nests are more readily accessible.

List of Localities where the Fungus has been planted.

Spring, 1908. — Concord, Gerrish Island, Me., South Billerica, State Line, Waltham.

Fall, 1908. — North Andover.

Spring, 1909. — Ballardvale, Chelmsford, Concord, Lowell Junction, Newburyport, North Andover, North Wilmington, Rowley, Salisbury, West Newbury, Woburn.

Fall, 1909. — Mishawum, North Wilmington, Newbury.

Spring, 1910. — Territory along railroad track from Ipswich to New Hampshire line. Scattered plantings on six private estates.

Fall, 1910. — Amesbury, Andover, Billerica, Bolton, Boston, Boxford, Clinton, Cohasset, Dracut, Georgetown, Groveland, Fitchburg, Framingham, Harvard, Leominster, Lunenburg, Medfield, Methuen, Newbury, North Andover, Reading, Rowley, Scituate, Shirley, Tewksbury, West Newbury, Worcester.

Spring, 1911. — Intensive planting in and around Ayer. Dunstable, Groton, Leominster, Lunenburg, Pepperell, Shirley, Stony Brook, Westford, Whalom.

Fall, 1911. — Amesbury, Arlington, Ashland, Bedford, Belmont, Berlin, Boxford, Burlington, Carlisle, Concord, Danvers, Dedham, Dover, Fayville Dam, Framingham, Georgetown, Groveland, Hamilton, Hopkinton, Hudson, Ipswich, Lakeside, Lexington, Lincoln, Lynn, Marlborough, Malden, Melrose, Merrimac, Needham, Northborough, North Reading, Newbury, Roberts, Salisbury, Saugus, South Acton, Southborough, Stoneham, Swampscott, Wakefield, Waltham, Wellesley, Weston, West Acton, West Newbury, Wilmington, Winchester, Woburn.

This list indicates the localities where the fungus has been planted, but not the number of plantings. In many instances several plantings were made in the same town.

List of Hosts of *Entomophthora Aulicæ* Reich. reported in the United States. Hosts of *Empusa grylli* Fres. are excluded.

<i>Agrotis</i> sp., cutworm,	Thaxter. ¹
<i>Catocala</i> sp.,	Clinton.
<i>Estigmene acraea</i> , salt-marsh caterpillar,	Clinton.
<i>Euproctis chrysorrhoea</i> , brown-tail moth caterpillar,	Kirkland, Stone and others. ²
<i>Hyphantria textor</i> , fall webworm,	Thaxter. ³
<i>Lithophane</i> (<i>Xylina</i>), cutworm,	Thaxter. ¹
<i>Malacosoma americana</i> , tent caterpillar,	Clinton.
<i>Mamestra</i> sp., cutworm,	Thaxter. ¹
<i>Orgyia nova</i> , rusty tussock moth,	Thaxter. ³
<i>Phlegethontius carolina</i> , tomato worm,	Thaxter. ¹
<i>Phlegethontius celeus</i> , tomato worm,	Thaxter. ¹
<i>Pyrrharctia isabella</i> , Isabella moth,	Thaxter. ³
<i>Spilosoma virginica</i> , yellow bear,	{ Thaxter. ³ Webster. ⁴
<i>Euchetes Egle</i> ,	Thaxter, herb.
<i>Smerinthus modestus</i> ,	Thaxter, herb.
<i>Amphipyra pyramidoides</i> ,	Thaxter, herb.
Larva of diurnal lepidoptera, probably <i>Vanessa</i> ,	Thaxter, herb.
Larva of diurnal lepidoptera, sp.,	Thaxter, herb.

¹ Ann. Rept. Connecticut Agri. Exp. Sta., 1890; 96, 1891.

² Ann. Rept. Mass. Supt. Suppression of Gypsy and Brown-tail Moths, 1, 130, 1906.

³ Mem. Boston Soc. Nat. History, IV.; 159-162, 1888.

⁴ Journal Cincinnati Soc. Nat. History, XVI.; 175, 1894.

EXPERIMENTS WITH THE GYPSY FUNGUS.

In the spring of 1908, while Dr. Clinton was carrying on preliminary experiments with the brown-tail fungus, he received from the Melrose laboratory specimens of Japanese gypsy larvæ, shipped from Japan with other material, which had been killed by the attack of an *Entomophthora*, but owing to the fact that the caterpillars had been dead for some weeks, all attempts to make this fungus develop its spores were unsuccessful. As it was thought that this species of *Entomophthora* might be as effective in destroying the gypsy larvæ as *Entomophthora Aulicæ* was in destroying the brown-tail, Dr. Clinton, through the generosity of a friend of Harvard University, was sent to Japan to obtain the living fungus, and after great difficulties succeeded in bringing a few infected Japanese cater-

pillars to Cambridge. Of the few larvæ which survived the long trip and severe heat only two developed the disease. These two were put immediately into a moist culture dish, so arranged that the spores would be discharged on healthy caterpillars. Only one of the latter developed typical conidia, but the growth was so feeble that probably very few spores were discharged. The pustules of conidiophores and attached spores were picked off and transferred directly to healthy caterpillars, and the dead bodies of the few larvæ which had developed resting spores were carefully saved. The caterpillars directly inoculated showed signs of the disease externally on the eighth day after infection, but in no case was the appearance typical. From this generation of the fungus 30 caterpillars were inoculated directly as above, and by successive transfers the number which developed the conidial form of the disease was increased steadily, though slowly. Resting spores were generally formed with the conidia. By the time the disease was running well in the infection boxes the larvæ in the field had practically all become prepupæ or pupæ, and since the attempt to raise caterpillars from cold-storage eggs was unsuccessful, the disease, from lack of hosts on which it could be propagated, died out late in August.

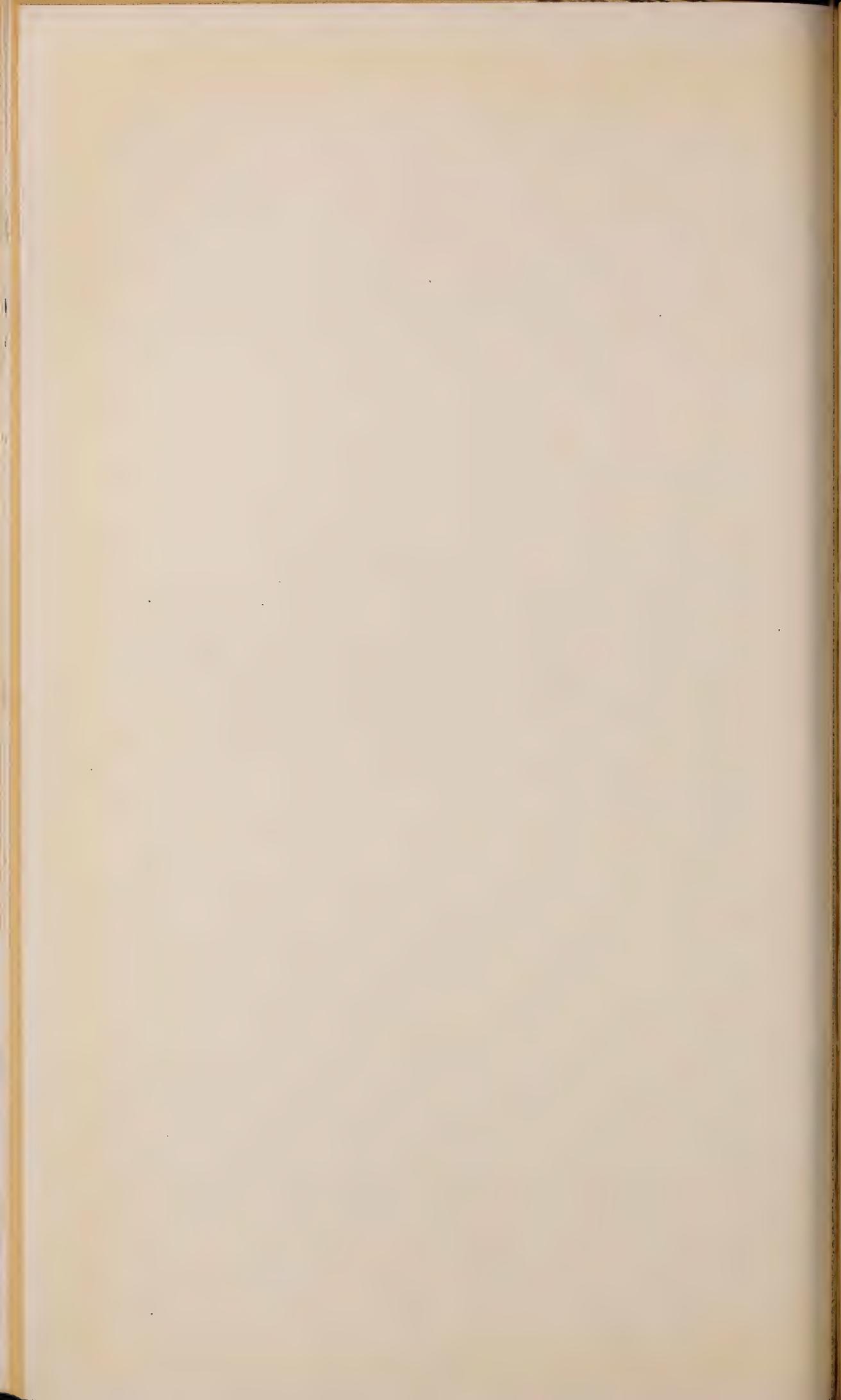
Healthy gypsy larvæ were put into the infection box of the previous spring on May 15, 1910, and the disease, which developed spontaneously on the 2d of June, was kept running until the last of August. Reinfection was undoubtedly accomplished through the germination of some of the thousands of resting spores, formed during the previous season, which were lying on the bottom of the box. From June 15 to July 2 six plantings were made, following the same methods used successfully with the brown-tail fungus, in Billerica, Brookline, Lynn, Saugus and North Wilmington, but regular and careful inspection of these plantings revealed neither the conidial nor the more common resting-spore stage of the fungus.

In the spring of 1911 the same plantings were inspected carefully to see whether the disease had possibly started as a result of the infection made in 1910, but no indication of its presence was discovered. The disease boxes at the garden had not been disturbed during the winter, so they contained all the

PLATE VI.



Gypsy caterpillars dead from a disease similar to the brown-tail fungus. Note the characteristic position of the body of the dead caterpillars.



resting spores formed in 1909 and 1910, except those which must have germinated and the few removed for experiment and examination. The disease appeared on the 23d of May, when a very small larva broke out with a few feebly growing pustules. On the 27th a half-grown caterpillar died from the disease in the greenhouse, and again on the 9th of June a large gypsy was found rigid and ready to shoot. From these larvæ, and from others which subsequently developed the disease, about 500 caterpillars were directly inoculated, but it was not until the 19th of June that the supply of diseased material warranted the first planting, at Brookline. On the 24th and 26th of June two other plantings were made in a badly infested scrub oak woodland in Roberts. Careful inspection on the 29th of June, and on the 6th and 15th of July, failed to reveal the slightest sign of the fungus in either of these plantings. The wilt disease appeared to be universally distributed wherever the gypsies were feeding, and was severe enough during the hot weather of the last half of June and of early July to kill off the caterpillars in the rearing boxes and the disease boxes at the garden to such an extent that the propagation of the fungus became more and more difficult, until finally it had to be abandoned, owing to the total destruction of the culture larvæ.

Conclusions from work on the Gypsy Fungus.

The experiments with the gypsy fungus, notwithstanding the fact that they were made under unfavorable weather conditions, both in 1910 and 1911, indicate that this disease is not a promising form for artificial use. This conclusion is based not only on the fact that the fungus is itself far more difficult to propagate than that of the brown-tail, and is much more sensitive to unfavorable weather conditions, but is also evident from the fact that the breeding in confinement of gypsy larvæ is associated with difficulties which are in themselves sufficient to render the continuous propagation of the fungus from month to month or from year to year almost impossible.

Should it obtain a foothold in the field, however, it might be expected to prove continuously effective from season to season, owing to its habit of forming resting spores in great abundance, which the experiments have shown are able to survive the New

England winter, and a very slight increase in virulence, such as often appears in parasitic fungi in successive seasons, might bring about quite different results from those above reported.

LITERATURE.

Among some of the more important articles dealing with insect diseases and their practical use the following may be mentioned:—

1855. COHN, F. *Empusa muscæ* und die Krankheit der Stubenfliegen. Nova Acta Acad. Caes. Leop. Carol. d. Nat., XXV., 301, 1855.
1869. REICHARDT. *Empusa Aulicæ*. In Bail, Ueber Pilzepizootien in Schriften d. Natur. Ges. Danzig. N. F. Band II., 3, 1869.
1875. COHN, F. *Entomophthora Aulicæ*. Beit. z. Biol. d. Pflanzen, Band I., Heft VII., 1875.
1882. NOWAKOWSKI, L. *Entomophthoraceæ*. Report in Bot. Zeit., 1882, 560.
1888. THAXTER, R. The *Entomophthoræ* of the United States. Mem. Boston Soc. Nat. Hist., 4, 133-201, 1888.
- FORBES, S. A. On the Present State of our Knowledge concerning Contagious Insect Diseases. Psyche, Vol. V., 3, January-February, 1888.
1889. GIARD, A. Review of Krassiltschik's "De Insectorum Morbis qui Fungis Parasiticis Efficiuntur." Bul. Sci. de France et de la Belgique, Tome XX., 120-136, 1889.
- SNOW, F. H. Experiments on Artificial Dissemination of Contagious Diseases among Chinch Bugs. Kansas Academy of Sciences, Vol. XII., Topeka, 1889.
1892. BUISSON, M. Le *Botrytis tenella*. Nouveau Moyen de détruire les Vers Blancs et les Hanneçons. Compiègne, Imprimerie Henry Lefebvre, 31 Rue Solferino, 1892.
1893. GIARD, A. *L'Isaria densa*. Bul. Sci. de la France et de la Belgique, Tome XXIV., 1893.
1895. PETTIT, R. H. Studies in Artificial Cultures of Entomogenous Fungi. Bul. 97, Cornell University Agri. Exp. Sta., 1895.
1897. ROLFS, P. H. A Fungous Disease of the San José Scale, *Sphaerostilbe coccophila* Tul., Bul. 41, Florida Agri. Exp. Sta., 1897.
1901. DANYSZ, M. J., and WIZE, M le Dr. K. De L'utilisation des *Muscardinæ* dans la Lutte avec le *Cleonus punctiventris*. Libraire Agricole de la Maison Rustique. 26 Rue Jacob, Paris, 1901.
- HOWARD, L. O. Experimental Work with Fungous Diseases of Grasshoppers. U. S. Dept. Agri. Yearbook, 459, 1901.

1902. BRUNNER, L. Killing Destructive Locusts with Fungous Diseases. U. S. Dept. Agri., Div. of Entomology, Bul. 38, new series, 1902.
1903. SHELDON, J. L. Cultures of *Empusa*. Journal of Applied Microscopy and Laboratory Methods, Vol. VI., No. 3, 2212-2220, Rochester, N. Y., 1903.
1906. OLIVE, E. W. Cytological Studies on the *Entomophthorææ*. Bot. Gaz. 41, 192-208, 229-261, 1906.
- RIDDLE, L. W. Cytology of the *Entomophthoraceæ*. American Acad. Arts and Sciences, 42, 10, 1906.
1908. ROLFS, P. H., and FAWCETT, H. S. Fungous Diseases of Scale Insects and White-fly. Bul. 94, Florida Agri. Exp. Sta., 1908.
- HITCHINGS, Professor. Note on the Infection Experiment at Kittery Point, Me. Maine Dept. Agri. Bur., III., 20, 1908.
1909. Spraying with *Aschersonia*. Florida Agri. Exp. Sta. Report for year ending June 30, 1909, 38-41; 1910, 39.
1910. BERGER, E. W. White-fly Control. Bul. 103, University of Florida Agri. Exp. Sta., 1910.
- FAWCETT, H. S. An Important Entomogenous Fungus, *Ægerita Webberi*. Mycologia, Vol. II., No. 4, July, 1910.
- RORER, J. B. The Green Muscardine of Froghoppers. Proc. Agri. Soc. of Trinidad and Tobago, Vol. X., 467-482. Society Paper No. 442, 1910.
1911. KELLY, E. O. G., and PARKS, T. H. Chinch Bug Investigations West of the Mississippi River. U. S. Dept. Agri., Bur. Entomology, Bul. 95, Part III., 40-52, 1911.
- BILLINGS, F. H., and GLENN, P. A. Results of the Use of the White-fungus Disease in Kansas. U. S. Dept. Agri., Bur. Entomology, Bul. 107, 1911.

Explanation of Plate VII.

FIGS. 1-4. — Typical conidia.

FIGS. 5-7. — Germinating conidia.

FIG. 8. — Secondary conidium produced directly from a primary conidium.

FIG. 9. — Four small hyphal bodies.

FIG. 10. — Group of conidiophores showing four stages, *a*, *b*, *c* and *d*, in the development of the conidium.

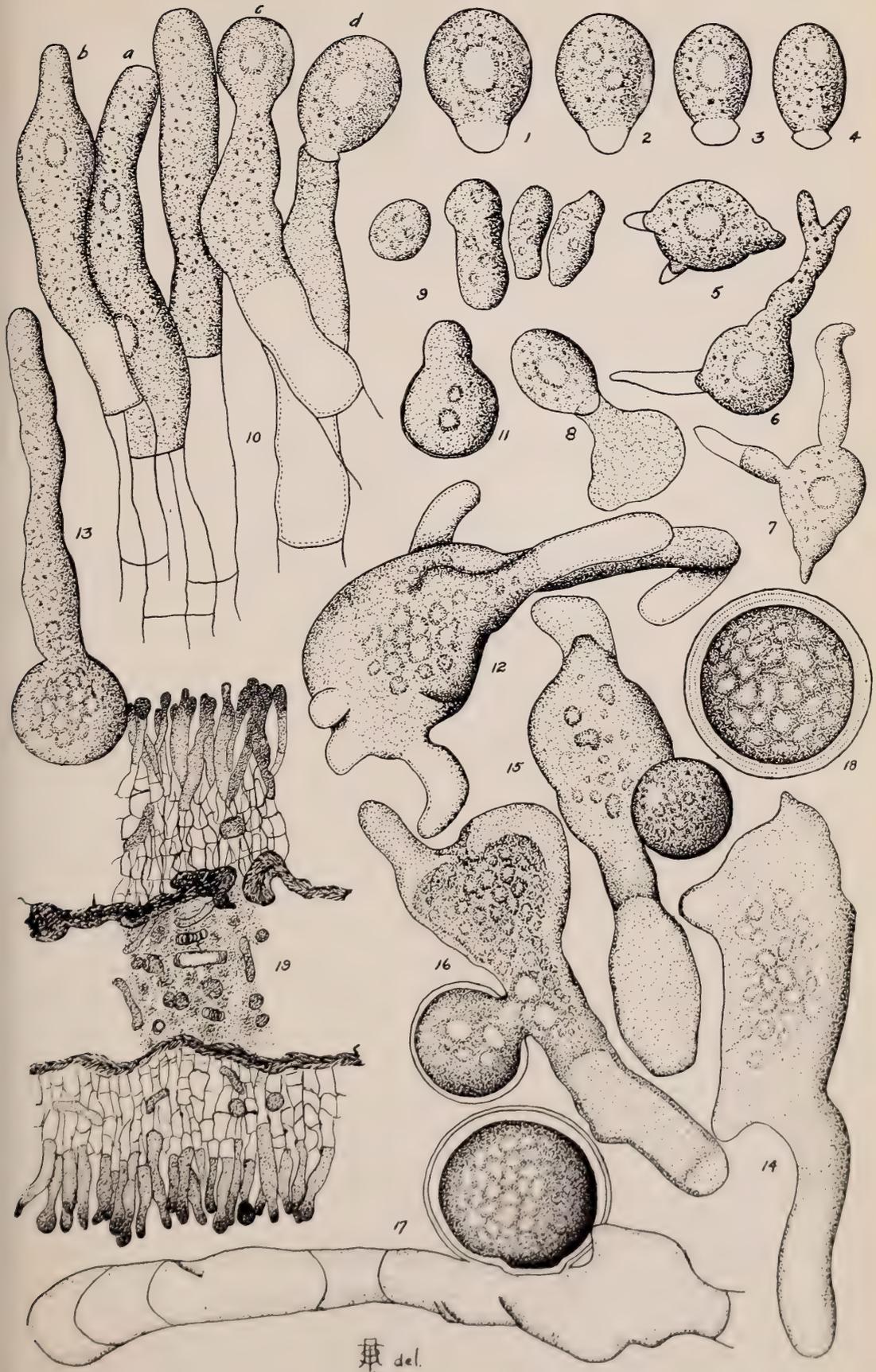
FIG. 11. — An abnormal hyphal body, apparently partially encysted.

FIGS. 12-17. — Characteristic forms of hyphal bodies prior to and during the formation of resting spores.

FIG. 18. — A mature resting spore.

FIG. 19. — Section through the body of a caterpillar, showing the relation of the conidiophores to the integument.

PLATE VII.



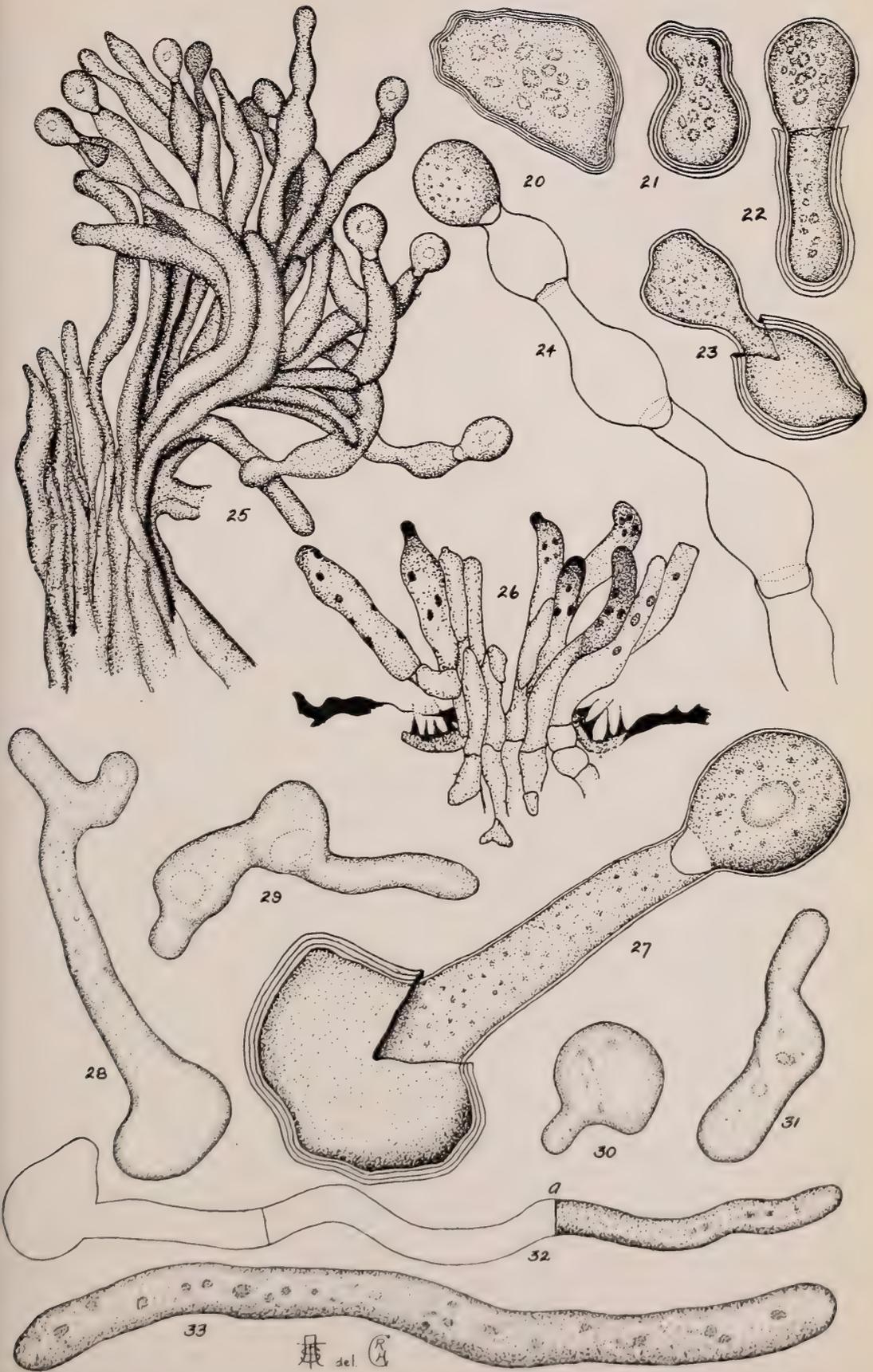
del.

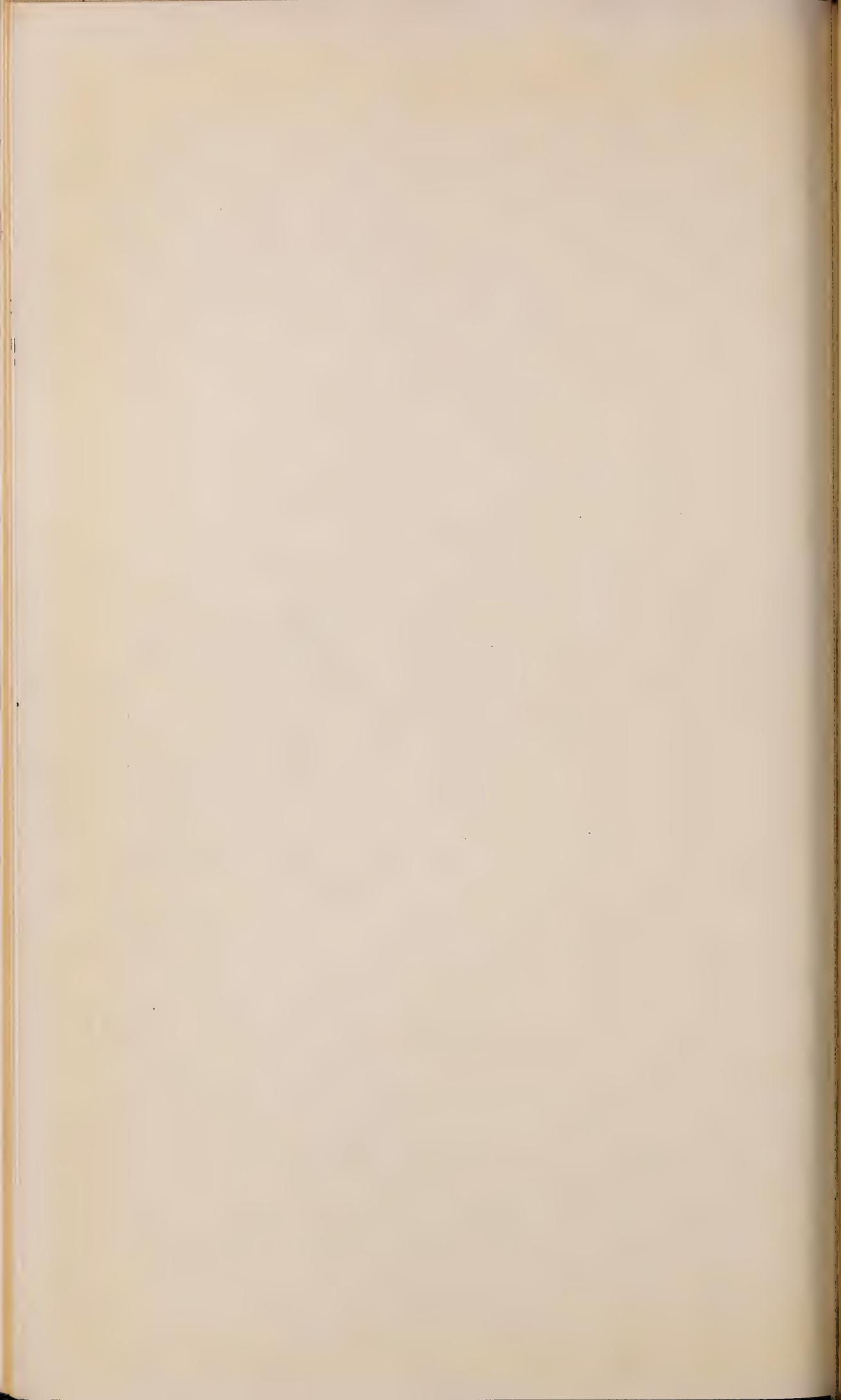
Explanation of Plate VIII.

- FIGS. 20-21.—Encysted hyphal bodies (autumn).
FIGS. 22-23.—Germination of the encysted hyphal bodies.
FIG. 24.—A conidiophore, showing the old walls of primary, secondary and tertiary conidia which have germinated *in situ*.
FIG. 25.—Pustule of conidiophores which developed from germinating encysted hyphal bodies in a culture dish in the laboratory.
FIG. 26.—Section view of a similar pustule breaking through the integument.
FIG. 27.—Formation of a conidium from the germination of an encysted hyphal body.
FIGS. 28-31.—Germination of the ordinary type of hyphal bodies.
FIG. 32.—A germinating conidium showing the cross septa *a* which closes the empty tube after the advancing protoplasm.
FIG. 33.—An abnormally large hyphal body.

All the figures were drawn with the aid of the camera lucida, and are reduced about one-third in reproduction. With the exception of Figs. 19, 25, 26 and 27 the magnification was approximately 425; for Fig. 19 the magnification was about 90; for Figs. 25 and 26, about 300; and for Fig. 27, about 600.

PLATE VIII.





8

THE BROWN-TAIL MOTH.

How to identify and know all about it. See colored plate.

ISSUED BY THE MASSACHUSETTS STATE FORESTER,

F. W. RANE.

APPROVED BY
THE STATE BOARD OF PUBLICATION.

INTRODUCTORY.

This publication is issued by the State Forester in order to explain briefly that which people desire to know about the brown-tail moth. The text is largely a revision of a former bulletin, now out of print. The illustrations in color shown herewith are natural size, and should acquaint one immediately with the various stages in the development of the insect.

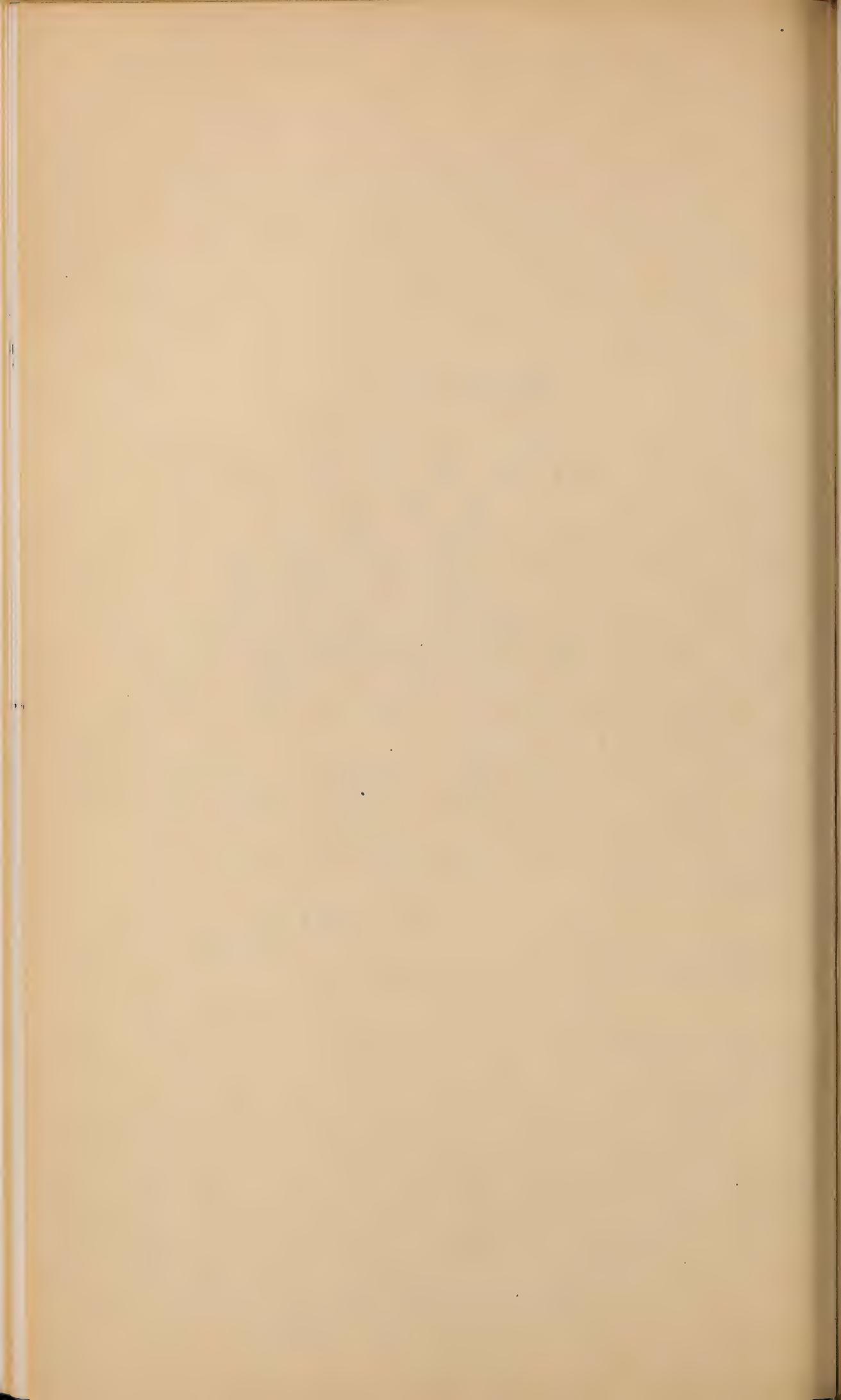
Heretofore it has been customary to publish the literature on the brown-tail moth in the same bulletin with the gypsy moth, as the same State law of suppression applies to each. This has resulted in a tendency to confuse the two insects, which really are totally different. For that reason this bulletin refers to the brown-tail moth only.

Nothing is given herein regarding the State laws, governing their suppression, as this is published in full in a small pamphlet in which are compiled all the forest laws of the State. This may be had by Massachusetts citizens upon application to the State Forester.

F. W. RANE,

State Forester.

6 BEACON STREET, BOSTON, MASS., March, 1912.





Winter nest



Male pupa



Female pupa



Male moth



Full-grown
Caterpillar



Egg mass and
moth laying eggs



Female moth

E. O. Cockayne, Boston, Lith.

L. C. C. Krieger, del.

THE LIFE HISTORY OF THE BROWN-TAIL MOTH (*EUPROCTIS CHRYSORRHOEA*).

THE BROWN-TAIL MOTH.

This insect, a common European pest of fruit and shade trees, has been an object of interest to gardeners from the earliest times. Throughout Europe it is known as the "common caterpillar" and accounts of its habits and periodical ravages are to be found in nearly all European works on entomology and horticulture. It found its way accidentally to Somerville, Mass., in the early 90's, probably in a shipment of roses from Holland, multiplied, spread, and is now generally disseminated over eastern New England.

Damage by the Brown-tail Moth.

While at first a pest of the pear and other fruit trees, the brown-tail moth has now adapted itself to feeding on various species of forest trees, notably the oaks. In the spring, as soon as the buds unfold, the young caterpillars begin to feed, and where numerous completely strip even large trees. When the food supply gives out, they swarm forth along fences, walks, etc., in search of foliage.

The damage by the caterpillars to the fruit trees is only a part of the harm wrought by them. Whenever these insects come in contact with human flesh, they produce a most severe and painful nettling. This is due, apparently, to some poisonous substance in the hairs, and also, perhaps, to the finely barbed and brittle hairs themselves. So severe is this affection that in many cases people have been made seriously ill by it. The best remedy for it is the liberal use of cooling lotions, or what is more satisfactory, even if less pleasant, the free use of common vaseline. A prescription which has given great relief in actual practice is: carbolic acid, $\frac{1}{2}$ drachm; zinc oxide, $\frac{1}{2}$ ounce; lime water, 8 ounces; shake well and rub into the affected parts. It is also stated on good authority that a saturated solution of hyposulphite of soda is an excellent remedy.

Where the brown-tail moth caterpillar exists in great numbers, it at times gathers upon houses and even enters them,

causing extreme annoyance. Like the gypsy moth, the brown-tail moth, where it abounds, depreciates the value of residential property.

Life History.

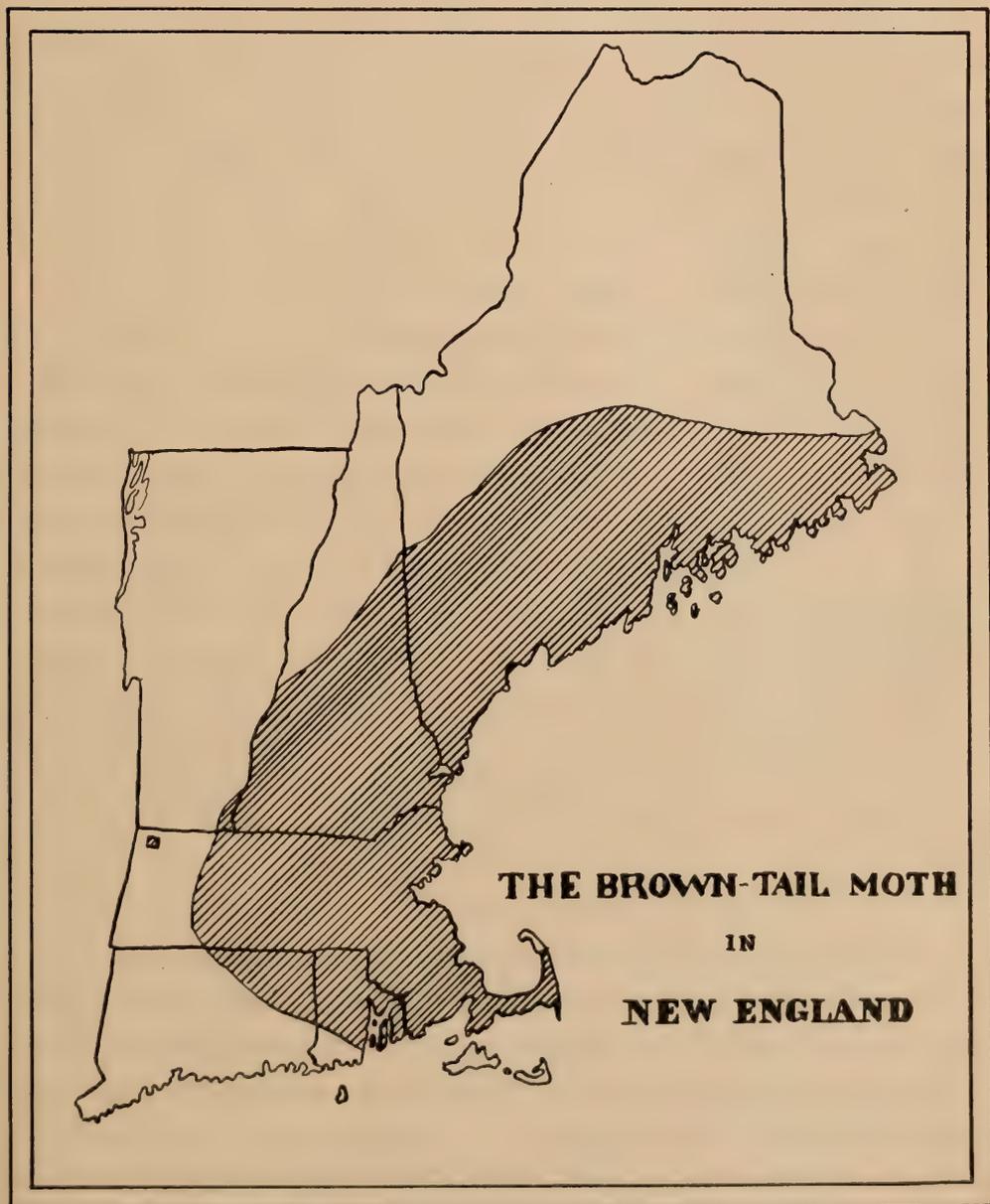
The Egg. — The egg mass of the brown-tail moth somewhat resembles that of the gypsy moth, but it is laid on the under side of a leaf—seldom on a tree trunk—and is smaller and more elongated, and of a brighter reddish-brown color. From July 15 to the end of the month the white moths lay their eggs in brown, hair-covered masses on the leaves near the top of pear and other trees. Each egg cluster contains about three hundred eggs, closely packed in a mass about two-thirds of an inch long by one-fourth of an inch wide.

The Caterpillar. — The eggs hatch during August, and the young caterpillars begin to feed in clusters on the upper surface of the leaves. They soon commence the work of spinning their winter webs. In making the web a number of leaves in the vicinity of the egg clusters are drawn together and carefully spun in with a tenacious silken web. The web is grayish in color, composed of dead leaves and silk, and is very hard to tear apart. Each web contains about two hundred and fifty caterpillars, and varies in length from four to six inches. With the approach of cold weather the caterpillars enter the web and close the exit holes. We then have the strange phenomenon of a caterpillar wintering over when only one-quarter grown, and emerging the following spring to complete its life history. The extremes of cold in Massachusetts do not seem to affect these insects adversely. They emerge in the spring, usually early in April, eat first the buds and then the blossoms, and attack the foliage of fruit trees as soon as it develops. The full-grown caterpillar is about two inches in length, with a broken white stripe on either side and two conspicuous red dots on the back near the posterior end.

Stripping the foliage of one tree, they go to others, and continue to eat until full grown, when the cocoons are spun within the leaves at the ends of the branches or sometimes on the tree trunks.

The Pupa. — The caterpillars pupate within their cocoons at the tips of twigs. Usually the mass of cocoons is formed within a spray of leaves, but at times the cocoon is made on a house

wall, fence, tree trunk, etc. The pupa is a compact, dark-brown body, about five-eighths of an inch long, with yellowish-brown hairs scattered over its surface. Pupation takes place the latter part of June, and the moths emerge about the middle of July.



The Moth.—The moths are pure white on the wings. The male is slender bodied, while the female has a conspicuous bunch of brown hair at the tip of the abdomen, hence the name “brown-tail moth.” The female has a wing expanse of about one and one-half inches, the male being slightly smaller.

Both the male and female brown-tail moths fly mainly by

night, and are greatly attracted to lights. As in the case of the gypsy moth, all the destructive work of the brown-tail moth is done by its caterpillar, which, unlike the gypsy moth caterpillar, habitually feeds by day.

Distribution.

The brown-tail moth is known to have spread at least as far to the northeast as Eastport, Me., and as far south as Cape Cod, Mass. To the west it has been found at Amherst, and at North Adams and Clarksburg, Mass. The eastern portion of Massachusetts from north to south is now quite solidly infested, and the moth doubtless exists in many communities in and out of Massachusetts from which it has not yet been reported.

The female winged brown-tail moth, like the male, is a strong, swift flier, and can carry her eggs long distances before depositing them. For this reason the brown-tail moth has spread much farther from its point of introduction in Massachusetts than has the gypsy moth. In its flight the brown-tail moth is often aided by strong winds. It is also transported on steamboats and in electric and steam cars, to which it is attracted at night by the lights.

The caterpillar of the brown-tail moth has, when young, the "spinning down" habit, and is transported by vehicles and pedestrians. The neighborhoods of traveled highways, therefore, should be kept free from the brown-tail moth.

Where to look for the Brown-tail Moth.

The Eggs. — The gathering of leaves which bear egg masses is only feasible in the case of shrubs and young trees where the foliage may be reached from the ground. Rose bushes, dwarf fruit trees and ornamental shrubs often may be cleared from the moth in this way.

The Caterpillar. — The winter webs or nests containing the hibernating caterpillars are conspicuous objects at the tips of twigs from October to April. These webs should be sought out and removed by the use of pole shears or long-handled pruners, and then carefully collected and burned. It is more satisfactory, where possible, to burn the webs in a furnace or stove, since, where an open bonfire is used, extra care must be taken

to see that none of the webs escape with a mere scorching. When a light snow is on the ground the work of web destruction and gathering can be carried on to best advantage, although it is desirable that the work should be done as early as possible in the season after the leaves fall. When tall trees are infested, two men, one to point out the nests from the ground, the other in the tree to cut off the nests, can work more rapidly and economically than one man. It should be borne in mind that webs cut off and thrown on a dump heap, as well as those that are beaten off by storms, will yield their quota of caterpillars the following spring.

Spraying is very effective against brown-tail moth caterpillars, since they are much less resistant to the action of poison than are those of the gypsy moth. To secure best results spraying should be done as soon as the foliage develops in the spring. Five to eight pounds of the arsenate of lead paste to one hundred gallons of water is sufficient for the spray, or if preferred, one pound of good Paris green kept well stirred in one hundred and fifty gallons of water may be applied.

Spraying may be done not only in the spring, but also in August, when the caterpillars hatch from the egg, except in cases of trees in fruit.

Spraying or sprinkling with kerosene emulsion or strong soap suds is often useful in destroying the swarming caterpillars on fences, walks, etc.

Such trees as are free from brown-tail moths may be protected from the caterpillars which crawl from neighboring estates by applying a sticky band. The banding will not prevent the infestation of the trees by the female winged moths, which, flying in July, will alight on the foliage of such trees and deposit their egg clusters thereon. It is therefore clear that sticky banding, when used against brown-tail caterpillars, has a more strictly limited usefulness than in the case of the gypsy moth.



Pruning shears suitable for removal of winter webs.

The Pupæ. — When the caterpillars have changed to pupæ enclosed by their cocoons, these may be gathered, although the work is likely to be attended by severe inflammation of the skin from contact with the nettling hairs. Cocoons thus gathered should be placed in a barrel covered with mosquito netting, so that any parasites may escape while the moths are confined. Brown-tail moth pupæ are most numerous during the latter half of June.

The Moths. — As has been already mentioned, the moths assembled in great numbers around electric and other lights. It often occurs on a morning during the flying season that a lamp pole is covered by hundreds if not thousands of the winged moths. In such cases the free use of the hose will wash down and kill the insects. No effective form of lamp trap has yet been devised, and, in fact, it is not at all clear that the brown-tail moth can be combated economically in the winged stage.

Natural Enemies of the Brown-tail Moth.

The brown-tail moth has its natural enemies in the fungus *Entomophthora Aulicæ*, in various parasites and in the Calosoma beetles. The fungous disease has been found to occur in this country naturally and has also been propagated by this office and spread artificially. Many plantings of it were made last season in woodland where no suppressive measures were used.



Improved pruner
with rope instead
of wire, and im-
proved cutter.

The parasites and beetles have been planted all over the most thickly infested sections and are spreading naturally.

For further information in regard to the fungous disease, or for assistance in combating this insect, application should be made to the local moth superintendent in your town or city, as he is in immediate charge of the work of suppression.

A publication now in press on the fungous disease may be secured by Massachusetts citizens by applying to the State Forester, 6 Beacon Street, Boston, Mass.

THE GYPSY MOTH.

How to identify and know all about it. See colored plate.

ISSUED BY THE MASSACHUSETTS STATE FORESTER,
F. W. RANE.

APPROVED BY
THE STATE BOARD OF PUBLICATION.

INTRODUCTORY.

This publication is issued by the State Forester in order to explain briefly that which people desire to know about the gypsy moth. The text is largely a revision of a former bulletin, now out of print. The illustrations in colors shown herewith are natural size, and should acquaint one immediately with the various stages in the development of this insect.

Heretofore it has been the practice to publish the literature regarding the gypsy moth in the same bulletin with the brown-tail moth, as the same state law of suppression applies equally to each. This has resulted in a tendency to confuse the two insects, which are totally different. For that reason this bulletin refers to the gypsy moth only.

Nothing is given herein regarding the State laws governing their suppression, as this is published in full in a small pamphlet in which are compiled all the forest laws of the State. This may be had by Massachusetts citizens upon application to the State Forester.

F. W. RANE,

State Forester.

6 BEACON STREET, BOSTON, MASS., March, 1912.





Male moth



Female moth



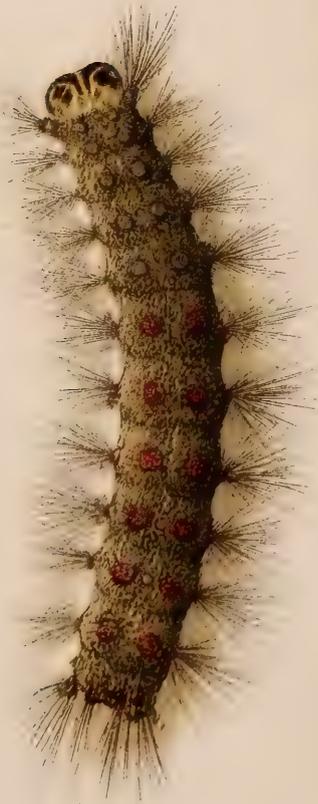
Male moth at rest



Female moth laying eggs



Female pupa



Full grown caterpillar



Egg mass



Male pupa

E. O. Cockayne, Boston, Lith.

L. C. C. Krieger, del.

THE LIFE HISTORY OF THE GIPSY MOTH (*PORHETRIA DISPAR*).

THE GYPSY MOTH.

As far back as authentic records exist, the gypsy moth has been a destructive insect pest in Europe; at times increasing enormously and disastrously, then for other periods decreasing, only to increase again and renew its extensive ravages. At the present time it is most numerous and destructive in southern Russia.

Up to the year 1868 the gypsy moth was not known to exist anywhere within the western hemisphere. In that year the insect was brought from Europe by an experimenter to Medford, Mass. Soon escaping, it spread into many cities and towns of eastern Massachusetts, and, increasing enormously, became in 1890 so serious a pest that the Commonwealth began exterminative work against it. This was continued for ten years. By 1900 the State work had so reduced the numbers of the moth that it was doing little or no serious damage, and had, indeed, ceased to be generally noticed, having been exterminated in many places. The Commonwealth then abandoned its operations against the insect; whereupon it rapidly gained headway, and soon became again a formidable menace. To-day, in many localities, the gypsy moth occurs in enormous numbers, as it did in 1890, but it is found over a much larger territory than it occupied at that time.

The Damage caused by the Gypsy Moth.

The gypsy moth caterpillar will attack all fruit, shade and woodland trees. It shows a preference for the apple, white oak, red oak, willow and elm. It will devour on occasion nearly every useful grass, plant, flower, shrub, vine, bush, garden or field crop that grows in Massachusetts.

The caterpillar kills both deciduous and coniferous trees, but in its early molts will not feed on pines. Woodlands assailed by it in formidable numbers are stripped bare, as in winter, and many trees are killed. While several consecutive

strippings are usually necessary to cause the death of a healthy deciduous tree, one thorough stripping will kill the white pine and other coniferous trees. Where the gypsy moth abounds in residential districts, it not only eats nearly everything green, but it swarms, in caterpillar form, upon houses, walks and verandas, and often enters dwellings. In residential districts most heavily infested by the moth real estate tends to rapid depreciation, so that it sometimes becomes a matter of difficulty to rent or sell property.

Life History.

The gypsy moth, like all insects of its class, exists under four different forms during the year.

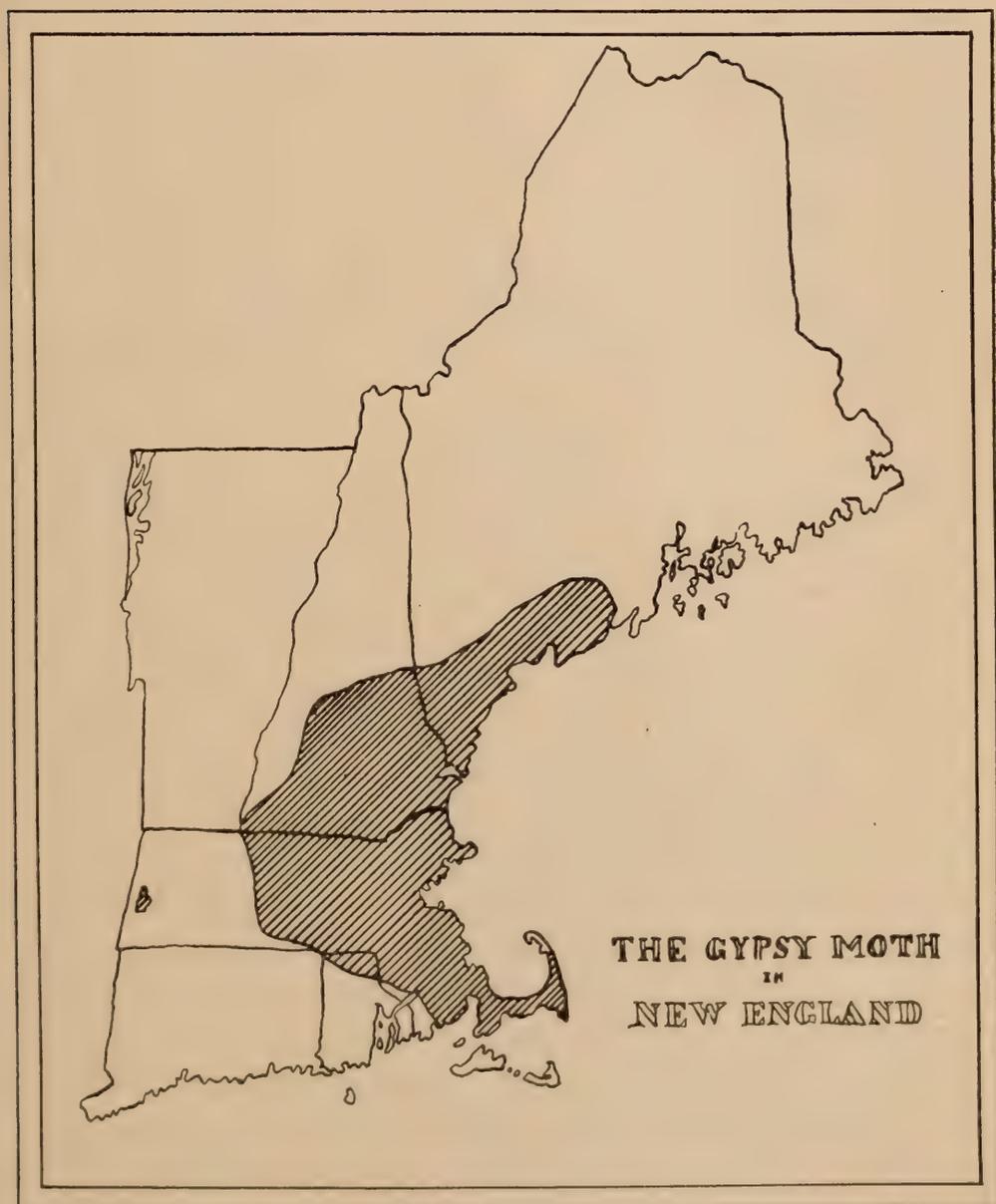
The Egg. — The eggs of the gypsy moth are laid in July and August in a yellowish, hair-covered mass, averaging about one and one-half inches long and about three-fourths of an inch wide. To the eye the egg mass resembles a small, tightly stuffed, oval, buff-colored cushion. During winter the color often fades to a dingy white. In this mass, the eggs, to the average number of about five hundred, are closely packed with yellowish hair from the body of the female moth. An individual egg is scarcely as large as a pinhead, salmon-colored when first laid, but turning dark in the course of a few weeks.

The Caterpillar or Larva. — The eggs hatch about May 1, and each mass or "cluster" yields a swarm of small caterpillars, the bulk of which become fully grown by midsummer. Gypsy moth caterpillars of any age are decidedly hairy. The head of the caterpillar is large in proportion to its body, this being especially noticeable when it is young.

The mature caterpillar has a dusky or sooty-colored body. Along the back, counting from the head, which is marked with yellow, is a double row of blue spots followed by a double row of red spots. This double row of spots almost invariably may be seen very distinctly on the back of a gypsy moth caterpillar which has attained a length of one inch and a half or more. There are five pairs of blue spots and six pairs of red spots. No other New England larva has this double row of blue and red spots along its back. Until the gypsy moth caterpillar grows to the length of an inch and a half, however, it does

not always show very distinctly these pairs of spots. The mature gypsy moth caterpillar not infrequently attains a length of three inches.

The Pupa. — When fully grown, usually in July, the caterpillar spins a few threads of silk as a supporting framework,



casts its skin and changes into a pupa, or, as it is sometimes called, a chrysalis. The pupa is dark reddish or chocolate in color and very thinly sprinkled with light reddish hairs. Unfortunately it resembles the pupae of certain other moths found in Massachusetts, and cannot, unless by experts, be identified

at a glance. The thinly sprinkled, light reddish hairs are, however, characteristic.

The Moth. — From July 15 to August 15 the winged moths emerge from the pupæ, the date varying according to the season and time of pupation. The male moth is brownish yellow, varying to greenish brown in color, has a slender body and expands about one and one-half inches. It flies actively by day, with a peculiar zigzag flight.

The female moth is nearly white, with numerous small black markings, heavy bodied and sluggish, and expands about two inches. The female does not fly, otherwise the spread of the gypsy moth would be most rapid. After mating, the moths live but a short time. The female dies after depositing her egg mass. The winged moths take no food. All damage to foliage is caused by the caterpillars.

Distribution.

The gypsy moth spreads chiefly during the caterpillar stage. While the caterpillars do not crawl very far from where they hatch, except when there is a scarcity of food, they have the habit, when small and young, of spinning down on their silken threads from trees, and, falling on vehicles, are then carried from place to place. Electric cars, pleasure and business vehicles, bicycles and automobiles are common means of thus transporting the gypsy moth. The special attention of all those upon whom gypsy moth suppression devolves is therefore directed to the necessity of keeping the neighborhoods of traveled highways free from the insect. The caterpillars often crawl upon vehicles standing in an infested spot, and by this means also are carried from one place to another. It has also been proven conclusively that young caterpillars can be carried a great distance on the wind. This probably accounts in some cases for new colonies which are found at some distance from any known source of infestation. The egg clusters of the gypsy moths may also be transported upon any of the numerous objects on which they are laid. Freight cars that have stood near infested foliage for a period long enough for the laying of gypsy moth eggs upon them may even thus transport the pest.

Outside the State the gypsy moth now occurs in southern New Hampshire and the southwestern part of Maine.

Where to look for the Gypsy Moth.

The Egg. — From August to May the egg masses of the gypsy moth may be found in places near which the moth emerged from the pupa case. In laying, the female moth chooses tree trunks, the under sides of limbs, sheltered crotches and holes in trees, hollow trees, crevices in or under rough bark, etc. The egg clusters are also found on shrubbery, buildings, scattered and heaped rubbish, barrels, boxes and similar objects standing out of doors, wood piles, stone piles, fences, walls, boulders and the like. Gypsy moth egg clusters have been found upon an immense variety of objects, and occasionally may be seen in almost any situation that is not too far from vegetation. The tendency is to deposit the eggs on the lower or inner surface of an object. The moths disregard all rules when they swarm in a place, and their egg clusters may then be found plentifully in sight as well as out, and in all sorts of places, even within buildings.

The Caterpillar. — From May to August the caterpillars may be found in various stages of growth, diminishing in numbers rapidly after July 15. In the spring the small caterpillars should be looked for on the foliage, feeding principally on the under side of the leaf. As the caterpillars grow, they molt or cast their skin several times, and these molted skins are characteristic signs of the presence of the moth. As the caterpillars acquire size, they commence to feed by night, and during the day seek shelter, generally in clusters, on the shady side of tree trunks, beneath large limbs, under rough or loose bark, in holes in trees, under fence rails, in walls, stone heaps, rubbish piles, in short in any accessible place offering shelter from the sun and the birds.

The Pupa. — Gypsy moth pupæ are most abundant during the latter half of July. They are to be found in the same situations as are chosen for depositing the egg clusters, and not infrequently, also, in the foliage of trees and shrubs.

The Moth. — The peculiar zigzag flight of the male moth has already been noted. The large, white, conspicuous female moths

sit or crawl on tree trunks, etc., near their pupa cases. In July (chiefly the latter half) and through August these females may be found busily engaged in laying their eggs.

Danger Signs. — The bristly, cast-off molt skins of the gypsy moth caterpillars, often with the head cases attached, may frequently be found in the situations chosen for the eggs and pupæ. They are often massed in bunches, and are very commonly associated with empty gypsy moth pupa cases or hatched or unhatched gypsy moth egg clusters.

Gypsy moth molt skins and empty pupa cases are resistant to weather and decay, and may be found at any season of the year. The presence in any locality of such molt skin, empty pupa case or hatched egg cluster of the gypsy moth indicates the probable presence near by of the living moth in some form, and therefore is a sign of danger not to be disregarded. The hatched-out egg masses of a previous year often remain intact in sheltered places, and thus give a clue to the presence of the insect.

Remedies against the Gypsy Moth.

Egg Killing. — No single method of destruction against the gypsy moth is more effective than killing the eggs. The egg masses wherever accessible can be killed from August to May by soaking them thoroughly with creosote mixture. The creosote may be applied with a small swab or paint brush. In killing gypsy moth eggs in high trees, it is usually best to work with two men, one man to point out the egg clusters from the ground, another to kill the eggs in the trees. Creosote mixture may be purchased at agricultural warehouses and seed stores at from eighteen to twenty-five cents per gallon.

Where trees and shrubbery (especially low-cost woodland and unimproved tracts of brush) are extensively infested with the eggs of the gypsy moth, the growth should be cut and burned. The eggs are, however, remarkably resistant to fire, and an intense heat applied directly to the clusters is required to kill them all. Where the clusters are very plentiful, burning the ground over with oil to destroy eggs scattered as a result of the cutting of trees and bushes will be required to insure thorough work. The practice of burning is resorted to only in very exceptional cases, however, as the damage from fire in the loss of forestry conditions is to be guarded against.

Caterpillar Destruction. — Spraying infested foliage with arsenate of lead at the rate of ten pounds to one hundred gallons of water is very effective when the caterpillars are small. Any of the common hand outfits will suffice for the spraying of shrubs or flowering plants. For use on trees, a pump mounted on a barrel or hogshead is desirable. The poison should be thoroughly mixed in water, and applied, if possible, on a clear, dry day, in such a manner as to cover the leaves, rather slowly, with a fine mist. The foliage should never be drenched with a stream. When the leaves begin to drip, spraying should at once cease. Spraying should begin at the top of the trees. This work is most effective when done during May and early June. Where tall street trees or trees in easily accessible woodland are to be sprayed, the use of a power outfit is to be recommended. Steam or gasoline engine sprayers are not so economical of the spray as hand pumps, but make a great saving in the cost of labor. Furthermore, with a properly equipped power outfit the work can be done with the greatest possible rapidity. Where arsenate of lead cannot be obtained, Paris green, one pound to one hundred and fifty gallons of water, may be used, but it should be borne in mind that this insecticide often scorches the foliage, and that it washes off with the first rain. Arsenate of lead is not open to these objections. In order, however, to secure the best results from the use of arsenate of lead, it is well to be sure that the poison is pure and will stand proper tests. The formula which is furnished by this office is as follows for arsenate of lead paste : —

50 per cent. dry arsenate of lead.

No less than 15 per cent. arsenic oxide ($AS^2 O^5$).

To contain not more than $\frac{3}{4}$ of 1 per cent. of soluble arsenic.

To contain no free acids or adulterant or inert substances.

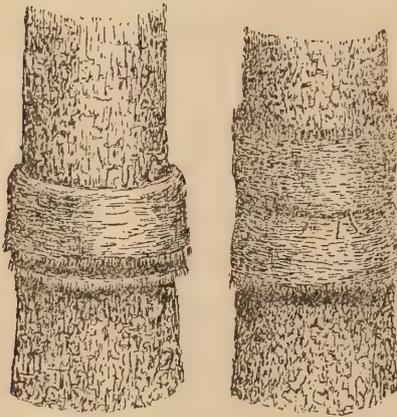
To be in a good mechanical and physical condition.

Dealers should be required to supply arsenate of lead which will stand test for this formula.

Great care should also be taken to insure a thorough mixing of the poison in the keg before it is used.

Burning over infested wood or brush land in May or June is a very effective method of destroying gypsy moth cater-

pillars, and is the logical complement to the method of egg killing by burning previously described. The trees and bushes should be cut before the hatching time of the eggs, and may be left lying as they fall. A few trees should be left standing, and to these such caterpillars as escape the burning will resort for food, and they may then be killed by spraying or by burlapping, as described farther on. The burning of the fallen trees and



Manner of applying the burlap.

brush should be done when the caterpillars are very young and small. At this time they quickly succumb to flame. When the caterpillars are older, burning is less effective. The use of fire, however, should be the last thing to be resorted to on account of its being a bad forestry practice.

If a strip of burlap or other coarse, cheap cloth is tied about an infested tree trunk by the middle, in such manner that the flaps hang down, the caterpillars, as soon as they have acquired the night-feeding habit, will gather under the cloth and can then be destroyed by crushing or by cutting with a sheath knife. The burlaps should be examined daily, or, when the caterpillars are in great numbers in a locality, several times a day. Burlap can be successfully employed from the latter half of May to the first or middle of August, for the caterpillars commonly pupate under burlap and winged moths lay many eggs under it. It should be borne in mind that the cloth band is in no sense a tree protector; nor is it a trap. Its function is simply to give the shelter which the caterpillars seek by day. Serving as it does as a hiding place for various insects, it is better off the tree than on unless it can be attended to and kept clean. At the end of the caterpillar season, all burlaps should be removed and burned. To insure best results on high trees, such as street elms, burlaps should be placed around some of the larger limbs, as well as around the trunk, as many caterpillars will seek shelter up in the tree rather than descend to the ground. The most effective results in using the burlap are obtained where cavities, crevices, etc., in the trees have been

first filled with cement or covered with zinc and all loose bark removed. If these hiding places are destroyed, nearly all the caterpillars will seek the burlap at some time during the season.

Banding a non-infested tree with insect lime or other sticky substance or mixture to keep the caterpillars out of it is an effective means of protection, provided the branches of the tree do not interlock with those of an infested tree, and provided the two do not stand so near that the small caterpillars can pass from the infested tree to the other by means of their fine threads. A band, of whatever material composed, to be effective must remain sticky. When caterpillars are numerous in a place, they often, in their attempts to cross the band, bridge it over with their threads and dead bodies, with the result that other caterpillars coming later are able to ascend the tree. For this reason and in order that the caterpillars which collect beneath may be killed, the sticky band should be frequently inspected. If the many caterpillars which frequently "herd" below the sticky bands are not killed, they will in time leave the trees for shrubbery, where they are less easily destroyed, there to complete their feeding period and transform into moths. Insect lime, raupenleim, tanglefoot, bodlime, printer's ink or even axle grease are among the materials most used for banding. All may be dangerous to the tree and should be removed after the caterpillar season has passed.

Destroying Pupæ and Moths. — Pupæ are commonly found under the burlap and in other places frequented by the caterpillars. They are often massed under large branches or in other sheltered places. In similar locations the female moths may be found in numbers. Both forms of the insect may be crushed by hand to advantage during July and August.

Natural Enemies of the Gypsy Moth.

In addition to all the aforesaid methods of destruction used against the gypsy moth, we may also mention some natural enemies that seem at the present time to promise help in the warfare.

First, the wilt disease or "flacherie" of the gypsy moth. The disease occurs naturally when the caterpillars are in great

numbers, so as to find feeding scarce. It is a bacterial disease which affects the intestinal canal of the caterpillar and soon causes death.

We are endeavoring now to plant and spread this disease artificially. Owners of woodland containing bad infestations may, by applying through their local moth superintendent to this office, obtain plantings of the disease, together with instructions concerning its use and artificial spread.

There are other diseases of the caterpillars which afford help at times, but the wilt disease is the most important.

Parasites of the gypsy moth are now planted over all the worst infested sections, and it is believed that they are increasing in numbers and actually becoming acclimated. The large carnivorous ground beetles, such as *Calosoma* sp., have been planted throughout the infested territory, and are believed to be well established. All these are helps to the suppression of the gypsy moth, and the appearance of these natural enemies should be studied, so that they may not be destroyed by mistake.

For further information in regard to parasites and the wilt disease, or the State laws regulating the gypsy moth, read the bulletins on the subjects which are sent to citizens of Massachusetts upon application to F. W. Rane, Massachusetts State Forester, 6 Beacon Street, Boston, Mass.

For assistance in combating this insect apply directly to the local moth superintendent in your town or city, as he is in immediate charge of the work of suppression.

FOREST NURSERY

AND REFORESTATION WORK

IN

MASSACHUSETTS



By R. S. LANGDELL, ASSISTANT

UNDER THE DIRECTION OF F. W. RANE, STATE FORESTER

BOSTON

WRIGHT & POTTER PRINTING COMPANY, STATE PRINTERS
18 POST OFFICE SQUARE

1913

APPROVED BY
THE STATE BOARD OF PUBLICATION.

CONTENTS.

	PAGE
Introduction,	5
Acknowledgments,	5
The forest nursery,	7
Procuring the seed,	7
Layering seed in sand,	8
Site for a nursery,	9
Preparation for the seed beds,	9
Time to plant seed,	9
A marker,	10
Sowing the seed,	10
Mulching,	10
Shading,	10
Damping off,	11
Protection for the winter,	11
Hardening off of evergreens,	12
Transplanting,	12
Puddling,	12
Heeling in young trees,	13
Root pruning,	13
Packing seedlings,	13
Data on collecting and storing forest tree seeds,	14
Cost of seedlings and transplants per thousand,	15
Reforestation,	15
Cut-over land,	15
Burnt-over land,	16
Run-out pasture land,	16
Seedlings and transplants,	17
Varieties to plant,	17
Trees suitable for forest planting in Massachusetts,	18
Nurserymen,	19
Spacing of trees,	19
Heeling in on lot,	20
Method of setting the trees,	20
Time to plant,	21
Protection of plantation,	21
Fire lines,	21
Reforestation work done by the State,	23
Reforestation act (chapter 478, Acts of 1908, as amended by chapter 214, Acts of 1909),	24
Sylvicultural characteristics of trees,	25
Trees most commonly found growing in Massachusetts, the uses to which their timber is put, and a few of their most important enemies,	25
Application for examination of lands,	36

111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200

INTRODUCTION.

The State Forester has been anxious to place in the hands of our people some definite information on forest nursery and reforestation work. It is believed that this bulletin will meet the requirements.

Nearly every farm in Massachusetts — in fact, in New England — has its woodlot, or some land suited only to the growing of trees. In most cases such land has been wholly or partly cut off or burned over, and left as barren, worthless tracts, an unsightly addition to the rest of the property.

It is the purpose of this bulletin to set forth a remedy which will bring these waste and denuded lands back into forest growth, and provide a method to keep them in a condition to be a source of revenue to the owner at a very small outlay. If, when a woodlot is cut off, provision is made for restocking it, either by natural reproduction, as the leaving of seed trees, or by replanting it with nursery-grown stock, much headway will be made towards bringing the waste lands of Massachusetts back into forest growth.

Nursery work and that of reforestation go hand in hand though two entirely separate undertakings. It is from the nursery that the young trees are furnished to be used on land to be restocked.

ACKNOWLEDGMENTS.

The work of writing and compiling the data in this bulletin was intrusted to Mr. R. S. Langdell, my assistant, who has for the past six years been devoting his energies to carrying on the nursery work at Amherst, and furthering the reforestation work throughout the State. This bulletin was first issued in 1910, but that edition becoming exhausted, we now offer the second edition, with slight additions.

F. W. RANE,
State Forester.

11
12
13

14
15
16
17
18
19
20
21
22

23

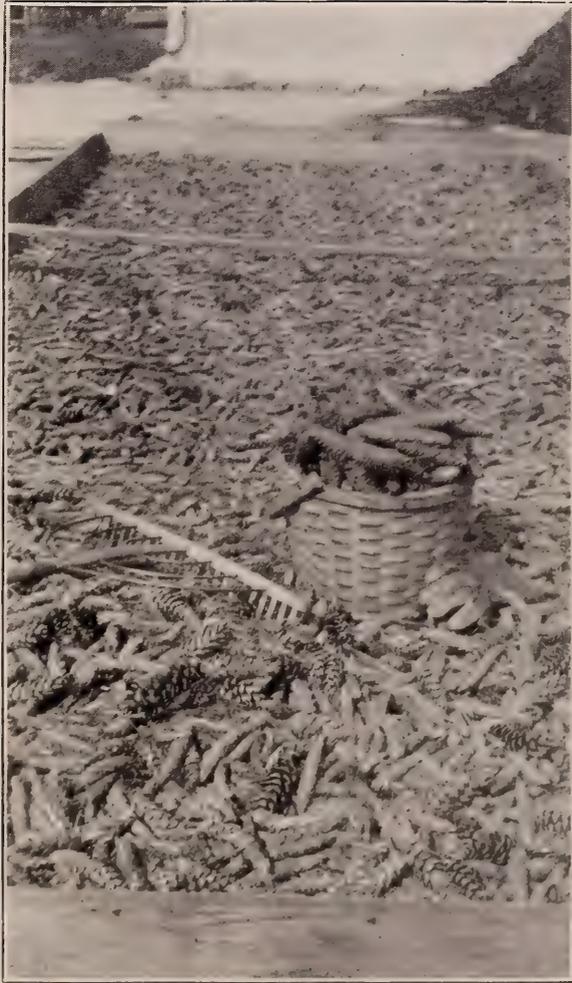


FIG. 1.—Pine cones spread out to dry, in order that seed may be extracted.

1911

1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100

REFORESTATION IN MASSACHUSETTS.

THE FOREST NURSERY.

One of the first things in nursery work is the procuring of the seed. In most cases our native trees furnish this in great abundance, though in some years the seed crop is much more heavy than in others, due to climatic conditions. Practically all of the seeds referred to may be easily gathered in almost any locality throughout the State.

Procuring the Seed.

The white pine (*Pinus strobus*), our native pine, bears its seed in the cones or burrs, which generally grow in clusters of twos or threes on the upper branches of the tree. Many persons wonder why it is that they cannot find the seed in the opened cones picked up in any pine grove; in fact, a number of cases have been known where persons have planted the cones which have fallen to the ground in late fall or winter, the scales open and the seed escaped, and expected to obtain a crop of trees. The seed is located two under each scale of the cone, and is about the size of a raisin seed, being provided with a small, bee-like wing, which favors its distribution by the wind. The cones commence to turn brown in this section about the middle of August, and from then on ripen very rapidly, one or two sunny days drying the scales so that they open and set the seeds at liberty. The cones must therefore be picked while green, before the scales have opened, by climbing the tree and picking by hand or with pruning shears. Sometimes a person may be fortunate enough to find a large number where the trees are being cut for lumber, — they are then readily picked into baskets. The squirrels also at times cut off large numbers of cones, which fall to the ground and can be gathered up, care being taken to select cones which have matured sufficiently for the seeds to be fertile.

After the cones are picked they should be spread out in the sun on a smooth floor (Fig. 1), where they can be raked over from time to time, to aid drying. In a week or two the scales will

begin to open and the seed fall out. The cones can then be raked off and the seed swept up. If the cones are then put into a bag and flayed, any remaining seed will rattle out. The cones should be kept from getting wet while drying, as the scales will close and will have to dry thoroughly again before opening. They should also be kept away from birds and mice, which often destroy large quantities of seed before being detected. If a large amount of seed is to be extracted, a drying room with drying racks and screens may be provided.¹

Spruce, hemlock, larch, Norway pine, pitch pine and other coniferous tree seeds can be gathered and extracted in the above manner. If properly stored, the seed in most cases retains its vitality for a number of years.

The seed should be cleaned by winnowing, and then put into bags and kept in a cool, dry place through the winter, to be in readiness for planting the following spring.

The seed of maple, ash and other deciduous trees, except the nut trees, is most readily picked from the tree. The oak, chestnut, hickories, locust and some others ripen their seed in the fall, and shed it to the ground by the action of frost and wind.

Layering Seed in Sand.

It is best in most cases to protect the germinating qualities of nut seeds during the winter by storing in sand.

Layering is a method of storing certain seeds through the winter, and should be resorted to when keeping chestnut, oak, hickories, etc. For this purpose a well-drained slope should be selected, and a hole dug in the ground large enough to hold the seed; a layer of sand about 3 inches deep should then be placed in the bottom, then a layer of seed, followed by a layer of sand, and so on till the seed is stored. It should then be covered about 1 foot deep, to protect it from freezing and thawing. When only a small amount of seed is to be stored, a large drain pipe set in the ground with the bottom covered with fine mesh wire is very convenient, the seed being layered inside the pipe, to protect it from rodents. A wooden box used instead of the drain pipe will answer the purpose very well, and make it easier to remove the seed in the spring.

¹ Bulletin No. 73, Forest Service, Washington, D. C.

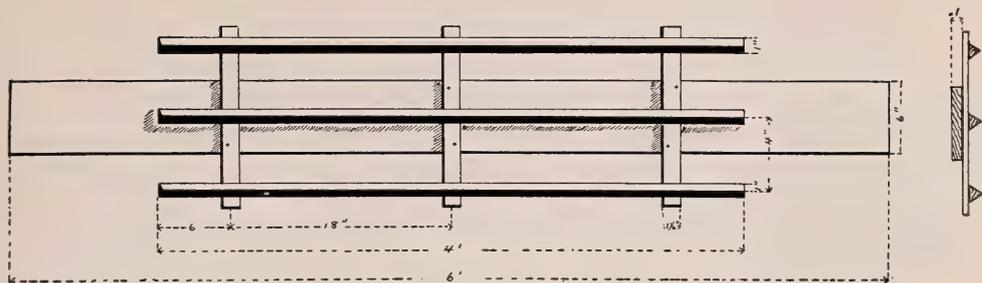


FIG. 2.— View of marker for making drill in which to sow evergreen seeds.

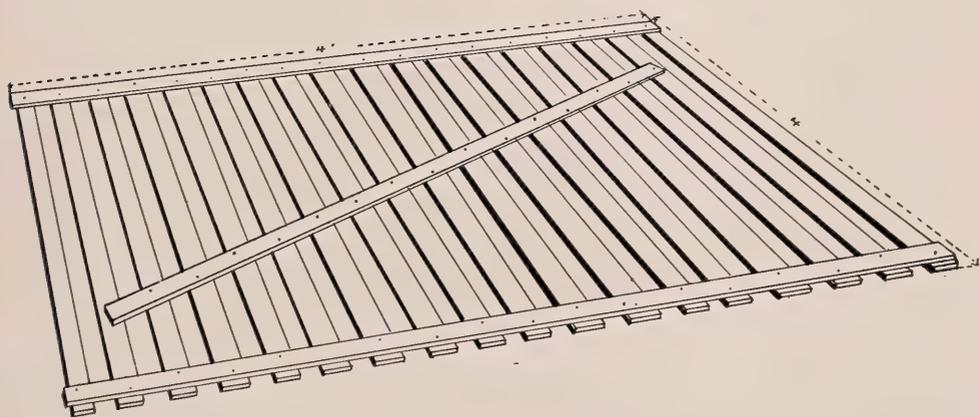


FIG. 3.— View of lath screen to be used in shading evergreen seedlings from the sun

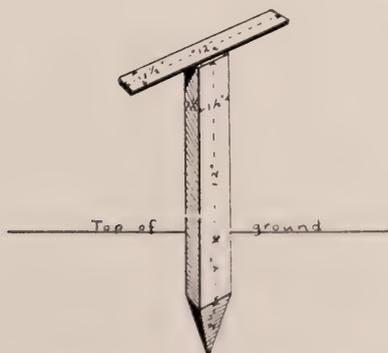


FIG. 4.— Stake to be driven into ground to hold screens above the seed beds.

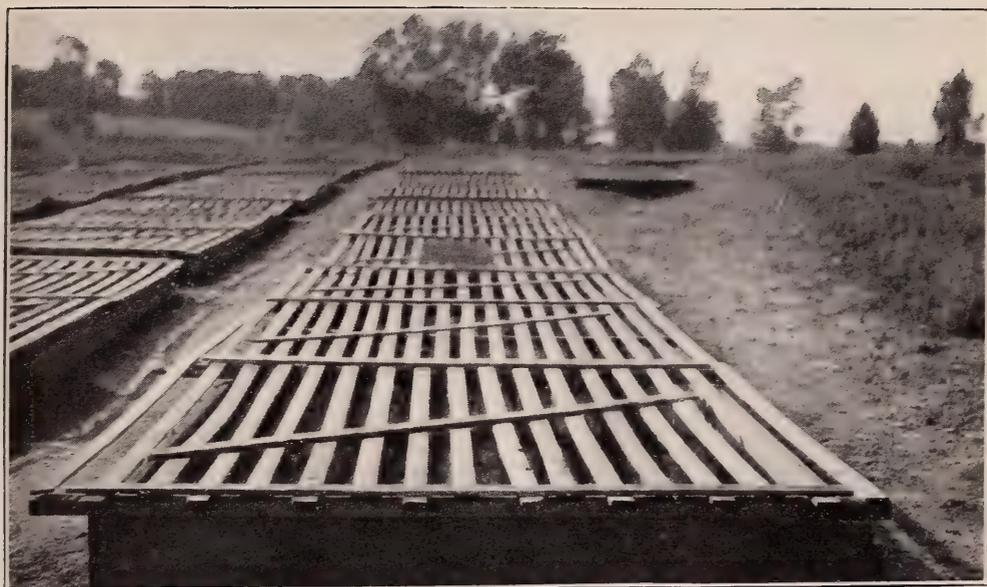


FIG. 5. — Showing method of screening evergreen seedlings from the sun (broadcast method).

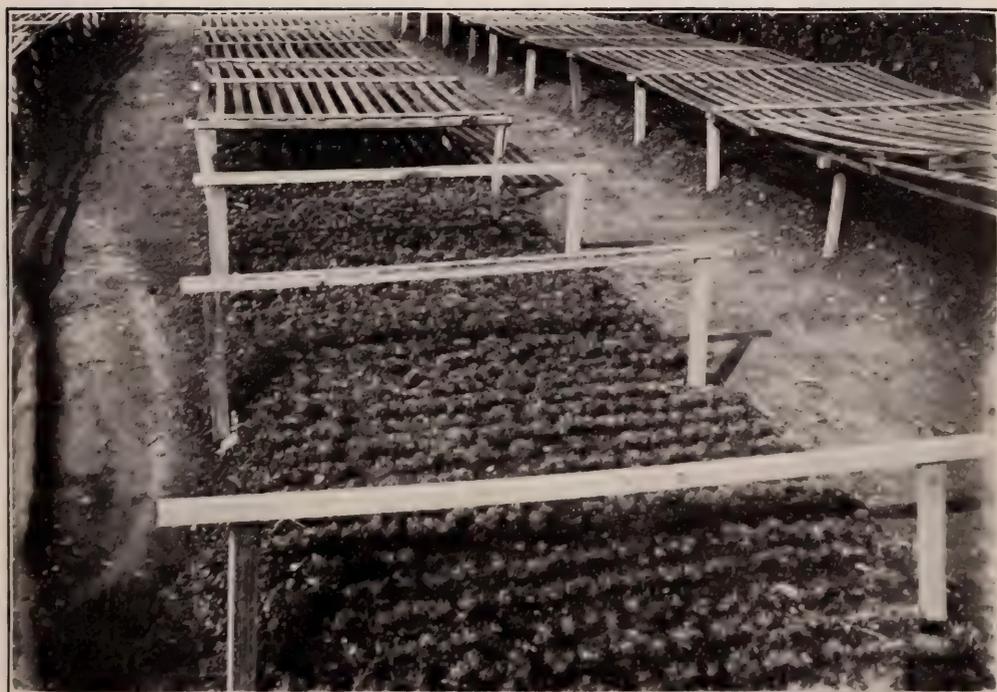


FIG. 6. — View of the seed beds with screens removed, to allow the beds to dry out and prevent damping off (drill method).

100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200

Site for a Nursery.

A level, well-drained site should be selected for a nursery, the soil being preferably a sandy loam, not subject to washing and free from stones. It is also well to select a plot near the house, where it will be convenient to take care of, and offer some protection from birds and rodents, which often destroy the seed after it has been planted. A small plot in the garden will be well suited for the purpose.

Preparation for the Seed Beds.

The land to be used for the seed beds should first be well plowed and harrowed till the soil is pulverized. A small amount of well-rotted barn-yard manure, free from weed seeds, may be used to advantage. The beds should then be laid out, the most convenient size being a bed 4 feet wide and any convenient length, with walks 2 feet wide between the beds. If the surface soil retains water it will be well to raise the bed a few inches above the walk, and have it about 1 inch higher in the center than on the sides. This will give the moisture a chance to drain off. After the beds have been made up they should be raked over with an iron rake till all small stones and lumps have been removed and the soil thoroughly pulverized. The beds are then ready for the seed, which may be planted in drills or sown broadcast.

Time to plant Seed.

As a rule, the seed should be planted in the spring, as soon as the ground has warmed up a little, generally in April or May.

Drill Method (a Marker).

For making the drills to plant pine seed, a marker made of strips of wood 4 feet long, nailed to cross-pieces on a board, with the strips about 4 inches apart, and so arranged as to make a drill about $\frac{1}{2}$ inch deep, has been found very useful. The marker (Fig. 2) can then be pressed down across the bed. If, each time it is moved, the inside cleat is allowed to rest in the trench previously made by the outside cleat, very uniform drills can be made.

Drill Method (Sowing the Seed).

After the drills have been made, the seed should be sown similarly to any garden seed. In case of pine seed, if sown nearly touching each other, 1 pound would cover a bed 4 feet wide and 40 feet long. After the seed is sown, it should be covered by lightly brushing or sifting a little fine soil over it and firming it slightly. If the marker has been made by nailing strips to a smooth board, the back side can be used for this purpose.

Broadcast Method (Box Beds).

Most nurserymen prefer to sow seed broadcast, as it takes less space and there is much less weeding, the seedlings growing nearer together and checking or choking out the weeds. In order to keep the edge of the beds from washing, they are enclosed in a wooden frame made of 1-inch boards 6 inches wide. The frame is 12 feet long and 4 feet wide. The bed inside the frame should be raised slightly above the walks outside to assure drainage, and holes can be bored at intervals along the bottom of the frame to allow the water to run out. Some nurserymen recommend making a wire screen for the top and sides, to protect the beds from rodents and birds.

White pine seed may be sown broadcast about $\frac{3}{4}$ of a pound to a bed. The ground should be slightly firmed by light pressure on a board or tamper, and a little sand sprinkled over the bed to the depth of $\frac{1}{16}$ of an inch will be sufficient covering.

Mulching.

As soon as the seed is sown, the beds should be covered over with leaves or needles about 3 inches deep, or burlap the width of the bed may be used if the corners are slightly weighted to keep the burlap in place, in order to hold the moisture in the ground and keep an even temperature. This prevents the soil from becoming dry, in which case the seed would not germinate. As soon as the seed commences to appear above ground, the mulch should be carefully removed. Screens for shading should be provided in the meantime, as pine seed does not generally germinate for from two to three weeks.

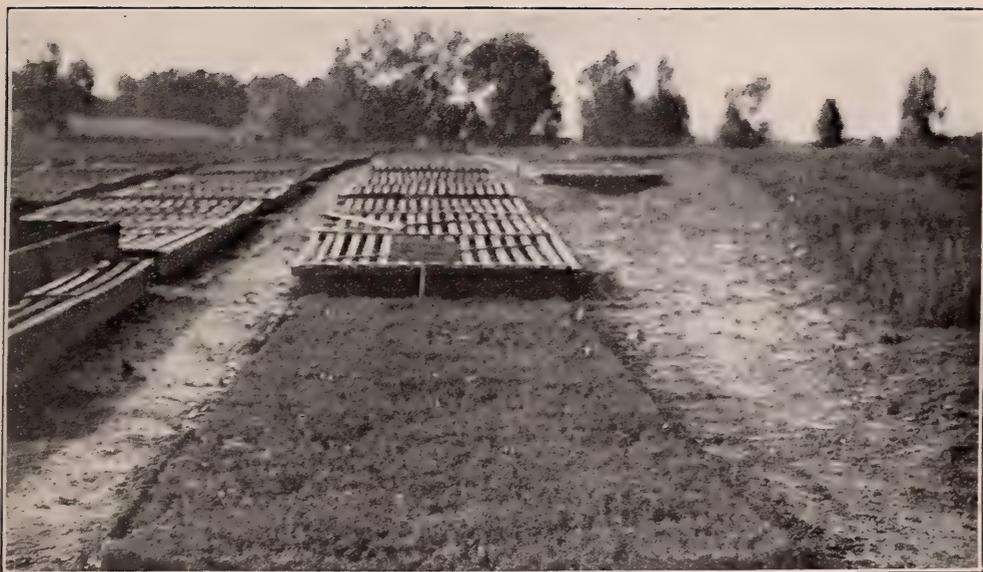


FIG. 7. — Two-year-old Norway spruces grown broadcast. Box-led frame removed the second year.



FIG. 8. — Transplant beds, State forest nursery at Amherst.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100

Shading.

For the first two years most coniferous seedlings need to be protected from the sun (Figs. 5 and 6). For this purpose lath screens (Fig. 3) may be cheaply made, using two laths as cross-pieces, and nailing others to them about their width apart. If a lath is nailed on slanting through the middle, it makes the screen much more firm. The screens should then be placed about 1 foot above the bed, the laths running north and south. Stakes with a cross-piece 1 foot long nailed on top (Fig. 4), stuck into the ground at each corner of the screens, will hold them in place. In case box beds are used the screens may be laid directly on the top of the frames.

Damping off.

After the seedlings have appeared above ground and the mulch been removed, a dangerous disease to the seedlings is liable to appear, especially if cool, wet weather sets in. This disease causes the seedlings to wilt or die off in large numbers, the stem near the ground rotting off, so that the seedling tips over and dies. The best way to prevent this disease is to remove the screens for a short time each day. Care must, however, be taken not to allow them to remain off long enough for the sun to burn the seedlings, as they are very tender at this stage. If the beds are sprinkled with coarse sand, it also prevents the soil from becoming wet and damp.

The seed beds should be carefully weeded as soon as any weeds appear, care being taken not to root up the seedlings. After the seedlings have obtained a good start, the roots have branched out and a firm hold has been secured, a small hand weeder may be drawn between the drills, to remove the small weeds and at the same time cultivate and fine the soil about the roots of the trees.

Oak, chestnut and other deciduous tree seeds may be sown in beds 8 or 10 feet wide and 25, 50 or 100 feet long, the seed being planted about 2 inches apart in trenches 1 foot apart. This leaves ample space for cultivating seedlings. It is a safe rule to plant seed twice its own depth, as if planted too deep it is liable not to come up till the following spring. Under average conditions, deciduous seeds need not be mulched or shaded. In a short time they should be of sufficient size so that a small hand cultivator may be used.

Protection in the Winter.

In order to protect the tender seedlings from alternate freezing and thawing during the winter, they should be mulched with leaves, pine needles or burlap. The screens should then be removed from the seed beds of evergreens, and the mulch spread over the beds to a depth of from 3 to 4 inches. The screens can then be laid down on the mulch, to hold it in place and prevent it from being scattered by the wind.

The seedlings of deciduous trees need not be mulched, but it is often well to hill them up slightly just before the ground freezes, by piling a little earth up around the stem with a hoe or cultivator. Mulching may, however, be resorted to where the winter is severe.

In the spring, as soon as the snow is off and the frost out of the ground, the mulch should be removed and the screens put up over the evergreen seedlings. Weeding should be done when necessary during the season, from three to four times probably being sufficient if they have been well taken care of in the previous year.

Hardening off of Evergreens.

In the later part of the season, when the sun is not as strong as during the summer, the screens should be removed for a short time each day, a little longer each time, and finally left off altogether. This will harden the plants, and get them into condition to withstand the second winter without mulching, so that they will be ready to transplant in the following spring.

Transplanting.

When the white pine seedlings are two years old, they should be either transplanted in the nursery (Figs. 7 and 8) or set in their permanent sites. It is generally preferable to transplant them in the nursery for one or two years, in order to form a more compact root growth and make a more stocky plant.

Two-year white pine seedlings can be set in beds 100 feet long and 4 feet wide, the rows running crossways of the bed, 6 inches apart. The trees are set $1\frac{1}{2}$ inches apart, 31 trees to the row. A bed would contain 6,200 trees under this method of setting. The use of a transplanting board greatly facilitates the work.

If it is intended to grow the trees more than one year in the transplant bed, they should be set in beds 100 feet long and 10 feet wide, the rows running lengthwise and 1 foot apart, the trees being set in the rows 6 inches apart. Under this method of growing, a hoe or small hand cultivator can be used without injuring the trees; it also affords ample space for the growth of each tree.

In the spring, as soon as the frost is well out of the ground (April or May), the seedlings should be dug up and tied in bunches of 50 or 100. In digging, care should be taken not to break off many of the small rootlets. It is also better to choose a cloudy day for the work, rather than a bright, sunshiny day, when there is danger of the roots drying out quickly.

Puddling.

As soon as the trees are dug and tied into bunches, the roots should be dipped into a puddle of mud and water mixed to the consistency of common paint. This covers the roots with a thin coating of dirt, which prevents their coming in contact with the air and drying out.

Heeling in Young Trees.

To keep the trees in good condition till ready for transplanting, they may be temporarily set in a trench about 1 foot deep, dug with one side on a slant. The bunches of seedlings may then be placed side by side against the slanting trench, and a little damp soil thrown over the roots and firmed down. Should it be intended to keep the trees heeled in more than a week, the bunches should be untied and the trees separated and spread along the trench, to prevent them from heating.

Most hardwood trees should be transplanted when one year old, as they develop a long tap root, which, if allowed to grow for a number of years without resetting, becomes so well rooted that it will be impossible to dig up the plant without serious injury.

Root Pruning.

In order to cause the tree to develop a compact root growth, it is generally considered advisable to cut off a portion of the tap root on deciduous seedlings, such as ash, hickories, catalpa, etc. The cutting off of about one-third of the root causes it to develop a lateral growth.

Packing Seedlings.

When the trees are to be removed some distance from the nursery, the bunches should be packed in boxes, with the roots in damp sphagnum moss. A layer of damp moss should be put in the bottom of the box, and by alternating the bunches so that the roots will all be in the center, making first a layer of moss, then a layer of trees, and so on till the box is full, a large number may be packed in a small space. It is also well to puddle the roots before packing, giving them an additional coating of soil.

Data on collecting and storing Forest Tree Seeds.

COMMON NAME.	Latin Name.	Cost of Seed.	Number of Seeds per Pound.	Time to collect.	Storage.	Time to plant.
White pine,	<i>Pinus strobus</i> ,	\$2 00	29,000	August to September,	Dry and cool,	Spring.
Pitch pine,	<i>Pinus rigida</i> ,	3 50	20,000	October to September,	Dry and cool,	Spring.
Red pine,	<i>Pinus resinosa</i> ,	6 00	75,000	September to October,	Dry and cool,	Spring.
Scotch pine,	<i>Pinus sylvestris</i> ,	-	-	September to October,	Dry and cool,	Spring.
Norway spruce,	<i>Picea excelsa</i> ,	75	80,000	September to October,	Dry and cool,	Spring.
European larch,	<i>Larix europæa</i> ,	1 25	9,000	September to October,	Dry and cool,	Spring.
Arbor vitae,	<i>Thuja occidentalis</i> ,	2 50	70,000	September to October,	Dry and cool,	Spring.
Hemlock,	<i>Tsuga canadensis</i> ,	5 00	65,000	September to October,	Dry and cool,	Spring.
Rock maple,	<i>Acer saccharum</i> ,	1 00	7,000	September to October,	Layer in sand,	Spring.
White ash,	<i>Fraxinus americana</i> ,	60	10,300	October,	Layer in sand,	Spring.
Tulip tree,	<i>Liriodendron tulipifera</i> ,	75	9,000	October,	Layer in sand,	Spring.
White birch,	<i>Betula papyrifera</i> ,	2 00	482,000	September to October,	-	At once.
Beech,	<i>Fagus ferruginea</i> ,	75	1,800	October to November,	Layer in sand,	Spring or fall.
Chestnut,	<i>Castanea Dentata</i> ,	40	98	October to November,	Layer in sand,	Spring or fall.
White oak,	<i>Quercus alba</i> ,	50	90	September to October,	Layer in sand,	Spring or fall.
Red oak,	<i>Quercus rubra</i> ,	25	78	September to October,	Layer in sand,	Spring or fall.
Hickory,	<i>Hicoria ovata</i> ,	35	80	September to October,	Layer in sand,	Spring or fall.
Black locust,	<i>Robinia pseudacacia</i> ,	65	30,000	October,	Dry and cool,	Spring or fall.

Cost of Seedlings and Transplants per Thousand.

VARIETY.	PRICE OF AMERICAN TREES.		
	1 Year.	2 Years.	3 Years.
White pine,	-	\$2 25-\$4 00	\$6 00
Pitch pine,	-	2 25- 4 00	-
Red pine,	-	2 25- 4 00	-
Scotch pine,	-	2 25	6 00
Norway spruce,	-	2 25	6 00
European larch,	-	2 25	6 00
Arbor vitæ,	-	2 50	-
Hemlock,	-	24 00	-
Rock maple,	\$6 00	15 00	-
White ash,	2 75	6 00	-
White birch,	-	20 00-30 00	-
Beech,	-	8 00	-
Chestnut,	8 00-15 00	-	-
White oak,	10 00-15 00	-	-
Red oak,	4 00-15 00	-	-
Hickory,	12 00-25 00	-	-
Black locust,	2 25- 5 00	-	-

REFORESTATION.

The total area of Massachusetts is about 5,321,787 acres, of which 2,672,950 acres is land adapted only to the growing of trees. Of this area there are about 700,000 acres which at the present time constitute practically worthless tracts, being simply a tax to the owners, who at a very small outlay could bring the land back into a profitable forest growth, as well as adding to the scenic beauty of the section.

This land lies in tracts varying in size from one to thousands of acres. Practically every farm has a portion which at one time or another has been cut off, burnt over, or allowed to relapse into a condition where it is no longer a source of revenue, but a piece of property which brings in no return, though it is still taxable. Lumbermen, mill owners, water-right companies and farmers all have some land which falls under one of the following types, and it is this sort of land which fortunately furnishes ideal conditions for forest planting.



FIG. 9. — Cut-over land, suitable for restocking with white pine. The sawdust pile tells the story.



FIG. 10. — Burnt-over land, where all the seed and young trees have been destroyed by repeated fires. Land should be reforested.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100



FIG. 11. — Run-out pasture land, which should be brought back into forest growth.



FIG. 12. — Land coming up to gray birch and undesirable hardwood, and which should be reforested.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100

Cut-over Land (Fig. 9).

It can be safely said that every lumberman owns one or more tracts of land which he has cut off, but which has not come back into a growth which will ever be of any great profit to himself or others, if allowed to remain in its present condition. Nature intends that this land should remain in forest growth, but through inconsiderate cutting it has come up to an undergrowth of small value. It is always preferable to restock this type of land as soon as possible after it has been cut, as the sprout and hardwood growths, if allowed to gain too great a headway, will hold the seedlings in check.

Burnt-over Land (Fig. 10).

On land which has been subjected to repeated fires, destroying the growth and ground cover, the soil is left free to the action of the weather, to be quickly dried out by the sun, or, if on a side hill, to be washed into the valley by rains. The seed or seedlings which may have been on the ground have been destroyed, and the land might lie for a long period of years before it would reseed itself naturally. Land of this type, therefore, should be set with considerable care, in order to obtain the best results. It is generally advisable to set a three-year-old or four-year-old transplant here, rather than seedlings.

Run-out Pasture Land (Figs. 11 and 12).

Many of the farms throughout the State are becoming run out, and are allowed to grow up to brush and undesirable hardwoods. Pasture lands especially are being encroached upon by some of our less valuable trees, such as bird cherry and gray birch, which so overshadow the ground that good pasturage runs out, and the lot is abandoned for fields affording better forage. In many cases scattering white pine have crept in, and probably in time would seed in the whole piece; but the old trees, while doing good work in reseeding, would be of little value, as, growing so scattered, they would develop large lateral branches, instead of giving a clear, straight bole to the trunk, so desirable in the best grade of lumber. If the lot could be set out with seedlings and the trees allowed to grow in sufficiently dense stands, the lower branches would die off naturally, and smooth, clear lumber would be assured.

Seedlings and Transplants.

It is generally considered advisable to set transplants rather than seedlings, although under most conditions in this section the two-year-old white pine has been planted with good results. As a rule two-year-old seedlings may be planted on land classed as run-out pasture land or on cut-over land with good success, there being a little shade afforded by gray birch or low bushes.

Three-year-old or four-year-old transplants are adapted for planting on open land, exposed to the drying effects of sun and wind (Fig. 13). As their root growth is large, they can be more deeply set in the ground where they can take up the moisture; whereas, if the roots were near the surface, as they would necessarily be if seedlings were used, the trees would die from lack of moisture in the top soil. It is also best to set transplants in old fields or mowings, where small plants would be beaten down and choked out by the thick fog or dead grass.

Varieties to plant.

There are a number of varieties of trees which may be planted, with good results. It is advisable to set some tree which grows naturally in the locality in which the work is to be done.

The white pine (*Pinus strobus*) (Fig. 14) has been used largely for reforestation purposes throughout the State, and has adapted itself to most of our New England conditions; in fact, this section of the country at one time was covered with primeval forest comprised largely of white pine. The rapidity of its growth and the many uses to which the variety of wood may be put makes it a practical tree for forest planting, and the one most used in this work. It is, however, recommended to use some other variety on Cape Cod, unless the plantation is well protected from the wind, which on the Cape causes a somewhat stunted growth.

The white ash (*Fraxinus americana*) is well suited for planting on a springy side hill, where the growth and texture of the wood of this variety often reaches its highest quality. It is also practically immune from the attack of the gypsy and brown-tail moths, which are so detrimental to the trees in many towns in the eastern part of the State.

The Norway spruce (*Picea excelsa*), a tree grown on an exten-



FIG. 13. — Land planted with white pine transplants, six years after setting.
Notice remarkable growth of leading shoot.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100

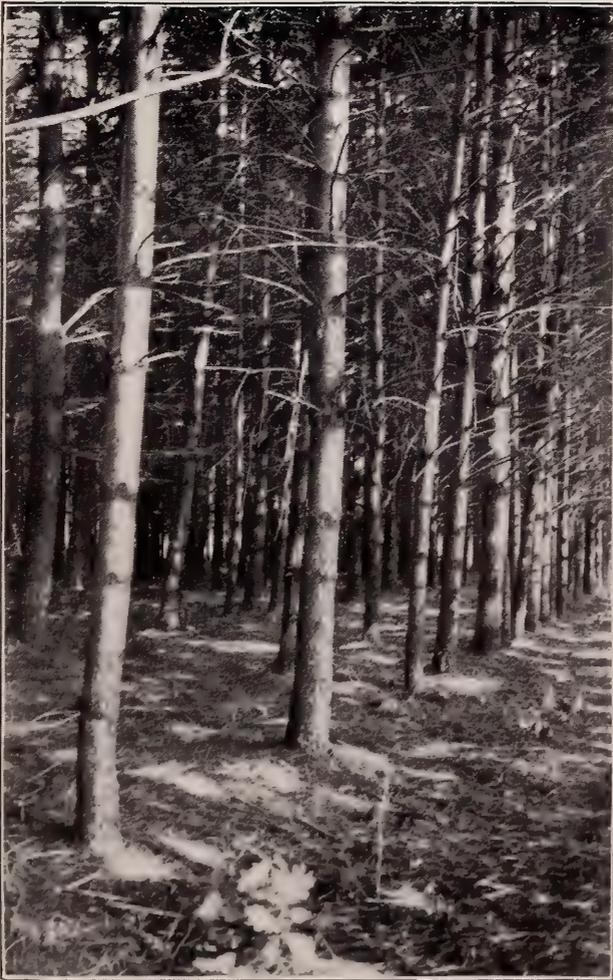


FIG. 14.—View of thirty-eight-year-old plantation of white pine, showing how the lower branches have died from lack of light, giving a clear, straight bole to the trunk, and producing clean lumber, free from large knots.

100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200

sive scale in European countries with climatic conditions similar to our own, is a tree well suited for planting in sections where our native red spruce is the predominating species. It is a rapid grower, and its wood is also claimed to have properties for the manufacture of paper pulp not contained in other native trees. This variety has been planted quite extensively in New York State, where excellent results have been obtained.

For planting on Cape Cod, the Scotch pine, pitch pine, Austrian pine, black locust and oak should be used. The Cape conditions vary in a number of ways, and should be looked into to some extent before undertaking to plant the trees. In many sections of the Cape repeated fires have so destroyed the ground cover and even burnt into the top soil that a transplant should be used, whose root could reach down into the soil deep enough to obtain moisture. In other cases a screen of some rapid-growing trees should be planted around the plantation, to act as a protection from the prevailing wind, which often causes the trees to lean. In almost every instance a plantation on the Cape should have some protection from forest fires. The sandy formation of the soil offers great inducement for making and retaining a fire line, at very small expense. A furrow in most cases could thus be made with a plow, and the dry, sandy soil thus turned up would act as a check to a running fire. It could be very easily kept free and clear from dead grass, leaves and brush. In fact, if the towns comprising the Cape could be brought to see the advantage of maintaining a strip 50 feet wide on each side of a town line, many of the large disastrous fires of that section could be prevented. And, as the town lines necessarily have to be blazed or marked every few years, the labor and expense for such work could be done away with. This is a line of work which might receive some attention in other sections of the State, as well as on the Cape. In a number of towns where a rather modified form of the work has been done, it has been found remarkably effective and the expense comparatively small.

Trees suitable for Forest Planting in Massachusetts.

NAME OF SPECIES.	Soil.	Uses.
White pine, . . .	Any soil not near coast or swampy,	Lumber, box boards.
Pitch pine, . . .	Sandy soil, on coast, . . .	Lumber, to hold sand in check.
Red pine, . . .	Sandy soil, inland, . . .	Lumber, ship timbers.
Norway spruce, . . .	Sandy loam, . . .	Lumber, Christmas trees.
European larch, . . .	Light soil, . . .	Piles, ship building.
Arbor vitæ, . . .	Sandy soil, . . .	Posts, shingles, etc.
Hemlock, . . .	Well-drained soil, or swampy, . . .	Lumber, ties, tanning.
Rock maple, . . .	Well-drained soil, . . .	Furniture, floors.
White ash, . . .	Wet land, swampy, . . .	Lumber, carriages, tools.
Tulip tree, . . .	Sandy loam, . . .	Lumber, pulp wood.
White birch, . . .	Sandy or gravelly soil, . . .	Furniture, fuel, handles.
Poplar, . . .	Sandy or gravelly soil, . . .	Pulp wood, excelsa.
Beech, . . .	Moist loam, . . .	Tools, laths, etc.
Chestnut, . . .	Well-drained soil, . . .	Poles, posts, ties, etc.
White oak, . . .	Sandy loam, . . .	Agricultural tools.
Red oak, . . .	Well-drained soil, . . .	Lumber, fuel.
Hickory, . . .	Sandy loam, . . .	Carriage building, tools.
Black locust, . . .	Sandy soil, on coast, . . .	Posts, ties, etc.

Nurserymen.

Franklin Forestry Company, . . .	Watertown, Mass.
Northeastern Forestry Company, . . .	New Haven, Conn.
American Forestry Company, . . .	South Framingham, Mass.
Massachusetts State Forester, . . .	Boston, Mass. ¹
Keene Forestry Company, . . .	Keene, N. H.

Spacing of Trees.

In order to produce a dense stand of trees, where the lower branches will die off and fall to the ground from lack of light, giving a clear, straight bole (Fig. 14), so desirable for lumber purposes, the trees should be set 6 feet apart each way, or about 1,210 to the acre. The exact number will necessarily vary according to the condition of the land. On rough, stony tracts, where the trees will be set only where there is sufficient soil for the roots to obtain a firm footing, the number of trees may be a

¹ The State Forester often knows of local growers who have from 1,000 to 500,000 trees for sale each year, and is glad to give information in regard to them, but does not sell trees from his own nurseries.



FIG. 15.—First step in making the hole.



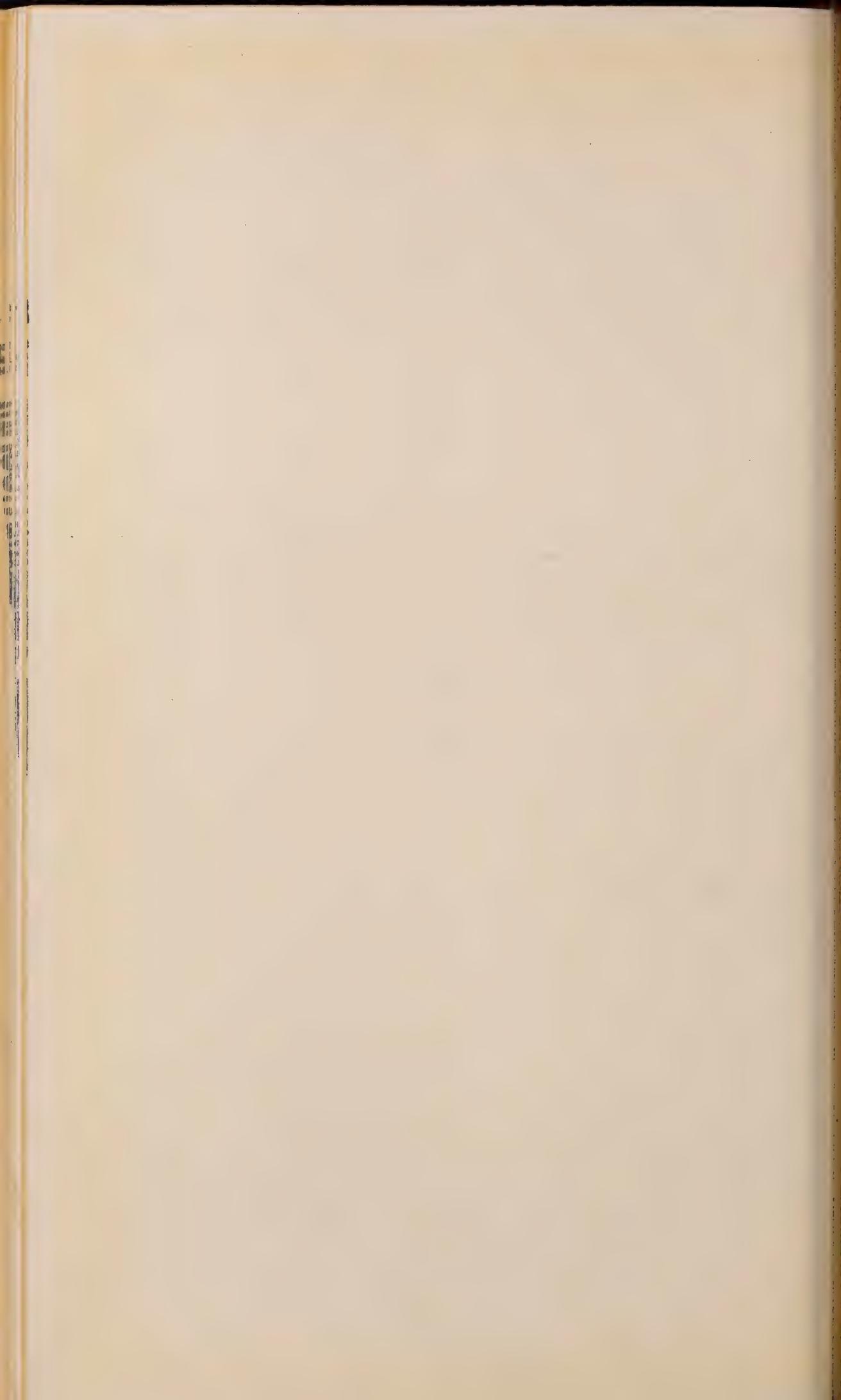
FIG. 16.—Second step in making the hole.



FIG. 17.—Setting the seedling and covering the roots.



FIG. 18.—Firming the soil by pressure of the foot.



few hundred less than on land covered by a good top soil. If the trees are set in rows running from one side of the lot to the other, it will be found quite easy to keep track of the portion which has been set. The distance apart may be very readily determined by making the holes two paces apart, or about 6 feet. It is also generally considered best to make a clear planting, rather than to mix varieties.

Heeling in on Lot.

Where a large number of trees are to be planted, they should be heeled in on the lot in a place where there is some protection from the sun; otherwise, a screen of brush may be put up. It will also be well to choose a spot near a brook or stream, as the seedlings will need to be watered if they become dry before transplanting. After they have been set in their permanent site they will take care of themselves, as to water them when spread out over a large area would be an almost impossible undertaking.

Method of setting the Trees.

The most convenient method of setting the trees is for the men to work in pairs, one making the holes and the other planting the trees. The first man with a grub hoe or mattock should strike into the ground (Figs. 15 and 16) and make a small hole, leaving as much as possible of the soil removed where it can be readily used to place around the roots when the tree is set; then he takes two paces and makes another hole. The second man, carrying a pail containing a bunch of seedlings, the roots of which are in a puddle of mud and water always to be kept in the pail, takes a plant and sets it in the hole (Fig. 17) at about the same depth as it originally grew, covering the roots with fine soil and firming it down by pressure of the foot (Fig. 18). The men should keep together and work from one side of the lot to the other and then back, the rows being kept about two paces apart. If stakes with flags are placed along the outside row and moved from time to time, it will be much easier to follow the row. One man should superintend from six to eight pairs of men.

Time to plant.

Planting should be undertaken as soon as the frost is out of the ground in the spring, the month of April and first of May being preferable, in order that the young roots may get started before the dry season sets in. Spring planting is preferable to fall planting, as the roots having started will not be as likely to be heaved out by the frost; although under certain conditions fall planting is sometimes resorted to, as in a case where a piece of land is too wet to work in the spring, but becomes dry during the summer and fall.

Two men working in the above manner will set about an acre per day, the expense of reforesting a tract, therefore, ranging from \$8 to \$10 per acre, depending on the price of the trees used and the cost of labor, white pine seedlings generally selling for from \$2.25 to \$4 per 1,000, and labor ranging from \$1.50 to \$2 per day. The above estimate is based on about 80 lots planted by the State Forestry department, the lots ranging in size from 20 to 200 acres. It was generally found that the average cost is much smaller on large lots than on small ones, the men becoming used to the lay of the land, and thus being able to work with greater speed.

Protection of Plantation.

After the lot has been planted, it needs practically no care unless a large proportion die out, in which case the blanks should be filled in with transplants. The lot should not be pastured, as many of the young trees would be trampled down. It is also well to put up posters prohibiting hunters and berry pickers, who often through carelessness start fires capable of great damage.

Fire Lines (Fig. 19).

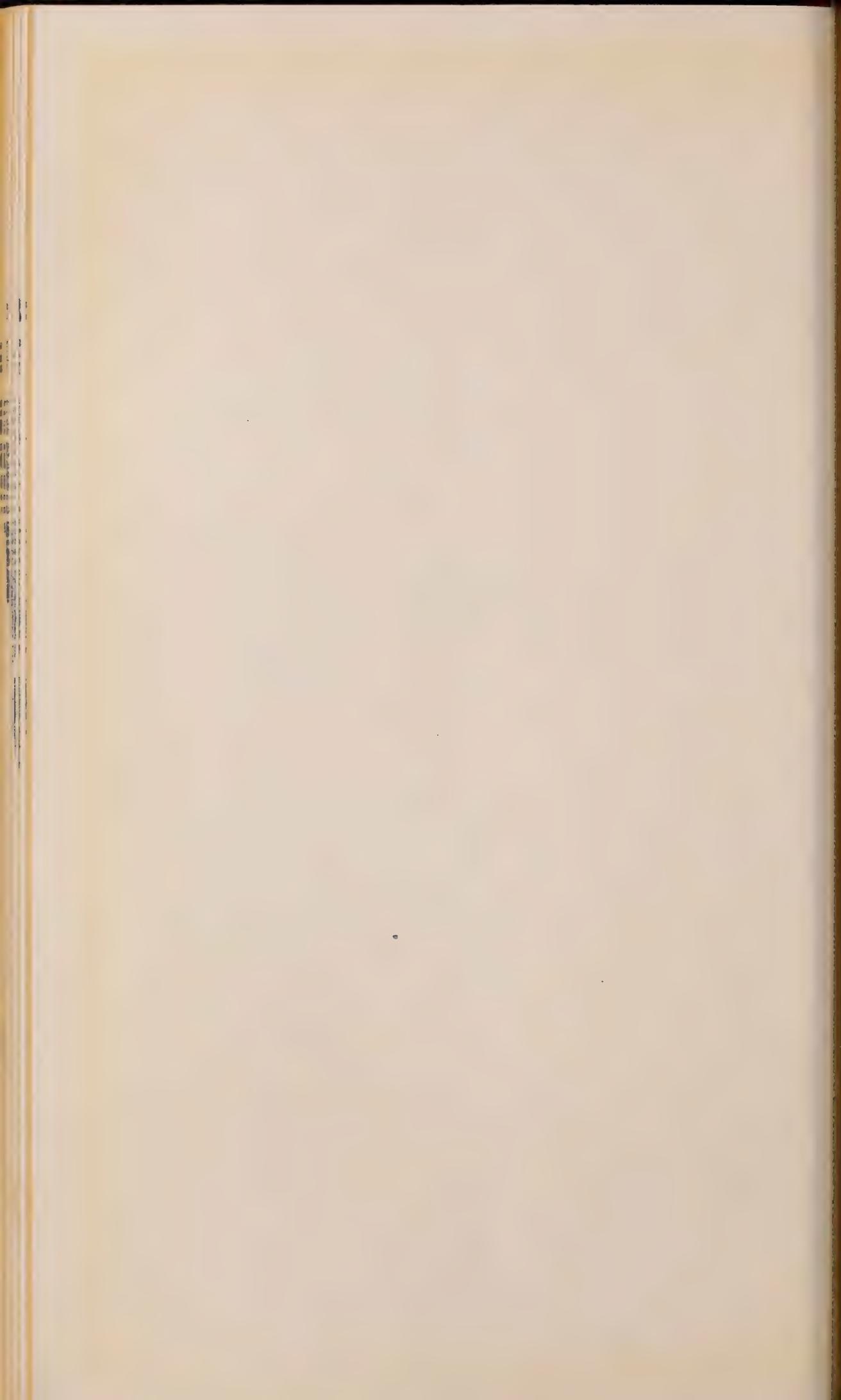
Around large lots a fire line should be cut on the exposed side of the plantation, to protect them from forest fires creeping in from adjoining land. A strip 50 feet wide cleaned of brush has been found very effective, the brush being piled and burned when the snow is on the ground (Fig. 20). On the side nearest the plantation (Fig. 20) a trench 6 feet wide should be grubbed up or plowed up, and kept free from weeds and dead leaves. In this way a fire working in from other land would be unable to jump across



FIG. 19. — Fire line, Metropolitan Water Board reservation, Boylston.



FIG. 20. — Burning brush along a fire line, work being done when the snow is on the ground, to prevent the fire from running. A trench six feet wide indistinctly shown on the left.



the trench, having nothing to feed on. A trench on the outside of the line would also be of advantage; but in case only one trench is deemed advisable, it is better to have it on the inside of the fire line. A line so made will offer a place for checking a fire or back-firing. The cost will vary according to the growth which has to be cleared. In cases where the wood is large enough to put it into cord wood, the expense will be small, the work nearly paying for itself; but under average conditions, where no return can be derived, the cost will vary from \$150 to \$200 per mile. It is best to cut and pile the brush for such a line in early fall, when there will be no danger from sparks or fire running. A strip of this kind is of especial advantage along railroads.

In extremely dry times, when there is danger from berry pickers or hunters, a look-out from some high knoll will be of advantage. A fire patrol of a lot, whether planted, or a natural stand, is practical in dry times. The old saying, that "An ounce of prevention is worth a pound of cure," certainly applies in cases where forest fires are concerned.

REFORESTATION WORK DONE BY THE STATE.

Under "An Act to provide for the purchase of forest land and for reforestation," passed by the Legislature of 1908, provision is made that private land owners may turn tracts of land suitable for reforestation purposes over to the State, to be planted and handled under practical forestry management, such owners reserving the right to redeem the land at any time within ten years, for the actual amount expended.

During the years 1909, 1910, 1911 and 1912 about 1,000 acres per year were planted under the supervision of expert foresters from the State Forester's office, the work being done by local gangs (Fig. 21) picked up in the various towns where the lots were situated. The cost of planting, including price of trees and labor of setting, ranged from \$8 to \$10 per acre, according to land and labor conditions. The first three years a large number of trees were purchased from outside nurserymen, but in 1912 the output of the State nursery had increased sufficiently to meet the demand, and by raising our own trees the cost is kept at a minimum.

Reforestation Act.

SECTION 1. For the purpose of experiment and illustration in forest management and for the purposes specified in section seven of this act, the sum of five thousand dollars may be expended in the year nineteen hundred and eight, and the sum of ten thousand dollars annually thereafter, by the state forester, with the advice and consent of the governor and council, in purchasing lands situated within the commonwealth and adapted to forest production. The price of such land shall not exceed in any instance five dollars per acre, nor shall more than eighty acres be acquired in any one tract in any one year, except that a greater area may so be acquired if the land purchased directly affects a source or tributary of water supply in any city or town of the commonwealth. All lands acquired under the provisions of this act shall be conveyed to the commonwealth, and no lands shall be paid for nor shall any moneys be expended in improvements thereon until all instruments of conveyance and the title to be transferred thereby have been approved by the attorney-general and until such instruments have been executed and recorded.

SECTION 2. The owners of land purchased under this act, or their heirs and assigns, may repurchase the land from the commonwealth at any time within ten years after the purchase by the commonwealth, upon paying the price originally paid by the commonwealth, together with the amount expended in improvements and maintenance, with interest at the rate of four per cent per annum on the purchase price. The state forester, with the approval of the governor and council, may execute in behalf of the commonwealth such deeds of reconveyance as may be necessary under this section: *provided, however*, that there shall be included in such deeds a restriction requiring that trees cut from such property shall not be less than eight inches in diameter at the butt.

SECTION 3. The state forester may in his discretion, but subject to the approval of the deed and title by the attorney-general as provided in section one, accept on behalf of the commonwealth gifts of land to be held and managed for the purpose hereinbefore expressed. A donor of such land may reserve the right to buy back the land in accordance with the provisions of section two, but in the absence of a provision to that effect in his deed of gift he shall not have such right.

SECTION 4. Land acquired under the provisions of this act shall be under the control and management of the state forester, who may, subject to the approval of the governor and council, cut and sell trees, wood and other produce therefrom.

SECTION 5. All moneys received by or payable to the commonwealth or any one acting on its behalf under the provisions of this act shall be paid into the treasury of the commonwealth.

SECTION 6. Land acquired under the provisions of this act and subsequently reconveyed under the provisions of sections two or three shall not be exempt from taxation on account of any plantation of trees set out or planted while it was held by the commonwealth.



FIG. 21. — A planting gang at work under the reforestation act.



FIG. 22. — View of example in thinning, where undesirable hardwoods have been removed and put into cord wood, to give the undergrowing stand of white pine a chance to grow.



SECTION 7. For the purpose of assisting in reforestation a portion, not exceeding twenty per cent of the money authorized by this act to be expended may be used by the state forester for the distribution at not less than cost of seeds and seedlings to land owners who are citizens of the commonwealth, under such conditions and restrictions as the state forester, subject to the approval of the governor and council, may deem advisable.

SECTION 8. The state forester shall replant or otherwise manage all land acquired by the commonwealth and held by it under the provisions of this act, in such manner as will, in his judgment, produce the best forest growth both as to practical forestry results and protection of water supplies.

SECTION 9. All acts and parts of acts inconsistent herewith are hereby repealed.

SECTION 10. This act shall take effect upon its passage.

The purpose of the above act is to place before the people an example along forestry lines which will aid them in carrying out the work for themselves. For this reason it is desired that the State, as far as possible, take over lots easily accessible to main highways.

In some instances lots have been taken over where it has been deemed advisable to protect the plantations from forest fires by making a fire line, or making provision for some one in the near vicinity to be supplied with fire extinguishers and equipment for fighting fires, and to patrol the lot in exceedingly dry times.

A number of lots have also been acquired where a small portion had some small growth which, if systematically thinned, could be profitably handled (Fig. 22).

Private parties owning land in the State adapted for reforestation purposes should make application to the State Forester, who will gladly furnish advice along forestry lines.

SYLVICULTURAL CHARACTERISTICS OF TREES.

Trees most commonly found growing in Massachusetts, the Uses to which their Timber is put, and a Few of their Most Important Enemies.

For convenience in the matter of reference, we shall separate the different species under three heads: (1) conifers, (2) northern hardwoods and (3) southern hardwoods, the term "hardwoods" being used for all trees other than conifers.

Under (1) will be treated white pine, red or Norway pine, pitch pine, Scotch pine, hemlock, red spruce, and Norway spruce.

Under (2) come rock maple, beech, white birch and yellow birch.

Under (3), chestnut, red oak, white oak, red maple, shagbark hickory, black locust and white ash.

1. CONIFERS.

White Pine (Pinus strobus).

This species is placed first, both because of its marked adaptability to growth in this State and because of the universal demand for its lumber.

It may be found growing in all sorts of situations except in extremely wet soil, such as swamps. This does not, of course, mean that the tree grows equally well everywhere, for it undoubtedly prefers a well-drained, loamy sand, and there reaches its best development. Ideal conditions exist on the slopes and at the bottoms of the old glacial deposits so numerous all over the State.

The white pine grows either pure or in mixture with other species, but in the latter case the other trees should form a lower or under story about the pine, otherwise, the tree will not grow well, being too much shaded by the others. It is a mistake to believe that white pine is a shade-enduring tree, for, while some shade is beneficial in the early stages of growth, it is very harmful at later periods.

Reproduction is by seed, which is produced annually, but in much larger quantities at intervals of from five to six years, called "seed years." The seeding process is described in detail elsewhere in this bulletin.

As regards size and rate of growth, white pine compares favorably with any eastern tree and far exceeds most of them in these respects, reaching merchantable size in about fifty years, as shown in the "Forest Mensuration of the White Pine in Massachusetts," published by the State Forester in 1908. If left to grow undisturbed, it reaches a size excelled only by trees of the Pacific coast, specimens having been recorded that exceeded 200 feet in height, with a diameter of 6 feet, while heights of 100 feet, with 3-foot diameters, are not uncommon.

The chief enemy of this tree, as of all others in this State, is fire, which, if it does not kill, so weakens it as to render it liable to attack by all kinds of insects and fungi. The white pine is

especially susceptible when young, even a slight ground fire being quite sufficient to completely kill it. In this respect it resembles the chestnut.

Leading insect enemies are the pine weevil and the various bark borers, all of which are much less likely to cause trouble in healthy stands than in those weakened by other causes. The gypsy moth, while it will eat pines as well as everything else, is not apt to invade pure stands containing this species alone. The brown-tail and leopard moths do not eat pine.

It seems almost unnecessary to enumerate the uses of the tree, as they are so well known. Among them may be mentioned building timber of all kinds, laths, various kinds of cabinet material, interior finish, wooden ware, matches, flag poles, masts and boxes.

Red or Norway Pine (Pinus resinosa).

This tree, while common in southern Maine, is not so familiar to residents of Massachusetts, partly because it does not grow in pure stands, but only as scattered individuals, and partly because the difficulty of collecting the seed renders the cost of planting either seed or seedlings very high. The tree, however, is a very excellent species, and compares favorably with white pine in many respects.

It grows on the same kind of soil as the white pine, but will grow on dry ridges, where the white pine will not. It will not grow in swamps or in poorly drained soil.

It associates usually with white pine, growing in scattered groups throughout the stand. More rarely it is found in company with hardwoods, such as oaks and birches.

Red pine is a rather poor seeder, not beginning to bear until about twenty-five years old, and then giving only light crops at four or five year intervals. The seed will not germinate in thick grass or sod, and the seedlings require much light. A bare mineral soil containing some moisture is best. The percentage of germination is high.

In rate of growth red pine is more rapid than white, especially when young, though it is more short-lived in the long run. It reaches a diameter of 23 inches and a height of 80 to 90 feet in one hundred and twenty-five years, producing merchantable timber. Sixty years will produce good small stock.

No serious insect pests or fungous diseases attack this species, and it is remarkably free from rot. Light ground fires do not injure it so much as they do white pine, especially as the tree grows older.

The wood is used for general construction, bridge timbers, shipbuilding, car construction and flooring.

Pitch Pine (Pinus rigida).

This tree grows on dry sandy soils, and is especially suited to planting in such localities. When pure it forms very thin stands, owing to its extreme intolerance, and it must be above all other species in mixture, or it will die.

It is a prolific seeder, and succeeds well under the above conditions, and is also a fairly rapid grower, reaching at times a height of 80 feet and a diameter of 30 inches.

It is not subject to attack by insects or fungi, and is probably the most resistant to fire of any conifer in Massachusetts, surviving repeated burnings.

The wood is used largely for fuel, being brittle and not strong.

Scotch Pine (Pinus sylvestris).

This tree is the common pine of northern Europe, occupying there the same place that the white pine does in this country as a timber tree. Its growth, however, more closely resembles our Norway, both in quality of lumber and in the kind of soil preferred by the tree.

It differs, however, in the fact that it grows well in dense pure stands rather than in mixture with other species, and also in that it seeds often and abundantly, and therefore costs much less to grow than red pine.

In common with the other pines, Scotch is not much subject to disease and insect attack, but is somewhat more sensitive to fire than red.

It is used for the same purposes as red pine.

Hemlock (Tsuga americana).

This tree, easily the most tolerant of the American conifers, prefers cold north and east slopes of the hillsides in the northern parts of the State. Because of its extreme tolerance, it will grow

either with any other species, evergreen or hardwood, or in dense pure stands in all stages of growth.

The seeds are borne in very small cones, and are very light. Reproduction is good under favorable conditions of soil and location, and the tree frequently grows apparently out of bare rock, so thin is the soil.

Trees of this species often grow to a very large size, but such individuals are apt to be rotten and shaky. Other species will not grow under hemlock because of the dense shade cast by it.

The wood is being used more and more for building timber, as the supply of other species grows scarcer, and some lumber dealers prefer it to spruce for rough frame timbers. If care is not used in drying it is very likely to check.

Red Spruce (Picea rubra).

This tree is the timber spruce of Maine, and is now the most important species in that State in size of cut. It will grow in northern Massachusetts on the higher elevations, preferably in mixture with pine and hemlock.

It will grow in the shade of other trees for many years, and shows marked ability to start up and grow when suddenly exposed to the light.

Growth is not rapid, and large size is not reached by this species; but good, straight timber is produced, which finds a ready market. The limbs do not drop off readily, however, and clear timber can therefore be grown only in dense stands.

The tree reproduces itself well when the leaf litter on the ground is not too thick, and the seedlings therefore start readily under the mature trees of the same species, forming a stand containing trees of all ages.

The principal enemy is the spruce bark beetle (*Dendroctonus piceaperda*).

The uses of the wood are well known; building timber, piano sounding boards, inside finish, clapboards, and in Maine pulpwood, are among them.

Norway Spruce (Picea excelsa).

This is one of the principal timber trees of Europe, and is strongly recommended for planting in this country, possessing, as it does, all the advantages of the red with the added one of being a much more rapid grower.

2. NORTHERN HARDWOODS.

Rock Maple (Acer saccharum).

This tree, known also as the sugar maple, is one of the most important of our northern hardwoods, both for sugar and timber. It grows usually in mixture with beech, oaks, ashes, etc., as well as conifers, but may grow in pure stands.

Its chief silvicultural feature is its extreme tolerance, making it the most shade-bearing of all American hardwoods, with the possible exception of beech. A deep, moist soil is necessary for good growth.

Seed is produced almost every year, but full seed years occur only at intervals of from three to five years. The percentage of germination is rather low, but this is offset by the ability of the young trees to stand dense shade.

Growth is slow, but persists for a long time, the tree reaching a height of 70 or 80 feet and a diameter of 2 or 3 feet. The tree is not very wind-firm.

Rock maple is not very susceptible to injury by fire or fungi, though a good deal of damage is sometimes done by the forest tent caterpillar, which strips the foliage from the tree and so reduces its vigor. Another enemy is the "saddled prominent" (*Heterocampa guttivitta*), which has caused a great deal of damage in Maine and New Hampshire, but is now being brought under control by natural enemies.

Beech (Fagus ferruginea).

This tree is conceded to be the most tolerant of all the hardwood species found in Massachusetts; that is, it will grow well beneath the most dense shade, provided the soil is suitable for germination, and not only this, but it requires shade in order to start at all. It grows best on rich, loamy soil, on cool slopes,

in mixtures with other hardwoods, such as the oaks, chestnut and maple. It sometimes forms pure stands with here and there scattering pine and hemlock.

The nuts are so much liked by squirrels that reproduction is hindered by these animals.

The beech is a rather slow-growing tree, generally owing to the dense shade which surrounds it; but it reaches good size, both in height and diameter.

The principal enemy in Massachusetts may be said to be the "saddled prominent," previously mentioned, which prefers the leaves of this tree to all others, thus causing the woods to resemble winter in the height of the growing season.

The wood forms one of our most valuable hardwoods, and is used for tool handles, furniture, flooring and in turnery.

White Birch (Betula papyrifera).

This tree is to be rigidly distinguished from the gray birch (sometimes called "white") so common in this State. The latter species (*Betula populifolia*) is practically valueless for all purposes, fuel included, and must not be confused with the white, which forms a valuable timber tree.

White birch grows on northerly slopes, in mixture with other hardwoods, pine and hemlock. The seed is very light, favoring reproduction by the wind, and causing the propagation of the species over burned areas when there is enough soil moisture to support tree growth. The tree will not stand shade, being very intolerant, and the seed will not germinate on a thick layer of humus, so that reproduction within the woods is unlikely.

A long, clear bole is developed by growth in the forest, the tree reaching a height of 70 to 80 feet in sixty to seventy-five years. It is a short-lived tree, seldom living over one hundred and twenty years when grown from seed; sprouts do not live over ninety years.

Its most serious enemy is fire, since it is not subject to attacks by insects, fungi or windfall.

The wood is used, to the practical exclusion of all others, in the manufacture of spools, shoe pegs, shoe shanks, and very largely for toothpicks, dowels, bobbins, shuttles and various toys and novelties.

Yellow Birch (Betula lutea).

This tree is quite commonly found in Massachusetts in mixture with evergreens and deciduous species, where it is distinguished by its yellow, shiny bark, usually of a tattered appearance.

It is a valuable species for ship building, furniture and wheel hubs, having a very fine, clear texture of grain.

It is mentioned in this list not because we desire to urge planting this species, but in order that owners may recognize it as a valuable tree, and not of the same class as the gray birch, which, of no value in itself, usually causes more or less injury to its neighbors by interfering with their proper development.

3. SOUTHERN HARDWOODS.

Chestnut (Castanea dentata).

This tree, like the oak, reaches its best condition on the lower slopes of hills, or in coves where the soil is rich, moist and fairly deep. It will grow, however, on a very thin soil, if it be loamy. It grows much more rapidly than the oaks, attaining saw log size in about fifty years. Under favorable conditions it will attain a height of 100 feet and a diameter of 3 or 4 feet. As a sprout its growth is remarkable, excelling that of any deciduous tree except poplar.

It bears a crop of seed each year, but the crop varies in abundance.

The tree is quite intolerant, but, as it grows more rapidly than the other hardwoods with which it associates, it has little trouble in getting all the light it wants.

The chestnut, in common with the hardwoods, is of course eaten by the gypsy moth, but it has few insect enemies peculiar to itself. It is, however, gravely affected by a fungus called the chestnut bark disease (*Diaporthe parasitica*), which has killed practically every chestnut tree within twenty miles of New York. The tree is severely injured by fire, on account of the lightness and inflammability of its bark.

The wood is light, stiff, strong, and very durable in contact with the soil. It is used for ties, poles, building material, posts, slack cooperage and furniture. The wood is distilled, and produces a tanning extract used in the place of tan bark. The cut of chestnut has increased nearly 100 per cent. in the past decade.

The Oaks, White, Red and Black.

For their best development our native oaks require a rich, moist soil, situated in cover or on the lower slopes of a hill. With the exception of the swamp white oak, they will not grow on wet land; and, on the other hand, they make a fair growth on the top of dry, exposed ridges.

They require considerable sunlight for their best development, but the black and red oaks will stand some shading. The white oak is quite intolerant.

The white oak bears seed nearly every year, but the trees of the black oak family require two years to mature the acorns.

The oak is a slow-growing tree, requiring at best seventy-five years to obtain a tree of saw log size. The black and red oak grow more rapidly than the white in early youth, but the white oak maintains its growth for a longer period, so that at the age of maturity there will be little to choose between them as to size.

Brown-tail and gypsy moths seem to be particularly fond of oaks, but, as they eat other species very readily, this preference is not of great importance. The "saddled prominent" (*Heterocampa guttivitta*), an insect now doing a large amount of damage in northern New England, is known to eat it at times. The oak is unusually free from borers and bark beetles, and is quite resistant to damage by ground fires.

Oak wood is heavy, hard, tough, close-grained and very durable. White oak has these qualities to a greater degree than the red and black. The wood is used extensively in ship building, tight cooperage, vehicle manufacture, farm implements, ties, interior finish and furniture. So great is the economic value of this wood that the available supply is being rapidly exhausted.

Red Maple (Acer rubrum).

This tree is partial to wet land, and is our typical swamp tree, growing pure or in company with ash, hornbeam and hemlock. Like other swamp-land trees, it is very tolerant of shade, although in this condition its growth is slow.

It bears an abundance of seed each spring.

Under forest conditions it seldom attains a height of more than 60 feet and a diameter of more than 15 inches. It grows quite

rapidly when young, but slacks materially when about thirty years old.

It is not attacked so readily by gypsy and brown-tail moths as are most of the other hardwoods.

The wood is lighter, not as strong and more subject to decay than is hard maple, but is sometimes used as a substitute for it.

It is not a tree that is recommended for forest planting.

Shagbark Hickory (Hicoria ovata).

This tree is of increasing importance because of its increasing scarcity, due to the heavy demand for hickory wood, — a demand caused by its unrivalled good qualities for certain kinds of construction.

It is primarily a tree of fresh, fertile soils and rich situations along streams, and produces good wood in clay soil.

It is never found pure to any great extent, but always in mixture with other species, and, being very tolerant, will grow well in the shade of the others.

Seed is borne in a fairly prolific manner every two or three years, but the nuts are largely eaten by weevils and squirrels. Growth is not very rapid, but is extremely persistent, the tree living to an age of two hundred to two hundred and twenty-five years, in full vigor. Timber trees are produced in about one hundred years.

The wood is used for vehicle construction, handles of axes, etc. It is the strongest of the hickories except pignut, and should be favored over that species except on dry soils and where there is no market for the nuts.

Black Locust (Robina pseudacacia).

The black locust is a more southern species, but will grow in Massachusetts, and is recommended where a quick-growing tree is desired. It demands plenty of light and a mineral soil, and produces its best wood at forty to fifty years, reaching only some 60 to 70 feet in height. The seed is borne in pods, and if left in them preserves its germinating power for several years. Seedlings grow best when raised in the nursery for one year.

The wood is heavy, exceedingly hard and strong, very durable in contact with the soil, and is used in ship building, turnery and construction. It is preferred for tree nails, and makes good railroad ties.

White Ash (Fraxinus americana).

This tree prefers to grow on rich, moist bottom lands, where it will be found mixed with elm, basswood, yellow birch and maple. It will grow in a wet swamp and equally on dry, exposed ridges, so that it may be said to be versatile in habit.

It is quite tolerant when young, but when too much shaded its diameter growth is very slow.

Some seed is produced each year, but abundantly only once in three years. It is quite easy to collect, and the tree is therefore one used quite extensively in forest planting.

The rate of growth is rapid when compared with that of most of the associated hardwoods, but it varies considerably according to conditions of moisture and situation. Post timber may be obtained from it in from fifteen to twenty years.

White ash is attacked by a number of fungous diseases, which injure the leaves and flowers, but not sufficiently to kill the trees. It has the distinction of being the only deciduous tree which the gypsy moth does not attack, although there have been cases where this pest has attacked this tree when everything else was gone.

The wood is tough and elastic, and this, combined with its ability to take a good polish and to season without injury, makes it a timber of exceptional value for furniture, car vehicles, manufacture, interior woodwork, agricultural implements and tools.

Plantations will do best in a protected valley on a light loam.

No.....

Received.....



APPLICATION
FOR AN
EXAMINATION OF LANDS SUITABLE
FOR REFORESTATION
TO THE
MASSACHUSETTS STATE FORESTER,
6 BEACON STREET, BOSTON.

The State Forester is empowered, under chapter 478, Acts of 1908, to accept, on behalf of the Commonwealth, gifts of land to be held and managed for the purpose of experiment and illustration in forest management and for reforestation.

The owners of land acquired under this act, or their heirs and assigns, may redeem the land from the Commonwealth at any time within ten years, upon payment to the Commonwealth of the amount expended in improvements and maintenance; provided, however, that there shall be included in the deed of reconveyance a restriction requiring that in the future the cutting of trees on this land shall be in accordance with modern forestry methods.

"SECTION 8. The state forester shall re-plant or otherwise manage all land acquired by the Commonwealth and held by it under the provisions of this act, in such manner as will, in his judgment, produce the best forest growth both as to practical forestry results and protection of water supplies."

Upon receipt, this request will be placed on file, and you will be informed, in order of application, approximately when the examination can be made, and a mutual date can then be decided upon.

It is always more satisfactory to personally meet on the property the owner or party most interested. In this way a definite understanding can be had as to future undertakings.

When sending in this application, a brief description of the land will assist us.

With the above understanding, I desire to have an examination made of a tract or tracts of land of approximately.....acres, located in the town of.....county of.....State of Massachusetts.

Signed.....

Address.....

Date.....19 .



Portable mill operating in pine woods.



Box factory at Oxford. A factory of this type will use 20,000,000 feet of pine per annum.

12

INFORMATION

THAT MAY INTEREST YOU

ABOUT

FORESTRY

IN MASSACHUSETTS



By

F. W. RANE, State Forester

AND

H. O. COOK, Assistant State Forester

WRIGHT & POTTER PRINTING COMPANY, STATE PRINTERS
18 POST OFFICE SQUARE, BOSTON

1913

100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200

FORESTRY IN MASSACHUSETTS.

PART I.

WHAT IS FORESTRY?

Forestry is technically defined as the science which is concerned in the forming, cultivating and harvesting of timber; in short, the management of timber as a crop. Forestry is to be distinguished from arboriculture by the fact that arboriculture deals with trees as individuals, whereas forestry deals with them in forest stands, — as a community of trees. This distinction is worth emphasizing because many men who care for shade and ornamental trees call themselves foresters when in reality they are arboriculturists. Forestry is distinguished from landscape gardening by its point of view. Landscape gardening deals with trees both as individuals and as groups, but always with the purpose of producing artistic effects. If any timber or wood is produced, it is merely incidental. We do not mean to say that forestry can always be divorced from the considerations of arboriculture and landscape architecture, but if these other considerations are uppermost, the work is not forestry.

Forestry is chiefly concerned with the economic production of merchantable wood and timber, and it aims to do one or all of these things: to produce a greater amount of timber than an uncared-for forest in the same amount of time; to produce a better quality of timber than the uncared-for stand or the same amount of timber in a lesser period of time. We will not attempt here to describe how these things may be done, for to do so would be to write a whole textbook on forestry, and is not in the scope of this bulletin.

The considerations which make forests desirable, however, are many, and they vary somewhat in the different sections of the country and also, to some extent, in the same section, according to local needs and the desires of individual owners of

woodland. In steep, mountainous countries the protection of the soil and the maintenance of its ability to store moisture and to equalize the run-off of the streams is of more importance than the raising of timber. In the prairies of the central west the forests have an important influence on climate by reducing the velocity of the winds and reducing the extremes of temperatures, and a forest there has a value greatly in excess of its value as a source of timber. The preservation of the natural beauty of the countryside is often an important consideration, as well as the production of forest products.

As a rule, if forestry is practiced for commercial purposes, if the land is made to produce continuously the greatest amount of merchantable material with the least possible expenditure, the protective and beautifying functions of the forest will be performed.

IMPORTANCE OF FORESTRY IN MASSACHUSETTS.

The proper management of our forests is of much greater importance to this Commonwealth than the average citizen realizes. From rather rough studies made by this office we have estimated the forest area of the State at 2,400,000 acres out of a total acreage of 5,320,000, or about 40 per cent. Included in this acreage is a great deal of land which could hardly be called forest, — cut-over land only partially restocked, cut-over land that has been burned so that it bears nothing but a scrub growth, and old fields and pastures only partially stocked. In addition we have estimated that there are 500,000 acres of abandoned fields and pastures and cut-over land on which no forest growth worth mentioning is coming up, and which we designate as waste lands, making about 3,000,000 acres available for forest purposes. The Geological Survey estimates the forest area at 2,688,000 acres.

Our citizens probably do not realize the present extent of the lumber industry in this State, that in spite of our large population, our small size and our depleted forests, we are still producing considerable quantities of lumber. In New England our production is only exceeded by Maine and New Hampshire, and we are only a short distance behind the latter. The census of 1910 gives the lumber-cut of Massachusetts as 350,000,000

feet, three-quarters of which is pine, one-eighth chestnut and the remainder made up of oak, maple, spruce, beech, ash, etc. Lumber, however, is not the only forest product taken from the woods. Immense quantities of oak and chestnut are cut for railroad ties and telephone poles. We know that the railroads of this State use approximately 600,000 ties each year, the equivalent of 230,000,000 feet of lumber, the larger part of which are cut in this State, so that it is safe to assume that the timber cut in this State is equivalent to 500,000,000 feet of timber worth, on the stump, nearly \$4,000,000. In addition to the lumber there is a large amount of cordwood cut, no figures for which are available.

In spite, however, of this apparent large production, the 3,000,000 acres available could with proper management produce and produce continuously three or four times the present amount. In the meantime our manufacturers are going to Canada, the south and to the Pacific coast to get their supplies, and they are sending money with their orders that might go to land owners in Massachusetts. By neglecting to practice forestry, the owners of woodland are allowing a great natural resource to go to waste.

Wood is always needed. In spite of many substitutions it is more in demand than ever before. The amount of wood annually consumed is not only increasing rapidly, but it is increasing at a rate in advance of that of the population, so that one cannot put much confidence in the arguments put forward that wood is to be displaced, for such substitutions as have been made have produced no effect as yet on the annual consumption or on the price.

THE FUNDAMENTAL CONDITIONS.

There are five fundamental conditions that must precede or accompany the permanent development of forestry in any country. The first is the presence of a considerable area of non-agricultural land which is capable of bearing forest growth; the second is a good market for forest products; the third is the presence of good transportation facilities; the fourth is an adequate system of protection from fires; and the fifth is a fair method of taxation of forest lands.

To practice forestry means, on the part of the man who does it, the sacrificing of a portion of his present profits for future results, and the forest owner is not apt to do this unless all the conditions are favorable.

1. *Non-Agricultural Land.*

It is not a sound economic proposition to grow trees on land which could earn larger dividends as cultivated land; but in this State we have, as has been said before, nearly 3,000,000 acres which either bear forests or are not capable of bearing any other crop. This State, therefore, fulfills the first of these conditions.

2. *Good Markets.*

The second condition — that of a good market for forest products — is also fulfilled in this State. Where there is building going on there is a demand for lumber; where manufacturing is going on wood is being used somewhere in the process of manufacture or in creating the product for shipment; where there are railroads there is a demand for ties; where there are telephone and telegraph lines there is a demand for poles; and where farming is going on there is a demand for lumber, fence posts and firewood. The degree to which forest cultivation can be carried on depends largely on the market for forest products, and the market for forest products depends largely on the density and distribution of population. There is only one State in the Union that has a denser population than Massachusetts, and although congested around Boston, there is no large section of the State that is not settled with cities and towns of considerable size. Manufacturing is going on not only in the larger towns but in most of the smaller ones. It is readily seen that a market for wood and lumber is not far to seek in any part of this State; no one has better markets.

3. *Transportation Facilities.*

Transportation has an important bearing on forestry. Forest products are as a rule bulky and heavy, and their transportation is consequently a considerable item in the cost of marketing. Whether this or that operation can be adopted in the woods often depends on the question whether the lumber can be carried to

the market with a margin of profit. If transportation facilities are good much more intensive forestry can be practiced than otherwise.

The transportation problem here in this State is comparatively simple. A network of railroads puts nearly every section of the State within practical hauling distance of a shipping point. Our country roads, when compared to those of other States, are excellent, and we have 1,000 miles of macadamized State highway which is being added to each year.

4. *Protection from Fire.*

Fire is the greatest enemy of the forest. It not only injures and destroys merchantable timber, but it kills young growth upon which our future timber supply must depend. The constant recurrence of fires on large tracts changes them to barren wastes, producing nothing and a burden to the community that contains them. More damaging than the actual loss by fire is the fear of it, which prevents conservative and scientific handling of our woodlands. We cannot condemn the lumberman for skinning the land when we cannot give him reasonable assurance that it will not burn over at any time. We must protect his crop to the extent of making it possible for him to insure it at reasonable rates that do not exceed the growth of the crop.

Great progress has been made in the matter of fire protection in this State in the past few years. The forest warden act of 1907 put the matter of fighting forest fires in our towns in the hands of one responsible man and clothed him with sufficient authority. The fire warden acts of 1911 created the office of State Fire Warden, with district deputies to supervise the work of the town wardens and a small appropriation to expend in the work of forest-fire prevention. Under this law the smaller towns have been provided with fire-fighting apparatus, and a system of watch towers has been erected for the early detection of fires.

With all our improvements, however, we are still a long distance from the ideal condition because we still have far too many fires and too many acres of burned land. The State Fire Warden, instead of acting merely in an advisory capacity, should have legal authority in the enforcement of the fire laws,

authority to investigate and punish those violating the laws, and authority over the laws affecting railroads. Without such authority the central office is in a very weak position, and there is no agency which takes interest enough in the matter to enforce the statutes.

5. *A Fair Method of Taxation.*

The system now in vogue of assessing forest lands for purpose of taxation provides not only for the taxing of the land but of the growing crop as well. Not only is the crop taxed once but many times over, and for many years before any returns come in. The only reason that this unjust condition of affairs has not been realized before is that the assessors have purposely undervalued forest lands, and that therefore what is wrong in principle has not been apparent in practice. Indeed, were forest land given its full value and taxed at the prevailing rate, the tax would be nearly equal to the value of the entire annual increment on the woodland. How long could any business last whose entire income had to go to pay taxes? Either the assessor must break the law and undervalue the forest or else he practically confiscates it. Such a system is neither fair to the landowner nor the assessor.

This Commonwealth, which leads in many forms of legislation, is also leading in this matter of forest taxation. As long ago as 1905 a commission was appointed to study the matter, and as a result of their study and the constant agitation in behalf of the reform, the Legislature and the people have at last adopted a constitutional amendment which allows the Legislature to make a new system of taxation for forest lands. Just what forms this new system should take is now a matter of investigation and study, and we hope that a satisfactory solution of this most perplexing problem will be found.

RECAPITULATION.

As we said before, there are five conditions which are fundamental to a permanent and successful development of forestry: (1) the presence of a considerable area of non-agricultural land that is capable of forest growth; (2) a good market for forest products; (3) good transportation facilities; (4) a good

system of fire protection; (5) a fair method of forest taxation. The first three of these conditions we already have, the fourth we are attaining slowly and the fifth we are on the eve of having, so that we should feel greatly encouraged in our endeavor to establish forestry in this Commonwealth.

PART II.

THE COMMONWEALTH'S FOREST POLICY.

The office of State Forester was established in 1904, with an appropriation of \$5,000 and a force made up of one assistant and a clerk. The work at that time was wholly along educational lines, and those lines have been continued with additions to the present time. The chief line of work first undertaken was that of assisting the private landowners in the management of their woodlands. It is very important that the private owner should be encouraged to practice improved forestry methods, and the State has taken the position that it will furnish to the people the services of experts and leave the owners to make use of their services or not, as they see fit. This work has been continued with an increasing patronage each year.

Publications.

It has always been the plan of this office to investigate the different phases of forestry work and to publish instructive bulletins on these subjects. From 1904 to the present time 16 bulletins in addition to the annual reports have been issued. Some of these bulletins are now out of print, but a list of those available is appended to this report.

Public Lectures.

The State Forester and his assistants are constantly engaged in giving lectures or talks on various phases of forestry before the State Board of Agriculture, boards of trade, granges, clubs and kindred organizations. These lectures, sometimes illustrated by lantern slides, are undoubtedly conducive to the proper management of the forests of the Commonwealth and in creating a sentiment favorable to forestry.

Forest Nursery.

The act creating the office of the State Forester gave him the privilege of establishing a nursery for the propagation of forest-tree seedlings on the grounds of the agricultural college

at Amherst. This nursery was established with the idea of selling the stock to private owners, but with the passage of the reforestation law in 1908 the output was used by this office and the policy of selling seedlings was stopped. It seemed unnecessary to continue this policy, because in the meantime a number of commercial forest nurserymen had started in business, and they were prepared to furnish trees in large quantities and at reasonable rates.

At the present time the Amherst nursery and the branch at Sandwich will yield fully 1,000,000 three and four year transplants, a quantity sufficient for the reforestation work of this office, and in addition several million seedlings, a portion of which we do not set into the transplant beds, and we distribute them free of charge to our State institutions having lands to be reforested.

Reforestation Work.

In 1908 the Legislature appropriated \$10,000 yearly for the State Forester, to purchase land under certain restrictions and to set it out with young trees. The same law also contained a provision whereby any one could deed their land over to the Commonwealth and this office should plant it, the original owner to have the right to redeem the land at any time within ten years by paying the State the cost of the planting. Under this law approximately 3,500 acres have been planted, one-third of which was purchased and two-thirds deeded. With the present appropriation it is possible to plant, on an average, 800 to 1,000 acres per year.

Forest-fire Work.

Previous to 1907 the forest-fire fighting system was in a very chaotic condition. The law of that day allowed the towns to appoint a number of fire wardens, no one of whom was in supreme authority. Many of the towns made no attempt to have any fire wardens, and in those that did there was little organized attempt at forest-fire fighting. In 1907 the Legislature passed the forest warden act, so called, wherein every town and city was called upon to appoint one man as a forest warden, who should have complete charge of the forest-fire work. This official is appointed by the selectmen, but his appointment must

be approved by the State Forester. This clause has the effect of giving permanence to the position. The result of this act has been to bring the forest-fire fighting system in our country towns to a much higher dignity and proficiency than the happy-go-lucky system prevailing before. There is a tendency in many towns to combine the office of tree warden, forest warden and local moth superintendent, and this tendency is to be commended because it produces a position which may well occupy most of the time of a capable man. It was with this object in view that the 1907 act called the men forest wardens instead of fire wardens, for we expect that when the practice of forestry becomes a settled thing in this country, each forest warden shall become a local expert in the care of forests and shade trees, and the fighting of woods fires shall be only an incidental part of his work.

This State has never adopted the policy, prevalent in most States with a definite forest policy, of reimbursing a portion of the cost of fighting forest fires, but in 1909 it passed an act to reimburse towns having a valuation of less than \$1,500,000 one-half the cost of installing apparatus for fighting forest fires, provided such apparatus did not cost more than \$500. To date 80 towns out of 170 entitled to reimbursement have taken advantage of this law.

In 1911 the Legislature constituted an office, and an appropriation to support it, which we had long endeavored to obtain, namely, the position of State Fire Warden, who acts as the representative of the State Forester in all matters dealing with the suppression of this enemy of our forests. Previous to that time, such small authority as was lodged with the State Forester was exercised by him through his regular forestry assistants, and as there were no funds provided for paying the expenses of such work, and as the time of the assistants was largely occupied in forestry work, the time and means applied to fire work was necessarily small and included only the absolutely necessary clerical work which the forest warden law required. The Legislature gave \$10,000 for the work of the fire warden the first year and increased this amount to \$20,000 in 1912. The State has been divided into four districts, each with a deputy fire warden to supervise the work of the town wardens

in their districts. Nineteen watch towers have been erected on various hills and mountains over the State, and from March to November watchmen are kept in these towers to look out for incipient forest fires in the range of vision, which includes a radius of 6 to 12 miles, depending on the state of the atmosphere. Each tower is connected by telephone with the nearest exchange, so that the watchmen can call up the fire warden or deputy nearest the scene of action. In this way, many fires are put out in the early stages instead of being allowed to grow into uncontrollable conflagrations. Not only does the State Fire Warden supervise the work of town wardens and the work of these watchmen, but he also co-operates with the railroad commission in the inspection of locomotives, with the idea of lessening the number of railroad fires. Not only has this office done great service in controlling the forest fires of this State, but with the possibility of increased powers being conferred upon the fire warden there is a field for wider usefulness.

In the foregoing we have endeavored to give a history of the work of the State Forester's office and the development of its forest policy. Let us turn now to our plans for future development.

PART III.

SOME IMPORTANT WOODLAND PROBLEMS.

The principal points in the State's forest policy as it exists to-day have been described, but there remain to be considered some matters of interest which pertain to the future growth of this policy.

State Forests.

The Commonwealth ought to extend its policy to include a system of general State forests, for when all is said and done it is only a portion of the private owners who can practice forestry, and only a very small portion who can practice it in intensive form. As we have said before, the practice of forestry means the sacrifice of present profits for future greater ones, but the man who must spend his present income for his daily needs cannot afford to make such a sacrifice except in a small way, whereas the owners with a large surplus income who can afford to practice intensive forestry are few. Therefore we see that if we depend wholly on the development of private forestry in this Commonwealth we shall make but slow progress.

The federal government is already well committed to the government ownership of forest land, with its 160,000,000 acres of national forests in the west and its recent purchases in the east. The constitutional limitation, however, that such forests must be for the protection of the headwaters of navigable streams, precludes the idea that they will ever operate in this State. Indeed, each State should do this work for itself and not wait for aid from the national government. The great Commonwealths of New York and Pennsylvania are thoroughly committed to this idea of State forests, the former having acquired nearly 2,000,000 acres and the latter 1,000,000. Even our neighbors here in New England have taken up this policy, although their beginnings are small, and Connecticut, New Hampshire and Vermont all have State forests under the management of the State Forester. Of course, the lands which we have taken over under the reforestation law are in a way State forests, but they are only temporarily so, for after ten years they revert to the original owners if these owners choose to make use of their privileges.

This State already owns a considerable area of wild forest land in the form of reservations protecting some of our more prominent mountains. The principal of these reservations are Greylock, Wachusett, Everett, Mt. Tom and Sugar Loaf. These reservations, aggregating 12,000 acres, would form an excellent nucleus for a State forest system, and can be made to produce forest supplies without any injury to their present use. In fact, it seems rather incongruous that this State should on the one hand urge upon the private landowner the advantages of forestry management when on the other hand it refuses to practice it on the lands that it already owns. Territory can be added to these reservations already existing and new ones created. Land for such reservations can be purchased for \$10 per acre or less. A few years ago Connecticut purchased 900 acres at a cost of \$1.64 per acre, but this was, of course, an exceptional case. When once well stocked, the sale of mature timber should not only provide for its maintenance, but should yield a net revenue to the treasury. The kingdom of Prussia owns 6,000,000 acres of forest land from which it derives a net revenue of \$9,000,000, and the State forests of France yield a net annual revenue of \$2 per acre.

City and Town Forests.

There are many reasons why cities and towns would do well to own and manage woodlands, when suitable cheap lands are to be found in their boundaries. This could be done in many instances at a moderate initial cost, and, as said above in connection with State forests, such holdings should in time provide for their own maintenance and even return a net revenue to the town that owns one. Many towns already have the possibility of such a municipal forest in their possession in the form of lands which they are holding for the protection of their water supplies. Fall River owns 4,000 acres, Westfield, 1,500, Holyoke, 2,000 and many others smaller amounts. Such lands should not be allowed to lie idle producing nothing, but should be put under management so that they will help supply the future timber needs of the community, and at the same time they are in better shape to conserve the water supplies that they were created for.

CONCLUSION.

The friends of forestry in this Commonwealth are much encouraged by the interest which has been manifested by the general public. The Massachusetts Forestry Association and the Boston Chamber of Commerce, which has a forestry committee, the State Board of Agriculture, the State Grange, etc., have been powerful factors in focusing this interest on legislation and in other ways. This interest is so hearty that it tempts us to look forward to a time when the old abandoned farm, coming up to red cedar or worthless birches, will be a thing of the past; when waste lands from Cape Cod to Berkshire will be occupied with thrifty stands of white pine and other useful timber trees; when the woodlot will produce saw logs as well as cordwood; when the State over cities and towns will own forests for the production of timber and recreation grounds for the people; to a time when the greater part of the timber used in the Commonwealth will be produced within its borders. All these things are possible and practicable from an economic view, but it will take an intelligent interest on the part of the private owners, and an intelligent sentiment on the part of the general public, to bring these conditions about.

LIST OF PUBLICATIONS OF THE STATE FORESTER.

Forestry Bulletins.

Forestry in Massachusetts.
Wood-using Industries of Massachusetts.
The White Pine in Massachusetts, Log Scales, Volume Tables.
Massachusetts Forest Laws.
Reforestation in Massachusetts.
Improvement Cuttings and Thinnings.
The Chestnut Bark Disease.
The Chestnut in Massachusetts.
Study of Trees in our Primary Schools.
Study of Evergreens in the Schools.
How to collect Pine Seed.
Forest Fires in Massachusetts.

Gypsy Moth Publications.

The Gypsy Moth.
The Wilt Disease of the Gypsy Moth.
The Brown-tail Moth.
The Brown-tail Fungus.
Annual Report of the State Forester.

Faint, illegible text or markings along the left edge of the page, possibly bleed-through from the reverse side.



Land coming up to gray birch and undesirable hardwood, and which should be reforested.

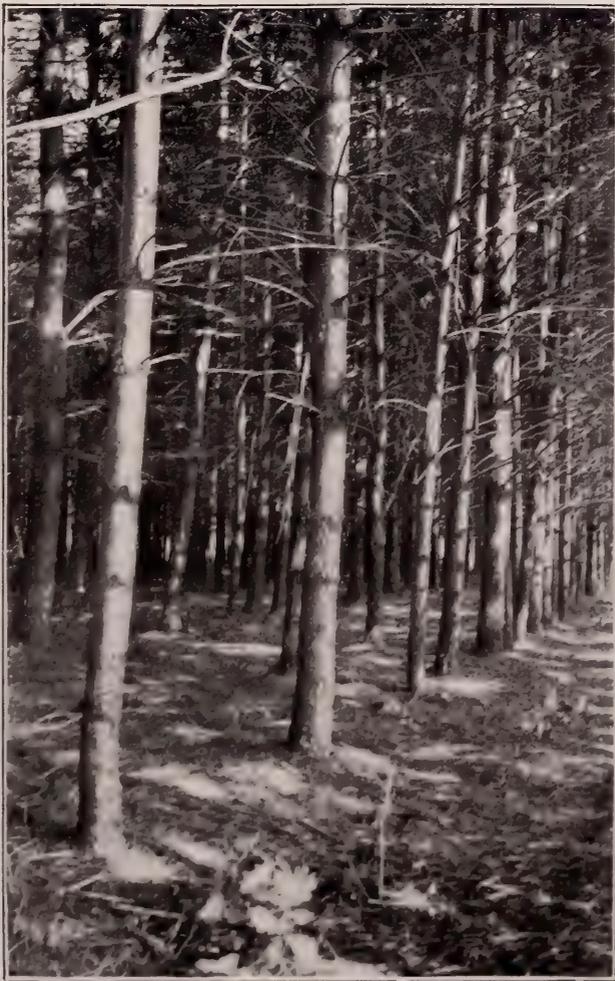


Brush after logging piled and burned. The cord wood was cut from the slash.

1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900



Land planted with white pine transplants, six years after setting. Notice remarkable growth of leading shoot.



View of thirty-eight-year-old plantation of white pine.

100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200



Before thinning in mixed forest.



After thinning in stand above. Only the thrifty trees are left.

100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200



Pine trees left standing for reseedling purposes, on the Burbank Hospital property, at Fitchburg.

Fragment of text from the adjacent page, visible on the left edge of the page.

INSTRUCTIONS FOR MAKING
**IMPROVEMENT
THINNINGS**

AND THE MANAGEMENT OF
MOTH-INFESTED WOODLANDS

BY
H. O. COOK, M.F., Assistant Forester

AND
P. D. KNEELAND, M.F.
Forester, Moth Division

UNDER THE DIRECTION OF
F. W. RANE, State Forester



WRIGHT & POTTER PRINTING CO., STATE PRINTERS
32 DERNE STREET :: :: :: BOSTON, MASS.

1914

100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200

INTRODUCTION.

This bulletin, the third edition printed on the same subject by this office, is published by the State Forester so that the people of this State may have at their disposal the information so often desired on the thinning of woodlands.

While it is believed that after a careful study of this bulletin a man should be able to go into his wood lot and select approximately the right trees to be taken out, yet it must be admitted that the problems of thinning work are many and intricate, so that it is impossible to give more than the general theory in a publication of this kind.

We believe that in those sections of the State infested by the gypsy and brown-tail moths a proper management of the woodland offers an important solution of the problem in controlling these pests, and we commend to your attention the portion of this bulletin on this subject written by Mr. Kneeland.

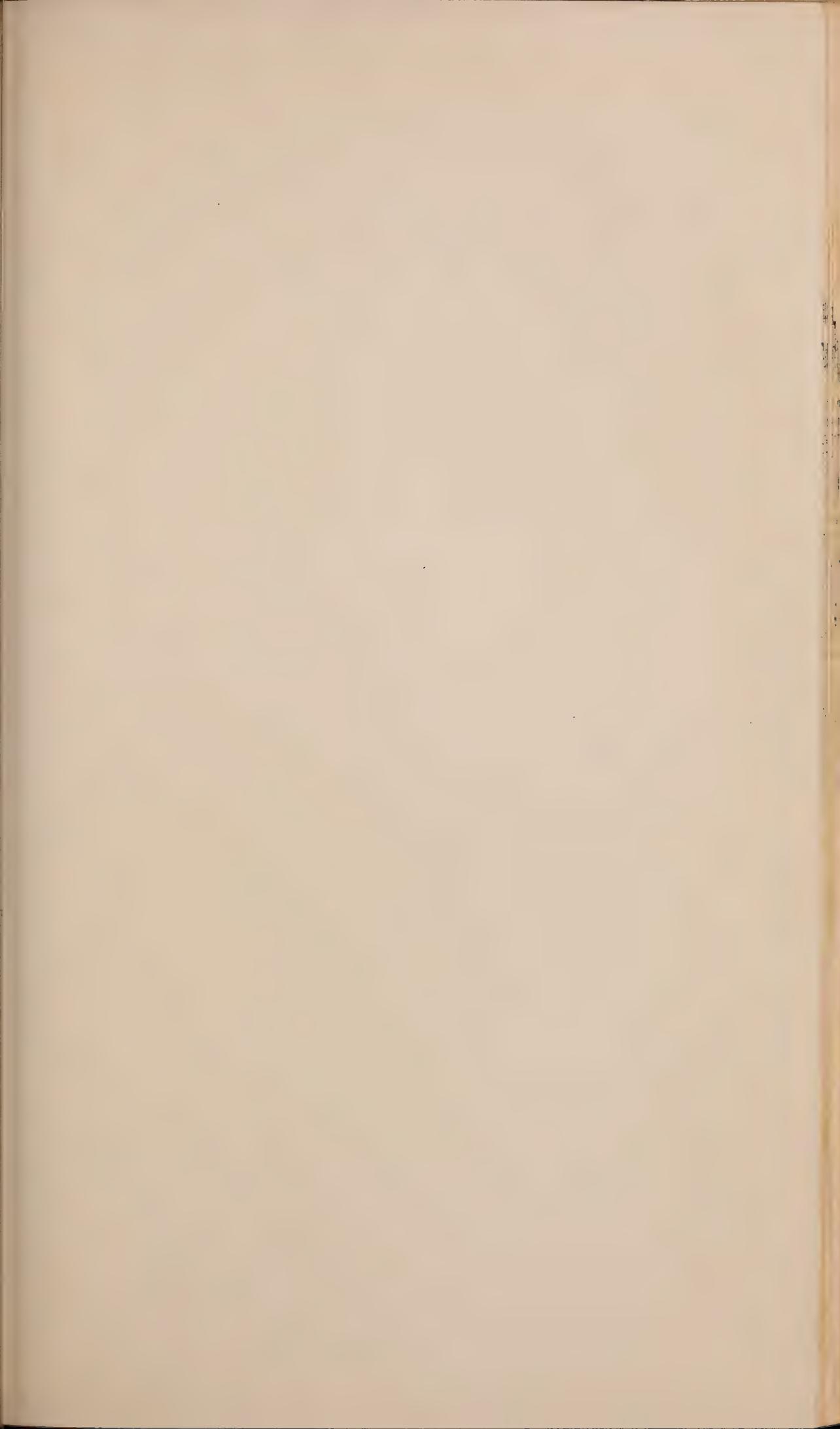
Your attention is called also to the policy of this office in sending out trained foresters. At the request of any owners of woodland in the State, the forester will go over the land with the owner and will explain to him his ideas on its treatment, the method of procedure and the probable expense. Application blanks for such work can be had by applying to the State Forester's office, 6 Beacon Street, Boston.

ACKNOWLEDGMENTS.

The work of writing and compiling the data in this bulletin was done by my assistant, Mr. H. O. Cook, M.F. The section dealing with the management of woodlands infested with the gypsy moth was written by Mr. Paul D. Kneeland, M.F., who has charge of the work being done along this line. Mr. Roy G. Pierce, M.F., wrote the paragraph on chestnut thinnings. He worked in the State department in co-operation with the United States Bureau of Plant Industry. Mr. John Murdoch Jr., A.M., an assistant in our department, compiled much of the cost data.

F. W. RANE,
State Forester.

Fragment of text from the reverse side of the page, appearing as bleed-through or a partial view of the adjacent page. The text is mostly illegible due to the angle and fading.





A neglected and badly moth-infested woodland. The growth here is not large enough to pay for thinning, and contains quantities of dead trees, which condition is one of the worst to deal with. About all that can be done is to cut it clean and replant. There are many acres of this type and they are most discouraging propositions to the owners. Starvation methods may be practiced under favorable circumstances.



A woodland thinning to assist in controlling the gypsy moth. The favorite food trees are removed. The white pine is encouraged. A process of building over the forest. A thinned forest like this can be sprayed and looked after at far less expense. The forest products removed pay for the treatment. One hundred acres on the Weld estate, Dedham.

HOW TO MAKE IMPROVEMENT THINNINGS IN MASSACHUSETTS WOODLANDS.

IMPORTANCE OF THINNING.

By improvement thinnings and cuttings we mean the systematic removal of a portion of the trees in a growing forest, in order to benefit the portion that remains. It is the forester's method of cultivation, and it is the only practical way he has of increasing the yield and improving the quality of his crop. The methods of the arboriculturist are, except in limited cases, too costly to have a place in practical forestry.

Those people who doubt the value of forestry practices often argue against thinnings, on the ground that nature's methods must be the best. It is no more true that nature's methods are best in the forest than in the orchard or garden. The practice of thinning in European forests for nearly one hundred years has established beyond a doubt that this work increases the amount and quality of the lumber. In 1830 the average annual growth in German forests was 20 cubic feet per acre, while in 1904 it was 65 cubic feet, — an increase of 300 per cent., which can be attributed almost entirely to the methodical thinning of their forests.

Nearly 45 per cent. of the land area of Massachusetts is covered with some form of woodland growth, which can be apportioned roughly among three main types; the pine forest, which has come up on abandoned fields and pastures; the mixed growth, composed of hard woods, usually of seedling origin; together with pine and hemlock and sprout forest. Above an altitude of 1,200 feet spruce replaces pine. A seedling tree is one which has come from a seed or nut; and by a sprout we mean one which had its origin in a sucker sent out by a stump from which a tree has been cut.

The principles of thinning apply to all kinds of forest, but it is perhaps the sprout land which chiefly needs improvement. It is the largest single type, and yet, with the exception of sprout chestnut, which is used for ties and poles, this sprout land is at present producing nothing but cord wood. Proper care might bring these cord wood stands to producing saw timber.

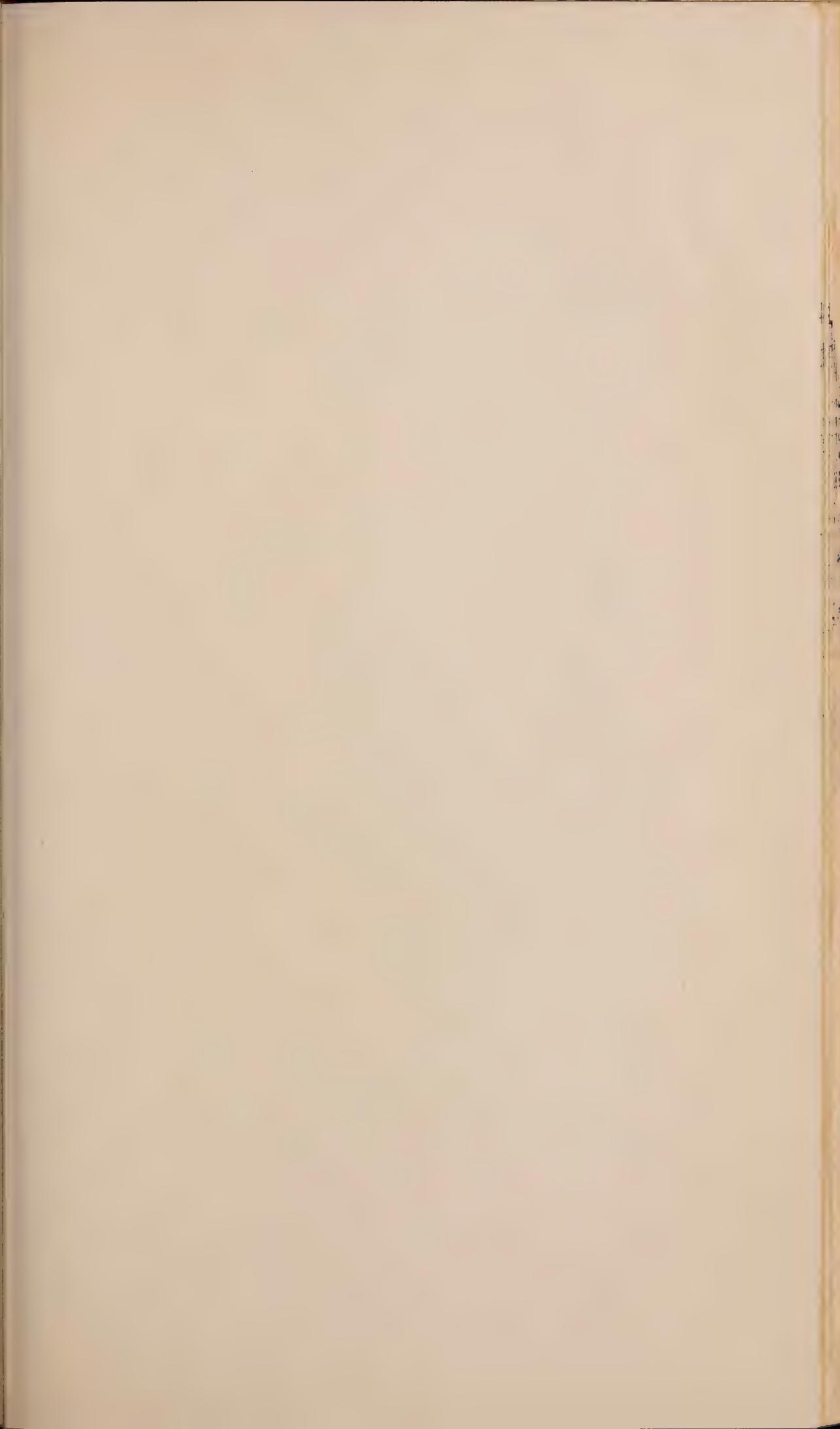
THEORY OF THINNING.

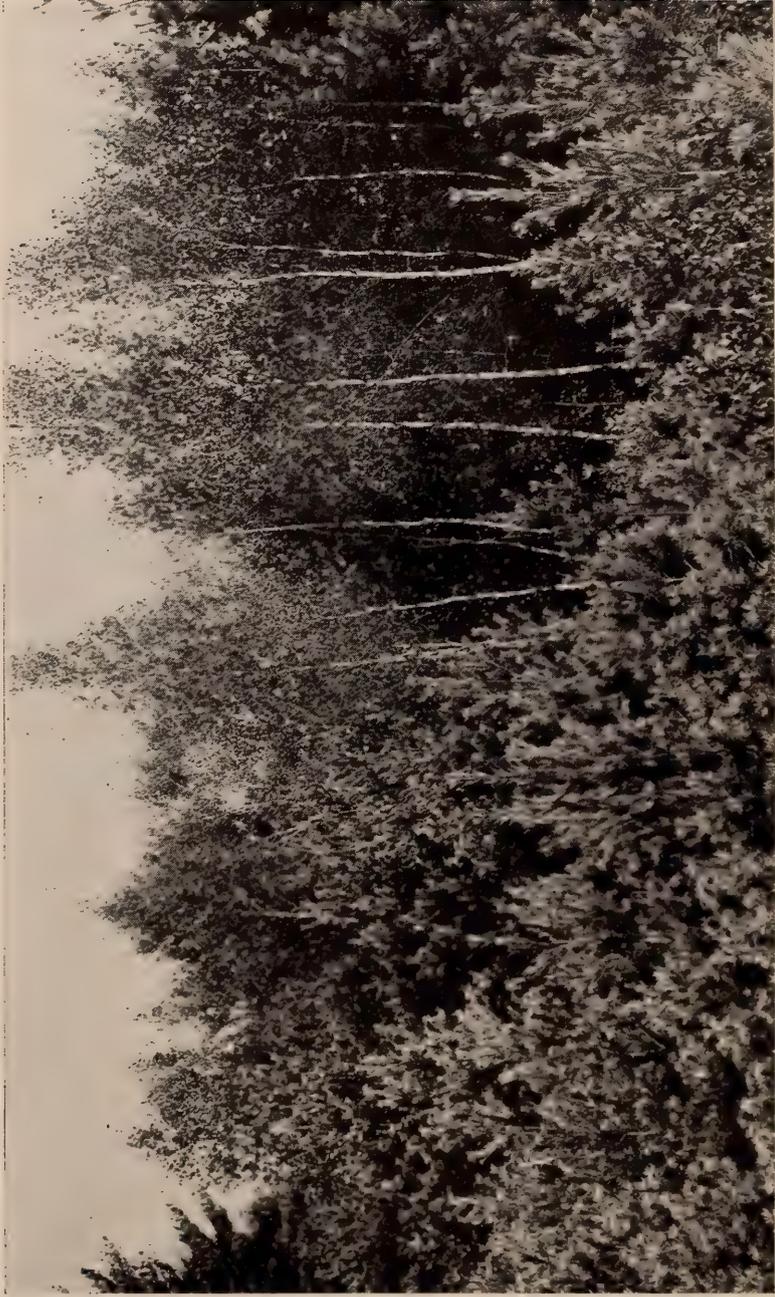
In order that one may understand the principles which underlie the process of thinning, he must know something of the physiological growth of single trees, and of that collection of trees known as a forest.

Plants are made up of tissues composed of numberless small cells. These cells are largely composed of carbon derived from the carbon dioxide of the air and water. The carbon dioxide enters into the leaves through minute pores (stomata), and by the action of the sunlight on the green chlorophyll grains, the process of assimilation, which in plants answers to digestion in animals, takes place. The carbon is combined with the water and a small amount of mineral matter taken from the soil by the roots to form the growing material of the plant, while the oxygen is returned to the air. Therefore any crowding or shading which deprives the tree of these necessary agents, foliage and sunlight, checks its volume growth in proportion.

To take a simple example, let us suppose a plantation set out with seedlings 6 by 6 feet apart; then there will be 1,210 trees on an acre, and each tree will have 36 square feet in which to spread its branches. When the side branches meet we have what is called a closed stand, and a struggle commences. It is characteristic of trees to take all the room they can get; and not having any more at the sides, they seek the sunlight by growing upwards at a rapid rate. Trees even of the same species differ in their rate of growth, so that some get ahead of the others; and when they do, they spread out their side branches and so overtop their weaker neighbors. Unless these overtopped trees happen to be in the class called by foresters tolerant, *i.e.*, shade-bearing, they will soon sicken and die. By the time our plantation is fifty years old, only 400 trees will remain of the original 1,210.

In the early life of the forest, say the first fifteen to twenty years, a sharp conflict of this kind is very useful, for it produces all tall, straight trees; in the second place, on account of the dense crowding the side branches are killed off when young, and the tree is free from knots; and in the third place, the ground is kept shaded and the moisture retained in the soil. After twenty years growth, however, these objects have been accomplished, and then the forester steps in and opens up the stand so as to allow the crowns to spread. Larger crowns mean, of course, a more rapid increase in volume growth. Furthermore, the slower-growing trees





Sample plot, gray birch and pine, before improvement cutting (exterior view).

are removed while they are still alive and fit for use, and are not allowed to gradually sicken and die, an invitation to insects and diseases of the forest.

In the case of sprout land the crowding is generally more severe and the need of thinning more urgent than the plantation supposed above, for from every stump 10 to 50 suckers may spring, so that several thousands of young trees may start up on an acre.

PRACTICE OF THINNING.

WHEN TO THIN.

The conditions which exist in most parts of this country do not permit us to thin as early or as often as is desirable. The market for small-sized wood is uncertain, and we must be satisfied with a less intensive cultivation of our forests than our European friends enjoy.

A safe rule to follow is to thin a stand as soon as the material to be removed has reached such a size that its sale will pay the cost of the removal, and as soon again as the material to be removed has accumulated in sufficient quantities to pay the expense involved. The profit is to be found in the improved growth of the stand. When the wood lot owner is a farmer, or has farm help during the winter months, when they might be idle much of the time, the net cost of the work may be held quite low.

A less commercial and a more scientific rule would state that a thinning should be made as soon as the trees have attained their maximum rate of height growth, and the lower limbs are well pruned off. In practice this would mean a moderate thinning when the stand is from twenty to thirty years old, and a heavier one ten to fifteen years later. If the rate of growth of our native trees and their response to treatment were better known, we could afford to thin at some net expense, being able to calculate what the profit would be; but unfortunately American foresters have not had time to gather the necessary data on this subject, and until we do, the rule of letting the material pay the expense is the best to follow.

WHAT TO THIN.

The extent to which a closed stand may be opened up depends on several circumstances. Species which are called "tolerant," because they stand the shade well, should be kept quite thick, for they cling tenaciously to their side limbs. Hemlock and beech are extreme examples of "tolerant" trees. A forest on a dry,

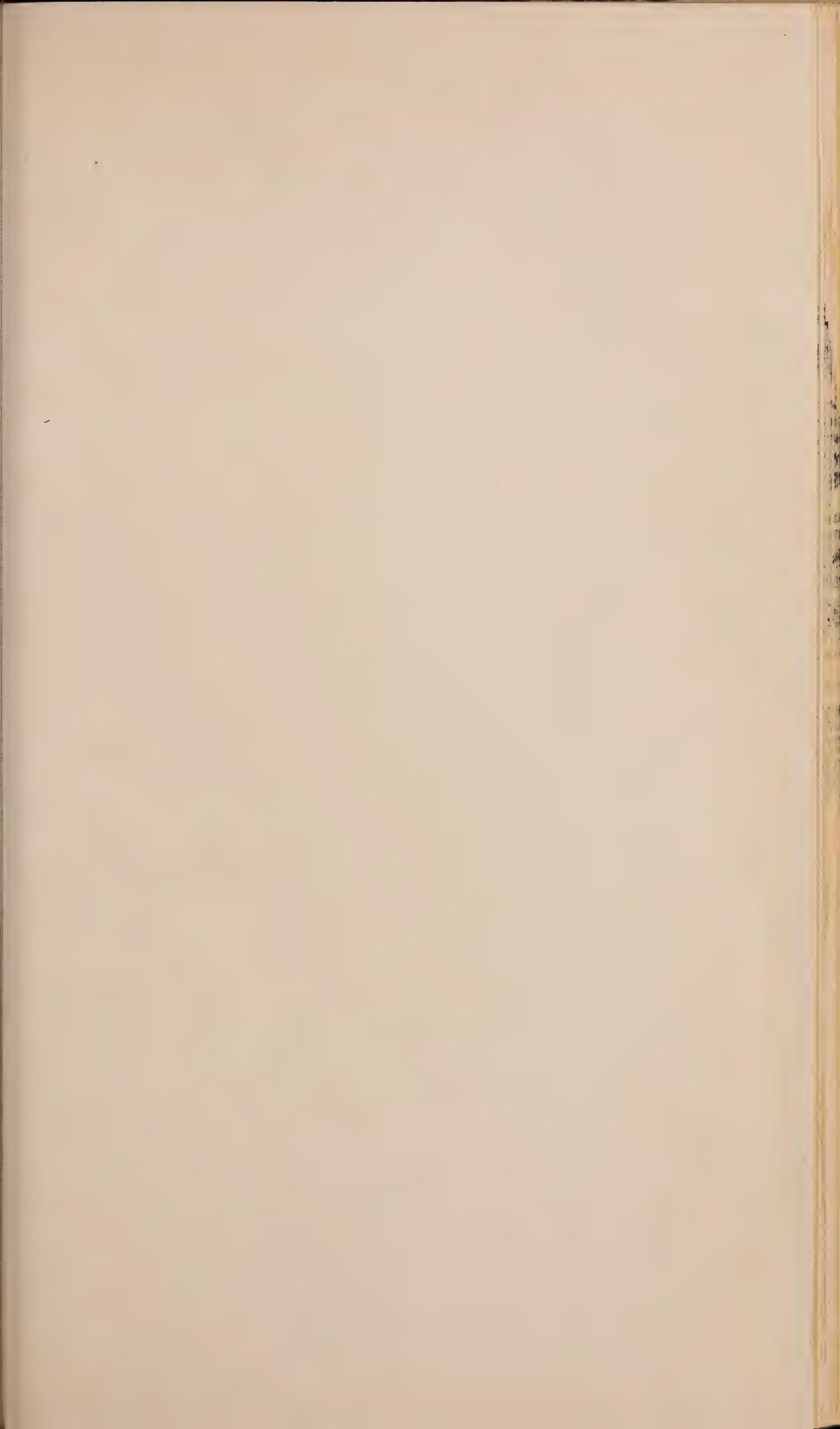
sandy soil or on a hilltop should not be thinned as heavily as one on low, moist ground, because under such circumstances the soil must be kept shaded to retain the scanty supply of moisture. The age of the trees and the kind of timber desired have an influence on the decision of what to take. For instance, if the owner of a chestnut sprout stand wishes it to yield poles rather than ties or lumber he should thin it lightly.

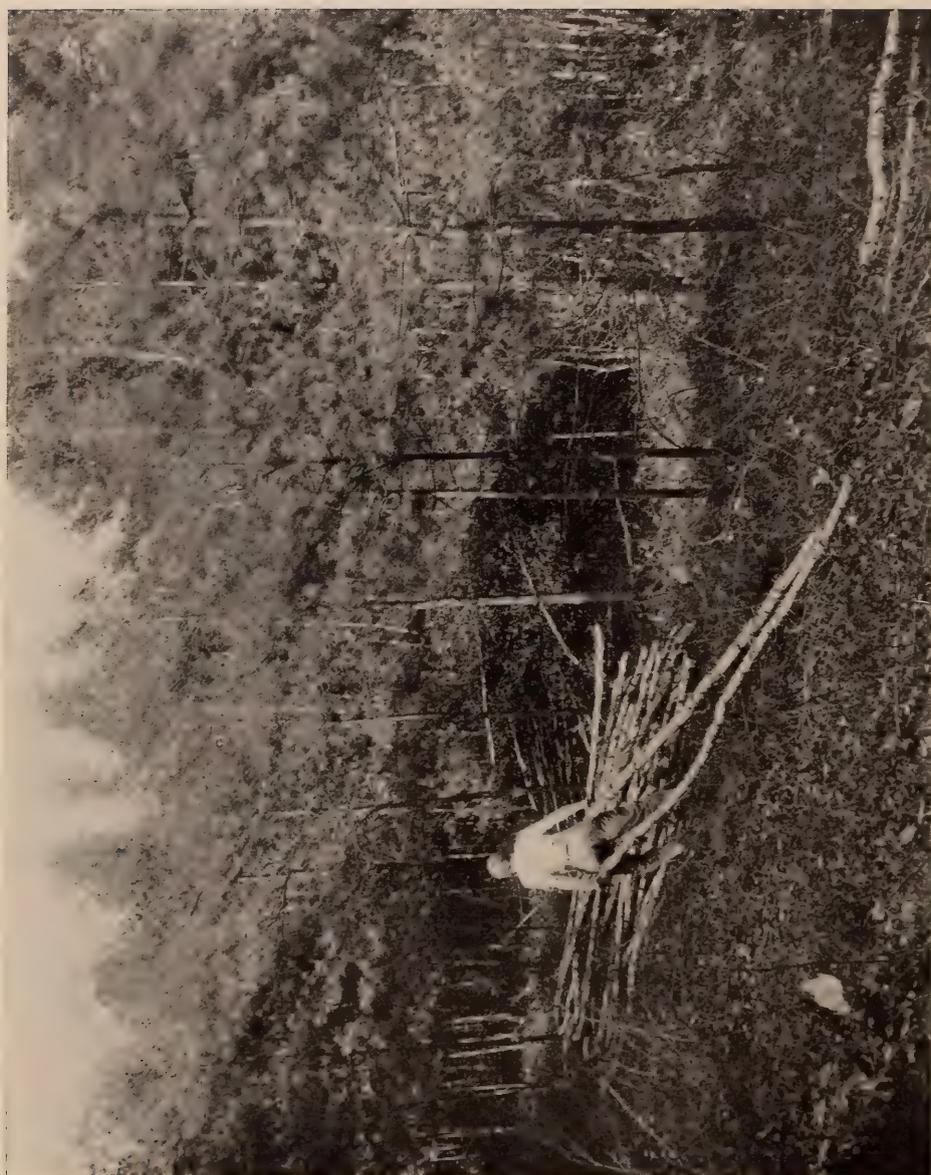
The simplest problem of thinning is in a wood lot consisting of but one species. We first divide the trees into four classes: dominant, intermediate, suppressed and dead. Dominant trees have large, full crowns, well up in the light. Intermediate trees receive light from above, but are somewhat crowded at the sides, some more than others. Suppressed trees are those which have been wholly overtopped by their more vigorous neighbors, and are slowly dying. A moderate thinning would consist in the removal of the intermediate trees, which are closely pressed by their neighbors, and all the suppressed trees if they will make a marketable product. Dead trees do no injury to the growing crop, and are only removed to improve the appearance of the woods, or as a precaution against fires, insects and disease.

When the wood lot contains a number of species the problem becomes more complicated, for we have the relative value of species as another factor which we must consider. The relative worth of different species depends in part on their value in the market; in part on the owner's plans as to the final disposition of the wood lot; and in part on their adaptability to the soil in which they are growing.

The hardwoods of the eastern part of the United States are divided into two types: the northern and the southern. Generally speaking, the order of preference in the northern hardwoods would be rock maple, paper birch, yellow birch and beech. Among the southern hardwoods the names might be arranged as follows: chestnut, white ash, red oak, hickory, white oak and soft maple. Gray birch, poplar and wild cherry are usually classed as forest weeds, and are taken out. Where these latter three species are growing by themselves, and are not interfering with other and better trees, they can of course be left; but they are not worth any improvement work.

Where white pine is mixed with deciduous trees it is usually favored at their expense; and spruce in the higher altitudes should be similarly benefited. Pitch pine, however, is in a class below





Sample plot, during cutting (interior view).

the better hardwoods; and there is no call to favor hemlock, because it is very "tolerant."

After the trees have been classified and the order of preference by species determined upon, a third consideration must enter into our calculations. Defects, such as decayed trunks, fire scars or extreme crooks, are a sufficient reason for the removal of a tree, so that it is not impossible to have a wood lot in which the dominant trees, being in poor condition or of a valueless species, would be removed. Such a cutting could, however, scarcely be called a thinning, but would rather partake of the nature of an improvement cutting.

One can readily understand that the man who is put in charge of a thinning operation must have sound judgment, and be well instructed in the principles of the work. Where possible, it is well to have a trained forester mark the trees to be cut. It is better to be conservative rather than radical in the selecting of the trees to be removed, as a thinning which is too light can be easily remedied, but one which is too heavy will take years to mend. A mere cleaning up of the underbrush and a few suppressed trees is not a thinning, however.

In practice it is customary to blaze the trees to be cut, and often they are blazed twice, once about 4 feet from the ground, and once low down on the stump. Unless one has great confidence in his man, it is not wise to let the chopper cut at so much a cord, because as a rule in a thinning operation we take only the smaller and poorer trees, so that the chopper is under a great temptation to increase his pile by taking some of those intended to be left, and it is difficult to detect the fraud.

THINNING CHESTNUT WOODLANDS.

Very frequently it becomes advisable for the wood lot owner to carry on thinning operations in stands of pure chestnut or in mixed hardwood growth, with chestnut forming a large part of the mixture.

This is especially the case in stands of from twenty-five to forty years of age, where the competition has been so great that the trees have grown very slowly in diameter. Height growth has been secured at the expense of growth in diameter.

Chestnut, because of its great sprouting capacity, generally grows up in a dense stand, the number of sprouts from one stump

ranging from 3 to 7, sometimes even more. This makes for height growth.

A moderate thinning would remove only the dead, suppressed and poorer intermediate trees. This would not stimulate diameter growth very much, and it is this diameter growth which is desired in the chestnut stands of the ages mentioned above.

The advent of the chestnut blight, and the possibility of the destruction of the chestnut by this fungous disease within a comparative short length of time, makes it imperative that the stands of chestnut should be brought up to merchantable size as fast as possible.

A heavy thinning, which would include the trees removed in the moderate thinning, with the addition of some codominant trees, would result in increased rate of growth.

A damage cutting should be made at the same time as the thinning and all diseased trees removed. This should be repeated every year or two if possible.

EXPLANATION OF DIAGRAMS.

We have endeavored to represent in Diagram No. 1 a section of a typical sprout chestnut stand, 50 feet in length and 20 feet in width. The trees of the dominant class are marked A; the intermediate class, B; and the suppressed trees, D. The small maples, although apparently suppressed, are not so; but, being very tolerant of shade, they have come up under the shadow of the chestnuts, and form a sort of second cover. The trees removed in thinning include five suppressed, two intermediate and one dominant. The dominant chestnut was removed primarily because of its poor, crooked bole, and secondarily because there was a good red oak and a chestnut ready to grow into the vacated space. The maples were not cut because they were so small that they could not interfere with the larger trees, and they help to keep the ground shaded until the broken cover is re-established. Diagram No. 2 represents the stand as it appeared after the thinning.

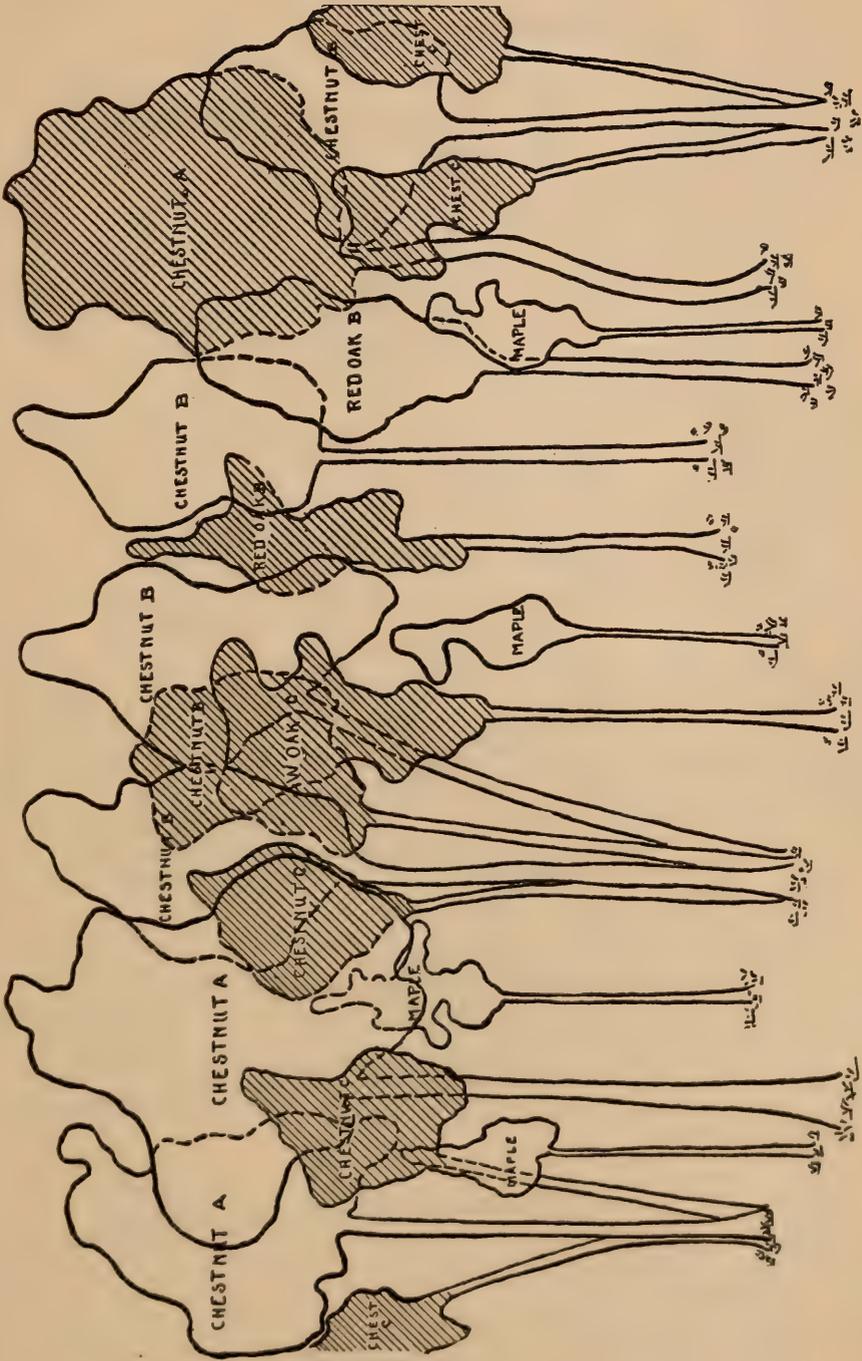


DIAGRAM NO. 1.

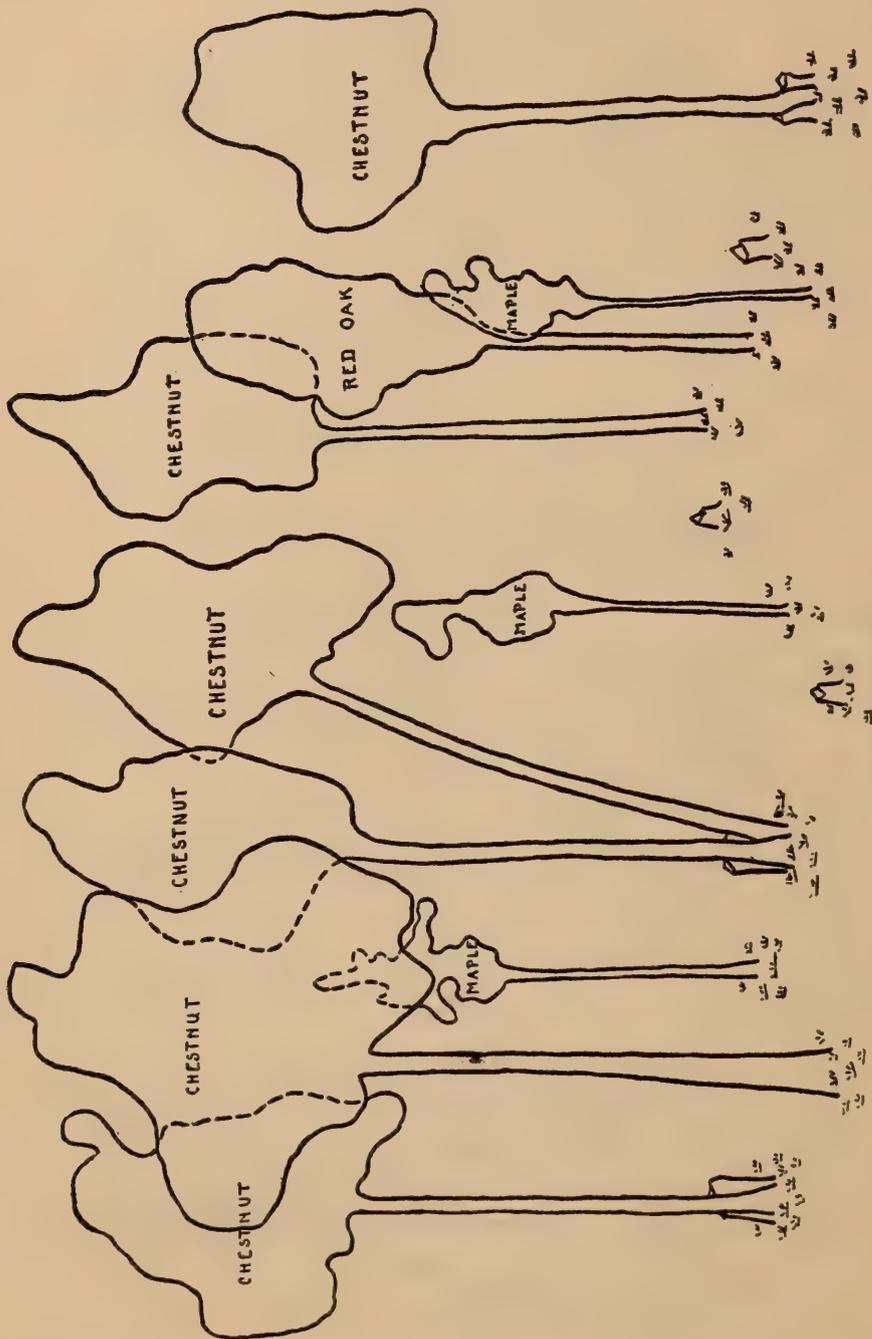


DIAGRAM NO. 2.

RESULTS OF THINNING.

We said in the section on the "Theory of Thinning" that the more light and air a tree receives the more rapidly it grows in diameter; so that a thinning, by opening up the stand and allowing the crowns of the remaining trees to enlarge, stimulates the volume growth of the stand. There are fewer trees in the stand, but larger and better ones. This may not be considered important until we realize how much more valuable a tree of large diameter is than a small one. For example, the average white pine, 10 inches in diameter breast high, and 60 feet in height, contains 95 feet of round-edge lumber; whereas a pine of the same height, 15 inches in diameter, contains 195 board feet of lumber; that is, with a 50 per cent. gain in diameter there is an increase of 100 per cent. in the product. This is not the whole story, because with the increase in the size of the tree the boards are wider and have less knots, yielding a higher price; so that the gain in money value is even greater than the increase in volume. An average chestnut tree 10 inches in diameter will produce 2 ties and .03 cords of firewood. Supposing a railroad tie to be worth 50 cents, the tree may be said to be worth about \$1. A 15-inch chestnut will yield 5 ties and .06 cords of wood, worth about \$2.50, or an increase in money value of 150 per cent. In the case of sprout oaks and other sprout hardwoods, thinnings made at the right time may result in converting what would otherwise be nothing but a cord wood lot into one of saw-timber size.

If, as a result of thinning, the trees become larger in a given space of time, conversely they will attain any suitable size in a shorter space of time than without a thinning. The experiments of European foresters have shown that the rotation of the timber crop can be shortened by judicious thinnings from 10 to 20 per cent.

In the course of this work many unsightly and diseased trees are removed, and this fact tends to make the woodland more attractive to the eye. Where forest land is used for park purposes as well as for timber production, a moderate thinning is highly recommended. It should, however, be conducted under careful supervision, as the tendency is often towards a "sand-papering" treatment of the woods, to which many people who appreciate primitiveness in nature object; and they wrongfully believe this effect to be a necessary result of forestry work.

IS THINNING PRACTICABLE?

There are many owners of forest property who, although they do not doubt that a thinning will benefit their woods, say that the cost of the work is prohibitive. Of course there are many places in this State so remote from a market that the product will not even pay the charge for labor; but the trouble with most of these people is that they want to get back their wages, a fair stumpage, and often an additional profit from work meant for improvement only. It is an especially valuable line of work for the landowner who is obliged to keep men and horses through the winter months, with little for them to do. Such a man makes something out of the thinning work, no matter if the actual returns are small.

In the sprout hardwood stands, from 3 to 8 cords will be found to be the usual product of thinnings, depending on the age and density of the stand. In the seedling hardwoods and mixed stands the density is so variable as to make any definite statement in regard to the probable product of thinnings impossible. As a rule, about one-third of the trees, and from one-fifth to one-quarter of the total volume in the wood lot, are taken out in this work.

Two years ago this office published a small pamphlet containing data on the white pine. Part of this booklet was given over to yield tables. A pine yield table is one which shows the volume of well-stocked pine stands at different ages, which in this case ranged from twenty-five to fifty-five years. These tables were made by measuring the trees on many sample plots of all ages, and averaging the results. When these sample plots were calipered, those trees which would be removed if the stand was thinned were noted separately. From this data a table of the yield from pine thinnings was made and published at that time. We print it again in this pamphlet, on account of its connection with the subject.

YIELD FROM THINNINGS.

Trees under 5 inches, from report of the New Hampshire Forestry Commission, 1906.

AGE (YEARS).	TREES OVER 5 INCHES IN DIAMETER.				TREES UNDER 5 INCHES IN DIAMETER.		
	Board Feet.	Value at \$16 per M.	Stumpage at \$6.	Cubic Feet.	Cords.	Value at \$3 per Cord.	Cubic Feet.
25,	1,400	\$22 40	\$8 40	280	7½	\$22 50	750
30,	3,700	59 20	22 20	720	6	18 00	600
35,	4,950	79 20	29 70	850	4½	13 50	450
40,	6,000	96 00	36 00	1,030	3	9 00	300
45,	6,800	108 80	40 80	1,140	1½	4 50	150
50,	7,400	118 40	44 40	1,240	-	-	-
55,	7,900	126 40	49 40	1,310	-	-	-

MISCELLANEOUS CUTTINGS.

There are many kinds of cuttings which one can make to improve woodland which cannot strictly be called thinnings because their primary object is not to open up the crown cover in order to stimulate the growth of the trees. It is not always possible to draw a hard-and-fast line between such improvement cuttings and thinnings because one may partake of the nature of the other, and the two may be carried out at the same time. Such cuttings can best be suggested by a few examples.

We will suppose that an insect pest which attacks some particular species of tree — for instance, maples — is more or less prevalent in a region. As a matter of protection, the owner of mixed woodland might go through it and take out all the maples so as not to attract the insects to his land. The removal of hardwoods from a pine stand as a precaution in fighting gypsy moths is another protection cutting, which we have described elsewhere in this bulletin.

One often finds among the woods large, spreading old trees, more or less decayed and of little value for timber. It is good forest policy to cut such trees down, and to allow the large amount of ground space which they occupy to come up to a new growth of more value.

In old, abandoned pastures we often see young pines coming up underneath a stand of gray birches. While the pine seedlings are very young, let us say not more than four or five years old, the birches protect them from the hot sun and wind, and act in the rôle of nurse trees. But as the pines increase in size they need the sunlight; and, further, the branches of the birches, as they sway in the wind, cut the tender leading shoot of the pine, killing it and causing the tree to be stunted and crooked. In such cases the birches should be removed; but if they are too small to make cord wood, or if the young pines are scattered, it is only necessary to remove the trees immediately surrounding the pines. If done in this manner, one man can easily cover an acre or two a day.

If diseased or decaying trees are removed from a stand with no special reference to the principles of thinning, the operation is an improvement cutting and not a thinning.

THINNINGS IN GYPSY AND BROWN-TAIL MOTH WORK.

Thinnings are a logical development in the fight against the gypsy and brown-tail moths. However, thinnings as made in this work differ considerably from the improvement thinnings previously mentioned, and perhaps some other term should be used to describe them. They vary all the way from what practically amounts to clear cutting to merely the chopping out of underbrush and dead trees.

METHODS OF MOTH CONTROL.

Some account of the habits of the gypsy and brown-tail moths and the methods used in their control may help in explaining the purposes and possibilities of moth thinnings. The present means of fighting the moths may be classified under three heads, — direct entomological methods, indirect entomological methods and forestry methods. The direct entomological methods seek the destruction of the moths in one of their various forms by human agency, as in spraying or creosoting. The indirect methods seek the propagation of parasites or disease which will destroy the moths. The forestry methods seek the eradication of tree growth which is favorable to the moths, and, conversely, the encouragement of growth unfavorable to their development.

It has been found, from our own and from European observations and experiments, that although it will eat practically all kinds of vegetation, the gypsy moth thrives only on a limited number of species of trees. These trees, which are the oaks (especially the white oak), willow, cherry and fruit trees, and probably the gray birch, may be called "non-resistant" trees. The brown-tail moth is virtually the same, except that it will not eat coniferous growth (pines, etc.) at all. Unless a large proportion of their food consists of the leaves of these "non-resistant" trees, under ordinary conditions both gypsies and brown-tails will soon either pass on to a more favorable feeding ground or die. Therefore forestry methods rather than attempting to destroy the moths themselves would destroy their food. If we grow forests of resistant species, as conifers, maple, ash, chestnut, etc., the moths will cease to be destructive.



Before thinning, at Manchester-by-the-Sea. Imagine the difficulty in treating this woodland for gypsy moths as it is.



After thinning, at Manchester-by-the-Sea. Not only are the conditions better for combating moths, but the improved forestry conditions are evident.

Vertical text on the left margin, likely bleed-through from the reverse side of the page. The text is illegible due to its orientation and low contrast.

The forestry methods of control consist of what we here term moth thinnings. The moths themselves carry on these thinnings in a crude way if left to ravage undisturbed. They will kill off most of the "non-resistant" trees, together with many "resistant" ones, it is true; but after many years, if undisturbed, the forest will grow up almost wholly "resistant." Moth thinnings will prevent the large waste which this natural method would entail, and also will hasten the regeneration of the forest and save many "resistant" trees which would not be killed unless mixed with the "non-resistant" species. Thus these thinnings, like other kinds of thinnings, are for the purpose of saving and encouraging the growth of the forest as a whole by sacrificing some of its unnecessary or dangerous individuals.

KINDS OF THINNINGS.

Moth thinnings may be classified under four different heads which are more or less distinct.

1. *Cuttings made solely for the Purpose of aiding in Direct Methods of Moth Control.* — These are not real thinnings. They usually consist of merely taking out the underbrush and a few dead or undesirable trees. They have been carried on for years in practically all park and ornamental woodland where large sums of money were to be spent in spraying the trees or painting the egg-clusters. They are based on the principle that cuttings of this character will greatly lessen the cost and increase the effectiveness of the other work.

2. *Cuttings which are made for the Purpose of leaving the Woodland wholly "Resistant."* — Not over 5 to 10 per cent. of "non-resistant" trees are left after a thinning of this sort; the brush may or may not be cut, according to its character, and the expectation is that no further measures of moth control will be necessary. These are moth thinnings of the extreme type. In stands which have a good percentage of resistant growth they are real thinnings and leave a fair forest cover. In stands almost wholly non-resistant they practically amount to clear cutting, and should always be followed by reforestation.

3. *Thinnings which are a Compromise between the Two Preceding Kinds.* — In the cutting all possible non-resistant trees are removed, but not enough to seriously break the forest cover, and it is expected that further measures of moth control, as spraying, will be utilized when necessary. One purpose of this type of cutting

is to enable the owner to maintain a forest cover at the least possible expense, with no unnecessary trees to take care of, and with the largest possible proportion of resistant trees. The real purpose of these thinnings should be to make it the first step in a gradual elimination of all non-resistant trees, and the remaking of the forest into one of a resistant character without too great a disturbance of the forest conditions during the process. Natural reproduction or underplanting of desirable species should follow the cutting.

4. *Damage Cuttings.* — To a greater or lesser extent in all woodland where the moths have been present for a number of years there are moth-damaged trees which have to be removed when a thinning is made. However, under this heading it is intended to include only cuttings made for the main purpose of marketing the dead and damaged trees before they become too much decayed to be merchantable. Of course this sort of a cutting has no effect in controlling the moths. The wood cut from dead trees is not usually as valuable as that cut from live ones, and also it costs more to cut it; so damage cuttings are only profitable in better quality growth near a good market. Resistant thinnings should be made where possible before serious infestation, to prevent the necessity of damage cuttings.

ADVANTAGES AND DISADVANTAGES OF THINNINGS AS A METHOD OF MOTH CONTROL.

The great advantage of thinning is in its small cost. The direct methods of moth control are a net expense and are liable to have to be repeated year after year. In most woodland the annual cost of spraying or of a thorough creosoting is greater than the value of the wood which that woodland will produce in a year. Therefore it is cheaper for the owner, unless the area has a considerable value other than for the wood it grows, to cut down all his trees and sell them than to try direct methods of control. This fact is well known, and is the reason why in recent years little attempt has been made to stop the moths in woodland unless it was mainly used for park or pleasure purposes, or in case of a light infestation, to keep it from spreading.

Moth thinnings will pay for themselves, or come very near doing so, as will be seen from figures of actual operations which are given later. The product in cord wood, ties, piles, logs, etc., will, in almost every growth which is at least fair, pay for the work done, and in many cases will yield a profit.

Moth thinnings in many types of woodland offer a permanent solution of the moth problem; they do not call for a heavy annual expenditure.

In all woodland, thinnings will aid and lessen the cost of other methods of control, even if not in themselves completely solving the problem. A thinned area can be sprayed for a fraction of the cost of the unthinned, and the work is much more effective. The same is true of creosoting, clipping nests, etc.

In wild woodlands the chief value of which is for the wood they produce, thinning with the aid of parasites and diseases seems to offer the only reasonable solution of the problem.

However, it must be remembered that moth thinnings are not a cure-all for every phase of the moth problem. It is desirable, and always will be, to grow "non-resistant" species for shade trees and in park, ornamental and protection woodland. Here the other methods must be continued.

There is a great class of woodland which is so poor that no possible cutting will pay for itself. This includes young sprouts, gray birch growth and areas which contain a large amount of brush, as scrub oak, hawthorn, briars, etc. Moth thinnings are so expensive in these lands that they can hardly be advisable. However, some people have cleaned them off and replanted to pine. Where there is considerable young pine mixed with the other growth on these areas a thinning will pay in future returns from the pine, even though the wood removed will not cover the first cost.

RESULTS OF MOTH THINNINGS.

The result of moth thinnings and of natural selection in the case of badly infested woodland will be the elimination of a large part of the oak from our forest growth. This will prove to be a blessing rather than a disaster if pine is substituted. Most of the sprout oak in the moth-infested territory is occupying natural pine land. The soil is poor and unsuited to the best development of oak, but is excellent for pine. It is thought that originally the land was almost wholly covered with pine. The pine has the advantages of being more valuable, more rapid growing, and generally more satisfactory and productive than the oak in this region. Oak can be left on the richer soils and moister slopes, where it may be able to withstand the ravages of the moths. Generally the oak must be relegated to the position of unimportance which it occupies in European forestry, and the white oak, the poorest of all in this

region, will be almost exterminated. Of the other trees affected, the cherry and gray birch are weed trees, and so of no importance, and the willow is rather uncommon and quite capable of withstanding repeated moth attacks.

HOW TO THIN.

The types of forest growth in the cut-over lands of Massachusetts are so many and the conditions are so varied that no hard-and-fast rules in thinning can be laid down. Outside of forest conditions the wishes and purposes of the owner of a specific tract must be one of the main factors to determine the method of its treatment.

If a stand is almost purely non-resistant, as an oak growth, it is for the owner to decide whether he wants the stand clear cut at once and replanted with pine, or whether he wants to gradually thin out the area, and underplant, keeping all the while some sort of forest cover. The first method is the cheaper, but the woods are gone for a number of years until the pine grows up. If the second method is chosen, practically all white oaks should be cut out anyway, as they are by far the most undesirable trees from the moth standpoint. Of the other species of oaks only those in poor condition, of poor form, or the suppressed, overtopped and intermediate should be removed. One or two of each bunch of sprouts can usually be cut down. An intermediate tree of a resistant species, as pine or maple, should be left, and the oak which is crowding it out removed.

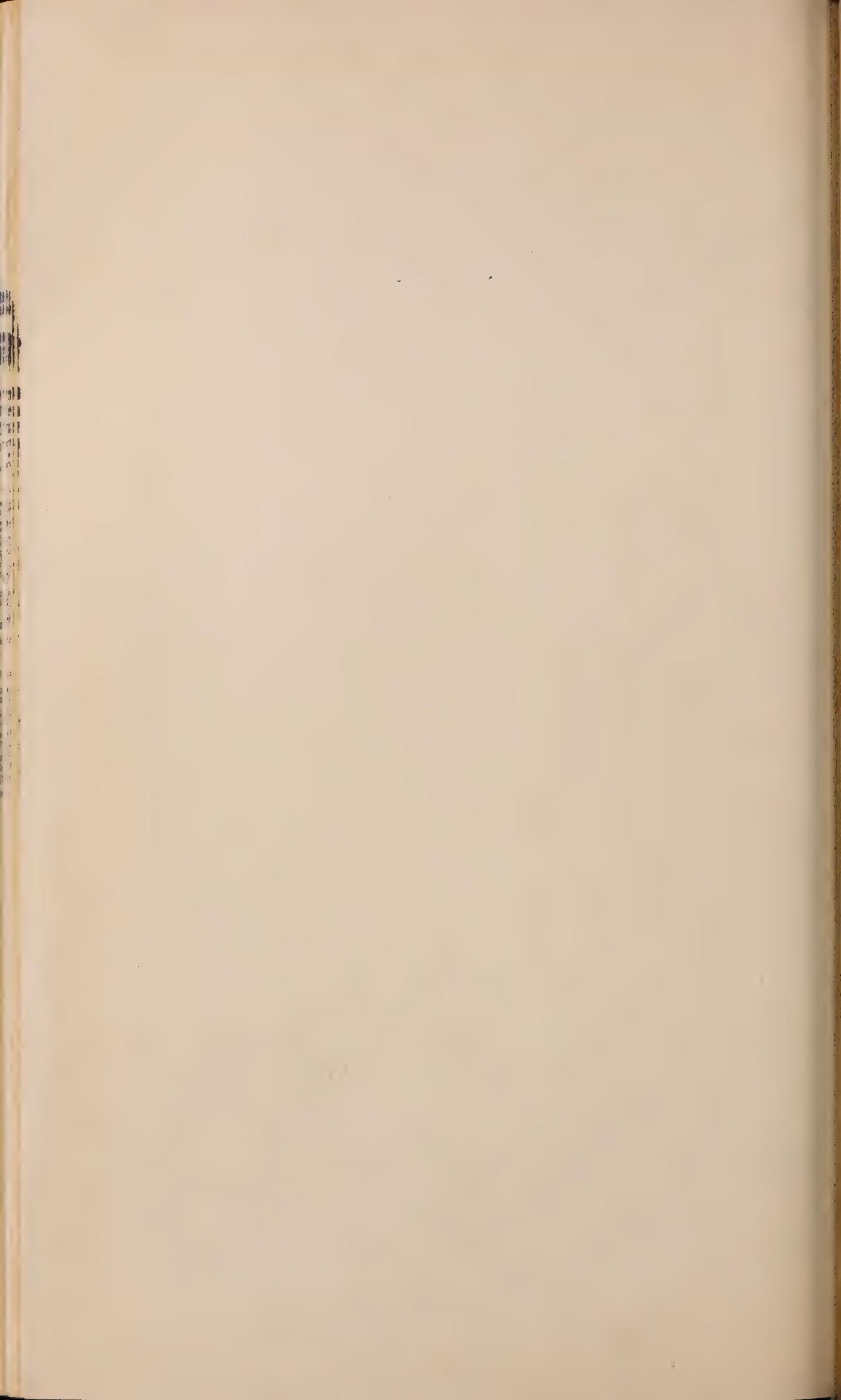
Where a hardwood stand of good density is to be underplanted, probably 60 per cent. numerically, and from 30 to 50 per cent. in volume, should be removed. Where there is considerable natural pine reproduction under the hardwood, or where it is possible to gain it, not all shade should be taken away, but a heavy thinning should be made. Experience has shown us that, where there is only the choice between leaving the young pine without protecting cover, or leaving white oak as that cover, it is better to remove the white oak if the moth infestation is serious.

There is one combination method of treatment in nearly pure oak stands where the owner does not wish to lose the wooded effect and yet does not want to go to the expense of taking care of the whole area.

By this method a thinned strip, which can be sprayed easily, is left along the edge, on the roads or bordering fields, and back of this strip the growth is cut clean and the land replanted.



A splendid stand of large white pine with a relatively small mixture of hardwoods on the fine Rodman estate in Dedham. The pine tops show the ravages of the gypsy moth. A number of the large pines are past redemption. This whole estate is being thinned out at the present time. The hardwoods are being taken out, together with the dead pines. Had the hardwood been removed early all of the pines could have been saved.



In stands 50 per cent. or more of moth-resistant character practically all non-resistant trees should be removed. No white oaks, and not more than 10 per cent. of other oaks, should be left unless the owner is prepared to use other methods of moth control.

In stands which contain not over 10 to 20 per cent. oak, and the rest pine, a thinning out of all oak is especially important. It has been uniformly observed that in such stands the damage to the pine is greatest. All oak undergrowth should be removed also.

In pure or nearly pure gray birch a thinning is unprofitable and unadvisable unless the birch is large enough and the market good enough to make a clear cutting pay for itself. In stands where there is a large amount of young pine mixed with the gray birch a cutting out of all birch would seem advisable, even if made at a small present financial loss.

BRUSH DISPOSAL.

The disposal of the brush and slashings is a large problem in connection with this work. The following are several general rules which have been formulated in the work this department has undertaken and supervised:—

Cutting of Brush and Undergrowth.

1. The cutting of brush is a net expense, and where financial considerations enter largely as little as possible should be done.

2. In park or ornamental woodland, or where spraying or creosoting are to follow the cutting, it is usually advisable to cut practically all the underbrush. Care should be taken, however, not to cut valuable young reproduction, as pine, maple, ash, etc., or valuable flowering shrubs, as flowering dogwood, *Viburnum lantanoides*, laurel, etc.

3. In ordinary woodland only "non-resistant" brush and reproduction should be cut, such as scrub oak, oak, birch, shadbush and witch-hazel.

Burning of Brush and Slashing.

1. In park or ornamental woodland; where planting is to follow the cutting; where other measures of moth control are to follow the cutting; where there is any æsthetic value to the woodland; and where the fire danger is considerable, all brush and slashing should be burned.

2. Along roads, rights of way and boundary lines the brush should be burned.

3. Hardwood brush is not as dangerous as softwood brush, and where left it should be scattered. Brush is sometimes an aid to natural reproduction, but whether it is burned or not is usually a financial consideration with the owner. Except in the above-named cases we do not advise its being burned when the expense would be a burden.

4. Brush should be burned in the winter or spring or on rainy days.

5. Except where it is very thick it is usually cheaper and better to pile the brush first and burn afterwards than to pile and burn at the same time.

The cost of brush disposal will be discussed later.

USES AND MARKETS FOR WOOD.

The products of these thinnings are depended on to meet completely or in a large measure the costs of the work. Therefore it is essential that the wood cut should be utilized in the best possible manner and sold to the best advantage. An enumeration of the various products obtainable and a discussion of their possibilities for profit follow:—

1. *Cord Wood.*—Cord wood is usually the chief product of the thinnings. It is universally cut into 4-foot lengths in the woods and is used for fuel. It might be graded into two or possibly three grades, and also its value varies somewhat with species. The best grade is cleft wood. It is usual to split any stick over 5 inches in diameter. Wood below that size is called round, or, if very small (2 to 3 inches), trash wood. A small percentage—usually not over 10 per cent.—of round or trash wood may be included with cleft wood and sold as such. If there is a larger percentage than that of round wood it is a poorer grade and as high a price cannot be obtained. Trash wood is very difficult of sale, and most dealers refuse to buy any, but a certain amount can be sold locally in many places at a low price. Oak wood almost all over the State is considered the best kind, although in some places maple is more in demand. Birch is usually of less value, although near cities for fireplace use good cleft birch will often obtain a better price than oak. Birch, not split, will rot if left out in the open over summer. Oak needs a year of seasoning before sale in most places.

In all cities of the State there is a good although limited demand for cord wood. The rural districts consume more proportionally than the cities. There are a number of dealers constantly in the

market for wood in large quantities. In many places the owner can obtain a better price by himself selling the wood to the consumer, but to do so he must have the facilities to haul and deliver it. A large amount of wood, often of the poorer grades, is consumed by the brick yards and charcoal kilns.

The value of the wood depends not only on its quality but on its location. The going price for average wood stacked where cut in many sections of the State is \$3 a cord. However, that price is far from universal, and as high as \$5 a cord or as low as \$2 are known to have been obtained for the same kind of wood. The price of cutting by the cord, where the chance is good, is usually \$1.50, but may be less in some sections.

2. *Logs.* — Oak lumber is in good demand in many sections for furniture, agricultural implements, plumber's woodwork, ship timbers, lobster pots, car stock, vehicles, flooring, dimension timber and planing-mill products. Large logs which will saw fair to good quality lumber can be sold almost anywhere. The value of the lumber delivered on the cars will vary from \$16 to \$35 per thousand feet, depending on the quality and use. The usual log lengths are from 10 to 16 feet. It costs more to cut, handle and saw oak than it does pine, so usually saw logs of less than 8 to 10 inches in diameter at the top are not used. Before cutting logs it is usually advisable to see where and at what price they can be sold.

3. *Ties.* — There is a good demand for cross-ties made of all species of oak. The steam and electric railroad companies buy them. The New Haven road at present buys them in three sizes when hewed on two sides, and without bark; No. 1, 8 feet long, 7 to 12 inch face, 7 inches thick; No. 2, 8 feet long, 6 to 12 inch face, 6 inches thick; No. 3, 8 feet long, 5 to 12 inch face, 6 inches thick. The prices delivered are: No. 1, 70 cents; No. 2, 55 cents; No. 3, 35 cents. The specifications of other companies vary somewhat from these, the street railways usually buying the smaller sizes.

It takes an average log of 8½ inches diameter at the small end to make a No. 3 tie. If the log is over 15 inches in diameter it has to be hewed or sawed on four sides, for which the specifications are somewhat different.

As a general rule it does not pay to saw the oak into ties, on account of the expense of handling. It can be done profitably under favorable circumstances, but usually ties should be hewed. Hewers can be obtained who will cut and hew for from 12 to 20 cents a tie.

4. *Piling.* — Considerable oak piling is used. In the larger sizes — 35 feet long and upward — there is a good demand. The smaller lengths from 16 feet up can be sold, but there is a good deal of risk in cutting them unless a market is obtained beforehand. White oak is the best for piling. No general price for piling can be given, because the distance of haul and expense of handling is such a large factor. From 2 to 6 cents a running foot cut in the woods has been received for the short piles, and as much as \$5 apiece standing for the big ones.

5. *Posts.* — In a few places it has been possible to sell white oak posts 6 inches in diameter. With the chestnut going this seems to offer a good field for future development.

6. Other recorded uses are for rustic furniture, fences, baskets and chemical wood.

COST OF THINNING.

The cost of carrying on a thinning operation depends on the amount of wood to be cut; the amount of brush and its disposal; the size and density of the growth; the severity of the thinning; the efficiency of the labor; and to a lesser degree on the area of the tract, the supervision, the tools and equipment, and other minor factors, as weather conditions, topography, etc.

Figuring of cost should be done on the basis of so much per cord, tie, thousand board feet, etc., rather than so much per acre. Labor should be hired on the cord basis where possible. In light thinnings, in brush cutting, near cities, or for brush disposal it is often impossible to have the work done except by day labor. In places where the labor supply is inadequate it is better to put up a camp and bring in a crew than to use irregular and inefficient local labor.

It must be borne in mind that the per cord cost of thinning is higher than the cost of the ordinary wood chopping. In a thinning only part of the trees are taken, making the felling more difficult, and the work more scattered. Also the poorer and smaller trees are cut and the best ones left, which also adds to the proportionate expense. Usually the owner of the thinned area wants a fairly neat job done, with low stumps and some sort of brush disposal. This adds to the cost. Therefore the owner should undertake these thinnings not to make money, but to keep from losing money through the destruction caused by the moths or the cost of combating them. In fair growth he probably will make a little money, but his largest returns will be in the conservation of what he has.



Extreme resistant thinning. All oaks removed and forest cover seriously broken. Natural pine reproduction is expected, which will be followed by the removal of remaining large trees. Notice the hewed oak ties.



Moderate thinning. All possible nonresistant trees removed, but forest cover not seriously broken. Wood enough cut to pay for the cost of the work. First stage of remaking the stand into a resistant growth if thinning is followed by natural reproduction or by planting of pine.

Fragment of text from the reverse side of the page, appearing as bleed-through or a partial view of the adjacent page. The text is illegible due to its orientation and partial visibility.

However, before undertaking a thinning, with some exceptions, the owner should be assured that he will very nearly "break even," in order to be justified in doing the work.

The following general rules are laid out to enable owners to tell whether a thinning will pay for itself or not:—

1. The thinning should be fairly heavy. At least 7 or 8 cords per acre must usually be cut out to assure financial success.
2. There must not be a large amount of brush to cut.
3. Not very much ornamental work, as limbing up trees that are left, etc., can be done.
4. Large open-grown trees cost more to cut than the wood is worth, also small sprouts.
5. The labor must be efficient. If day labor is employed it should be previously experienced in this kind of work, or its cost will be excessive.
6. Experienced and constant supervision is necessary in an operation of any size to get the best results.

COST DATA.

In the following tables the costs of thinning operations are analyzed. "Supervision" takes account of the foreman's time when not engaged in productive work, and includes part of the time spent in marking trees for the cutters. "Cutting" includes chopping or sawing down the trees; trimming the branches; cutting tie logs, saw logs and piles, and in one case hewing the ties; and cutting, splitting and piling the cord wood. "Brush disposal" includes cutting the underbrush where necessary, and piling and burning all the rubbish. Where the cost of this item per cord is high, much underbrush was cut; on the job where it was 35 cents per cord, practically all the underbrush was left. "Miscellaneous" includes the foreman's time on rainy days; sharpening saws; time and expenses in moving; and so forth. "Tools" cover the actual cost of depreciation and replacement of the tools used.

In computing the costs per cord it was assumed that tie logs cost 5 cents each to cut; oak saw logs \$2 per M and pine \$1; piling 1 cent per running foot; and cedar posts 5 cents each. From these figures was calculated the equivalent in cords of all other products on each job, and the sum of cords and equivalents taken as the total number of cords cut.

Table I. gives the total cost, with the average, high and low cost per cord and per acre of the different items, for six representative

lots, totalling 191.9 acres, from which were cut 2,121 cords or equivalent. The six taken together give a fair average of the conditions that are likely to be met in thinnings. They do not represent any cuttings in small growth. The average number of cords per acre was 11; high, $25\frac{1}{4}$; low, 7. On all of these lots the brush was burned and the place cleaned up. Most of the work was done by day labor, but some by the cord. The average result shows a small profit if wood can be sold at \$3 per cord on the lot, which can be done almost anywhere in the moth-infested region.

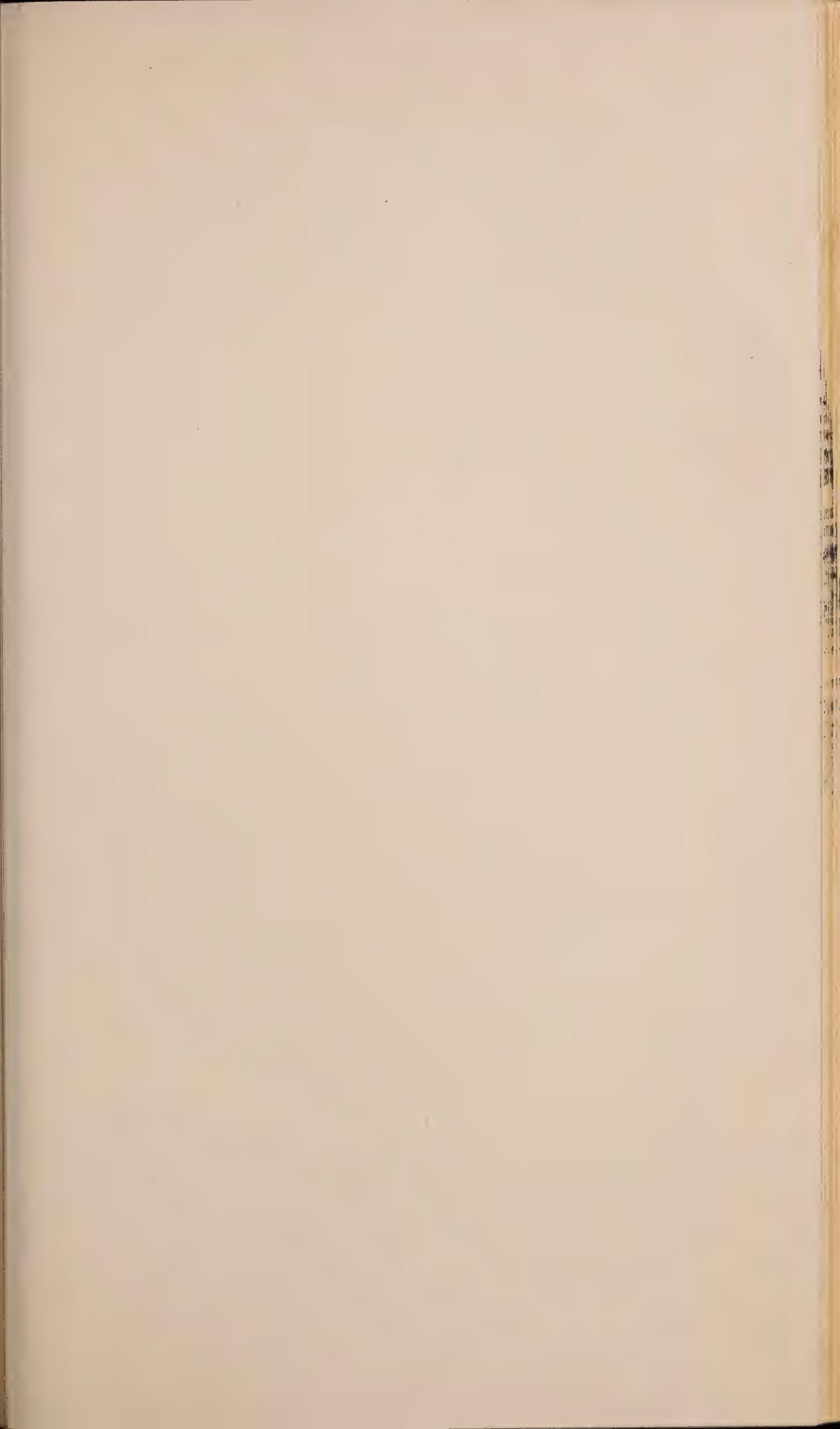
TABLE I.

Average of six lots, 191.9 acres, 2,121 cords.

	Total Cost.	COST PER CORD.			COST PER ACRE.		
		Average.	High.	Low.	Average.	High.	Low.
Supervision, . . .	\$314 30	\$0 148	\$0 45	\$0 10	\$1 638	\$4 72	\$0 83
Cutting,	4,429 57	2 088	2 42	2 00	23 083	50 81	14 00
Brush disposal, . .	1,131 68	534	1 09	35	5 897	11 35	3 67
Miscellaneous, ¹ . .	220 47	143	35	10	2 033	3 68	1 18
Tools,	80 91	038	08	03	422	74	27
	\$6,176 93	\$2 913	\$4 30	\$2 68	\$32 193	\$68 16	\$18 77

¹ Five lots.

Table II. gives the data for a thinning in a 30 to 40 year hardwood stand of medium size. The growth was 80 per cent. of oak with the rest pine and resistant hardwood, mostly maple. A purely resistant cutting was not made, but practically all white oak was taken and enough of the other species were left so that the forest cover was not seriously broken. This thinning is typical of the first stage in the remaking of an oak growth into one of a resistant character. It is expected that the place will be sprayed in the future when necessary, but at a greatly reduced cost over former sprayings. After this thinning, part of the area is ready for underplanting of pine, and part of it has sufficient pine reproduction so that planting will be unnecessary. All oak brush was cut and all brush and slashings burned. This thinning is especially interesting because when the wood is all sold it will have paid for itself and made a small profit,—about \$5 an acre for the owner. The work was done wholly by experienced day labor under a competent foreman.





A mixed growth of hard and soft wood that is sure to be destroyed by the gypsy moth unless the owner spends large sums of money in spraying and treating. The only practical forestry solution is to immediately cut out the hardwoods and give the whole area over to the white pine. In an infested stand like this the pines are killed outright in a year or two; therefore, owners having similar woodlands should give them early attention. The pine in clear stands by itself is perfectly resistant to the moths.



A severe thinning, to be followed by underplanting with white pine. The product, which was largely white oak, sold for enough to meet the expense. Gypsy moth suppression work on the Karlstein property at Dedham. This property was stripped the past season.

TABLE II.

Karlstein, Dedham, 83.5 acres, 579 cords.

	Total Cost.	Cost per Cord.	Cost per Acre.
Supervision,	\$68 30	\$0 12	\$0 83
Cutting,	1,155 78	2 00	14 00
Brush disposal,	302 60	52	3 67
Tools,	22 00	04	27
Total,	\$1,548 65	\$2 68	\$18 77

From this lot all the ties have been sold at a price to net 39½ cents in the log (64½ cents delivered, less 25 cents hewing and hauling); 100 cords of wood have been sold at \$3.35 on the lot; the rest of the wood, including some of poorer quality, should average at least \$3. If it fetches \$2.50, the work will have paid for itself; anything over this will be profit.

Table III. gives the cost data for a cutting operation which represents varied conditions. The main stand, in two lots totalling 22¼ acres, was a growth of large oak with a little pine. The oak had been so seriously damaged that not only was it necessary to clear it off, but also the wood had so deteriorated through the attacks of borers that but little of it could be utilized for anything but cord wood. On one lot of 11¾ acres a sort of thinning was attempted, as it was possible to leave enough maple, pine and other resistant growth to partly cover the ground. The other 10½ acres were cleaned off of all growth and replanted to pine. On this piece the growth was so heavy in places that as much as 80 cords to the acre were cut, with an average of 45 cords per acre. Besides this main stand there were 6 acres of a young mixed hardwood growth from which all oak and birch was cut, and a larch plantation of 5 acres, which had grown so thick with brush as to be nearly impassable, and which was put into condition. On account of these varied conditions the costs can hardly be called typical, and both the cutting and brush-disposal costs are high, one on account of the large quantity of heavy wood which had to be split, and the other because of the cleaning up in the sprouts and the plantation. Some of the wood was cut by the cord at \$1.50 per cord and the rest by day labor. These figures are interesting, however, to show that a difficult proposition like this can be made to show a profit.

TABLE III.

French lot, North Andover, 33.6 acres, 851 cords.

	Total Cost.	Cost per Cord.	Cost per Acre.
Supervision,	\$87 60	\$0 10	\$2 60
Cutting,	1,709 66	2 01	50 81
Brush disposal,	381 71	45	11 35
Miscellaneous,	89 50	10	2 66
Tools,	25 00	03	74
Total,	\$2,293 47	\$2 69	\$32 19

From this lot there have been sold 5 M of oak logs at \$25 and 14 M of pine at \$12, delivered at the mill. The ties have been delivered, and should net at least 50 cents on the lot (the cost of hewing is included in "cutting"). Much of the wood has been sold at prices up to \$4 per cord yarded by the road. The operation, when all the wood is sold, will have paid for itself, paid for planting up the clear-cut area and underplanting part of the thinning, and returned some profit, estimated to be about \$15 an acre.

In the Schrafft lot in Weston, on about 25 acres, a damage cutting was made where most of the growth (a medium hardwood stand) had been killed a year or two previously, and so the wood was largely dry. Here all the wood was cut by the cord at prices varying from \$1.50 to \$2, with an average of \$1.70 for 570 cords. Most of the brush was burned by the acre at \$5 to \$6 per acre, making an average cost of brush disposal of about 25 cents per cord. The supervision cost was 15 cents per cord, making a total cost with tools of about \$2.12 per cord. This lot is not one of the six averaged in Table I.

CONCLUSION.

As a forest insect the gypsy moth offers a distinct and important problem. Its extermination can no longer be hoped for. In the woodland its control by shade-tree methods is impracticable on account of expense, if not impossible. It has already been responsible for the destruction of a large part of the growth on hundreds of acres of woodland. Thinnings with the aid of parasites and diseases offer a practical method of combating the moths in forest areas, and an ultimate solution of the woodland problem. The result of these methods will be the replacement of a large part of our oak

growth with more valuable coniferous stands, for which the land is better suited.

This department is anxious to co-operate with all owners of woodland in the State where moth invasion is present or threatened. Free of all charge they will inspect such woodland with the owners, and offer expert advice as to its condition and treatment. They will also, without expense to the owner, supervise thinning operations, mark trees to be cut, furnish labor and aid in the sale of the wood. If desired this department will take entire management of an operation and see that it is satisfactorily carried on, the owner bearing the actual cost of the work and making any profit that may result.

For aid or advice write to the State Forester.

REPORT ON THE PRACTICAL THINNING OF A WHITE PINE WOOD LOT.

INTRODUCTION.

The following report is a record of the conditions and facts connected with the experimental thinning of a white pine woodlot in Warwick, Mass., belonging to Dr. P. W. Goldsbury:—

THE TRACT.

The tract extends over an area of 12 acres of gradual swales and ridges at the bottom of a valley. Excepting for a small area where a ledge outcrops or lies very near the surface, the soil is a deep, sandy loam of good moisture, and everywhere well drained.

The stand, which averages fifty years of age, is interrupted by two small ponds from being a block of solid growth. This growth is a result of a natural seeding of an old pasture. As a result of this natural seeding, there are represented two conditions which governed the policy of the thinnings,—the first that of a dense condition where the trees had practically started at the same time and grown up to form an even-aged stand, tall and comparatively clean of their side limbs. A sample plot taken in this condition will better illustrate it:—

PLOT $\frac{1}{4}$ ACRE, SOUTH OF BAPTISM POND, IN DIRECTION OF THE HOUSE.

	DIAMETER BREAST HIGH (INCHES).													
	6	7	8	9	10	11	12	13	14	15	16	17	18	22
Number of trees, .	3	5	3	9	8	4	7	7	7	3	4	2	2	2

A total of 66 trees, or 264 to the acre, with a height of 65 to 70 feet.

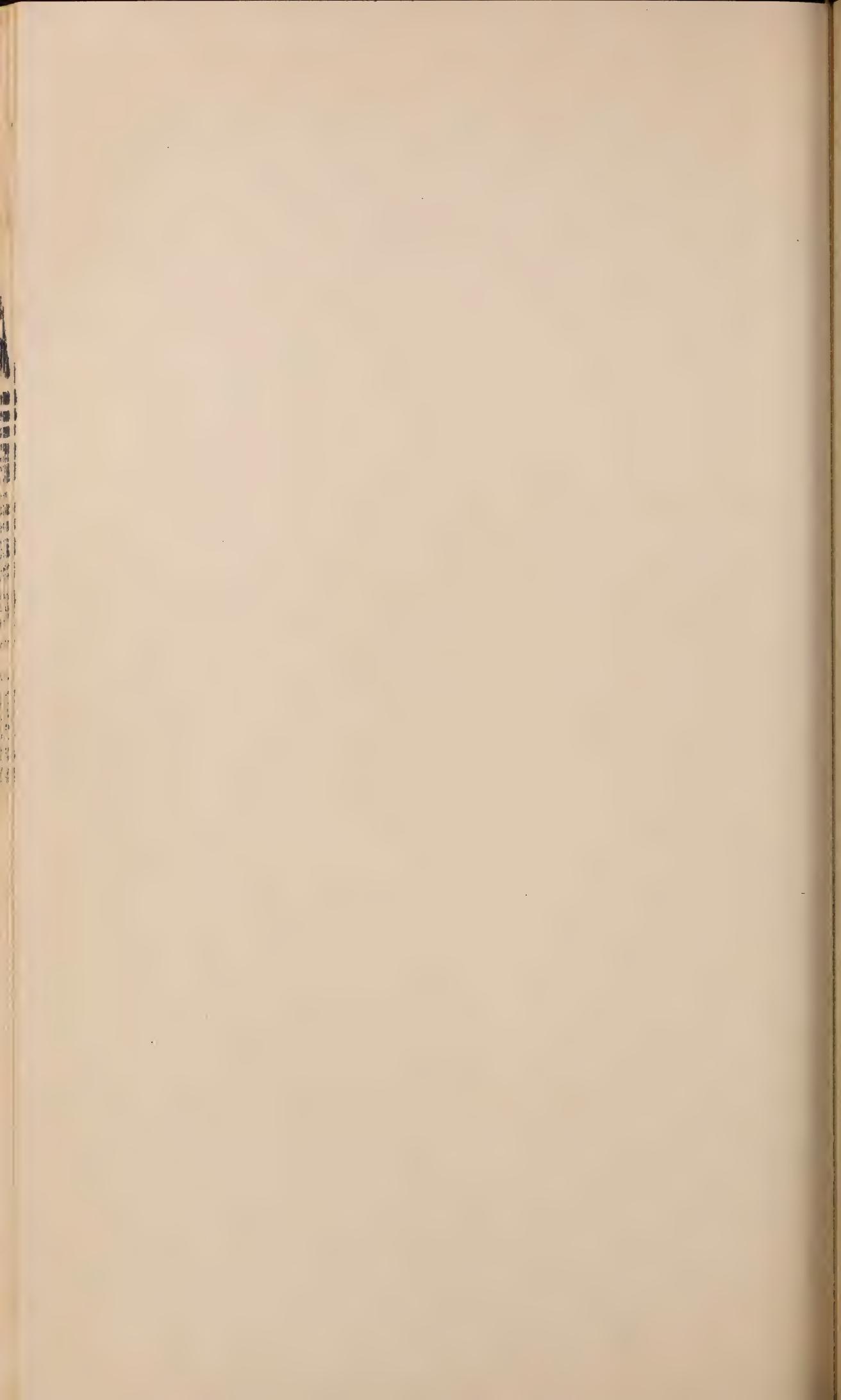
PLOT $\frac{1}{4}$ ACRE, ON THE FLAT BETWEEN THE TWO PONDS.

	DIAMETER BREAST HIGH (INCHES).											
	5	6	7	8	9	10	11	12	13	14	15	16
Number of trees,	2	3	12	12	13	14	12	5	9	4	3	1

A total of 91 trees, or 364 to the acre, with a height of 60 to 70 feet.



Goldsbury lot, after thinning (exterior view).



A better idea of the density of these trees can be realized if it is known that 302 trees spaced regularly over an acre would be 12 by 12 feet apart.

The other condition was that where a few trees had started and developed very wide spreading, and with large side limbs near to the ground. The density varied from a condition where the side limbs of the trees came together and completely shaded the ground to where the trees stood with open spots and areas about them. In these open areas there was almost always a good reproduction of white pine coming in among the blueberry, huckleberry and kalmia bushes. The following sample area was taken where the pines had a great deal of room about them, with a good reproduction of pine coming in:—

Plot $\frac{1}{4}$ Acre, Northeast of Large Pond, in Direction of a Field.

	DIAMETER BREAST HIGH (INCHES).				
	9	16	18	22	24
Number of trees,	1	1	1	1	1

A total of 5 trees, or 20 to the acre, with a height of 55 to 60 feet.

OWNER'S DESIRE.

It was Dr. Goldsbury's first desire not to mar the beauty of his farm, or to make his woodlot an eyesore to the village of his town by cutting and stripping the land of its fine growth. Furthermore, he desired to take such steps as would improve his lot and place it in a more flourishing condition, so that it would come down to the younger generation unimpaired. Lastly, his difficulty in getting any one to attempt the thinning of his lot influenced him to sacrifice his woodlot to an experiment which would make a basis of calculations for such work in the future.

GENERAL POLICY.

For the first condition above mentioned or the even-aged growth, the plan was to thin out the weak and poorer trees, leaving the good specimens with sufficient room for their tops to spread and develop without retardation for some ten years at least. The ground for this policy was based on the fact that the trees had made their main height growth, and their energies were now towards developing their diameters. The growth in diameter of a tree is in proportion to the size of its top, since the leaves are the laboratories of the food material which goes to make up the growth,—the more laboratories the faster the growth.

With this theory in mind, actual practice meant leaving the better and more promising individuals with sufficient room about them to

allow the tops to grow unchecked for at least ten years. If this is successfully accomplished, the trees will have developed a larger top, more laboratories or a larger feeding area.

The following data show the proportion of trees in number and volume removed and left on the same area:—

	DIAMETER BREAST HIGH (INCHES).																	
	5	6	7	8	8	10	11	12	13	14	15	16	17	18	19	20	21	22
Trees removed,	6	17	31	30	38	40	17	18	12	10	3	-	2	1	-	-	-	-
Trees left, . . .	1	1	3	10	16	32	19	36	36	32	29	24	24	10	4	4	4	1

A total of 225 removed and 286 now standing; in volume (according to Massachusetts volume tables), 27,050 B. M. feet were removed and 50,140 B. M. feet left; in fact, about two-fifths of the trees in number and one-third the volume were taken out in the thinnings.

For the second condition the policy was that of encouraging a natural regeneration where a good reproduction did not exist, and assisting a good reproduction where it did exist. Wherever the trees were close enough together, so as to form a complete shade, certain of the poorer specimens were taken out, allowing light to enter and encouraging the growth of any seedlings.

Wherever a good reproduction had started around or underneath any of these large pines, better known to lumbermen and foresters as the "pasture pines," they were removed, taking care to destroy as few of the smaller or young trees as possible.

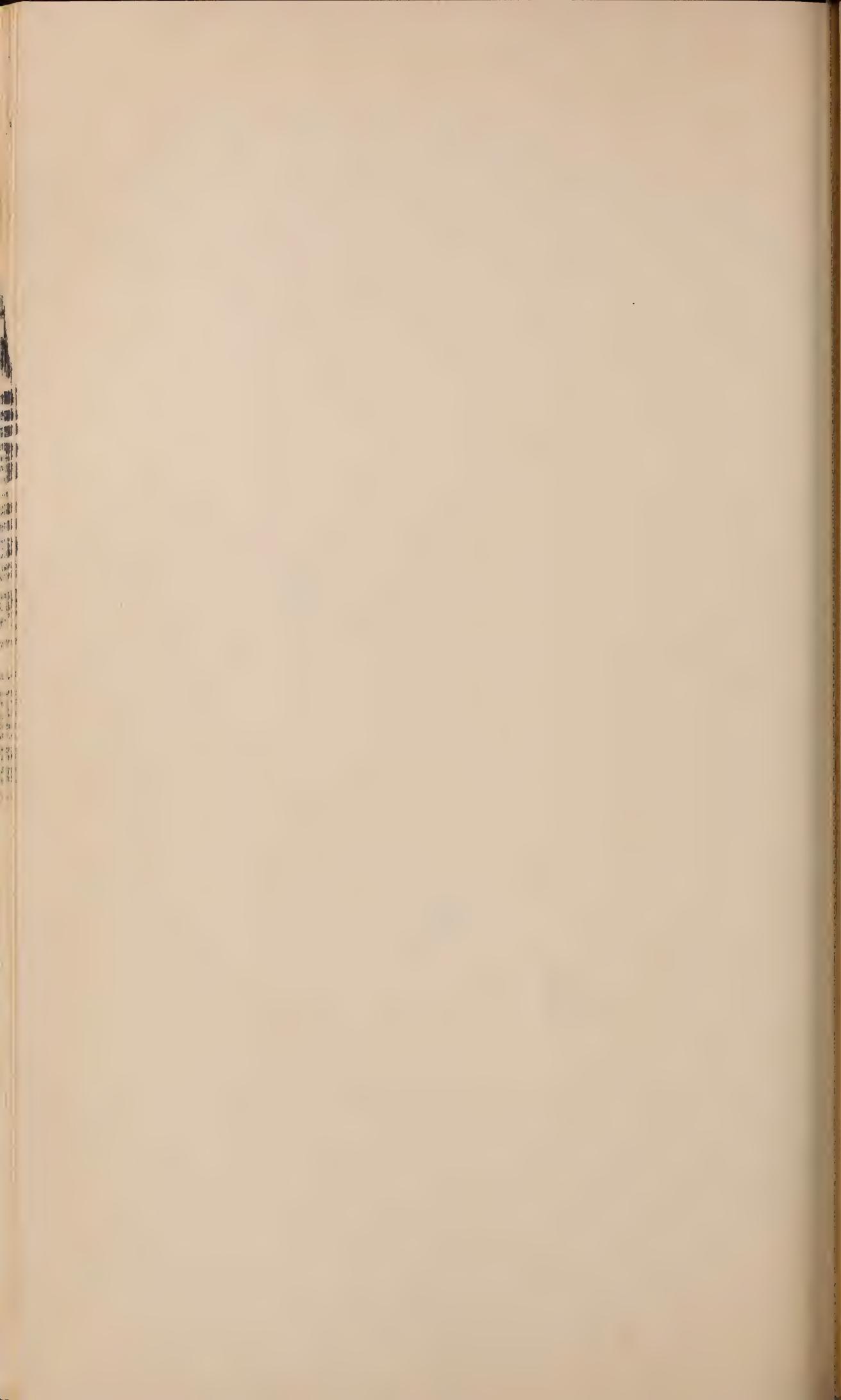
Through the entire work there were not any hard-and-set rules which could be followed entirely, for there was here and there a problem which could be decided only on the spot. Around the edges of the stand, thinning if carried on at all was not very heavy, since it was thought that too much sun and wind would be admitted from the sides. The presence of a ledge overtopping and lying very near the surface in one instance resulted in a very light thinning, since it was thought that the stand on it was liable to windfall. Other local problems were treated in like manner, but as a rule the main ideas were not deviated from.

THE OPERATING.

Every tree to be removed was blazed with a hatchet, in order that the choppers might not make any mistake. In marking, care was necessary in order to mark those with which there would not be any difficulty in felling. Oftentimes it was necessary to remove trees where some difficulty could not be avoided; yet there were also times when a little foresight would obviate any trouble and still allow good specimens



Goldsbury lot, during thinning (interior view).



to remain. A little time was sufficient to mark an area which would take some time for the choppers to cover.

The choppers were most efficient in gangs of three. One man, going ahead, would under-cut tree just above the ground and on the side towards which it was to fall. It is remarkable to observe the skill some men have in directing the tree through any small opening by the right position of this under-cut on the tree. The other two men following him would saw just above and on the opposite side of the under-cut until the tree fell. It was the first man's duty now to trim the tree of its side branches and mark the tree into logs with lengths most economical for it to be sawed by the other two men.

This system sounds bunglesome to relate, but, once started, one man should not be interrupted or in the way of the others, and under ordinary conditions the work would be about equally portioned.

Frequently a tree was found so wedged in between its neighbors, their limbs interwoven, or so balanced in regard to its necessary felling direction, that some means was required to give the tree a start before it would fall. This was overcome in large trees by wedging the stump and bole in the saw-kerf, or in small trees by directing the men to throw their weight against the tree. Other methods were: picking up small trees and carrying them away at the bole in the opposite direction they were to fall; felling other trees against the one which does not start; and finally, the most useful method, that of turning the tree with a cant-hook, twisting its top in the direction of least support until it gains momentum sufficient to crash to the ground.

The labor of chopping over the 12 acres required seven hundred and forty-eight hours. Over this area many of the so-called "pasture pines" were removed, which always tended to make the average cost high, since so much time was required to rid them of their side branches. The fact is that the more expensive trees were removed and the least expensive to handle were left.

Good woodsmen are obtained for \$2 per day, or for 74.8 days an expense of \$149.60 over the whole work. The logs were sawed "live-run" into 2 $\frac{1}{8}$ -inch plank with 1-inch sidings, and according to the mill scale totalled between 125,000 and 130,000 B. M. feet. Upon the basis of 130,000 feet, the average cost would be \$1.15 per thousand for the felling and sawing into logs.

The ordinary contracting price when cutting clean is around \$1 per thousand, — sometimes a little more and sometimes a little less; as a rule, however, a little more, getting as high as \$1.30 per thousand. The chopping of this lot clean would have cost \$1 to contract.

Since it was foreseen that the removing of the "pasture pines" was sure to add to the average cost of chopping the improvement thinnings, a record was kept of the labor and the material removed from an area where the work was entirely that of thinning. It required 112.5 hours

to go over 2.5 acres, where 27,000 feet were removed and 50,000 feet left. At the rate of \$2 per day, \$22.50 was the cost of the work of the improvement thinning, or an average of \$0.83 per thousand by day labor.

The logging of this tract was done upon a low, four-wheeled truck for two horses, since it was found to be more handy in driving about the trees than the ordinary wooden-shod sled or "skid." On snow a traverse sled was used. A few of the trees had to be snaked out with a horse, but ordinarily two men could handle the logs by actually picking them up and carrying them to the sled or truck. The ordinary contracting price for logging this lot would not be over \$1.50 per thousand, and the additional expense for picking the logs up from among the trees left standing was not over \$0.15 per thousand.

CONCLUSION.

Up to date (December, 1909) there are no bad results in the stand left.

From a practical standpoint there seem to be quite definite conclusions that it is possible to thin out a pine growth fifty years of age with an additional cost of not over \$0.15 per thousand for chopping and \$0.15 per thousand for the logging under ordinary conditions.

JOSEPH J. DEARBORN.

AUG. 15, 1908.

Goldsbury lot, looking upward after thinning (before, one could not see through the tops).



Vertical text or markings along the left edge of the page, possibly bleed-through from the reverse side.

APPLICATION FOR EXAMINATION.

Should you desire an examination for thinning send to the State Forester for a blank application like the following, fill it out and send it in:—

No.....

Received.....

APPLICATION

FOR AN

EXAMINATION OF FOREST LANDS

TO THE

MASSACHUSETTS STATE FORESTER,

6 BEACON STREET, BOSTON.



The State Forester stands ready at all times to promote the perpetuation, extension and proper management of the forest lands of the Commonwealth, both public and private (1904, chapter 409, section 2).

If you have such lands and desire an examination of them and advice as to their management, fill out the following blank form and send it to the above address of State Forester.

Upon receipt, this request will be placed on file, and you will be informed, in order of application, approximately when the examination can be made, and a mutual date can then be decided upon.

The only expense the applicant promises to pay is that of travel and subsistence of the State Forester or his assistants, incurred in making the examination.

It is always more satisfactory to personally meet on the property the owner or party most interested, at least when the preliminary examination is made. In this way a definite understanding can be had as to future undertakings, and whether working plans are necessary. Often a preliminary visit to gain knowledge of the problem and give advice on the grounds are all the services needed.

When sending this application in, a brief description of the land will assist us.

With the above understanding, I desire to have an examination made of a tract of land of approximately.....acres, located in the town of.....county of.....State of Massachusetts.

Signed

Address

Date.....19 .

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100

THE OLDER
FOREST PLANTATIONS

IN

MASSACHUSETTS.

CONIFERS.

J. R. SIMMONS, ASSISTANT FORESTER, UNDER THE DIRECTION OF
F. W. RANE, STATE FORESTER.



BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
32 DERNE STREET.

1915.

APPROVED BY
THE STATE BOARD OF PUBLICATION.

FOREWORD.

Mr. Simmons has brought together in this bulletin some very valuable information. All of the examples cited are results of actual early planting in this State.

Many of the plantations, it may be said, have not had the normal conditions that would exist to-day. Most of the stock planted was wild stock dug from the surrounding country, and in some instances the land used was extremely inferior.

With nursery-grown transplants, adaptable soils and modern methods of thinning far better results may be had in the future.

The results reported herewith are extremely conservative, and the reader, I am sure, cannot help receiving encouragement in attempting forest planting of pine in this State.

Interest in reforestation is growing rapidly each year, and we may anticipate what our well-directed efforts of to-day will bring forth twenty-five to fifty years hence by the results here shown.

Every 1,000 acres planted now will mean much to posterity, and, as well, reflect great credit and profit to our generation.

F. W. RANE,

State Forester.

FEB. 1, 1915.

FOREST PLANTATIONS IN MASSACHUSETTS.

INTRODUCTION.

The object of this bulletin is to show the practicability and results of forest planting of coniferous trees, and deals with plantations which have reached an age when value can be measured in terms of lumber. The tracts selected for observation were originally planted by private individuals who represent the pioneers in the work of reforestation in this State. By interviewing these owners, or those to whom their property has been handed on, a considerable amount of information has been collected with regard to the objects which they had in mind in the beginning, the methods employed and the later management of their plantations. To this has been added measurements of each wood lot, either as a whole, or by the selection of sample plots, and the contents computed as described in the succeeding pages. The data and accompanying illustrations were taken in 1914. It is the desire of the State Forester to encourage those who own waste land to bring it back into forest production. This investigation represents one method of showing what may be expected from such an undertaking.

EARLY METHODS AND INTEREST IN FOREST PLANTING.

The period between 1820 and 1880 was one of enthusiastic planting of pine in New England. The lumberman foresaw the time when natural white pine as a marketable commodity would be gone, and the rise in prices would make planted timber of economic importance. Large plantations were made by private owners, and a few by corporations. Seedlings were usually dug up from the fields lying around old seed pines, and planted either at random or in rows, and spaced at distances

varying from 4 to 15 feet. Seed plots were attempted by some, and others even tried out broadcast sowing. At the end of this period there were in Massachusetts alone forest plantations of white pine to the extent of 10,000 acres.¹

Typical of the forest planters of this time was Mr. Augustus Pratt, a former member of the State Board of Agriculture, who, when nineteen years old, planted pine seed on an old pasture belonging to his father. The wood lot which thus developed has been recently cut, and was between forty and fifty years old.

After 1880 interest began to decline, chiefly because of the immense supply of lumber brought from the region of the Great Lakes at a low rate of transportation and the inadequate methods of combating forest fires; these conditions tended to gradually dampen the enthusiasm of the forest planter.

PRESENT NEED OF REFORESTATION.

We are now entering once more upon a campaign for the reclamation of waste land. This is due not alone to the decrease in our supply of lumber, but also to the following facts:—

There is a growing sentiment among our people for forests and scenic beauty. There are nearly 1,000,000 acres of waste land in Massachusetts; our hardwood forests are threatened by gypsy, brown-tail and other moth pests, and our beautiful chestnut tracts by the ever-increasing chestnut bark disease. Improved methods of forest-fire fighting and the co-operation of railroads, local fire departments and individuals have made possible the protection of forests, once they have been acquired.

Coniferous trees offer the best means of realizing our present needs. They act as the most effective check upon the devastations of the moth, being unedible to the brown-tail, while the gypsy will pass them by if he can find anything else upon which to subsist.² Beneath a pine forest there is always a thick bed of needles which keeps the ground moist and free from sprouts and deciduous seedlings. Therefore, while pine develops tremendous heat in case of fire, it prevents the collec-

¹ United States Forest Service Bulletin No. 35.

² See Massachusetts State Forester's Bulletin on "Improvement Thinnings."

tion of inflammable material which would feed on ordinary ground fire; in other words, it is a good preventive against the first causes.

RECENT PLANTATIONS.

Excellent plantations of pine, ranging from trees a few inches in height to 15 or 20 feet, may be seen on the watersheds of many of our lakes and streams. A large number of individuals and corporations in all parts of the State have undertaken reforestation, either upon their own initiative or with the cooperation of the State Forester. In 1914 the amount of land planted under the reforestation act was 550 acres. In addition to this, the Massachusetts State institutions and commissions planted about 700 acres. The transplants were supplied from the State Forester's nursery at Amherst, Mass. A new State Forest Commission has, within the year, been appointed by the Governor, and empowered to acquire wild and waste lands for the purpose of converting them into State forests. These lands will be turned over to the State Forester for planting and management. In most parts of the State the work of private forestry companies is also becoming evident. To many people a flourishing forest is sufficient remuneration. For the economic advantages of reforestation the reader is referred to the measurements given herewith, and also to "Forest Mensuration of the White Pine," which can be obtained by writing to the State Forester.

THE FOREST TAXATION LAW.

The advantages of the new forest taxation law should be known and understood by those interested in the subject of reforestation. In order to benefit by the provisions of the law the forest plantation must first be registered. The law then substitutes for the general tax on land and timber two taxes, *i.e.*, one on the land at its own value, the same as if all the trees had been removed, and one equal to 6 per cent. of the stumpage value, payable when the timber is cut. The owner of a registered plantation would therefore pay an annual tax on the value of his land (\$1 to \$10 per acre, which at a \$20 rate would amount to 2 to 20 cents) so long as the plantation stood, and a yield tax of 6 per cent. when the timber was cut

(\$10 to \$20 per acre). These two taxes would be considerably less than the amount paid under the present system, and their amount would be a known quantity, because the owner could determine in advance the amount which he would have to expend. Under the old system he would be subject to the judgment of his assessors, who can raise the amount of his valuation from year to year. The reader is referred to the Massachusetts State Forester's Bulletin, "The Forest Taxation Law."

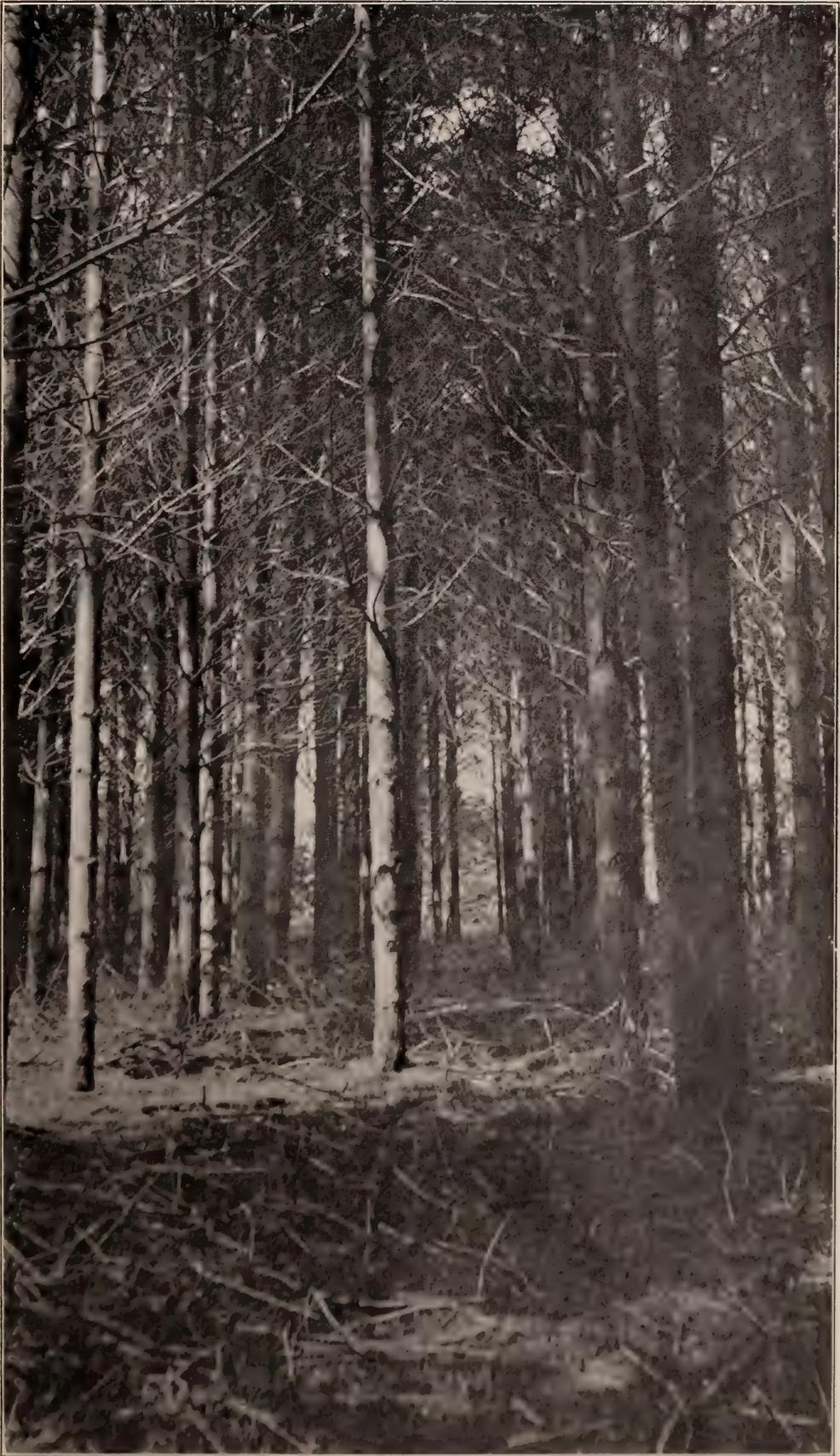
PLANTATIONS.

South Orleans, Mass. — Owner, John Kenrick.

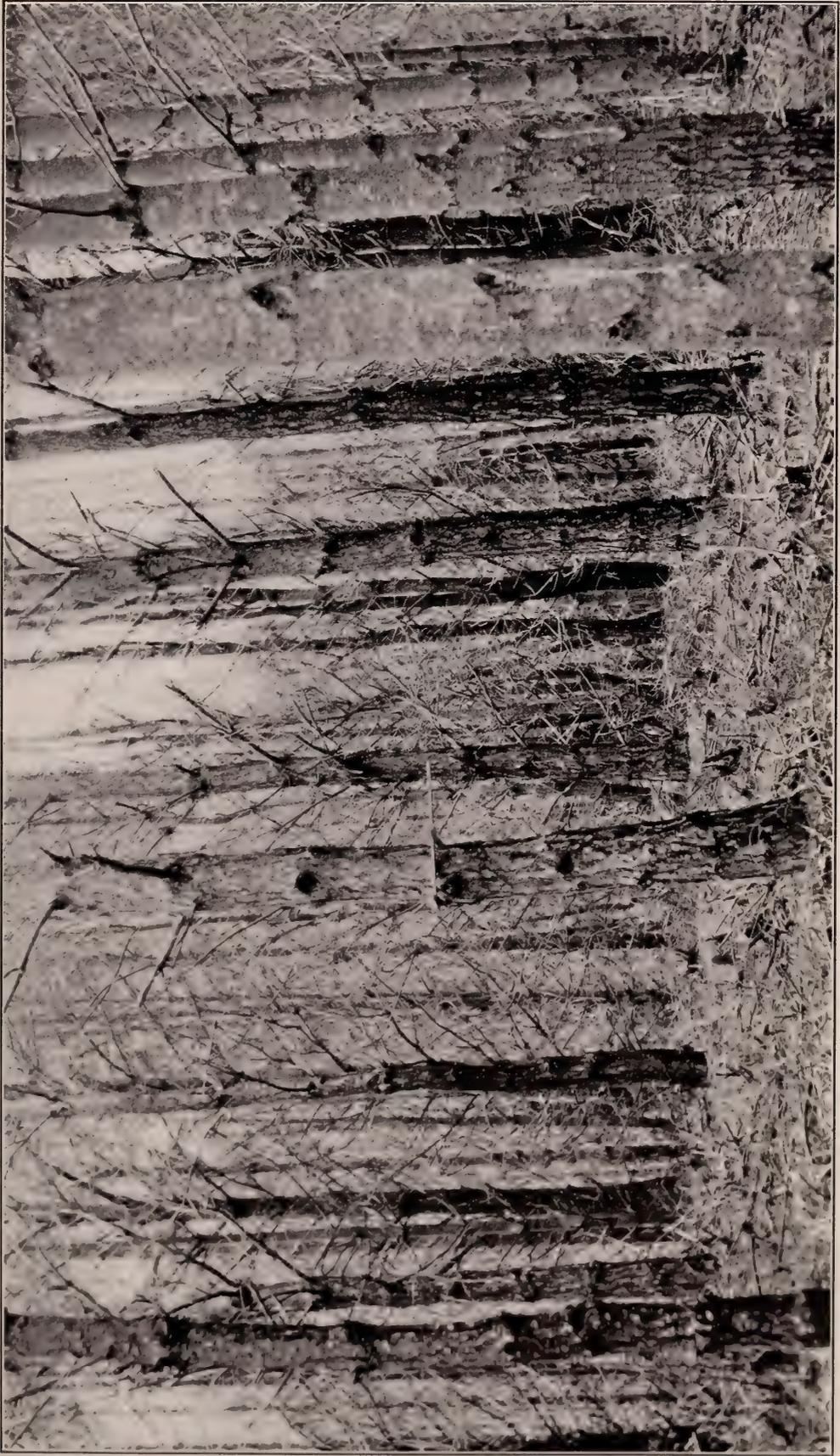
History. — This plantation was made in March, 1876, by John Kenrick, Sr., and consists of about 7 acres of white pine, Scotch pine and American larch. Previous to planting, the land had borne rye for one year and corn for two years, and the trees were set out on the corn stubble 4 feet apart. On a portion of the tract, instead of using seedlings, small seed spots were sown, always with the same spacing. The larch consisted entirely of seedlings. In spite of the close spacing, the trees have made a remarkable growth for this section of the State, and there are very few blank spaces, even where the seed was used. Occasionally a small group of trees more slender than the others marks where several seedlings sprang up as if from a single root out of the seed spot, but usually the most vigorous tree has crowded out the others.

Objects. — Personal interest in forest planting, and to demonstrate the practicability of forest planting on Cape Cod; to improve and utilize land otherwise of little agricultural value.

Treatment. — The original owner lived to make his first forest thinning, though well on in years when the planting was done. This was confined almost entirely to removing the dead and overcrowded trees. The 4-foot spacing remains in evidence throughout most of the tract. A large number of trees could now be removed to advantage, but even as they stand they present a marked contrast to the native pitch pine, being taller and of greater diameter.



Thirty-eight year old plantation of white pine. John Kenrick, South Orleans, Mass. 111



Thirty-eight year old plantation of Scotch pine. John Kenrick, South Orleans, Mass.



Plot No. 1. White Pine predominating.

Sample plot, 280 by 110 feet; age, thirty-eight years.

DIAMETER BREAST HIGH (INCHES).	NUMBER OF TREES.			Board Feet.
	White Pine.	Scotch Pine.	Height (Feet).	
5,	70	25	35	1,188
6,	59	21	35	1,400
7,	55	23	35	1,950
8,	38	21	40	2,065
9,	21	14	40	1,575
10,	16	8	40	1,320
11,	8	6	45	1,085
12,	7	2	45	810
13,	-	4	45	410
14,	1	-	45	120
Total,	275	125	40 ¹	11,923

Total number of trees to acre, 571.

Total board feet to acre, 17,033.

¹ Average height.*Plot No. 2. Scotch Pine predominating.*Area, $\frac{1}{4}$ acre; age, thirty-eight years.

DIAMETER BREAST HIGH (INCHES).	NUMBER OF TREES.		Board Feet.
	Scotch Pine.	White Pine.	
5,	21	14	525
6,	15	19	680
7,	22	7	870
8,	26	12	1,330
9,	7	5	540
10,	5	-	275
11,	-	-	-
12,	1	-	75
Total,	97	57	4,295

Total number of trees to acre, 616.

Total board feet to acre, 17,180.

Average height, 40 feet.

*Plot No. 3. Tamarack.*Area, $\frac{1}{4}$ acre; age, thirty-eight years.

DIAMETER BREAST HIGH (INCHES).	Number of Trees.	Board Feet.
5,	19	238
6,	29	508
7,	27	675
8,	15	450
9,	10	375
10,	4	190
11,	1	60
12,	1	70
13,	1	80
Total,	107	2,646

Total number of trees to acre, 428.

Total board feet to acre, 10,584.

Average height, 35 feet.

*Plot No. 4. Tamarack.*Area, $\frac{1}{4}$ acre; age; thirty-eight years.

DIAMETER BREAST HIGH (INCHES).	Number of Trees.	Board Feet.
5,	92	920
6,	51	765
7,	32	640
8,	5	125
9,	1	30
10,	2	80
Total,	183	2,550

Total number of trees to acre, 732.

Total board feet to acre, 10,200.

Average height, 30 feet.

West Monponsett Lake, Mass. — Owner, Frank H. Albee.

History. — Before this land was bought by the present owner it was covered with a beautiful plantation of white pine. This was for the most part lumbered in 1913 and cut, according to the buyer of the timber, 30,000 board feet to the acre. Measurements have been made of a sample acre of stumps and one inch

deducted to determine the diameter of the original trees breast high. The plantation was made about forty-six years ago by Samuel Alden, East Bridgewater, Mass., and a Mr. Kingman of Brockton, Mass., and the land selected was on an abandoned farm. Planting was begun in the fall and finished in the spring, and the spacing was done by means of cross-plowed furrows about 10 feet apart.

Objects. — Interest in reforestation, and to utilize waste land.

Treatment. — The removal of dead trees was the only care given this tract, so far as could be determined. The wide spacing prevented excessive overcrowding, but the diameter growth was much better than the height, as estimated from the few trees left standing.

Sample Plot.

Area, 1 acre; age, forty-six years.

DIAMETER BREAST HIGH (INCHES).	Number of Trees.	Height (Feet).	Board Feet.
8,	13	30	325
9,	9	30	270
10,	26	30	1,040
11,	17	30	850
12,	44	40	3,300
13,	44	40	3,740
14,	54	40	5,400
15,	40	40	4,600
16,	36	40	4,860
17,	19	50	3,800
18,	9	50	2,115
19,	2	60	670
20,	1	60	380
21,	1	60	430
Total,	315	42 ¹	31,780

¹ Average height estimated.

Rehoboth, Mass. — Owners, Miss Fannie Douse and Mrs. Clara I. Hubbard.

History. — This fifty-five year old plantation was made by Mr. Christopher Carpenter. Pasture trees were used and the spacing was about 8 to 10 feet. At the end of the first ten

years the trees had reached the height of a man's head. The property is now in the possession of Miss Fannie Douse and Mrs. Clara I. Hubbard.

Treatment. — About four years ago the dead trees were removed and measures taken to protect the plantation from forest fires.

An examination of the tract showed so regular a growth, and so much care in lining up the rows, that a slightly different method was used in measuring it, as follows: —

Two rows of trees through the plantation were measured for heights and diameters, and the contents in each case multiplied by the total number of rows. As a check on this work, a sample quarter acre was measured, with about the same average result.

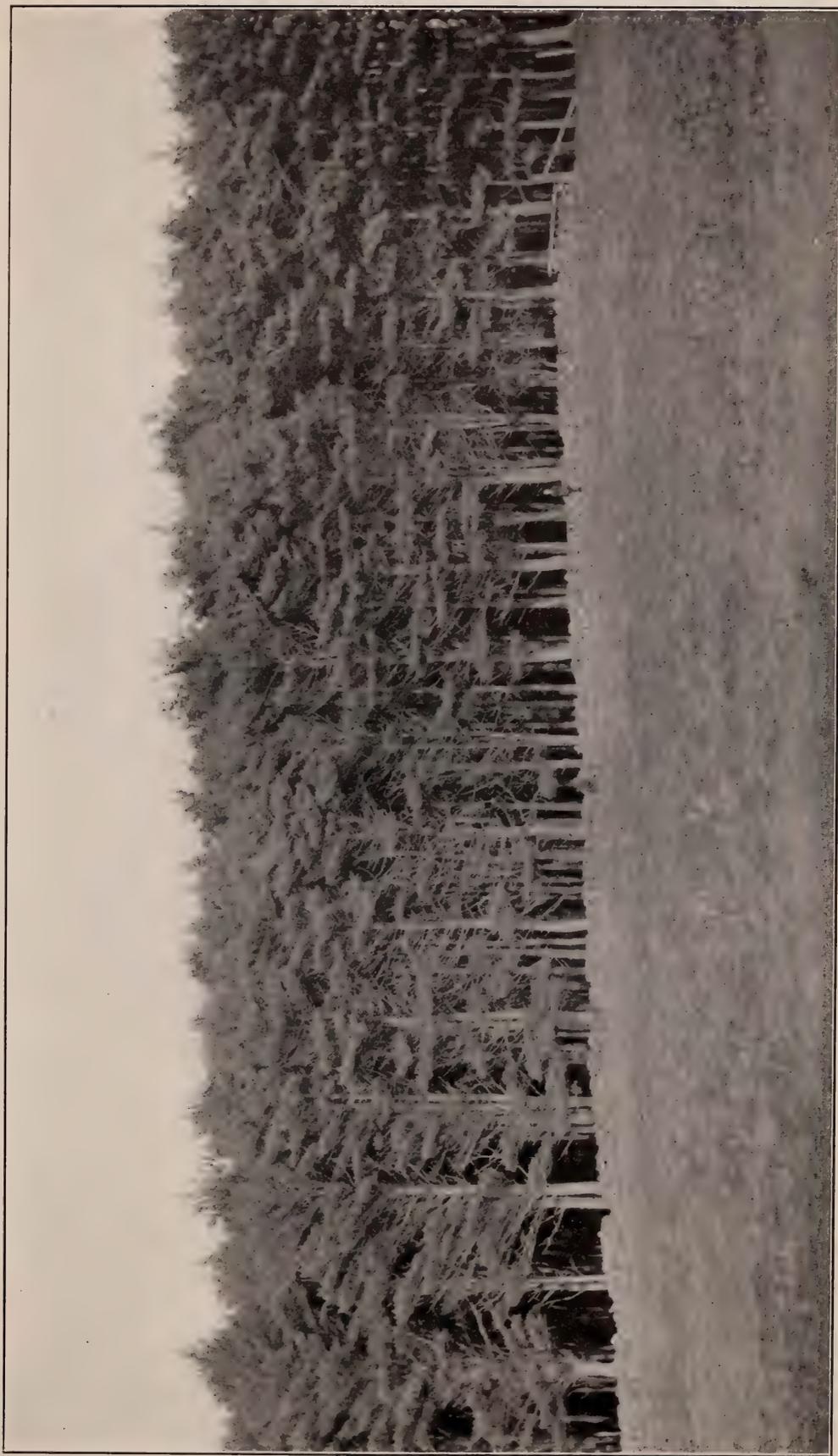
Row No. 1.

Area, 7 acres; age, fifty-five years.

DIAMETER BREAST HIGH (INCHES).	Number of Trees.	Board Feet.
6,	4	120
7,	1	40
8,	5	250
9,	7	420
10,	4	300
11,	7	630
12,	13	1,265
13,	4	480
14,	4	560
15,	2	320
16,	—	—
17,	1	260
Total,	52	4,645

Total number of rows, 66.
Total board feet, 306,570.
Total number of acres, 7.

Total board feet to acre, 43,796.
Average height, 50 feet.



Fifty-five year old plantation of white pine owned by Mrs. Clara I. Hubbard and Miss Fannie Douse, Rehoboth, Mass.







A view of the same tract, taken inside the woods.

Row No. 2.

DIAMETER BREAST HIGH (INCHES).	Total Number of Trees.	Board Feet.
6,	1	30
7,	2	80
8,	2	100
9,	5	300
10,	11	825
11,	6	540
12,	12	1,260
13,	7	840
14,	2	280
15,	-	-
16,	2	360
Total,	50	4,615

Total number of rows, 66.
 Total board feet, 304,590.
 Total number of acres, 7.

Total board feet to acre, 43,512.
 Average height, 50 feet.

Total Results Averaging Rows Nos. 1 and 2.

Area, 7 acres.
 Number of trees to acre, 480.
 Board feet to acre, 43,654.

Sharon, Mass. — Owner, Mr. Edwin Fobes.

History. — The original planter was Mr. Lyman Plimpton, who in 1858 planted white pine on the site of an old peach orchard which had been killed by blight. When first made, the plantation comprised about 6 acres, but a forest fire swept through it a number of years ago, destroying or badly damaging over half of it. A few of the remaining trees show scars upon their trunks, but otherwise appear very thrifty.

Purposes. — To utilize poor land. Interest in forestry, from the standpoint of lumber value and beauty of landscape.

White Pine.

Area, 2 acres; age, fifty-six years.

DIAMETER BREAST HIGH (INCHES).	Number of Trees.	Height (Feet).	Board Feet.
6,	16	60	480
7,	23	60	1,150
8,	50	60	3,250
9,	75	60	7,875
10,	74	70	9,250
11,	98	70	14,210
12,	60	70	9,900
13,	35	70	6,650
14,	25	70	5,375
15,	17	75	4,624
16,	12	75	3,660
17,	6	75	2,040
18,	5	75	1,900
19,	5	75	2,110
20,	3	80	1,515
21,	2	80	1,110
22,	2	80	1,190
23,	1	80	640
Total,	509	70 ¹	76,929

Total number of trees to acre, 254.

Total board feet to acre, 38,464.

¹ Average height.

Along the road which passes this plantation is a row of pine trees which were planted at the same date. Their growth, on account of the added amount of light they have received, has been so much greater than that of average forest trees that it was deemed advisable to measure them separately. While their height is about 10 feet less than that of the adjoining plantation, they show a far greater diameter growth, which will give some idea of what might be expected from white pine if given every possible advantage.



Fifty-six year old plantation of white pine. Edwin Fobes, Sharon, Mass.



A row of forty-two white pine trees, fifty-six years old. Edwin Fobes plantation, Sharon, Mass.







White pine on the edges of the Edwin Fobes plantation. Note the heavy reproduction in the background.

White Pine.

Measurements for a row of trees along road spaced about 10 feet; age, fifty-six years. (See illustration.)

DIAMETER BREAST HIGH (INCHES).	Number of Trees.	Board Feet.
15,	1	200
16,	2	460
17,	-	-
18,	3	885
19,	4	1,340
20,	8	3,040
21,	6	2,880
22,	2	1,040
23,	5	2,825
24,	1	600
25,	4	2,580
26,	4	3,440
27,	2	1,880
Total,	42	21,170

Average height, 60 feet.

Because these trees are planted in a straight row, 10 feet apart, the spread of the branches, laterally, is nearly 50 feet. It would therefore require only about 80 trees of this size to cover an acre of ground. In terms of the above measurements they would yield a little over 40,000 board feet.

Bridgewater, Mass. — Owner, C. M. Cook.

History. — So far as could be ascertained from residents in the vicinity of this small plantation it was made about fifty years ago, trees dug up from the surrounding pastures being used. Stumps within and on the border of the lot show between 45 and 50 rings. Other information than these observations and the measurements given is lacking.

*White Pine.*Area, 200 by 320 feet (approximately $1\frac{1}{3}$ acres); age, fifty years.

DIAMETER BREAST HIGH (INCHES).	Number of Trees.	Average Height (Feet).	Board Feet.
5,	33	40	495
6,	32	40	640
7,	51	40	1,530
8,	59	40	2,065
9,	94	40	4,230
10,	85	50	6,375
11,	78	50	7,020
12,	75	50	7,875
13,	54	50	6,480
14,	29	50	4,060
15,	11	50	1,760
16,	1	50	180
17,	5	60	1,300
18,	4	60	1,180
19,	1	60	335
20,	-	-	-
21,	1	70	480
22,	-	-	-
23,	1	70	565
Total,	614	-	46,570

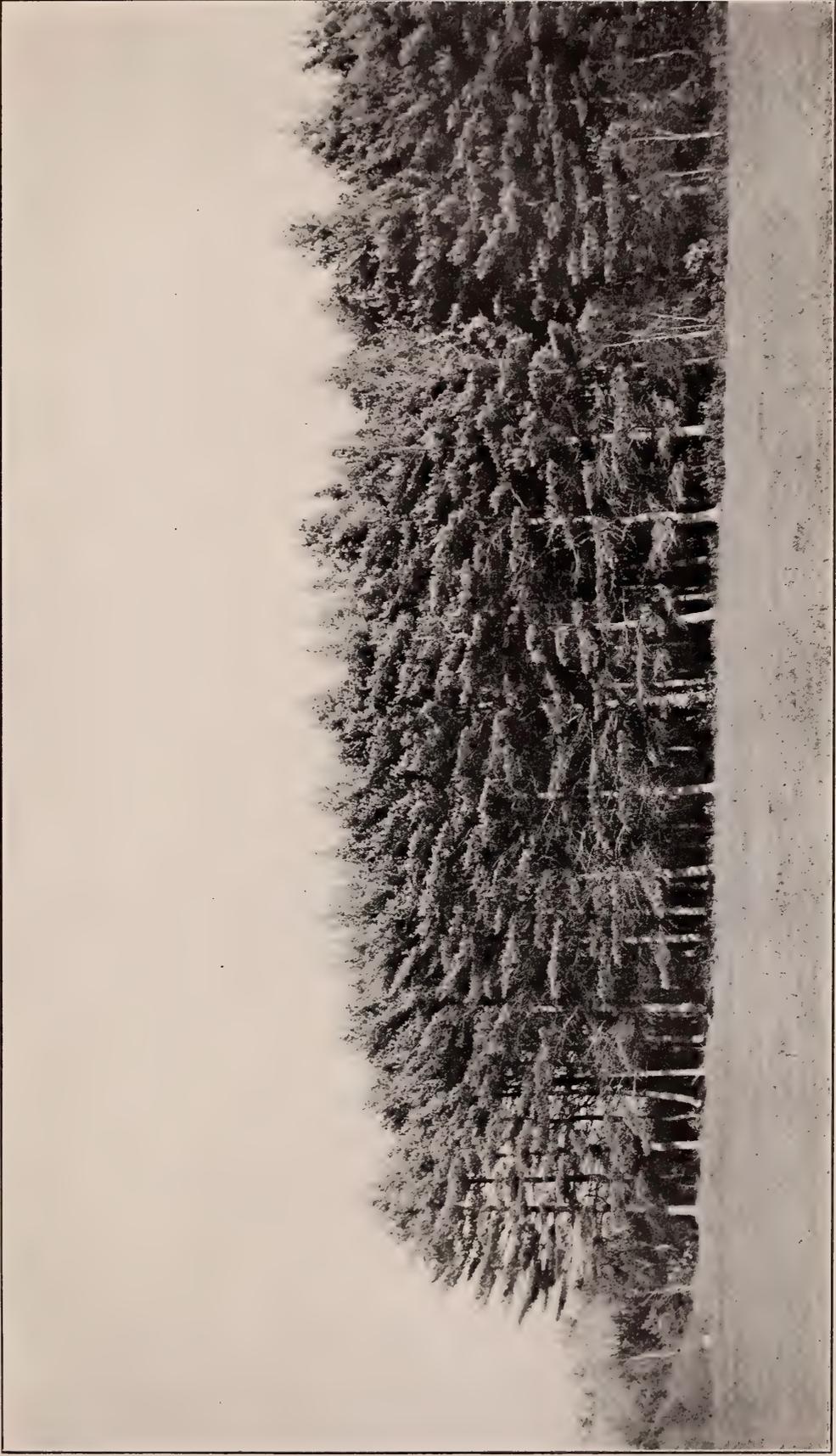
Total number of trees to acre, 460.

Total board feet to acre, 34,927.

East Bridgewater, Mass. — Owner, Mr. Harris Latham.

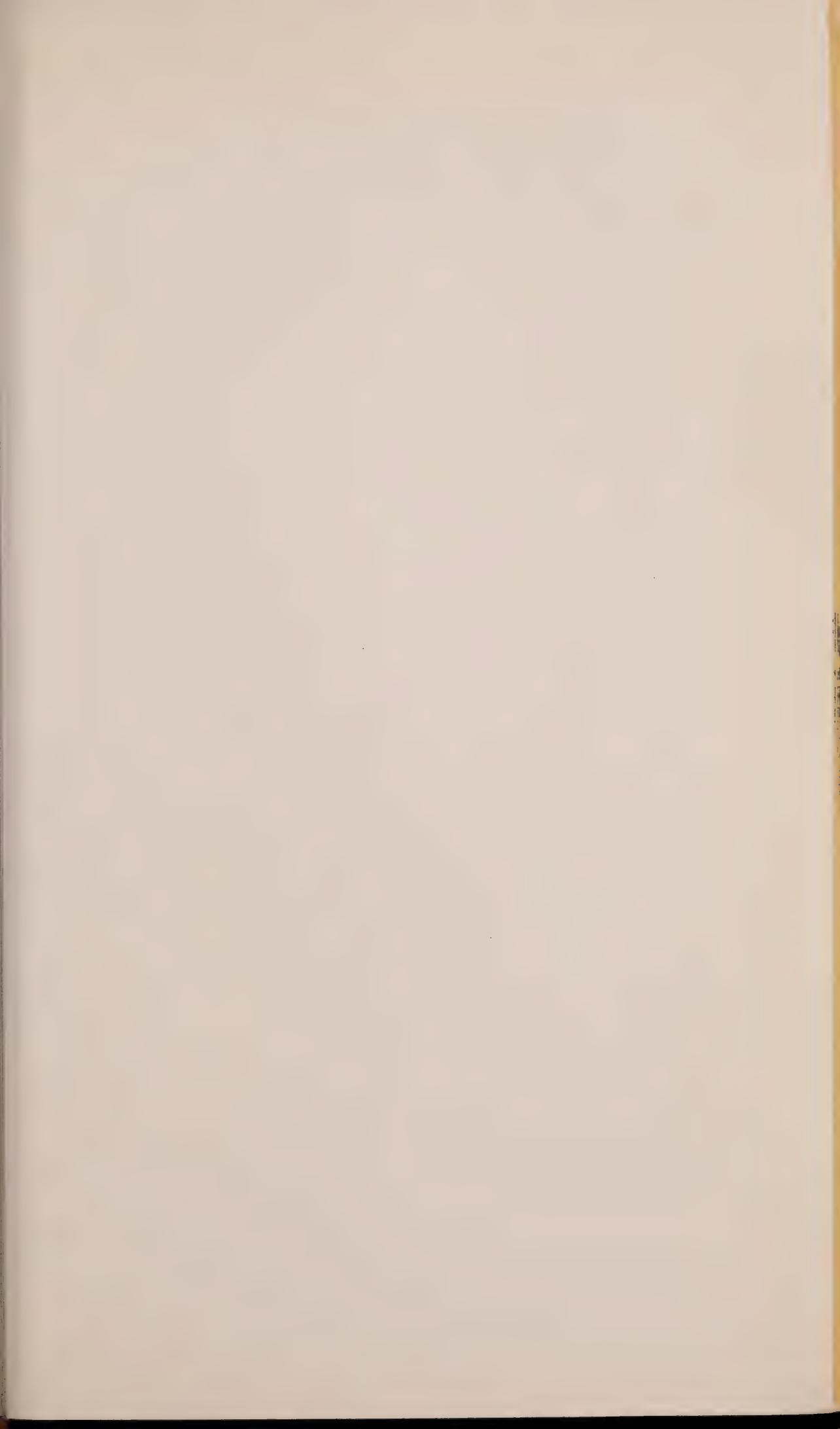
History. — Mr. Latham's plantation is one of the largest investigated, and covers about 12 acres. It can be seen from any one of three roads, and has the appearance of a well-kept park. The original planter was Mr. Galen Latham, father of the present owner, and the trees were set out in 1875, in furrows, plowed 8 to 10 feet apart. Pasture trees 10 to 12 inches in height were used.

Objects. — Interest in forestry. To improve the landscape and to utilize land difficult of successful cultivation. To utilize a large number of seedlings which had sprung up in the pasture.



Fifty year old plantation owned by C. M. Cook, Bridgewater, Mass.







Two views of the Harris Latham plantation, East Bridgewater, Mass.; age, thirty-nine years.

Treatment. — No thinnings have been made. A very few dead trees have been removed, and no limbs and refuse allowed to remain on the ground.

This experiment is the most extensive recorded in this bulletin from the standpoint of the number of trees measured. The land was resurveyed as a check on the area.

White Pine.

Area, 12 acres; age, thirty-nine years.

DIAMETER BREAST HIGH (INCHES).	Number of Trees.	Board Feet.
5,	470	4,700
6,	749	22,470
7,	896	35,840
8,	981	49,050
9,	927	55,620
10,	705	52,875
11,	371	33,390
12,	170	17,850
13,	85	10,200
14,	53	7,420
15,	15	2,400
16,	8	1,440
Total,	5,430	293,255

Total number of trees to acre, 452.
Total board feet to acre, 24,428.
Average height, 50 feet.

South Lancaster, Mass. — Owner, Mr. Harold Parker.

History. — This plantation was made by the father of the present owner forty-three years ago. Natural seedlings were used, taken from the surrounding woods, and spaced about 10 by 10 feet. The whole area reforested covered between 15 and 20 acres, and, besides pine, several types of hardwoods were planted. The area from which measurements were taken, and devoted almost entirely to pine, is about 4 acres.

Objects. — To utilize waste land for commercial advantage, and to determine what might be expected from planted white pine as an investment. To improve the appearance of the land

from the standpoint of beauty of landscape. Interest in horticulture and the care of woodlands.

Treatment. — In 1905 the government laid out four sample plots, numbered and measured the diameters of all the trees in each plot, and most of the suppressed trees were removed. The total numbers of trees removed (compare following lists of data) were as follows: —

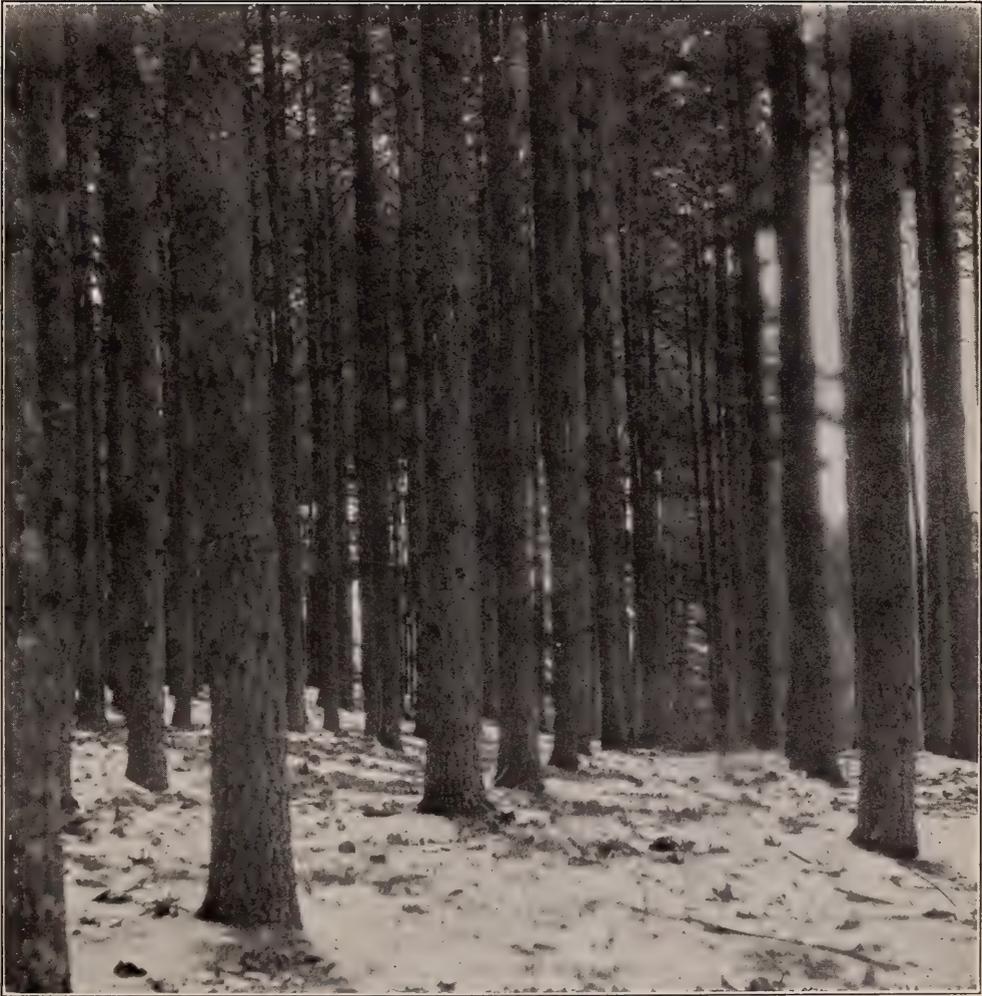
Plot No. 1,	1
Plot No. 2,	73
Plot No. 3,	46
Plot No. 4,	32

A record of the data taken in 1905 was loaned by the United States Forest Service in Washington and compared with measurements made in 1914. For convenience in obtaining board measure, trees whose diameters fell over or under the half-inch division of the rule were recorded to the nearest inch. No height measurements were made in 1905. The heights for that date have therefore been estimated at 5 feet below the measurements for 1914. It is believed that this is a conservative estimate.

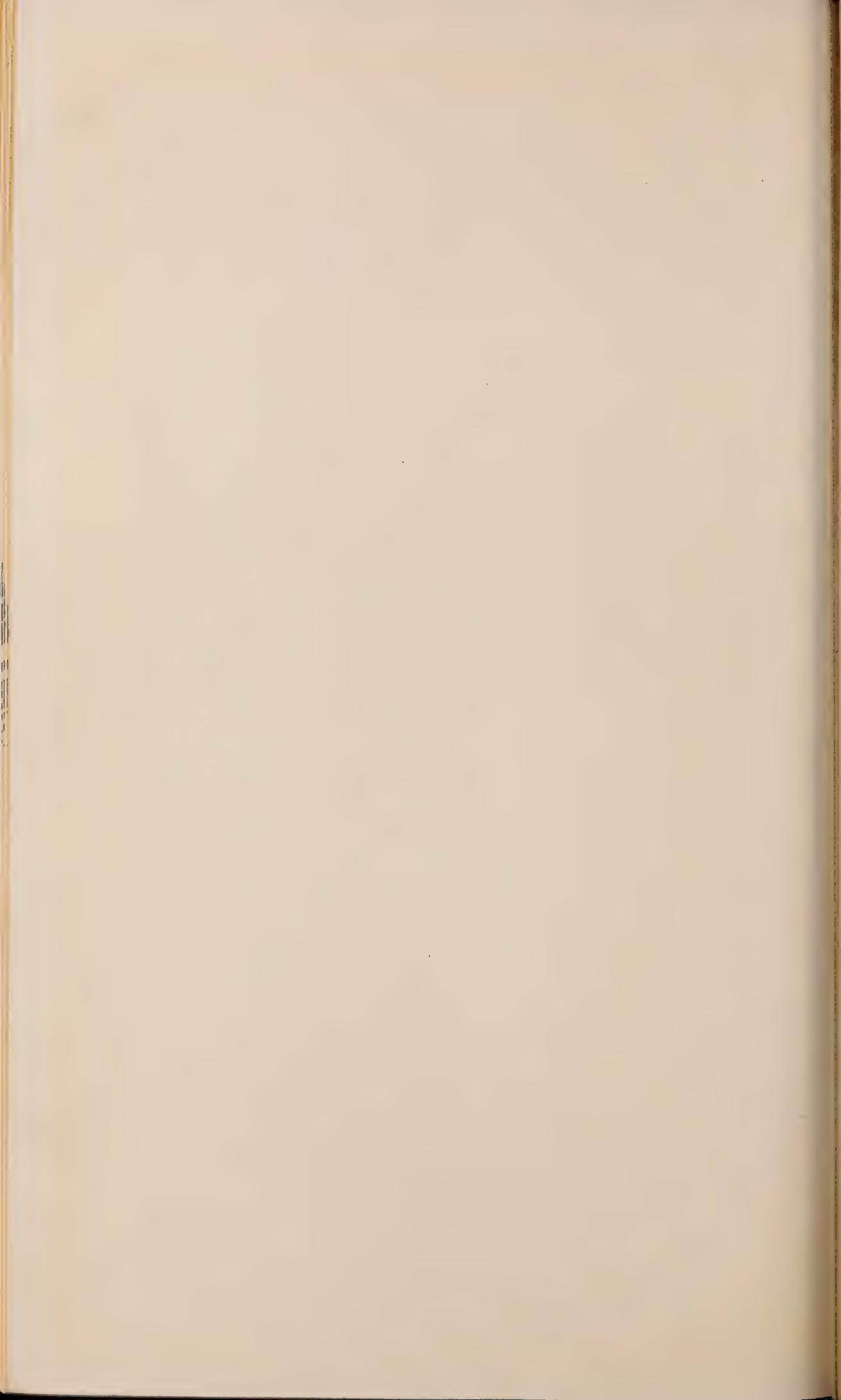
Sample Plot No. 1 (Government Plot No. 4).

Area, $\frac{1}{4}$ acre; age, forty-three years.

TREE NUMBER.	Species.	DIAMETER BREAST HIGH (INCHES).		Class.	BOARD FEET.		Gain in Board Feet.
		1905.	1914.		1905.	1914.	
1,	White pine,	12	12	2	105	120	15
2,	White pine,	12	13	1	105	138	33
3,	White pine,	12	12	1	105	120	15
4,	White pine,	10	12	1	75	120	45
5,	White pine,	10	11	1	75	103	28
6,	White pine,	13	14	1	120	158	38
7,	White pine,	10	10	2	75	85	10
8,	White pine,	10	10	2	75	85	10
9,	White pine,	13	14	1	120	158	38
10,	White pine,	13	14	1	120	158	38
11,	White pine,	13	15	1	120	180	60
12,	White pine,	15	15	1	160	180	20



Forty-three year old plantation of white pine which is making a current annual growth of about 1,000 B. F. to the acre. Harold Parker, South Lancaster, Mass.



Sample Plot No. 1 (Government Plot No. 4) — Continued.

TREE NUMBER.	Species.	DIAMETER BREAST HIGH (INCHES).		Class.	BOARD FEET.		Gain in Board Feet.
		1905.	1914.		1905.	1914.	
13,	White pine,	13	14	1	120	158	38
14,	White pine,	9	9	2	60	70	10
15,	White pine,	12	13	1	105	138	33
16,	White pine,	10	10	1	75	85	10
17,	White pine,	12	13	1	105	138	33
18,	White pine,	11	12	1	90	120	30
19,	White pine,	10	11	2	75	103	28
20,	White pine,	10	10	2	75	85	10
21,	White pine,	10	11	1	75	103	28
22,	White pine,	9	10	2	60	85	25
23,	White pine,	11	11	1	90	103	13
24,	White pine,	8	8	2	50	58	8
25,	White pine,	9	10	2	60	85	25
26,	White pine,	7	7	2	40	45	5
27,	White pine,	11	12	1	90	120	30
28,	White pine,	10	11	1	75	103	28
29,	White pine,	12	14	1	105	158	53
30,	White pine,	14	15	1	140	180	40
31,	White pine,	8	8	2	50	58	8
32,	White pine,	11	12	1	90	120	30
33,	White pine,	11	12	1	90	120	30
34,	White pine,	12	13	1	105	138	33
35,	White pine,	8	8	2	50	58	8
36,	White pine,	8	8	2	50	58	8
37,	White pine,	12	13	1	105	138	33
38,	Hemlock,	2	3	5	3	3	-
39,	Hemlock,	3	4	5	5	5	-
40,	White pine,	13	14	1	120	158	38
41,	White pine,	8	8	2	50	58	8
42,	White pine,	10	10	1	75	85	10
43,	White pine,	8	8	2	50	58	8
44,	White pine,	14	15	1	140	180	40
46,	White pine,	8	8	2	50	58	8
47,	White pine,	11	12	2	90	120	30
48,	White pine,	12	12	1	105	120	15

Sample Plot No. 1 (Government Plot No. 4) — Continued.

TREE NUMBER.	Species.	DIAMETER BREAST HIGH (INCHES).		Class.	BOARD FEET.		Gain in Board Feet.
		1905.	1914.		1905.	1914.	
49,	White pine,	12	12	2	105	120	15
50,	White pine,	8	9	1	50	70	20
51,	White pine,	8	8	3	50	58	8
52,	White pine,	10	11	1	75	103	28
53,	White pine,	11	12	1	90	120	30
54,	White pine,	12	13	1	105	138	33
55,	White pine,	12	12	1	105	120	15
56,	White pine,	10	10	1	75	85	10
57,	White pine,	7	7	3	40	45	5
58,	White pine,	10	11	1	75	103	28
59,	White pine,	9	10	1	60	85	25
60,	White pine,	12	13	1	105	138	33
61,	White pine,	10	10	1	75	85	10
62,	White pine,	12	13	1	105	138	33
63,	White pine,	10	10	1	75	85	10
64,	White pine,	14	15	1	140	180	40
65,	White pine,	11	12	1	90	120	30
66,	White pine,	12	13	1	105	138	33
67,	White pine,	12	14	2	105	158	53
68,	White pine,	13	14	1	120	158	38
69,	White pine,	12	13	1	105	138	33
70,	White pine,	13	14	1	120	158	38
71,	White pine,	10	11	1	75	103	28
72,	White pine,	11	11	2	90	103	13
73,	White pine,	9	9	3	60	70	10
74,	White pine,	14	15	1	140	180	40
75,	White pine,	9	10	2	60	85	25
76,	White pine,	12	13	2	105	138	33
77,	White pine,	13	14	1	120	158	38
78,	White pine,	12	13	1	105	138	33
79,	White pine,	14	16	1	140	205	65
80,	White pine,	12	14	1	105	158	53
81,	Hemlock,	3	3	6	5	5	—
82,	Hemlock,	4	4	4	10	10	—
83,	White pine,	5	5	3	15	25	10

Sample Plot No. 1 (Government Plot No. 4) — Concluded.

TREE NUMBER.	Species.	DIAMETER BREAST HIGH (INCHES).		Class.	BOARD FEET.		Gain in Board Feet.
		1905.	1914.		1905.	1914.	
84,	White pine,	9	9	3	60	70	10
85,	White pine,	8	10	3	50	85	35
86,	White pine,	8	9	2	50	70	20
87,	White pine,	11	11	1	90	103	13
88,	White pine,	10	11	1	75	103	28
Total, . . . . .	. . . . .	-	-	-	7,303	9,429	2,126

Average height, 1905, 50 feet.

Average height, 1914, 55 feet.

Summary of Data.

Total board feet to acre, 1905,	29,212
Total board feet to acre, 1914,	37,716
Total gain in board feet per acre,	8,504
Current annual gain in board feet per acre,	945

Sample Plot No. 2 (Government Plot No. 5).

Area, $\frac{1}{2}$ acre; age, forty-three years.

TREE NUMBER.	Species.	DIAMETER BREAST HIGH (INCHES).		Class.	BOARD FEET.		Gain in Board Feet.
		1905.	1914.		1905.	1914.	
1,	White pine,	13	14	1	120	158	38
2,	White pine,	12	14	1	105	158	53
3,	White pine,	12	14	1	105	158	53
4,	White pine,	11	13	1	90	138	48
5,	White pine,	8	9	1	50	70	20
6,	White pine,	9	11	2	60	103	43
7,	White pine,	11	13	1	90	138	48
8,	White pine,	7	9	2	40	70	30
10,	White pine,	7	9	2	40	70	30
11,	White pine,	6	9	2	30	38	8
12,	White pine,	10	11	1	75	103	28
13,	White pine,	10	11	1	75	103	28
14,	White pine,	8	9	2	50	70	20
15,	White pine,	8	8	2	50	58	8

Sample Plot No. 2 (Government Plot No. 5) — Continued.

TREE NUMBER.	Species.	DIAMETER BREAST HIGH (INCHES).		Class.	BOARD FEET.		Gain in Board Feet.
		1905.	1914.		1905.	1914.	
16, . . .	White pine, . . .	9	9	2	60	70	10
17, . . .	White pine, . . .	10	11	1	75	103	28
18, . . .	White pine, . . .	11	11	1	90	103	13
19, . . .	White pine, . . .	10	11	2	75	103	28
20, . . .	White pine, . . .	10	11	2	75	103	28
22, . . .	White pine, . . .	11	12	1	90	120	30
23, . . .	White pine, . . .	12	14	1	105	158	53
24, . . .	White pine, . . .	9	9	2	60	70	10
25, . . .	White pine, . . .	10	11	1	75	103	28
27, . . .	White pine, . . .	11	13	1	90	138	48
29, . . .	White pine, . . .	8	9	2	50	70	20
31, . . .	White pine, . . .	7	8	2	40	58	18
33, . . .	White pine, . . .	8	8	2	50	58	8
34, . . .	White pine, . . .	6	7	2	30	45	15
36, . . .	White pine, . . .	8	9	2	50	70	20
43, . . .	White pine, . . .	7	7	1	40	45	5
45, . . .	Larch, . . .	7	7	1	40	45	5
46, . . .	White pine, . . .	3	3	3	5	8	3
47, . . .	White pine, . . .	4	4	3	10	15	5
48, . . .	White pine, . . .	8	9	2	50	70	20
49, . . .	White pine, . . .	6	6	2	30	38	8
50, . . .	White pine, . . .	6	7	2	30	45	15
54, . . .	White pine, . . .	7	8	2	40	58	18
55, . . .	White pine, . . .	6	7	2	30	45	15
56, . . .	White pine, . . .	6	7	2	30	45	15
57, . . .	White pine, . . .	9	10	1	60	85	25
58, . . .	White pine, . . .	8	8	2	50	58	8
59, . . .	White pine, . . .	7	8	2	40	58	18
60, . . .	White pine, . . .	6	7	2	30	45	15
61, . . .	White pine, . . .	9	10	1	60	85	25
68, . . .	Larch, . . .	9	10	1	60	85	25
69, . . .	Larch, . . .	5	6	2	15	38	23
70, . . .	Larch, . . .	5	5	2	15	25	10
71, . . .	White pine, . . .	12	15	1	120	180	60
72, . . .	White pine, . . .	6	8	3	30	58	28

Sample Plot No. 2 (Government Plot No. 5) — Continued.

TREE NUMBER.	Species.	DIAMETER BREAST HIGH (INCHES).		Class.	BOARD FEET.		Gain in Board Feet.
		1905.	1914.		1905.	1914.	
73, . . .	White pine, . . .	13	15	1	120	180	60
74, . . .	White pine, . . .	13	15	1	120	180	60
76, . . .	White pine, . . .	15	16	1	160	205	45
77, . . .	White pine, . . .	12	13	1	105	138	33
78, . . .	White pine, . . .	16	18	1	180	295	115
79, . . .	White pine, . . .	14	15	1	140	180	40
80, . . .	White pine, . . .	17	18	1	200	295	95
81, . . .	White pine, . . .	12	13	1	105	260	20
83, . . .	White pine, . . .	14	17	1	140	260	20
84, . . .	White pine, . . .	15	16	1	160	205	45
86, . . .	White pine, . . .	11	11	1	90	103	13
87, . . .	White pine, . . .	8	10	3	50	85	35
88, . . .	White pine, . . .	11	12	1	90	120	30
90, . . .	White pine, . . .	10	10	2	75	85	10
92, . . .	White pine, . . .	9	9	2	60	70	10
93, . . .	White pine, . . .	11	13	1	90	138	48
94, . . .	White pine, . . .	8	9	2	50	70	20
96, . . .	White pine, . . .	12	13	1	105	138	33
99, . . .	White pine, . . .	11	11	2	90	103	13
100, . . .	White pine, . . .	11	11	-	90	103	13
102, . . .	White pine, . . .	11	12	1	90	120	30
103, . . .	White pine, . . .	9	9	1	60	70	10
105, . . .	White pine, . . .	11	12	1	90	120	30
106, . . .	White pine, . . .	9	9	2	60	70	10
107, . . .	White pine, . . .	9	10	1	60	85	25
108, . . .	White pine, . . .	10	10	1	75	85	10
112, . . .	White pine, . . .	14	16	1	140	205	65
113, . . .	White pine, . . .	9	9	2	60	70	10
114, . . .	White pine, . . .	9	9	-	60	70	10
120, . . .	White pine, . . .	8	8	3	50	58	8
121, . . .	Larch, . . .	6	7	2	30	45	15
122, . . .	White pine, . . .	9	10	1	60	85	25
123, . . .	White pine, . . .	10	11	1	75	103	28
124, . . .	White pine, . . .	12	13	1	105	138	33
127, . . .	White pine, . . .	7	7	2	40	45	5

Sample Plot No. 2 (Government Plot No. 5) — Continued.

TREE NUMBER.	Species.	DIAMETER BREAST HIGH (INCHES).		Class.	BOARD FEET.		Gain in Board Feet.
		1905.	1914.		1905.	1914.	
128, . . .	White pine, . . .	10	10	2	75	85	10
129, . . .	White pine, . . .	8	9	1	50	70	20
131, . . .	White pine, . . .	12	14	1	105	158	53
132, . . .	White pine, . . .	11	12	1	90	120	30
133, . . .	White pine, . . .	13	14	1	120	158	38
136, . . .	White pine, . . .	12	14	1	105	158	53
137, . . .	White pine, . . .	10	12	1	75	120	45
138, . . .	White pine, . . .	12	13	1	105	138	33
144, . . .	White pine, . . .	9	10	2	60	85	25
145, . . .	White pine, . . .	8	9	1	50	70	20
146, . . .	White pine, . . .	11	11	1	90	103	13
147, . . .	Hemlock, . . .	3	4	4	5	15	10
148, . . .	Hemlock, . . .	3	4	5	5	15	10
149, . . .	White pine, . . .	9	9	2	60	70	10
150, . . .	White pine, . . .	7	7	3	40	45	5
151, . . .	White pine, . . .	9	10	1	60	85	25
152, . . .	White pine, . . .	8	9	1	50	70	20
154, . . .	White pine, . . .	9	11	1	60	103	43
157, . . .	White pine, . . .	11	12	1	90	120	30
158, . . .	White pine, . . .	10	10	1	75	85	10
159, . . .	White pine, . . .	7	7	2	40	45	5
161, . . .	White pine, . . .	8	9	1	50	70	20
162, . . .	White pine, . . .	6	7	2	30	45	15
164, . . .	White pine, . . .	10	11	1	75	103	28
166, . . .	White pine, . . .	9	10	1	60	85	25
167, . . .	White pine, . . .	7	8	2	40	58	18
168, . . .	White pine, . . .	9	9	2	60	70	10
169, . . .	White pine, . . .	10	12	1	75	120	45
170, . . .	White pine, . . .	8	8	2	50	58	8
172, . . .	White pine, . . .	8	8	2	50	58	8
173, . . .	White pine, . . .	10	10	2	75	85	10
174, . . .	White pine, . . .	10	12	1	75	120	45
175, . . .	White pine, . . .	7	8	2	40	50	10
177, . . .	White pine, . . .	8	8	2	50	58	8
178, . . .	White pine, . . .	8	9	2	50	70	20

Sample Plot No. 2 (Government Plot No. 5) — Concluded.

TREE NUMBER.	Species.	DIAMETER BREAST HIGH (INCHES).		Class.	BOARD FEET.		Gain in Board Feet.
		1905.	1914.		1905.	1914.	
179, . . .	White pine, . . .	11	11	1	90	103	13
180, . . .	White pine, . . .	8	9	2	50	70	20
181, . . .	White pine, . . .	9	9	2	60	70	10
182, . . .	White pine, . . .	9	10	1	60	85	25
185, . . .	White pine, . . .	6	8	3	30	58	28
186, . . .	White pine, . . .	11	11	1	90	103	13
187, . . .	White pine, . . .	8	8	2	50	58	8
188, . . .	White pine, . . .	10	11	1	75	103	28
189, . . .	Larch, . . .	6	6	2	30	38	8
191, . . .	White pine, . . .	11	12	1	90	120	30
193, . . .	White pine, . . .	9	10	1	60	85	25
195, . . .	White pine, . . .	10	11	1	75	103	28
196, . . .	White pine, . . .	10	10	1	75	85	10
197, . . .	White pine, . . .	12	13	1	105	138	33
199, . . .	White pine, . . .	12	13	1	105	138	33
200, . . .	White pine, . . .	12	13	1	105	138	33
201, . . .	White pine, . . .	8	9	1	50	70	20
202, . . .	White pine, . . .	10	11	1	75	103	28
203, . . .	White pine, . . .	11	12	1	90	120	30
204, . . .	Larch, . . .	9	9	1	60	70	10
207, . . .	Larch, . . .	5	6	2	15	38	23
212, . . .	Larch, . . .	5	5	2	15	25	10
213, . . .	Larch, . . .	6	6	2	30	38	8
215, . . .	White pine, . . .	11	13	1	90	138	48
Total, . . .	. . .	-	-	-	9,820	13,371	3,551

Average height, 1905, 50 feet.

Average height, 1914, 55 feet.

Summary of Data.

Total board feet to acre, 1905,	19,640
Total board feet to acre, 1914,	26,742
Total gain in board feet per acre,	7,102
Current annual gain in board feet per acre,	789

Sample Plot No. 3 (Government Plot No. 6).

Area, $\frac{1}{8}$ acre; age, forty-three years.

TREE NUMBER.	Species.	DIAMETER BREAST HIGH (INCHES).		Class.	BOARD FEET.		Gain in Board Feet.
		1905.	1914.		1905.	1914.	
3, . . .	White pine, . . .	7	7	1	50	58	8
5, . . .	White pine, . . .	11	12	1	115	150	35
7, . . .	White pine, . . .	6	6	2	35	48	13
8, . . .	White pine, . . .	6	6	2	35	48	13
10, . . .	White pine, . . .	6	7	1	35	48	13
11, . . .	White pine, . . .	6	6	2	35	48	13
12, . . .	White pine, . . .	6	7	1	35	58	23
13, . . .	White pine, . . .	6	7	2	35	58	23
14, . . .	White pine, . . .	5	6	2	20	48	28
15, . . .	White pine, . . .	5	5	2	20	35	15
16, . . .	White pine, . . .	10	11	1	95	130	35
21, . . .	White pine, . . .	7	7	2	50	58	8
22, . . .	White pine, . . .	5	6	2	20	48	28
23, . . .	White pine, . . .	8	9	1	65	93	28
24, . . .	White pine, . . .	7	9	1	50	93	43
25, . . .	White pine, . . .	9	11	1	80	130	50
27, . . .	White pine, . . .	6	7	1	35	58	23
29, . . .	White pine, . . .	7	8	1	50	75	25
30, . . .	White pine, . . .	6	6	2	35	48	13
31, . . .	White pine, . . .	6	7	2	35	58	23
33, . . .	White pine, . . .	8	9	1	65	93	28
35, . . .	White pine, . . .	8	9	1	65	93	28
44, . . .	White pine, . . .	6	7	2	35	58	23
45, . . .	White pine, . . .	8	9	1	65	93	28
46, . . .	White pine, . . .	8	9	1	65	93	28
49, . . .	White pine, . . .	7	8	2	50	75	25
53, . . .	White pine, . . .	8	9	1	65	93	28
54, . . .	White pine, . . .	8	9	2	65	93	28
55, . . .	White pine, . . .	8	9	2	65	93	28
56, . . .	White pine, . . .	7	8	2	50	75	25
57, . . .	White pine, . . .	6	6	2	35	48	13
59, . . .	White pine, . . .	6	7	2	35	58	23
61, . . .	White pine, . . .	8	9	1	65	93	28
63, . . .	White pine, . . .	6	6	2	35	48	13

Sample Plot No. 3 (Government Plot No. 6) — Concluded.

TREE NUMBER.	Species.	DIAMETER BREAST HIGH (INCHES).		Class.	BOARD FEET.		Gain in Board Feet.
		1905.	1914.		1905.	1914.	
64,	White pine,	5	7	2	20	58	38
66,	White pine,	7	7	2	50	58	8
67,	White pine,	8	9	3	65	93	28
69,	White pine,	7	8	1	50	75	25
71,	White pine,	9	10	1	80	110	30
73,	White pine,	9	10	1	80	110	30
74,	White pine,	8	9	2	65	93	28
75,	White pine,	7	8	2	50	75	25
76,	White pine,	6	6	3	35	48	13
77,	White pine,	9	10	1	80	110	30
78,	White pine,	7	7	2	50	58	8
81,	White pine,	9	9	1	80	83	13
83,	White pine,	7	7	2	50	58	8
85,	White pine,	6	7	2	35	58	23
86,	White pine,	8	10	1	65	110	45
87,	White pine,	5	5	2	20	35	15
89,	White pine,	7	7	2	50	58	8
91,	White pine,	8	9	1	65	93	28
92,	White pine,	7	7	2	50	58	8
94,	White pine,	7	7	2	50	58	8
101,	White pine,	9	11	1	80	130	50
Total,		-	-	-	2,860	4,135	1,275

Average height, 1905, 60 feet.

Average height, 1914, 65 feet.

Summary of Data.

Total board feet per acre, 1905,	22,880
Total board feet per acre, 1914,	33,080
Total gain in board feet per acre,	10,200
Current annual gain in board feet per acre,	1,133

Sample Plot No. 4 (Government Plot No. 7).

Area, $\frac{1}{8}$ acre; age, forty-three years.

TREE NUMBER.	Species.	DIAMETER BREAST HIGH (INCHES).		Class.	BOARD FEET.		Gain in Board Feet.
		1905.	1914.		1905.	1914.	
1,	White pine,	6	7	2	35	58	23
2,	White pine,	6	6	2	35	48	13
3,	White pine,	6	6	2	35	48	13
5,	White pine,	6	6	2	35	48	13
7,	White pine,	7	8	1	50	75	25
8,	White pine,	5	5	2	20	35	15
9,	White pine,	7	8	1	50	75	25
10,	White pine,	5	5	2	20	35	15
12,	White pine,	7	7	1	50	58	8
13,	White pine,	6	6	1	35	58	23
16,	White pine,	6	6	1	35	48	13
17,	White pine,	6	6	2	35	48	13
18,	White pine,	7	7	1	50	58	8
19,	White pine,	5	5	2	20	35	15
20,	White pine,	6	6	2	35	48	13
21,	White pine,	4	5	3	10	35	25
22,	White pine,	7	7	1	50	58	8
23,	White pine,	8	10	1	65	110	45
24,	White pine,	5	6	2	20	48	28
25,	White pine,	7	7	2	50	58	8
26,	White pine,	7	8	1	50	75	25
27,	White pine,	6	6	2	35	48	13
29,	White pine,	7	7	2	50	58	8
30,	White pine,	8	9	1	65	93	28
35,	White pine,	5	5	2	20	35	15
36,	White pine,	4	4	3	10	15	5
37,	White pine,	7	8	1	50	75	25
38,	White pine,	6	7	1	35	58	23
39,	White pine,	4	5	2	10	35	25
41,	White pine,	7	7	1	50	58	8
42,	White pine,	5	5	2	20	35	15
43,	White pine,	6	6	2	35	48	13
46,	White pine,	7	8	1	35	75	40
48,	White pine,	5	5	2	20	35	15

Sample Plot No. 4 (Government Plot No. 7) — Continued.

TREE NUMBER.	Species.	DIAMETER. BREAST HIGH (INCHES).		Class.	BOARD FEET.		Gain in Board Feet.
		1905.	1914.		1905.	1914.	
49,	White pine,	8	9	1	65	93	28
51,	White pine,	8	9	1	65	93	28
52,	White pine,	7	7	2	50	58	8
53,	White pine,	7	8	1	50	75	25
55,	White pine,	7	7	2	50	58	8
56,	White pine,	8	9	1	65	93	28
57,	White pine,	4	4	3	10	15	5
58,	White pine,	4	4	3	10	15	5
59,	White pine,	9	9	1	80	93	13
60,	White pine,	6	6	2	35	48	13
61,	White pine,	7	7	2	50	58	8
62,	White pine,	5	6	3	20	48	28
63,	White pine,	4	5	2	10	35	25
64,	White pine,	5	6	2	20	48	28
65,	White pine,	7	9	1	50	93	43
66,	White pine,	6	6	2	35	48	13
68,	White pine,	6	7	2	35	58	23
70,	White pine,	7	8	2	50	75	25
71,	White pine,	7	7	1	50	58	58
72,	White pine,	10	11	1	95	130	3
73,	White pine,	5	5	2	20	35	15
74,	White pine,	5	5	2	20	35	15
75,	White pine,	6	6	2	35	48	13
76,	White pine,	6	6	3	35	38	13
77,	White pine,	9	11	1	80	130	50
79,	White pine,	8	9	1	65	93	28
81,	White pine,	5	5	2	20	35	15
82,	White pine,	8	8	2	65	75	10
83,	White pine,	5	6	2	20	48	28
85,	White pine,	7	8	2	50	75	25
86,	White pine,	8	8	1	65	75	10
87,	White pine,	7	7	2	50	58	8
88,	White pine,	6	7	2	35	58	23
89,	White pine,	4	4	3	10	15	5
98,	White pine,	11	12	1	115	150	35

Sample Plot No. 4 (Government Plot No. 7) — Concluded.

TREE NUMBER.	Species.	DIAMETER BREAST HIGH (INCHES).		Class.	BOARD FEET.		Gain in Board Feet.
		1905.	1914.		1905.	1914.	
99, . . .	White pine, . . .	5	5	2	20	35	15
101, . . .	White pine, . . .	6	7	2	35	58	23
102, . . .	White pine, . . .	8	9	1	65	93	28
105, . . .	White pine, . . .	5	5	3	20	35	15
106, . . .	White pine, . . .	6	6	3	35	48	13
107, . . .	White pine, . . .	6	6	3	35	48	13
108, . . .	White pine, . . .	6	6	3	35	48	13
109, . . .	White pine, . . .	6	6	3	35	48	13
110, . . .	White pine, . . .	5	5	3	20	35	15
111, . . .	White pine, . . .	8	8	2	65	75	10
112, . . .	White pine, . . .	11	12	1	115	150	35
113, . . .	White pine, . . .	8	8	1	65	75	10
Total, . . .	. . . . .	-	-	-	3,345	4,835	1,490

Average height, 1905, 60 feet.

Average height, 1914, 65 feet.

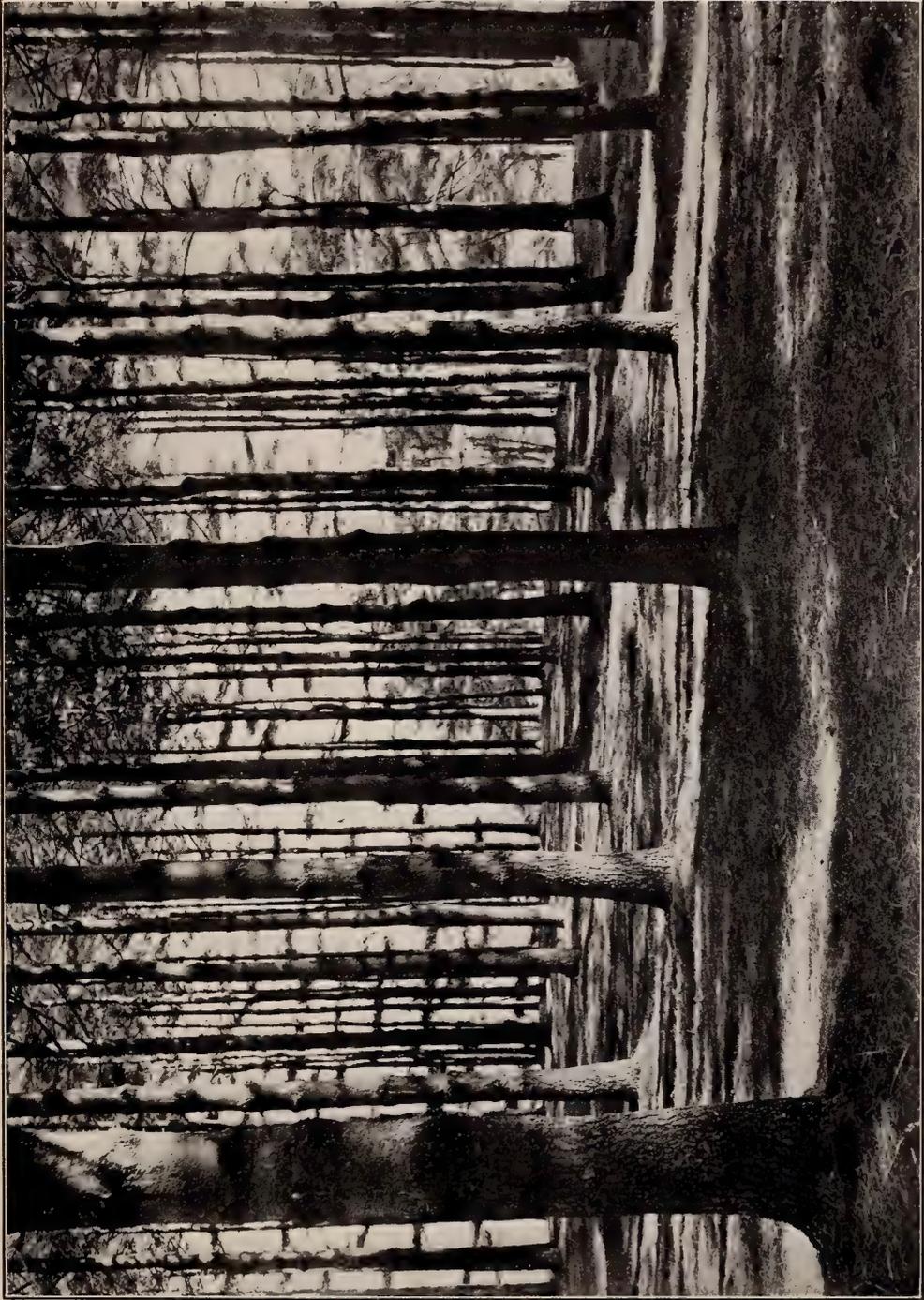
Summary of Data.

Total board feet to acre, 1905,	26,760
Total board feet to acre, 1914,	33,680
Total gain in board feet per acre,	11,920
Current annual gain in board feet per acre,	1,324

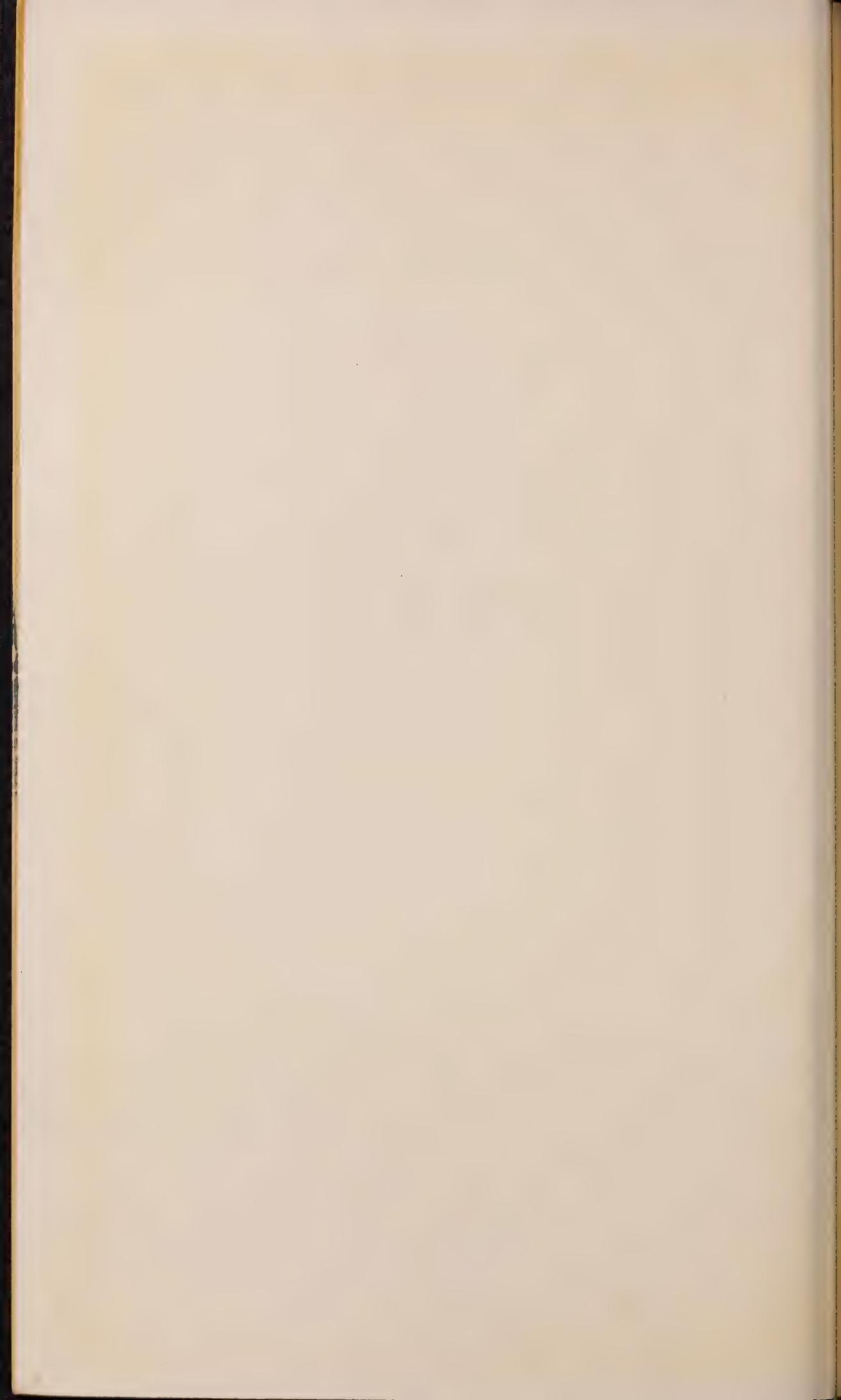
South Lancaster, Mass. — Owner, Mrs. Abbie F. Kilburn.

History. — This plantation joins that of Mr. Harold Parker, only a stone wall separating the two lots. It was made by Mr. Jonas Goss, and was planted in two sections, aged sixty years and forty-one years, respectively. The spacing was 6 by 8 feet. Since that time trees of various ages have been added around the edges. A survey was therefore necessary to show the areas of the original lots of even aged trees, which are: for the sixty-year old lot, 2.11 acres, and for the forty-one year old lot, 2.02 acres. If all trees are included, the area is 7 acres, and the figures given under "Treatment" were worked out on that basis by Mr. W. G. Kilburn.

Treatment. — In 1908 a thinning was made under the direc-



Abbie F. Kilburn plantation, after thinning was made; age forty-one years.



tion of this office, and about one-third of the trees removed. The following is a record of the lumber taken out:—

Box boards,	14,000 feet.
Wood,	40 cords.
Cost of brush burning,	\$35
Stumpage price received for lumber,	\$8 per M.
Stumpage price received for wood,	\$1 per cord.
Profit per acre,	\$20
Net profit,	\$150

While this work was going on the small dead branches so persistent on white pine were removed from the trunks of the trees in order to improve the general appearance of the grove. The thinning was not made so much with the idea of an immediate profit, as to increase the value of the plantation. While six years is not sufficient time to judge accurately as to the increase in growth due to thinning, the trees have every appearance of being stimulated by the added light received. This is shown by the healthy bark, green tops and absence of any dead or dying trees.

Section 1.

Area, 2.11 acres; age, sixty years.

DIAMETER BREAST HIGH (INCHES).	Number of Trees.	Board Feet.
6,	7	210
7,	19	950
8,	60	3,900
9,	130	10,400
10,	152	14,440
11,	155	17,825
12,	148	19,980
13,	69	10,695
14,	32	5,600
15,	16	3,200
16,	12	2,760
17,	8	2,080
Total,	808	92,040

Total number of trees to acre, 383.
 Total board feet to acre, 43,620.
 Average height, 60 feet.

Section 2.

Area, 2.02 acres; age, forty-one years.

DIAMETER BREAST HIGH (INCHES).	Number of Trees.	Board Feet.
5,	5	50
6,	21	630
7,	57	2,565
8,	122	7,015
9,	151	10,570
10,	116	9,860
11,	102	10,455
12,	46	5,520
13,	26	3,575
14,	5	788
15,	3	540
16,	4	820
Total,	658	52,388

Total number of trees to acre, 325.

Total board feet to acre, 25,934.

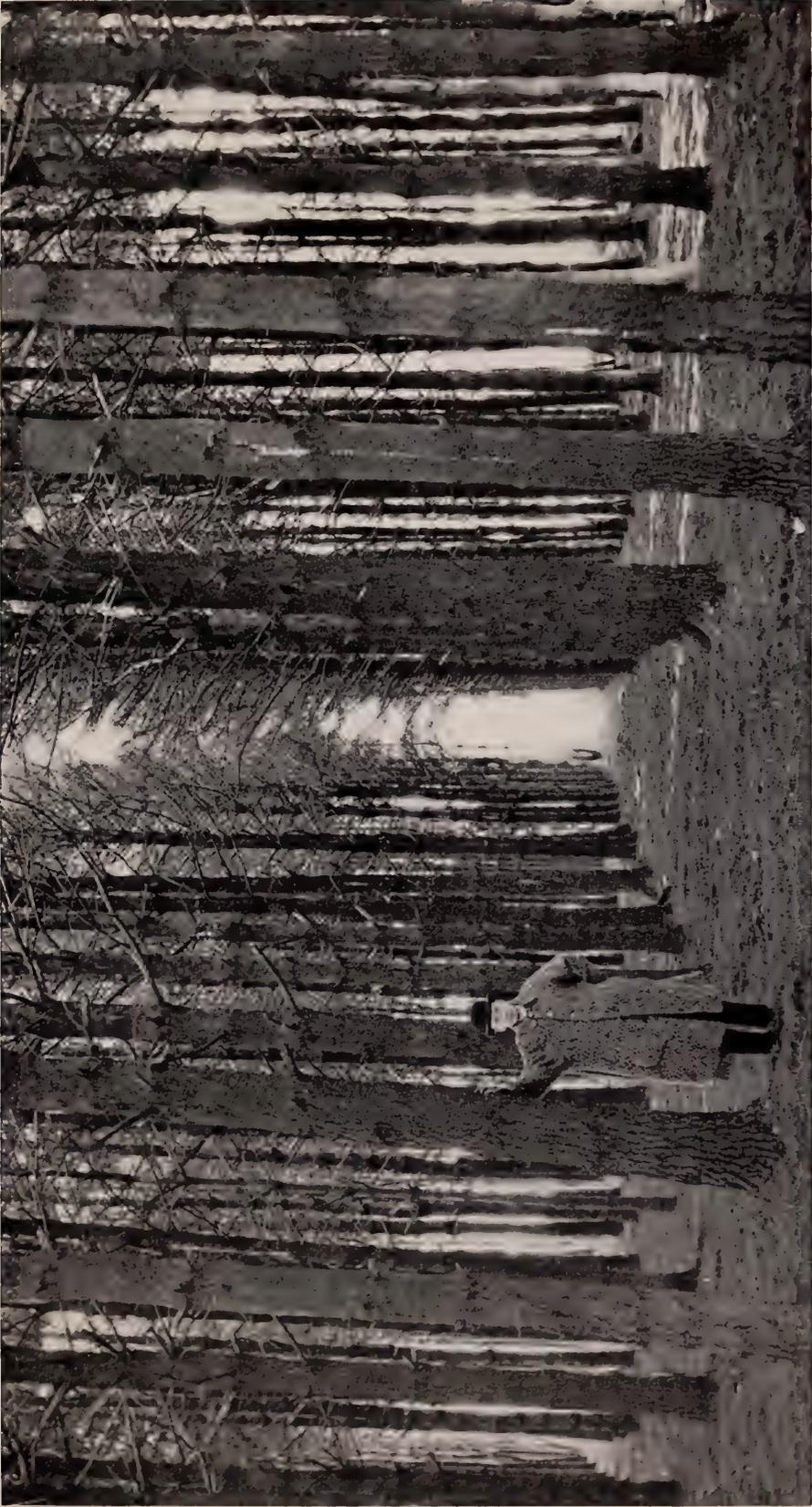
Average height, 55 feet.

East Taunton, Mass. — Owner, Miss Margaret Dean.

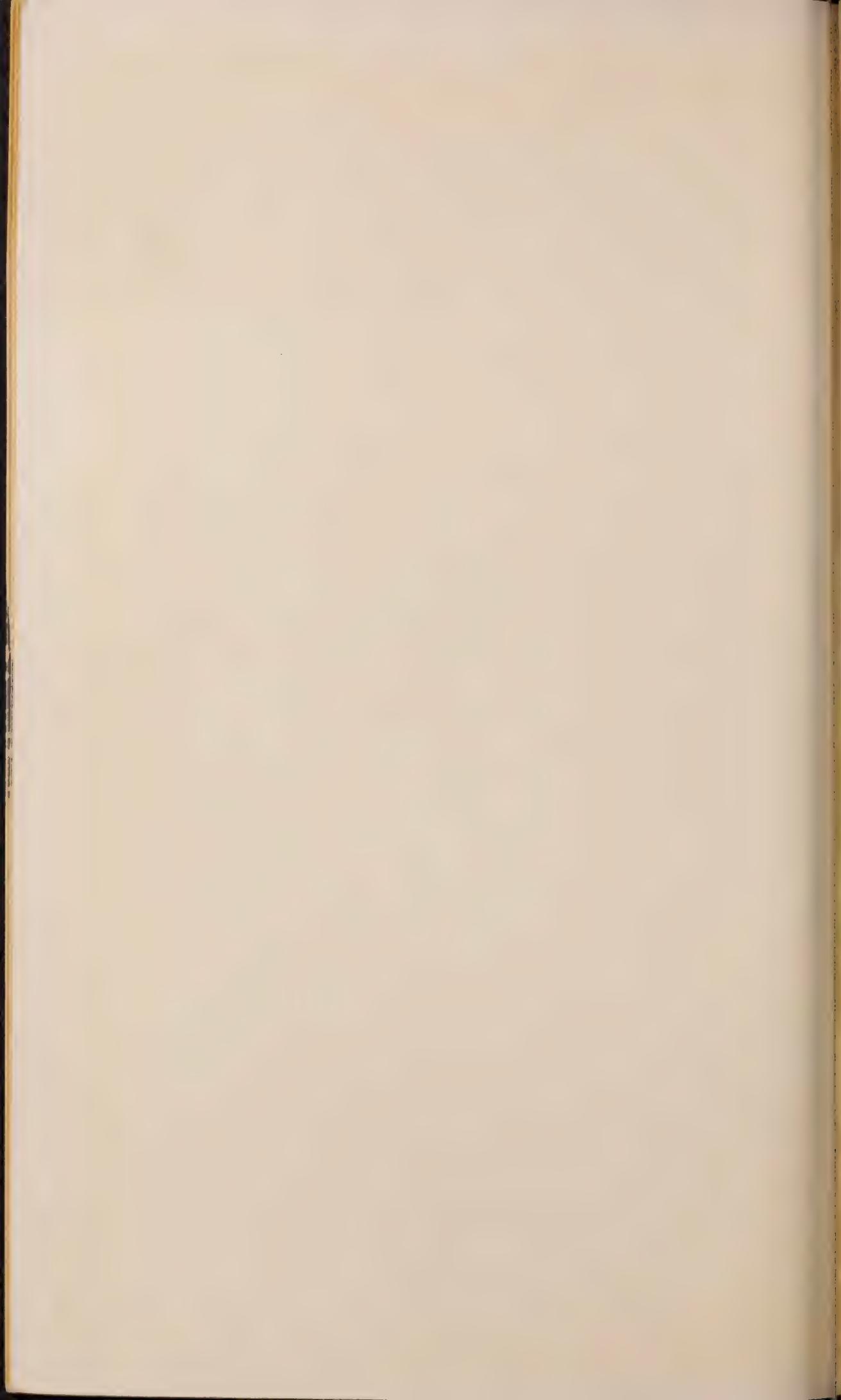
History. — About 1854 David Dean, a brother of the present owner, set out this plantation of white pine near his home, and about 1880 another lot adjoining was planted. Field trees were used and spaced 10 by 10 feet.

Object. — At that time the "American Agriculturist," published in New York, was advertising the planting of pine, and the original owner was one of those who became interested in forest planting.

Treatment. — This tract, while an excellent illustration of the growth of New England white pine, would have increased from 2 to 3 inches in diameter growth if it had been thinned at the proper time. A few trees have died out, and some were blown down during a heavy gale. Observations were made of the stumps of these trees. The last 20 annual rings were scarcely thicker than a sheet of paper, showing a tendency towards stagnation. For the first twenty years the rings show a growth, in some cases, better than normal.



White pine plantation, fifty years old, owned by Miss Margaret Dean, East Taunton, Mass.



The measurements were made early in the year (1914), and the total results placed upon the records in the State Forester's office. The inch classes are therefore omitted.

Section 1, Sixty-one Year Old Plantation.

Area, 1½ acres.

Total number of trees, 400.

Average height, 60 feet.

Board feet to acre, 41,000.

Section 2. Thirty-eight Year Old Plantation.

Area, 1½ acres.

Total number of trees, 375.

Average height, 50 feet.

Board feet to acre, 29,000.

Georgetown, Mass. — Owner, H. E. Guptill.

History. — Although this timber was measured in 1912, the totals are here given to show the results of the growth of white pine planted with Norway spruce. The plantation was forty-eight years old when measured, and was made with natural seedlings transplanted from the woods.

White Pine and Norway Spruce.

Area, 2.57 acres; age, forty-eight years.

Total board feet of spruce, 27,000.

Total board feet of pine, 55,000.

Total stand per acre, 33,000 board feet.

CONCLUSION.

The total results of the investigation, in terms of board measure for pine, are as follows. The two sample plots of tamarack and the forty-two roadside trees at Sharon, Mass., are not included.

	Board Feet per Acre.
Plantations 30 to 40 years old,	21,910
Plantations 40 to 50 years old,	32,726
Plantations 50 to 60 years old,	41,186

These results compare favorably with measurements made by this office of healthy stands of native Massachusetts white pine. No attempt has been made to show that planted pine, untreated, would produce more. On only two of the plantations was anything like a systematic thinning made (pages 18 and 31), and in no case were trees removed at an age when an added amount of light would have given the remaining trees the maximum amount of growth. The present method of planting calls for a 6 by 6 foot spacing, but with the idea that thinning is to be done as the trees develop to prevent overcrowding, to realize something in the way of an income on the plantation, and to develop the best diameters and heights possible for the final stand.

In conclusion the reader is referred to the yield tables on pages 37 and 38, representing the financial rotations of white pine plantations, the one under the present general system of taxing forest land, and the other under the new forest taxation law enacted in 1914. These tables are compiled by H. O. Cook, supplementary to the financial rotations in his bulletin on "Forest Mensuration of the White Pine." The volume tables used in this investigation were taken from the same bulletin.

When we speak of the yield of a pine plantation we think principally of the amount of lumber which can be cut from the land. Now, while this is important, the real determining factor as to whether a plantation is a success or not is the financial profit that such a plantation will bring. As with any investment, it is not the amount of business done, but the profits made which in the last analysis determine failure or success.

Timber crops are peculiar in that they cannot be harvested except after a period of years, so that it is not alone necessary to deduct actual expenses from gross returns in order to determine net yield, but these expenses must be carried from the date of their incurrence at some determined rate. As most savings banks pay 4 per cent., we must use a rate better than that, and have chosen 5 per cent. The net yield is in this case, therefore, a speculative profit over and above 5 per cent.

The gross returns are in this case the stumpage value ob-

tained from a yield table made by measuring sample plots in well-stocked natural stands in all parts of this State. Natural stands were taken because of the limited number of plantations that can be taken for this purpose. It will be seen on comparison, however, that the amounts given in the table are in substantial agreement with the average shown by the plantations described in this bulletin. The stumpage rates chosen run from \$6 to \$10, and are the rates of the present day, no allowance being made for the increase that future years will bring.

In compiling these tables certain assumptions were made, based on actual experience. The cost of the land is assumed to be the first expense, and is placed at \$5 per acre. The second premise is the cost of planting which is placed at \$12 per acre. These two expenses must be carried at compound interest from the beginning to the end of the rotation.

We have presented two tables, one of which shows the returns of a plantation taxed under the present general system, and the other for the same plantation registered under the new taxation law. We have assumed the tax rate to be \$20 per thousand. The land, of course, pays taxes from the beginning, but the timber not until the twenty-fifth year. In the case of classified land it pays no tax until it is cut, when it pays a product tax of 6 per cent. All of these expenses are carried at 5 per cent. compound interest to the end of the rotation, and we see that in the case of unclassified land the maximum yield comes at fifty years, when there is an excess profit of \$60. In the case of registered land the maximum yield comes at fifty years, and there is an excess profit of \$140, or two and a half times that of the unregistered. It should be said here, however, that in the case of the unclassified land we have assumed that the assessors taxed it at its full value, which is unusual in practice.

We would urge that every owner of a young artificial plantation should register his land, for it will be seen that while the owner of Plantation 1 invested in actual cash \$83 on his timber in fifty years, the owner of the registered Plantation 2 only risked \$40 in cash. On account of the time element and risk of a forest plantation the owner should take every opportunity

of keeping down his money investment. At present prices on lumber, a pine plantation is a 6 or 7 per cent. investment in Massachusetts, but an increase in stumpage values of whatever per cent. will make a corresponding increase in the returns. In other words, the planter of the present day can assume that he is investing for a 10 or 12 per cent. return rather than a 6 or 7 per cent. return.

One Acre Pine Plantation unclassified. Investment, Interest, Profit.

[Money valued at 5 per cent. Land at \$5 per acre. Cost of planting, \$12 per acre.]

AGE OF STAND (YEARS).	RETURNS.		EXPENSES AND INTEREST.										PROFIT.	
	Volume, Board Feet.	Stumpage Value.	PRODUCTION COST.		TAXES —				ON LAND.	Total Invest- ment (Money).	Total Invest- ment plus Interest.	Gross (Money).	Net in Excess of 5 Per Cent.	
			Interest on Value of Land.	Cost of Planting plus Interest.	ON TIMBER.		Amount paid in Money.	Amount paid with Interest.						Amount plus Accrued Interest.
					Annual for Five- year Periods.	Amount paid in Money.									Amount paid with Interest.
25,	4,000	\$24 00	\$11 92	\$40 62	\$0 48	-	\$2 50	\$4 15	\$14 50	\$56 69	\$9 50	-\$32 69		
30,	7,500	45 00	16 62	51 84	90	\$2 40	3 00	5 80	17 40	77 04	27 60	-32 04		
35,	17,000	136 00	22 56	66 18	2 72	6 90	3 50	7 85	22 40	105 37	113 60	31 63		
40,	25,200	200 00	30 20	84 48	4 00	20 50	4 00	10 90	36 50	155 36	163 50	44 64		
45,	32,100	257 00	39 90	107 22	5 14	40 50	4 50	13 95	57 00	217 92	200 00	39 08		
50,	37,600	376 00	57 30	137 58	7 50	66 20	5 00	18 30	83 20	315 34	292 80	60 66		
55,	42,100	420 00	73 17	175 62	8 40	103 70	5 50	23 85	121 20	445 60	308 80	-25 60		
60,	44,500	445 00	93 40	224 10	8 90	145 70	6 00	30 90	163 70	619 40	281 30	-174 40		
65,	46,200	462 00	116 70	386 02	9 24	191 20	6 50	40 00	209 70	951 94	254 30	-489 94		

One Acre Pine Plantation classified. Returns, Taxes, Interest, Profits.

[Money valued at 5 per cent. Land at \$5 per acre. Cost of planting, \$12 per acre.]

AGE OF STAND (YEARS).	RETURNS.		EXPENSES AND ACCRUED INTEREST.						PROFIT.		
	Stumpage Value.	Volume, Board Feet.	PRODUCTION COST.		TAXES—			Total Investment (Money).	Total Investment plus Interest.	Gross (Money).	Net in Excess of 5 Per Cent.
			Interest on Value of Land.	Cost of Planting plus Interest.	ON LAND.		Yield. Paid if Cut.				
					Amount paid in Money.	Amount plus Interest.					
25,	\$24 00	4,000	\$11 92	\$40 62	\$2 50	\$4 15	\$1 44	\$15 94	\$58 13	\$9 00	-\$33 13
30,	45 00	7,500	16 62	51 84	3 00	5 80	2 70	20 80	76 96	24 20	-30 96
35,	136 00	17,000	22 56	66 18	3 50	7 85	8 16	23 35	96 59	112 65	39 41
40,	200 00	25,000	30 20	84 48	4 00	10 90	12 00	28 00	137 58	172 00	62 42
45,	257 00	32,100	39 90	107 22	4 50	13 95	15 42	31 92	176 49	225 08	80 59
50,	376 00	37,600	57 30	137 58	5 00	18 30	22 56	39 56	235 74	336 44	140 25
55,	420 00	42,100	73 17	175 62	5 50	23 85	25 20	42 70	297 84	377 30	132 16
60,	445 00	44,500	93 40	224 10	6 00	30 90	26 70	44 70	375 10	400 30	69 90
65,	462 00	46,200	116 70	386 02	6 50	40 00	27 72	46 22	570 44	415 76	108 44

THE GYPSY MOTH IN MASSACHUSETTS



A BULLETIN OF THE
DEPARTMENT OF CONSERVATION
DIVISION OF FORESTRY

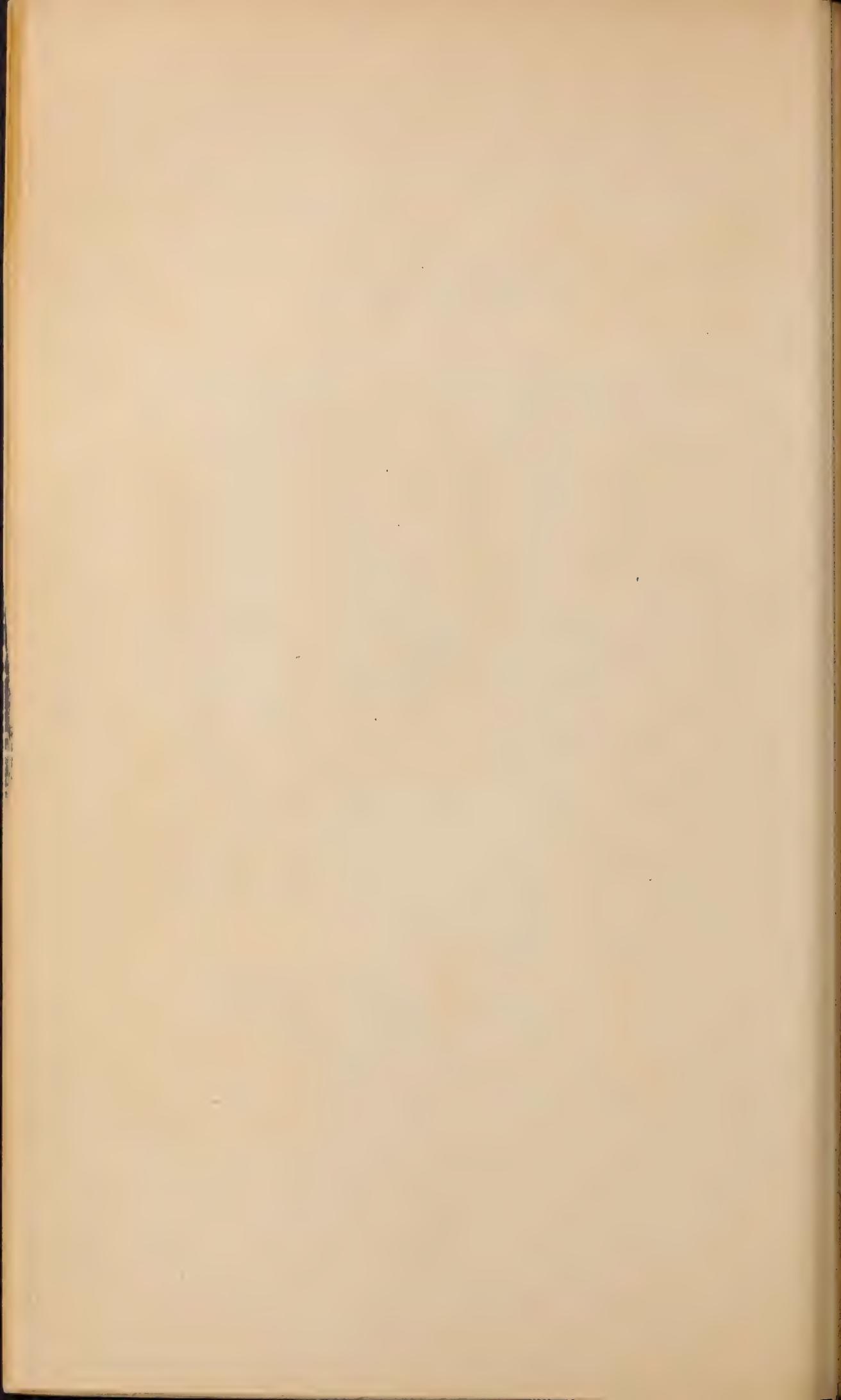
PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

INTRODUCTION

This bulletin on the gypsy moth is the successor of several that have preceded it, and the last edition, published in 1912, has been exhausted for some time. The present edition differs from its predecessors because it contains not only information on the life history and artificial methods of controlling the insect, but we have added paragraphs on its insect enemies and the wilt disease. The writer, H. O. Cook, M.F., has derived his information not only from the experience of the State Forester's department, but has drawn freely from the results of the investigative work of the United States Bureau of Entomology, and we wish especially to acknowledge the valuable assistance rendered us by Mr. A. F. Burgess, the chief of that department of the Bureau engaged in the work against the gypsy moth in New England. The aim has been to bring inside one cover, and in brief form, all the up-to-date information concerning this pest, its habits, and its control. We trust that our readers will find herein the information that they are seeking.

W. A. L. BAZELEY,

Conservation Commissioner and State Forester.





Male moth



Female moth



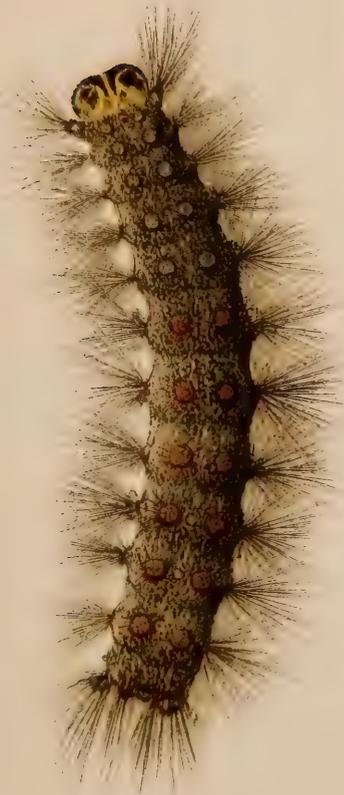
Male moth at rest



Female moth
laying eggs



Female pupa



Full grown caterpillar



Egg mass

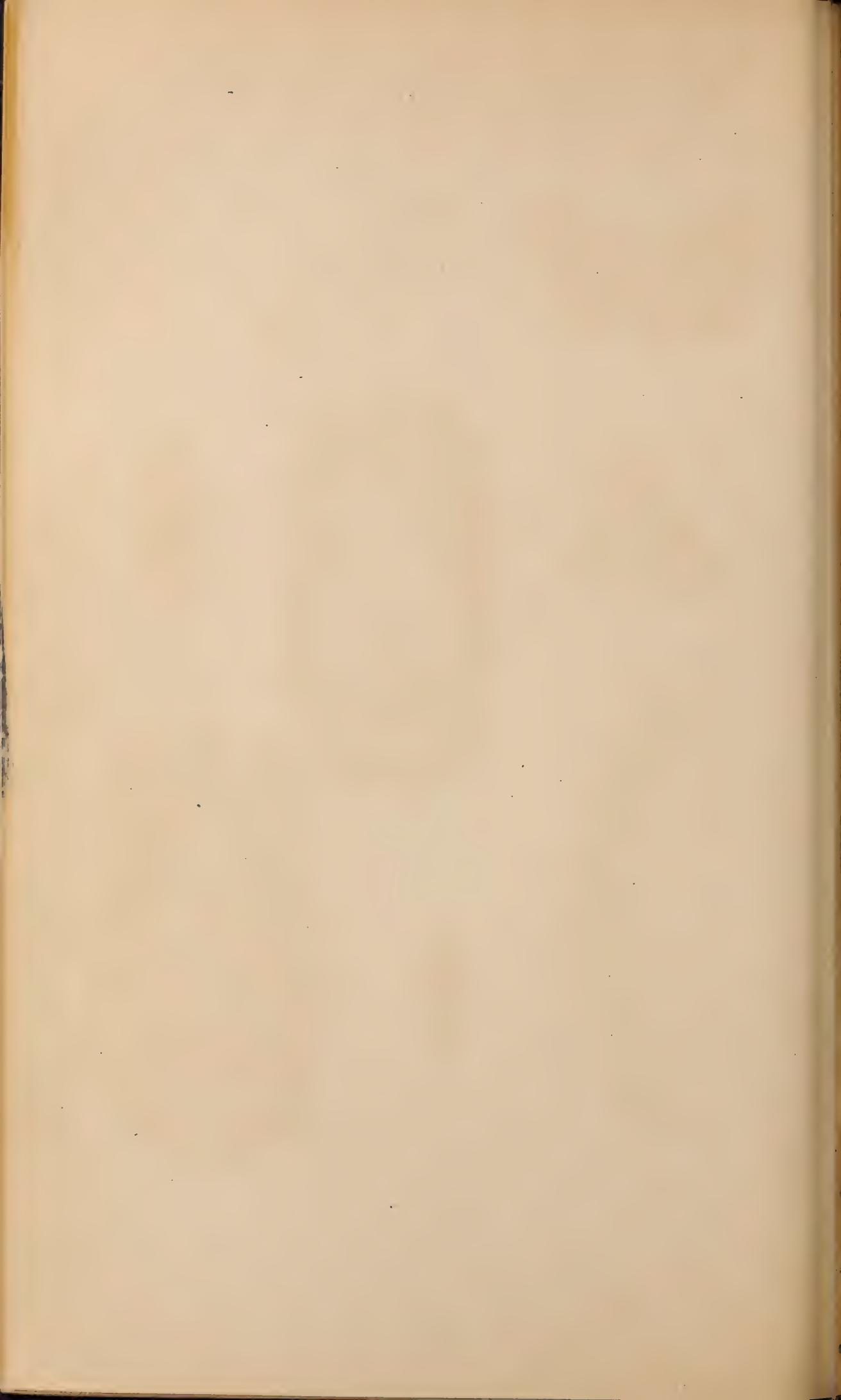


Male pupa

E. O. Cockayne, Boston, Lith.

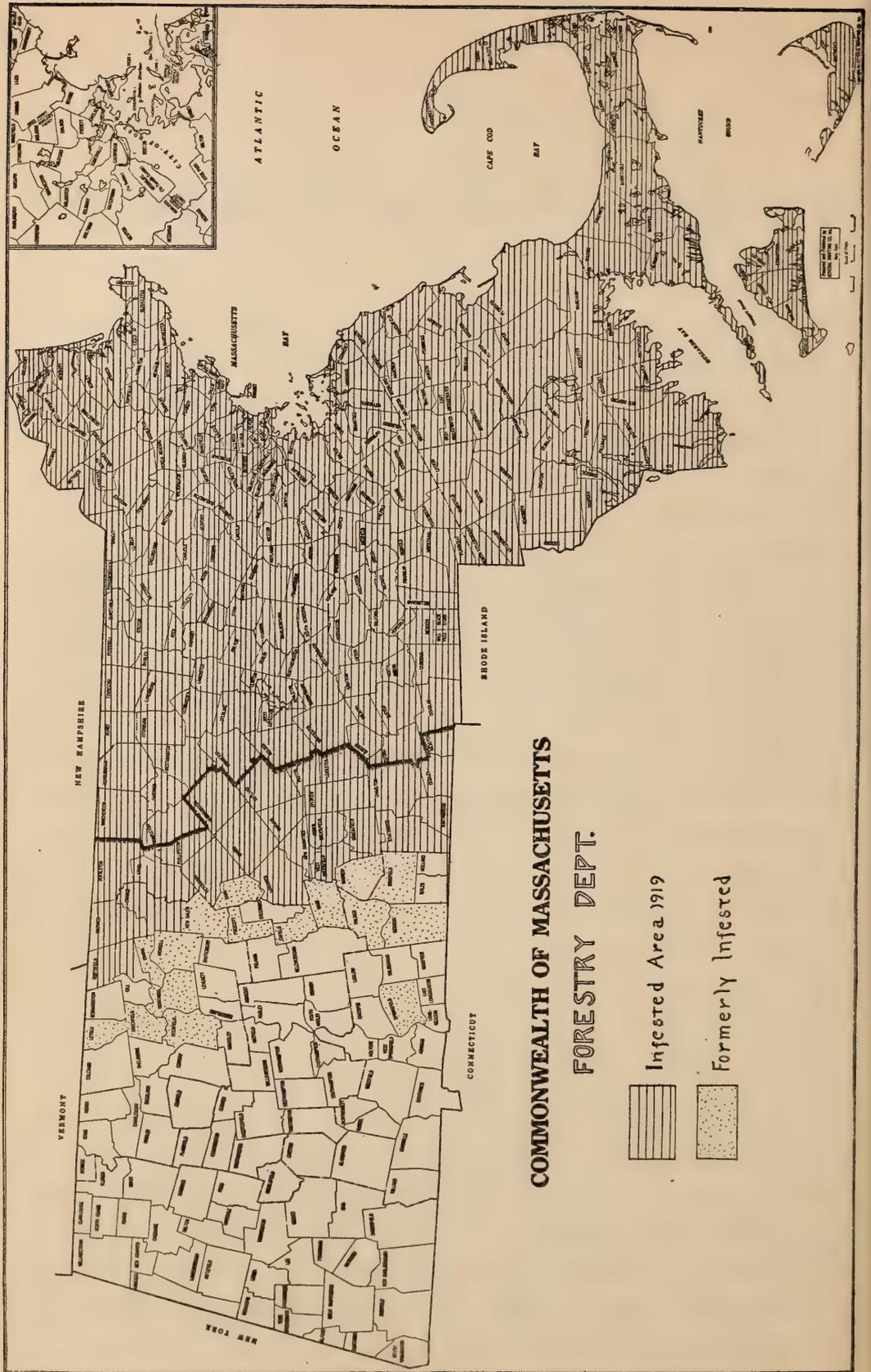
L. C. C. Krieger, del.

THE LIFE HISTORY OF THE GYPSY MOTH (*PORHETRIA DISPAR*).



The Gypsy Moth in Massachusetts

The gypsy moth was introduced from Europe by a naturalist, Leopold Trouvelot, in 1868, who at that time was living in Medford. Professor Trouvelot was endeavoring, by cross-breeding the gypsy moth and the silk worm, to produce a variety of the latter that could live in this climate. Unfortunately, one of the cages in which gypsy moths were confined became broken, and some of the caterpillars escaped. Mr. Trouvelot warned the people of Medford of the seriousness of the situation by articles in the local paper, but the warning was so disregarded that ten years later, when a strange caterpillar began to make its appearance in Medford, it was only after considerable investigation that it was identified as the gypsy moth of Europe. By 1889 the insect had reached alarming proportions, and a State appropriation was made to exterminate the insect. For ten years the work was carried on under the supervision of the Board of Agriculture. By 1900 the gypsy moth had been so decreased that it had ceased to be a public nuisance, and the Legislature was induced to withdraw the appropriation. This stopping of the fight against the gypsy moth was a serious mistake, for had it been continued the insect could at least have been kept under permanent control. The result of discontinuing the work was that by 1905 the depredations of the moth had again assumed alarming proportions, and they had spread over a territory far larger than they had occupied previous to 1900. In 1905 work was again taken up by the State under the supervision of a superintendent of moth work, and in 1909 the office was placed under the control of the State Forester.



LIFE HISTORY

The life history of the gypsy moth, like that of many insects, is divided into four stages, — egg, larva, pupa, and imago, or perfect insect.

Egg. — The eggs are spherical, yellow in color, and about the size of the head of a pin. They are laid in masses of about four hundred, on the trunks of trees, fences, stone walls, etc., and are covered by the female with yellow hairs from her body. These egg masses are laid by the female moth from about the middle of July to the middle of August.

Larva. — The larva, or caterpillar, hatches from these eggs about May 1, and when it emerges is a small, black, hairy caterpillar, less than one-quarter inch long. The caterpillar has six stages, or molts, and by the time it has reached the third molt it develops distinct markings. A double row of five raised blue spots is followed by a double row of six red. The full-grown caterpillar is from $1\frac{1}{2}$ to 3 inches long. It is the larval stage of the moth which does all the damage to foliage.

Pupa. — When fully grown, usually about the middle of July, the caterpillar spins a few silken threads as a supporting framework, casts its skin, and changes into a pupa, or chrysalis. The pupa is dark reddish brown in color, and very thinly sprinkled with brownish yellow hairs.

Moth. — From the middle of July until the middle of August the winged moths emerge from the pupæ. The male moth is brownish yellow, with dark brown markings. It has a slender body, and a wing expansion of $1\frac{1}{2}$ inches. It flies actively by day, with a peculiar zigzag flight.

The wings of the female moth are yellowish white, with numerous black markings, and expand about 2 inches. The abdomen is pale yellow and very heavy, as it is completely filled with eggs. The female is sluggish and does not fly.

THE GYPSY MOTH IN MASSACHUSETTS

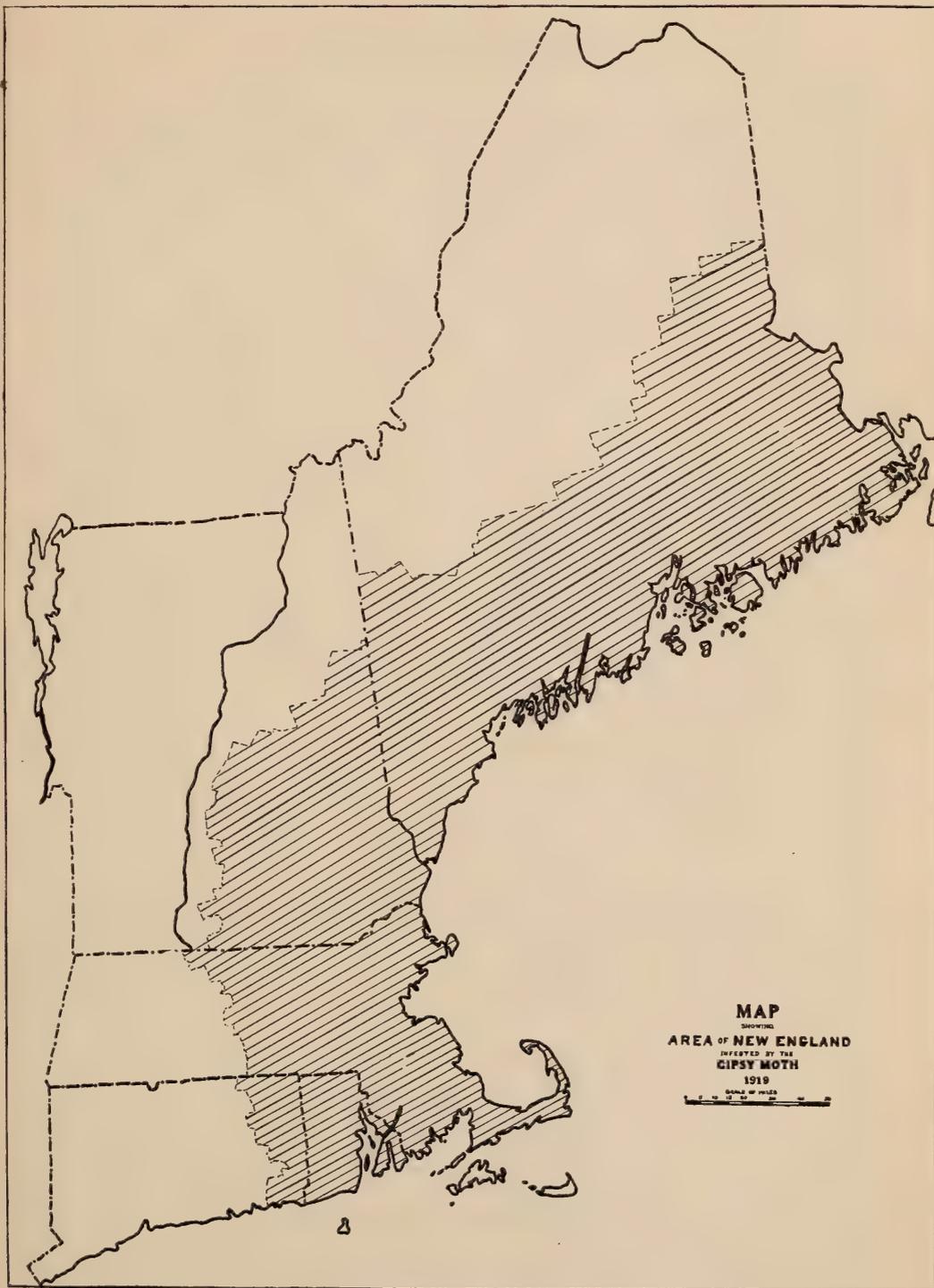
If it were otherwise, the spread of the gypsy moth would be much more rapid. After mating the moths live but a short time, and the female dies after depositing her eggs. The winged moths take no food, and all damage to foliage is caused by the caterpillars.

DISTRIBUTION

As the female moth does not fly, it is quite evident that the dispersion of this insect must be quite slow, unless it is carried by other means. The caterpillars, when first hatched, are very small — about one-eighth inch in length — and very hairy. A moderate breeze will pick up these small larvæ and carry them many miles. To test this matter the Federal Bureau of Entomology erected screens on the Isles of Shoals and at Provincetown, and on these screens small caterpillars were caught which had been blown from 13 to 20 miles. If one will notice the map of New England showing the present distribution of the gypsy moth, he will note how much farther to the northeast the moth has spread than to the southwest. This is due to prevailing southwesterly winds at the season the eggs are hatching.

When roadsides are badly infested the caterpillars may get on automobiles and other vehicles, and be carried in this way. This method of dispersion is not as prevalent as it may seem, however, and the rapid-moving automobile is less liable to transport caterpillars than the horse-drawn vehicle.

Another method of distribution of the gypsy moth is the transportation of egg-clusters on nursery stock, decorating material, and forest and quarry products. It is for this reason that the Federal government has placed a quarantine on the shipment of the above classes of materials from within the moth-infested areas to points outside, and requires that all such shipments be inspected before they can be shipped.



FEEDING HABITS

When the work of suppressing the gypsy moth was first undertaken the insect was considered a general feeder, and, in fact, some early experiments with laboratory feeding seemed to bear out this testimony. Long-continued field observations of the caterpillars showed, however, that they clearly favored certain species, especially the oaks, so that some very careful laboratory experiments were tried to determine just what is, and what is not, favorable food. The laboratory experiments were supplemented by detailed observations of selected areas in the field. It was found that the feeding propensities of the gypsy caterpillar change considerably with its age, and if forced to live in its early stages on what may be called "unfavorable foliage" the caterpillar could not survive and complete its life history. The result of these experiments is to place our native trees in four classes, as follows:—

I. Species favored by all larval stages: oaks, gray birch, willow, linden, larch, apple.

II. Species not favored by early larval stages: chestnut, hemlock, pine, spruce.

III. Species not favored, but which may be eaten: maple, yellow birch, elm, hickory, cherry.

IV. Species not favored by any larval stages: ash, butternut, walnut, catalpa, arbor vitæ.

The significance of this discovery lies in the fact that it aids us in part to control the ravages of the insect by forest management. By removing from our forests the favored food plants the increase of the moth can be greatly checked, and its suppression by other means assisted. The interested reader will find this matter discussed in detail in our bulletin on "Forest Thinning."

PARASITES

The insect world is controlled by natural forces. Were it not so, on account of their extreme power of reproduction, even one species would soon render the earth uninhabitable. To illustrate: Under the most favorable circumstances the gypsy moth will increase by sixfold in one year. Theoretically, it could increase two hundredfold, for each female moth lays four hundred eggs, and approximately half of these eggs produce female moths. What becomes of the one hundred and ninety-four eggs or caterpillars that perish by the way-side? Enormous numbers of the young caterpillars die in infancy because they are unable to obtain food soon enough after hatching, or because they are carried by the winds to places where no food exists, or because they are forced to subsist on unfavorable food. One of the potent agencies which nature uses in her control of insects is parasitism. Parasites are a class of insects which at some stage of their existence attack other insects, called hosts, and live upon them, usually internally. The importation of parasites of the gypsy moth is one of the romances of the entomological world. As this importation did not begin until 1905, and the gypsy moth came here in 1868, we must not be discouraged if the parasites have not yet increased in numbers or spread in area equally with the gypsy moth. Investigation in Europe and Japan shows that there are about thirty species of parasites feeding on the gypsy moth at some stage of its existence, and twenty of them have been imported in large numbers. Through co-operation between the Federal Bureau of Entomology and the superintendent for suppressing the gypsy and brown-tail moths a laboratory was established, first at North Saugus, and later at Melrose, to receive and handle importations of parasites. It was the largest effort in deliberate long-distance insect transportation ever tried, and it required considerable patience and investiga-

THE GYPSY MOTH IN MASSACHUSETTS

tion before satisfactory methods of transporting and rearing these insects were evolved.

It is not necessary in this bulletin to go into the life history of all these parasites, but a brief description of a few, which serve as types, may be of interest. These parasites attack the gypsy moth in three stages, — egg, caterpillar, and pupa. In fact, for parasitic work on the gypsy moth to be effective, all three stages should be attacked.

Two species of minute hymenopterous flies, *Anastatus* and *Schedius*, attack the eggs of the gypsy moth by laying their eggs within the eggs of the host. The young grubs which hatch out live on the substance of the gypsy-moth egg, thus destroying it. *Apanteles melanoscelis*, also a small hymenopterous parasite, lays its eggs in the bodies of small gypsy-moth caterpillars, and the young grubs live on the interior contents of the host until it is destroyed. There are several parasites of this class, and some of them attack the brown-tail as well as the gypsy-moth caterpillar.

The beneficial insect called the *Calosoma* beetle, introduced from Europe, is not a true parasite because it does not attach itself to its host. It attacks and eats the gypsy-moth caterpillars both as a beetle and as a larva. It also eats the gypsy-moth pupæ. It is voracious in appetite, active and hardy. This species has increased and spread in a most satisfactory manner, and has made great inroads on the gypsy moth in many localities. The beetles are from 1 to 1½ inches long, and a beautiful iridescent green, while the larvæ, which are about 1½ inches long, are shining black. There are two native *Calosoma* beetles somewhat similar in appearance to the imported. They are not as effective as the European species because of the inability of their larvæ to climb trees.

WILT DISEASE

Infectious diseases, as well as parasites, are some of nature's means of checking the overproduction of the insect family. In fact, observations in Europe have indicated that where such disease does not exist the parasites are not able to hold the gypsy moth in check. There are several diseases affecting caterpillars, some of which are infectious and some of which are not. Of the infectious diseases none are more effective than the so-called "wilt disease." This disease is caused by a filterable virus which may affect the caterpillar at any stage, but which does not appear abundantly until the third or fourth molt. At this time the infected caterpillar loses its vitality, a brown liquid appears at the mouth and anus, and the caterpillar hangs downward, suspended by one or two pairs of feet. After death the caterpillar has a most offensive odor.

Adverse conditions of several kinds may lead to the contraction of this disease on the part of the gypsy moth, but a prime factor appears to be a decrease in the amount or nutritive value of their food. This may be brought about by an oversupply of caterpillars, which completely strip the foliage while the insects are young, or by the necessity of feeding the caterpillars on "unfavorable" food. Warm, moist weather during the feeding season seems to help in the spread of the disease. It was first thought that the disease could be artificially propagated by raising diseased larvæ in the laboratory, and liberating them among their fellows. It was found, however, that where circumstances were not propitious artificial propagation was of no avail, and that where they were favorable the disease appeared on its own account, so that laboratory propagation of wilt disease was discontinued. The disease not only kills large numbers of caterpillars, but passes with them to the pupæ. In fact, a thorough attack of wilt disease may reduce a heavy infestation of gypsy moth 80 to 90 per cent in a single season.

GYPSY MOTH IN EUROPE

Inasmuch as the progenitors of our gypsy moths came from Europe, there is much interest in the status of this insect on that continent. In Europe it has occasional severe outbreaks over restricted areas, lasting two or three years. Its outbreaks are more numerous in Hungary and in southern Europe than they are in northern Europe. This is due undoubtedly to the higher percentage of deciduous, especially oak, growth in the forests of those countries. On the whole, it is not considered to be a dangerous insect, and is not nearly as much feared by foresters as its first cousin, the nun moth (*Liparis monacha*). The reason that the gypsy moth is not as injurious in its native land, especially in northern Europe, as it is here is due to three causes, — parasitism, caterpillar diseases, and forest conditions. It takes all three factors to control an insect pest as hardy as the gypsy moth. If forest conditions, — that is, feeding conditions, are favorable to the gypsy moth, neither parasites nor disease will provide more than a temporary check. In those portions of Europe where forestry has reached a high state of development it is quite evident that the foresters have, consciously or unconsciously, eliminated the gypsy moth as a dangerous insect by greatly curtailing the growth of its favorite food. Oaks are grown only in favorable localities, in small groups, or sparsely mixed with resistant trees. Until we attain a somewhat similar condition in this State we cannot hope to have complete natural control of the gypsy moth, and must keep up the fight by artificial means.

METHODS OF CONTROLLING THE GYPSY MOTH

We have been discussing nature's methods of combating the gypsy moths by parasites and diseases, and we now come to the artificial methods of control.

Creosoting. — One of the best methods of controlling the gypsy moth is to paint the egg clusters during fall and winter with creosote, to which coal tar has been added. This is applied with a long-handled brush, and the creosote kills the eggs, at the same time staining the cluster a dark brown.¹ Unless the creosoting is to be followed by spraying it must be carefully done. If half the egg clusters are left undisturbed there will be enough caterpillars to strip the trees, and the work done is practically wasted. Where thorough spraying is carried out it is often not necessary to creosote at all, as the spray will prevent stripping. It often happens, however, where infestation is very heavy, that the young caterpillars are so numerous as to strip the foliage before it can be sprayed, and in such cases creosoting is resorted to to reduce the force of the early outbreak of the caterpillars.

Tanglefooting. — A band of tree tanglefoot about 3 inches wide may be spread around the trunk of trees to prevent caterpillars crawling up to the foliage. If the egg clusters on the trees have been previously treated, and the tree does not stand too close to untreated trees, it is an effective measure. If the caterpillars attempt to ascend the tree they mass below the sticky band and die from starvation or wilt disease.

Spraying. — The cheapest and most effective method of combating this insect in a large way is by spraying with a solution of arsenate of lead and water, using paste at the rate of 10 pounds of lead to 100 gallons of water. Many persons

¹ Creosote may be obtained in local hardware stores for 45 cents per gallon, or, in many towns, it can be purchased from the local moth superintendent for about 27 cents. These prices are the 1920 quotations, and on account of the unsettled business conditions, with which we are all familiar, are subject to change from year to year.

THE GYPSY MOTH IN MASSACHUSETTS

now prefer the powdered arsenate of lead, which is mixed on a ratio of 5 pounds to 100 gallons. It is more convenient to handle, and more economical.¹ There are a great many types and sizes of spraying machines, from a barrel pump operated by hand to the so-called high-power truck sprayer driven by a 40-horsepower truck engine. Most types of gasoline sprayers are designed for orchard use, and cannot be used on street and woodland trees unless climbing is resorted to, — an expensive method. A satisfactory high-power sprayer drawn by two horses has a 400-gallon tank and a triplex pump capable of delivering 35 gallons per minute at 200 to 250 pounds' pressure. Such a machine throws a stream 70 to 80 feet in the air, and in woodland work a length 1,500 feet of hose is frequently used with success. This pump is driven by a 4-cylinder 10-horsepower engine.² The cost of spraying is very variable, and depends on several factors, the chief of which is the distance which it is necessary to traverse in going for water to fill the tank. Even under favorable circumstances about half the time is consumed in this operation. In woodland the cost varies greatly, dependent on the conditions. Woods that have been thinned, and underbrush cleared, can of course be sprayed much cheaper than woodland uncared for. An abundance of roads, making all parts of the woodland easily accessible, reduces the cost by making it possible to reach all sections with a short hose. Where a central water supply, as a pond or brook, is available, it is better to station the sprayer at this point, and reach all parts of the woodland by use of a long hose rather than to haul the water. In general, woodland spraying costs from \$10 to \$15 per acre, and as much woodland is valued at less than this amount it is hardly practical to

¹ In hardware stores paste arsenate, in small lots, costs 40 cents per pound, but in many towns it can be purchased from the local moth superintendent for 12 or 13 cents per pound, and the dry powdered for 27 cents. These prices are the 1920 quotations, and on account of the unsettled business conditions, with which we are all familiar, are subject to change from year to year.

² It costs about \$40 per day to operate such a machine.

spray the average woodland. The cost of roadside spraying, if figured at the cost per tree, will depend on the number of trees per mile of road and their size. In general, the cost of spraying ornamental roadside trees is about 25 cents per tree, — an investment well worth making. Of course the above costs are average, and subject to wide variations. They also apply only to operations carried out on a large scale. The cost of spraying two or three acres of woodland, or a few ornamental trees around a house, would be much higher, as allowance must be made for time lost in getting out the machine and going to and from the job.

One of the chief difficulties in spraying for the gypsy moth is the shortness of the time allowed for the job. The feeding season of the caterpillars extends from the middle of May until the middle of July, but spraying cannot well commence until the trees are in full leaf, which is not until the 1st of June, and spraying done after the 1st of July is not very effective, for the larvæ have already done their worst damage, and the foliage may be so badly stripped as to be incapable of holding the poison. It is not possible to spray in wet weather because the poison will not stick to the foliage, and it is difficult, at least, to spray in windy weather, so that there is sure to be considerable lost time to be taken out of the one month of spraying season.

The proper method of handling the gypsy moth in woodland or shade trees, orchards, or parks should be based on the infestation as determined by some one who is familiar with the work. Much energy and money may be wasted in applying remedies, unless their application is based on a thorough knowledge of existing conditions. An owner of an infested estate should apply to the State Forester to have an examination made by one of his assistants, who not only can give him reliable information as to the proper treatment, but, under some conditions, will assume responsibility for seeing that the work is carried out.

ADMINISTRATION OF WORK

The laws regulating the work against the gypsy moth are published in a separate publication, and will not be reprinted here, but a brief statement of the method of carrying on the work will be of value in this bulletin.

The law provides that each individual town shall care for the suppression of the gypsy and brown-tail moths within its borders through a local superintendent appointed by the mayor or selectmen, with the approval of the State Forester. In carrying out the measures for such suppression the local superintendent acts under the direction of the State Forester and his district superintendent. The financing of this work, as provided by law, is somewhat complicated, and need be only briefly outlined here. Each town is required to expend one twenty-fifth of 1 per cent of its valuation in suppressive work. This sum, which amounts to only a few hundreds in small towns, and runs up to a maximum of \$5,000, the community must spend from its own funds, provided conditions call for it. Where an amount in excess of this liability is spent by the towns the whole or a portion of said excess may be reimbursed to the town by the State, the percentage of such reimbursement depending on the valuation of the town. Such reimbursements are paid partly in money, but supplies also constitute part of the amount, because it is possible for the State Forester to buy materials in large quantities much cheaper than the towns, and economy in disbursing the State appropriation is thus secured.

In addition to the work done under the direction of the State Forester, the Federal government appropriates \$300,000 per year for the suppression of the gypsy moth. This work is done by the Federal Bureau of Entomology, and although their territory includes all New England, a considerable portion of their funds are expended in Massachusetts. By agreement between it and this department it

THE GYPSY MOTH IN MASSACHUSETTS

undertakes the work of stopping the spread of the moth by work on the frontier of the infested territory. The work of controlling the gypsy moth west of the heavy line shown on the map of this State is in the hands of the Bureau of Entomology. They have assumed the responsibility for all work of a scientific character, such as parasite importation and investigation in field and laboratory of various conditions affecting the life of the gypsy moth. They also have charge of the inspection of the shipments of forest products mentioned before. Because they are not restricted by State lines they are better able to carry on this line of work than the State Forestry Division.

BIBLIOGRAPHY

For the benefit of those who may wish to study into certain phases of the gypsy-moth problem more thoroughly than the present bulletin gives opportunity, we append this list of Federal and State bulletins. It is only fair to state that many of these publications give the result of earlier investigations, and do not contain the most up-to-date information on the subject that they are supposed to cover.

State Forester: —

- Parasites of the Gypsy Moth.
- Wilt Disease of the Gypsy Moth.
- Management of Moth Infested Woodlands.
- Calosoma Beetle (card in colors).

United States Department of Agriculture: —

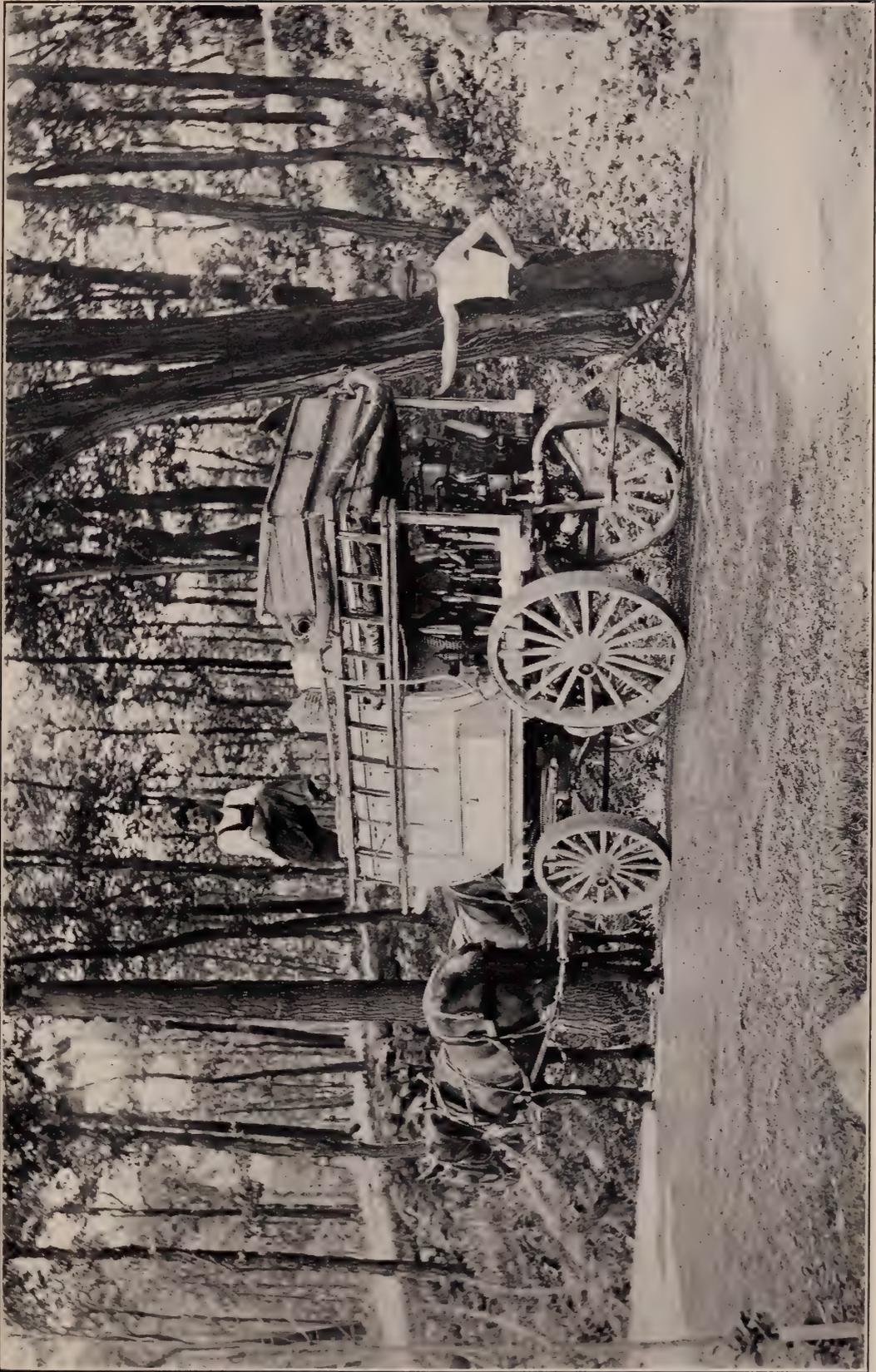
- Farmer's Bulletin (564) Gypsy Moth, with Suggestions for its Control.

Bureau of Entomology Circular: —

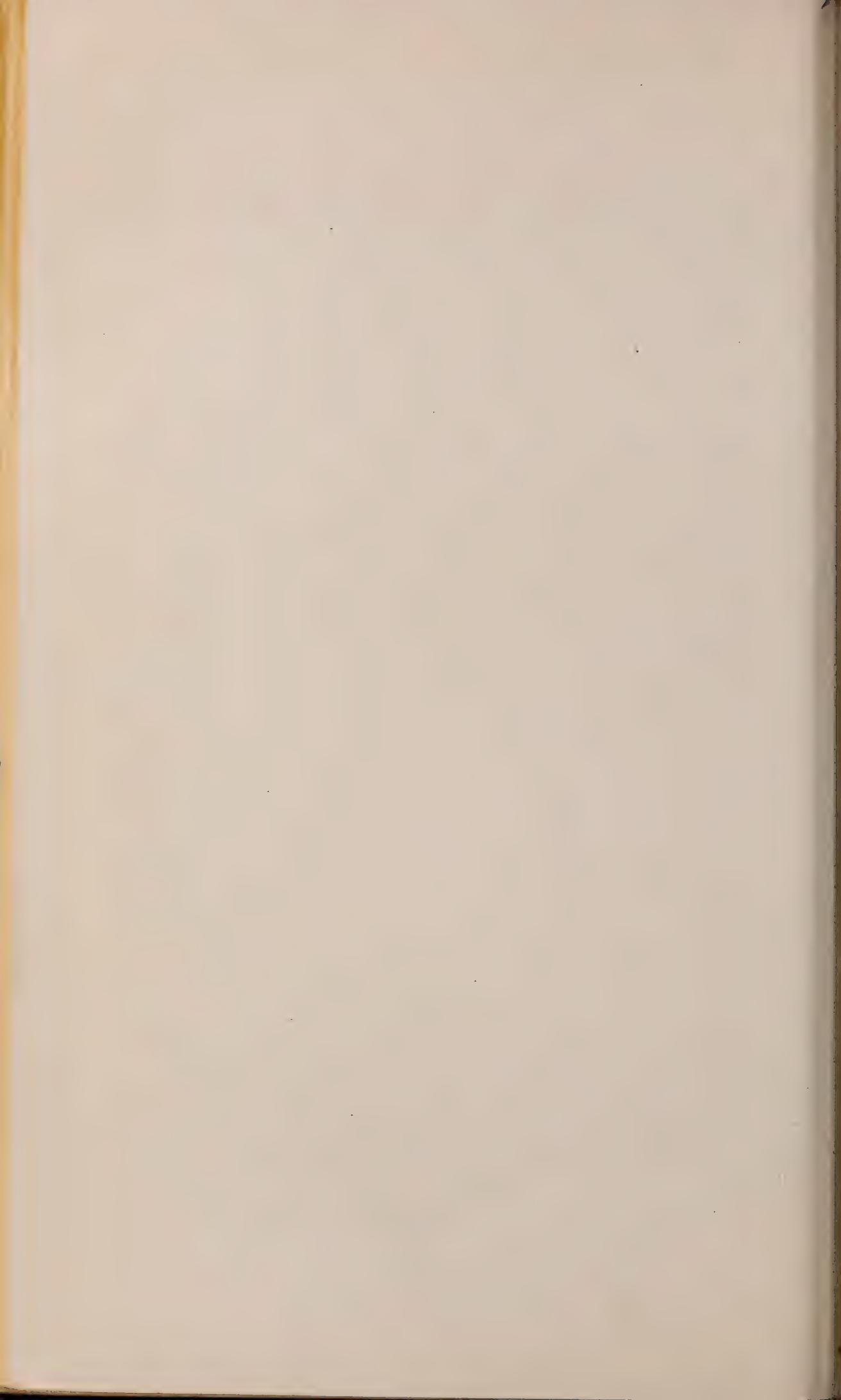
- (164) Gypsy Moth as a Forest Insect.

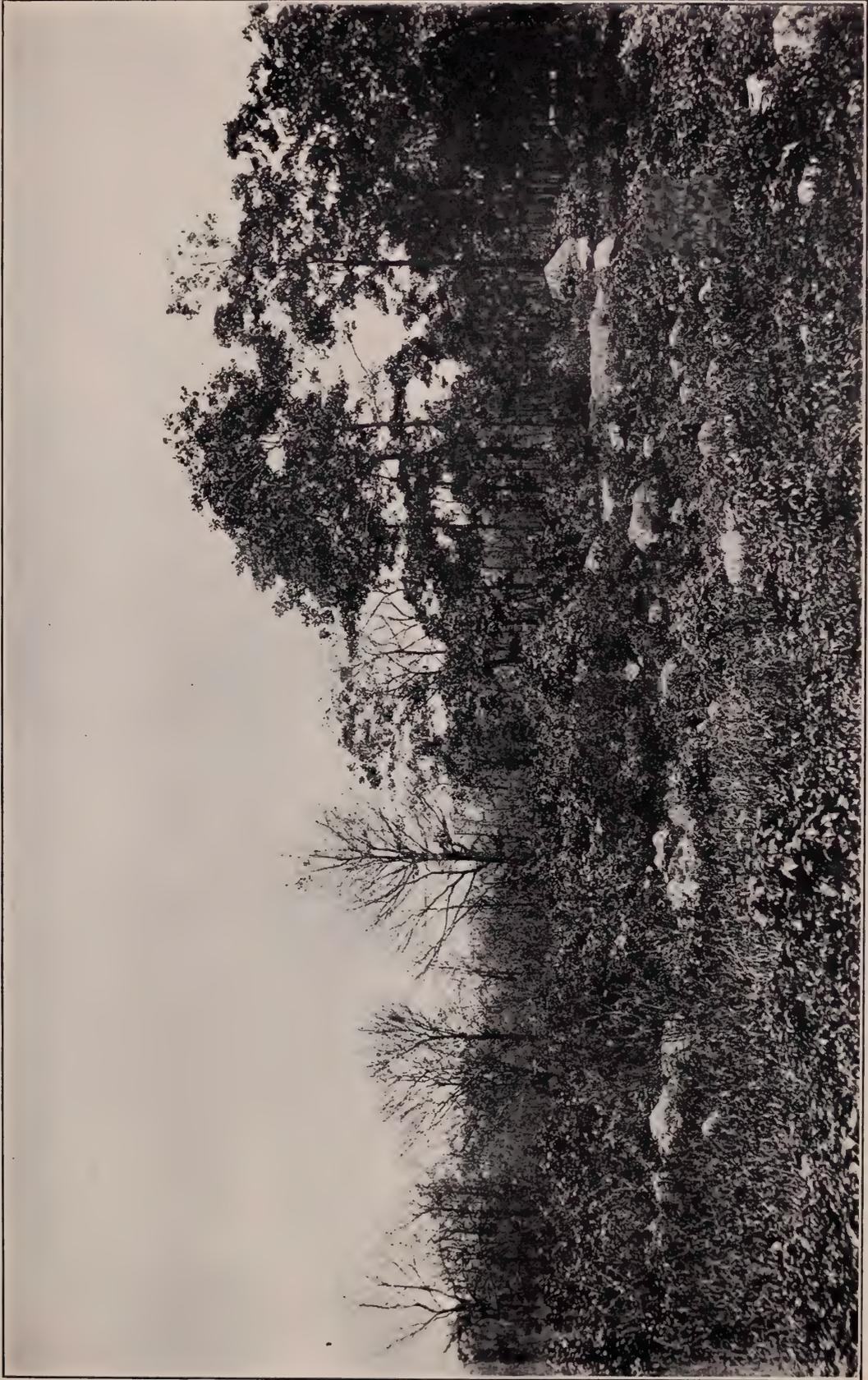
Bureau of Entomology Bulletins: —

- (273) Dispersion of Gypsy Moth Larvæ.
- (251) The Calosoma Beetle in New England.
- (250) Food Plants of Gypsy Moth in America.
- (204) Report on Gypsy Moth in New England.
- (484) Control of Gypsy Moth by Forest Management.
- Wilt of Gypsy Moth Caterpillars. *Journal of Agri. Research* 1915, Vol. IV, No. 2.

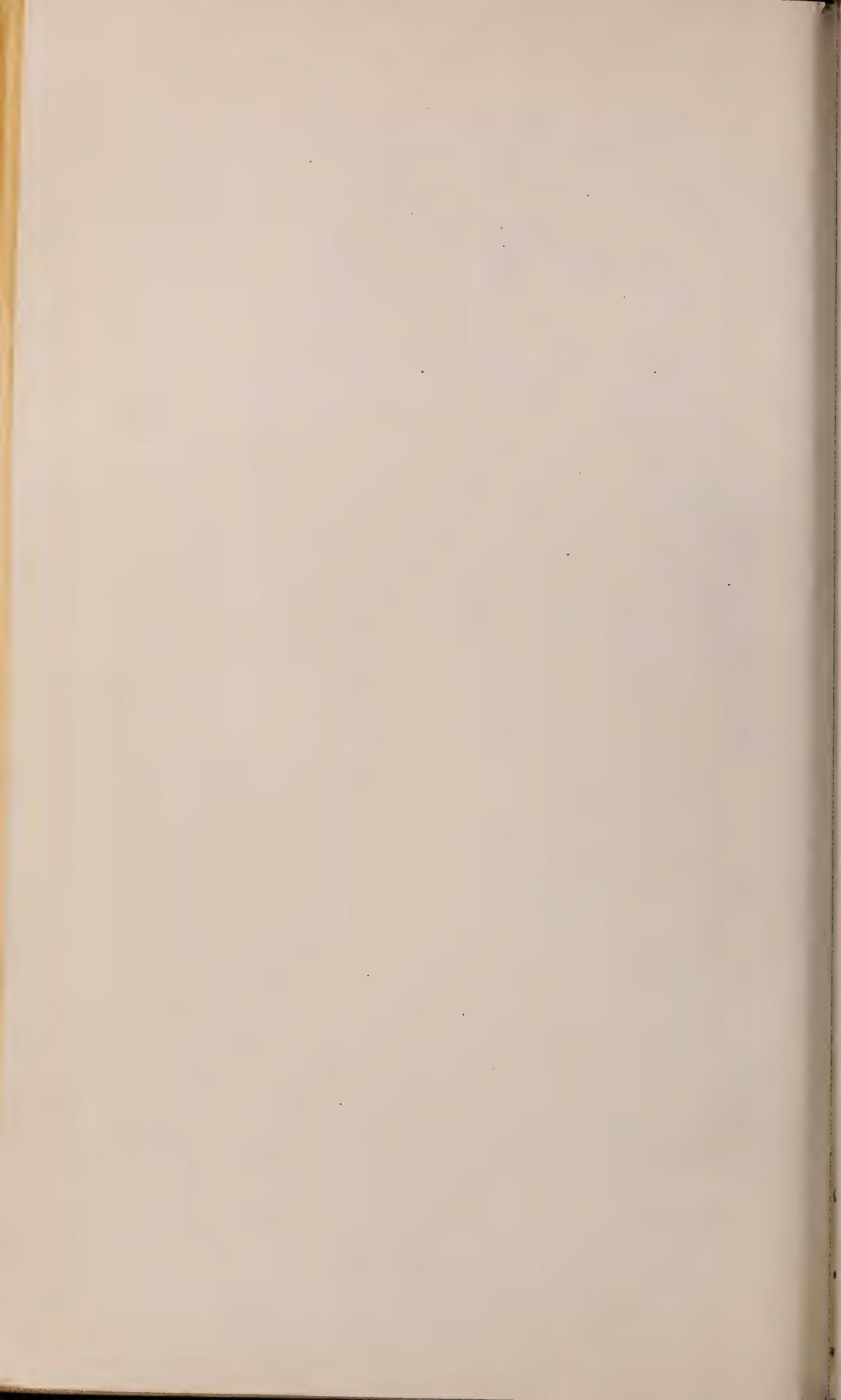


Horse-drawn sprayer equipped for service.



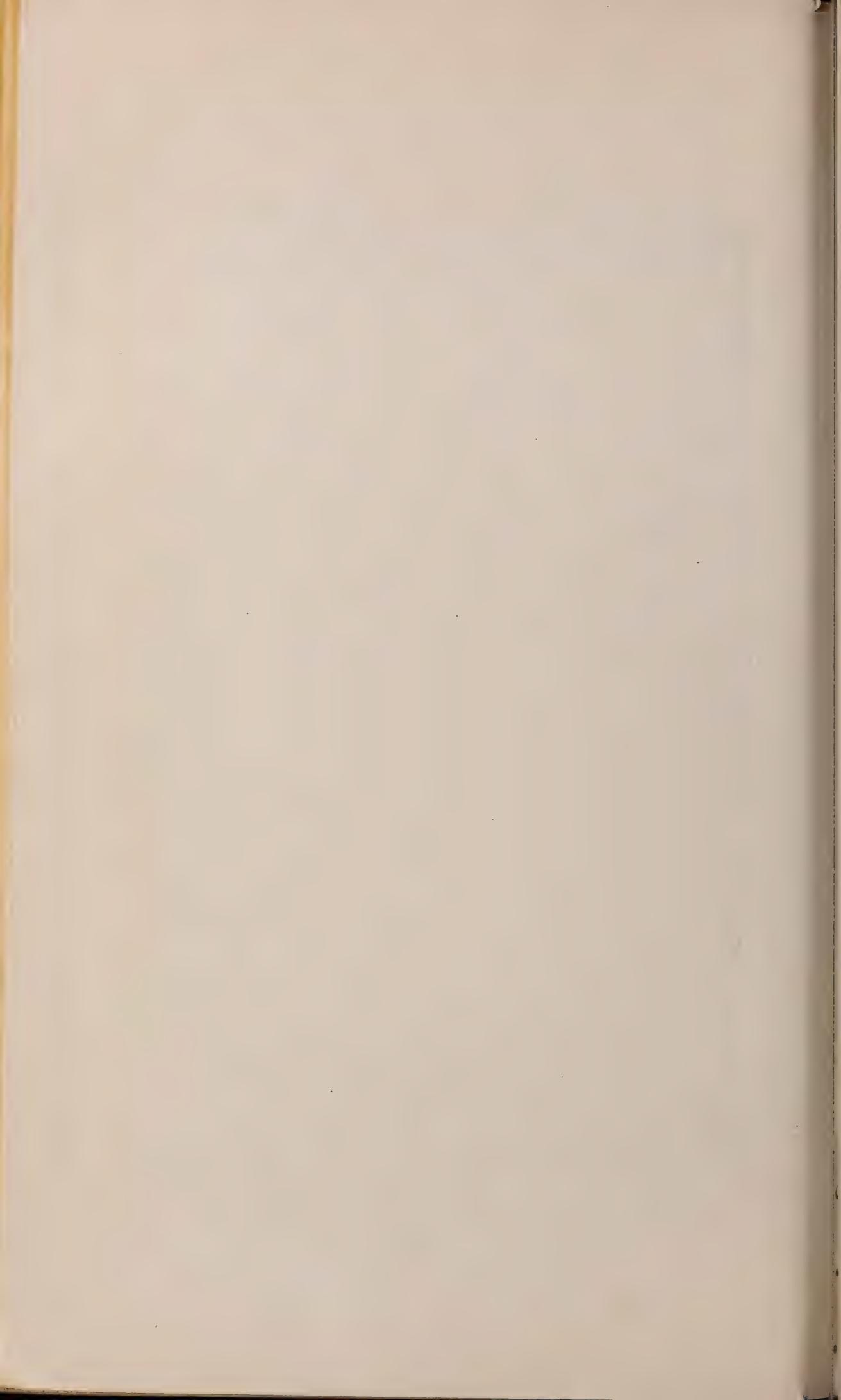


Trees on right sprayed; on left not sprayed.





Spraying ornamental trees.





Spraying in woodland.

THE
CHESTNUT BARK
DISEASE

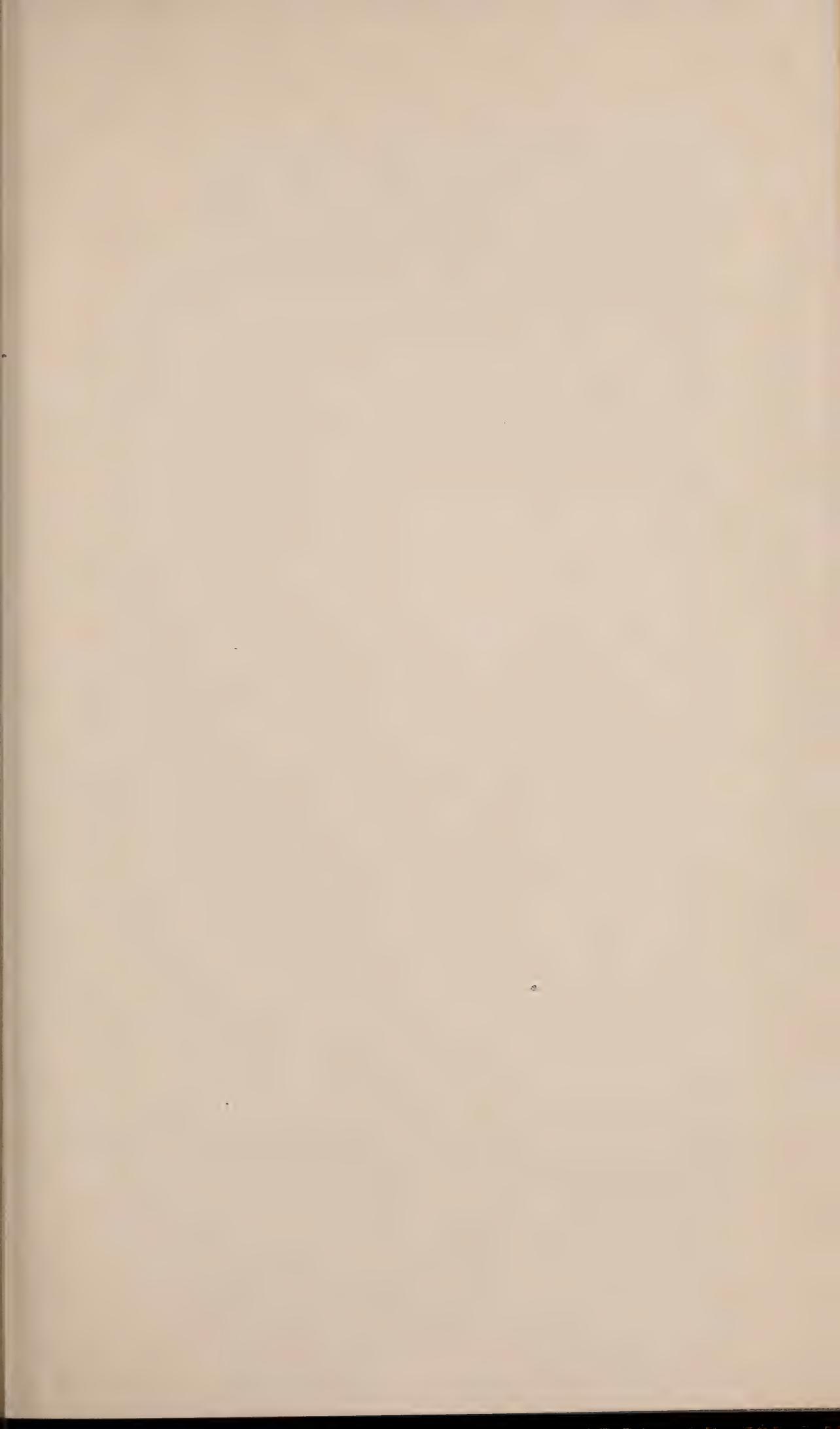
AND THE
CHESTNUT MARKET
IN
MASSACHUSETTS

Where found
How to tell the disease
Methods of control
Trees should be utilized before they die
Markets

F. W. RANE, STATE FORESTER
6 BEACON STREET, BOSTON, MASS.

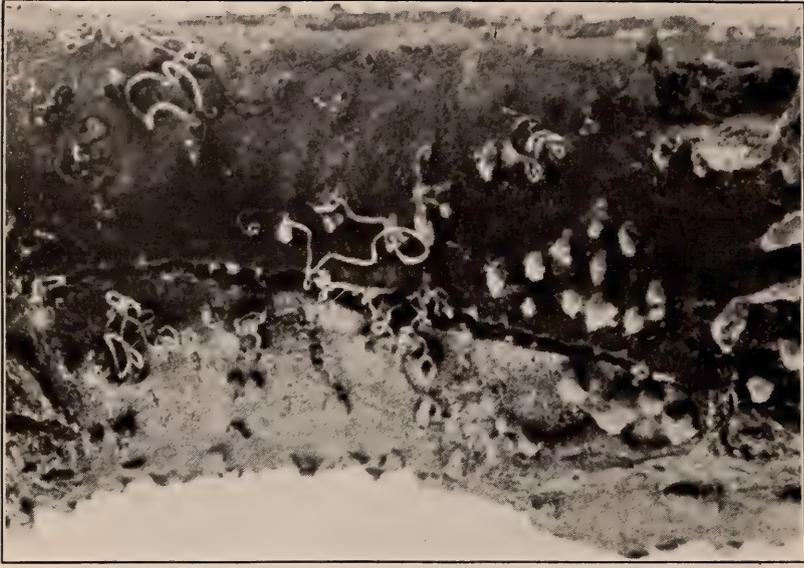
BOSTON
WRIGHT & POTTER PRINTING COMPANY, STATE PRINTERS
32 DERNE STREET
1916

APPROVED BY
THE STATE BOARD OF PUBLICATION.





Early stage of infection on smooth-barked young tree.
Specimen obtained at Barre, Mass.



Section of infected bark, showing pustules and strings of summer spores. (Magnified.)
These strings are yellowish and sticky to the touch. (Reproduced by permission of the United States Department of Agriculture.)

THE CHESTNUT BARK DISEASE.

INTRODUCTION.

The chestnut bark disease as a serious menace to chestnut growth of Massachusetts first became apparent within our boundaries in 1910, and the following winter the State Forester published a pamphlet on the subject. In 1912 this pamphlet was followed by a more complete bulletin by Mr. John Murdoch, Jr., then in charge of the bark disease investigation. In order to aid the owners of infected stands to dispose of their timber, Mr. Murdoch was commissioned to issue a bulletin on the "Chestnut and its Market." Both of these bulletins are now out of print, and Mr. Simmons of this department has combined and brought up to date the essential information contained in both in this new edition.

Acknowledgment should be made to the United States Bureau of Plant Industry for information on the characteristics of the chestnut bark disease (Farmers' Bulletin No. 467) and to the United States Forest Service and the State Forester of Connecticut for data from which tables in the market bulletin were constructed (United States Forest Service Bulletin 96; Connecticut Agricultural Experiment Station Bulletin 154). Mention should be made of Mr. Roy G. Pierce, who, following Mr. Murdoch in charge of bark disease investigations, served in this department for a year and added valuable data to the knowledge concerning this disease in our State.

THE DISEASE.

History and Distribution.

The chestnut bark disease was first recognized as a serious disease in the vicinity of New York City in 1904. Its origin is unknown, but there is some evidence that it was imported from the Orient with the Japanese chestnut. It is certain that it has now spread into at least ten States.

So far as is now known the bark disease is limited to the true chestnuts, that is, to the members of the genus *Castanea*. The American chestnut, the chinquapin and the cultivated varieties of the European chestnut are all readily subject to the disease. Only the Japanese and perhaps other east Asian varieties appear to have resistance. In spite of popular reports to the contrary, it can be quite positively stated that the bark disease is not now known to occur on living oaks, horse-chestnuts, beeches, hickories or the golden-leaf chinquapin (*Castanopsis chrysophylla*) of the Pacific coast.

Distribution in Massachusetts.

The serious character of the attack of the disease in this State was not realized until the summer of 1912. During June, July and August of that year Mr. A. H. Graves, representing the United States Department of Agriculture, made a tour of various portions of Massachusetts. This was supplemented by work done during the late fall by two special representatives from this office. These investigations showed that the blight was very widely scattered over the State. In Berkshire, Hampden, Hampshire, Franklin and western Worcester counties the infection was general, and sporadic cases were discovered as far east as Bedford, Quincy and Taunton. In 1913 Mr. Roy G. Pierce, government expert, began his work in connection with the State Forester's office, and covered the State quite thoroughly, making examinations, giving advice and lectures, and disseminating knowledge generally in regard to the disease and its workings, so that most woodland owners have at present a very fair idea of what the disease is like. He found that the disease was distributed over the entire chestnut area of the State.

Cause and Symptoms.

The chestnut bark disease is caused by a fungous parasite known under the technical name of *Diaporthe parasitica* Murrill. When any of the microscopic spores of this fungus gain entrance into any part of the trunk or limbs of a chestnut tree they give rise to a spreading "sore" or lesion. If the part attacked happens to be the trunk, the whole tree is killed, perhaps in a single season. If the smaller branches are attacked, only those





Section of infected bark, showing pustules producing winter spores. Specimen obtained at Barre, Mass., December, 1911.

branches are killed and the remainder of the tree may survive for several years.

Some of the symptoms are quite prominent. Limbs or the trunks of young trees with smooth bark attacked by the fungus soon show dead, somewhat discolored, sunken areas (occasionally with a raised margin), or the outer bark may, in the earlier stages, be raised in the form of a blister, which continues to enlarge and soon becomes covered more or less thickly with yellow, orange or reddish-brown spots about the size of a pin-head. These spots are the pustules of the fruiting fungus. In damp weather masses of summer spores are extruded in the form of long, irregularly twisted strings or "horns," which are at first bright yellow to greenish yellow or even buff, becoming darker with age. If the lesion is on thick bark the pustules show in the cracks. After smooth-barked limbs or trunks are girdled the fungus continues to grow extensively through the bark sometimes covering the entire surface with reddish-brown pustules. These pustules produce mostly winter spores.

After a trunk or branch is girdled the leaves change color and sooner or later wither. Such branches have a very characteristic appearance. In case the girdling is completed late in the season, the leaves of the following spring assume a yellowish or pale appearance and do not develop to their full size. The chestnut fruits (burs) on a spring-girdled branch may or may not attain full size. These burs commonly persist on the tree during the following winter. The dead leaves also frequently persist through at least the first part of the winter.

Perhaps the most easily seen as well as the longest persistent symptom of the bark disease is the prompt development of sprouts or "suckers" on the trunk of the tree and at its base, or somewhat less frequently on the smaller branches. Sprouts may appear below every girdling lesion on a tree, and there are usually many such lesions. These sprouts are usually very luxuriant and quick growing, but rarely survive the second or third year, as they in turn are killed by the fungus. Sprouts are sometimes produced as a result of other injuries, and are common following thinning of a chestnut stand as a result of the increased amount of light admitted.

Means of Spread and Entrance.

The disease is spread by the spores of the fungus, — minute, dust-like bodies corresponding to the seeds of higher plants, — of which there are two kinds. The spores, by rain, are washed down from twig infections to the lower parts of the tree. There is strong evidence that the spores are spread extensively by birds, especially woodpeckers, thus causing the isolated areas of infection far ahead of the main line of advance, and there is also excellent evidence that they are spread by insects and by various rodents, such as squirrels. Although both kinds of spores are said to be sticky, the uniform and often rapid spread of the disease from a center of infection would seem to indicate that they are often carried to some distance by the wind. An infected area may, under favorable conditions, increase by several hundred per cent. in the course of a single season.

When the spores have once been carried to a healthy tree, they may develop in any sort of a hole in the bark which is reasonably moist. These may be wounds or mechanical injuries, but by far the most common place of infection is a tunnel made by a borer.

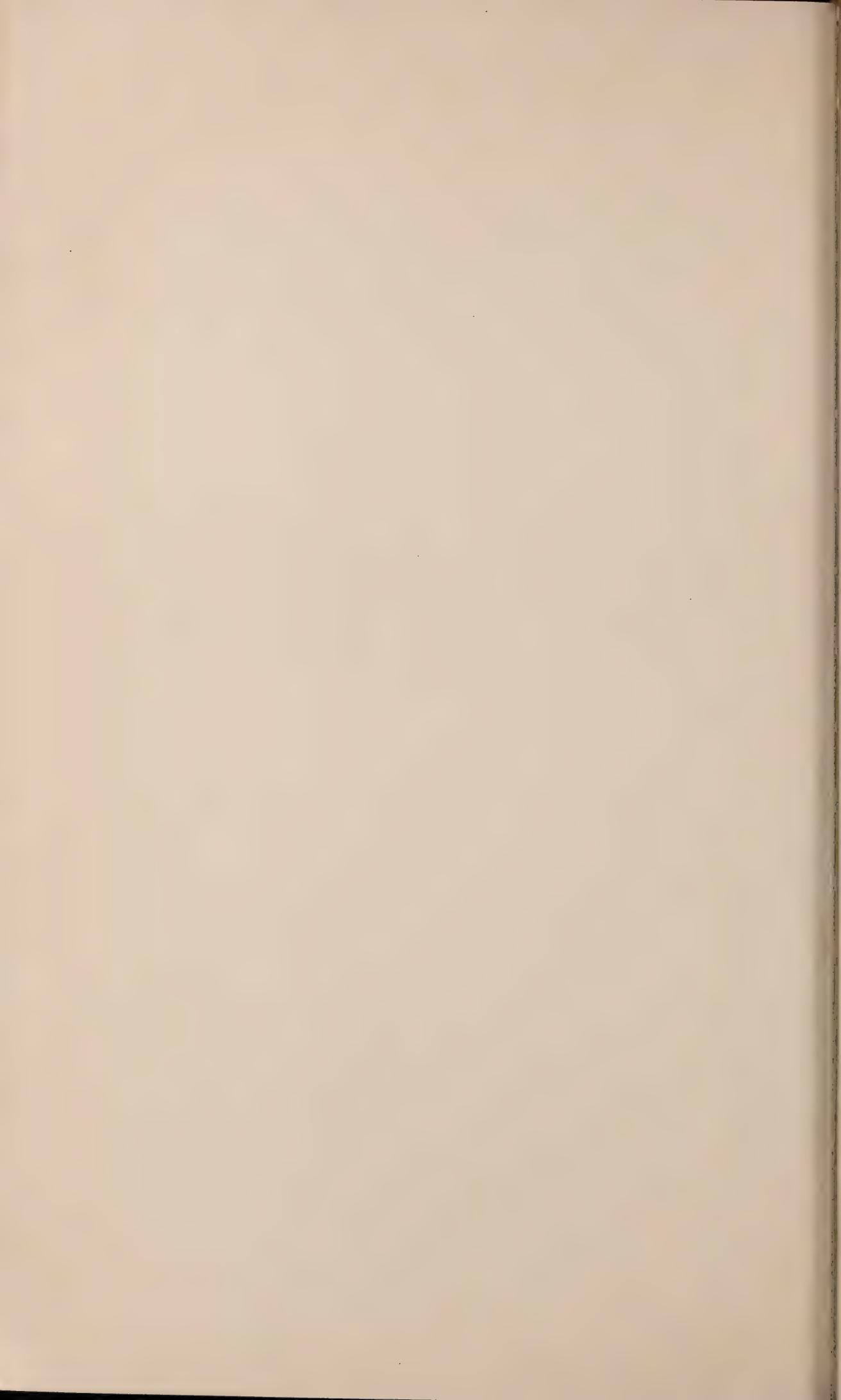
The disease attacks only living trees, but the fungus apparently may continue to grow in the bark and to produce an abundance of spores for six months or more after the tree has died.

Possibility of Checking the Disease in Massachusetts.

It is admitted that after the disease has once become well established in a locality there is no practicable method of eradicating it. When Mr. Pierce began his work in 1913 a plan was discussed for drawing a "dead line" near the main front of the advance of the disease, for abandoning all chestnut behind this line and for locating and destroying all cases in front of it. But the survey of the State which was made showed that, if such a line were drawn, not less than two-thirds of the total chestnut stand in the State, probably much more, must be left behind it. To eradicate the disease outside



General appearance of blighted chestnut tree, dead top, with numerous suckers along trunk.

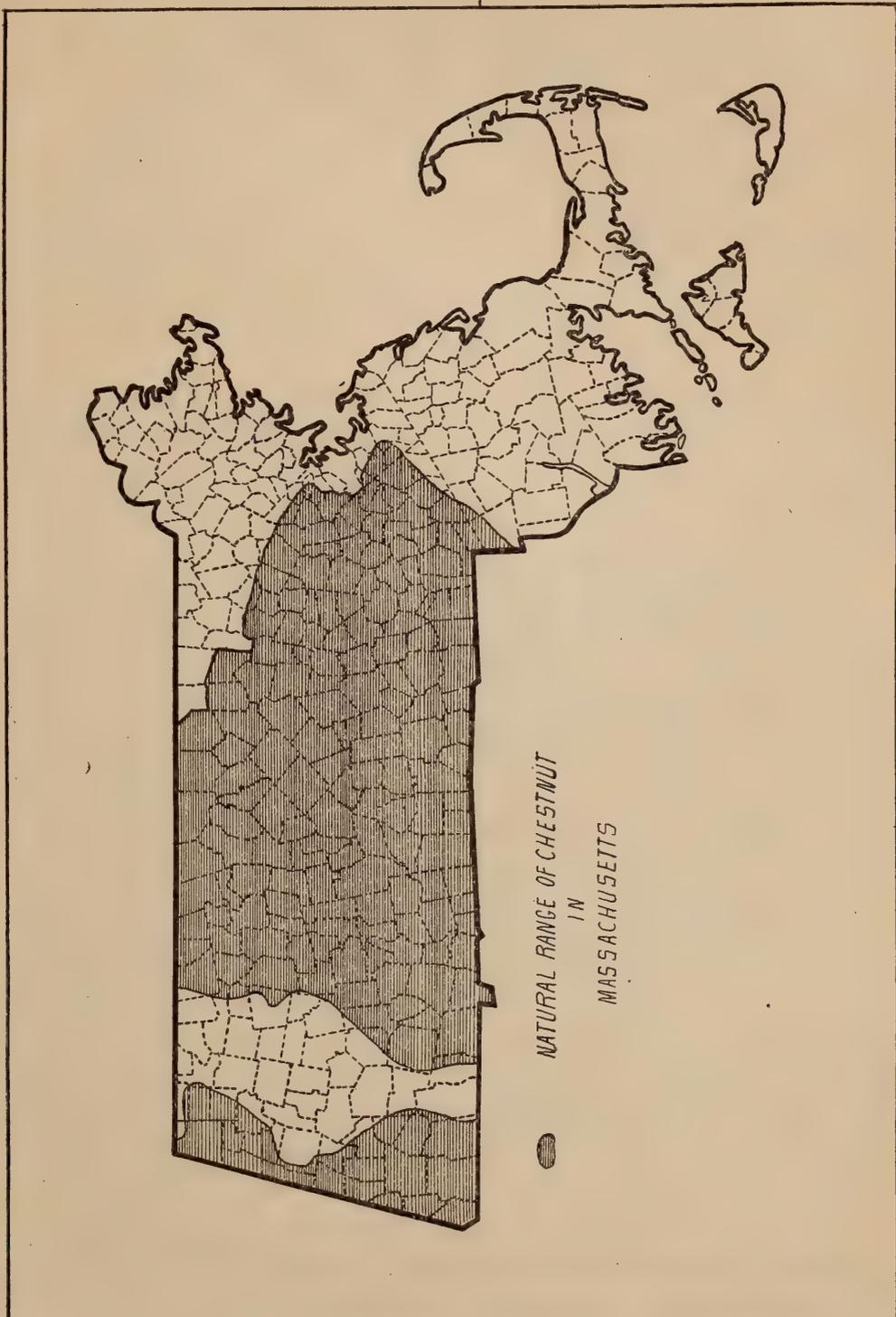






Withered chestnut leaves on blighted sprouts.

the line would necessitate a tree-by-tree inspection of every patch of timber containing chestnut throughout the rest of



Massachusetts, since the blight has been found at or near the eastern limit of the species across the entire width of the State.

The expense of such an examination would be enormous, to say nothing of the cost of removing the diseased trees when located, and of the subsequent re-examinations necessary to locate new infections and to make sure that none had been overlooked in the first instance. In view of the comparatively small amount of timber that could be saved in any case, the great cost of the work and the uncertainty of final success, it was not believed that any State-wide attempt to check the disease was advisable. The State Forester was reluctantly compelled to predict the probability of the practical elimination of the chestnut as a tree of commercial importance in Massachusetts within a comparatively short term of years.

It is possible that in the case of valuable groves, especially in localities where there is not much other chestnut for some distance, vigorous local action may be able to preserve the timber. Such action is not advised unless there is a local market which will dispose of the diseased trees as they are cut.

Although chestnut is a very durable wood when cut green and properly seasoned, the sapwood of dead trees left on the stump soon rots. The railroads assert that the wood of trees attacked by the disease deteriorates even before the death of the tree, in that ties cut from such trees do not hold spikes as well as do those from uninfected trees. Since the bulk of the chestnut in Massachusetts seems doomed to infection within a few years it is evident that sound chestnut timber will soon be an exceedingly scarce article in this State. Although the price of timber from infected trees will fall very low in the next year or two, as the market becomes flooded with such material, and will undoubtedly carry the price of sound material with it for a few years, it is certain that the price of sound chestnut lumber will rise again before long, and should reach figures considerably above those prevalent before the effects of the disease began to be felt in the market.

Any chestnut that is allowed to stand until killed by the disease will certainly be a dead loss. A great quantity of chestnut will probably be cut and thrown on the market when threatened with the disease, and prices will fall until they will no more than cover the cost of lumbering, leaving no margin for stumpage. But a man who is able to cut ties, poles, etc., while his

trees are still sound, and so pile them that they will keep for some years, will then have an article that will be exceedingly scarce, and that should pay a good profit on the investment. Statistics show that the average life of a chestnut tie in active service is eight years. Material carefully piled should be in good condition after at least the same period.

Summary.

1. The chestnut disease is now almost universally distributed throughout the State. In the western half, infection is quite general; in the eastern half, the centers of infection are mostly small.

2. The area of severe infection is already so great, and the proportion of chestnut that there would be any hope of saving is so small, that the Commonwealth would not be justified in making any attempt to stop the disease.

3. Chestnut forms approximately one-sixth of the timber of Massachusetts. Practically all of this is almost certain to die within a comparatively few years unless some unforeseen conditions come to its rescue.

4. Timber attacked by the disease soon becomes unmerchantable. Timber cut before it is infected may be seasoned and kept for many years.

5. This bulletin is not for the purpose of over-exaggeration of the chestnut disease, but is to give our citizens the exact conditions as they appear. Let every one interested acquaint himself with his conditions by looking over the trees in his section. The illustrations will aid you.

6. The State Forester's office stands ready to examine and give advice on chestnut stands in any section of the State for traveling expenses only. We desire to assist in every way possible.

CHESTNUT: ITS MARKET IN MASSACHUSETTS.

DESCRIPTION.

The chestnut, *Castanea dentata*, in this State seldom grows over 90 feet high, with a diameter of 1 to 2 feet. In the open it sometimes reaches a diameter of 4 to 6 feet, but it is then shorter and has a brushy crown. The leaves are oblong-lanceolate in shape, 6 to 8 inches long, with acute apex, wedge-shaped base and dentate margin. The flowers, which appear about the 4th of July, are creamy white, in slender catkins 6 to 8 inches long. The fruit is a bur containing from 1 to 3 nuts.

The typical form in which chestnut occurs in Massachusetts is an even-aged sprout stand. This results from the common practice of clean cutting. Following such an operation, practically every chestnut stump sends up a number of vigorous sprouts, which soon close together and form a complete cover. The weaker sprouts are soon shaded out, as are any seedlings which may have started, and the resulting stand is of nearly even height as well as age. Chestnut rarely reproduces by seed in the forest, since it is unable to endure shade.

Chestnut frequently occurs in nearly pure stands, and frequently also is mixed with different species of oak. White pine sometimes occurs in mixture, its ability to endure a certain amount of shade and its rapid growth when once started enabling it to hold its own with the more rapidly starting chestnut.

The State forester of Connecticut has determined that the average growth of sprout chestnut is as follows: —

AGE (YEARS).	Height (Feet).	Diameter (Inches).
20,	36	3
40,	62	9
60,	70	16
80,	74	22
100,	77	28

MARKET.

Lumber.

Chestnut lumber has many uses. Perhaps the most important for the native article is in bridge construction. It is especially adapted to this, owing to its durability when exposed to moisture. It is also used to a considerable extent in the construction of buildings, as framing, rough siding and sometimes as coarse shingles. Native chestnut is also used in the manufacture of agricultural implements, boxes and crates, furniture, house finish and stair work, slack cooperage, and toys, such as tool chests and wagons. In 1908 the amounts used in Massachusetts and the prices paid were as follows:—

PRODUCT.	Per Cent. of Total used grown in State.	Quantity from Massachusetts (Feet B. M.).	Average Price at Factory.
Boxes and crates,	33	782,000	\$16 36
Furniture,	46	2,284,500	24 36
Musical instruments,	8	300,000	23 33
Interior finish and stair work,	92	310,000	20 13
Cooperage,	100	110,000	15 00
Agricultural implements,	100	50,000	15 00
Toys,	100	158,000	13 14

It will be seen that there is a very considerable market for chestnut in the furniture industry. This requires lumber free of wormholes, and otherwise nearly clear.

It is difficult to form any estimate of the amount of lumber employed in bridge and building construction, since these uses are very largely local.

The current prices range as follows:—

Bridge plank, \$20, \$24, \$25, \$28, \$30, \$31.

Bridge timbers, \$21, \$25.

Framing timbers, \$25, \$32.

Chair lumber, \$30, \$35 f. o. b. factory (surface measure, 1½ inches).

Tie sidings, \$15 (used for toys, etc.).

Boards:—

Mill run, \$20 (wholesale price), \$28 (retail price).

Clear, \$40 (retail price).

Covering boards, \$22 (retail price).

Ties.

The specifications for ties vary according to the company. The Boston & Albany Railroad has three classes of 8-foot ties. "First-class," if sawed on all four sides, must have 8-inch face and 7 inches thickness; if flattened on only two sides, they must have at least 7-inch face. "Second-class" ties are 7 by 7 inches squared, or with 6 to 7 inch face if flattened on two sides. "Third-class" ties are 6 inches thick, with face of 8 inches if squared, or 6 inches and up if flattened.

The New York, New Haven & Hartford and the Boston & Maine railroads publish identical specifications. "No. 1" ties, if sawed square, are to have 7 inches thickness and 9-inch face; if flattened, 7 to 12 inch face. "No. 2" ties are 6 inches thick, with 8-inch face if squared, or 6 to 12 inch face if flattened. "No. 3" are the same as "No. 2," with 1 inch less face. The right is reserved to "limit the proportion of No. 2 and No. 3 ties."

The Central Vermont Railway takes two classes of ties, both 8 feet long and 6 inches thick. "No. 1" are 6 inches or over on the face if flattened, and 8 to 9 inches if squared. "No. 2" have a 5-inch face if flattened, and 6 to 8 inch face if squared.

Many of the electric railways use 8-foot ties 6 inches thick, of which the first class have a face of 6 inches or over and the second 5 inches or over if flattened, or corresponding widths if sawed square. Some of the roads make a flat price for all ties, accepting not more than 10 per cent. of the total in second-class.

The Boston Elevated and the Middlesex & Boston use only 7-foot ties in one class, which are 6 inches thick with 8-inch face if squared, or 6 to 9 inch face if flattened.

All the specifications call for ties cut from sound, living timber, and freed from bark. Some of the companies demand winter-cut ties.

The published prices are as follows:—

DIMENSIONS (SQUARED).	Prices (Cents).
7 by 9 inches by 8 feet,	70
7 by 8 inches by 8 feet,	65
7 by 7 inches by 8 feet,	60
6 by 8 inches by 8 feet,	46, 50, 55, 60
6 by 7 inches by 8 feet,	30, 35, 40
6 by 8 inches by 7 feet,	45 (52½ on track), 55-60 f. o. b. Boston

Switch timbers are sawed square, 7 by 9 inches, and in lengths as ordered. The price is \$18 to \$20 per M feet B. M.

Poles.

The general specifications for poles are: cut from living timber, reasonably straight, free from rot, shakes or large knots, limbs trimmed close and bark peeled. They must conform to the following minimum dimensions: —

LENGTH (FEET).	Diameter at Top (Inches).	Diameter 5 Feet from Butt (Inches).
30,	7 (8) (9)	11 ¹ (12) (14)
35,	7 (8) (9)	12 (13) (15)
40,	7 (8)	14 (14)
45,	7	15
50,	7	16
55,	7	17
60,	7	18
65,	7	18½
70,	7	18½

¹ One company specifies a butt diameter of 12 inches with 7-inch top.

The New England Telephone and Telegraph Company, the largest user of poles in the State, specifies dimensions as follows: —

[Circumference in inches 6 feet from top or butt.]

LENGTH (FEET).	CLASS A.		CLASS B.		CLASS C.		CLASS D.		CLASS E.	
	Top.	Butt.	Top.	Butt.	Top.	Butt.	Top.	Butt.	Top.	Butt.
25,	—	—	—	—	20	30	20	27	15½	26
30,	24	40	22	36	20	33	20	31	15½	29
35,	24	43	22	40	20	36	20	35	20	34
40,	24	45	22	43	20	40	20	39	20	38
45,	24	48	22	47	20	43	20	43	20	42
50,	24	51	22	50	20	46	20	46	20	46
55,	22	54	22	53	20	49	—	—	—	—
60,	22	57	22	56	—	—	—	—	—	—

The prices for poles vary as follows:—

LENGTH (FEET).	Prices.
25,	\$1, \$1.83
30,	\$2.50, \$3, \$3.50, \$4, \$4.50 ¹
35,	\$3.38, \$4, \$4.50, \$5, \$5.50, \$6 ¹
40,	\$5.50, \$5.75, \$6, \$7, ¹ \$8 ¹
45,	\$6, \$6.60, \$8
50,	\$9, \$10
55,	\$15, \$18
60,	\$18, \$22
65,	\$30

¹ These prices were given for poles delivered at the hole.

The higher prices for each length are generally for poles of the larger diameters shown above. It should be understood that there is no certainty of obtaining the price given for any pole, but that these are simply prices which have recently been paid by the various companies for poles of the given dimensions.

Cordwood.

Cordwood in general has a smaller market value, volume for volume, than other of the principal forest products. Chestnut in particular has a low value as cordwood, the price running from \$3 to \$4.50 per cord. The market is limited. In Berkshire County the lime kilns use much chestnut wood, and it is occasionally burned for charcoal. In the Connecticut valley a good deal is also used in the brickyards. Elsewhere the demand is largely supplied by other species of higher fuel value. The low price limits the profitable haul for chestnut wood to a comparatively short distance.

COST OF PRODUCTION.

The most variable item in the cost of production is hauling. This varies with both the length of haul and the rate of wages. It is ordinarily assumed that a work team can average 18 miles a day, half loaded and half light, over average roads. The wages of team and driver ordinarily vary from \$4.50 to \$5.50

per day. In some sections \$6 is the usual rate. Table 1 gives the hauling cost for different wage rates and distances.

TABLE 1. — *Costs of Hauling.*
[Reprinted from Forest Service Bulletin 96.]

Wage rate,	\$4.50.	\$5.	\$5.50.
DAILY HAULING CAPACITY FOR 1 TEAM.	Hauling Cost per Load.		
1 load,	\$4 50	\$5 00	\$5 50
2 loads,	2 25	2 50	2 75
3 loads,	1 50	1 67	1 83
4 loads,	1 13	1 25	1 38
5 loads,	90	1 00	1 10

Table 2 gives the average costs of production, except hauling, of the different products, as determined for Connecticut.

TABLE 2. — *Costs of Production.*
[Compiled from tables in Forest Service Bulletin 96.]

	LUMBER PER M FEET B. M.		Ties per M Feet B. M.	Cordwood per Cord.
	Minimum.	Average.		
Cutting,	\$1 25	\$1 50	\$1 50	\$1 00
Skidding,	1 50	1 75	1 75	-
Sawing,	2 50	3 50	2 00	-
Piling,	1 00	1 00	-	-
Peeling,	-	-	35	-
Total,	\$6 25	\$7 75	\$5 60	\$1 00

Cost of cutting and peeling poles assumed to be 30 cents for poles 25 to 35 feet long; 35 cents for poles over 35 feet long.

The average cost of production of lumber in Massachusetts, as given by various operators, seems to be lower than that in Table 2. The costs given run from \$4.50 to \$7. In the following tables, therefore, the minimum Connecticut cost has been used as the average Massachusetts cost.

Table 3 gives the combined costs of production and hauling per unit of volume based on the figures in Tables 1 and 2, for different daily capacities and wage rates. Since no estimate of

costs is complete without including interest on the money invested in the operation, 6 per cent. has been added to cover this charge.

TABLE 3. — *Cost of lumbering and hauling Different Products, with Interest Charges at 6 Per Cent.*

[Compiled from tables in Forest Service Bulletin 96.]

DAILY HAULING CAPACITY FOR 1 TEAM.	Teaming Wage Rate per Day.	Cost per M Feet B. M. Lumber.	Cost per M Feet B. M. Ties.	COST PER POLE.				Cost per Cord.
				25 to 30 Foot (6 per Load).	35 Foot (4 per Load).	40 to 45 Foot (2 per Load).	50 Foot (1 per Load).	
1 M lumber, 1 M ties or 1 cord wood, . . .	\$5 50	\$12 45	\$11 77	\$1 29	\$1 78	\$3 29	\$6 20	\$6 89
	5 00	11 92	11 24	1 20	1 64	3 02	5 67	6 36
	4 50	11 40	10 71	1 11	1 51	2 76	5 14	5 83
2 M lumber, 2 M ties or 3 cords wood, . . .	5 50	9 54	8 85	80	1 05	1 83	3 29	3 00.
	5 00	9 28	8 59	76	98	1 70	3 02	2 83
	4 50	9 01	8 32	72	91	1 56	2 76	2 65
3 M lumber, 3 M ties or 5 cords wood, . . .	5 50	8 54	7 88	64	80	1 34	2 31	2 23
	5 00	8 40	7 71	61	76	1 26	2 14	2 12
	4 50	8 22	7 53	58	72	1 17	1 96	2 01

VALUE OF STANDING TIMBER.

The stumpage values for lumber, ties, poles and cordwood here given are derived from the market values and costs of production given above.

The real stumpage value is the difference between the market value and the total operating costs, less a reasonable profit on the combined investment in stumpage and production. The profit has been computed for the purpose of this bulletin at 20 per cent.

Table 4 gives the stumpage value per unit of volume for different hauling capacities, wage rates and market prices, based on the total costs of production given in Table 3. These are the prices which the wood-lot owner should receive for his timber under the given conditions.

TABLE 4. — *Stumpage Value of Different Products after deducting a Lumberman's Profit of 20 Per Cent.*¹
 [Compiled from tables in Forest Service Bulletin 96.]

DAILY CAPACITY.	Team- ing Rate.	LUMBER PER M AT MARKET VALUE.		TIERS PER M AT MARKET VALUE.		POLES AT VALUES PER POLE.							CORDWOOD AT VALUE OF —					
		\$18.	\$24.	\$30.	\$11.40. ²	\$16. ³	\$17.50. ⁴	\$1.50.	\$3.	\$4.10.	\$5.30.	\$6.50.	\$9.	\$15.	\$18.	\$3.50.	\$4.	\$4.50.
1 M lumber, 1 M ties or 3 cords wood,	5 50	3 08	8 08	13 08	-	2 09	3 34	\$0 05	1 30	1 78	1 40	2 73	1 83	6 33	9 33	\$0 09	50	92
	4 50	3 60	8 60	13 60	-	2 62	3 87	14	1 39	1 91	1 66	2 99	2 36	7 36	9 86	27	68	1 10
	5 50	5 46	10 46	15 46	\$0 65	4 48	5 73	45	1 70	2 37	2 59	3 92	4 21	9 21	11 71	40	81	1 23
2 M lumber, 2 M ties or 4 cords wood,	5 00	5 72	10 72	15 72	92	4 74	5 99	49	1 74	2 44	2 72	4 05	4 48	9 48	11 98	53	94	1 36
	4 50	5 99	10 99	15 99	1 18	5 01	6 26	53	1 78	2 51	2 86	4 19	4 74	9 74	12 24	66	1 07	1 49
	5 50	6 46	11 46	16 46	1 62	5 45	6 70	61	1 86	2 62	3 08	4 41	5 19	10 19	12 69	69	1 10	1 52
3 M lumber, 3 M ties or 5 cords wood,	5 00	6 60	11 60	16 60	1 79	5 62	6 87	64	1 89	2 66	3 16	4 49	5 36	10 36	12 86	80	1 21	1 63
	4 50	6 78	11 78	16 78	1 97	5 80	7 05	67	1 92	2 70	3 25	4 58	5 54	10 54	13 04	91	1 32	1 74

¹ The costs used in computing these stumpage values are those given in Table 3.

² 6 by 7 inch ties at 30 cents per tie.

³ 6 by 8 inch ties at 50 cents per tie.

⁴ 7 by 9 inch ties at 70 cents per tie.

Relative Value of Different Products.

Table 5 gives the contents and values of average trees of different sizes in different products, under the teaming conditions and market values given in the note. "Additional wood" is the wood in tops and limbs, which is assumed to be put into cordwood. The first column in the table gives the diameter of the tree outside the bark at $4\frac{1}{2}$ feet from the ground; the second gives the average height of trees of that diameter. The columns headed "value" give the stumpage values of the trees in the given product; those headed "value and profit" are computed from the combined stumpage and profit, and represent the clear gain, over and above costs, of the owner who does his own logging.

The contents of the different trees are taken from Tables 6, 7, 8 and 9. The figures for ties are those in the Connecticut bulletin, which are lower than the average in the Forest Service bulletin, so the values are correspondingly lower.

TABLE 5. — Contents and Stumpage Value, with and without Lumberman's Profit, of Trees of Different Sizes in Different Products.

[Adapted from tables in Forest Service Bulletin 96 and Connecticut Agricultural Experiment Station Bulletin 154.]

DIAMETER AT BREST HIGH (INCHES).	Height (Feet).	LUMBER AND ADDITIONAL WOOD.				TIRES AND ADDITIONAL CORDWOOD.				POLES AND ADDITIONAL WOOD.				CORDWOOD.			
		Board Feet.	Cords.	AT \$18 PER M.		6 by 7.	6 by 8.	Cords.	Value.	Value and Profit.	Length (Feet).	Cords.	Value.	Value and Profit.	Cords.	Value.	Value and Profit.
				Value.	Value and Profit.												
6,	50	-	-	-	-	-	-	-	-	-	-	-	-	0.06	\$0 03	\$0 07	
7,	50	-	-	-	-	-	-	-	-	-	-	-	-	.08	04	09	
8,	50	-	-	-	-	-	-	-	-	-	-	-	-	.11	06	13	
9,	55	30	\$0 21	\$0 34	\$0 36	0.07	\$0 04	\$0 11	0.03	04	11	-	-	.13	06	15	
10,	65	40	26	43	46	0.07	19	34	.03	19	34	-	-	.17	08	20	
11,	65	58	37	59	66	.07	34	59	.04	34	59	-	-	.21	10	25	
12,	65	78	48	76	87	.07	42	70	.05	42	70	25	\$0 52	.26	13	30	
13,	65	100	61	95	111	.07	49	83	.05	49	83	25	52	.30	15	35	
14,	70	122	74	116	135	.08	74	96	.06	74	96	30	1 80	.34	17	40	
15,	70	147	89	140	162	.10	89	107	.06	65	1 07	35	2 49	.41	20	48	
16,	70	172	103	162	189	.10	103	120	.07	72	1 20	40	2 76	.47	24	55	
17,	70	213	128	200	234	.12	128	140	.08	87	1 40	40	2 77	.53	26	62	
18,	70	242	144	225	265	.12	144	153	.09	94	1 53	40	3 72	.61	30	71	
19,	70	280	167	259	307	.13	167	176	.09	109	1 76	45	4 08	.70	35	82	
20,	70	308	183	285	337	.14	183	189	.10	117	1 89	45	4 10	.77	38	90	
21,	75	340	203	318	373	.18	203	212	.10	132	2 12	50	4 53	.86	43	101	
22,	75	375	225	352	412	.21	225	248	.11	155	2 48	55	9 51	.95	48	111	
23,	75	422	253	395	464	.23	253	272	.12	170	2 72	55	12 07	1.04	52	122	
24,	75	450	270	423	495	.26	270	308	.13	193	3 08	55	12 10	1.14	57	133	
25,	75	488	293	459	538	.29	293	340	.14	214	3 40	55	12 12	1.25	62	146	
26,	75	530	319	498	584	.31	319	387	.15	244	3 87	55	12 14	1.36	68	159	
27,	75	580	349	547	639	.35	349	433	.16	267	4 33	55	12 17	1.47	74	172	
28,	80	630	360	599	695	.39	360	459	.17	290	4 59	55	12 21	1.60	80	187	
29,	80	700	421	660	771	.42	421	506	.18	320	5 06	55	12 24	1.72	86	201	
30,	80	800	481	751	881	.46	481	577	.19	365	5 77	60	12 03	1.86	93	218	

Daily hauling capacity of 1 team assumed as 3 cords, 2 M of lumber or ties, or equivalent number of poles. Team wage rate, \$5. Market value of lumber, \$18 and \$24; cordwood, \$4; 6 by 7 inch ties, 30 cents; 6 by 8 inch ties, 50 cents; 25-foot poles, \$1.50; 30-foot, \$3; 35-foot, \$4.10; 40-foot, \$5.30; 45-foot, \$6.90; 50-foot, \$9; 55-foot, \$15; 60-foot, \$18.

It will be seen that the values for lumber at \$18 and those for ties are nearly equal, with the advantage in favor of lumber. At \$24 per M, the values for lumber rise towards those for poles. The values for cordwood are very small, and show conclusively that it does not pay to make into wood any chestnut fit for other products.

VOLUME TABLES.

The tables which follow show the volumes in different kinds of materials for trees of different sizes, calculated from tables in the United States Forest Service Bulletin 96. These were based on measurements of 218 felled trees in Connecticut and adjacent portions of New York. Since the conditions of growth here are similar, these figures will apply to Massachusetts trees.

Since volume tables give the average of large numbers of measurements, they cannot be expected to be accurate for individual trees, but only for numbers of trees growing in well-stocked stands. To apply the tables, the number of trees of each inch diameter class should be ascertained by measurement or estimate. The average height of trees of each diameter should be taken to the nearest 10 feet. The total volume can then be found by multiplying the number of trees in each diameter class by the figure in the table for the corresponding height, and adding the products.

The figures published by the State forester of Connecticut in 1906 are included in these tables for the purpose of comparison. These figures are set in heavy type. They are based on over 400 trees.

Cordwood.

Table 6 is computed from the Forest Service table of volume in cubic feet of round wood, and the table of converting factors — percentages of solid wood in stacked cordwood — to reduce these to cords. These factors are said to be conservative, which probably explains why the Connecticut figures are slightly larger than the corresponding ones calculated from the Forest Service bulletin.

TABLE 6. — *Volume of Chestnut in Cords.*

[Computed from tables in Forest Service Bulletin 96.]

Height in feet, .	20.	30.	40.	50.	60.	70.	80.	90.
DIAMETER BREAST HIGH (INCHES).	Volume in Cords.							
2,	0.003	0.005	-	-	-	-	-	-
3, . . . . .	.006	.01	0.01	-	-	-	-	-
4,	-	.02	.02, .02	0.03	-	-	-	-
5,	-	.02	.04, .04	.04	-	-	-	-
6,	-	-	.04	.06, .06	0.07	-	-	-
7,	-	-	.06	.07, .08	.09	-	-	-
8,	-	-	.07	.09	.11, .11	0.12	-	-
9,	-	-	.09	.11	.13, .13	.15	-	-
10,	-	-	.12	.14	.16, .17	.18	0.20	0.21
11,	-	-	.14	.17	.19, .21	.22	.24	.26
12,	-	-	.17	.20	.23	.26, .27	.29	.32
13,	-	-	.19	.23	.27	.30, .31	.34	.38
14,	-	-	-	.27	.31	.36, .34	.40	.44
15,	-	-	-	.30	.35	.41, .41	.46	.51
16,	-	-	-	.34	.40	.46, .47	.52	.58
17,	-	-	-	.38	.45	.52, .53	.59	.66
18,	-	-	-	.43	.50	.58, .61	.66	.74
19,	-	-	-	.46	.53	.64	.70, .73	.82
20,	-	-	-	.51	.61	.71	.77, .81	.92
21,	-	-	-	-	.68	.79	.86, .90	1.01
22,	-	-	-	-	.74	.86	.95, .99	1.11
23,	-	-	-	-	.80	.94	1.04, 1.07	1.21
24,	-	-	-	-	.88	1.03	1.14, 1.17	1.32
25,	-	-	-	-	.96	1.12	1.25, 1.28	1.44

Figures in heavy type are those in the Connecticut bulletin.

Lumber.

The volume table for lumber is adapted from that in the Forest Service bulletin. Logs were scaled by the International rule, reduced 10 per cent. to allow for the wide kerf of the ordinary portable mill. The volume of topwood and limbs has been reduced to cords by dividing by 80, a conservative factor.

The Connecticut figures were based on a modification of the Doyle rule, amounting practically to a mill-tally rule.

TABLE 7. — *Volume of Chestnut in Lumber and Additional Cordwood.*

[Computed from tables in Forest Service Bulletin 96.]

Height in feet, .	50.		60.		70.		80.		90.	
DIAMETER BREAST HIGH (INCHES).	VOLUME.									
	Board Feet.	Cords.	Board Feet.	Cords.	Board Feet.	Cords.	Board Feet.	Cords.	Board Feet.	Cords.
9,	10	.07	15, 35	.09	22	.10	-	-	-	-
10,	26	.06	32, 47	.08	40	.09	48	.09	56	.08
11,	42	.06	50, 60	.08	58	.09	69	.09	80	.09
12,	58	.06	68, 75	.08	78	.09	92	.09	107	.10
13,	74	.06	87, 91	.08	100	.09	116	.10	133	.10
14,	92	.06	107	.08	122, 110	.09	141	.10	160	.11
15,	110	.06	127	.08	147, 131	.10	168	.11	190	.12
16,	129	.06	150	.09	172, 155	.11	196	.12	222	.14
17,	-	-	174	.09	200, 180	.12	226	.14	255	.17
18,	-	-	198	.09	227, 206	.12	257	.16	291	.19
19,	-	-	223	.09	257, 235	.13	292	.17	328	.21
20,	-	-	250	.09	288, 266	.14	327	.19	368	.24
21,	-	-	276	.10	318, 298	.16	363	.21	409	.27
22,	-	-	305	.10	350, 335	.17	400	.24	451	.30
23,	-	-	333	.11	385, 372	.19	440	.27	493	.34
24,	-	-	363	.11	420, 411	.21	479	.30	538	.39
25,	-	-	396	.12	457, 451	.23	520	.34	583	.45
26,	-	-	-	-	495	-	-	-	-	-
27,	-	-	-	-	541	-	-	-	-	-
28,	-	-	-	-	587	-	-	-	-	-
29,	-	-	-	-	637	-	-	-	-	-
30,	-	-	-	-	688	-	-	-	-	-

Figures in heavy type are those in the Connecticut bulletin.

Ties.

Table 8 gives the contents of trees in 6 by 8 inch ties, with the wood left in tops and limbs. The Connecticut figures run lower than those of the Forest Service.

TABLE 8. — *Volume of Chestnut in 6 by 8 Inch Ties and Additional Cordwood.*

[Computed from tables in Forest Service Bulletin 96.]

Height in feet, . . .	50.		60.		70.		80.		90.	
DIAMETER BREAST HIGH (INCHES).	VOLUME.									
	Ties.	Cords.	Ties.	Cords.	Ties.	Cords.	Ties.	Cords.	Ties.	Cords.
10,	1	.11	1, 1	.13	1	.14	1	.13	3	.12
11,	1	.10	1, 2	.12	2	.13	2	.13	4	.12
12,	2	.09	2, 2	.11	3	.13	3	.13	4	.13
13,	3	.09	3, 3	.10	3	.12	4	.12	5	.13
14,	3	.08	3	.10	4, 5	.12	5	.12	8	.13
15,	5	.08	5	.09	4, 5	.12	6	.12	9	.13
16,	6	.07	6	.09	5, 7	.11	7	.13	9	.14
17,	-	-	6	.08	5, 8	.11	8	.13	10	.16
18,	-	-	7	.07	8, 6¹	.12, .09	9	.14	11	.17
19,	-	-	7	.07	8, 7¹	.12, .09	10	.15	12	.19
20,	-	-	8	.06	10, 8¹	.12, .10	11	.17	13	.22
21,	-	-	9	.06	10, 9¹	.13, .10	11	.18	14	.24
22,	-	-	11	.06	10, 10¹	.14, .11	14	.21	17	.27
23,	-	-	12	.06	12, 11¹	.15, .12	14	.23	17	.31
24,	-	-	12	.06	13, 13¹	.16, .13	15	.27	19	.36
25,	-	-	15	.06	15, 14¹	.18, .14	18	.30	21	.42
26,	-	-	-	-	16¹	.15	-	-	-	-
27,	-	-	-	-	18¹	.16	-	-	-	-

Figures in heavy type are those in the Connecticut bulletin.

¹ Seventy-five feet in height.

Poles.

Table 9 gives the length of pole that can be obtained from trees of different dimensions, with the volume in cords of additional wood. The Connecticut figures agree exactly with the corresponding ones of the Forest Service.

TABLE 9. — *Volume of Chestnut in Poles and Additional Cordwood.*

[Computed from tables in Forest Service Bulletin 96.]

Height in feet,	50.		60.		70.		80.		90.	
DIAMETER BREAST HIGH (INCHES).	VOLUME.									
	Length of Pole.	Cords.	Length of Pole.	Cords.	Length of Pole.	Cords.	Length of Pole.	Cords.	Length of Pole.	Cords.
12,	-	-	25, 25	-	-	-	-	-	-	-
13,	25	.04	25, 25	.08	25	.12	25	.15	25	.18
14,	30	.02	30	.06	30, 30	.11	30	.14	30	.17
15,	35	-	35	.04	35, 35	.10	35	.13	35	.16
16,	-	-	-	-	40, 40	.08	40	.11	40	.14
17,	-	-	-	-	40, 40	.10	45	.10	45	.13
18,	-	-	-	-	45, 45	.06	50	.09	50	.11
19,	-	-	-	-	45¹	-	-	-	55	.10
20,	-	-	-	-	45¹	-	-	-	60	.09
21,	-	-	-	-	50¹	-	-	-	-	-
22,	-	-	-	-	55¹	-	-	-	-	-
23,	-	-	-	-	55¹	-	-	-	-	-
24,	-	-	-	-	55¹	-	-	-	-	-
25,	-	-	-	-	55¹	-	-	-	-	-
26,	-	-	-	-	55¹	-	-	-	-	-
27,	-	-	-	-	55¹	-	-	-	-	-
28,	-	-	-	-	55¹	-	-	-	-	-
29,	-	-	-	-	55¹	-	-	-	-	-
30,	-	-	-	-	-	-	60	-	-	-

Figures in heavy type are those in the Connecticut bulletin.

¹ Seventy-five feet in height.

LIST OF OPERATORS MAKING A SPECIALTY OF HANDLING
CHESTNUT.

This list includes all the dealers handling chestnut of whom this office knows.

Amherst, F. A. Cadwell.
 Ashland, Lewis Alberine, Winter Street.
 Athol, Page & Farrington.
 Attleboro, Clarence Lincoln, R. F. D. 1.
 Attleboro, Frederick C. Rounds, R. F. D. 4.
 Ayer, Levi Phelps.
 Barre, James A. Rice.
 Belchertown, Louis Giroux, R. F. D. 1.
 Belchertown, A. B. Howard & Son.
 Belchertown, A. L. Kimball.
 Belchertown, C. D. Lyman.
 Belchertown, D. C. Nutting.
 Belchertown, J. A. Pessa.
 Belchertown, James Pezo.
 Belchertown, E. F. Shumway.
 Belchertown, Gay & Shumway.
 Belchertown, E. C. Witt.
 Berlin, Walter A. Wheeler.
 Bernardston, E. E. Benjamin.
 Bernardston, Baxter Burrows.
 Billerica, Leslie A. Bull, Box 142.
 Blackstone, D. W. Gaskill.
 Blandford, A. E. Blaeslee.
 Bondsville, E. L. Bond.
 Bondsville, R. L. Bond.
 Boston, Willis C. Bates & Co., 70 Kilby Street.
 Boston, Boston Lumber Company.
 Boston, J. A. Hurd Lumber Company.
 Boston, Geo. McQuesten Company, 27 Kilby Street.
 Boston, Pettingell-Andrews Company, Pearl Street.
 Boston, Virginia Tie and Lumber Company, Mason Building.
 Boston, Western Electric Company, 115 Purchase Street.
 Brockton, Kendrick & Lawton, 40 Tilton Ave.
 Canton, John Estey.
 Charlton Depot, E. A. Lamb.
 Chartley, Joseph Dumont.
 Chelmsford, H. L. Parkhurst.
 Chester, George H. Brown.
 Chester, Thomas Rose.

Chester, G. C. Turner.
 Clinton, Wm. L. Bancroft.
 Clinton, Philbin Bros., 142 High Street.
 Deerfield, S. W. & C. B. Childs.
 Deerfield, Henry Wells.
 Dwight, L. A. Randolph.
 Easthampton, W. T. Evans.
 East Foxborough, Mr. Forrest.
 East Foxborough, Mr. Hamilton.
 East Norton, A. E. & C. W. Sweet.
 Enfield, C. W. Felton.
 Enfield, F. E. Hamilton.
 Everett, Albert Lennox, 159 Nichols Street.
 Fall River, A. A. Bedard, Cory Street.
 Feeding Hills, Nelson G. King.
 Fitchburg, A. A. Marshall, 14 Prospect Street.
 Fitchburg, Benjamin F. Ordway.
 Florence, Wilfred Learned.
 Foxborough, Arthur Coombs.
 Foxborough, Amelia Jackson.
 Framingham, D. L. Whitney.
 Franklin, Edward S. Cook.
 Grafton, H. G. Stowe.
 Granby, R. A. French.
 Granville, Peter Oveson.
 Granville, B. J. Roberts.
 Granville Center, David L. Roache.
 Great Barrington, Warren H. Davis.
 Great Barrington, Charles Hollenbeck.
 Great Barrington, Geo. A. Stevens.
 Great Barrington, N. B. Turner.
 Greenfield, Cladwell, Glazier & Porter.
 Greenfield, H. C. Porter.
 Greenwich Village, W. H. Walker.
 Hampden, Nelson M. Carew.
 Hampden, E. H. Temple.
 Hampden, Thresher Bros.
 Holden, J. W. Holt.
 Holliston, Aldrich & Mainini.
 Holliston, Henry M. Cutler.
 Holliston, J. H. Dewing.
 Holliston, George Fair.
 Holliston, W. P. Kingsbury.
 Holliston, Daniel Phipps.
 Hopedale, The Draper Company.
 Hopedale, Hopedale Cemetery Company.

Hopkinton, Chas. R. Burnap.
Hopkinton, A. W. Keyes.
Hopkinton, John Pond.
Hopkinton, Michael Rafty.
Housatonic, Noble Turner.
Huntington, DeWitt C. DeWolf.
Huntington, S. S. Eastwood.
Huntington, M. R. Fisk.
Huntington, E. L. Gorham.
Huntington, Annie N. Lewis.
Huntington, J. B. Lyman.
Huntington, Leon Savoit.
Huntington, Fred Staunton.
Indian Orchard, G. C. A. Fuller.
Indian Orchard, J. L. Simonds.
Lancaster Center, M. A. Estabrook.
Lee, W. C. Baldwin.
Lee, D. D. Hopkins.
Lee, Emerson Houston.
Leominster, A. L. Walker.
Littleton, Flagg Bros.
Ludlow, H. M. Bartlette.
Ludlow, Frederick L. Burr.
Ludlow, The Burr Company.
Ludlow, Burr & Munsing.
Ludlow, Arthur D. King.
Lunenburg, A. A. Cook.
Mansfield, F. I. Sherman.
Marlborough, Theodore Temple.
Mendon, D. H. Barnes.
Mendon, C. A. Fletcher.
Mendon, J. A. Fletcher.
Mendon, E. H. Taft.
Mendon, Leonard Taft.
Milford, John Remick.
Millbury, Geo. J. Dudley.
Millbury, Samuel Goodell, Box 177.
Millbury, Thomas Hill.
Millis, Lemuel Clark.
Monson, Albert Blanchard.
Monson, Lyman C. Flynt.
Monson, Theodore Gunther.
Monson, C. F. Hancock.
Monson, H. D. Moulton.
Monson, W. M. Peck.
Monson, W. M. Tucker.

Montague, F. T. Lyman.
Montgomery, Merton E. Camp.
Montgomery, Edward C. Clark.
Montgomery, Edwin F. Hall.
Montgomery, Andrew Katre.
Montgomery, Myron E. Kelson.
Montgomery, C. A. Williams.
New Salem, Bullard Bros.
Newton Upper Falls, C. H. Spring.
Norton, A. E. Sweet.
Norton, A. H. Sweet & Son.
North Attleborough, Jas. Lavery.
North Attleborough, N. J. Mangan & Co.
North Attleborough, W. H. Riley & Son.
North Amherst, W. D. Cowles.
North Amherst, R. D. Dickenson.
Northampton, S. A. Bailey.
Northborough, T. E. Mentzer.
Northbridge, W. Brown.
Northbridge, F. S. Haward.
North Brookfield, E. A. Batcheller.
North Brookfield, H. E. Cummings.
North Brookfield, W. F. & F. A. Fullam.
North Brookfield, Geo. A. Whiting.
North Brookfield, J. A. Hurd Lumber Company.
North Dana, Gee & Tyler.
North Dana, Grover & Gee.
North Easton, Jerry Drake.
North Grafton, C. R. Atwell.
North Wilbraham, Chas. M. Calkins.
North Wilbraham, H. M. Green.
North Wilbraham, W. F. Morgan.
Oxford, Chaffe Bros. Company.
Palmer, J. M. Allen.
Palmer, Booth Bros.
Palmer, Elmer I. Bradway.
Palmer, Harwood & Hamilton.
Palmer, H. M. Sutcliffe.
Pittsfield, Peter Cimini, 37 Jordan Avenue.
Russell, Dana F. Dewey.
Russell, Wilbur L. Herrick.
Russell, Clifford Williston.
Sharon, Edward Drake, Bay Road.
Shirley, G. M. Ballou.
Shirley, Jas. L. Hazen.
Shrewsbury, Defresne Bros.

Shrewsbury, Geo. N. Gates.
Shrewsbury, S. R. Howe, Turnpike Road.
Shrewsbury, Allen E. Knowlton.
South Berlin, E. W. Wheeler.
South Berlin, Walter A. Wheeler.
Southampton, E. K. Parsons.
Southampton, H. L. & W. A. Parsons.
Southbridge, Fred E. Hall, 43 Eastford Street.
Southbridge, F. C. Spaulding.
Southbridge, S. W. Plympton.
South Deerfield, S. W. & C. B. Childs.
South Framingham, Frank H. Twitchell.
South Hadley Falls, H. R. Britton.
South Hadley Falls, J. J. Moriarty.
Southwick, Palmer Bros.
Spencer, H. F. Davidson.
Spencer, W. A. Wilson.
Springfield, J. L. Brooks, care of Brooks Banknote Company.
Springfield, Max Elpert, 166 Ferry Street.
Springfield, Samuel Hurwitz, 42 Plymouth Street.
Springfield, Marcus Penn, 236 Dickinson Street.
State Line, E. O. Raynor.
State Line, M. L. Vernnes.
State Line, John H. Wilcox.
Sterling, Wilder, Walker & Davis.
Stockbridge, G. L. Bradley.
Stoughton, Daniel Lehan.
Stow, Chas. Felcher.
Sunderland, H. H. Bixby.
Taunton, Clifford L. Chase, 623 Tremont Street.
Taunton, Geo. A. Crane.
Taunton, Arthur H. Goff.
Taunton, George E. Rounds.
Taunton, William Slater.
Townsend, Clarence Stickney.
Tyringham, Carl Curtis.
Tyringham, James McCarthy.
Upton, B. C. Wood.
Uxbridge, Walter Gaskill.
Uxbridge, C. E. Talbot.
Wales, H. F. Bradley.
Wales, E. L. Needham & A. L. Hubbard.
Wales, La Roy Squier.
Wales, James H. Walker.
Ware, A. N. Coney.
Ware, H. M. Coney.

Ware, E. W. Lawton.
 Ware, John M. Moore.
 Ware, Amedee Vigeant.
 Ware, Geo. C. Wesson.
 Warren, F. E. Gleason.
 Warren, H. N. Shepard.
 Webster, Racicot Bros.
 Wellesley, Chas. S. Spring.
 Westborough, Herbert D. Adams.
 Westborough, A. M. Nourse.
 Westborough, Mason Taft.
 Westfield, Geo. W. Loomis.
 Westford, Oscar Spaulding.
 Westminster, C. H. Merriam.
 Worcester, M. Bagdasarian, 57 Hamilton Street.
 Worcester, Bemis & Dodge, 737 Slater Building.
 Worcester, Joseph Boucher, 178 Plantation Street.
 Worcester, L. B. Davis, 805 Grove Street.
 Worcester, Ashabel Griswold, 24 Dewey Street.
 Worcester, Geo. L. Jacques.
 Worcester, W. H. Sawyer.
 Woronoco, Mrs. Nettie Cortes.
 Woronoco, Andrew Oleksak.
 Woronoco, Gregor Oleksak.
 Wrentham, G. W. Gilmore.
 Wrentham, C. E. Williams.

Other States.

Cumberland Hills, R. I., John McLaughlin.
 Eagleville, Conn., J. M. White.
 Norwich, Conn., L. B. Brockett.
 Norwich, Conn., A. L. Potter & Co.
 Suffield, Conn., W. L. Stiles.
 Thompsonville, Conn., I. D. Woodworth.

The Forests of Worcester County

THE RESULTS OF A FOREST SURVEY OF THE
FIFTY-NINE TOWNS IN THE COUNTY

AND A

STUDY OF THEIR LUMBER INDUSTRY



By H. O. COOK, M.F., Under the Direction of
F. W. RANE, State Forester

Massachusetts State Forester, 1916

BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
32 DERNE STREET
1917

APPROVED BY
THE SUPERVISOR OF ADMINISTRATION.

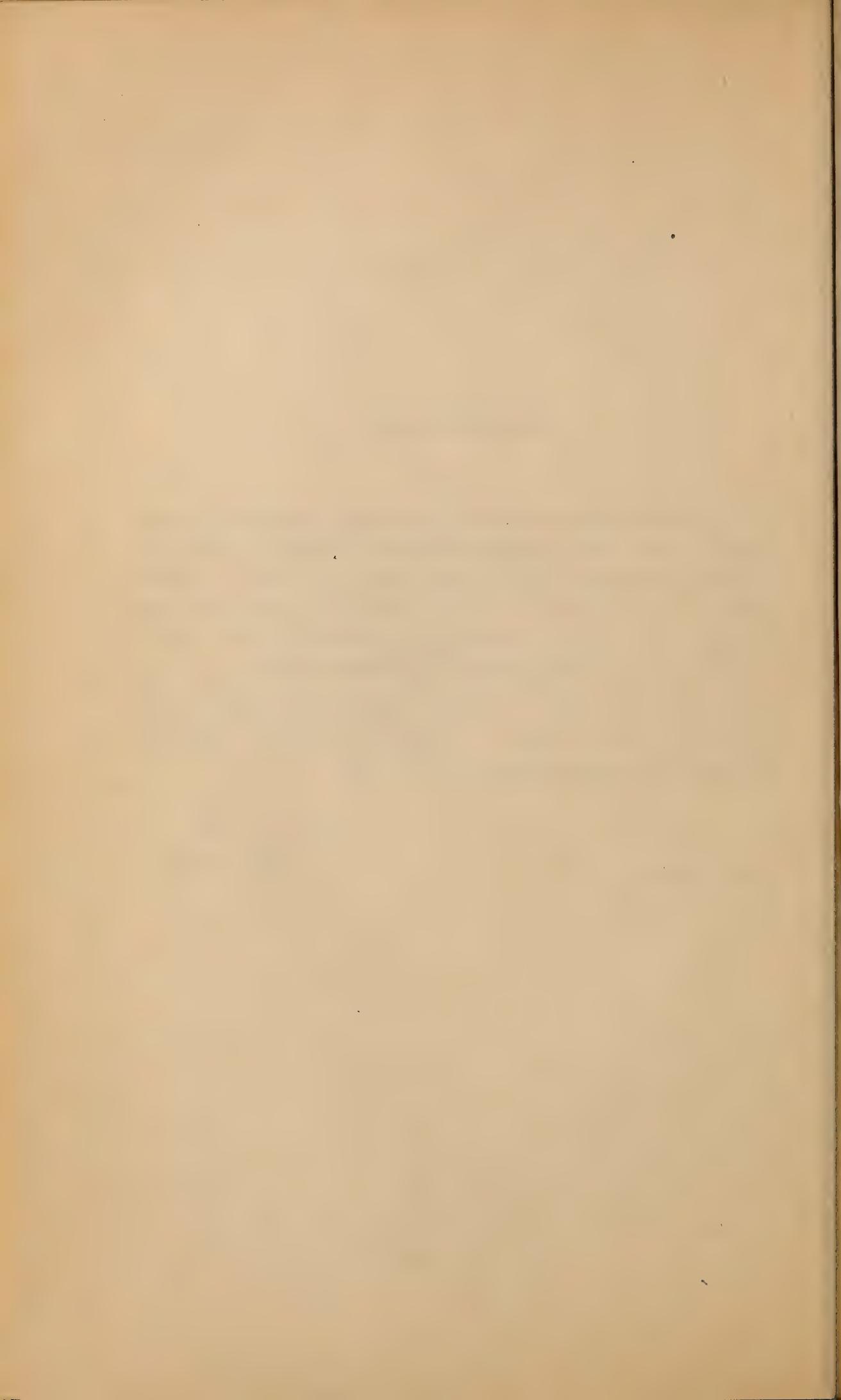
FOREWORD.

We are fortunate in being able to present herewith the forest survey of the towns composing Worcester County. This work has been in progress for the past three years, under the supervision of my assistant, Mr. H. O. Cook, M.F., who has had the assistance of several young men from various forestry schools who have worked largely during the summer vacations.

It is believed that these data will prove very valuable for present and future use in our State forestry development, and our purpose is ultimately to complete the work in the other counties of Massachusetts in the same way.

F. W. RANE,
State Forester.

Nov. 2, 1916.



CONTENTS.

	PAGE
Explanation of survey,	7
Explanation of data:—	
Size classes,	10
Forest types,	12
Open land types,	14
Worcester County,	14
Town forest conditions:—	
Ashburnham,	20
Athol,	21
Auburn,	23
Barre,	24
Berlin,	25
Blackstone,	26
Bolton,	27
Boylston,	28
Brookfield,	29
Charlton,	30
Clinton,	31
Dana,	32
Douglas,	33
Dudley,	34
Fitchburg,	36
Gardner,	37
Grafton,	39
Hardwick,	40
Harvard,	41
Holden,	42
Hopedale,	44
Hubbardston,	45
Lancaster,	46
Leicester,	47
Leominster,	48
Lunenburg,	49
Mendon,	50
Milford,	51
Millbury,	52
New Braintree,	53
North Brookfield,	54

Town forest conditions — *concluded.*

	PAGE
Northborough,	55
Northbridge,	56
Oakham,	58
Oxford,	59
Paxton,	60
Petersham,	61
Phillipston,	62
Princeton,	63
Rutland,	65
Shrewsbury,	66
Southborough,	67
Southbridge,	68
Spencer,	69
Sterling,	70
Sturbridge,	72
Sutton,	72
Templeton,	74
Upton,	75
Uxbridge,	76
Warren,	77
Webster,	78
West Boylston,	79
West Brookfield,	80
Westborough,	82
Westminster,	83
Winchendon,	84
Worcester,	86

THE FORESTS OF WORCESTER COUNTY.

EXPLANATION OF SURVEY.

One of the first essentials in carrying on a business of any extent is an inventory showing the stock on hand. Our raw material in the forestry business in this State is our forest land. We have never had any thorough investigation which would answer the simplest question in this connection, — namely, how much of the area of this State is under forest cover and how much is tillage and pasture. About eleven years ago this department, in co-operation with the Massachusetts Bureau of Statistics, sent maps to the various town assessors and had them locate on these maps the forest land in their towns. Due partially to ignorance of conditions on the part of the assessors and partly to the impossibility of locating from memory all forest land on a small map, we found that the results of this investigation were very crude and unsatisfactory. A few towns were checked up, and the results showed that this investigation underran the actual forest area by 25 to 50 per cent. For this reason we have rejected these data as trustworthy bases of comparison, believing that the estimate of well-informed people is more reliable. An investigation which shows simply the forest area as compared with the open land, while most interesting, has very little practical value. Such a survey to be of use must in addition show the amount of various species which compose the forest, and also the various ages and size classes. It is only with such information that we can make any estimate as to the present and future lumber and cordwood supply in this State.

It was with these conditions in mind that three years ago we decided to make a forest survey of Worcester County. This is not only the largest county in area, but is the most important

from the forestry standpoint. Its woodlands produce the largest amount, and its wood-using industries consume the largest amount of native lumber of any county in the State.

The forest surveying was done in the summer months by students of various forest schools. In this way we were able to get trained men at small expense. The work has taken more time than we anticipated, and was not completely finished until this summer. In the meantime, however, a similar survey of Plymouth County has been undertaken and will be completed this year.

Method of Survey.

Investigations similar to this have been attempted in other States, and the usual method of work has been for the men to traverse all the roads in each town and to sketch in the forest and open land on a base map provided for the purpose. We started our work on the same plan, but after completing a couple of towns changed our method. We found that most of the open farming land lies along the roads, and that the bulk of the forest lies back of this open country. For this reason, while it is possible to sketch in boundaries of the forest land from the roadside, it is impossible to obtain any adequate idea of the composition, size and density of the woodland without actually traversing it. Such a system, therefore, did not give us the information that we most desired.

The method of field work finally used is an adaptation of a large-scale timber cruising system which we felt gave a maximum amount of information at a minimum cost. Each man worked one town at a time, running lines one-half mile apart by compass and pace from one boundary to the other. In a specially ruled notebook, on a scale of 1 inch to 1,000 feet, the length of each type as shown by the pace was recorded. Pantograph enlargements of government topographical sheets on a scale of 1,000 feet to an inch were used as a base map. The data on the notebooks were therefore easily transferred to the map. One of these maps is shown as a cut of the town of Bolton. (In the Plymouth County survey photographic enlargements of the topographic sheets on a scale of 2,000 feet to the inch were found satisfactory, and were more convenient to handle.)

By means of symbols the species making up the type, by numbers the size, and by per cents. the density of stocking, are shown; for example, the following note on the line data, A E C, 2-3, 80, 700, means this: a mixed stand of pine, oak and chestnut, principally pine, of a size midway between Classes 2 and 3, 80 per cent. being fully stocked and extending over 700 feet of line run. In addition, there were special symbols representing chestnut bark disease, fire hazard, etc., if there chanced to be any present. The number of feet in each type, as compared with the total number of feet run in the town, is then proportioned into the total area of the town and the area of each type in acres calculated.

The data obtained in this way are very complete, and in working these up for purposes of publication it was necessary, for the sake of brevity, to exclude some, or to combine several different types and size classes. The complete data are all on file, however, and can be used whenever it appears to be worth while.

Reports.

In addition to the survey each examiner was asked to write a report on each town, covering his observations of the forest, topographical and soil conditions, lumbering and woodworking industries, timber prices, the names of principal landowners, forest-fire conditions, chestnut blight, gypsy-moth infestations, and everything which might be of interest to this department. These reports and the forest maps are on file in the office, and can be referred to whenever any forestry problem comes up in the town.

In order to limit the size of this bulletin it was decided that only those sections of the reports dealing with the forest conditions and wood-using industries should be published.

The following is a list of men who made these forest surveys and reports, with the towns in which they worked: —

DAVID L. DORWARD,	. . .	Brookfield, North Brookfield, Warren, West Brookfield.
HAROLD FAY,	. . . . .	Auburn, Barre, Dana, Hardwick, Millbury, New Braintree, Oakham, Oxford, Worcester.

CEDRIC H. GUISE, . . .	Dudley, Grafton, Holden, Leominster, Northbridge, Paxton, Princeton, Rutland, Shrewsbury, Spencer, Sterling, Sutton, West Boylston.
WALTER G. ILES, . . .	Athol, Phillipston, Royalston, Templeton.
O. D. INGALLS, . . .	Winchendon.
HERBERT J. MILES, . . .	Ashburnham, Gardner, Harvard, Westminster.
JAMES MORRIS, . . .	Charlton, Hubbardston, Leicester, Petersham, Southbridge, Sturbridge.
J. R. SIMMONS, . . .	Boylston, Berlin, Bolton, Clinton, Douglas, Fitchburg, Lancaster, Lunenburg, Northborough, Southborough, Uxbridge, Webster, Westborough.
LENTHALL WYMAN, . . .	Blackstone, Hopedale, Mendon, Milford, Upton.

EXPLANATION OF DATA.

Size Classes.

It is a difficult matter to divide the woodland into size classes and draw a hard-and-fast line between them. For purposes of classification we have recognized four classes, Class 1 being the largest and Class 4 the smallest. In the field intermediate classes were recognized, but in the final classification these have been included with one of the four principal classes. The illustrations are a help in recognizing these size classes.

Class 4. — This smallest class includes both seedling and sprout growth from one to twelve years in age, from 1 to 20 feet in height, and less than 2 inches in diameter. This class has no merchantable value, not even as cordwood.

Class 3. — This class includes growth of from twelve to thirty years of age, from 20 to 35 feet in height, and from 2 to 6 inches breast high diameter. With cordwood species such as oak and maple this type has a low merchantable value as a producer of small, low-grade fuel wood. There is no saw timber in this type, so that saw species, such as pine and chestnut, in this size class can be said to have no merchantable value.

Class 2. — This size includes trees from thirty to forty years of age, from 30 to 50 feet in height, and from 6 to 12 inches in

Open Land Types.

These types are pretty well described by their names, so that no discussion is necessary, except in one or two instances.

It is difficult to distinguish between open and brush pasture, as nearly all pasture has some brush growing in it. The directions to the examiners, however, were to include in brush pasture such lands as were so fully grown up with blueberry bushes, hardhack, sweet fern, etc., as to be about three-fourths covered with such brush growth. When pasture was stocked with a young growth of gray birch, maple, etc., it was included in the birch and maple, size 4, class, and for this reason the area of brush pasture may seem to be smaller than it should be.

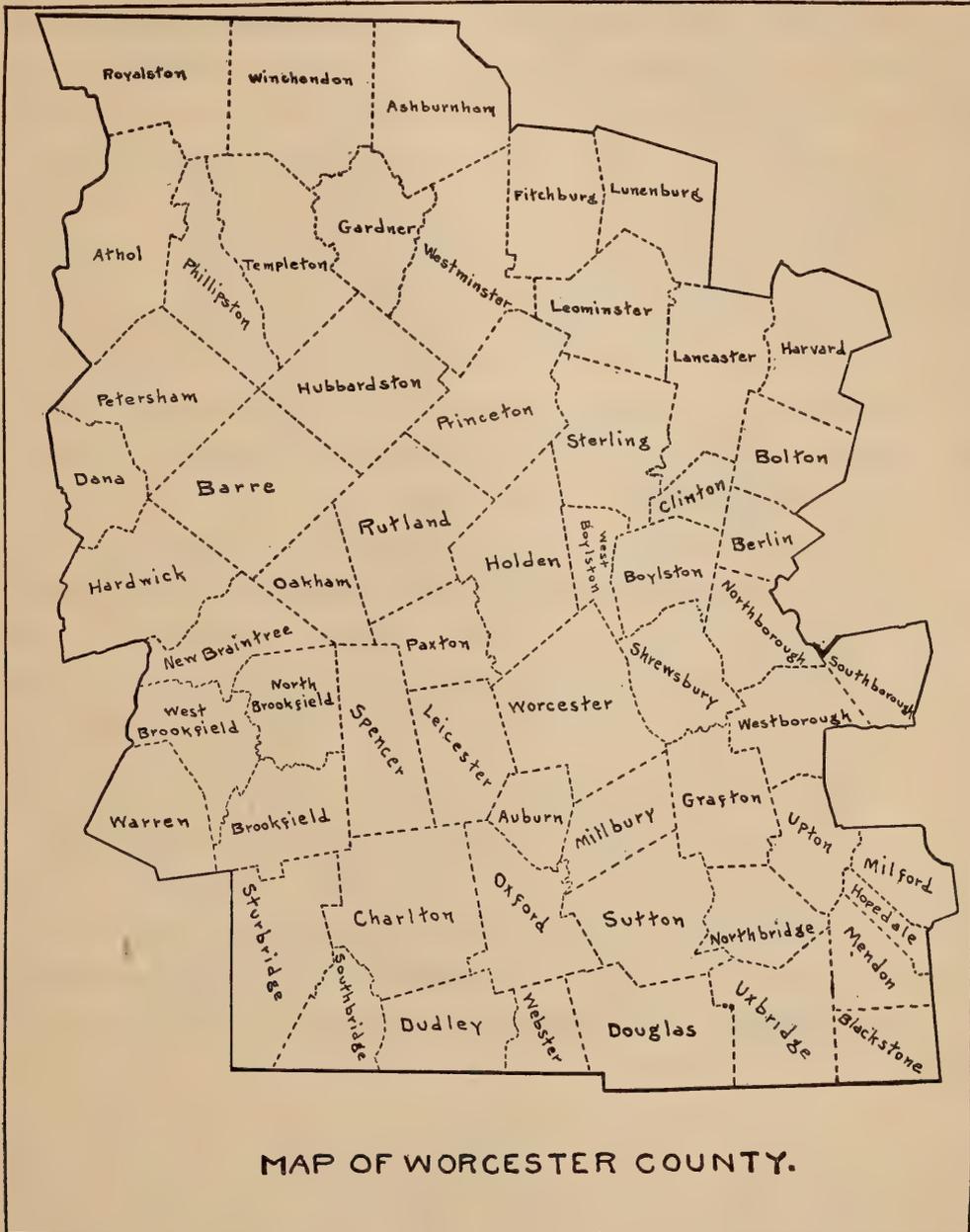
In small towns it is a difficult matter to separate the area described as business and residential from the purely farming land, and in many very small communities no attempt was made to do so. Business and residential represent the area occupied by the village or urban section of the township.

Water areas are obtained from the topographical maps, and are not very trustworthy in many cases. The topographical survey was made forty years ago, and since then new dams have been built in brooks and rivers and new areas flooded, while, on the other hand, old dams which existed at that time have broken down and the mill ponds have disappeared. On the whole, we find that there is more water area than these maps show.

WORCESTER COUNTY.

Worcester County, the largest in the State, is located in the central part and extends from the New Hampshire line to the Connecticut and Rhode Island lines. The city of Worcester fittingly calls itself the heart of the Commonwealth. Three lines of railroad traverse it from east to west, — the Fitchburg Division of the Boston & Maine in the northern part, the Central Massachusetts Division of the Boston & Maine through the central part, and the Boston & Albany in the southern section. These roads are cross connected by several small branch lines of the three main lines mentioned above, so that no part of the county is more than 10 miles from the railroad.

Like all of Massachusetts, the principal business is manufacturing, although there is a considerable farming and dairying business carried on in the county. The manufacturing industries are quite varied, the principal ones being machinery,



wire goods, textiles, — both cotton and wool, — paper, furniture and shoes. Worcester, the second city of the State, is the county seat, while Fitchburg, one of the larger communities of the State, contains the county offices for the northern district.

Topography.

Worcester County is on the southern extension of those highlands which in New Hampshire form the divide between the Connecticut and Merrimack rivers. In Massachusetts all the streams on the west side of the divide drain into the Connecticut, while on the east side of the divide the streams in the north section drain into the Merrimack, and those in the southern section drain directly into the ocean. A line drawn from Ashburnham in the northeast corner of the county to Sturbridge in the southwest will about divide these two watersheds. The principal streams draining the western watershed are the Miller's, Ware, Swift and Quaboag rivers, while on the eastern side are the Nashua, which empties into the Merrimack, the Quinebaug, a tributary of the Nashua, the headwaters of the Assabet and Sudbury rivers, both of which are tributary to the Merrimack, and the Blackstone.

The general character of the topography is that of gently rounded hills with rather narrow valleys between. Occasionally these hills take the form of distinct ridges running north and south. This is especially the case in the southern part of the county, but on the whole there is little regular arrangement. Elevations are highest at the north end of the county, where they average between 1,000 and 1,200 feet above sea level, and decrease gradually towards the south, where they are between 700 and 800 feet in altitude. The most prominent hill is Mount Wachusett in Princeton and Westminster, which, with its elevation of 2,100 feet, dominates the entire hill country, and is the highest hill in Massachusetts east of the Connecticut River.

Soil.

In general the soil is a light sandy loam containing many stones. The top soil is underlaid by coarse gravel or hardpan. The better quality of soil is found on the hill slopes, while the valley bottoms are, as a rule, very sandy or gravelly. Low swamps and meadow lands have a black mucky soil, but these are of local occurrence. Although swampy areas are numerous

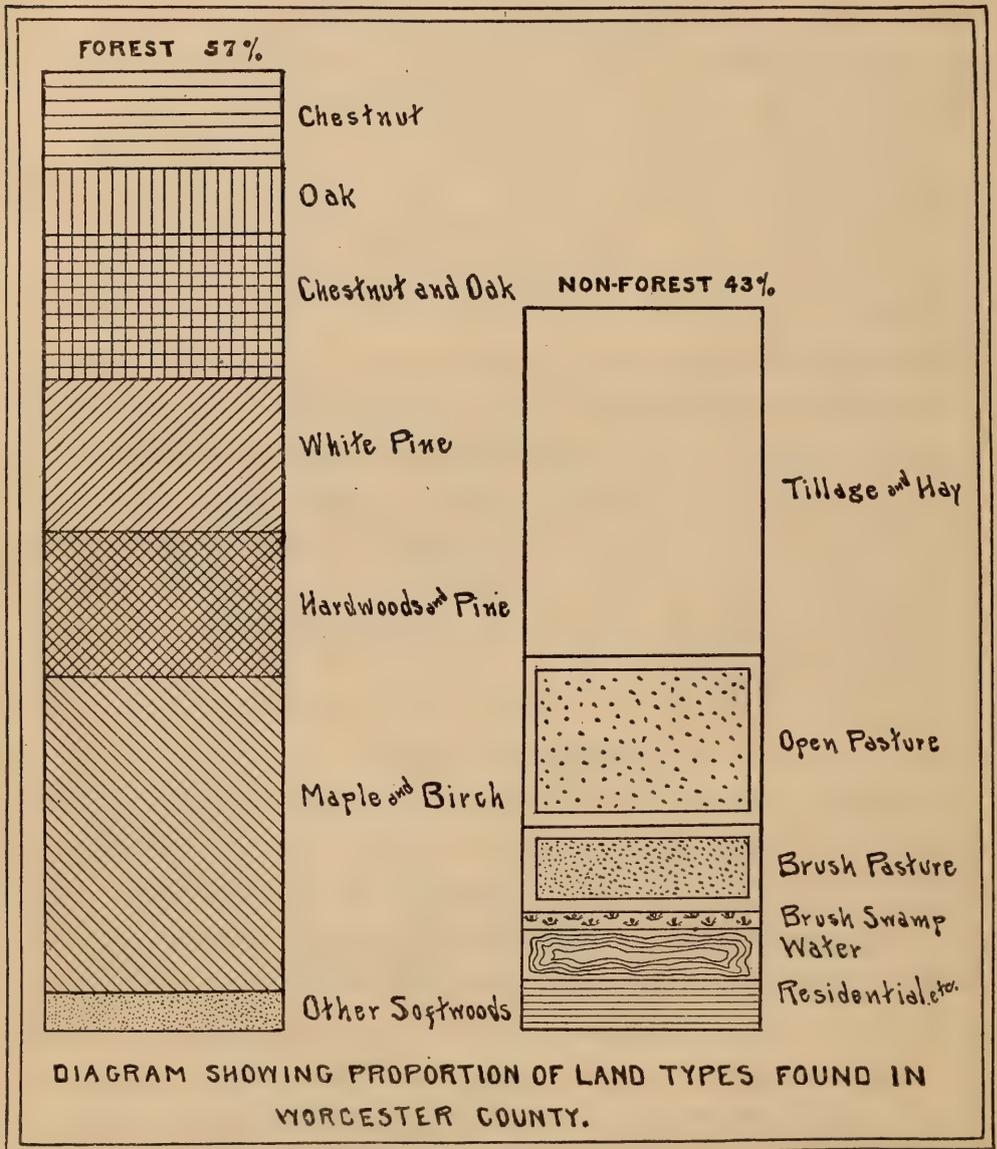
they are of small extent, and the county may be said to be well drained. There are swamps of considerable area in the southern part of Brookfield and in the southern part of Auburn. The Nashua River valley in Lancaster has an extensive clay loam area distinct from anything else in the county. This area contains deposits of fuller's earth, a clay used in the scouring of woolen cloth. The soil is generally deep even on the hills, and outcropping ledges of the underlying rock are not common. This underlying rock is of igneous origin, either granite, schist or gneiss. About Milford the granite has a pinkish tinge and is called "Milford pink granite," and is much prized in some kinds of stone work, while in Fitchburg there are quarries of common gray granite cut chiefly into edgestones and block pavement.

Worcester County soil and topography would be favorable for agricultural development were it not for the great amount of stones and bowlders which make it impossible to work the soil with economy. For this reason much of the area must remain absolute forest soil. The soil on the whole is more favorable to conifers than to hardwood growth, although in low, moist situations and on north slopes deciduous growth thrives excellently.

Forest Conditions.

Worcester County is on the boundary line between the southern limit of what is called the northern forest type — which contains, as hardwoods, beech, white and yellow birch and rock maple, and as conifers, white pine, hemlock, fir and spruce — and the northern edge of the southern forest region, whose type of trees includes chestnut, oaks, hickory, gray birch, red maple, white pine, pitch pine and hemlock. Lying as it does in this intermediate zone between these two forest regions its forest flora is very extensive. As explained before, it has been necessary to group these various species into types, and we give herewith a table showing the area of these forest types and non-forest types for the whole county. It will be seen from this table that the forest area covers more than one-half of the county, or 57 per cent. It will be noted with regret that the

largest single type is that of the comparatively worthless maple and gray birch, but on the other hand two-thirds of the forest area is made up of types which contain saw species. One-quarter of this forest area is doomed to serious damage on account of the chestnut bark disease. Seven-tenths of the



forest area is practically below merchantable size, even for cordwood. This is not to be taken, however, as a discouraging feature, as naturally stands which have reached a merchantable size are soon cut down, and the proportion of the larger sizes must always be low.

Wood-using Industries.

Worcester County is an important district from the local lumbering standpoint, for of the annual lumber cut in the State, amounting to 400,000,000 feet, it produces at least a third, and of the annual consumption of locally grown lumber used in wood-using industries, amounting to at least 200,000,000 feet, more than one-half is used in this county. The three chief centers for wood-using industries of the State are located in Worcester County; they are Gardner, Winchendon and Athol. The industries using the greatest amount of home-grown timber are those producing boxes, pails, toys, tubs, chairs and match blocks. As the industries of these towns and others are explained in detail in the individual town reports, we will not go further into the matter in this chapter.

Total Land Types.

[59 towns.]

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	9,059	17,965	21,150	9,981	58,155	10	-
Oak,	14,037	16,993	6,682	2,181	39,893	7	-
Chestnut and oak,	29,049	33,290	16,388	6,019	84,746	15	-
White pine,	13,048	28,907	29,259	21,584	92,798	16	-
Hardwoods and white pine,	26,086	43,320	12,918	5,454	87,778	15	-
Maple and birch,	93,184	70,256	17,610	5,575	186,625	33	-
Softwoods other than white pine.	5,022	10,073	6,882	2,992	24,969	4	-
Total,	189,485	220,804	110,889	53,786	574,964	-	-
Percentage,	33	39	19	9	-	100	57
NON-FOREST TYPES.							
Tillage and hay,					214,450	-	21
Open pasture,					101,974	-	10
Brush pasture,					50,109	-	5
Alder and brush swamp,					7,461	-	1
Business, residential, etc.,					25,475	-	3
Water,					27,341	-	3
Total area of county,					1,001,774	-	100

ASHBURNHAM.

Pine is fairly abundant in Ashburnham in scattered stands, especially in the south part of the township, and there is considerable reproduction. The greater part of the woodlands is composed of swamp or moisture-loving species, such as spruce, larch, red maple, birch (gray, white and yellow), red oak, poplar and beech. Red maple and beech are particularly abundant, and there are large areas of spruce, larch and hemlock swamp. The mixed hardwood type is composed of red maple, birches, red oak, poplar, beech and a little chestnut, although most of the chestnut has been cut off for the chair factories in Gardner, Winchendon and Ashburnham.

The general size of the timber is in the 3-2 class, the rate of growth is fairly rapid, and the timber is in fair health. On the northwest of Stodge Meadow Pond, and also about 1 mile west from Ashburnham Center, are two areas where red pine is abundant in mixture with white pine. Here the red pine is growing about as rapidly as the white pine, and is cleaning itself fairly well, especially where shaded at the side. Reproduction in old pastures is plentiful where white pine stands from which seed has come are near by.

The principal sawmill owners are L. Lashaway, Jr., W. E. Jefts, Warren Marble, Charles Russell and W. E. Peckens. L. Lashaway cuts pine, spruce and hemlock, about 1,000,000 board feet per year. The other owners saw irregularly, but probably each saws from 500,000 to 1,000,000 board feet per year. In addition there are many portable mill operators who come in from other towns.

The W. F. Whitney Company, in South Ashburnham, has two mills, using mostly southern oak and a little birch, beech and maple from New Hampshire and Vermont.

The Curtis chair shop at Ashburnham uses per year 120,000 board feet of chestnut and 132,000 of birch, beech and maple, practically all of which comes from outside the State.

Wright's crutch factory turns out 3,500 crutches per month, and uses the following: —

Rock maple, $1\frac{1}{8}$ inch, 100 M board feet per annum.
 Rock maple, $1\frac{1}{4}$ inch, 6 to 8 M board feet per annum.
 Birch, $1\frac{1}{4}$ inch, 10 M board feet per annum.
 Rosewood, 300 board feet per annum.
 Cherry, 5 to 6 M board feet per annum.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	91	-	97	-	188	1	-
Oak,	195	273	234	143	845	4	-
Chestnut and oak, . . .	58	39	169	150	416	2	-
White pine,	318	937	1,201	3,368	5,824	31	-
Hardwoods and white pine, ¹	726	779	189	336	2,030	11	-
Maple and gray birch, .	2,564	2,012	356	785	5,717	31	-
Softwoods other than white pine. ²	617	1,525	941	643	3,726	20	-
Total,	4,569	5,565	3,187	5,425	18,746	-	-
Percentage,	24	30	17	29	-	100	71
NON-FOREST TYPES.							
Tillage and hay,					3,173	-	12
Open pasture,					2,745	-	10
Brush pasture,					513	-	2
Business, residential, etc.,					324	-	1
Water,					1,123	-	4
Total area of town,					26,624	-	100

¹ Hardwoods are mostly gray birch and maple with some white birch, poplar and beech.

² Swamp spruce with a little larch and hemlock. Very little pitch pine.

ATHOL.

The northern portion of the town is a natural white pine region. White pine is the principal growth, with chestnut, oak, birch and maple coming next in order. The largest stand of white pine noted was possibly 150 acres in area, while the average stand was about 30 acres. In some places red pine was found in mixture with the white pine, and for the same period of years the red pine seems to have outgrown the white pine

in volume. The southern part of the town is more of a hardwoods region. Here the main growth is chestnut and oak, with white pine, birch and maple coming next in order named. Occasionally small stands of pure hemlock were found. The hardwoods, chestnut and oak, were found in both pure and mixed stands. In the mixed hardwoods, suppressed pine was found but very rarely. Small areas of gray birch and white pine were found in mixture.

Athol has one sawmill and several wood-using industries. A sawmill situated in Athol and owned by Fred Patenaude cuts 8,000 board feet per day of white pine for local use.

Athol Center has several wood-using industries, as follows: (1) Diamond Match Company, which consumed 19,000,000 board feet of white pine in 1912 and 13,000,000 in 1913; this was used for match blocks; 3,000,000 came from Maine, 1,000,000 from Connecticut, while the balance was divided between Massachusetts and New Hampshire. (2) N. D. Cass Company use 1,500,000 of white pine, chestnut and hemlock in the manufacture of wooden toys. (3) Stratton Bros & Co., manufacturers of boxes and interior house finishings, use 500,000 board feet of white pine and southern yellow pine; the yellow pine amounting to 80,000 board feet. (4) A. J. Raymond consumes 2,000,000 board feet of white and hard pine and a small proportion of cypress in the manufacture of sash, doors and blinds; this comes from California, Oregon, Michigan, Maine, New Hampshire and Massachusetts. (5) A. T. Tyler Company, product, sash and blinds, use 1,000,000 to 1,500,000 board feet of white pine, coming from New York and Michigan, and about 100,000 feet of sugar pine, coming from California. (6) L. Morse & Sons manufacture furniture from white pine, oak and chestnut received from local parties. (7) H. M. Peckham supplies local demands with rails, posts and balustrades.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	296	255	497	128	1,176	7	-
Oak,	336	242	222	-	800	5	-
Chestnut and oak,	988	967	537	134	2,626	16	-
White pine,	370	672	1,048	766	2,856	18	-
Hardwoods and white pine, ¹	1,182	1,538	1,303	262	4,285	26	-
Maple and gray birch,	2,553	1,350	322	74	4,299	26	-
Softwoods other than white pine. ²	20	148	168	20	356	2	-
Total,	5,745	5,172	4,097	1,384	16,398	-	-
Percentage,	35	32	25	8	-	100	75
NON-FOREST TYPES.							
Tillage and hay,					2,298	-	10
Open pasture,					1,794	-	8
Brush pasture,					262	-	1
Business, residential, etc.,					894	-	4
Water,					370	-	2
Total area of town,					22,016	-	100

¹ Hardwoods are largely birch and maple, with some oak and chestnut in the larger sizes.

² Mostly hemlock and spruce.

AUBURN.

Chestnut is the chief tree of the town, the chestnut and oak type seeming to predominate. Most of it is still unmerchantable save for cordwood, and a good deal has been cut over within the last ten years. Clear cutting is the rule, with a little poor selection cutting which leaves thin, scraggly stands. There are a few small stands of merchantable pine, notably Prospect Park, just south of Stoneville. There is a good stand of small merchantable chestnut and some pine about a mile southeast of the center of the town. There is quite a little maple swamp, and in places small stands of pitch pine.

No sawmills nor woodworking industries were found in the town. A mill belonging to Geo. L. Jacques of Worcester had recently cut off the southeast slope of Prospect Hill, where there was a stand of small chestnut, oak and some pine.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	220	140	180	70	610	14	-
Oak,	60	50	40	20	170	4	-
Chestnut and oak, . . .	600	360	60	30	1,050	24	-
White pine,	-	160	80	40	280	6	-
Hardwoods and white pine, ¹	130	340	40	-	510	12	-
Maple and gray birch, .	780	710	100	50	1,640	37	-
Softwoods other than white pine. ²	90	-	70	-	160	3	-
Total,	1,880	1,760	570	210	4,420	-	-
Percentage,	43	40	13	4	-	100	49
NON-FOREST TYPES.							
Tillage and hay,					2,960	-	33
Open pasture,					320	-	9
Brush pasture,					390	-	4
Water,					460	-	5
Total area of town,					9,050	-	100

¹ Hardwoods are mostly gray birch and poplar.

² Mostly pitch pine with some cedar.

BARRE.

Although this town has been extensively logged, there is still a large amount of growing pine left, amounting to 50 per cent. of the forest area. There is very little, however, of commercial size. Commercially speaking, chestnut follows pine in importance, but occurs with far less frequency. Red maple and birch form one-fifth of the forest area.

Most of the lumber cut in Barre has been shipped outside. There is a sash and blind factory at Barre Plains belonging to Mr. T. E. Rich, and a planing mill owned by H. A. Knight. James A. Rice is the leading operator.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	-	67	393	193	653	4	-
Oak,	-	121	48	48	217	1	-
Chestnut and oak, . . .	490	858	417	42	1,807	12	-
White pine,	459	2,213	1,415	744	4,831	32	-
Hardwoods and white pine, ¹	889	3,059	314	48	4,310	29	-
Maple and gray birch, .	2,080	883	151	12	3,126	21	-
Softwoods other than white pine.	-	24	79	85	188	1	-
Total,	3,918	7,225	2,817	1,172	15,132	-	-
Percentage,	26	48	18	8	-	100	52
NON-FOREST TYPES.							
Tillage and hay,					6,922	-	24
Open pasture,					6,402	-	22
Brush pasture,					393	-	1
Business, residential, etc.,					248	}	1
Water,					151		
Total area of town,					29,248	-	100

¹ Hardwoods are gray birch, maple and poplar in smaller sizes, giving way to chestnut and oak in larger sizes.

BERLIN.

The proportion of timbered land to the total area of the town is about 50 per cent. The predominating type is oak and pine, usually in mixed stands. Chestnut exists in pure stands and in mixed stands with oak and pine. Hickory is more common than in the average town, but there are no absolutely pure stands.

Edmund W. Wheeler of South Berlin operates a sawmill cutting about 250 M board feet per year. He uses mostly pine, chestnut and oak. W. A. Wheeler of Berlin cuts chestnut poles and ties.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	70	170	140	280	660	16	-
Oak,	140	820	260	70	1,290	31	-
Chestnut and oak,	70	170	130	70	440	10	-
White pine,	30	70	160	160	420	10	-
White pine and hardwoods, ¹	40	320	110	60	530	13	-
Maple and gray birch,	230	500	30	40	800	19	-
Softwoods other than white pine. ²	-	30	30	10	70	1	-
Total,	580	2,080	860	690	4,210	-	-
Percentage,	14	49	20	17	-	100	50
NON-FOREST TYPES.							
Tillage and hay,					2,820	-	33
Open pasture,					560	-	7
Brush pasture,					740	-	9
Water,					110	-	1
Total area of town,					8,440	-	100

¹ Hardwoods are principally birch, maple and oak.

² Pitch pine and hemlock.

BLACKSTONE.

The wooded section of Blackstone is in poor condition as regards thriftiness and percentage of useful species, on account of the severe fires which have swept through. There is almost no timber left which is merchantable, and very little which will grade above a straight Class 3. Pine and softwoods are lacking, even in reproduction, partly because of their greater susceptibility to fire, which makes for a higher percentage of hardwoods wherever it gets in. There are scattered small lots of pine in the northern part of the town and on Candlewood Hill, but the greater part of the land is covered with a sprout growth of oaks, gray birch, chestnut and red maple.

There were no portable mills working in the town at the time the survey was made. Moreover, there is only one permanent mill. This mill is located in East Blackstone, being

run by water power from the Mill River. Mr. A. S. Kelley is the owner. This mill is a small one, the amount cut varying, but seldom exceeding 50 M board feet annually. The stock is mostly chestnut, with some pine.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	118	243	76	-	437	7	-
Oak,	186	274	15	22	497	8	-
Chestnut and oak,	63	871	278	54	1,266	19	-
White pine,	55	27	34	102	218	3	-
Hardwoods and white pine, ¹	307	452	157	41	957	14	-
Maple and gray birch,	985	572	181	51	1,789	27	-
Softwoods other than white pine. ²	446	536	296	166	1,444	22	-
Total,	2,160	2,975	1,037	436	6,608	-	-
Percentage,	33	45	15	7	-	100	64
NON-FOREST TYPES.							
Tillage and hay,					2,054	-	20
Open pasture,					363	-	3
Brush pasture,					1,184	-	11
Water,					197	-	2
Total area of town,					10,406	-	100

¹ Hardwoods consist of maple, chestnut and oak.

² Largely pitch pine with some cedar.

BOLTON.

The general condition of the forest is good, especially in the pine, oak and hardwood types. There is a good layer of humus. The principal species are pine and chestnut and oak in clear and mixed stands. Ash and hickory are common in the mixture and also as roadside trees. Suppressed pine is common in the chestnut and oak types. The Century Mill, W. J. Webber, proprietor, cuts chestnut and pine to the extent of about 75 M board feet per year. This is the only lumber mill in Bolton, and it is idle most of the time.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	128	527	383	55	1,093	17	-
Oak,	150	419	155	153	877	13	-
Chestnut and oak,	424	887	255	230	1,796	28	-
White pine,	20	424	166	361	971	15	-
Hardwoods and white pine, ¹	100	349	50	72	571	9	-
Maple and gray birch,	132	780	164	-	1,076	16	-
Softwoods other than white pine. ²	-	112	35	9	156	2	-
Total,	954	3,498	1,208	880	6,540	-	-
Percentage,	14	53	19	14	-	100	51
NON-FOREST TYPES.							
Tillage and hay,					4,373	-	34
Open pasture,					902	-	7
Brush pasture,					945	-	7
Water,					30	-	1
Total area of town,					12,790	-	100

¹ Principally maple and birch.

² Pitch pine.

BOYLSTON.

The proportion of wooded land to the total area of the town is about 50 per cent. The chief types are chestnut, oak, pine and soft maple, in clear and mixed stands. In general the condition is healthy. Practically all of the pine plantations around the shores of the reservoir show a healthy growth.

The Sterling Lumber Company, represented by Walker, Wilding & Davis, a Worcester firm, transact most of the lumber business of this town, and cut about 200 M feet per year.

George F. Flagg, Boylston Center, does some lumbering and cuts about 200 M feet per year.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	100	240	110	220	670	10	-
Oak,	430	610	60	50	1,150	18	-
Chestnut and oak,	350	1,330	240	90	2,010	31	-
White pine,	40	310	100	40	490	7	-
Hardwoods and white pine, ¹	-	300	40	110	450	7	-
Maple and gray birch,	390	1,340	20	10	1,760	26	-
Softwoods other than white pine. ²	-	40	30	-	70	1	-
Total,	1,310	4,170	600	520	6,600	-	-
Percentage,	20	63	9	8	-	100	52
NON-FOREST TYPES.							
Tillage and hay,					2,450	-	19
Open pasture,					420	-	3
Brush pasture,					600	-	5
Water,					2,580	-	21
Total area of town,					12,650	-	100

¹ Hardwoods are mostly maple, with some chestnut, oak and gray birch.

² Pitch pine.

BROOKFIELD.

The woodlands are practically a mixture of all kinds of hardwoods. The stands are all second growth in origin. The woods were cut many years ago when the railroads were using wood for fuel. These grew up and in many cases were cut again within the last twenty or twenty-five years. Chestnut is not abundant. There are a few pure stands, but as a rule it occurs chiefly as a part of a mixture. This mixture is mostly maple, gray birch, oak and chestnut, with an occasional cherry. The stands are very irregular, the type constantly changing so that the term "mixed hardwoods" is the best one to apply. White pine is an important factor in nearly all the stands. In many cases the type could be changed to a pure pine type with good stocking if the inferior species were eliminated.

There are no sawmills in the town, but the cutting is done chiefly by William F. Fullam and H. E. Cummings of North Brookfield.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	460	600	410	30	1,500	14	-
Oak,	-	-	100	-	100	1	-
Chestnut and oak,	120	20	80	350	570	5	-
White pine,	80	270	100	70	520	5	-
Hardwoods and white pine, ¹	500	1,200	1,650	110	3,460	33	-
Maple and gray birch,	470	1,160	2,300	420	4,350	42	-
Total,	1,630	3,250	4,640	980	10,500	-	-
Percentage,	16	31	44	9	-	100	59
NON-FOREST TYPES.							
Tillage and hay,					2,810	-	14
Open pasture,					1,650	-	9
Brush pasture,					480	-	3
Brush swamp,					1,110	-	6
Business, residential, etc.,					140	-	1
Water,					1,010	-	6
Total area of town,					17,700	-	100

¹ Hardwoods are largely maple and birch, with some chestnut and oak.

CHARLTON.

The maple and birch type predominates, mostly in small sizes. Following this type in order of importance come the chestnut and oak type, the hardwoods and white pine type, and the white pine type. Few pure stands of chestnut exist. The same holds true of oak. The only type running into the Class 1 size that was noted was that of the white pine.

There are two combined sawmills and box shops capable of cutting from 300 to 500 M board feet per annum. That of Marcus Carpenter is located in Charlton City, while the Putnam Brothers' mill is situated in the eastern part of the

town about $1\frac{1}{2}$ miles from Richardson's Corner. Both obtain their logs locally, and sell their products either in Charlton or in Worcester.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	30	120	160	-	310	2	-
Oak,	50	180	20	-	250	2	-
Chestnut and oak,	1,270	1,650	110	-	3,030	22	-
White pine,	150	800	1,000	80	2,030	15	-
Hardwoods and white pine,	890	1,660	160	-	2,710	20	-
Maple and birch,	3,700	1,720	30	-	5,450	} 39	-
Hemlock,	-	40	10	-	50		
Total,	6,090	6,170	1,490	80	13,830	-	-
Percentage,	44	44	11	1	-	100	49
NON-FOREST TYPES.							
Tillage and hay,					7,240	-	26
Open pasture,					3,130	-	11
Brush pasture,					2,520	-	9
Alder swamp,					410	-	1
Business, residential, etc.,					150	-	1
Water,					850	-	3
Total area of town,					-	-	100

CLINTON.

The proportion of forest to cleared land is about 40 per cent. The principal types are pine, oak and chestnut in mixed stands, very little being of timber size. The entire northeast corner is sprout land, sizes 3 and 4. Merchantable timber is found in very small isolated wood lots. The general condition is only fair.

W. A. Fuller cuts pine, chestnut, oak and pitch pine; amount per year about 1,400 M.

W. L. Bancroft cuts pine, chestnut and oak; amount per year a little less than 1,000,000 feet.

Phillip Philburn cuts 250 M per year, — pine 200 M, chestnut 50 M, and 1,500 cords of wood.

Bennett Alder cuts cordwood only, — chestnut, oak and pine mostly, in Clinton, Boylston and Bolton.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total. Acres.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
Chestnut,	—	120	30	90	240	14	—
Oak,	340	380	60	20	800	47	—
Chestnut and oak,	—	280	60	60	400	23	—
White pine,	20	40	20	10	90	5	—
Hardwoods and white pine, ¹	—	10	—	—	10	1	—
Maple and gray birch,	40	50	—	—	90	5	—
Pitch pine,	—	—	90	—	90	5	—
Total,	400	880	260	180	1,720	—	—
Percentage,	23	51	15	11	—	100	37
NON-FOREST TYPES.							
Tillage and hay,					650	—	14
Open pasture,					80	—	2
Brush pasture,					30	}	28
Business, residential, etc.,					1,280		
Water,					860	—	19
Total area of town,					4,620	—	100

¹ Hardwood is principally gray birch.

DANA.

Over two-thirds of the town is in forest, and white pine types predominate. There is a considerable amount of pine of commercial size, but it is being rapidly logged at this time. Oak is widespread, but usually in mixed stands.

The chief industry at North Dana is a hat factory, but wood-using industries occupy a considerable place. There is a box factory in North Dana belonging to Grover and Gee, and also one at Soapstone now operated by a Mr. Donnell. Principal wood-lot operators are C. E. Gee, Cleveland Grover, R. N. Doubleday and Otis Hager. The F. M. West Box Company of Springfield have large holdings of pine timber in Dana.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	70	110	230	240	650	8	-
Oak,	90	130	110	10	340	4	-
Chestnut and oak,	190	140	10	-	340	4	-
White pine,	220	930	1,000	590	2,740	32	-
Hardwoods and white pine, ¹	990	1,250	100	250	2,590	31	-
Maple and gray birch,	340	420	200	130	1,090	13	-
Softwoods other than white pine. ²	100	480	110	20	710	8	-
Total,	2,000	3,460	1,760	1,240	8,460	-	-
Percentage,	24	41	21	14	-	100	67
NON-FOREST TYPES.							
Tillage and hay,					1,710	-	14
Open pasture,					1,110	-	9
Brush pasture,					880	-	7
Business, residential, etc.,					170	-	1
Water,					210	-	2
Total area of town,					12,540	-	100

¹ Hardwoods consist of gray birch, maple and oaks.

² About one-half pitch pine and one-half hemlock.

DOUGLAS.

The town is about 85 per cent. wooded. This wooded area contains mostly a dense healthy growth of white pine, pitch pine, oak, chestnut and hardwoods, varying in size from 4 to 1. There is a considerable amount of swamp in town containing some hemlock and cedar.

There are two sawmills in the town; that of Mr. W. R. Wallis saws about 500 M feet of pine and chestnut per year, while that of Charles Church, running about half the time, cuts about 200 M board feet of chestnut and pine per year. Mr. W. R. Wallis also owns a box factory which, in connection with his mill, uses about 1,000,000 feet of pine, oak, chestnut, spruce and cedar. Mr. R. E. Dudley operates a portable mill during the fall and winter months. He cuts about 1,000,000 feet per year of pine, oak and chestnut.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	-	82	287	211	580	3	-
Oak,	369	199	-	-	568	3	-
Chestnut and oak,	4,262	1,739	1,505	826	8,332	40	-
White pine,	64	867	867	1,064	2,862	13	-
Hardwoods and white pine, ¹	1,306	2,810	896	357	5,369	25	-
Mixed hardwoods, ¹	1,458	1,399	240	100	3,197	15	-
Softwoods other than white pine. ²	59	-	35	47	141	1	-
Total,	7,518	7,096	3,830	2,605	21,049	-	-
Percentage,	36	34	18	12	-	100	88
NON-FOREST TYPES.							
Tillage and hay,					1,768	-	7
Open pasture,					322	-	1
Brush pasture,					76	}	2
Business, residential, etc.,					334		
Water,					580	-	2
Total area of town,					24,129	-	100

¹ Hardwoods are maple, oak, chestnut and gray birch.

² Cedar and hemlock.

DUDLEY.

In Dudley the timber is confined to several distinct areas. Along the western boundary and in for about three-quarters of a mile it forms an almost solid belt. From this line over to the lake region the town is given over almost entirely to agriculture, and outside of small patches of mixed hardwoods of unmerchantable size very little hardwood occurs. A longitudinal strip, comprising the eastern quarter of the town, is covered with some excellent stands of chestnut.

The prevailing types are chestnut, chestnut and oak, mixed hardwoods and birch, while in some places pine occurs, usually in combination with one of the above-named types. In no place was found a stand which could be classified as large merchantable. The chestnut along the western and eastern parts runs close to Class 2, but it will be some time before the

bulk will reach this size. The majority of the best trees now run in a large 3 to a small 2 class. The chestnut stands in the eastern part of the town contain trees of splendid quality, and provided the blight does not come in too severely these will be quite valuable for saw logs and poles ten or fifteen years hence.

Several areas of very large extent occur which have nothing but a growth of young chestnut and oak sprouts. These sprouts are generally infected with the bark disease, and from the present indications will amount to very little. Around the ponds in the east, and particularly in the southeast, the best timber occurs.

There are no sawmills or woodworking industries in Dudley. Portable sawmills have worked there recently, but have now moved elsewhere, evidently from lack of suitable material to operate upon.

The paper mill located at West Dudley uses only rags and old paper, and is in no way connected with the wood pulp industry.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total. Acres.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
Chestnut,	170	200	310	110	790	14	-
Oak,	380	360	10	-	750	13	-
Chestnut and oak,	470	620	190	-	1,280	23	-
White pine,	-	-	30	30	60	1	-
Hardwoods and white pine, ¹	80	210	30	30	350	6	-
Maple and gray birch,	1,510	700	180	-	2,390	42	-
Softwoods other than white pine. ²	-	30	-	-	30	1	-
Total,	2,610	2,120	750	170	5,650	-	-
Percentage,	46	38	13	3	-	100	40
NON-FOREST TYPES.							
Tillage and hay,					5,770	-	40
Open pasture,					1,010	-	7
Brush pasture,					1,390	-	10
Water,					450	-	3
Total area of town,					14,270	-	100

¹ Hardwoods are red maple and gray birch.

² White cedar.

FITCHBURG.

About 50 per cent. of the town is made up of wood and sprout land. The principal types are white pine, pitch pine, oak and chestnut, with hemlock, maple, poplar, white and gray birch, beech, ash and other hardwoods. Clear stands are usually of pine, oak, chestnut and maple. Mixed stands of hardwood contain red maple in abundance, and a considerable amount of hard maple on the hills. The general condition of the wood growth is very good. There is not very much waste land in the town.

Fitchburg is not a large consumer of native lumber, but there are a few box manufacturers who take native pine and chestnut. Most of the lumber used in building operations and builder's finish comes from outside the State. The Crocker & Burbank Company, paper manufacturers, use considerable lumber, spruce and hard and soft pine. They occasionally buy wood lots which they operate themselves. The Parkhill Manufacturing Company use pine and hemlock for cloth boards, and operate their own wood lots. Messrs. P. R. Eaton and I. P. Lawrence also operate locally.

Box Makers.

O. S. Cook & Sons.	|	Webber Lumber Company.
C. A. Priest Lumber Company.	|	S. G. Cushing & Sons.
Haldie Nickerson.	|	Chas. A. Priest Lumber Company.

Lumber Dealers.

Webber Lumber Company.	|	E. E. Watson.
H. A. Lawrence Company.	|	Wiley & Foss.
P. R. Eaton.	|	Lawrence & Klein Lumber Company.

Cordwood Dealers.

C. H. Greene.	|	Union Coal Company.
---------------	--	---------------------

Wood Novelties.

Mossman Manufacturing Company.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	40	190	430	50	710	8	-
Oak,	70	140	-	-	210	2	-
Chestnut and oak,	130	420	310	-	860	10	-
White pine,	80	890	980	560	2,510	29	-
Hardwoods and white pine, ¹	100	450	260	480	1,290	15	-
Maple and gray birch,	670	1,830	230	130	2,860	33	-
Softwoods other than white pine. ²	-	80	220	20	320	3	-
Total,	1,090	4,000	2,430	1,240	8,760	-	-
Percentage,	12	46	28	14	-	100	48
NON-FOREST TYPES.							
Tillage and hay,					4,770	-	26
Open pasture,					890	-	5
Brush pasture,					560	-	3
Business, residential, etc.,					3,030	-	17
Water,					230	-	1
Total area of town,					18,240	-	100

¹ Hardwoods are red maple and birch.

² About one-third pitch pine and two-thirds hemlock.

GARDNER.

No extensive areas of woodland occur. There is a considerable amount of forest scattered here and there in groups and separated by large logged areas, swamps and brushy pasture. The northern part of the town is more forested than the southern part. Much good white pine is found and a considerable amount of maple, beech and birch. The pine is mixed with maple, beech, birch, poplar and cherry rather than with chestnut and oaks, as it commonly is in the southern part of Worcester County. Both red and sugar maple are more plentiful here than in the southern part of the county. Extensive areas of swamp land bearing red and black spruce, larch and hemlock occur. These swamps contain a young growth scarcely large enough for box boards.

Gardner uses probably more lumber than any other town in the State outside of Boston in manufacturing industries, and the chief products are chairs and baby carriages. Naturally the bulk of the lumber used are hardwoods, and the leading species are birch, oak, chestnut, maple and beech. Considerable quantities of cheap pine and spruce are used for crating purposes.

Only about 20 per cent. of the lumber used in the industry is cut in this State, although the bulk of it comes within the limits of New England. Inasmuch as the lumber is cut up into small pieces, the chair manufacturers can utilize a rather low grade of hardwood lumber, Classes 1, 2 and 3 common. The largest concern in Gardner is the Heywood Bros. & Wakefield Company. This concern has mills also at Wakefield, Mass., and Chicago, Ill. When running to capacity it employs 1,700 hands and consumes 20,000,000 feet per year. The other chair-making concerns are much smaller and use from 2,000,000 to 5,000,000 feet per year. The following is a list of these manufacturers of chairs: —

S. Bent & Brothers.
 Conant, Ball & Co.
 P. Derby & Co.
 John A. Dunn Company.
 Greenwood Associates.
 Brown Brothers Company.
 Pineo Manufacturing Company.

Kelly Brothers.
 Howe Spalding.
 Nichols & Stone.
 L. B. Ramsdell.
 S. K. Pierce & Son.
 A. & H. Knowlton.

In addition to the above manufacturers of chairs, the Central Oil Stove Company run a small sawmill at their plant at which they cut up cheap pine and spruce for crating shooks. L. A. Wright has a stationary mill in which they do custom sawing and planing, handling pine largely. Timothy E. Sheary manufactures boxes and carries on a general lumber business. E. Osgood & Sons and L. H. Kendall are the chief dealers in cordwood.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut and oak,	-	-	-	-	-	-	-
White pine,	441	64	947	173	1,625	19	-
Hardwoods and white pine, ¹	1,010	237	275	179	1,701	20	-
Mixed hardwoods, ¹	2,756	787	281	141	3,965	46	-
Spruce, larch and hemlock,	582	83	588	64	1,317	15	-
Total,	4,789	1,171	2,091	557	8,608	-	-
Percentage,	56	14	24	6	-	100	59
NON-FOREST TYPES.							
Tillage and hay,					1,913	-	13
Open pasture,					627	-	4
Brush pasture,					1,509	-	10
Business, residential, etc.,					1,663	-	11
Water,					460	-	3
Total area of town,					14,780	-	100

¹ Smaller sized hardwoods are mostly gray birch; larger sized are maple, beech, chestnut and oak.

GRAFTON.

The greater part of this town has been cleared for farming and pasture land. Timber land is relatively scarce, but where it does occur it is in excellent condition. Chestnut is the leading species, followed closely by oak and red maple. White pine is scarce. On some of the old fields and farms reproduction of white and pitch pine is rapidly taking possession. Numerous small areas of gray birch are found scattered throughout the entire town. A few excellent stands occur. Just east of the Country Club is a stand of chestnut of Class 2 with an 85 per cent. stocking. Some of the trees will run to Class 1. The bulk of the timber lies in the eastern quarter of the town in scattered wood lots of from 5 to 50 acres. This ranges from Class 1 to Class 3, the larger part being in Class 2.

Grafton has no permanent sawmills or woodworking industries.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	199	149	336	653	1,337	25	-
Oak,	105	149	118	12	384	7	-
Chestnut and oak,	690	503	174	87	1,454	} 28	-
White pine,	-	12	-	-	12		-
Hardwoods and white pine, ¹	155	131	44	-	330	6	-
Maple and gray birch,	945	696	62	-	1,703	32	-
Pitch pine,	-	31	50	-	81	2	-
Total,	2,094	1,671	784	752	5,301	-	-
Percentage,	40	31	15	14	-	100	35
NON-FOREST TYPES.							
Tillage and hay,					5,966	-	40
Open pasture,					2,020	-	14
Brush pasture,					1,264	-	8
Business, residential, etc.,					261	-	2
Water,					118	-	1
Total area of town,					14,930	-	100

¹ Mostly gray birch with a little white pine.

HARDWICK.

Commercially speaking, chestnut is the most distinctive tree in the town of Hardwick, and there is an unusual amount of commercial size present. White pine follows closely on chestnut, but it runs rather smaller. The western part of the town is the most extensively wooded, but a considerable area in this section was burned over in a large fire some years ago, so that the woodland of better quality will be found in the eastern and central parts.

There are no wood-using industries in this town, unless the paper mill at Wheelwright can be called such. The wood pulp used in this mill, however, all comes from mills in Maine and New Hampshire. A Mr. Spooner on the Greenwich road has a water mill which apparently is seldom used. A Mr. Howard on the Gilbertville road has a water mill which is still in use. Formerly he operated and sawed timber from his own lands,

but his work now is largely confined to custom sawing of logs brought in. Chestnut is the chief product, and is put into dimension lumber for local building purposes.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	180	630	620	970	2,400	17	-
Oak,	220	170	20	-	410	3	-
Chestnut and oak,	230	310	400	-	940	7	-
Hardwoods and white pine, ¹	1,220	3,550	150	160	5,080	36	-
White pine,	130	710	290	500	1,630	12	-
Maple and birch,	1,080	940	160	140	2,320	17	-
Softwoods other than white pine. ²	90	700	100	270	1,160	8	-
Total,	3,150	7,010	1,740	2,040	13,940	-	-
Percentage,	23	50	12	15	-	100	54
NON-FOREST TYPES.							
Tillage and hay,					3,280	-	13
Open pasture,					5,530	-	22
Brush pasture,					2,540	-	10
Business, residential, etc.,					110	}	1
Water,					200		
Total area of town,					25,600	-	100

¹ Hardwoods are mostly maple.

² About 50 per cent. pitch pine; remainder, largely hemlock.

HARVARD.

The hills in this town are covered mostly with the chestnut and oak type, with considerable white pine in mixture and as an understory. Frequent stands of white pine occur on ridges and benches. In the northeastern part of the town near Shaker River is an extensive stand of white pine of first quality and size. Similar stands are also found on some flat land extending into, but raised above, the great swamp in the southwestern part of the town. Poplar and maple are found in the swamps of the stream bottoms, while on raised situations some pine is found. Gray birch is rapidly coming into the old pastures and in small tracts where there is an outcropping of sandy or rocky

soil. The extensive sand barren in the northwest part of the town is covered by a sparse growth of pitch pine with occasional bunches of white pine where there is better soil or more moisture available. The general condition of the woodlands is good. There are, however, many local areas where thinnings are needed.

Mr. E. J. McLaughlin owns and operates a mill in which he saws pine for box boards and chestnut for chair stock, barrel staves and heading. Some poplar and pine are also used for the latter products. There is a planer in the mill and also stave and barrel-head making machinery. Mr. McLaughlin also operates local wood lots.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	389	243	591	394	1,617	18	-
Oak,	223	66	-	-	289	3	-
Chestnut and oak,	132	-	92	39	263	3	-
White pine,	230	184	164	394	972	11	-
Hardwoods and white pine, ¹	670	526	322	250	1,768	19	-
Mixed hardwoods, ²	2,280	926	263	105	3,574	39	-
Pitch pine,	256	329	13	59	657	7	-
Total,	4,180	2,274	1,445	1,241	9,140	-	-
Percentage,	46	25	16	13	-	100	53
NON-FOREST TYPES.							
Tillage and hay,					4,836	-	28
Open pasture,					1,721	-	10
Brush pasture,					762	-	4
Brush swamp,					348	-	2
Business, residential, etc.,					100	-	1
Water,					360	-	2
Total area of town,					17,267	-	100

¹ Hardwoods are made up of about 30 per cent. chestnut and oak, 40 per cent. gray birch and 30 per cent. maple.

² About 30 per cent. chestnut, 30 per cent. gray birch and 40 per cent. maple.

HOLDEN.

About 65 per cent. of the town is covered with a woody growth. Chestnut is the leading species, followed closely by oak. Numerous thick stands of birch occur, generally of Class

4 and up to Class 3. White pine is well distributed, and in the northeastern part of the town occurs very abundantly. Three-quarters of a mile south from the northeast corner is an area of several hundred acres of pure white pine varying in size from Class 4 to a small Class 1. Just across the road from this, and extending to the Boylston line, is an area of about the same size of pure chestnut, Classes 3 to 2, and stocked to a full 100 per cent. Stone House Hill is practically covered with chestnut, and chestnut and oak, of an average Class 3 to Class 2.

Asnebumskit Hill is almost entirely covered with woods. These are generally mixed hardwoods and mixed hardwoods and pine, although extensive areas of birch reproduction and brush pastures are found enclosed. Most of the woods have a heavy undergrowth of laurel.

Waldo E. Austin owns a sawmill and box mill. Chestnut and pine are cut almost exclusively. This mill works in the spring and cuts logs for private owners.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	598	1,170	1,298	71	3,137	21	-
Oak,	270	270	64	-	604	4	-
Chestnut and oak,	1,774	1,813	1,099	90	4,776	31	-
White pine,	116	296	315	251	978	6	-
Hardwoods and white pine, ¹	701	913	84	19	1,717	11	-
Maple and gray birch,	2,012	1,581	315	103	4,011	27	-
Total,	5,471	6,043	3,175	534	15,223	-	-
Percentage,	36	40	21	3	-	100	66
NON-FOREST TYPES.							
Tillage and hay,					4,776	-	21
Open pasture,					1,902	-	8
Brush pasture,					764	-	3
Business, residential, etc.,					64	}	2
Water,					405		
Total area of town,					23,134	-	100

¹ Hardwoods are chiefly swamp maple and gray birch.

HOPEDALE.

Chestnut is the most important tree, but considerable quantities of white pine occur also. The timber in the northern part of the town runs from 1 to a small 2 size, while in the southern part it is mostly found in the 4 and 3 classes. The timber on the land owned by the Draper Company and the town (750 acres) is almost all ready to cut, some of the pine running up to 90 feet high, and 30 inches diameter, breast high.

There are no sawmills or operators in Hopedale, the most of the land being kept as a sort of reservation.

The Draper Company uses a considerable quantity of lumber, keeping \$500,000 worth on hand all the time. Most of this is used in building houses and repair work. It uses the following stock: ash from Vermont and New Hampshire; Oregon pine from Washington; cedar shingles from Washington; and small quantities of chestnut and pine from surrounding towns.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	260	50	120	60	490	26	-
Oak,	90	-	-	-	90	5	-
Chestnut and oak,	-	40	-	-	40	2	-
White pine,	80	30	40	50	200	11	-
Hardwoods and white pine, ¹	50	120	20	-	190	10	-
Maple and gray birch,	280	470	80	-	830	44	-
Pitch pine,	30	-	-	-	30	2	-
Total,	790	710	260	110	1,870	-	-
Percentage,	42	38	14	6	-	100	56
NON-FOREST TYPES.							
Tillage and hay,					670	-	20
Open pasture,					140	-	4
Brush pasture,					300	-	9
Business, residential, etc.,					280	-	8
Water,					110	-	3
Total area of town,					3,370	-	100

¹ Hardwoods are principally red maple with some birch.

HUBBARDSTON.

Practically all trees found in this State are found in this town, although pitch pine and spruce are rare. The leading types are birch (mostly gray), red maple and pine. Chestnut and oak, while common, exist scattered among other types. There is an unusual amount of pine reproduction, and if allowed to grow it will make Hubbardston one of the leading pine towns in the State.

In Hubbardston village there is a blanket mill employing a few hands. There is a sawmill and box shop on the depot road, but it is not now running. The Roper Box Company at East Hubbardston operate a sawmill and box shop. William Clark holds considerable timber land which operates through hired mills. W. E. Coffin and S. A. Bigelow, owners of portable mills, operate extensively in Hubbardston and vicinity.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total. Acres.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	110	90	180	10	390	2	-
Beech,	60	150	70	-	280	2	-
Oak,	280	660	10	20	970	5	-
White pine,	1,130	2,070	1,580	320	5,100	28	-
Maple and gray birch, ¹	6,810	3,170	500	10	10,490	57	-
Softwoods other than white pine. ²	180	650	340	30	1,200	6	-
Total,	8,570	6,790	2,680	390	18,430	-	-
Percentage,	46	37	15	2	-	100	69
NON-FOREST TYPES.							
Tillage and hay,					3,510	-	13
Open pasture,					880	-	3
Brush pasture,					1,480	-	6
Brush swamp,					1,410	-	5
Business, residential, etc.,					770	-	3
Water,					210	-	1
Total area of town,					26,690	-	100

¹ Considerable poplar and alder included in Classes 3 and 4.

² Mostly hemlock and spruce.

LANCASTER.

The proportion of wooded land to the total area of the town is about 60 per cent. The best woodland lies in the southwest, between the river valley and the town line, along the George Hill and Ballard Hill ridges. The types are usually well defined, the most important being pine, oak, chestnut, soft maple and birch, in clear and in mixed stands. Reforestation is popular on the larger estates; white pine is preferred. The plantations show rapid and healthy growth.

The area in the northeast corner, bounded by Crumbury Pond, Shirley Road and the Nashua River, has a good covering of young pine, both white and pitch. The growth is not uniform, however, and a large amount of brush, dead trees and fallen birch should be removed to bring it into the best condition.

The rest of the town, except for a few acres surrounding the lakes, has been swept by forest fires. The reproduction consists of oak, chestnut, birch, soft maple and aspen, and in some cases a little pine.

Practically no cutting for lumber is done by residents of Lancaster. There is one small chair factory on the Leominster road at Wekepeke Brook. The owner is W. W. Bartlett of Lancaster. Some cutting is done in this town by the lumbermen of Clinton.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	40	170	80	430	720	6	-
Oak,	1,220	900	80	-	2,200	19	-
Chestnut and oak,	780	1,430	120	280	2,610	23	-
White pine,	160	940	120	800	2,020	18	-
Hardwoods and white pine, ¹	70	390	1,080	80	1,620	14	-
Maple and gray birch,	350	1,180	130	40	1,700	15	-
Softwoods other than white pine. ²	60	220	200	110	590	5	-
Total,	2,680	5,230	1,810	1,740	11,460	-	-
Percentage,	23	46	16	15	-	100	63
NON-FOREST TYPES.							
Tillage and hay,					5,360	-	29
Open pasture,					480	-	3
Brush pasture,					530	-	3
Business, residential, etc.,					150	-	1
Water,					130	-	1
Total area of town,					18,110	-	100

¹ Hardwoods are maple and gray birch.

² Largely pitch pine with about 50 acres of hemlock.

LEICESTER.

The principal woodland types are soft maple and gray birch, either separately or in mixture, chestnut, oak and white pine. There is a fair representation of older age classes. The pastures contain much sweet fern and sumac. Around the reservoir of Worcester water board on Kettle Brook there are some plantations of white pine.

There are no wood-using industries in the town and no permanent sawmills. There is a good market for box lumber, poles, ties and cordwood in Worcester, so that timber lots are cut as soon as they become of merchantable size. Southwick and Barry are the leading local operators and deal principally in chestnut products.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	230	320	440	10	1,000	10	-
Oak,	90	240	50	30	410	4	-
Chestnut and oak,	1,250	1,100	530	30	2,910	28	-
White pine,	360	250	340	50	1,000	10	-
Hardwoods and white pine,	150	500	610	30	1,290	13	-
Maple and gray birch,	2,570	800	100	-	3,470	34	-
Hemlock,	20	70	20	-	110	1	-
Total,	4,670	3,280	2,090	150	10,190	-	-
Percentage,	46	32	21	1	-	100	65
NON-FOREST TYPES.							
Tillage and hay,					2,770	-	18
Open pasture,					220	-	1
Brush pasture,					910	-	6
Alder and brush swamp,					480	-	3
Business, residential, etc.,					900	-	6
Water,					220	-	1
Total area of town,					15,690	-	100

LEOMINSTER.

About 50 per cent. of this town's area is wooded. The majority of the timber is in only fair condition, owing to forest fires and tree diseases. Chestnut is the leading species, and is the principal tree covering the large hills. White pine occurs everywhere, but not in such large and continuous stands as the chestnut. The chestnut and oak sprout lands and mixtures of white pine and gray birch occur abundantly and in about equal proportion. The white pine is in good healthy condition and growing rapidly wherever it occurs. Size classes range from the largest to the smallest. The majority of the stands, however, will fall under Class 3. Leaving out all trees under 6 inches, the average will run about 8 to 10 inches diameter, breast high.

No sawmills were found. Woodworking industries represent more capital than any phase of manufacturing in Leominster.

It is estimated that over 10,000,000 board feet are worked up annually in this city. Among the most prominent lumber-using and woodworking industries are the following: —

Whitney Reed Corporation.	W. A. Fuller Lumber Company.
E. G. Smith Piano Case Company.	Richardson Piano Case Company.
J. H. Lockey & Co., Piano Cases.	Jewett Piano Case Company.
Leominster Novelty Company.	Wellington Piano Case Company.
Merriam Hall Furniture Company.	E. A. Whitney Carriage Company.

The output of these concerns varies from 500,000 to 2,500,000 board feet annually. Practically all of the native woods and much foreign wood are used in the various products.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total. Acres.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
Chestnut,	122	875	617	32	1,646	19	—
Oak,	411	251	—	90	752	9	—
Chestnut and oak,	998	811	264	—	2,073	24	—
White pine,	64	359	462	392	1,277	14	—
Hardwoods and white pine, ¹	130	83	—	—	213	2	—
Maple and gray birch,	707	1,620	150	85	2,562	29	—
Pitch pine,	13	202	27	6	248	3	—
Total,	2,445	4,201	1,520	605	8,771	—	—
Percentage,	28	48	17	7	—	100	47
NON-FOREST TYPES.							
Tillage and hay,					5,048	—	27
Open pasture,					2,703	—	14
Brush pasture,					517	—	3
Business, residential, etc.,					1,327	—	7
Water,					451	—	2
Total area of town,					18,817	—	100

¹ Hardwoods are gray birch, red maple and poplar.

LUNENBURG.

The proportion of forest land to the total area of the town is about 65 per cent. The general condition is very good. Most of the woodland lies north of Lunenburg village, but there

are a few excellent lots of young timber trees in the middle and southern sections. The town has recently purchased 20 acres of pine land, size Classes 2 to 1, stocked nearly 100 per cent., just north of the village. It will be used as a park. The principal types found in Lunenburg are white pine, pitch pine, chestnut, oak, maple, poplar and gray birch. Most of the land is utilized, and waste tracts are very rare.

H. B. Francis of Lunenburg cuts about 100 M board feet per year of pine, chestnut and hardwoods and about 200 cords of wood.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	127	298	869	70	1,364	12	-
Oak,	336	368	165	-	869	7	-
Chestnut and oak,	584	1,465	406	152	2,607	22	-
White pine,	51	774	2,252	596	3,673	31	-
Hardwoods and white pine, ¹	184	729	222	146	1,281	11	-
Maple and gray birch,	837	647	89	32	1,605	14	-
Pitch pine,	-	114	152	38	304	3	-
Total,	2,119	4,395	4,155	1,034	11,703	-	-
Percentage,	18	38	35	9	-	100	63
NON-FOREST TYPES.							
Tillage and hay,					5,183	-	28
Open pasture,					844	-	4
Brush pasture,					101	-	1
Business, residential, etc.,					203	-	1
Water,					590	-	3
Total area of town,					18,624	-	100

¹ Hardwoods are gray birch and maple.

MENDON.

Although sizes 4 to 3 are the prevailing size classes, yet 20 per cent. or more of the timbered land has sizes 3 to 2 on it, mostly chestnut and oak with a little good merchantable pine. Mendon fares better than most of the surrounding towns in having a fair proportion of the cut-over lots coming in to pine.

Comparative freedom from fires may account for this to some degree.

There are no mills working in Mendon and no woodworking industries are located there. C. A. Fletcher buys and cuts off lots in Mendon and surrounding towns.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	172	303	99	20	594	8	-
Oak,	317	185	-	-	502	7	-
Chestnut and oak,	224	376	277	73	950	13	-
White pine,	152	53	-	46	251	3	-
Hardwoods and white pine, ¹	270	152	125	13	560	7	-
Maple and gray birch,	2,936	825	600	-	4,361	59	-
Pitch pine,	53	132	33	-	218	3	-
Total,	4,124	2,026	1,134	152	7,436	-	-
Percentage,	56	27	15	2	-	100	65
NON-FOREST TYPES.							
Tillage and hay,					2,427	-	21
Open pasture,					824	-	7
Brush pasture,					732	-	6
Water,					165	-	1
Total area of town,					11,584	-	100

¹ Hardwoods are largely gray birch, red maple and oaks.

MILFORD.

The strong market for cordwood and the ready market for saw stock as well have operated to keep the timber pretty well cut. Only a small percentage, perhaps 15 per cent., is older than Class 3, and by far the greater part would be classed as 4. Pitch pine takes the place of white pine to a considerable extent, but neither is present in anything approaching merchantable quantities. Chestnut, soft maple and oaks (black, red, scrub, white and chestnut) are the most important of the hardwoods. Between Cedar Street and the Holliston line are considerable quantities of scrub oak and chestnut oak.

There are no sawmills, either stationary or portable, in Milford. There are no operators resident in the town, but C. A. Fletcher of Mendon and D. W. Gaskill of Blackstone have done some cutting in the past. For the most part the owners cut their own wood, delivering it to the local cordwood dealers.

Z. C. Field Lumber Company use about 4,000,000 feet of lumber per year. Practically all of this lumber comes from outside of the State, and consists of white pine, western yellow pine, spruce, cypress, whitewood and hemlock. Most of their white pine is obtained from Canada.

S. A. Eastman Box Company use annually about 175 M board feet of native white pine.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	157	103	151	54	465	8	-
Oak,	163	133	48	-	344	6	-
Chestnut and oak,	664	428	78	-	1,170	21	-
White pine,	54	109	30	60	253	4	-
Hardwoods and white pine,	72	-	72	-	144	3	-
Maple and gray birch,	1,786	1,152	235	-	3,173	57	-
Pitch pine,	30	12	-	18	60	1	-
Total,	2,926	1,937	614	132	5,609	-	-
Percentage,	52	35	11	2	-	100	58
NON-FOREST TYPES.							
Tillage and hay,					2,228	-	23
Open pasture,					296	-	3
Brush pasture,					706	-	8
Business, residential, etc.,					622	-	7
Water,					127	-	1
Total area of town,					9,588	-	100

MILLBURY.

The condition of the woods of the southwest portion is very good. The soil is excellent, and fires have not done much damage. Chestnut and red maple are the principal trees. There is a little scattering of white pine and a few small stands of good merchantable pine. Of the comparatively small

acreage of timber in the town, mostly chestnut and oaks, little is merchantable at present. The best lies along the Oxford and Auburn sides. The cut-over areas are reproducing well. There are some brushy pastures coming into gray birch and fuel wood, with a very little white pine in places, and there are also considerable areas where repeated fires have left little but scrub oak and gray birch. Throughout the town, and especially in the east, are maple swamps, usually small in area.

There are three sawmills owned in Millbury. The owners are W. R. Howe, W. A. Harris and A. W. Rice. These are all small mills, sawing from 50 M to 150 M board feet per year when running; practically all local stock. The only wood-working industry is a small outfit at West Millbury making tool handles, used mostly by the local edge tool factories of which there are two.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	190	289	221	160	860	18	-
Chestnut and oak,	307	313	264	37	921	19	-
White pine,	6	-	43	98	147	3	-
Hardwoods and white pine,	258	344	25	40	676	14	-
Maple and gray birch,	1,419	602	104	86	2,211	46	-
Pitch pine,	-	-	18	-	18		
Total,	2,180	1,548	675	430	4,833	-	-
Percentage,	45	32	14	9	-	100	46
NON-FOREST TYPES.							
Tillage and hay,					3,032	-	28
Open pasture,					1,634	-	15
Brush pasture,					559	-	5
Business, residential, etc.,					362	-	3
Water,					332	-	3
Total area of town,					10,752	-	100

NEW BRAINTREE.

The woodland of New Braintree is not an important part of its assets. The chestnut type occupies the largest area and is the most important commercially. Pine is not as common as

in surrounding towns, and is found largely in the Ware River valley section. There is considerable chestnut of commercial size.

There are no wood-using industries in the town and no saw-mills. Ties are the chief forest product, and New Braintree depot is an important tie-shipping station for the surrounding country. James Barr & Son are the leading lumbermen in the town, although operators living in North Brookfield and Ware do most of the lumbering in this vicinity.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total. Acres.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
Chestnut,	151	404	341	297	1,193	} 26	-
Oak,	63	-	-	-	63		
Chestnut and oak, . . .	442	284	-	25	751	15	-
White pine,	189	310	83	126	708	14	-
Hardwoods and white pine, ¹	360	454	88	69	971	20	-
Maple and gray birch, .	410	575	32	51	1,068	22	-
Softwoods other than white pine.	69	88	-	-	157	3	-
Total,	1,684	2,115	544	568	4,911	-	-
Percentage,	34	43	11	12	-	100	36
NON-FOREST TYPES.							
Tillage and hay,					3,591	-	26
Open pasture,					4,753	-	35
Brush pasture,					430	} -	3
Water,					12		
Total area of town,					13,697	-	100

¹ Hardwoods are principally maple and birch, with a little chestnut and oak.

NORTH BROOKFIELD.

The woodland of North Brookfield is made up chiefly of second-growth hardwoods. Chestnut forms a less important timber tree than was the case in Warren and West Brookfield, *i.e.*, there are less pure stands. Pine is perhaps the most important species. There are several wood lots in the east and west, where young pine trees are growing very vigorously.

Poplar, although not abundant, is found generally throughout the town. In the northwest, near Sucker Brook, there is a pure stand of hickory of about 10 acres. Other species which make up the forest land are pitch pine, maple, hickory and ash.

There are two lumber dealers and operators in town, — William F. Fullam and H. E. Cummings. Both have portable sawmills which operate in the surrounding towns. Mr. Fullam also has a small mill operated by electricity in which he does planing, etc.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	240	700	520	20	1,480	27	—
Oak,	290	200	130	—	620	12	—
Chestnut and oak,	140	60	60	—	260	5	—
White pine,	—	60	50	10	120	2	—
Hardwoods and white pine, ¹	190	860	180	10	1,240	23	—
Maple and gray birch, ²	640	740	230	—	1,610	30	—
Softwoods other than white pine. ³	—	40	—	20	60	1	—
Total,	1,500	2,660	1,170	60	5,390	—	—
Percentage,	28	49	22	1	—	100	38
NON-FOREST TYPES.							
Tillage and hay,					3,810	—	27
Open pasture,					3,200	—	22
Brush pasture,					1,280	—	9
Business, residential, etc.,					280	—	2
Water,					250	—	2
Total area of town,					14,210	—	100

¹ Hardwoods are red maple, gray birch, oak and chestnut.

² This type contains some oak and chestnut.

³ Mostly pitch pine and hemlock.

NORTHBOROUGH.

The proportion of timbered land to the total area of the town is about 50 per cent. More than half of the high land is wooded, the farms lying mostly in the valleys. There is an abundance of healthy pine, usually in mixed stands, and nearly every wood lot contains at least a small amount. The oak and

chestnut timber are not in the best of condition. Gypsy and brown-tail moth devastations have been most severe, and are in evidence over the entire area of the town. Tree planting has been practiced on a small scale in at least two instances by citizens. One plantation is located near South Street and the other is owned by a Mr. Wesson. These plantations have reached the large pole stage and are in healthy condition.

Guilford P. Heath cuts from 50 M to 100 M board feet of lumber per year. It is mostly chestnut, with a fair proportion of oak and pine. G. H. Felt, although cutting no timber, buys and sells pine, hemlock, hard pine, cypress, white wood and red cedar, obtaining practically all the stock from outside the State.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	60	520	200	200	980	16	-
Oak,	300	830	60	250	1,440	23	-
Chestnut and oak,	400	640	40	150	1,230	20	-
White pine,	-	260	80	220	560	9	-
Hardwoods and white pine,	20	390	50	60	520	8	-
Maple and gray birch,	90	1,070	110	60	1,330	21	-
Softwoods other than white pine.	-	130	50	-	180	3	-
Total,	870	3,840	590	940	6,240	-	-
Percentage,	14	62	9	15	-	100	52
NON-FOREST TYPES.							
Tillage and hay,					3,200	-	27
Open pasture,					1,480	-	12
Brush pasture,					830	-	7
Business, residential, etc.,					100	}	2
Water,					200		
Total area of town,					12,050	-	100

NORTHBRIDGE.

Very few timber types are found in Northbridge. Chestnut and chestnut and pine are most prominent. In the southwestern part of the town the stands belonging to the Whitin

Machine Works will run a good average in size, while a fair amount will come under the head of mature merchantable. Scattered throughout the entire town are small patches of chestnut which will run to Class 2, although the majority is slightly smaller. Pine occurs, but not abundantly, in Class 2.

Stands of mixed hardwoods occur in many places. The plots are small and the trees are seldom larger than Class 3. These stands quickly run into chestnut and oak. Oak is very common. It occurs in large areas, generally in Class 3. Birch is not present in large amounts.

The type covering most of the town is a mixture of chestnut and oak sprouts, Class 4, with a stocking varying from 75 to 100 per cent. Where timber larger than Class 3 occurs it is practically always straight and sound, and will furnish excellent material for poles or for the sawmill.

At the time the survey was made there were no sawmills or woodworking industries in Northbridge.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	240	280	350	220	1,090	15	-
Oak,	470	340	-	30	840	11	-
Chestnut and oak,	840	290	100	90	1,320	18	-
White pine,	390	250	100	370	1,110	15	-
Hardwoods and white pine,	510	380	130	30	1,050	14	-
Maple and gray birch,	1,030	810	100	-	1,940	26	-
Pitch pine,	-	10	30	-	40	-	-
Total,	3,480	2,360	810	740	7,390	-	-
Percentage,	47	32	11	10	-	100	61
NON-FOREST TYPES.							
Tillage and hay,					2,060	-	17
Open pasture,					990	-	8
Brush pasture,					770	-	6
Brush swamp,					100	-	1
Business, residential, etc.,					320	-	3
Water,					530	-	4
Total area of town,					12,160	-	100

OAKHAM.

White pine types, either pure pine or mixtures of pine, chestnut and oak, form the largest part of the woodland, and there is a considerable amount of commercial, or nearly commercial, size. Chestnut is second in importance, and is found mostly in the south and west sections of the town. There appears to be more oak in this town than in the surrounding townships, but most of it is of small size and poor quality.

This town has no manufacturing industries of any kind. There is a basket factory in Coldbrook, but it was not running when the survey was made. Ash, hickory and oak were used in this business. There is at present a water mill on Five Mile River belonging to Walter Dean. Mr. Dean formerly bought and operated his own woodlands, but has done little of this business in recent years, and his mill work is confined largely to custom sawing.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	61	257	814	153	1,285	15	-
Oak,	373	43	43	43	502	6	-
Chestnut and oak,	349	496	263	110	1,218	14	-
White pine,	349	606	312	514	1,781	21	-
Hardwoods and white pine, ¹	716	1,199	202	153	2,270	27	-
Maple and birch,	594	569	135	-	1,298	15	-
Pitch pine,	12	122	37	37	208	2	-
Total,	2,454	3,292	1,806	1,010	8,562	-	-
Percentage,	29	38	21	12	-	100	63
NON-FOREST TYPES.							
Tillage and hay,					1,995	-	15
Open pasture,					2,062	-	15
Brush pasture,					685	-	5
Water,					281	-	2
Total area of town,					13,585	-	100

¹ Hardwoods are chestnut, oak and birch.

OXFORD.

Most of the forest land is found on the hills, those to the west being more generally forested than those on the east side. The largest individual types are the gray birch and maple, but the most prominent trees are chestnut and pine. There is a rather unusual amount of forest land, with a growth of commercial, or nearly commercial, size. In the non-forest type one is struck by the small amount of open and brush pasture as compared with tillage.

The principal wood-using industry of Oxford is the box factory of Chaffee Brothers. In addition to boxes they manufacture rough building lumber and planing mill products. They operate two or three portable mills, cutting lots in southern Worcester County and northern Connecticut, although occasionally they have operated wood lots as far away as New Hampshire and Maine. They handle more or less chestnut, which is either put into building lumber or ties. Their annual consumption of lumber is about 5,000,000 feet.

Turner Brothers make a specialty of dealing in chestnut, especially for ties.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	20	40	250	140	450	4	-
Oak,	290	130	-	-	420	4	-
Chestnut and oak,	1,030	650	440	20	2,140	19	-
White pine,	290	280	400	580	1,550	14	-
Hardwoods and white pine, ¹	510	1,230	490	860	3,090	28	-
Mixed hardwoods, ²	1,450	1,210	330	450	3,440	}	31
Softwoods other than white pine.	-	40	-	-	40		
Total,	3,590	3,580	1,910	2,050	11,130	-	-
Percentage,	32	32	17	19	-	100	64
NON-FOREST TYPES.							
Tillage and hay,					4,470	-	26
Open pasture,					730	-	4
Brush pasture,					600	-	3
Water,					600	-	3
Total area of town,					17,530	-	100

¹ Hardwoods are principally chestnut and oak.

² Gray birch and red maple in smaller classes, and chestnut and oak in the larger sizes.

PAXTON.

About 60 per cent. of Paxton is wooded, chestnut and white pine being the leading species. Oak and soft maple occur abundantly, and thick stands of young birch are found everywhere. Practically all of the timber in the eastern part of the town is below Class 2 in size. The best stand found was a mixture of pine and chestnut near the southern boundary of the town, one-half mile east of Kettell Brook. This is in splendid condition and ranges from Class 2 to Class 1 in size. Very small stands of pine of this class are found in scattered wood lots. Mixed hardwoods, common to low situations, are present in many places. In general, such stands are in rather poor condition. Tangled undergrowth and young dead trees are characteristic, and laurel is very common.

Edward E. Eames, Paxton, owns a water mill. He buys small wood lots and cuts timber. He has a number of wood lots well stocked with pine and chestnut, now too small to cut. He has done a little planting of white pine.

D. T. Grayton owns no mill, but buys wood lots and installs portable mills. In good years he cuts about 1,000 M board feet of pine, chestnut and hemlock. There are no woodworking industries in Paxton.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	-	270	250	50	570	10	-
Oak,	-	20	100	-	120	2	-
Chestnut and oak,	90	340	20	20	470	9	-
White pine,	270	100	190	220	780	14	-
Hardwoods and white pine, ¹	270	650	-	-	920	17	-
Maple and gray birch,	1,090	1,070	120	40	2,320	43	-
Softwoods other than white pine. ²	220	20	20	30	290	5	-
Total,	1,940	2,470	700	360	5,470	-	-
Percentage,	35	45	13	7	-	100	56
NON-FOREST TYPES.							
Tillage and hay,					3,140	-	32
Open pasture,					400	-	4
Brush pasture,					630	-	6
Water,					210	-	2
Total area of town,					9,850	-	100

¹ Hardwoods are gray birch, red maple and oak.

² Pitch pine, hemlock and spruce.

PETERSHAM.

This town has an unusually large percentage of pine, especially in the medium sizes, forming a large part of the large percentage of forest area which the town has. The second largest type, called maple and birch, which in most towns means red maple and gray birch, in this section includes also white and yellow birch, beech and sugar maple. There is an unusual amount of hemlock in the forests of Petersham. There is a rather high percentage of Class 2, which may be due to the fact that nearly 2,000 acres of the best timberland in the town is in the possession of the Harvard Forest School.

There is no manufacturing industry whatever in the town. The town obtains its livelihood from farming and catering to summer residents, for it is a popular summer resort. There is a small box shop belonging to John Carter and a water-power sawmill at Nichewaug, but neither is running at present. There is a ready market for pine and other lumber in Athol. The Diamond Match Company has now a portable mill operating in the town, while each winter the authorities in charge of the Forest School do some operating. There is a fair market for cordwood, but it is limited in extent.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	380	630	670	50	1,730	10	-
Oak,	560	830	300	50	1,740	10	-
White pine, ¹	940	2,150	2,390	750	6,230	37	-
Maple and birch, ²	2,860	2,710	470	40	6,080	36	-
Hemlock,	270	480	290	60	1,100	7	-
Total,	5,010	6,800	4,120	950	16,880	-	-
Percentage,	30	40	24	6	-	100	69
NON-FOREST TYPES.							
Tillage and hay,					3,000	-	12
Open pasture,					1,270	-	5
Brush pasture,					2,140	-	9
Brush and alder swamp,					770	-	3
Business, residential, etc.,					320	}	2
Water,					70		
Total area of town,					24,450	-	100

¹ White pine in mixture has been proportioned as if growing in pure stands.

² Smaller sizes are red maple and gray birch, while larger size classes contain white and yellow birch and beech.

PHILLIPSTON.

There are but a few good stands of timber left in Phillipston. Possibly the best of these lies on the ridge west of Queen Lake or Phillipston Pond. There is also a fairly good stand of white pine and mixed hardwoods — oak, chestnut, birch and maple — on the ridge which forms the eastern border of the lake.

Aside from the above-mentioned stands most of the forested lands of Phillipston consist of pure white pine stands and coppice hardwoods, together with mixed stands of white pine and hardwoods, which are of the reproduction and small merchantable size. Chestnut was found occasionally in pure stands, but in most cases it was mixed with oak and maple. Oak was found more frequently in pure stands than was the chestnut.

The principal species found, in order, are white pine, oak, maple, chestnut, gray birch, white birch, spruce, larch, hemlock and a little yellow birch. Basswood was noticed in many places, but this existed only in the reproduction size. Ash also appeared in small quantities.

On account of the scarcity of good timber there are no wood-working industries in the town.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Oak,	20	280	220	—	520	5	—
Chestnut and oak,	150	450	370	90	1,060	11	—
White pine,	180	460	560	330	1,530	16	—
Hardwoods and white pine, ¹	690	3,170	680	180	4,720	48	—
Maple and birch, ²	690	820	100	20	1,630	17	—
Softwoods other than white pine.	60	100	150	20	330	3	—
Total,	1,790	5,280	2,080	640	9,790	—	—
Percentage,	18	54	21	7	—	100	64
NON-FOREST TYPES.							
Tillage and hay,					3,130	—	20
Open pasture,					2,330	—	15
Water,					180	—	1
Total area of town,					15,430	—	100

¹ Hardwoods are gray birch, soft maple, oak and chestnut.

² Principally gray birch and red maple, with some white and yellow birch and beech in the larger sizes.

PRINCETON.

Woodlands show little variation either in composition or size classes over most of the area. The gray birch and maple types cover the largest area. White pine is generally found in mixture with hardwoods, although there are many small scattering wood lots which contain almost pure stands. Chestnut and oak are usually found in mixture together. The chestnut, however, is often found in pure well-distributed stands; but the oak, when separate from the chestnut, usually contains a mixture of maple and yellow and paper birch.

The Roper Lumber and Box Company is the only mill and woodworking industry in Princeton. It is located very close to the Hubbardston line. This mill has an average cut of about 1,000,000 board feet. Pine, hemlock and spruce constitute about nine-tenths of the annual cut, while mixed hardwoods make up the remainder.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	100	980	610	120	1,810	12	-
Oak,	310	550	430	40	1,330	9	-
Chestnut and oak,	340	840	270	-	1,450	10	-
White pine,	290	1,000	730	850	2,870	20	-
Hardwoods and white pine,	1,530	1,470	30	90	3,120	21	-
Maple and gray birch,	2,350	1,220	250	80	3,900	26	-
Softwoods other than white pine.	-	80	170	10	260	2	-
Total,	4,920	6,140	2,490	1,190	14,740	-	-
Percentage,	33	42	17	8	-	100	65
NON-FOREST TYPES.							
Tillage and hay,					2,610	-	11
Open pasture,					4,800	-	21
Brush pasture,					410	-	2
Water,					290	-	1
Total area of town,					22,850	-	100

ROYALSTON.

Royalston has but two or three stands of virgin growth left. These are white pine and hemlock on Jacob's Hill. The hardwood stands are of coppice growth, while the white pine stands seeded in naturally. The principal trees found in order of im-

portance and quantity are white pine, hemlock, chestnut, oak, maple (rock and red), white birch, yellow birch, beech, spruce, ash, larch, gray birch, red elm and ironwood.

Royalston has no wood-using industries. It has four saw-mills cutting white pine, chestnut, oak, hemlock, maple, birch and beech.

W. Farrar at South Royalston has a small mill cutting from 100 M to 500 M board feet per year.

Newton & Davis in the northeastern part of the town cut 1,000 M board feet per year.

C. Perry in the northern part cuts 200 M board feet per year, most of which is baled stock.

G. E. Pierce has done some cutting in the western part of the town.

The daily capacity of these mills is about 8 M board feet. They do not work steadily on account of a shortage of labor.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	70	130	180	20	400	2	—
Oak,	160	290	240	120	810	4	—
Chestnut and oak,	70	100	190	90	450	2	—
White pine,	280	1,480	1,570	880	4,210	20	—
Hardwoods and white pine, ¹	2,530	2,160	660	20	5,370	25	—
Mixed hardwoods, ²	3,000	2,800	1,410	520	7,730	37	—
Softwoods other than white pine. ³	310	880	620	310	2,120	10	—
Total,	6,420	7,840	4,870	1,960	21,090	—	—
Percentage,	31	37	23	9	—	100	75
NON-FOREST TYPES.							
Tillage and hay,					3,620	—	13
Open pasture,					1,990	—	7
Brush pasture,					1,020	—	4
Business, residential, etc.,					70	}	1
Water,					180		
Total area of town,					27,970	—	100

¹ Hardwoods are principally soft maple and gray birch, but some white birch and hard maple are represented in the larger classes.

² Mostly soft maple and gray birch, with some white birch, beech and sugar maple, especially in Classes 2 and 1.

³ Mostly hemlock, with some spruce and larch.

RUTLAND.

White pine is the leading tree, and the remainder of the woodland is made up of oak, chestnut, soft maple and birch, with small amounts of hemlock and spruce. White pine and birch is the leading type. Practically the entire northern quarter of the town is covered with this growth. The pine, in almost every case, is in very healthy condition, and has a good start on the birch. While birch is now present in large quantities, all conditions point to its suppression. In ten to twenty years this should be pure pine forest. Very little farm land is found in this section. The pine runs in size from Class 4 to Class 2. In the southern half of the town the composition is more varied. On the higher lands white pine, chestnut and oak predominate. In the lower portions soft maple and alder, with small amounts of hemlock and spruce, are found. Mixtures of soft maple and alder are very common. Trees of every size class are found, but the average is about Class 3. South of Demond Pond for three-quarters of a mile are stands of excellent chestnut. These trees average Class 2 in size. About 60 per cent. of the town is covered with wood growth.

John Moore of Ware has set up a portable mill in the southwest corner of the town, capable of sawing about 300 M board feet. He cuts chestnut mostly, with some oak and pine.

Daniels Worsted Mills, West Rutland, owns, in connection with the worsted mill, a permanent sawmill. This is used only when logs are brought in by farmers from time to time. Any kind of wood is sawed, but mostly chestnut and pine. This mill cuts about 50,000 board feet per year.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	-	60	170	250	480	3	-
Oak,	410	600	430	100	1,540	11	-
Chestnut and oak,	210	320	560	100	1,190	9	-
White pine,	230	1,400	810	440	2,880	21	-
Hardwoods and white pine, ¹	850	2,125	180	60	3,215	23	-
Maple and birch,	2,310	930	520	150	3,910	28	-
Softwoods other than white pine. ²	140	140	210	140	630	5	-
Total,	4,150	5,575	2,880	1,240	13,845	-	-
Percentage,	30	40	21	9	-	100	60
NON-FOREST TYPES.							
Tillage and hay,					4,910	-	21
Open pasture,					2,430	-	11
Brush pasture,					1,400	-	6
Water,					530	-	2
Total area of town,					23,115	-	100

¹ Hardwoods are maple, birch and oak.

² About 30 per cent. pitch pine; remainder, hemlock and larch.

SHREWSBURY.

About 50 per cent. of Shrewsbury is wooded. Small wood lots of from 10 to 25 acres, alternating with farm and pasture lands, are distinctly characteristic of the eastern three-quarters of the town. Chestnut in pure stands and in mixture with oak forms the larger part of the wood lots. In size the trees will range from Class 4 to Class 1. Birch occurs in numerous areas, though not in exceptionally large ones. The best timber in the town is found in the vicinity of Lake Quinsigamond. This is in perfect condition, and to a large extent falls in Class 1. It is made up mostly of chestnut in pure stands and in mixture with white pine.

Harlow Hill, in the northwestern part of the town, comprising roughly an area of 2 square miles, is completely covered with chestnut and pine, all size classes being represented. The

greater part is a sprout growth of Classes 4 to 3, stocked to a full 100 per cent. Pine and chestnut of Class 2 and better occur in large amounts on the north side of the hill.

There are no woodworking industries in town.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	250	260	950	400	1,860	27	-
Oak,	-	220	160	60	440	6	-
Chestnut and oak,	620	330	230	100	1,280	19	-
White pine,	30	100	40	30	200	3	-
Hardwoods and white pine, ¹	150	190	40	-	380	6	-
Maple and birch,	1,530	920	190	20	2,660	} 39	-
Pitch pine,	15	15	-	-	30		
Total,	2,595	2,035	1,610	610	6,850	-	-
Percentage,	38	29	23	10	-	100	49
NON-FOREST TYPES.							
Tillage and hay,					3,690	-	26
Open pasture,					1,880	-	14
Brush pasture,					860	-	6
Water,					690	-	5
Total area of town,					13,970	-	100

¹ Hardwoods are principally red maple, chestnut and oak.

SOUTHBOROUGH.

Gray birch and maple is the most common type, occurring mostly in small cordwood sizes. The chestnut and oak type and the white pine type are the most important. There are several stands containing good-sized trees of both of these types.

Marlborough, situated about 4 miles from Southborough, supplies this town by railroad and auto-truck service with all of its lumber and wood.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	-	-	70	100	170	4	-
Oak,	-	130	70	90	290	8	-
Chestnut and oak,	-	360	110	400	870	23	-
White pine,	50	150	50	170	420	11	-
Hardwoods and white pine, ¹	60	90	-	-	150	4	-
Maple and gray birch,	170	1,530	130	70	1,900	} 50	-
Softwoods other than white pine. ²	-	10	-	-	10		
Total,	280	2,270	430	830	3,810	-	-
Percentage,	7	60	11	22	-	100	39
NON-FOREST TYPES.							
Tillage and hay,					4,080	-	41
Open pasture,					730	-	7
Brush pasture,					150	-	2
Business, residential, etc.,					100	-	1
Water,					990	-	10
Total area of town,					9,860	-	100

¹ Hardwoods are red maple, gray birch, chestnut, red oak and poplar.

² Mostly pitch pine.

SOUTHBRIDGE.

The largest individual type is the gray birch and red maple, either mixed or in pure stands. Commercially speaking, both pine and chestnut are of about equal importance, but there is comparatively little growth of merchantable size in either type. There is an unusual amount of hickory in the town, although most of it is of small size. Considerable amounts of native lumber are used in town for the manufacture of boxes and sash and doors. The following concerns are interested in the lumber business in Southbridge:—

Clemence Associates, boxes, sash, blinds and building lumber.

Ide Lumber Company, building lumber, sash and doors.

Charles Hyde, boxes.

Charles M. Morse, operator, principally chestnut ties and poles.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total. Acres.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	380	360	250	30	1,020	13	-
Oak,	670	610	140	20	1,440	19	-
Hickory,	240	220	40	-	500	7	-
White pine,	250	750	410	210	1,620	21	-
Maple and birch,	1,780	930	90	20	2,820	37	-
Softwoods other than white pine.	20	110	90	20	240	3	-
Total,	3,340	2,980	1,020	300	7,640	-	-
Percentage,	44	39	13	4	-	100	57
NON-FOREST TYPES.							
Tillage and hay,					2,410	-	18
Open pasture,					800	-	6
Brush pasture,					940	-	7
Alder and brush swamp,					420	-	3
Business, residential, etc.,					1,000	-	8
Water,					100	-	1
Total area of town,					13,310	-	100

SPENCER.

Most of the southern half of Spencer is wooded, the chief species being white pine, chestnut, oak and birch, the amounts of these being in the order named, from most abundant to least. The timber is standing now in excellent condition, although not much of merchantable size is found. Portable mills have been working in at least five distinct areas within the last few years, and have made extensive clearings in various parts of the town. The best timber will be found in the south central, southwestern and the eastern edge of the town. Chestnut and pine are the only two species present of merchantable size, and these seldom range higher than Class 2.

No permanent sawmills were in operation at the time the survey was made, but portables have been at work almost constantly during the past few years. Mr. W. A. Wilson is

probably the leading operator in the town, cutting from 500 to 1,000 M board feet per year. Pine is cut almost entirely, there being very little chestnut of merchantable size.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	-	50	160	310	520	6	-
Oak,	70	310	660	180	1,220	14	-
Chestnut and oak, ¹	490	520	300	140	1,450	16	-
White pine,	-	-	90	-	90	} 10	-
Hardwoods and white pine, ²	30	720	100	-	850		-
Maple and gray birch,	870	2,030	620	40	3,560	40	-
Pitch pine,	110	150	440	540	1,240	14	-
Total,	1,570	3,780	2,370	1,210	8,930	-	-
Percentage,	18	42	27	13	-	100	41
NON-FOREST TYPES.							
Tillage and hay,					7,200	-	33
Open pasture,					2,160	-	10
Brush pasture,					2,470	-	11
Business, residential, etc.,					350	-	2
Water,					660	-	3
Total area of town,					21,770	-	100

¹ Chestnut greatly predominating.

² Hardwoods are largely red maple and birch.

STERLING.

The majority of the timber in Sterling is in excellent condition and growing rapidly, with the exception of the blight-infested chestnuts. Pine, pine and chestnut, pure chestnut, chestnut sprout growth, gray birch and birch and pine are the types most often found. The amounts of soft maple and other mixed hardwoods are very small when compared with these other types. Size classes range from reproduction to size 1, this latter being found only in small scattered lots. Pure pine and pine and chestnut are the trees generally found in such size classes.

The wooded portion covers about 50 per cent. of the town's area. The percentage of open country is much greater in the eastern two-thirds of the town, but in the west and northwest

the percentage of timber will run about 70 per cent. It is characteristic that where timber occurs the stocking will generally run complete.

The Sterling Lumber Company buys wood lots of varying size, installs portable mills, and after cutting the timber disposes of the land. There are no permanent mills working at the present time in Sterling. Pine and chestnut are cut in largest quantities, with small amounts of oak and other hardwoods. During the season of 1912-13 the amount cut was 2,000,000 board feet. This was taken from Sterling and surrounding towns.

There is a chair factory in the town, owned and operated by Edwin Stevenson. This factory uses practically all of the native woods, requiring about 200 M board feet per year. A small mill is run in connection with the factory.

Messrs. T. and E. R. Buck also operate a chair factory in town. They use practically every kind of lumber in the manufacture of their product.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	70	410	840	200	1,520	16	-
Oak,	240	330	40	-	610	6	-
Chestnut and oak,	810	1,110	590	110	2,620	27	-
White pine,	730	590	270	60	1,650	17	-
Hardwoods and white pine, ¹	290	690	90	-	1,070	11	-
Maple and gray birch,	1,120	780	290	-	2,190	22	-
Softwoods other than white pine. ²	30	-	20	60	110	1	-
Total,	3,290	3,910	2,140	430	9,770	-	-
Percentage,	34	40	22	4	-	100	49
NON-FOREST TYPES.							
Tillage and hay,					4,932	-	25
Open pasture,					4,230	-	21
Brush pasture,					460	-	2
Business, residential, etc.,					60	}	3
Water,					560		
Total area of town,					20,012	-	100

¹ Hardwoods are largely gray birch and red maple.

² Pitch pine and hemlock.

STURBRIDGE.

The largest individual type is gray birch and maple closely followed by oak. Chestnut and pine are not such prominent types as they are in neighboring towns, due to the fact that the town has been heavily logged for these species in recent years. For the same reason there is a dearth of larger size classes.

There are no wood-using industries in the town, and most of the logging is done by operators from Southbridge and Oxford. George Wright is the owner of a sawmill.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	160	140	460	60	820	5	-
Oak,	1,990	1,870	380	-	4,240	27	-
Chestnut and oak,	420	390	100	-	910	6	-
White pine,	270	780	650	220	1,920	12	-
Hardwoods and white pine,	1,090	1,090	220	-	2,400	15	-
Maple and birch,	3,460	1,350	260	-	5,070	32	-
Hemlock,	70	280	160	20	530	3	-
Total,	7,460	5,900	2,230	300	15,890	-	-
Percentage,	47	37	14	2	-	100	64
NON-FOREST TYPES.							
Tillage and hay,					4,250	-	17
Open pasture,					1,830	-	7
Brush pasture,					1,700	-	7
Alder and brush swamp,					120	}	1
Business, residential, etc.,					160		
Water,					990	-	4
Total area of town,					24,940	-	100

SUTTON.

The most common wood types are chestnut, gray birch and maple. White pine is rare, except along the southern border of the town and around the drier shores of the ponds. In such locations good stands occur. Most of the timber is in the small merchantable class. The ridges are stocked to almost 100

per cent. with chestnut and chestnut and oak, and the lake regions in particular bear heavy stands. Many of the ridge tops have been cut over within the last three or four years, and as a result bear dense growths of chestnut and oak sprouts. In the southeastern part of the town some of the timber owned by the Whitin Machine Works runs to a large diameter size, but timber larger than size 2 is very rare. The stands are usually dense, and the timber of excellent form and shape. In that region known as Purgatory and to the south, including the Whitin Game Preserve, are stands of chestnut and pine of Class 2, and some even larger. The stands will run to practically 100 per cent. stocking. In the south, central and eastern parts of the town are large areas as yet not cut by roads. Such areas are almost entirely covered with a timber growth, generally chestnut of sizes 3 to 2. Oak seldom occurs above a size 2, generally sizes 3 and 4. The same is true of the mixed hardwoods.

Mr. John Dudley has recently operated on a tract containing about 800 M board feet. Chestnut with some white pine was the principal species cut. Mr. Dudley's mill is operated electrically by power obtained from Saundersville.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	340	2,250	2,470	290	5,350	43	-
Oak,	40	210	190	-	440	3	-
Chestnut and oak,	460	320	330	10	1,120	9	-
White pine,	140	50	200	220	610	5	-
Hardwoods and white pine, ¹	180	310	380	-	870	7	-
Maple and gray birch,	1,330	2,550	-	-	3,880	31	-
Softwoods other than white pine. ²	70	70	170	-	310	2	-
Total,	2,560	5,760	3,740	520	12,580	-	-
Percentage,	20	46	30	4	-	100	58
NON-FOREST TYPES.							
Tillage and hay,					5,690	-	26
Open pasture,					1,090	-	5
Brush pasture,					1,850	-	8
Water,					740	-	3
Total area of town,					21,950	-	100

¹ Hardwoods are gray birch, red maple and poplar.

² Mostly white cedar.

TEMPLETON.

Templeton seems to be a natural white pine region. Although the entire town has been pretty much cut over, there are still some good white pine stands remaining, scattered through different parts of the town. Two of the best of these are in the extreme northern and in the extreme southern portions of the town. There is practically no virgin growth standing. The hardwoods are mostly coppice, and the greater portion of them are unmerchantable. The town contains considerable spruce and American larch. The best spruce is in a mixture with white pine on the land of the State School for Feeble-minded in the northern part of the town. Some of this spruce calipered from 18 to 22 inches diameter, breast high. White birch occupies a good proportion of the forested area. The principal trees found here are white pine, chestnut, oak, white birch, spruce, hemlock, maple, American larch, beech, white ash, and, as usual, an abundance of gray birch.

Templeton has two sawmills; one situated at Templeton Center and owned by Bourn & Hadley cuts about 1,000,000 board feet of native stock per year. At Otter River there is a mill owned by Louis LaPorte, with a capacity of 8 M board feet per day when it runs. This mill saws native stock only.

Among the wood-using industries are the following:—

NAME.	Product.	Approximate Output (Board Feet.)
New England Box Company,	Boxes,	7,000,000
Smith, Day & Co.,	Chairs,	800,000
Bishop & Dickinson,	Chairs,	125,000
Waite Chair Company,	Chairs,	600,000
E. L. Thompson & Co.,	Chairs,	600,000
Temple, Stewart Company,	Chairs,	175,000
Children's Vehicle Corporation,	Go-carts,	700,000
Bourn & Hadley,	Office furniture,	-

These concerns use pine, maple, oak, spruce, beech, tulip, poplar and white and yellow birch. A considerable amount of this lumber is obtained from outside the State.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	40	10	10	-	60	1	-
Oak,	150	230	260	110	750	6	-
Chestnut and oak,	140	390	170	50	750	6	-
White pine,	370	950	1,350	660	3,330	25	-
Hardwoods and white pine, ¹	2,140	1,000	150	-	3,290	25	-
Maple and birch,	2,470	1,560	400	80	4,510	34	-
Softwoods other than white pine. ²	100	230	80	20	430	3	-
Total,	5,410	4,370	2,420	920	13,120	-	-
Percentage,	41	33	19	7	-	100	63
NON-FOREST TYPES.							
Tillage and hay,					4,520	-	22
Open pasture,					1,830	-	9
Brush pasture,					890	-	4
Business, residential, etc.,					70	-	-
Water,					370	-	2
Total area of town,					20,800	-	100

¹ Hardwoods are largely maple and gray birch, with small amounts of white birch and oak.² Large sizes, mostly hemlock and spruce; smaller, tamarack and pitch pine.

UPTON.

The timber land in Upton has been largely cut over within twenty years, and most of the land is growing Class 3 sprouts. Gray birch is more common in Upton than in most of the surrounding towns, and the percentage of white oak is greater; probably over half the oak in Upton is white oak. Chestnut and white pine and hardwoods are the most important types. There are several lots of merchantable pine still left in Upton, but mostly in patches of a few acres each.

At the time this survey was made the only mill working in Upton was the portable mill of D. W. Gaskill of Blackstone. He had about 300 M board feet to cut, mostly chestnut, oak and pitch pine. Mr. B. C. Wood of Upton does considerable cutting in Upton and near-by towns. The Upton Manufacturing Company is a box company primarily, but they have their

own sawmill operated by water power. They use only local pine. The W. G. Fiske Lumber Company have a stationary mill, but do not do much cutting themselves. This past year they cut and sawed about 100 M board feet of lumber of which 75 per cent. was pine, the remainder being chestnut and oak.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	510	380	350	40	1,280	14	-
Oak, ¹	340	410	130	30	910	10	-
Chestnut and oak,	440	230	30	30	730	8	-
White pine,	120	390	10	180	700	8	-
Hardwoods and white pine, ²	980	760	70	30	1,840	20	-
Maple and gray birch,	2,310	1,050	60	-	3,420	38	-
Softwoods other than white pine. ³	100	50	-	-	150	2	-
Total,	4,800	3,270	650	310	9,030	-	-
Percentage,	53	36	7	4	-	100	65
NON-FOREST TYPES.							
Tillage and hay,					3,030	-	22
Open pasture,					1,050	-	7
Brush pasture,					600	-	4
Brush swamp,					90	}	2
Business, residential, etc.,					20		
Water,					140		
Total area of town,					13,960	-	100

¹ About one-third of the oak type is made up of white oak.

² Hardwoods are maple and gray birch.

³ Pitch pine.

UXBRIDGE.

The woodlands constitute about 70 per cent. of the area of the entire town, the principal species being pitch and white pine, oak and chestnut. The general condition of the timber is fair. There are numerous open spaces — as a result of lumbering operations, forest fires and the abandoning of farms — which could profitably be reforested. The best timber lies in the south central portion, and ranges from Class 3 to Class 1, with a stocking in some parts of 100 per cent.

The sawmill of Newell & King cuts during the late fall and winter months from 300 to 700 M board feet of pine, chestnut and oak, probably 75 per cent. of the whole cut being pine.

The Uxbridge branch of Wm. M. Harris, Providence, R. I., deals in southern and western pine, shingles and cordwood. This concern buys only cordwood locally, and this from woodlot owners who deliver the same.

W. B. Tucker cuts pine and chestnut when they can be bought.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	30	420	170	550	1,170	9	-
Oak,	280	500	160	40	980	8	-
Chestnut and oak, . . .	1,270	2,180	1,020	280	4,750	37	-
White pine,	280	280	430	320	1,310	10	-
Hardwoods and white pine, ¹	190	670	50	210	1,120	9	-
Maple and gray birch, . .	1,020	1,270	450	400	3,140	25	-
Pitch pine,	80	180	20	-	280	2	-
Total,	3,150	5,500	2,300	1,800	12,750	-	-
Percentage,	25	43	18	14	-	100	66
NON-FOREST TYPES.							
Tillage and hay,					4,650	-	24
Open pasture,					830	-	4
Brush pasture,					280	}	2
Brush swamp,					110		
Business, residential, etc.,					330	-	2
Water,					380	-	2
Total area of town,					19,330	-	100

¹ Larger sizes are mostly red maple; smaller, gray birch.

WARREN.

The woodland is chiefly a second growth of chestnut and oak. In the southern section there is a large area of young mixed hardwoods. A few stands of good merchantable chestnut and oak are left, but they are small and scattered. Pine forms a still smaller percentage of the forest growth in this town than it does in West Brookfield. The best stand of white pine is found

around Comins Pond. Elm swamps are to be found, but these are so rare that they have been classed as mixed hardwoods.

There are no operators in Warren. Mr. H. N. Shepard deals more or less in lumber, but he contracts for portable mills from outside to do his work. The lumber sawed is chiefly chestnut, oak and pine, with some ash, birch and maple.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	60	340	440	440	1,280	18	-
Oak,	50	140	80	10	280	4	-
Chestnut and oak,	430	560	120	170	1,280	18	-
White pine,	120	-	10	70	200	3	-
Hardwoods and white pine, ¹	-	190	50	-	240	4	-
Maple and gray birch,	1,720	1,250	610	10	3,590	52	-
Softwoods other than white pine. ²	50	50	-	-	100	1	-
Total,	2,430	2,530	1,310	700	6,970	-	-
Percentage,	35	36	19	10	-	100	38
NON-FOREST TYPES.							
Tillage and hay,					4,030	-	22
Open pasture,					6,660	-	37
Brush pasture,					420	-	2
Brush swamp,					20	}	1
Water,					130		
Total area of town,					18,230	-	100

¹ Hardwoods are largely gray birch and maple.

² Pitch pine.

WEBSTER.

The wooded section of this town is in a condition of healthy, rapid growth. Burned areas in the northeastern and southeastern corners are restocking with chestnut and oak sprouts, maple and birch. The best timber lies along the shores and to the east of Lake Chaubunagungamaug. There are many small areas of white pine, and reproduction is generally good. The proportion of woodland to the total area of the town is about 60 per cent.

Louis E. Pattison saws mostly pine, chestnut and oak from the towns of Webster, Douglas, Sturbridge, Charlton, Oxford and Thompson (Conn.). He saws about 350 M board feet per year of pine, chestnut and mixed hardwoods.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Oak,	320	200	110	—	630	12	—
Chestnut and oak,	490	470	250	150	1,360	25	—
White pine,	140	70	100	110	420	8	—
Hardwoods and white pine, ¹	80	380	320	50	830	15	—
Maple and gray birch,	1,030	870	300	—	2,200	40	—
Total,	2,060	1,990	1,080	310	5,440	—	—
Percentage,	38	37	20	5	—	100	59
NON-FOREST TYPES.							
Tillage and hay,					1,520	—	16
Open pasture,					270	—	3
Brush pasture,					100	—	1
Business, residential, etc.,					800	—	9
Water,					1,150	—	12
Total area of town,					9,280	—	100

¹ Hardwoods are largely gray birch and red maple.

WEST BOYLSTON.

While there is very little timber of merchantable size, the majority of that standing is in good, healthy condition. About 55 per cent. of the town is either pasture or tilled land. The remainder, with the exception of the water area, is covered with a wooded growth, chestnut being the predominating species. Chestnut also occurs mixed with oak and white pine.

The best timber is on the land owned by the Metropolitan Water Works; and while much of this is small and worth little now, it is only a matter of time until it will form a valuable forest. Size classes range from reproduction to 2, but the majority will fall under 10 inches diameter, breast high.

White pine growing naturally occurs well scattered. Around the reservoir extensive planting of this species has been carried

on, the planted trees now ranging from one to ten years in age. Red and Scotch pine have also been planted, but to a much less degree. These trees are making exceptionally rapid growth, some of the older ones averaging 2 feet in height annually. The best specimens are found in the northeastern corner of the town.

There are no sawmills or woodworking industries now located in this town, and there have been none since the reservoir was built. No portable mills were working when this survey was made.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	10	150	370	70	600	19	-
Oak,	100	130	120	-	350	11	-
Chestnut and oak,	220	360	390	-	970	30	-
White pine,	180	170	300	40	690	21	-
Hardwoods and white pine, ¹	10	70	30	-	110	3	-
Mixed hardwoods, ²	210	170	60	-	440	14	-
Softwoods other than white pine. ³	30	40	-	-	70	2	-
Total,	760	1,090	1,270	110	3,230	-	-
Percentage,	24	34	39	3	-	100	37
NON-FOREST TYPES.							
Tillage and hay,					4,110	-	47
Open pasture,					640	-	7
Brush pasture,					140	}	2
Brush swamp,					40		
Water,					660	-	7
Total area of town,					8,820	-	100

¹ Hardwoods are birch, chestnut, oak and red maple.

² Swamp maple, red maple and gray birch.

³ Pitch pine.

WEST BROOKFIELD.

Nearly all the woodland is second growth hardwoods, chiefly chestnut and oak. Here and there are small patches of good merchantable material. Broadly speaking, probably less than one-third of the town is covered with species which will develop into large timber. The chief species are chestnut and oak,

while the old pastures are fast growing up to gray birch. Soft maple occurs in the swamps, but the size of this is small, and it is of little practical importance. White pine occurs scatteringly in small percentages in nearly all types, but the only place where pure stands are likely to develop naturally is in the extreme eastern part. Located in this section is a fine but small tract of merchantable hemlock.

There are two stationary sawmills. One is owned by D. Tyler and is located east of Ragged Hill on Mill Brook. This mill is run by water power. The other is a gasoline sawmill owned by Henry Foster on Long Hill in the extreme southern part of the town. Both of these operators do only small odd jobs as the needs of the neighbors require. The logs for these purposes are supplied by the farmers.

The chief out-of-town operators are George Wasson and A. N. Cony of Ware, and Messrs. Cummings and Fullam of North Brookfield. The lumber sawed is mostly chestnut, oak and pine, with some ash, birch and maple.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total. Acres.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
Chestnut,	220	490	280	320	1,310	20	-
Oak,	30	-	90	40	160	2	-
Chestnut and oak, . . .	540	230	330	30	1,130	18	-
White pine,	50	100	40	20	210	3	-
Hardwoods and white pine, ¹	180	180	70	-	430	7	-
Maple and gray birch, .	1,110	1,550	550	20	3,230	49	-
Softwoods other than white pine. ²	20	20	-	20	60	1	-
Total,	2,150	2,570	1,360	450	6,530	-	-
Percentage,	33	39	21	7	-	100	48
NON-FOREST TYPES.							
Tillage and hay,					2,910	-	22
Open pasture,					3,070	-	23
Brush pasture,					600	-	4
Water,					390	-	3
Total area of town,					13,500	-	100

¹ Hardwoods are gray birch and red maple.

² Mostly pitch pine with some hemlock.

WESTBOROUGH.

The proportion of woodland is about 45 per cent., all in good condition, but mostly of small growth. There is a noticeable dearth of timber of all kinds on the land best adapted to growing it. A few wooded hills remain, covered with chestnut, oak and pine, but by far the greater part of the timber consists of soft maple, birch and cedar, running from Class 2 down to reproduction, and this lies in or near the swamps. At the present time little timber is being cut in Westborough, there being no mills and but one woodworking factory. Cordwood is handled only by dealers in coal and wood.

Frank Bartlett, owner of a box factory, cuts no timber. He uses spruce, pine shingles and some chestnut and oak. He uses about 3,000,000 board feet per year, most of which is obtained from outside of Massachusetts.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	40	80	50	340	510	8	-
Oak,	70	80	130	190	470	8	-
Chestnut and oak, . . .	360	240	150	100	850	14	-
White pine,	20	160	80	120	380	6	-
Hardwoods and white pine, ¹	100	150	-	-	250	4	-
Maple and gray birch, .	950	1,830	240	170	3,190	51	-
Softwoods other than white pine. ²	80	320	-	180	580	9	-
Total,	1,620	2,860	650	1,100	6,230	-	-
Percentage,	26	46	10	18	-	100	43
NON-FOREST TYPES.							
Tillage and hay,					4,520	-	31
Open pasture,					1,350	-	9
Brush pasture,					1,540	-	11
Brush swamp,					140	-	1
Business, residential, etc.,					500	-	3
Water,					250	-	2
Total area of town,					14,530	-	100

¹ Hardwoods are largely gray birch, red maple and poplar.

² Pitch pine in the large sizes; white cedar in the smaller sizes.

WESTMINSTER.

The woodlands of the town are largely in a state of neglect. The major growth is chestnut and hardwoods, with scattered stands of pine. There is considerable growth of pine in the north and east parts of the town. There is much swamp covered with maple, birch, spruce and alder. Many areas are found where cutting has been done, removing everything merchantable, leaving the land butchered, with slash and débris scattered about, forming veritable tinder piles. These areas occur throughout the township. This land is now growing up to gray birch, sprout chestnut or brush, and is well-nigh in a useless condition. Thinnings are needed everywhere and reforestation in many places. This last operation has been done to considerable extent. Careful forest management is needed in this town as in other towns examined. Fires have run through the cut-over lands and left them in a very poor condition. Practically all merchantable stuff has been cut.

In Westminster village is a box mill, belonging to Mr. Goodridge, which uses per year 1,500,000 feet of pine, spruce and hemlock. Most of the stock is obtained from outside the State because Westminster's supply and the stock near by is depleted. Last year 200 M board feet were cut here, the remainder coming from New Hampshire. E. H. Merriam runs a sawmill near Westminster depot in connection with his grain business. Sawing is done irregularly, and is largely custom work. This mill saws perhaps 500 M board feet to 1,000 M board feet per year. Pierce's chair mill at Whitmanville in the northerly part of the township uses 1,500,000 feet of chestnut per year. This comes from Pennsylvania, New Hampshire and New York. Two million feet of turned stock per year are used.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut,	970	470	340	300	2,080	14	-
Oak,	120	70	30	50	270	2	-
Chestnut and oak,	380	200	430	630	1,640	11	-
White pine,	660	330	770	780	2,540	17	-
Hardwoods and white pine, ¹	250	200	280	240	970	6	-
Maple and gray birch,	3,870	1,370	830	670	6,740	45	-
Softwoods other than white pine. ²	300	280	100	70	750	5	-
Total,	6,550	2,920	2,780	2,740	14,990	-	-
Percentage,	44	19	19	18	-	100	63
NON-FOREST TYPES.							
Tillage and hay,					4,380	-	18
Open pasture,					1,730	-	7
Brush pasture,					1,670	-	7
Brush swamp,					360	-	2
Business, residential, etc.,					70	}	3
Water,					670		
Total area of town,					23,870	-	100

¹ Hardwoods are largely gray birch and maple.

² Pitch pine and hemlock.

WINCHENDON.

Regarding the town as a whole, white pine is the predominating species. As a rule, it is thrifty and growing rapidly, but considerable damage caused by the weevil was noticed in some of the younger stands. It might be mentioned that, in general, although the pine stands are healthy and growing, they are understocked.

The gray birch and maple type, although at the present time covering a much larger area than the white pine, seems likely to be eventually suppressed by the latter.

Spruce, hemlock and larch were found scattered throughout the town in moist places. Considerable hemlock is found in the western part of the town, generally in mixture with pine and of

about the same age. In the swamps and bogs spruce, hemlock and larch are found, either pure, together, or in different combinations with lowland hardwoods, such as red maple and the various birches.

The sizes of the different types vary from reproduction to 1.

Mr. C. A. Brooks runs a sawmill in connection with his handle factory. He cuts per year 45 M board feet of spruce, 25 M board feet of hemlock, and 180 M board feet of pine. Nearly all of this lumber is bought in New Hampshire.

M. E. Converse & Sons own a toy factory, and use the following amount of board feet of lumber per annum: white pine, 1,000 M; chestnut, 250 to 300 M; basswood, 75 M; red gum, 50 M; miscellaneous, 100 M.

C. A. Brooks' handle factory uses about 400 cords of beech, birch and maple per year. Practically all of this comes from New Hampshire.

Wm. Brown & Son manufacture pails and ice-cream freezers. They use about 3,500 cords of pine annually.

Mason & Parker, toy manufacturers, use per annum: basswood, 200 M board feet; chestnut, 250 M board feet; poplar, 150 M board feet; pine, 100 M board feet; beech, birch and maple, 25 M board feet.

Carter & Campbell, furniture manufacturers, use per annum: spruce, 40 to 45 M board feet; maple, 30 M board feet; ash and miscellaneous hardwoods, 15 M board feet.

M. A. Parks, manufacturer of spools and bobbins, uses basswood, 500 M board feet; birch, 500 M board feet; pine, 1-inch boards, and pine, $2\frac{1}{8}$ inch boards, 100 M board feet; Pennsylvania beech, 50 M board feet.

E. Murdock & Co., manufacturers of pails and tubs, use 7,500 cords of pine logs; 1,500 cords of spruce, hemlock and hardwoods; 750 M board feet of $2\frac{1}{8}$ inch pine plank; and 500 M board feet of 1-inch hardwood boards.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Chestnut and oak,	270	320	470	160	1,220	6	-
White pine,	1,220	1,070	1,970	680	4,940	25	-
Mixed hardwoods, ¹	10	140	100	30	280	1	-
Maple and gray birch, {	M.1,460	1,510	700	70	3,740	19	-
	B.5,570	1,640	170	-	7,380	38	-
Softwoods other than white pine. ²	320	680	910	330	2,240	11	-
Total,	8,850	5,360	4,320	1,270	19,800	-	-
Percentage,	45	27	22	6	-	100	68
NON-FOREST TYPES.							
Tillage and hay,					4,350	-	15
Open pasture,					1,170	-	4
Brush pasture,					1,760	-	6
Business, residential, etc.,					1,240	-	4
Water,					800	-	3
Total area of town,					29,120	-	100

¹ Hardwoods are beech, hard maple and white birch.

² Spruce, hemlock, pitch pine and a little red pine.

WORCESTER.

Worcester is more interesting as a consumer of lumber than as a producer. Its percentage of woodland, 21, is far less than any other township in the county. What there is is valued far in excess of its timber value for residential and æsthetic purposes. For this reason the percentage of woodland in larger sizes is unusually large. Chestnut predominates, either pure or mixed with oak, while white pine is deficient and under the average percentage. The woodland is generally in good condition, except for the chestnut blight, which has done considerable damage in many sections. The woodland around Lake Quinsigamond shows the result of many ground fires.

A large manufacturing city like Worcester is naturally a large consumer of lumber, both for construction purposes and in its industries. Most of this lumber, however, comes from outside the State, as is the general run with our lumber supply. The

principal consumers of native lumber are the box manufacturers, of which there are two large concerns in Worcester. This city, with its numerous car lines and electric companies, offers a good market for ties and poles. Some native white oak is used by the car builders, and it is probable that some native white pine is used by the makers of sash, blinds and interior finish. Worcester offers a good cordwood market, but the supply in the vicinity is ample, so that prices are rather low. The following industries make up the principal timber consumers of Worcester: —

Box Manufacturers.

Baker Box Company.	| H. I. Gould.
Williams & Bridges.	|

Caskets.

F. E. Sessions Company.

Sash and Interior Finish.

Griffin Flooring Company.	| W. E. Putnam.
Adams & Powers.	| M. K. Smith Company.
Hatch & Barnes.	| Frank O. Stevens.
E. F. Hunt Company.	| Henry Braman.

Eaves and Troughs.

A. C. Lead Company.	| Edw. W. Witter & Co.
---------------------	----------------------

General Lumber Dealers.

F. O. Arnold.	| Frederick S. Hunt.
Baker Lumber Company.	| New England Lumber Company.
J. F. Bicknell Lumber Company.	| William H. Sawyer Company.
J. W. Bishop Company.	| Stone & Berg.
Henry H. Dyke.	| Stone & Foster.
John H. Grant.	| P. W. Wood Lumber Company.
Edward A. Hackwell.	|

Woodland Operators.

George L. Jacques.	| Chas. T. Luce.
Frank O. Arnold.	| H. I. Gould.
M. Bagdasarian.	|

Tie and Pole Operators.

George L. Jacques.	| Chas. T. Luce.
Frank O. Arnold.	| H. I. Gould.
M. Bagdasarian.	|

Lasts.

S. Porter & Co.

Agricultural Implements.

Richardson Manufacturing Com- pany.	|	Worcester Lawn Mower Com- pany.
--	--	------------------------------------

Car Builders.

Osgood-Bradley Company.

Piano Players.

Simplex Player Company.	|	Weber Piano Company.
-------------------------	--	----------------------

Refrigerators.

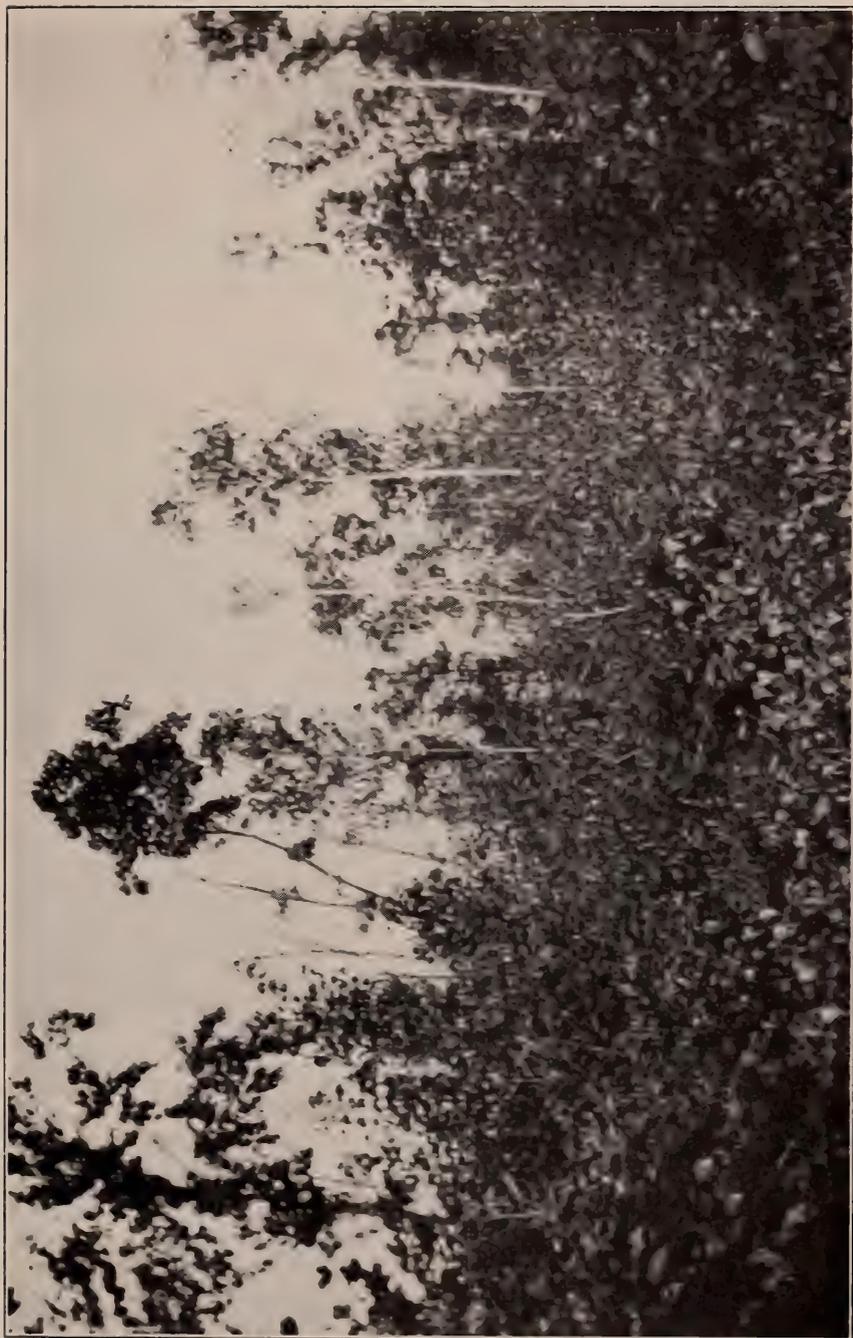
F. A. Atherton Company.	|	M. M. Whitman.
-------------------------	--	----------------

Cordwood Dealers.

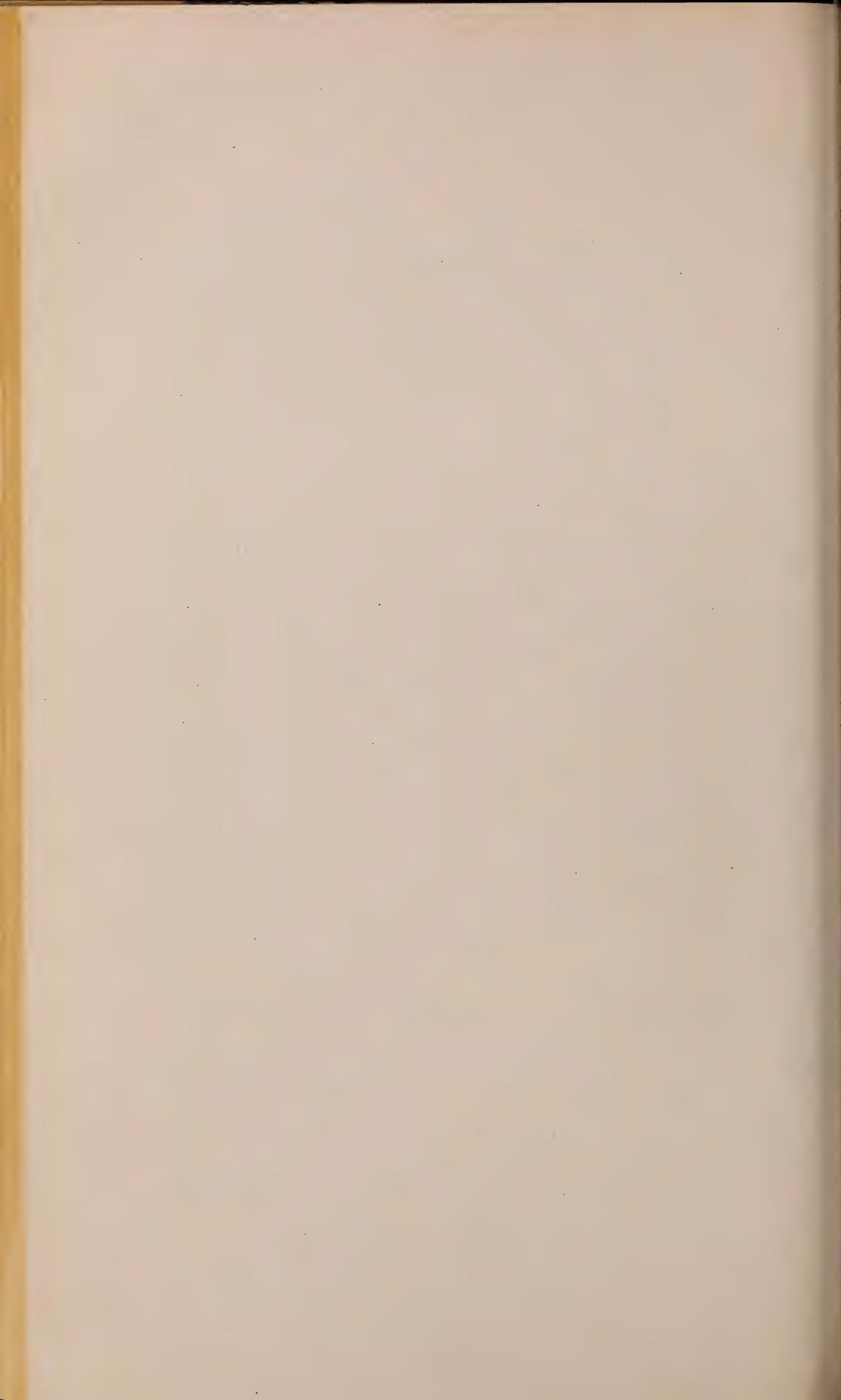
Ararat Wood Company.	|	Claffin Coal Company.
David Bergerau.	|	F. P. Defaleo.
Walker Ice Company.	|	New England Fuel Company.
E. Perreault.	|	Worcester Fuel Company.
F. O. Arnold.	|	F. E. Powers Company.

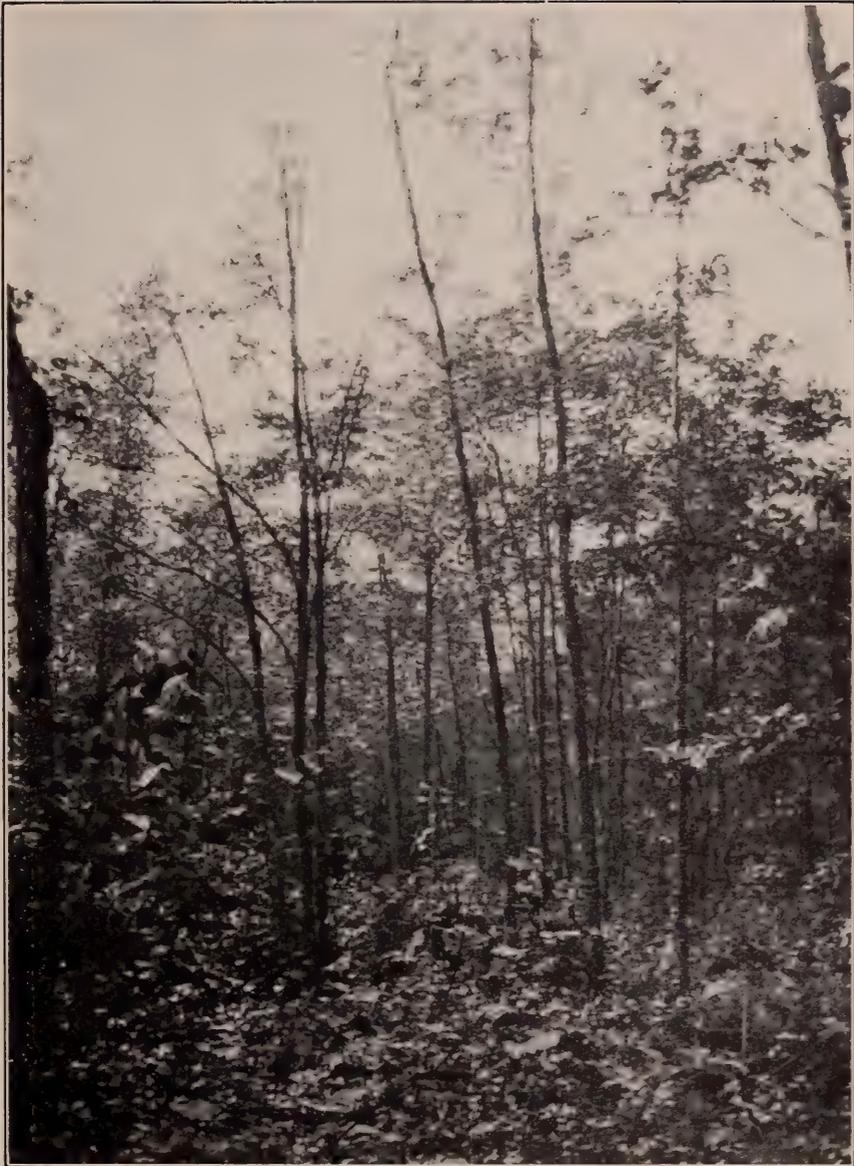
Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
	Acres.	Acres.	Acres.	Acres.	Acres.		
FOREST TYPES.							
Chestnut,	90	100	230	310	730	14	-
Oak,	20	360	30	60	470	9	-
Chestnut and oak,	410	420	960	210	2,000	39	-
White pine,	20	-	70	150	240	5	-
Hardwoods and white pine,	-	140	50	310	500	10	-
Maple and gray birch,	310	610	180	20	1,120	22	-
Pitch pine,	10	-	-	30	40	1	-
Total,	860	1,630	1,520	1,090	5,100	-	-
Percentage,	17	32	30	21	-	100	21
	NON-FOREST TYPES.						
Tillage and hay,					8,040	-	32
Open pasture,					2,800	-	11
Brush pasture,					680	-	3
Business, residential, etc.,					7,330	-	30
Water,					690	-	3
Total area of town,					24,640	-	100

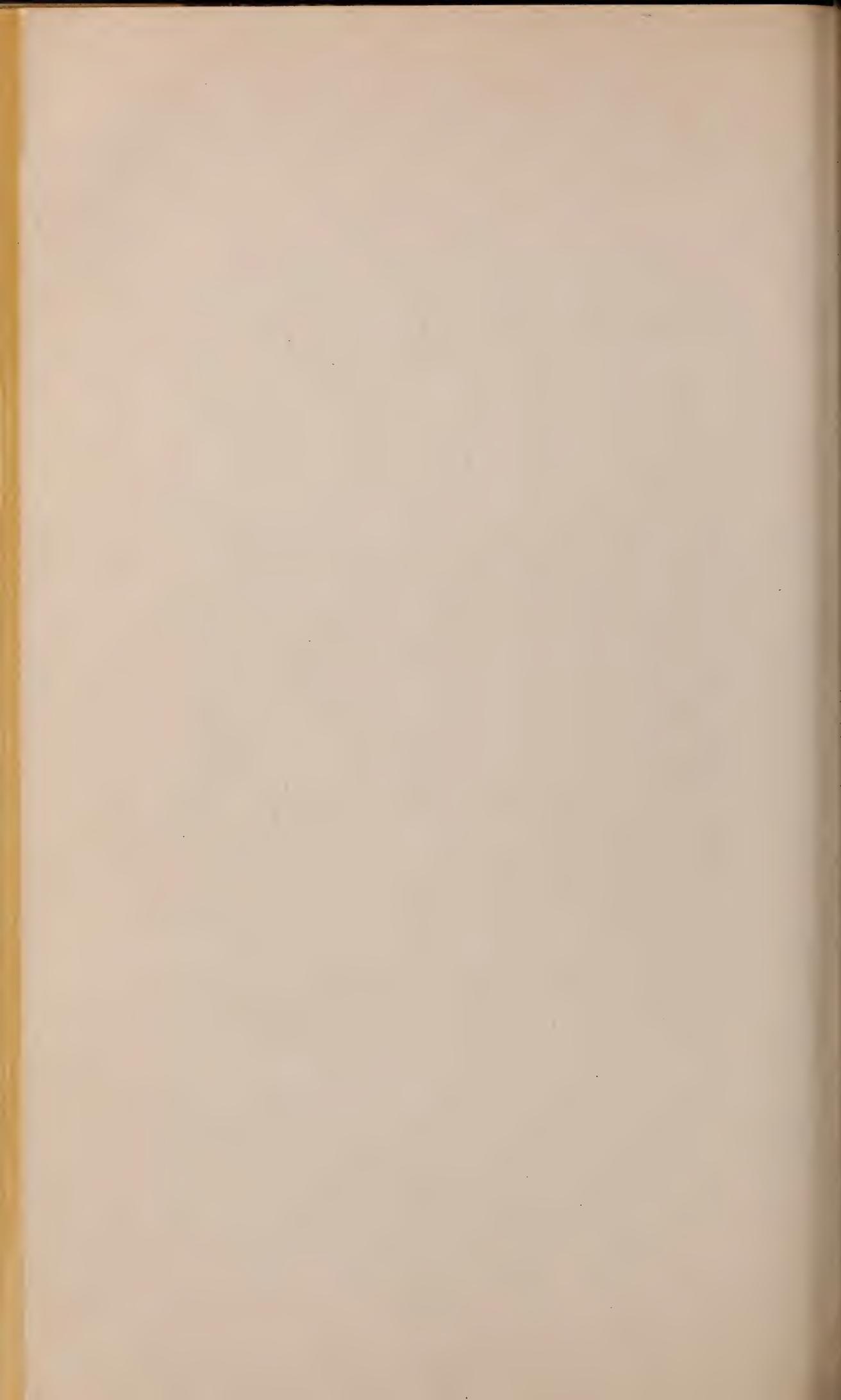


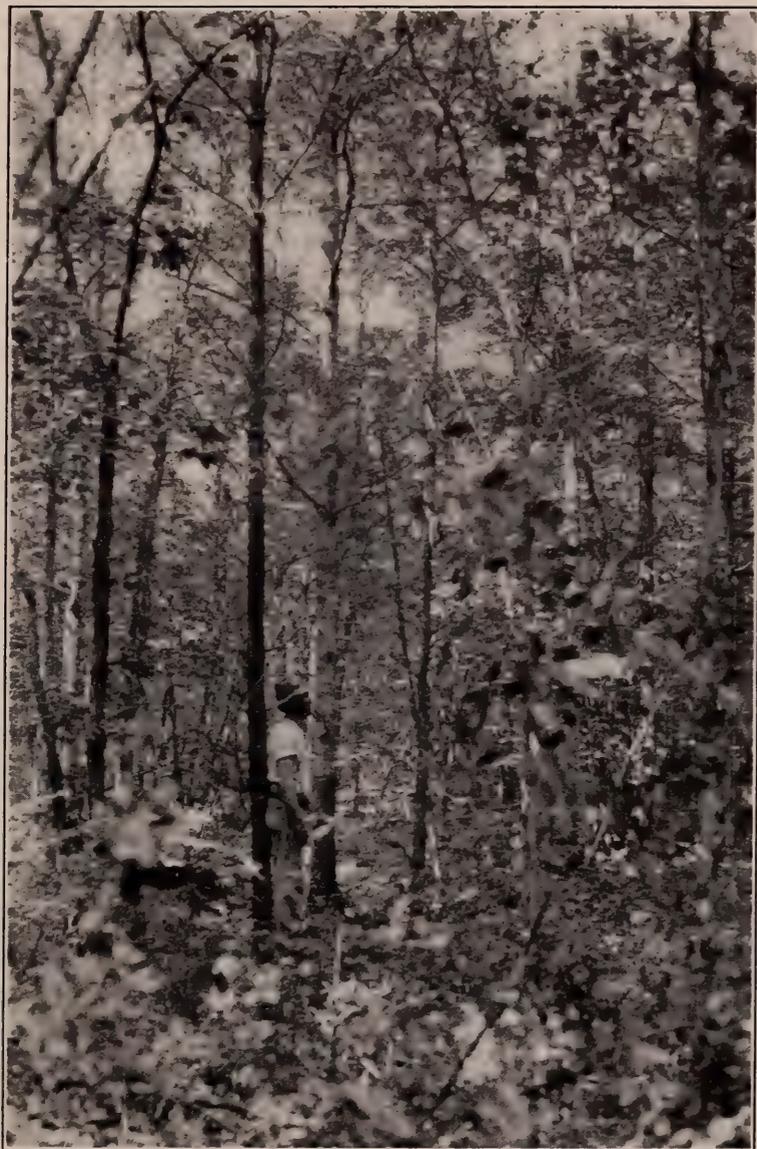
Sprout maple and gray birch on burned land. (Birch and maple type, Class 4.)





Red maple in swamp. Diameters, 3 to 7 inches; heights, 35 to 45 feet. (Maple and birch type, Class 3.)



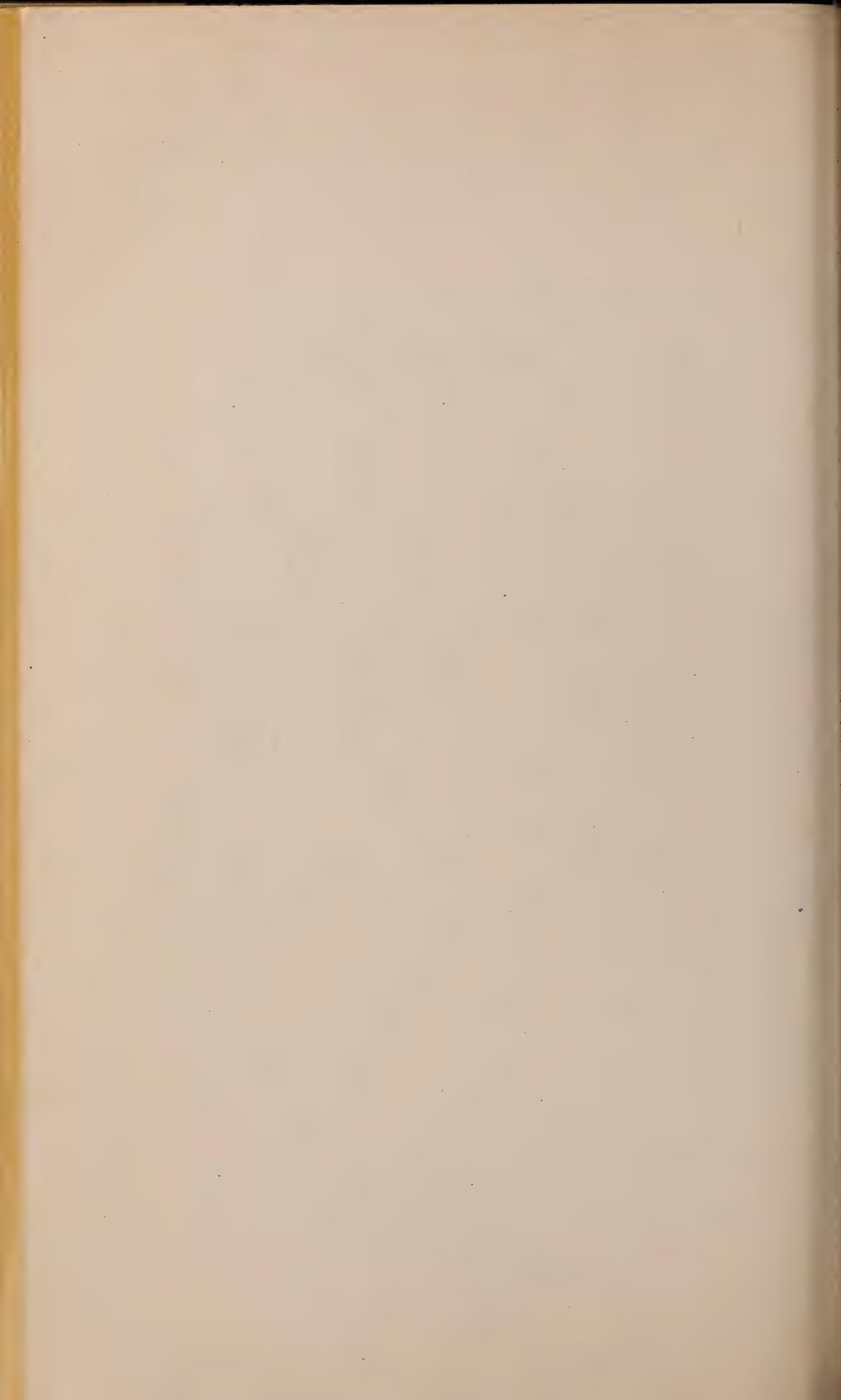


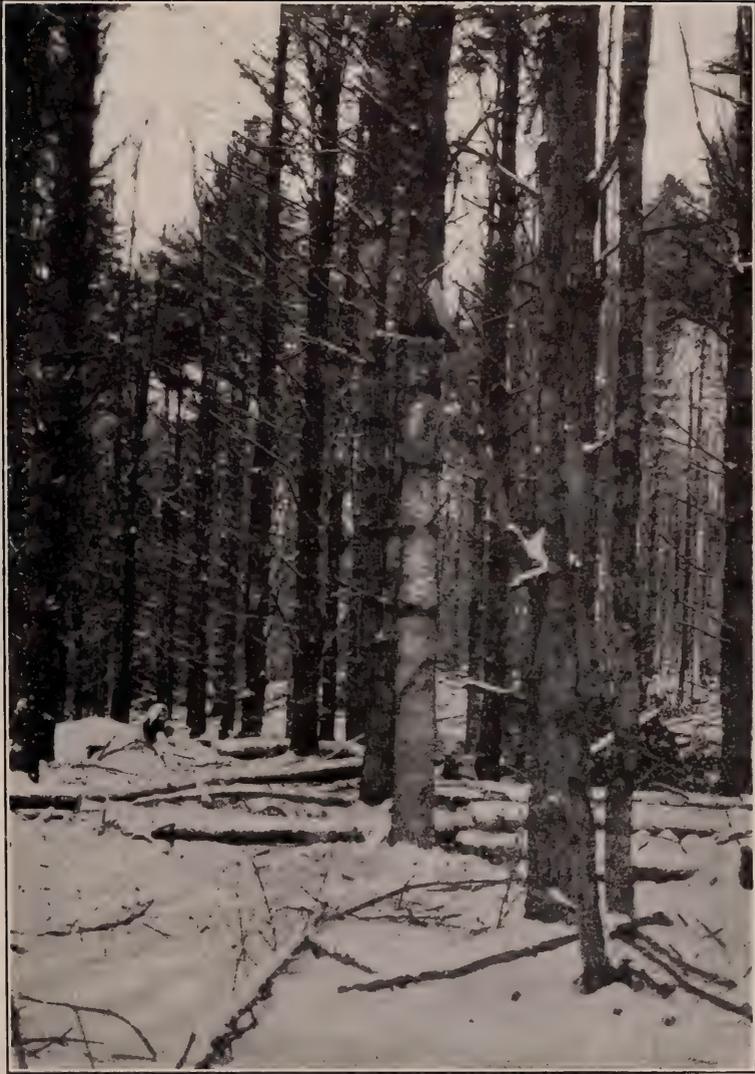
Oak, maple and pine in mixture. Diameters, 3 to 7 inches; heights, 20 to 30 feet. (Pine and hardwoods type, Class 3.)



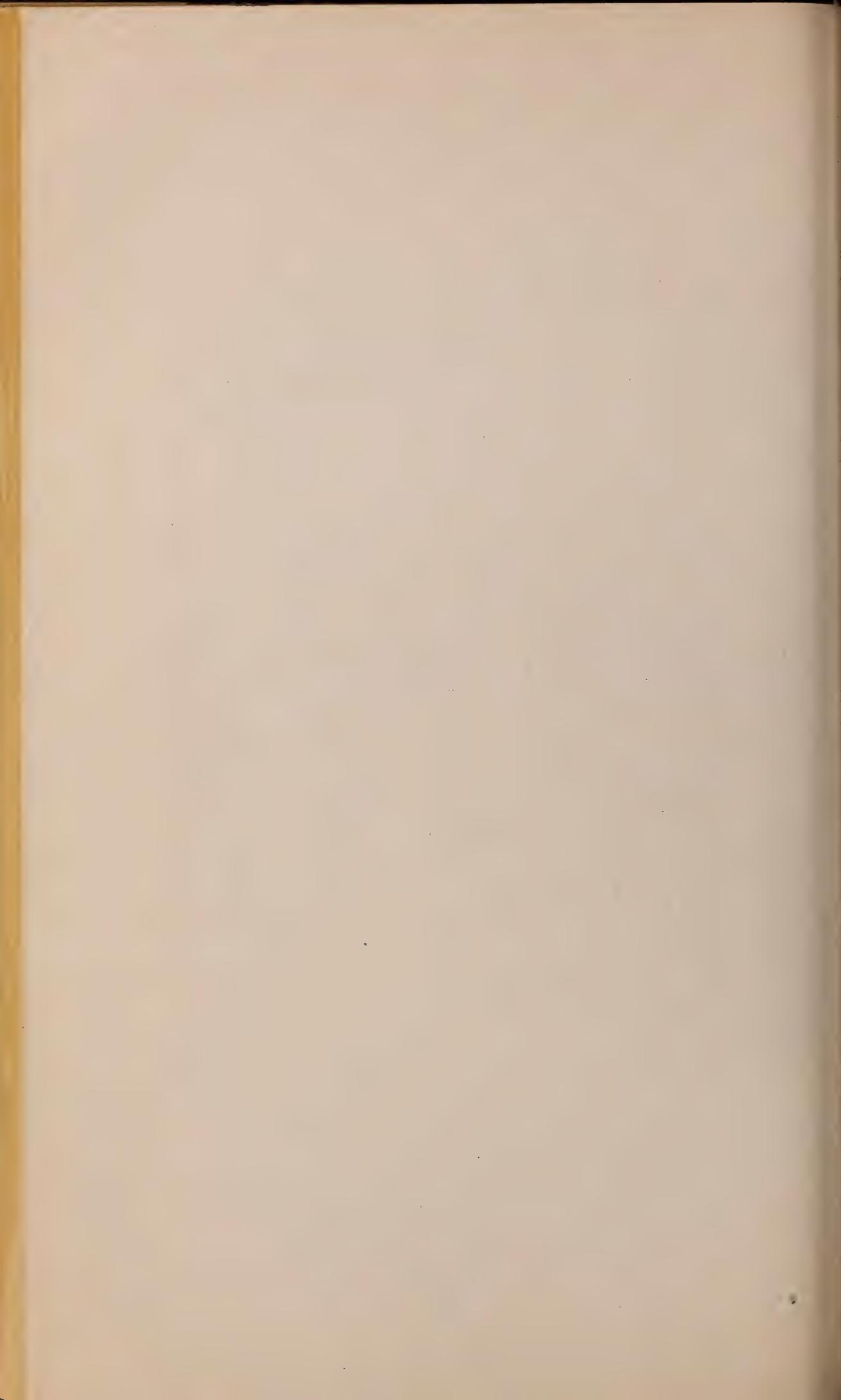


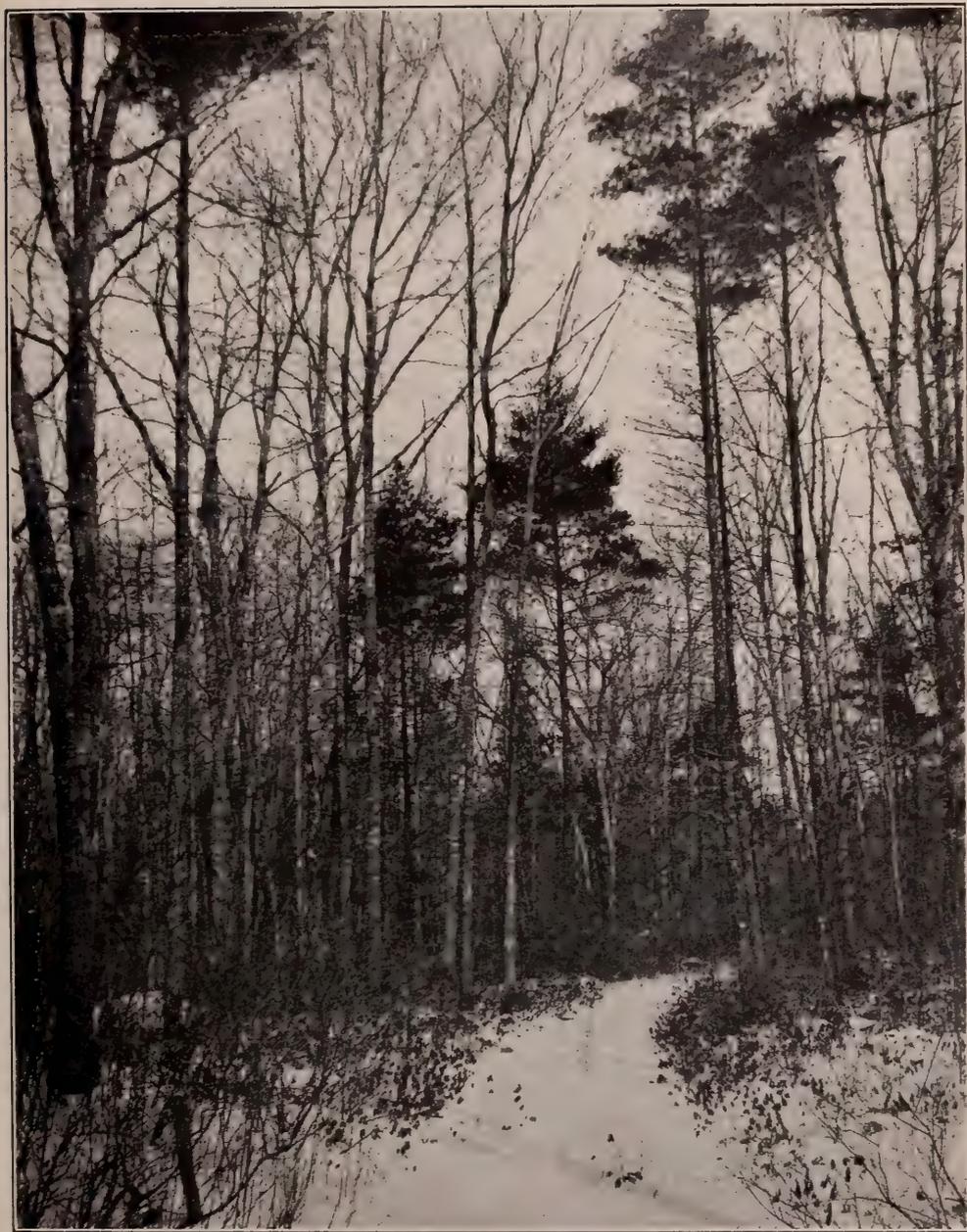
Large sprout oak. Diameters, 7 to 12 inches; heights, 50 to 60 feet. (Oak type, Class 2.)



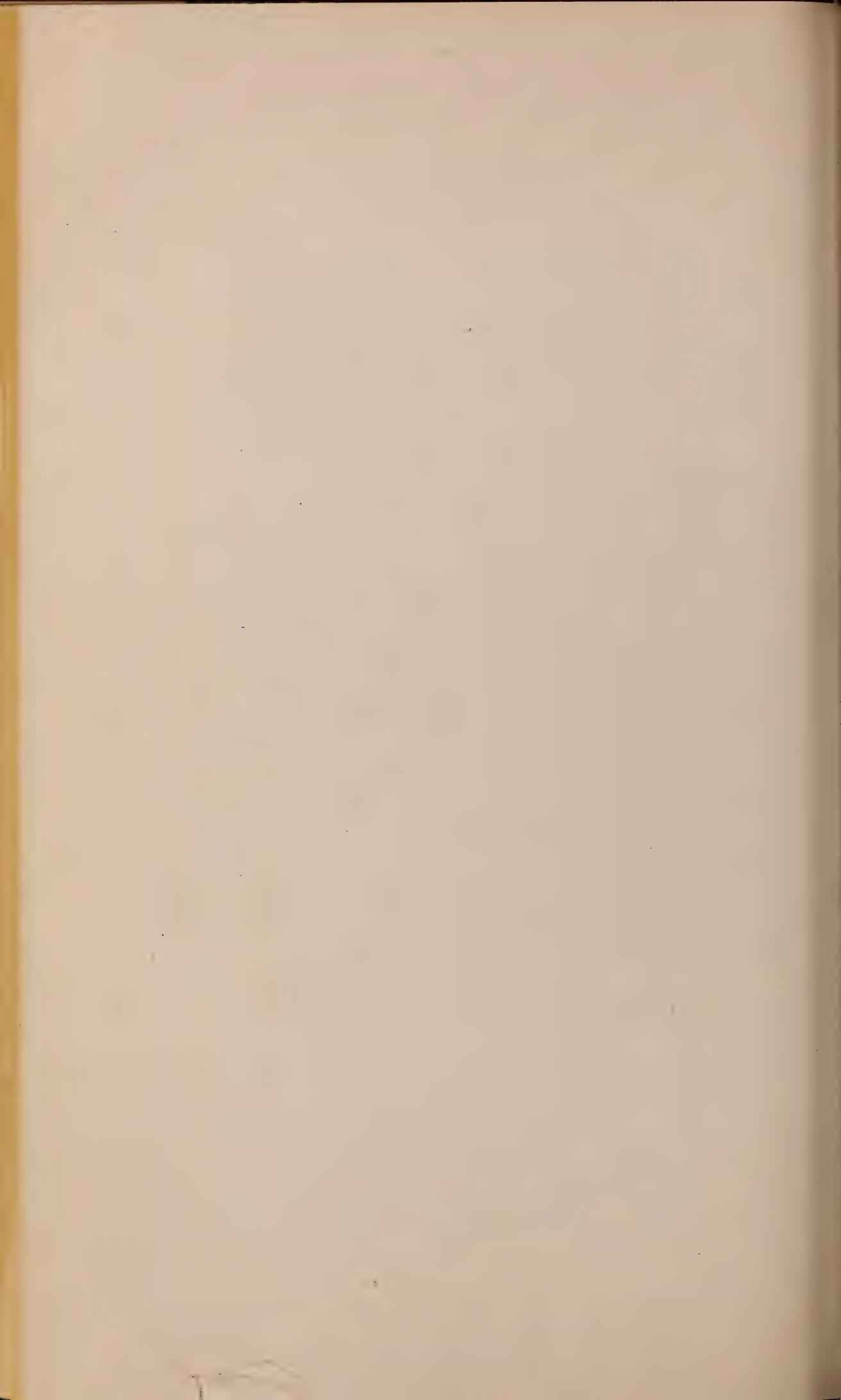


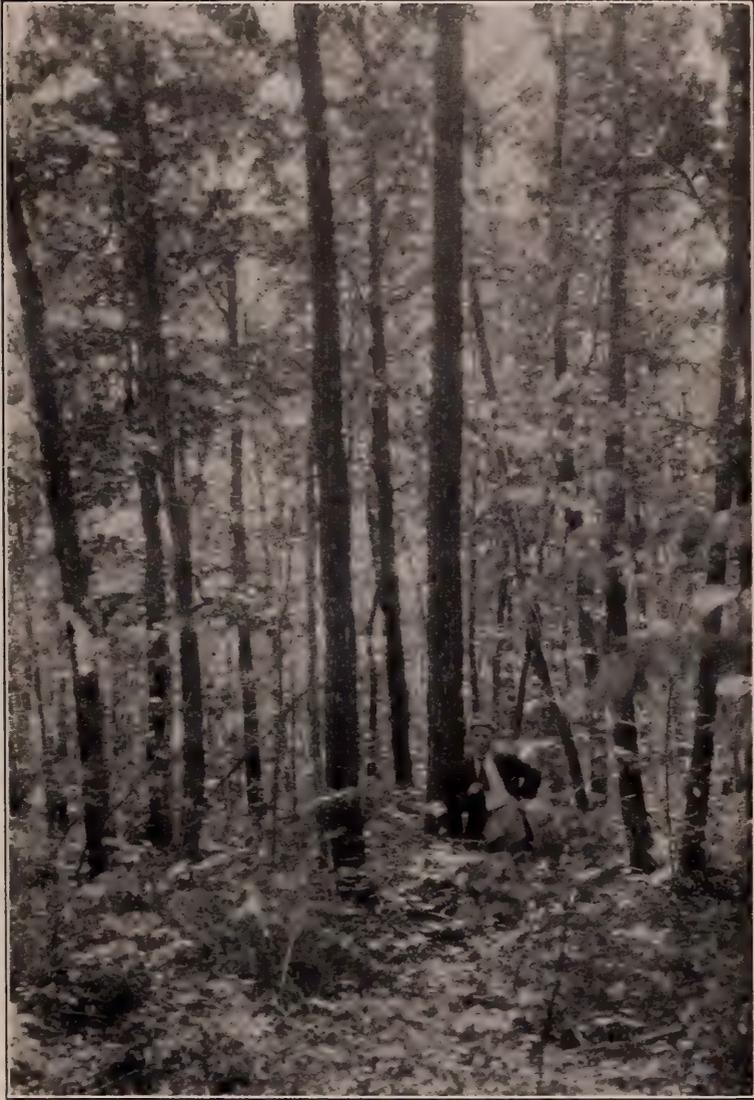
White pine fifty years old. Diameters, 8 to 13 inches; heights, 55 to 65 feet. (White pine type, Class 2.)



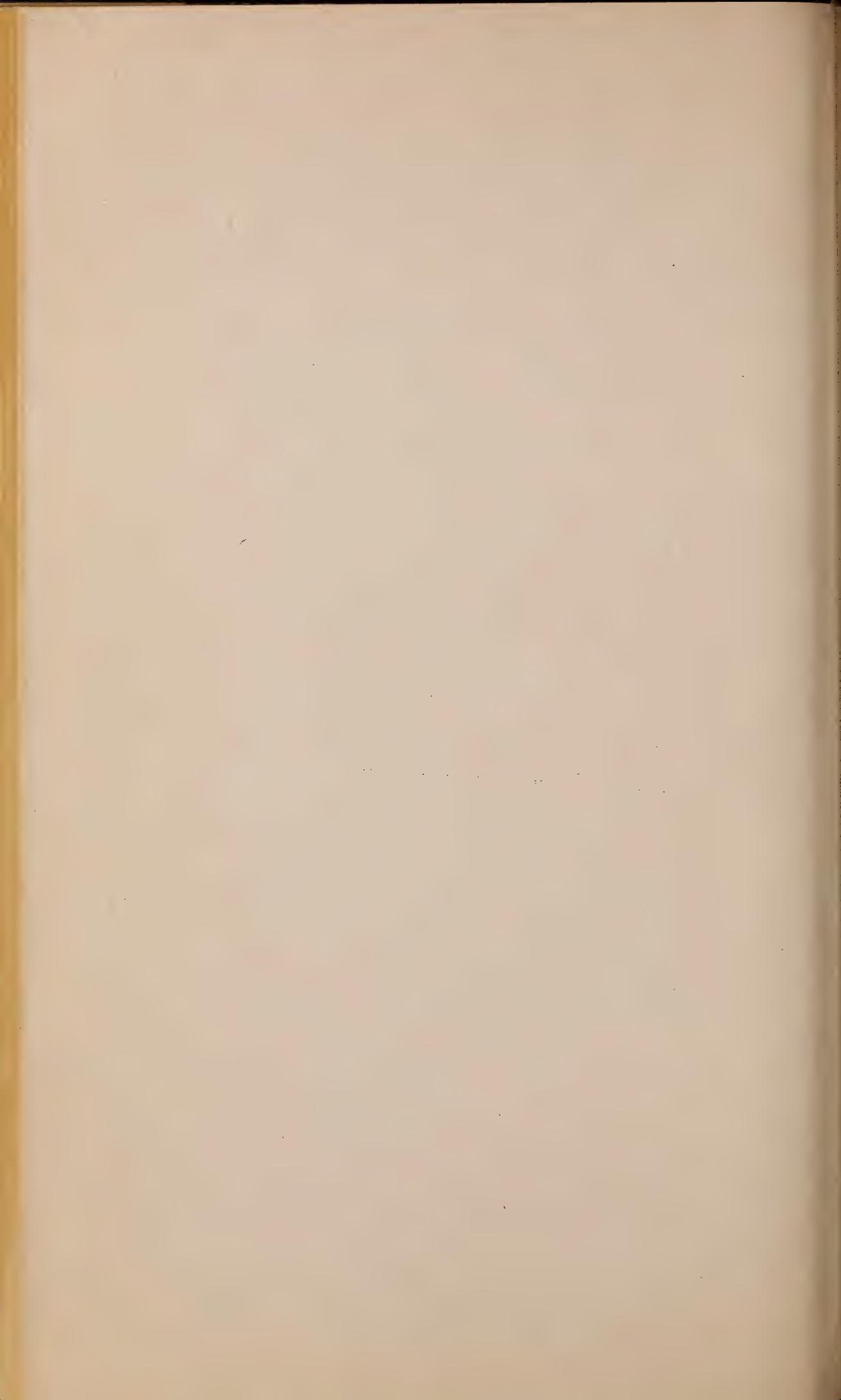


Pine, maple and oak. Diameters, 6 to 10 inches; heights, 50 to 60 feet. (Pine and hardwoods type, Class 2.)





Large sprout chestnut. Diameters, 8 to 14 inches; heights, 60 to 70 feet. (Chestnut type, Class 1.)



5.08
M38p

18

THE UTILIZATION OF FOREST PRODUCTS IN MASSACHUSETTS

AS AFFECTED BY THE WAR

By PAUL D. KNEELAND, M.F.

Assistant Forester

Under the Direction of

F. W. RANE, B.Agr., M.S.

Massachusetts State Forester



BOSTON
WRIGHT & POTTER PRINTING COMPANY, STATE PRINTERS
32 DERNE STREET
1918

PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

THE UTILIZATION OF FOREST PRODUCTS IN MASSACHUSETTS AS AFFECTED BY THE WAR.

Introduction.

The war in which we are now engaged has wrought great changes in the field of forest utilization. Many of these changes have been kaleidoscopic in their action, and they are still going on. What was true a year ago, perhaps, does not hold true to-day, and very likely will be still different a year from now. This bulletin is written from a popular rather than a scientific point of view, in order that the woodland owner may know some of the conditions which now prevail, and be able to take advantage of them. There is bound to be a reaction after the war, but there is little probability that things will go back to their former status.

Of all our natural resources perhaps the forests were the last to be called upon to help win the war. The other two great sources of raw material — the field crops and the mineral reserves — felt the stimulation of war prices long before this country entered the conflict. It was not until we were in it, and the great programs for ships, airplanes, cantonments, etc., were under way, that the lumber business became a great and necessary factor.

Massachusetts forests have not been able to help in a large way as have those of many of her sister States. Of airplane spruce and ship timbers we have but little. However, our forests are doing their bit, and all that our State can furnish is needed.

White Pine.

White pine is our most important species. Its chief market has always been for box boards. The war has brought about a great increase in this demand. Most of our munitions have to

issued since the government took over the railroads. They are appended herewith. A maximum price has been fixed which applies to all lines in New England. Not all the roads are now paying the maximum price or buying all classes, but it is expected that before long they will. All ties must be sold to the road on whose lines they are delivered. They cannot be shipped from one road to another. It is intimated that the railroads will do the buying for the trolley lines. Hard times have hit the trolley lines, anyway. Many have been discontinued, and the rest are doing as little in the line of construction and repair as possible. Therefore the market for the small trolley ties seems to be poor. The new price for ties averages slightly higher than previously, but not in proportion to the increase in lumber. The price of the smaller ties is lower than it was previously on certain roads. The 6-inch tie with 5-inch face is no longer specified, and will not be taken except as a cull, price not known. The small tie is our mainstay from the point of view of utilization of our forests, and it is to be hoped that later on the Railroad Administration may rectify the matter of their price and size. Probably the reason for the low price is that the railroads want as few of the small ties as possible. Operators should take the hint and cut their production of small ties to a minimum. The smaller chestnut can be more profitably used as lumber, and at present prices of lumber the larger material also.

3. *Lumber.* — The chestnut lumber market is the promising feature of the whole situation. The almost universal disposition of chestnut lumber in Massachusetts before the war — that of sawing it $1\frac{1}{2}$ inches round edge for the chair factories — has been somewhat modified. The chair factories are still buying and paying good prices, but are not buying in increased amounts. In fact, their demand has slightly decreased. Chestnut has come into demand for box boards as a substitute for pine. For this purpose, it is sawed mostly 1 inch with some $\frac{5}{8}$ inch and $1\frac{1}{2}$ inches thickness. The price has been from \$2 to \$5 per M less than the price for pine, while a little mixed with the pine has been accepted without price reduction. Not all box shops will buy chestnut, but an increasing number will. In this way it is possible to utilize trees which will make only

small ties, or which will be too small to make ties at all. Some operators have been cutting chestnut down to 4 inches, but that is not advisable if a sure market for the lumber is desirable, 6 inches being a safer minimum diameter.

There is a good demand for the better grades of chestnut squared up from the butt, and good second logs. This lumber is being sold in place of the southern chestnut, graded No. 1 and No. 2 common. In thicknesses of 1 inch, 1½ inches, 2 inches and thicker, 6 inches and up wide, it is commanding a price of from \$40 to \$55 per thousand feet delivered. Care should be taken, however, to saw this material full to thickness, so that it will dry to those sizes; also it must be stuck and dried properly. This material is used for coffins, finish, furniture, cabinet work, piano cases, construction, etc. Even higher prices might be realized if great care in sawing and grading is exercised. Wormy material cannot be sold in this class, nor can it be sold extensively for chair stock. Railroad ties and box boards are the best market for wormy chestnut. Some wormy lumber can be sold square edge, if it is sound, at a lesser price.

Some chestnut has been used for ship timbers, but it is doubtful whether that demand will continue.

Oak.

Oak is fast disappearing from the eastern section of the State, due to the gypsy moth. However, it is our most important hardwood tree, and in extensive demand at this time. The chief uses may be classified as follows: —

1. *Piling.* — White and red oak are in constant demand for piling. White oak is specified in some cases, but usually either may be used. The prices have ranged from 25 cents to \$1 (for very large sticks) per running foot for the piles delivered. About all the larger piles must be from 7 to 8 inches diameter at the small end, and from 14 to 20 inches at the butt. Lengths run from 30 to 60 feet. All must be fairly straight and thoroughly sound. The chief difficulty with piling is in handling, as it requires special knowledge and equipment. It is not advisable to cut piles except on order, as they rapidly deteriorate.

and wagon manufacture chiefly. Cherry can be sold for chairs and furniture. There is a special war use for cherry, — airplane propellers, — but it takes a very high grade.

Cordwood.

Cordwood for fuel has been one of the great features of the past year. The price last February was as high in isolated instances as \$12 to \$13 a cord on the cars and \$20 delivered. The price has now settled to about \$8 to \$10 a cord on the cars. It cannot go much lower than that with the present cost of labor and teams. We doubt very much whether there will be any such demand this winter as there was last, as there is much more wood cut. Very few of the woodland owners profited by those high prices last year. It went largely to the dealers and speculators. The market for chestnut wood is rather difficult. A limited amount can be sold from \$1 to \$2 under the price of hardwood. There is always a good demand for slabs and edgings for kindling wood. Owners should keep on cutting cordwood, but without the expectation of enormous profits. There is bound to be a good demand, and also a reaction after the present fuel crisis.

Labor.

The most difficult problem to-day for those wishing to produce lumber or wood is that of labor. It has steadily increased in cost, decreased in efficiency, and is now hard to find at any price. The cost of operating is surely double what it was three years ago, and the difficulties of operating are increased many fold. This must be borne in mind when the present high prices of products are considered. Labor is bound to get more scarce as the war continues.

Stumpage Value.

The value of lumber and wood stumpage of all kinds has unquestionably gone up in the last year. Pine lots have been sold as high as \$20 per M on the stump, and cordwood as high as \$4 per cord. Those prices are undoubtedly war prices, and will not last for long. However, pine stumpage is worth from \$10

to \$15 now, according to quality and location, for lots within a two-trip haul of the railroad, and will probably never go far back from those figures. More distant lots, or very small or difficult lots, are worth less than that. Chestnut, hemlock and spruce are worth from \$2 to \$3 less. Hardwood has about half of the value of pine. Oak and ash are worth more than pine.

Government Control.

The chief energies of the nation are to-day centered on the war. The government is slowly but surely heading all our forces so that they may directly contribute to the winning of the war. The lumber business must be prepared to do its share, if not voluntarily, then perhaps under government control. The recent embargo on the shipment on the railroads of all lumber and forest products is probably a step toward that end. It is now impossible to ship forest material (cordwood not included) on the cars without a permit, except to the government or to the railroads. At this writing the cause and effect of this embargo are not known. It may last for the duration of the war. Its effect will undoubtedly be to check the production of lumber for unnecessary uses, its shipment long distances, and the hoarding of lumber supplies. It will certainly stimulate the production of lumber for direct government use, and may result in lower prices and lessened production. The lumber producer must be prepared for anything. It is no time for speculation. Forest products are vital at this time, and the government will do nothing to hinder their production, but it will probably guide this production along necessary channels.

The Need of Forestry at the Present Time.

There never was a time when the need of forestry, of forest conservation, was greater than it is at present. We are undoubtedly, due to the impetus of the war, overcutting our forests, especially our pine forests here in Massachusetts; that is, we are cutting the lumber faster than it is growing. That means a shortage of lumber later, and the loss of wood-using industries which will go where they can get the raw material. Furthermore, we are cutting destructively, with no idea of the

United States Railroad Administration.

SPECIFICATIONS FOR CROSS TIES.

GRADE NO.	Squared.	Flatted.
1,	- -	6 x 6 inches.
2,	6 inches thick, 7-inch face, . . .	6 inches thick, 7-inch face.
3,	6 inches thick, 8-inch face, . . .	{ 6 inches thick, 8-inch face. 7 inches thick, 7-inch face.
4,	7 inches thick, 8-inch face, . . .	7 inches thick, 8-inch face.
5,	7 inches thick, 9-inch face, . . .	7 inches thick, 9-inch face.

Maximum Prices.

	Grade 1.	Grade 2.	Grade 3.	Grade 4.	Grade 5.
White oak,	\$0 60	\$0 70	\$0 95	\$1 20	\$1 35
Chestnut,	50	70	90	1 10	1 10
Red oaks,	40	50	75	1 00	1 10
Beech, birches, hard maples, . . .	40	50	75	90	95

Ties 8 feet are 6 per cent. less in price than above.

Quality. — All ties shall be free from any defects that may impair their strength or durability as cross ties, such as decay, splits, shakes or large or numerous holes or knots.

Manufacture. — Ties ought to be made from trees which have been felled not longer than one month.

All ties shall be straight, well-manufactured, cut square at the ends, have top and bottom parallel, and have bark entirely removed.

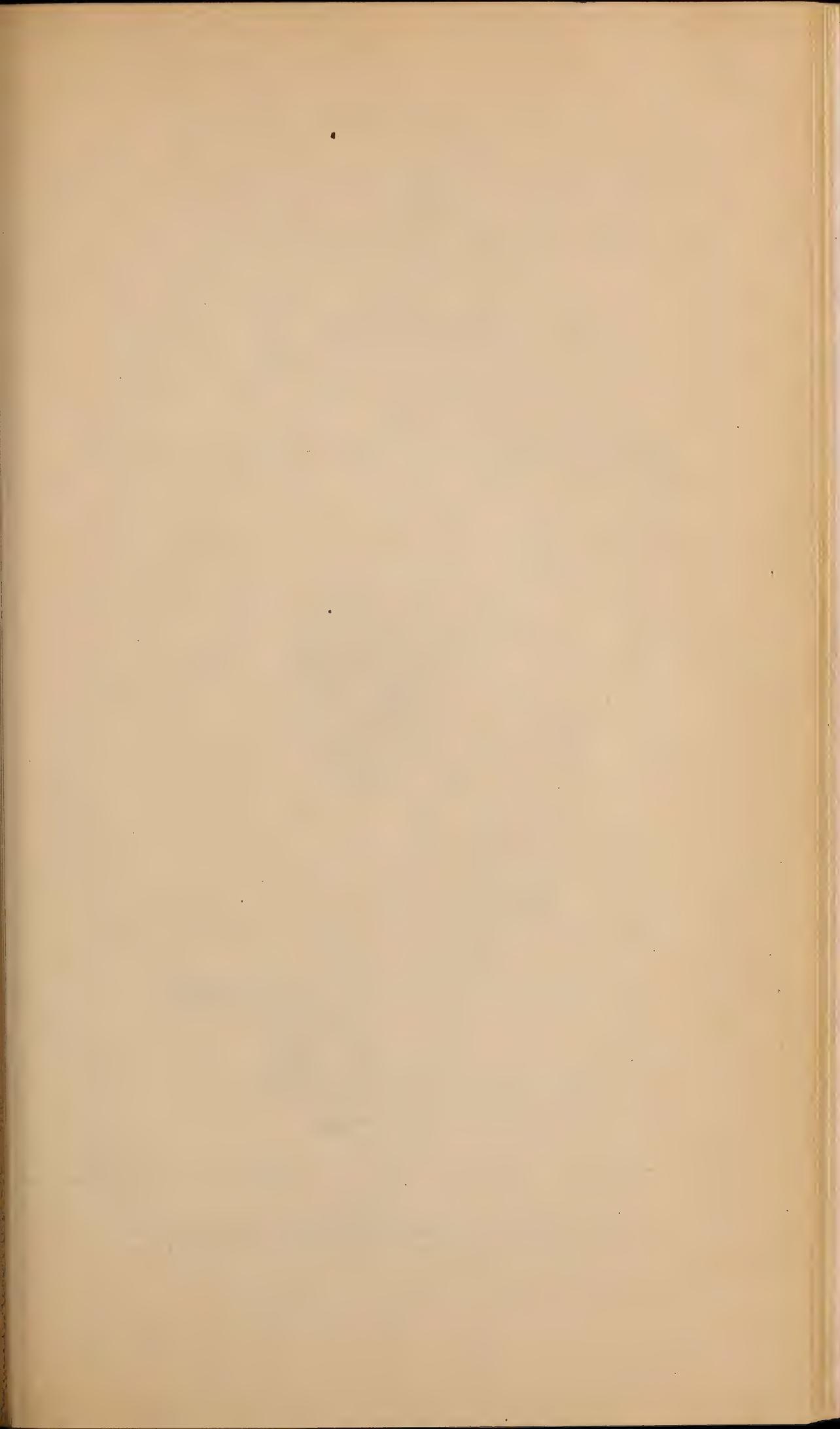
Dimensions. — All ties shall be 8 feet 6 inches long.

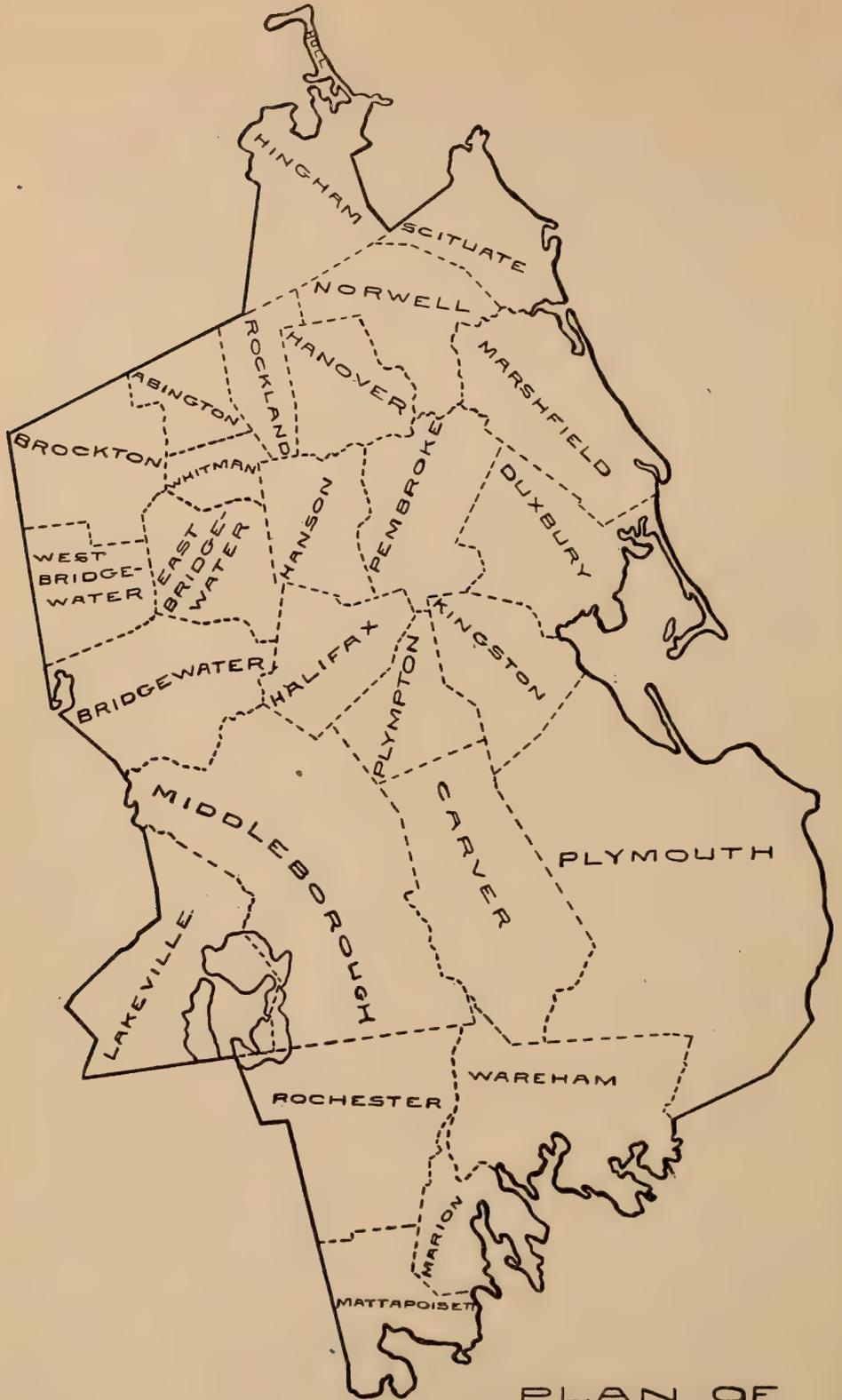
All ties shall measure both sections between 20 and 40 inches from the middle of the tie; and dimensions given are minimum.

Ties over 1 inch more in thickness, over 3 inches more in width, or over 2 inches more in length will be degraded or rejected.

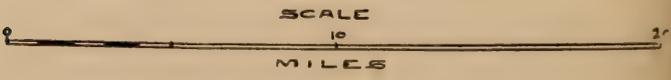
The top of the tie is the plane farthest from the pith of the tree, whether or not the pith is present in the tie.

Delivery. — All ties ought to be delivered to a railroad within one month after being made.





PLAN OF
PLYMOUTH COUNTY



THE FORESTS OF PLYMOUTH COUNTY

The Results of a Forest Survey OF THE Twenty-seven Towns in the County

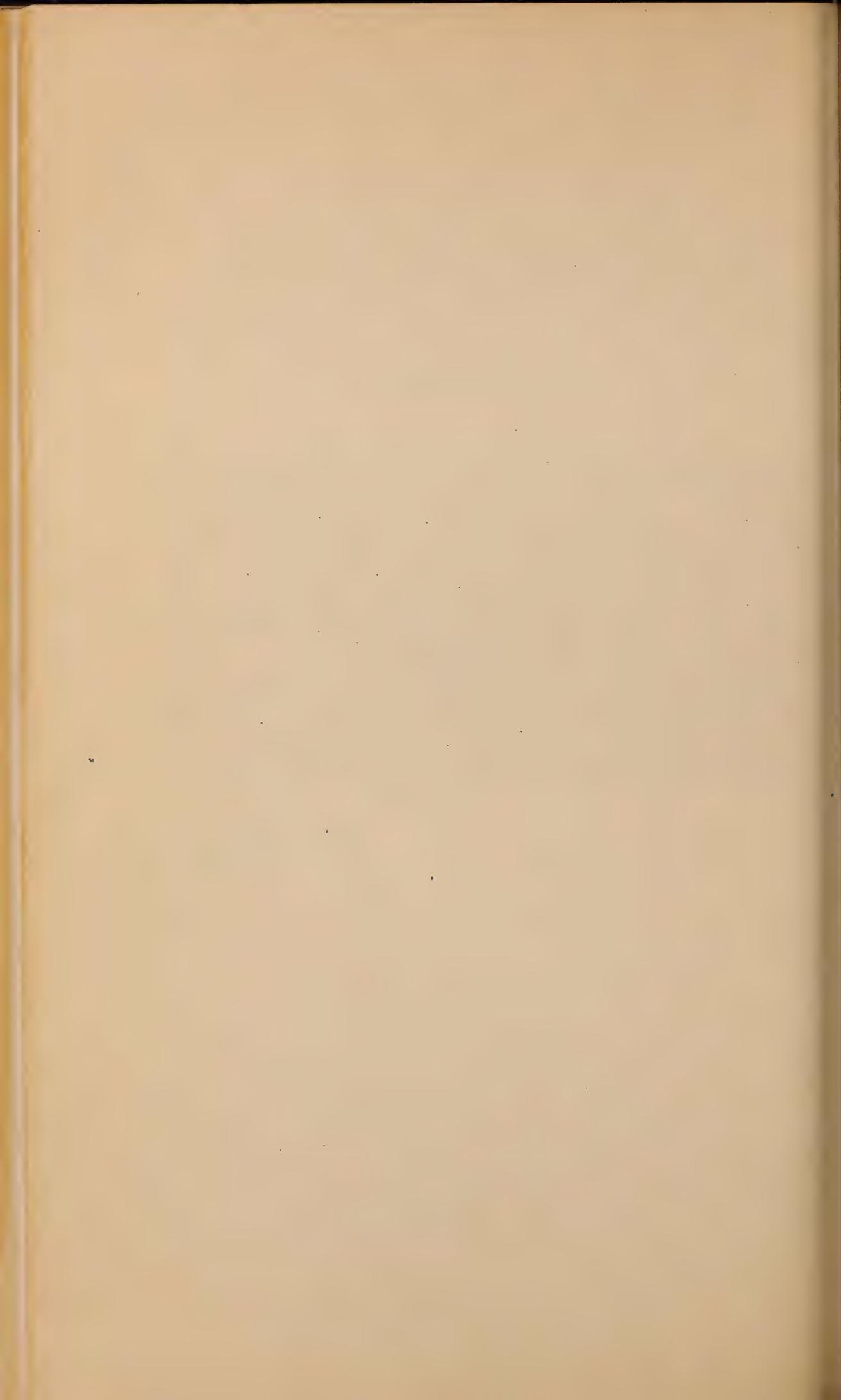


By JAMES J. MORRIS

Under the direction of F. W. RANE, State Forester

MASSACHUSETTS STATE FORESTER, 1918

BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
32 DERNE STREET
1918







Plymouth County saw mill.

THE FORESTS OF PLYMOUTH COUNTY.

EXPLANATION OF SURVEY.

The survey of the several towns of Plymouth County is the second work of this kind attempted by the State forestry department. The other survey, that of Worcester County, was carried on at odd times, and extended over a period of three years. The data were collected and published last winter in the form of a bulletin, which was entitled "The Forests of Worcester County."

In the Worcester County bulletin the reasons for making forest surveys of the different counties of Massachusetts were explained in detail, but it will not be amiss here to review briefly some of the main reasons.

Every manufacturing concern or business of any kind at some time or other takes an inventory of its stock. Without such an inventory no business can be carried on to the best advantage. The stock, or raw material, of forestry work is forest land, and since the State forestry department of Massachusetts is just what its name implies, the raw material with which this department must deal is the forest lands of Massachusetts.

If the woodlands of Massachusetts were made up of but one or two species of trees, or if the various species of trees were all of the same height or diameter size, this inventory would be a comparatively simple matter. But such conditions do not exist. Scattered throughout the State are many different kinds of trees differing greatly in importance, value, life habits, etc., from each other. Moreover, since the woodlands have been repeatedly cut over at different times for many years, we find existing a variegated collection of trees of all sizes and conditions; in fact, nearly every woodlot differs to a greater or less extent from others.

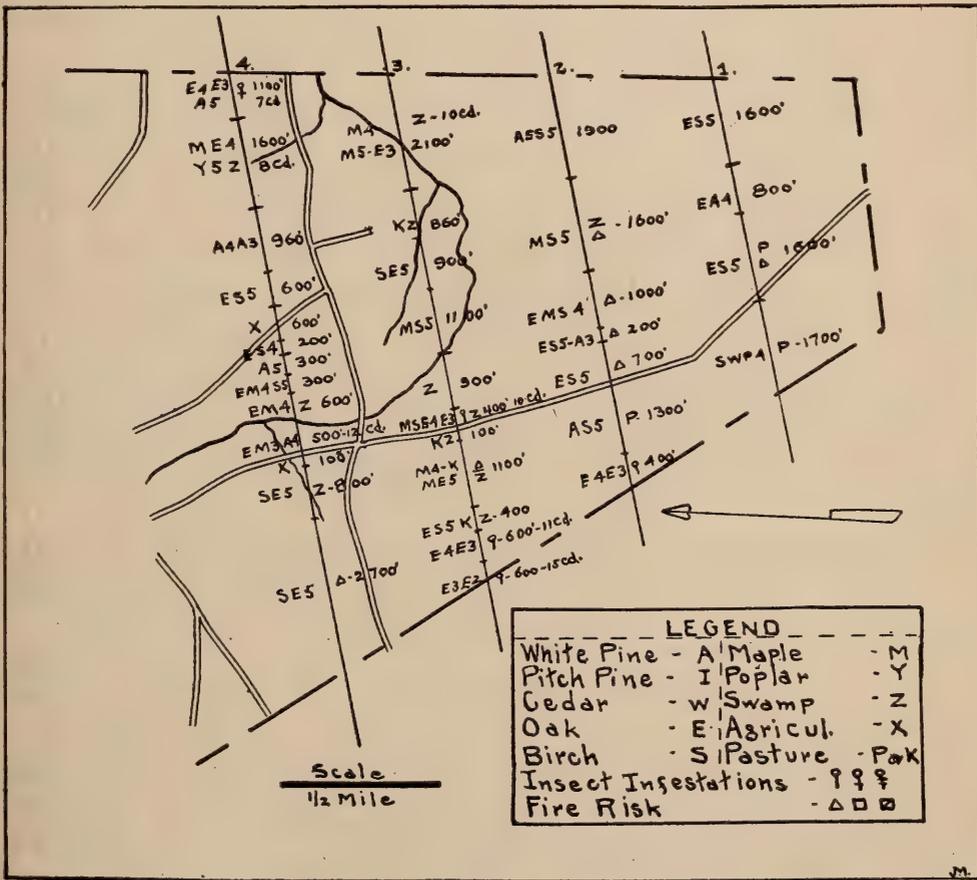
METHOD OF SURVEY.

In Worcester County each town was covered by one man, who did all the field work. In Plymouth County the men worked in a crew, each man covering a certain assigned section of the town which was being mapped. When one town was finished the men moved on to the next. There were several distinct advantages in this arrangement. Since the men camped in tents it was possible for them to choose a central location for their camp site and thus save time, inasmuch as in going to and from their work they were not obliged to cover the same ground as they would have been had they stopped at a farmhouse or hotel in one corner of the town, as was often the case in Worcester County. The cost of the survey was also lighter, the only expense incurred being for foodstuffs, since the men and camp equipment were moved from place to place by one of the department trucks.

For the main part, however, the methods followed in making this survey were similar to those followed in Worcester County. The men worked by compass and pace, using a copy of the United States topographical map as a guide map for each town. Each man would start at some convenient point on a road or edge of a pond and run a straight line through to the town line and then back to the opposite town line on a course parallel to the first, but one-half mile distant. Care was taken when laying off these parallel lines to have them cut the roads so far as possible; that is, if the majority of the roads in a certain town ran in an easterly and westerly direction the strips were run in a northerly and southerly direction, or *vice versa*. Cutting the roads in this manner enabled the men to get a truer idea of the actual forest conditions, and it was possible to obtain a more accurate average, because if the strips were run in the general direction of the roads some of them would parallel the roads, and since in most cases the type found along the roadsides, which is largely tillage, is not typical of the land lying a few hundred feet farther in, the data obtained in this way would not be trustworthy, as the lines would show an amount of farm and tillage land out of proportion to actual conditions.

For convenience and brevity in the field, symbols representing the various types, diameter classes, moth infestations, etc., were used. These symbols are somewhat similar to those used in the previous survey. The map work of each town has been completed, and photographic enlargements of the topographical maps used as a base are to be found at the office of the State Forester. These maps show the strip lines which were run in each town, and contain a symbolic explanation of the different types, size classes, etc. Tables containing summaries computed from the information obtained from the field work are contained in this bulletin.

The following diagram may serve to illustrate the method used in making this survey:—



Map of northern section of Rockland, showing method of survey.

Lines 1, 2, 3 and 4, running approximately east and west, represent strip lines one-half mile apart. On Line 1, and near the top of the plate, are the symbols "E S 5, 1600'." Consulting the legend we learn that along this line for a distance of

1,600 feet were found oak and birch of sprout size in mixture, the number 5 representing the size class. Oak predominates, since the letter "E," representing oak, precedes the letter "S," representing birch.

FOREST TYPES.

On account of the difference in topographical and climatic conditions, the types of Plymouth County vary to a considerable extent from those of Worcester County. Following is a list of types used and a brief explanation of each:—

White Pine.—This type consists of white pine in pure stands, that is, in stands made up of 80 per cent. or more of the one species. There is still a considerable amount of this type found throughout the county in spite of repeated cuttings and fires. It may be safely stated that there are several million feet of this type of good merchantable size, although it is somewhat scattered and found as a rule in stands of small areas.

Pine and Oak.—Stands of this kind are made up of 70 per cent. or more of white pine and oak in mixture. It is a common type. Sometimes the proportion of oak is greater than that of pine, while at other times there is about an equal amount of each. In all cases, however, the oak and pine in combination form at least 70 per cent. of the total stand, the remainder being made up of maple, pitch pine and unimportant hardwoods. This type is generally found on the higher gravelly lands.

Pine and Maple.—Substituting maple for the oak, this type is similar to the preceding. It is not so common as that of the pine and oak, and is generally found in low or swampy lands.

Oak.—This forms the largest type. It embraces stands made up of 80 per cent. or more of oak. A very large proportion in size class 5 is made up of the so-called scrub oak. More than one-half of the total for the county is of a diameter size too small for cordwood. There is, however, a considerable amount large enough for saw-logs.

Maple (Swamp Type).—Consists of nearly pure stands of maple. This type is found on low, wet land, and is fairly common. A good proportion is made up of species of cordwood size, with a moderate representation of the larger size classes.

Pitch Pine Type.—Next to the oak this is the largest indi-

vidual type found. It is found in all size classes, but more than 50 per cent. consists of the No. 5, or smallest, class. It is often found in pure stands, but generally contains some other tree in mixture. Scrub oak is its most common associate.

SIZE CLASSES.

In the Worcester County survey but four size classes were used. As an experiment it was decided in the Plymouth survey to split the No. 4 size in two, thus forming five size classes, and differentiating the small brush from saplings. Except for forestry purposes, such as determining more exactly the type of land on which planting might be done without preliminary brushing, the result does not warrant the distinction. Following is an explanation of the various classes:—

No. 1 forms the largest size class, and contains species whose diameters breast high average 10 inches or better, and whose height will average 60 to 80 feet.

No. 2 represents trees whose average diameters run from 8 to 10 inches, and whose height will average about 50 to 70 feet.

No. 3 constitutes the cordwood size, and species of this class average about 5 inches in diameter and 40 to 50 feet in height.

No. 4 embraces saplings and small cordwood, or thrash. Trees falling in this diameter class average about 2 inches in diameter and 30 to 40 feet in height.

No. 5 is formed of very young sprout or stunted growth, such as scrub oak, stunted pitch pine, etc. In no case do the diameters run higher than 2 inches.

NON-FOREST TYPES.

Tillage and Hay.— Land covered by this heading is all under cultivation. Included in this type is all the farming and agricultural land, with the exception of pasture and cranberry bogs.

Pasture.— In the Worcester survey much land which could not be classed exactly as No. 5 forest type, owing to the small amount of wood growth on it, and yet which was not actually used as grazing land, was classed as brush pasture.

In this survey the heading "Pasture" includes only such lands as are actually used as such. This accounts to a certain

extent for the great difference in the pasture totals of Worcester and Plymouth counties.

Water. — All inland waters fall under this classification: ponds, lakes, rivers and brooks. The figures are a little lower than those of the Waterways Commission, but considering the necessarily rough method in which they were obtained the results are very satisfactory.

Residential. — This term explains itself. It also includes business sections, cemeteries, fair grounds, etc.

Cranberry Bog. — Much of the low, mucky lands along streams is suitable for the raising of cranberries, and advantage has been taken of this fact. The area covered by these bogs, although almost negligible as compared to the total area of the county, is, nevertheless, worthy of mention because of the importance of the product.

Marsh. — This term has been used to cover two distinct types. In seacoast towns it applies to salt marsh, while in inland towns it covers the open swamps.

PLYMOUTH COUNTY.

Plymouth County lies in the southeast corner of Massachusetts, just north of Cape Cod. It contains approximately 440,000 acres. Plymouth, a town of about 13,000 population, situated on the coast in the central and eastern part, is the county seat. Brockton is the commercial center, and is important from an industrial standpoint. Other important towns are Middleborough, Whitman, Bridgewater and Rockland. All of these towns contain manufactories of various kinds, principally shoes.

In the western part the Cape Cod branch of the New York, New Haven & Hartford Railroad runs in a northerly and southerly direction the entire length of the county, while another branch follows the eastern coast line as far south as Plymouth. A line of the same road running east and west connects Plymouth and Middleborough, and in the north a connecting line runs to Plymouth. Electric roads traverse the county in various directions, connecting all the principal cities and towns. On the whole, it may be said that the railroad facilities in the county are good, except in the southern part.

The products of the county are many and varied. Among the most important may be mentioned shoes, rope, cotton cloth, rubber products, boxes, crates, shooks and shoemaking tools.

The important farming products are hay, potatoes, cranberries and miscellaneous vegetables. Dairying is not now a very important industry, and is becoming less so year after year. Stock and poultry raising is practiced to a slight extent.

Along the seashore are many fine summer resorts. Hundreds of fine residences have been built, and these resorts are constantly attracting people in larger numbers to enjoy the ocean scenery for which the shores of eastern and southern Plymouth County are justly famous.

Topography and Soils.

Running practically the entire eastern length of the county, along the coast, and extending inland roughly about 5 miles, is a strip of rolling, knobby land with basin-like intervalles. The hills are mostly rounded, irregular of distribution, and in very rare cases rise beyond 100 feet in altitude. This strip is made up of a terminal moraine, and is more rugged than the other sections of the county.

The remainder, which means practically the whole of the county, is made up of a level to gentle rolling topography. The elevation of the hills ranges from 100 to 200 feet. Numerous ponds abound, among the principal of which may be mentioned Assawompsett, Long Pond and Quittacas, all situated mainly or in part in the town of Lakeville. Several swamps of large areas also occur, the Great Cedar Swamps of Bridgewater and Middleborough being the most important.

The drainage of the county is effected mainly through several small rivers and their tributaries. The Weweantic River drains to the south into Buzzards Bay. The Taunton River, emptying into Mount Hope Bay, drains part of the western and central areas. Weir and Fresh rivers are the principal streams in the north, while North, South and Jones rivers drain to the east. Other important streams are the Mattapoissett, Wankinco, Agawam and Sippican. Many of the ponds and lakes throughout the county have no apparent outlet, and it is possible, par-

ticularly so in the eastern section, that they empty into the ocean through a subterranean flow which drains to a considerable extent the whole country.

Monk's Hill in Kingston is the highest elevation in the county.

The soils of the northern part of Plymouth County are mostly a light to heavy fine sandy loam, with outcroppings of granite, gneiss and schist. Much of this soil is forested, but that which is cultivated produces good and various crops. The sandier and stony types are found mostly in pastures.

Although the larger part of the soils of the central and southern sections are also sandy loam, they are coarser than those of the northern section, and carry a considerable amount of gravel and fine pebbles. Through Plymouth, Wareham and Middleborough deposits of muck occur. This soil is used extensively for growing cranberries, and, as shown in the tables, quite a sizable area is under cultivation.

Forest Conditions.

In the reports of the overseers of the earlier Plymouth County settlements reference is often made to the forests, but such references contain very scanty information as to their composition. It is probable, however, that at the time of the landing of the Pilgrims the greater part of the county was forested with large and thrifty virgin stands of white and pitch pine, oak and maple, — pine in uplands, oak and maple in lowlands.

We know that much of the pine was cut and shipped to England to be used for masts for the English navy, and also that England depended to a large extent upon New England pitch pine for her naval stores.

The original forest types exist to-day, but in a much depleted condition. Over large areas fires have swept repeatedly, burning off the humus — the forest floor covering — and greatly impoverishing the soil in many sections. From these fire-swept areas the original white or pitch pine stands have disappeared, and in their places are growths of scrub pitch pine and oak.

Throughout the greater portion of the county, however, white pine can be grown, and areas now given over to scrub oak should be reforested. On the sandier areas Scotch and good

grade pitch pine could be grown with success. In fact, reforestation has been carried on successfully in nearly all parts of the county. The State Forest Commission has recently acquired a tract of several thousand acres of land in the town of Carver, and this department is planting large quantities of white and Scotch pine there every year.

As mentioned above, white pine of good grade is still found in fair quantities and in pure stands distributed throughout the county.

It may be well to regard briefly the distribution of the various types. Practically all of the types are universally distributed, and in nearly every case all of the various size classes are found in each town.

The towns of Bridgewater, Hingham and Pembroke contain the highest percentages of white pine, while Abington, Plymouth, Rockland, Wareham and West Bridgewater contain the smallest. Good stands of the first quality may be found in all the towns, but Whitman, Scituate, Abington and Hanover are poorest in this respect. It may be stated here that these towns contain very little of the best quality of any of the different types.

Plymouth shows the highest proportion of forested land (82.5 per cent.), but there are several other towns containing 70 per cent. or more of forest growth. These towns are Carver, Hanover, Hanson, Kingston, Lakeville, Marion, Mattapoisett, Middleborough, Norwell, Pembroke and Plympton.

Brockton, Hingham, Marshfield, Scituate and Whitman have the smallest percentages of wooded areas.

The best oak is found in largest proportional quantities in Marion, Mattapoisett, Middleborough, Plymouth, Rochester and Scituate.

Maple is found mostly in cordwood sizes, but stands of first-class stock may be found in Lakeville, Marion, Mattapoisett, Middleborough, Norwell, Pembroke, Rochester and Scituate.

The best stands of pitch pine occur in Carver, Duxbury, Kingston, Mattapoisett, Marion, Plymouth, Rochester and Wareham, all seacoast towns with the exception of Carver and Rochester, which are sandy plains.

Of the non-forest types West Bridgewater contains the highest proportion of agricultural land. Others of the larger culti-

vated areas are Bridgewater, East Bridgewater, Hanover, Hingham, Scituate and Whitman.

Brockton and Whitman contain the largest proportional residential areas, although Plymouth and Middleborough have actual residential areas larger than Whitman.

Abington, Whitman and Hingham contain the largest proportional amount of pasture land.

Marshfield, Marion and Carver have large amounts of marsh land, Marshfield, as the name suggests, having by far the greatest area of this salt marsh.

The largest and best cranberry bogs are found in Carver and Wareham, while Lakeville contains more actual water area than any other town in the county.

Moth Infestation.

Since Plymouth County contains such a proportionately large amount of oak as compared to other sections of the State, we would naturally draw the conclusion that the moth infestation must be exceptionally large. This, however, is not true. Conditions here, with the exception of the town of Plymouth, are not much worse than those throughout the eastern part of Massachusetts, and at the present time the moth situation is such that, with careful supervision and a reasonable expenditure of money for spraying purposes, it may be kept well under control.

There are, however, large tracts of land forested with oak of poor quality, not large enough for cordwood and with little chance of being so for some years to come, that present a serious problem. These lots, most of them located in the southern part of the county, are situated far away from the centers, and on account of the poor quality of the wood, and its distance from a market, spraying is out of the question because of the expense entailed. These lots should be clean brushed and reforested with white or Scotch pine. The State forestry department has not at the present time the money to do this work, and anything that is attempted along this line must be done by the owners of the lands in question.

Forest Fire Protection.

The destructive fires which have raged over the entire Cape country, including the southern part of Plymouth County, have caused very serious damage to forest growth. Indeed, fire has been the most serious enemy of timber propagation in this section. The geographic location of this part of the State, together with the high winds which prevail at certain periods of the year, are conditions which make each small brush fire a potential holocaust.

This fire menace has been recognized for a long time by the residents of the Cape counties and by the State Forester's department. A fire tower was constructed in Plymouth by that town in 1905. In 1911 the office of State Fire Warden was established, and since then towers have been erected on high points in the towns of Kingston, Hanson, Hingham and Middleborough. These towers, with the addition of that in Bourne in Barnstable County, now cover the entire area of Plymouth County, and statistics from the State Fire Warden's reports show that the fire damage in this section has been reduced about 75 per cent. since their erection.

Forest Industries.

The shoe manufacturing and cranberry raising industries require very large amounts of wood in the manufacture of boxes, crates and barrels for the shipment of their products. Practically all of the wood used is obtained from the county. In nearly every town may be found mills which saw 100,000 board feet or more of pine and oak each year. Many of these mills turn out the finished product, — boxes, crates or barrels, as the case may be, — but a considerable number simply supply the boards, while others deliver their product in the form of shooks. The logs in almost all cases are cut short and bought locally by the cord, and are sawn into $\frac{5}{8}$ -inch boards, which is the standard dimension for box boards.

In addition to the manufacture of boxes, etc., several of these sawmills do custom work, but there is nowhere near so much of this done now as in former years.

In one important respect the sawmills of Plymouth County differ from those located in other parts of the State. They are

permanent. Logs are hauled to them by truck or shipped by rail. Were it not for the many destructive fires, the fact that these mills are permanent ones might have had a powerful effect in influencing the forest types.

Before a portable mill owner sets up his mill on a lot he must be sure that there are at least 200,000 feet of stock in the immediate vicinity that he can cut. Moving and setting up his mill to cut under that amount would hardly pay him unless the stock was exceptionally good.

When large tracts of land are cut over a change in forest conditions naturally results. New species, generally hardwoods, take the place of the old. These hardwoods, which grow very rapidly during their earlier years, shade and choke out the young reproduction of the conifers recently cut, and after a few years a stand of hardwoods, often of inferior quality, occupies the land formerly forested with pine or other valuable trees.

Where the mills are permanent, as in Plymouth County, the owner of a woodlot is not obliged to cut his lot clean. He can take out a few trees one year, haul them to the mill, and the following year cut out a few more.

When a stand is cut gradually in this way the type undergoes no serious change, since the reproduction is generally the same as the original trees.

To sum up the whole thing in a few words, permanent mills foster a system of selective cutting, and have a tendency to preserve the original species and types, while portable mills in many cases, through clean cutting, bring about a decided change in both.

Poplar makes an ideal wood for staves, and as an experiment the State Forest Commission has set out about 40,000 poplar cuttings on the State reservation in Carver.

White pine is the species most used in the manufacture of box boards, but of late years pitch pine is being substituted to some extent.

Stock for barrel staves is in some cases shipped from outside the State, some of it being loblolly pine from Virginia. Much of the stock, however, is obtained locally, and consists of pine and poplar with oak and maples for headings. Oak is used in the manufacture of piling and mine props. These products are used in the construction of docks, wharves, etc.

No attention has been given to cedar in the various tables,

but nevertheless quite a little of this species is found in isolated sections of the county, and generally in swamps. This wood is used in the manufacture of shingles, and on rare occasions for barrels. It is also used for posts and poles.

The manufacture of lobster pots may be classed as a special industry. Oak and white pine are used in this product, and there are several concerns engaged in their manufacture.

Some years ago charcoal was produced in large quantities in various parts of Plymouth County. This industry has practically disappeared. Last year this department undertook the manufacture of charcoal as an experiment in the town of Mashpee. The lot was made up entirely of oak of poor quality and small size class, and the wood was too far away from a market to be put profitably into cordwood. Three pits were maintained, and about 40,000 bushels of charcoal were produced. It was thought that charcoal made from oak would not sell readily, but no trouble was experienced in disposing of the entire production in near-by towns; in fact, double the quantity could easily have been gotten rid of. In this experiment about 40 bushels of charcoal were produced from each cord of wood.

Mashpee is not a town in Plymouth County, and therefore these remarks are somewhat irrelevant, but they are made because of the fact that scattered throughout Plymouth County are hundreds of acres of scraggly oak and pine too far away from a market to be cut profitably for fuel, which the results of the experiment cause us to believe could be burned for charcoal and disposed of for at least a small profit. So far as we know there is but one man in the county engaged in the manufacture of charcoal at the present time. A bulletin containing more detailed information in regard to this experiment will be issued from the office of the State Forester in the near future.

Other forest products of Plymouth County are pin wood, mallet heads, ship timbers, wagon stock and hardwood rollers.

In this bulletin is included a list of the sawmill operators of the county, which gives information regarding their production, stock used, etc. This list is as complete as it was possible for us to make it in the limited time we had at our disposal.

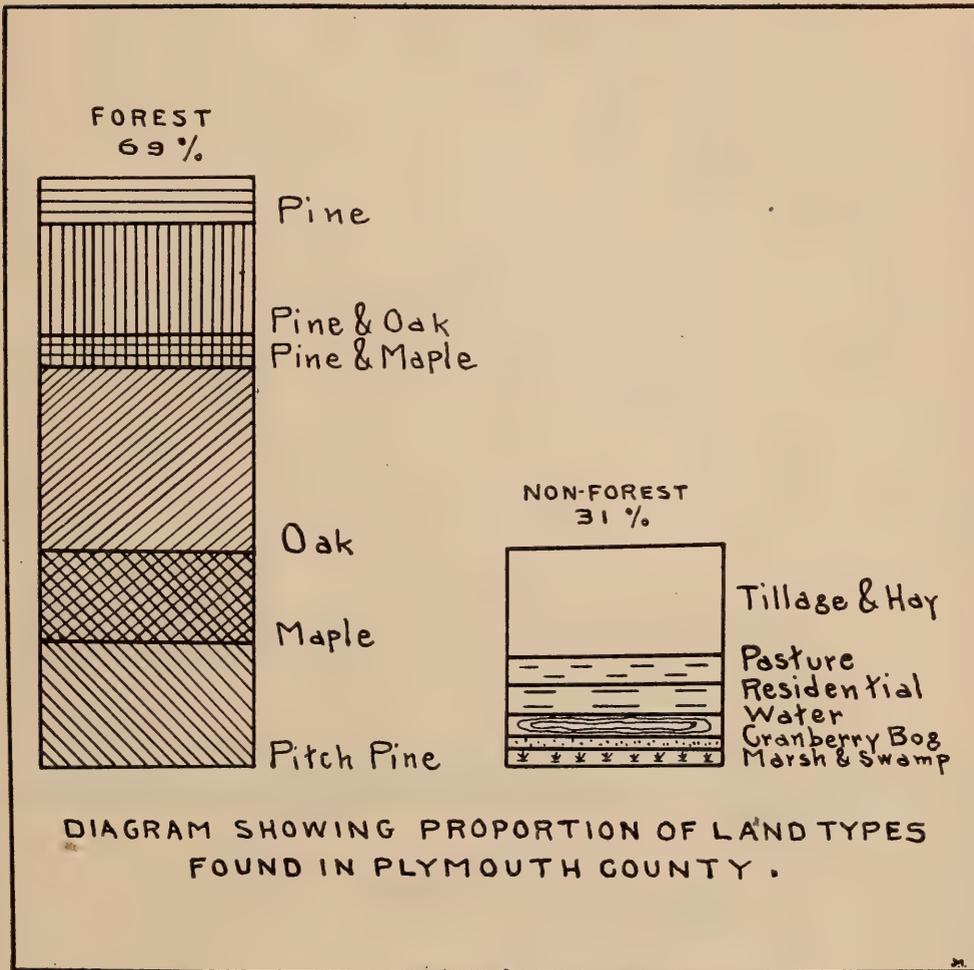
Following are the percentage sheets of 26 towns in the county. The town of Hull was not considered at all in making the survey, as there is not enough wood growth there to war-

rant it. These tables show the proportion of forest land to non-forest land, and also the relative proportions of the individual types of the forested areas. The tables alone could not be made to show the proportion of the separate type size classes, so they have been supplemented by diagrams from which may be formed an idea of the relative amounts of merchantable and non-merchantable timber of each type in each town. In these diagrams the proportion of non-merchantable sizes is represented by the inked portion of each line.

In arranging these diagrams size classes 1 and 2 of the white pine and pitch pine types were combined and classed as merchantable, while in the remainder of the types classes 1, 2 and 3 were combined and classified in the same way. The remainder of the size classes was combined in each type and classed as non-merchantable. It will be noticed from this explanation that in the case of the hardwoods and mixed hardwoods and pine, class 3, or cordwood class, has been listed as merchantable, while in the case of the pines only classes 1 and 2, containing lumber large enough for saw logs, were so listed.

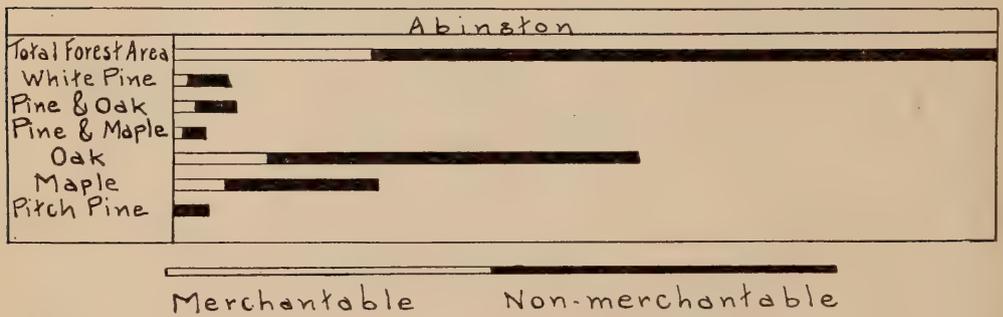
FOREST TYPES AND ACREAGE IN 26 TOWNS IN PLYMOUTH COUNTY.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	4,184	5,862	6,439	3,747	2,126	22,358	7.4	-
Pine and oak,	6,612	8,678	18,529	15,004	8,930	57,753	19.0	-
Pine and maple,	2,362	3,654	5,613	3,593	836	16,058	5.3	-
Oak type,	5,337	9,956	24,615	30,669	24,321	94,898	31.2	-
Maple type,	1,101	6,282	15,048	19,215	5,652	47,298	15.5	-
Pitch pine type,	1,879	4,126	8,501	11,271	39,991	65,768	21.6	-
Total,	21,475	38,558	78,745	83,499	81,856	304,133	-	69.1
Per cent.,	7.1	12.7	25.8	27.5	26.9	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						67,612	-	15.3
Pasture,						16,607	-	3.8
Residential,						18,565	-	4.2
Water,						14,101	-	3.2
Cranberry bog,						8,550	-	1.9
Marsh,						10,998	-	2.5
Total area of 26 towns,						440,566	-	100.0



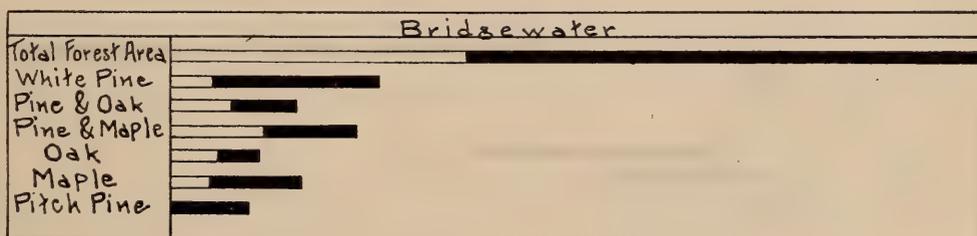
ABINGTON.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.								
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	-	50	56	63	-	169	4.6	-
Pine and oak,	-	31	38	-	182	251	6.9	-
Pine and maple,	38	-	19	75	-	132	3.6	-
Oak type,	-	63	427	251	1,330	2,071	56.6	-
Maple (swamp type),	-	44	182	414	257	897	24.5	-
Pitch pine,	-	-	-	25	113	138	3.8	-
Total,	38	188	722	828	1,882	3,658	-	56.4
Per cent.,	1.1	5.2	19.7	22.6	51.4	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						1,263	-	19.5
Pasture,						702	-	10.8
Residential,						709	-	10.9
Water,						100	-	1.5
Marsh,						56	-	.9
Total area of town,						6,488	-	100.0



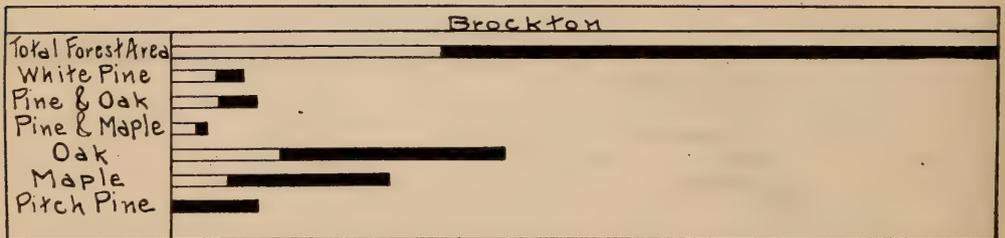
BRIDGEWATER.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	202	185	330	174	856	1,747	15.4	-
Pine and oak,	121	318	659	572	885	2,555	22.6	-
Pine and maple,	46	64	532	376	185	1,203	10.6	-
Oak type,	115	445	492	416	382	1,850	16.3	-
Maple (swamp) type,	40	162	625	1,319	752	2,898	25.6	-
Pitch pine,	-	-	23	87	972	1,082	9.5	-
Total,	524	1,174	2,661	2,944	4,032	11,335	-	62.9
Per cent.,	4.6	10.3	23.5	26	35.6	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						4,346	-	24.1
Pasture,						839	-	4.7
Residential,						544	-	3.0
Water,						515	-	2.9
Marsh,						434	-	2.4
Total area of town,						18,013	-	100.0



BROCKTON.

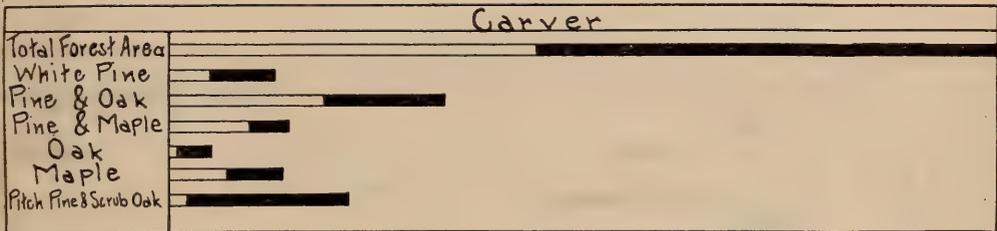
	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	130	161	78	52	150	571	8.5	-
Pine and oak,	114	161	171	192	62	700	10.4	-
Pine and maple,	-	83	150	-	52	285	4.2	-
Oak type,	130	228	638	830	907	2,733	40.5	-
Maple (swamp) type,	-	119	342	767	539	1,767	26.2	-
Pitch pine,	-	-	-	83	601	684	10.2	-
Total,	374	752	1,379	1,924	2,311	6,740	-	49.1
Per cent.,	5.6	11.1	20.5	28.5	34.3	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						2,411	-	17.5
Pasture,						716	-	5.2
Residential,						3,733	-	27.1
Water,						21	-	.2
Marsh,						124	-	.9
Total area of town,						13,745	-	100.0



CARVER.

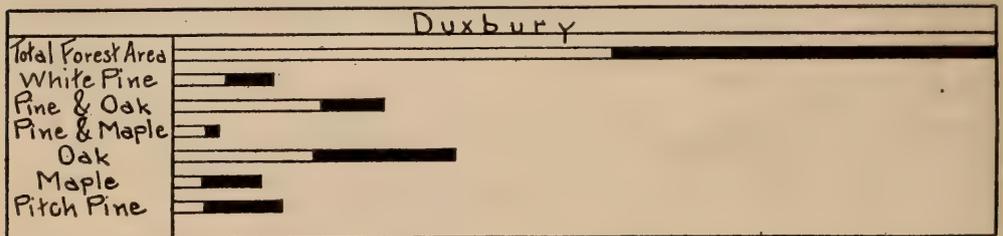
	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	302	604	685	705	-	2,296	12.4	-
Pine and oak,	-	1,281	2,260	2,621	-	6,162	33.2	-
Pine and maple,	163	1,016	846	622	-	2,647	14.3	-
Oak type,	36	24	65	812	-	937	5.1	-
Maple (swamp) type,	24	496	729	1,257	-	2,506	13.5	-
Pitch pine,	-	314	500	3,181	-	3,995	21.5	-
Total,	525	3,735	5,085	9,198	-	18,543	-	73.2
Per cent.,	2.8	20.1	27.4	49.7	-	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						1,667	-	6.6
Pasture,						667	-	2.6
Residential,						121	-	.5
Water,						761	-	3.0
Cranberry bog,						3,574	-	14.1
Total area of town,						25,333	-	100.0

Carver



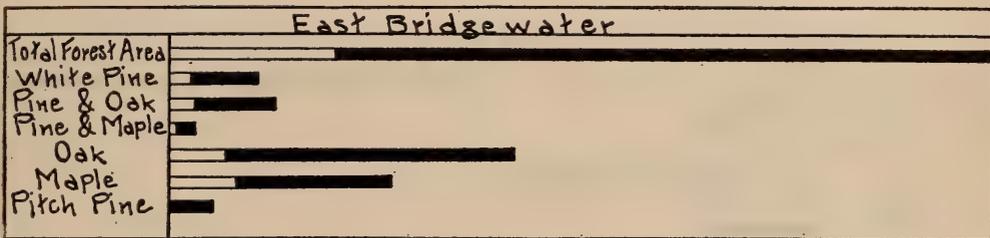
DUXBURY.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.								
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	444	233	391	42	127	1,237	11.7	-
Pine and oak,	317	550	1,004	581	222	2,674	25.3	-
Pine and maple,	63	95	275	127	-	560	5.3	-
Oak type,	254	412	1,216	1,164	560	3,606	34.1	-
Maple (swamp) type,	-	201	180	729	-	1,110	10.5	-
Pitch pine,	53	359	349	307	317	1,385	13.1	-
Total,	1,131	1,850	3,415	2,950	1,226	10,572	-	67.4
Per cent.,	10.7	17.5	32.3	27.9	11.6	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						2,729	-	17.4
Pasture,						784	-	5.0
Residential,						847	-	5.4
Water,						314	-	2.0
Cranberry bog,						408	-	2.6
Marsh,						31	-	.2
Total area of town,						15,685	-	100.0



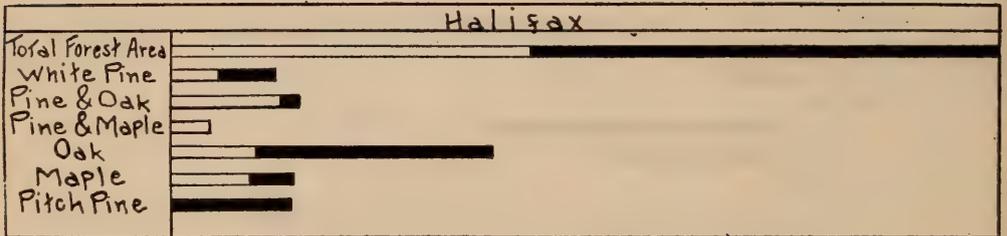
EAST BRIDGEWATER.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	75	98	230	310	17	730	10.6	-
Pine and oak,	-	40	184	252	396	872	12.7	-
Pine and maple,	-	-	52	149	-	201	2.9	-
Oak type,	34	120	287	1,308	1,130	2,879	41.8	-
Maple (swamp) type,	23	161	361	689	625	1,859	26.9	-
Pitch pine,	-	-	11	-	339	350	5.1	-
Total,	132	419	1,125	2,708	2,507	6,891	-	60.8
Per cent.,	1.9	6.1	16.3	39.3	36.4	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						3,284	-	28.9
Pasture,						648	-	5.7
Residential,						270	-	2.4
Water,						143	-	1.3
Marsh,						103	-	.9
Total area of town,						11,339	-	100.0



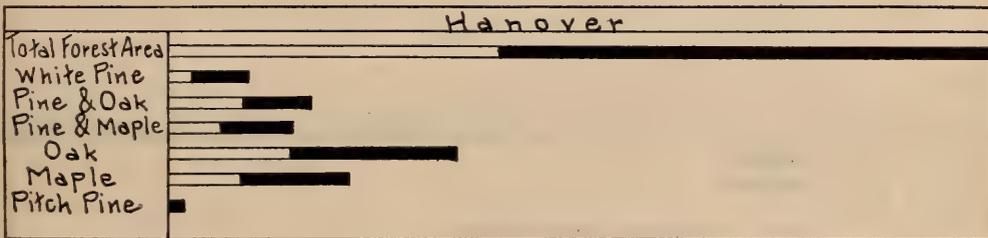
HALIFAX.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.								
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	139	278	285	110	102	914	12.5	-
Pine and oak,	22	22	922	-	146	1,112	15.2	-
Pine and maple,	-	102	241	-	-	343	4.7	-
Oak type,	-	66	666	878	1,222	2,832	38.7	-
Maple (swamp) type,	-	44	644	322	51	1,061	14.5	-
Pitch pine,	-	-	-	-	1,053	1,053	14.4	-
Total,	161	512	2,758	1,310	2,574	7,315	-	65.8
Per cent.,	2.2	7	37.7	17.9	35.2	-	100.0	-
NON-FOREST TYPES.								
Tillage,						1,857	-	16.7
Pasture,						278	-	2.5
Residential,						89	-	.8
Water,						889	-	8.0
Cranberry bog,						222	-	2.0
Marsh,						467	-	4.2
Total area of town,						11,117	-	100.0



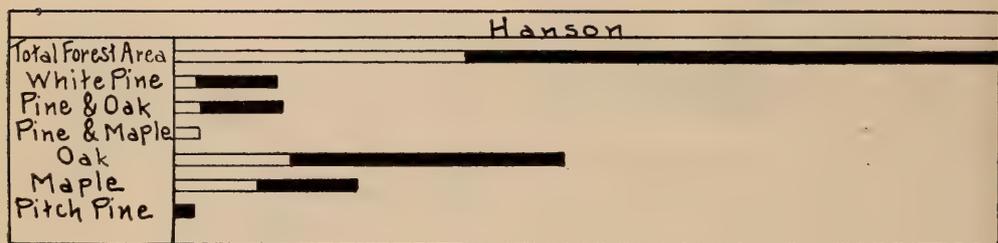
HANOVER.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	13	205	271	221	-	710	9.6	-
Pine and oak,	-	33	545	678	-	1,256	17.0	-
Pine and maple,	-	20	443	638	-	1,101	15.0	-
Oak type,	-	53	1,044	1,481	-	2,578	35.0	-
Maple (swamp) type,	-	46	588	978	-	1,612	21.8	-
Pitch pine,	-	-	59	66	-	125	1.6	-
Total,	13	357	2,950	4,062	-	7,382	-	73.8
Per cent., . . . . .	.2	4.8	40	55	-	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						2,221	-	22.2
Pasture,						26	-	.3
Residential,						377	-	3.7
Total area of town,						10,006	-	100.0



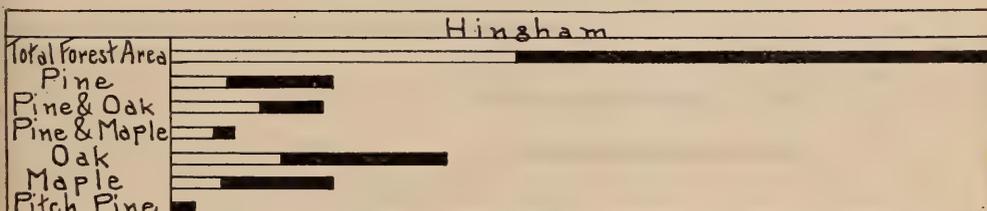
HANSON.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	69	176	195	365	63	868	12.3	-
Pine and oak,	-	19	208	309	391	927	13.1	-
Pine and maple,	-	19	208	-	-	227	3.2	-
Oak type,	-	290	788	1,430	800	3,308	47.0	-
Maple (swamp) type,	82	38	586	668	189	1,563	22.2	-
Pitch pine,	-	-	-	-	158	158	2.2	-
Total,	151	542	1,985	2,772	1,601	7,051	-	70
Per cent.,	2.1	7.7	28.2	39.3	22.7	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						1,655	-	16.3
Pasture,						422	-	4.2
Water,						479	-	4.6
Cranberry bog,						265	-	2.6
Marsh,						252	-	2.3
Total area of town,						10,124	-	100.0



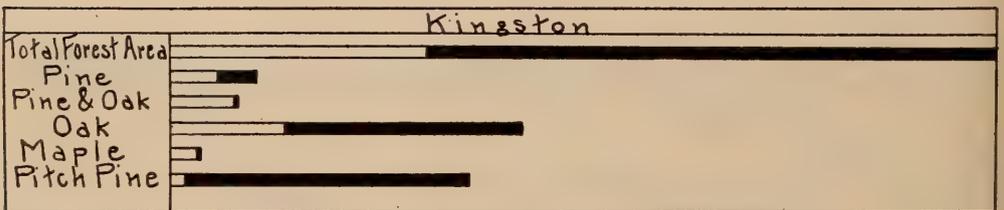
HINGHAM.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	190	318	310	554	-	1,372	19.2	-
Pine and oak,	18	123	617	541	-	1,299	18.1	-
Pine and maple,	49	80	257	154	-	540	7.5	-
Oak type,	209	263	445	1,473	-	2,390	33.4	-
Maple (swamp) type,	-	116	331	938	-	1,385	19.3	-
Pitch pine,	-	-	-	178	-	178	2.5	-
Total,	466	900	1,960	3,838	-	7,164	-	49.6
Per cent.,	6.5	12.6	27.4	53.5	-	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						3,243	-	22.4
Pasture,						2,421	-	16.8
Residential,						1,416	-	9.8
Water,						161	-	1.1
Marsh,						49	-	.3
Total area of town,						14,454	-	100.0



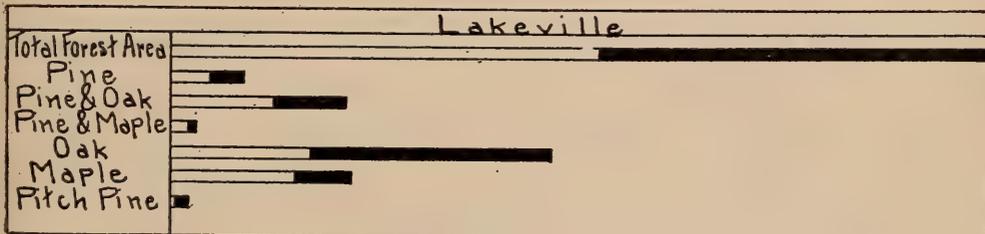
KINGSTON.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	270	235	165	78	139	887	10.2	-
Pine and oak,	96	314	270	-	44	724	8.3	-
Oak type,	148	61	1,019	853	1,602	3,683	42.3	-
Maple (swamp) type,	-	131	78	-	70	279	3.2	-
Pitch pine,	113	-	627	183	2,213	3,136	36.0	-
Total,	627	741	2,159	1,114	4,068	8,709	-	71.5
Per cent.,	7.2	8.5	24.8	12.8	46.7	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						2,107	-	17.3
Pasture,						97	-	.8
Residential,						780	-	6.4
Water,						341	-	2.8
Cranberry bog,						146	-	1.2
Total area of town,						12,180	-	100.0



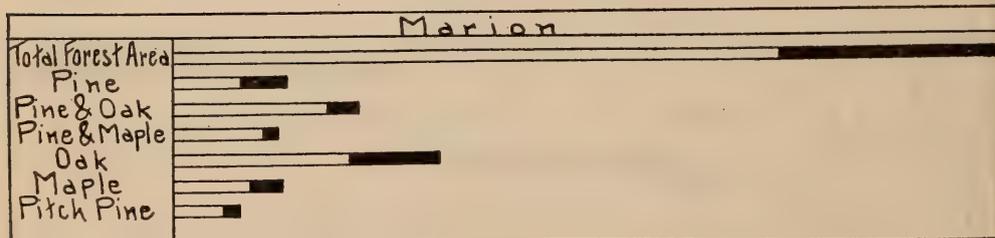
LAKEVILLE.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.								
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	134	652	284	200	-	1,270	7.6	-
Pine and oak,	351	819	919	718	551	3,358	20.1	-
Pine and maple,	117	167	100	33	33	450	2.7	-
Oak type,	635	752	1,570	1,704	3,074	7,735	46.3	-
Maple (swamp) type,	234	635	1,672	535	551	3,627	21.7	-
Pitch pine,	-	33	84	150	-	267	1.6	-
Total,	1,471	3,058	4,629	3,340	4,209	16,707	-	72.2
Per cent.,	8.8	18.3	27.7	20	25.2	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						3,286	-	14.2
Pasture,						1,157	-	5.0
Residential,						370	-	1.6
Water,						1,134	-	4.9
Cranberry bog,						417	-	1.8
Marsh,						69	-	.3
Total area of town,						23,140	-	100.0



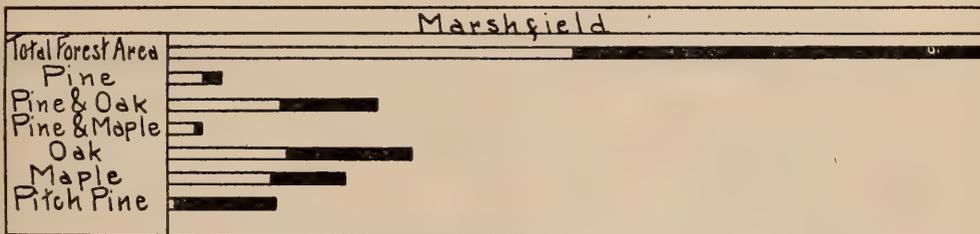
MARION.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.								
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	371	185	282	62	21	921	13.4	-
Pine and oak,	791	282	185	247	27	1,532	22.3	-
Pine and maple,	502	117	130	27	-	776	11.3	-
Oak type,	185	825	453	453	295	2,211	32.2	-
Maple (swamp) type,	82	151	419	137	110	899	13.1	-
Pitch pine,	89	337	103	-	-	529	7.7	-
Total,	2,020	1,897	1,572	926	453	6,868	-	75
Per cent.,	29.4	27.6	22.9	13.5	6.6	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						336	-	3.7
Pasture,						117	-	1.3
Residential,						618	-	6.8
Water,						268	-	2.9
Cranberry bog,						206	-	2.2
Marsh,						744	-	8.1
Total area of town,						9,157	-	100.0



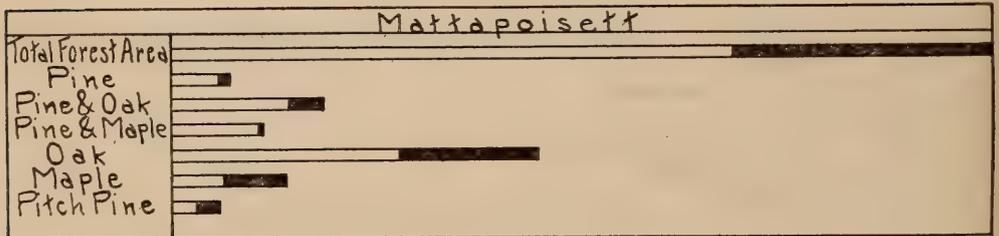
MARSHFIELD.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	135	242	72	81	45	575	6.4	-
Pine and oak,	207	207	817	673	386	2,290	25.5	-
Pine and maple,	-	81	242	36	18	377	4.2	-
Oak type,	54	242	1,015	835	512	2,658	29.6	-
Maple (swamp) type,	-	-	1,131	422	368	1,921	21.4	-
Pitch pine,	-	45	494	269	350	1,158	12.9	-
Total,	396	817	3,771	2,316	1,679	8,979	-	49.2
Per cent.,	4.4	9.1	42	25.8	18.7	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						3,358	-	18.4
Pasture,						839	-	4.6
Residential,						986	-	5.4
Water,						292	-	1.6
Cranberry bog,						91	-	.5
Marsh,						3,705	-	20.3
Total area of town,						18,250	-	100.0



MATTAPOISETT.

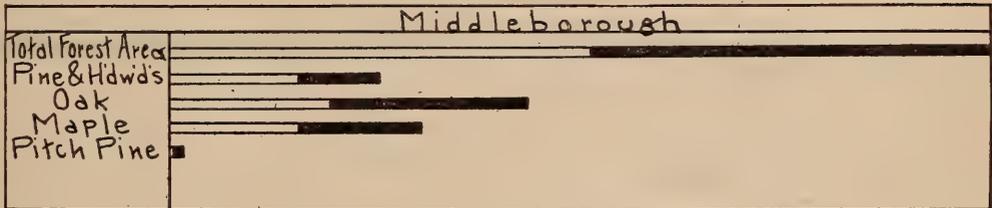
	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.								
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	334	147	41	-	49	571	7.0	-
Pine and oak,	580	326	237	98	245	1,486	18.3	-
Pine and maple,	530	237	106	33	-	906	11.2	-
Oak type,	440	1,011	799	587	750	3,587	44.3	-
Maple (swamp) type,	114	261	147	212	375	1,109	13.7	-
Pitch pine,	179	73	98	57	41	448	5.5	-
Total,	2,177	2,055	1,428	987	1,460	8,107	-	72.5
Per cent.,	26.9	25.3	17.6	12.2	18	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						1,400	-	12.5
Pasture,						403	-	3.6
Residential,						373	-	3.3
Water,						136	-	1.2
Cranberry bog,						124	-	1.1
Marsh,						646	-	5.8
Total area of town,						11,189	-	100.0



MIDDLEBOROUGH.

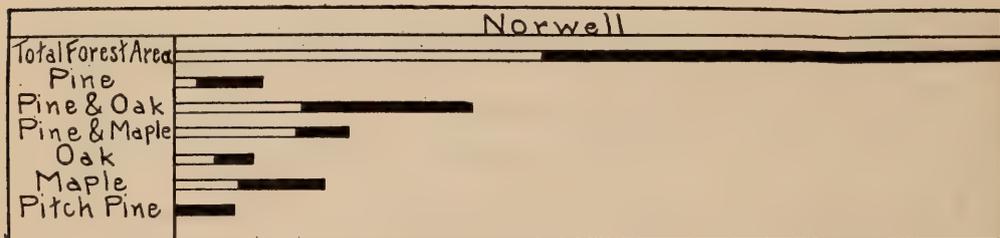
	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	1,365	1,197	2,943	3,499	-1	9,004	25.4	-
Pine and oak,								
Pine and maple,								
Oak type,	679	1,332	4,969	8,347	-1	15,327	43.3	-
Maple (swamp) type,	130	1,951	3,444	5,195	-1	10,720	30.3	-
Pitch pine,	10	108	79	145	-1	342	1.0	-
Total,	2,184	4,588	11,435	17,186	-	35,393	-	75.8
Per cent.,	6.2	13	32.3	48.5	-	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						8,187	-	17.5
Pasture,						1,770	-	3.8
Residential,						785	-	1.7
Water,						511	-	1.1
Marsh,						44	-	.1
Total area of town,						46,690	-	100.0

¹ Size classes 4 and 5 have been combined.



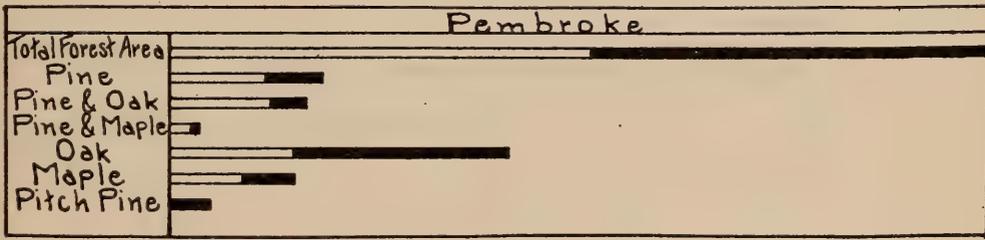
NORWELL.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	89	160	594	217	32	1,092	10.4	-
Pine and oak,	141	467	971	1,457	697	3,733	35.7	-
Pine and maple,	77	550	901	556	102	2,186	20.9	-
Oak type,	77	134	294	262	217	984	9.4	-
Maple (swamp) type,	26	326	435	658	300	1,745	16.6	-
Pitch pine,	-	-	300	192	243	735	7.0	-
Total,	410	1,637	3,495	3,342	1,591	10,475	-	76.7
Per cent.,	3.9	15.6	33.4	31.9	15.2	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						2,443	-	17.9
Pasture,						211	-	1.5
Residential,						89	-	.7
Water,						51	-	.4
Cranberry bog,						13	-	.1
Marsh,						371	-	2.7
Total area of town,						13,653	-	100.0



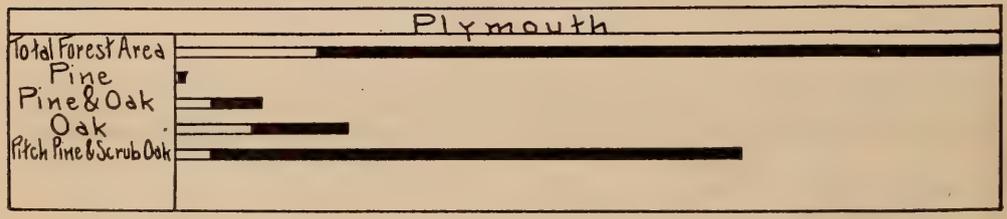
PEMBROKE.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.								
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	408	870	507	22	242	2,049	18.6	-
Pine and oak,	231	397	705	132	353	1,818	16.5	-
Pine and maple,	-	220	66	-	88	374	3.4	-
Oak type,	55	474	1,113	1,322	1,619	4,583	41.6	-
Maple (swamp) type,	33	297	650	595	77	1,652	15.0	-
Pitch pine,	-	-	66	-	474	540	4.9	-
Total,	727	2,258	3,107	2,071	2,853	11,016	-	74.0
Per cent.,	6.6	20.5	28.2	18.8	25.9	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						2,026	-	13.6
Pasture,						417	-	2.8
Residential,						74	-	.5
Water,						789	-	5.3
Cranberry bog,						342	-	2.3
Marsh,						223	-	1.5
Total area of town,						14,887	-	100.0



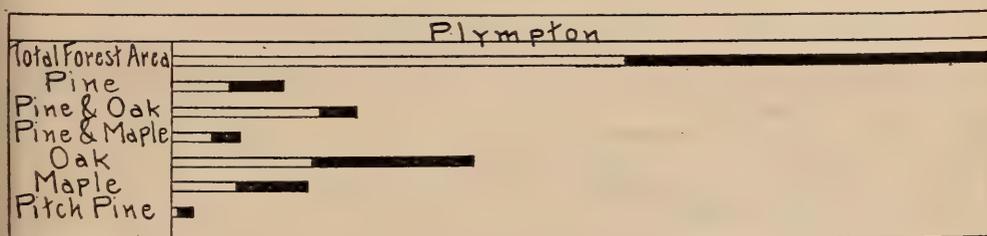
PLYMOUTH.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.								
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	163	54	218	54	-	489	.9	-
Pine and oak,	436	381	1,526	981	2,070	5,394	9.9	-
Oak type,	272	1,362	3,269	2,397	3,978	11,278	20.7	-
Pitch pine and scrub oak,	708	1,417	3,433	4,413	27,353	37,324	68.5	-
Total,	1,579	3,214	8,446	7,845	33,401	54,485	-	82.5
Per cent.,	2.9	5.9	15.5	14.4	61.3	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						5,020	-	7.6
Pasture,						330	-	.5
Residential,						1,783	-	2.7
Water,						3,500	-	5.3
Cranberry bog,						726	-	1.1
Marsh,						198	-	.3
Total area of town,						66,042	-	100.0



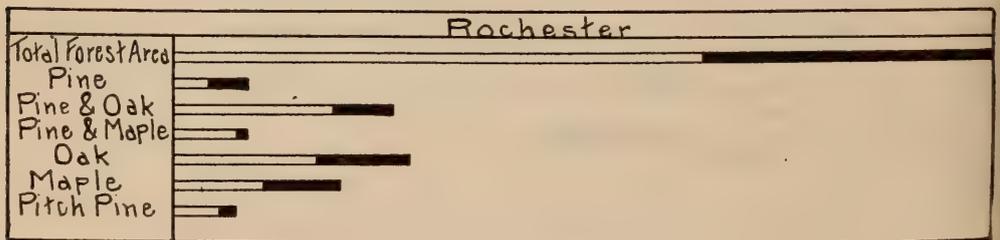
PLYMPTON.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.								
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	240	278	308	75	113	1,014	13.5	-
Pine and oak,	353	330	667	225	120	1,695	22.6	-
Pine and maple,	75	120	173	158	105	631	8.4	-
Oak type,	83	188	1,019	743	728	2,761	36.8	-
Maple (swamp) type,	-	60	532	458	188	1,238	16.5	-
Pitch pine,	30	23	30	-	83	166	2.2	-
Total,	781	999	2,729	1,659	1,337	7,505	-	77.2
Per cent.,	10.4	13.3	36.4	22.1	17.8	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						1,486	-	15.3
Pasture,						331	-	3.4
Water,						39	-	.4
Cranberry bog,						185	-	1.9
Marsh,						175	-	1.8
Total area of town,						9,721	-	100.0



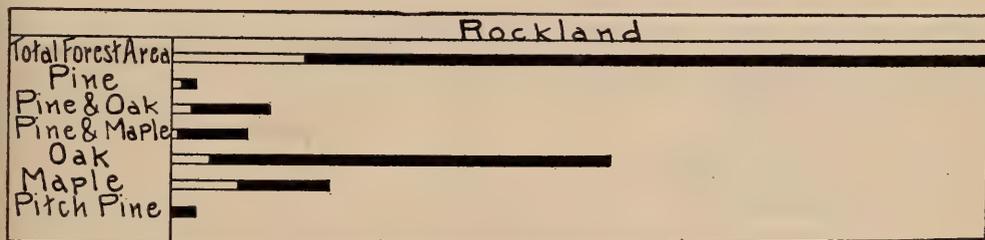
ROCHESTER.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.								
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	338	338	596	113	48	1,433	8.9	-
Pine and oak,	934	918	1,255	386	741	4,234	26.3	-
Pine and maple,	580	370	306	145	-	1,401	8.7	-
Oak type,	1,240	547	998	612	1,208	4,605	28.6	-
Maple (swamp) type,	193	757	773	885	628	3,236	20.1	-
Pitch pine,	419	467	64	177	64	1,191	7.4	-
Total,	3,704	3,397	3,992	2,318	2,689	16,100	-	69.8
Per cent.,	23	21.1	24.8	14.4	16.7	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						3,206	-	13.9
Pasture,						1,107	-	4.8
Residential,						323	-	1.4
Water,						1,338	-	5.8
Cranberry bog,						784	-	3.4
Marsh,						208	-	.9
Total area of town,						23,066	-	100.0



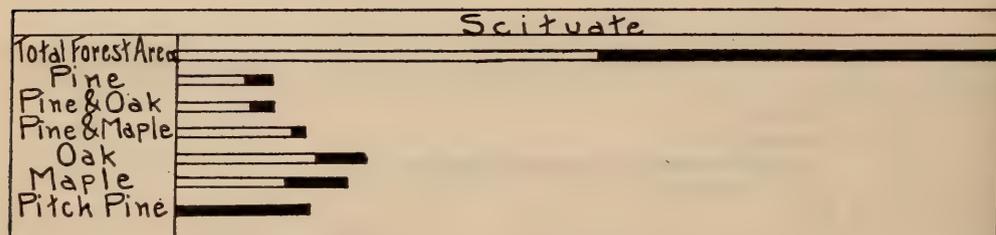
ROCKLAND.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	20	18	10	72	-	120	2.8	-
Pine and oak,	-	-	96	126	295	517	12.0	-
Pine and maple,	-	-	30	193	181	404	9.4	-
Oak type,	30	24	138	819	1,300	2,311	53.9	-
Maple (swamp) type,	24	48	277	439	30	818	19.1	-
Pitch pine,	-	-	-	102	18	120	2.8	-
Total,	74	90	551	1,751	1,824	4,290	-	66.3
Per cent.,	1.7	2.1	12.8	40.8	42.6	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						1,007	-	15.6
Pasture,						223	-	3.4
Residential,						861	-	13.3
Water,						24	-	.4
Marsh,						66	-	1.0
Total area of town,						6,471	-	100.0



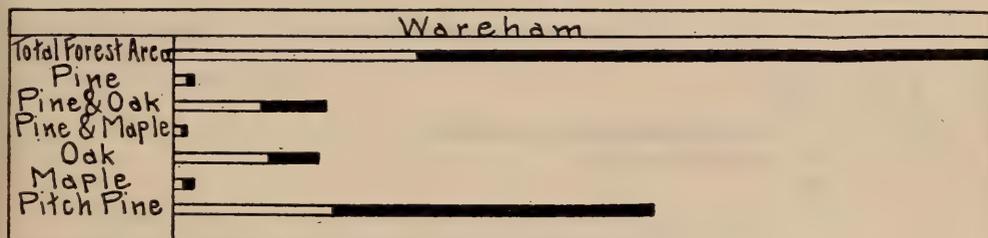
SCITUATE.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.								
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	11	74	319	160	17	581	11.7	-
Pine and oak,	80	86	274	154	-	594	11.9	-
Pine and maple,	40	268	382	103	-	793	15.9	-
Oak type,	239	245	348	143	182	1,157	23.3	-
Maple (swamp) type,	80	137	450	239	125	1,031	20.8	-
Pitch pine,	-	-	200	194	422	816	16.4	-
Total,	450	810	1,973	993	746	4,972	-	45.5
Per cent.,	9.1	16.3	39.7	19.9	15	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						2,291	-	21.0
Pasture,						325	-	3.0
Residential,						1,277	-	11.7
Water,						296	-	2.7
Marsh,						1,761	-	16.1
Total area of town,						10,922	-	100.0



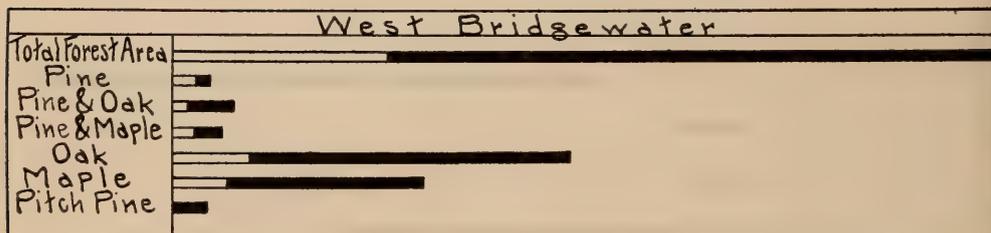
WAREHAM.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.								
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	49	196	49	-	82	376	2.3	-
Pine and oak,	443	376	950	327	917	3,013	18.4	-
Pine and maple,	82	16	49	-	49	196	1.2	-
Oak type,	312	655	917	327	605	2,816	17.2	-
Maple (swamp) type,	16	49	65	147	82	359	2.2	-
Pitch pine,	278	950	1,981	1,425	4,961	9,595	58.7	-
Total,	1,180	2,242	4,011	2,226	6,696	16,355	-	67.2
Per cent.,	7.2	13.7	24.5	13.6	41	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						2,750	-	11.3
Pasture,						535	-	2.2
Residential,						535	-	2.2
Water,						1,947	-	8.0
Cranberry bog,						1,047	-	4.3
Marsh,						1,169	-	4.8
Total area of town,						24,338	-	100.0



WEST BRIDGEWATER.

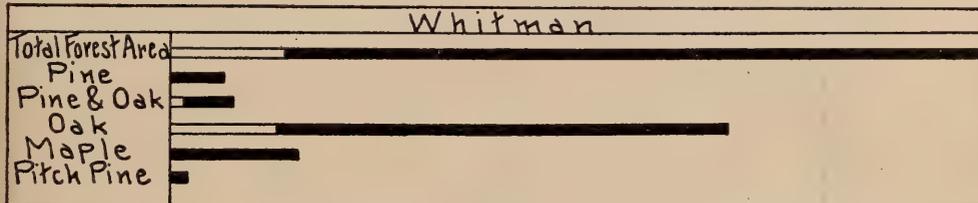
	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.								
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	58	105	41	17	23	244	4.4	-
Pine and oak,	12	-	76	174	145	407	7.3	-
Pine and maple,	-	29	105	168	23	325	5.8	-
Oak type,	110	116	401	657	1,418	2,702	48.2	-
Maple (swamp) type,	-	52	407	999	250	1,708	30.5	-
Pitch pine,	-	-	-	-	216	216	3.8	-
Total,	180	302	1,030	2,015	2,075	5,602	-	55.6
Per cent.,	3.2	5.4	18.4	36	37	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						3,081	-	30.6
Pasture,						767	-	7.6
Residential,						535	-	5.3
Water,						52	-	.5
Marsh,						46	-	.4
Total area of town,						10,083	-	100.0



WHITMAN.

	APPROXIMATE SIZE CLASSES.					Total.	PER CENT.	
	1	2	3	4	5		Forest.	Town.
FOREST TYPES.								
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine,	-	-	122	-	-	122	6.4	-
Pine and oak,	-	-	30	61	55	146	7.6	-
Oak type, ¹	-	24	225	565	502	1,316	68.6	-
Maple (swamp type),	-	-	-	213	85	298	15.5	-
Pitch pine,	-	-	-	37	-	37	1.9	-
Total,	-	24	377	876	642	1,919	-	42.9
Per cent.,	-	1.3	19.6	45.6	33.5	-	100.0	-
NON-FOREST TYPES.								
Tillage and hay,						952	-	21.3
Pasture,						475	-	10.6
Residential,						1,070	-	23.9
Marsh,						57	-	1.3
Total area of town,						4,473	-	100.0

¹ Considerable maple in mixture in medium and small sizes.



LIST OF SAWMILL OPERATORS AND BOX SHOPS IN PLYMOUTH COUNTY, CLASSIFIED AND INDEXED UNDER NAMES OF TOWNS.

TOWN.	Name.	Class. ¹	Buys.	Product.	Stock.
Abington,	E. J. Rourke,	4	-	-	Pine and oak.
Bridgewater,	F. C. Gammons,	2	Logs,	Box boards,	White pine.
Bridgewater,	B. F. Ellis,	3	Logs,	Boards and custom,	Pine and oak.
Brockton,	Mackie Brothers,	2	Boards,	Boxes,	White and pitch pine.
Brockton,	E. L. Bonney,	2	Boards and logs,	Boxes,	White pine.
Brockton,	Brockton Wood Working Com- pany.	3	-	-	-
Brockton,	George E. Keith,	2	Logs and boards,	Boxes and shooks,	White pine.
Duxbury,	Lot Phillips,	-	-	- ²	-
Carver,	T. M. Cole,	3	Logs,	Box boards and boxes,	White pine.
East Bridgewater,	Arthur Churchill,	-	-	Portable mill,	-
Halifax,	B. B. Waterman,	3	Logs,	Cordwood and charcoal,	Maple.
Halifax,	Austin Thompson,	4	Logs,	Box boards,	White pine.
Halifax,	J. B. Thompson,	3	Logs,	Box boards,	White pine.
Hanson,	G. L. Haywood,	4	Logs,	Box boards,	White pine.
Hanson (South),	John Foster Company,	1	Logs,	Boxes and shooks,	Pine, poplar, hemlock, spruce.
Hanover (North),	Wallis Hackett,	4	Logs,	Box boards and custom,	White pine.
Hanover (West),	Lot Phillips & Co.,	1	Logs and boards,	Boxes,	White pine.

Hanover,	National Fireworks Company,	-	-	-	-	-	-
Hingham,	Geo. Haywood,	4	Logs,	Custom,	-	-	-
Kingston,	F. G. Brackett,	3	Logs,	Box boards, planks, long boards,	-	-	White pine and oak.
Lakeville,	Betty's Neck Company,	3	Logs,	Boxes and barrels,	-	-	White pine and poplar.
Marion,	W. H. Ryder,	4	Logs,	-	-	-	-
Marion,	W. E. Sparrow,	4	Logs,	Box boards,	-	-	White pine.
Mattapoisett,	E. C. Stetson,	4	Logs,	Boards and shingles,	-	-	White pine and cedar.
Mattapoisett,	Dennis Mahoney,	2	Logs,	Box boards,	-	-	White pine and oak.
Middleborough,	Z. P. Cushman,	3	Logs,	Box boards and planks,	-	-	White pine and oak.
Middleborough,	L. O. Atwood,	1	Logs,	Boxes and shooks,	-	-	White pine.
Middleborough,	James Thomas,	3	Logs,	Box boards, mallet heads, rolls,	-	-	White pine and hornbeam.
Marshfield,	Chandler Mill,	3	Logs,	Box boards and lobster pots,	-	-	White pine and oak.
Norwell,	Arnold Beech Mill,	3	Logs,	Boards and custom,	-	-	White pine.
Norwell,	Dwelley Mill,	3	Logs,	Boards,	-	-	White pine.
Norwell,	Joseph Merritt,	4	Logs,	Box boards,	-	-	White pine.
Norwell,	C. H. Hackett,	4	Logs,	Box boards,	-	-	White pine.
Pembroke,	Lot Phillips branch,	-	-	-	-	-	-
Pembroke,	Horatio Chandler,	3	Logs,	Box boards,	-	-	White pine.
Pembroke,	Gilbert West,	1	Logs and boards,	Boxes,	-	-	Pine, oak, maple, chestnut, poplar.
Plymouth,	C. E. Taylor,	3	Sawed boards,	Boxes,	-	-	White pine.

¹ Class 4 saws less than 100,000 board feet per year; class 3 saws from 100,000 to 500,000 board feet per year; class 2 saws from 500,000 to 2,000,000 board feet per year; class 1 saws more than 2,000,000 board feet per year.

² See West Hanover.

LIST OF SAWMILL OPERATORS AND BOX SHOPS IN PLYMOUTH COUNTY, CLASSIFIED AND INDEXED UNDER NAMES OF TOWNS
— *Concluded.*

Town.	Name.	Class. ¹	Buys.	Product.	Stock.
Plympton,	Dennett Brothers,	3	Logs,	Box boards,	White pine.
Plympton,	Wm. Perkins,	3	Logs,	Boxes and barrels,	White pine and cedar.
Plympton,	Washburn & Soule,	3	Logs,	Boxes, shooks, barrels,	White pine and cedar.
Rochester,	Rounseville Brothers,	2	Logs,	Boxes, building lumber,	White pine and oak.
Rochester,	James Hartley,	3	Logs and boards,	Box boards and planks,	White pine and oak.
Rochester,	Ira Fuller,	3	-	Portable mill,	-
Situate,	C. H. Walker,	4	Logs,	Lobster pots and toys,	White pine and oak.
Wareham,	Taylor & Holmes,	3	-	Barrels,	White pine.
Wareham,	Geo. Morse,	2	Logs,	Box boards and cooperage,	White and pitch pine.
Whitman,	Atwood Brothers,	1	Logs,	Boxes,	White pine.

¹ Class 4 saws less than 100,000 board feet per year; class 3 saws from 100,000 to 500,000 board feet per year; class 2 saws from 500,000 to 2,000,000 board feet per year; class 1 saws more than 2,000,000 board feet per year.



White pine type. Diameter, 10 inches or larger; heights, 60 to 80 feet. (Class 1.)



Maple (swamp) type. Diameter, about 5 inches; heights, 40 to 50 feet. (Class 3.)





Pine, maple and oak. Diameters, 6 to 10 inches; heights, 50 to 60 feet. (Pine and hardwoods type, Class 2.)

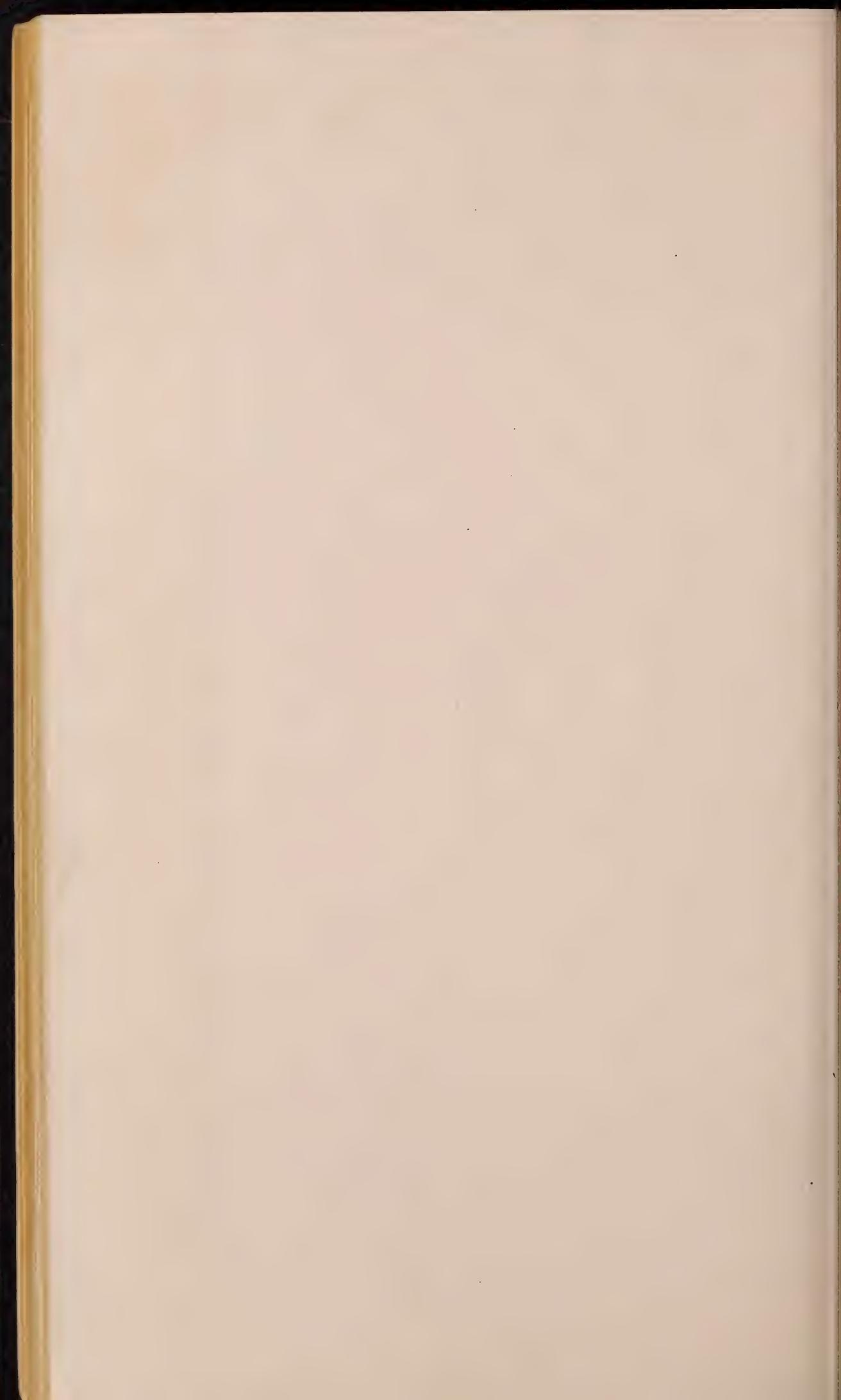




Oak type. Diameter, about 5 inches; heights, 40 to 50 feet. (Class 3.)



Pitch pine type. (Classes 4 and 5.)



MASSACHUSETTS AND HER FORESTS



FOR the past twenty-four years I have been employed as an official in educational, experimental, and demonstration forestry work in New England, having been State Forester of Massachusetts for the past thirteen years. During this time it has been my avowed purpose to do everything within mortal power to accomplish something in establishing fundamentals from which forestry practices of a permanent nature might be the outgrowth.

There are few, if any, problems of greater moment and more economic importance to New England at the present hour than that of forestry. There are those still living who have seen beautiful primeval forests dotting the hills and valleys everywhere throughout this rugged and beautiful country. Year by year these forests have succumbed to our mad rush of uneconomic commercialism, until today finds us in a sadly depleted and irrational condition.

THE FOREST PRIMEVAL

It is always easy to point out mistakes after they have happened; but experience, though a dear teacher, should sober us at the present time. Year by year the primeval forest has been cut and harvested. Second growth, inferior but valuable, has followed, where conditions have been favorable, which, in turn, has been utilized as soon as it reached merchantable size. Demand for forest products

MASSACHUSETTS

has increased in greater and greater proportions as we have been developing in commercial power and prestige, while products themselves have been approaching exhaustion. During the recent war New England was fairly gone over with a fine-tooth comb for forest products for every conceivable use, and with results only too well known to all business men.

We have looked upon our forest products as inexhaustible, and think that though New England should be depleted, there are other sections at our very doors with plenty for our demands. Many of our statesmen and foresighted, country-loving citizens have predicted our calamity, but they have been heeded as one crying in the wilderness.

THE COMMERCIAL ERA

The commercial era has absorbed us. Esthetics and standards of economics in a new country, whose natural resources are apparently boundless, are as nothing compared with commercial activities. There is bound to come a time, however, when the pendulum swings back, and unless our natural resources are conserved, we are bound to suffer the consequences. We are beginning to get a taste of it already.

We have in New England a natural forest country that will respond to forestry development as readily as any country on earth. We are dependent upon the forest crop to continue our innumerable industries located everywhere throughout our five states. In our studies of the Massachusetts wood-manufacturing industries in 1910 it was ascertained that this State alone converted 550,000,000

AND HER FORESTS

feet of rough lumber a year into finished products. When we realize that this is only a part of the product in one state, certainly not one-half of it, but only that portion which, after it leaves the sawmills, is further worked by machinery, it may give a basis for judging the industry. These wood-working industries are scattered everywhere throughout New England, and there are many thriving villages whose main livelihood is dependent upon them.

FORESTRY AND AGRICULTURE

Forestry and general agriculture in New England are to a great degree interdependent. While it is conceded that forestry is no longer a simple woodlot proposition, but one worthy of the economic utilization of all lands non-agricultural, nevertheless its development makes possible the use of labor and teams in winter at a time when they are available. Large forest areas in various sections will greatly augment, therefore, both manufacturing and agriculture.

We have not begun to realize even yet what we should in the economic utilization of the forest products we still possess. It was not until we were freezing, due to the coal shortage following war conditions, that we realized that wood has a value for fuel. Our fathers depended upon it altogether.

In recent years wood has gone out of style, and even farmers have found it more convenient to have coal shipped in from Pennsylvania and West Virginia than to cut it on their own farms. It is an actual fact that during the trying times a few years since, the winter of the unemployed, there were instances

MASSACHUSETTS

of people practically freezing to death while wood in great quantities was rotting all about on our hillsides.

War conditions drove our people to burning wood in their furnaces and fireplaces, and it is believed many will continue to use more firewood than heretofore as it has many advantages even over coal. Cordwood is really a by-product of the forest. Great quantities of wood for fuel should be available in all forest sections, as it is to the benefit of the forest that improvement thinnings be carried on, and whenever forest crops are being harvested there are always the limbs, tops, and slabs suitable for little else than cordwood. The great hindrance to the use of wood for fuel in the past has been the inconvenient form in which it has been dealt.

City people, and users in general, are delighted to purchase wood cut into convenient short sizes. They do not want four-foot lengths. Every conceivable kind of wood can be used if cut into small sizes. Why should we not be able to utilize every stick of wood possible for fuel in our more thickly populated sections of New England? In other sections there should be more definite plans for making it into charcoal, or shipping it to brick factories, or using it in other ways. One is impressed in this respect when in the Black Forest country abroad. Everything there is utilized, and there is no waste.

NEW ENGLAND FOREST POLICIES

Each of the New England States has its forest policies, and is feeling its way toward greater accomplishments. Much more has been done than most people realize. Massa-

AND HER FORESTS

chusetts, for example, has enacted laws aiding forestry in the following ways:

1. Expert advice at no expense, except travel and subsistence, to anybody in the Bay State.

2. Free forestry literature, to be sent to all citizens who care to make use of it.

3. Forest-fire prevention. — A forest warden in each town, with equipment, organization, and mandatory laws, to get results.

4. There are thirty-five forest-fire lookout stations scattered over the State on high points, which are connected by telephone with local and State officials to bring aid.

5. Forest Warden Conventions. — The forestry officials of cities, towns, and the State are empowered to meet to discuss methods, equipment, and better ways of co-operation.

6. State Aid for Forest Fire Equipment. — The poorer towns are given State aid in procuring equipment.

7. Utilization of Forest Products. — Studies and practices of making greater economic use of all wood in the industries, and for fuel. This includes the cost of production and transportation.

8. Regulations of brush and slash disposal.

9. Railroad fires and railroads.

10. Forest Taxation. — A modern system of taxing forest lands and their production.

12. The acquiring of lands for State Forests.

13. State Forest Nurseries. — Young trees are grown in State nurseries for use on State lands, and are sold at cost to citizens and municipalities.

14. The Governor has power to issue proclamations for a closed season on hunting in dry times.

15. Reforesting Private Lands. — Lands suitable for planting may be turned over to the State Forester by title, with power of redemption within ten years, provided the expense of planting and care is reimbursed to the State.

MASSACHUSETTS

16. We have probably planted in Massachusetts, in both public and private work, about 25,000 acres.

WEEDING OUT NEEDED

Do not think that planting or reforestation is the whole thing. Much of our present forest lands need weeding out or thinning, and rational management as well. We need mandatory laws that have enough teeth in them so that uneconomic practices cannot be allowed even on private holdings. This may seem a strong policy, but often individuals are their own worst enemies, and, after all, the economic use of lands as a whole can be made a success only when what benefits the individual also, in a larger sense, benefits the community.

England begins at once to spend \$17,000,000 in forestry. Are we of New England staggering under anything like the blow, both financial and otherwise, that all England is bearing? Should we not at least make a creditable start?

If our farmers are afraid that the Lane Bill in congress will create over-production in agriculture, why not convert a large part of our share into improving our forestry conditions throughout New England?

FUTURE WHAT WE MAKE IT

The future of New England forestry will be exactly what we of today propose to make it. We can continue to go along at a half-dying pace and try to feel we are doing something, but what is really needed is a definite and business-like and more drastic policy if we are to really accomplish results. We need more

AND HER FORESTS

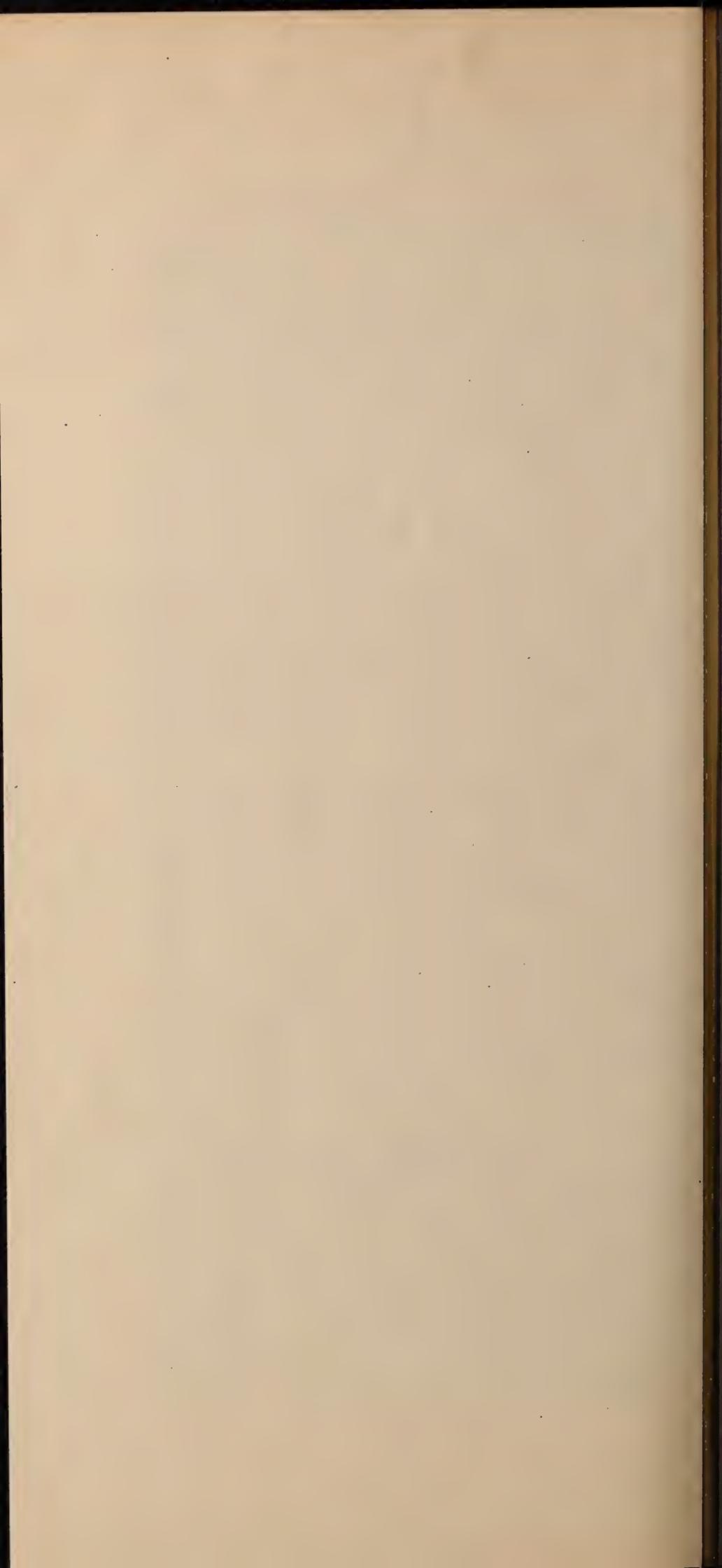
live business principles, backed up by modern financing. If, as Americans, we can build a Panama Canal, a Roosevelt Dam to irrigate the desert, and spend uncounted billions to better the world's conditions, surely the raising of funds sufficient to finance an undertaking bound to solve the future successful existence of a country whose traditions are dear to us is nothing for Americans to undertake.

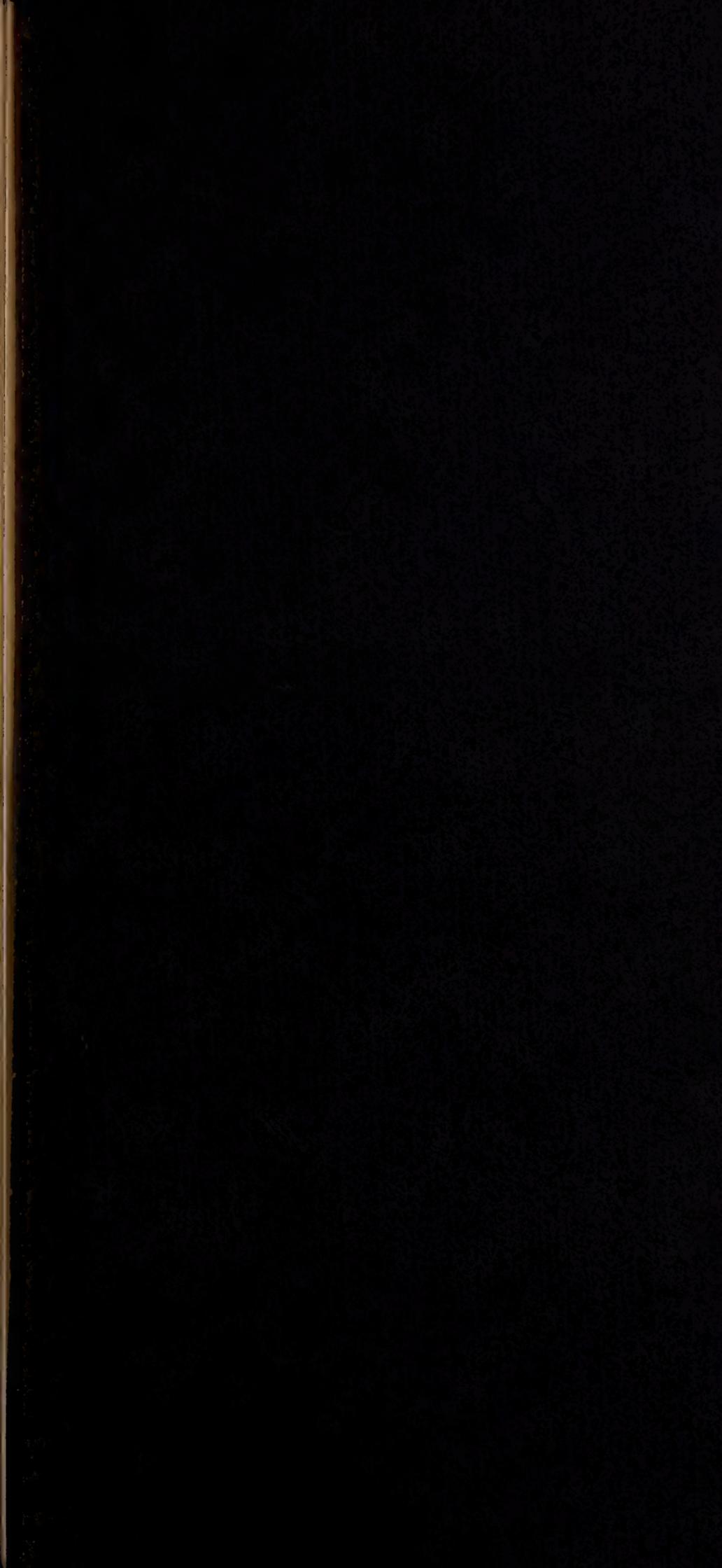
It matters not, either, whether the individual or the State does the work. The main thing is to get it done. Private forestry needs to be greatly encouraged, but it is believed that the State and Nation should shoulder the undertaking. Where would the Allies have turned had not France, to the credit of her statesmen and people, in earlier time begun the practice of forestry?

We need in New England to begin not tomorrow, but today, while we still have some remnants to tide us over the lean period, to go to work on a tremendous scale to recoup our birthright. It takes time to grow a forest, but we have the possibilities in millions of acres of idle lands that will work for us day and night, winter and summer, constantly solving the basal economic problem of the future of our Pilgrim lands, if only we do our duty by them.

It is the time for all men of affairs throughout New England to give this subject constructive thought. The future of New England Forestry will be what we of today make it in guiding its destiny.

State House, Boston, Mass.
Sept. 15, 1919.





Reforestation in Massachusetts



By J. R. Simmons, B.S., Assistant Forester

Under the direction of
J. W. Kane, State Forester

BOSTON
WRIGHT & POTTER PRINTING COMPANY, STATE PRINTERS
32 DERNE STREET
1919

PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

REFORESTATION IN MASSACHUSETTS.

INTRODUCTION.

The first bulletin issued from this department on the subject of reforestation was published in 1910 by R. S. Langdell, assistant to State Forester Rane. This bulletin becoming quickly exhausted, a second edition with slight additions was offered in 1913. Only a few copies of the second edition now remain.

The present edition is undertaken for the purpose of bringing our experience and practice up to date, after having observed during the last ten years the trees grown in experimental plantations and the effects produced by soil and location in different parts of the State.

While experiments are still in progress we have come to pin our faith more and more to the cone-bearing species, to the elimination of deciduous trees. We must develop a forest that shall be as nearly as possible gypsy-moth proof, as well as immune to destructive disease. To this end we have recommended in the following pages only the trees that, up to the present time, have stood the test.

Inasmuch as the average landowner is more interested in the actual reclaiming of the land than in nursery practice, less space has been devoted in the present bulletin to the forest nursery, and greater emphasis is placed on the handling of young trees in the plantation. To those wishing to establish a forest nursery we recommend government Bulletin No. 76, which may be obtained for a small sum by writing to the Superintendent of Documents, Washington, D. C. The bulletin in hand will give the general principles of this phase of the work, but is intended primarily for those who have purchased nursery stock from the Commonwealth, or from some of the many reliable nursery firms doing business throughout the State.

**SYLVICULTURAL CHARACTERISTICS OF TREES RECOMMENDED
FOR PLANTING IN MASSACHUSETTS.**

White Pine (*Pinus strobus*).— This species is placed first, both because of its marked adaptability to growth in this State and because of the universal demand for its lumber. It is but fair to say that the white pine blister rust offers some menace to clear plantations of this species, especially in Berkshire and Essex counties; but by making mixed plantings, and by eradicating currant and gooseberry bushes in the vicinity, white pine may be relied on to do its part in the conquest of the waste-land problem. Even the two-needle pines suffer from another species of blister rust (the alternate host being sweet-fern), and the owner must expect to lose a few specimens of whatever species he may use through disease, insects, winter-killing or dry weather. The present system of planting provides for more trees than are ultimately necessary on each acre of ground, as well as for thinning, both natural and artificial. A plantation in which white pine represents the *expectation crop*, but in which enough trees of other varieties have been planted to provide for any emergency, is, in our judgment, the practical and ideal undertaking.¹

The white pine may be found growing in all sorts of situations except in extremely wet soil. This does not mean that the tree grows equally well everywhere, for it undoubtedly prefers well-drained loamy sand, and there reaches its best development. Ideal conditions exist on the slopes and at the bottoms of old glacial deposits, so numerous all over the State.

Reproduction is by seed, which is produced at intervals of from three to seven years, called "seed years."

As regards size and rate of growth, white pine compares favorably with any of our eastern trees, and far exceeds most of them in these respects, reaching the best merchantable size in about fifty years. If left to grow undisturbed it reaches a size excelled only by trees of the Pacific coast, specimens having been

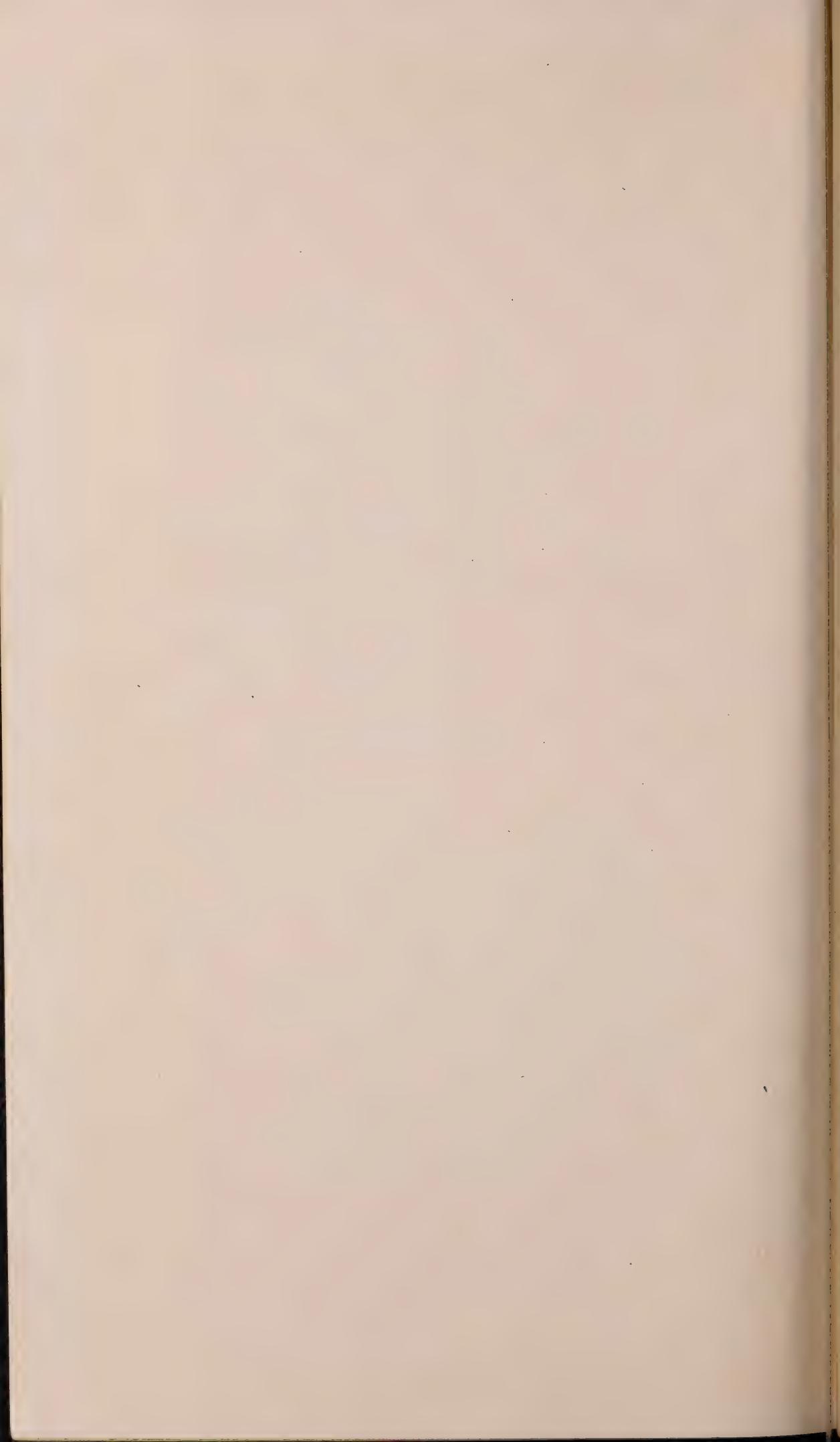
¹ Many of our lumbermen and most of our nurserymen, from their observations and experience, are still of the opinion that they will continue to plant white pine in pure stands as well as in mixed. Likewise, from correspondence and consultation with many of our leading plant pathologists and foresters as to diagnosing the future results of the white pine blister rust, the prevailing impression is that the presence of this disease does not warrant undue fear or exaggeration, or the abandonment of the white pine for reforestation purposes.



FIG. 1. — Four year white pine transplant.



FIG. 2. — Four-year red pine transplant.



recorded that exceed 200 feet in height, with a diameter of 6 feet, while heights of 100 feet, with 3-foot diameters, are not uncommon.

The chief enemy of the pine forests in this State is fire, which, if it does not kill the trees, so weakens them as to render them liable to attack by several kinds of insects and fungi. The white pine is especially susceptible when young, even a slight ground fire being quite sufficient to completely kill it.

The leading insect enemies are the white pine weevil and the pine aphid. The weevil attacks the main shoot, and in some cases greatly damages young trees up to the age of ten or twelve years. Infested shoots should be pruned and burned during the summer months. The aphid is a small sap-sucking insect, and seldom does permanent damage. A simple spray will easily control it in the event that it appears in large numbers on a small area or on individual trees.

The gypsy moth, while it will eat pines as well as nearly every other kind of tree, does not invade pure stands containing pine alone. The brown-tail moth does not feed on pine.

The many uses of white pine are well known. Among them may be mentioned building timber of all kinds, laths, cabinet material, interior finish, woodenware, matches, flag poles, masts and boxes.

Red or Norway Pine (Pinus resinosa). — This tree, while common in northern New England, is not very familiar to residents of Massachusetts. It does not grow in pure stands, but usually in scattered groups with other conifers and hardwoods. The difficulty of collecting the seed in this locality renders the cost of raising the seedlings and transplants very high. Red pine, however, is a very excellent species, and compares favorably with white pine in many respects. It is more nearly immune from the blister rust of two-needle pines than any other member of that group, and represents a safe investment when planted in a favorable location. It prefers a dry sandy loam, outstripping the white pine on gravelly ridges, and will thrive in dry, rocky land. It should never be planted in the swamps or on poorly drained land. In rate of growth the red pine is more rapid than the white when young, though it is shorter-lived in the long run. It reaches a height of 70 to 80 feet,

with trunk diameter of 2 to 3 feet, and in old age develops an open, round-topped, picturesque head. The wood is light, hard, close-grained, pale red, with thin yellow sapwood. The lumber is largely used in construction of bridges and buildings, and for piles, masts and spars. For many purposes the lumber is mixed with that of white pine, and the two varieties are not distinguished.

Scotch Pine (Pinus sylvestris). — The Scotch pine is the common pine of northern Europe, occupying there the same place that the white pine does in this country as a timber tree. Its growth more resembles our red pine, both in quality of lumber and in the kind of soil preferred by the tree. In common with other pines, Scotch is not much subject to disease and insect attack, but is somewhat more sensitive to fire than red pine. Scotch pine is used for the same purposes as red pine.

Austrian Pine (Pinus Austriaca, Endl.) — The Austrian pine has been used successfully in this State in experimental plantations, and is recommended as a substitute for, or in mixture with, Scotch and red pine. It grows on a sandy soil and is a tree of very beautiful appearance, having long and heavy needles. It should not be used for underplanting except where the woods are open, or where heavy thinnings have been made.

Hemlock (Tsuga americana). — The hemlock, one of the most tolerant (shade-enduring) of the American conifers, prefers cold north and east slopes of the hillsides. Because of its ability to thrive even in dense shade, it will grow as an understory with other species, evergreen or hardwood, or in pure stands in all stages of growth.

The wood is being more and more used for building timber as the supply of other species grows scarcer, and some dealers prefer it to spruce for rough frame timbers. If care is not used in drying, it is likely to check.

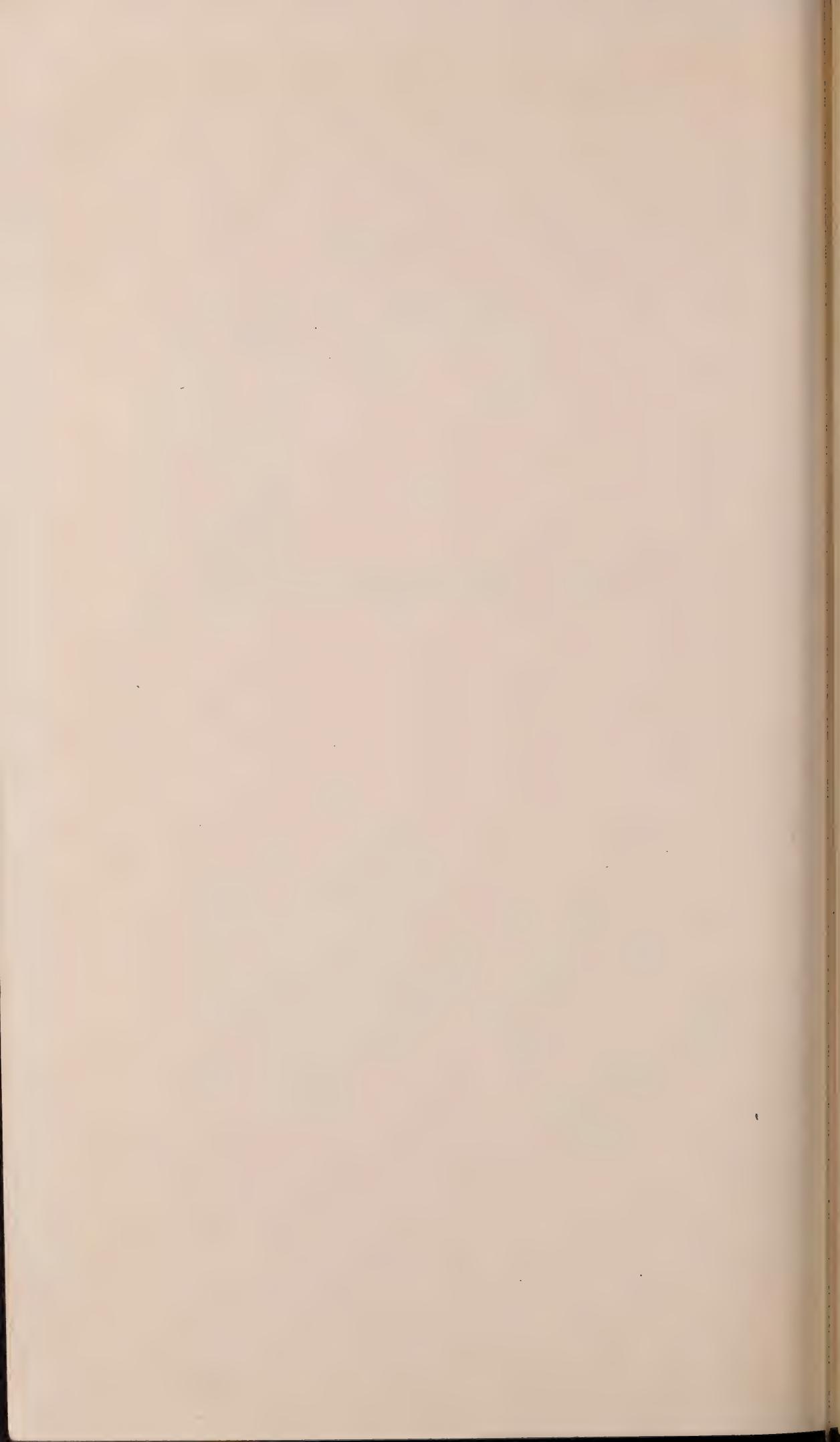
Norway Spruce (Picea excelsa). — This is one of the principal timber trees of Europe, and is strongly recommended for planting in this country, possessing, as it does, all of the advantages of our native red spruce, with the added one of being a much more rapid grower. Our experience is that Norway spruce suffers much less from winterkill than pine, and recovers remarkably after suppression by hardwoods. It is especially de-



FIG. 4. — Evolution of a four-year white pine transplant. Seedling shown in upper left-hand corner is one year old.



FIG. 3. — Four-year Scotch pine transplant.



sirable for underplanting in hardwood stands, a good combination being spruce and hemlock.

Red Spruce (Picea rubra). — This tree is the timber spruce of the northeast, and is now the most important species in New England in size of cut. It will grow in northern Massachusetts on the higher elevations, preferably in mixture with pine and hemlock. It will grow in the shade of other trees for many years, and shows marked recuperative ability when suddenly exposed to the light.

Growth is not rapid, and large size is not reached by this species; but good straight timber is produced, which finds a ready market. The limbs persist, as in the case of white pine, and the best clear timber is grown in mixed stands.

The tree reproduces itself well when the leaf litter on the ground is not too thick, and seedlings start readily under the mature trees of the same species, forming a stand containing trees of all ages.

The uses of the wood are well known, — building timber, piano sounding-boards, inside finish, clapboards and pulp-wood.

American Larch (Larix laricina) and European Larch (Larix decidua, Mill). — The American larch, also known as tamarack and hackmatack, is the only native deciduous conifer in Massachusetts. In winter, after the needles have been shed, it presents the appearance of a dead tree. It bears little resemblance to any of our native conifers, but closely resembles the European larch (*Larix decidua, Mill*), which may be distinguished by its larger cones, stouter twigs and more abundant leaves. The European larch is the more rapid grower, and will thrive in a less moist and less fertile soil than the native species. Larch should be planted in mixture with other trees, among which are recommended spruce, balsam, fir and hemlock. The principal uses are ship and boat timber, telegraph poles, fence posts and railroad ties.

Balsam Fir (Abies balsamea). — This tree is of small commercial importance in Massachusetts, but is recommended for certain areas where other more valuable species are hard to propagate, notably in swampy land, and for use in underplanting. It is sometimes planted in mixture and thinned out later for Christmas trees. Tolerance and comparative freedom from

insects and disease are arguments in its favor. Experimental plantations made by this department several years ago demonstrate that the balsam fir, like the Norway and red spruce, will hold out under a considerable amount of shade, and resume normal growth when released.

THE FOREST NURSERY.

The forest nursery represents the first step in the work of land reclamation. Seed-plots were at one time a favorite experiment among farmers and landowners, and plantations are in existence that were started in this way. But nature is prodigal in her waste of seed, and it was early discovered that by gathering and planting this waste seed in beds a high percentage could be germinated and brought to an age adaptable to low-cost reforestation. A three-year or four-year transplant may be used in grass or brush land where seed would not have one chance in a thousand.

Procuring the Seed.

The cone-bearing trees differ from the hardwoods in the matter of bearing seed, usually devoting a few years to preparation for a large crop. Our native white pine produces an abundant crop every five to seven years, and bears its seed in cones or burrs, which generally grow in clusters of twos or threes on the upper branches of the tree. There are two seeds at the base of each scale of the cone.

All coniferous seed should be gathered from the trees before the cone-scales have opened. The cones should be spread out on a smooth floor in the sun, raked over from time to time, and finally flayed until the seed has been completely threshed out. This should then be cleaned by winnowing, and kept in bags in a cool dry place, out of the reach of birds and mice. If properly stored the seed in most cases retains its vitality for a number of years.

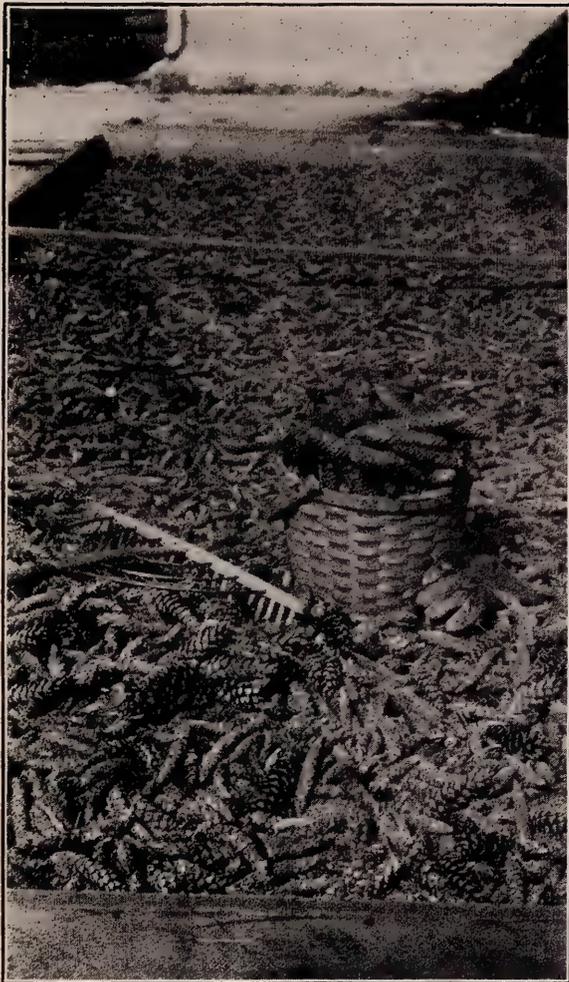
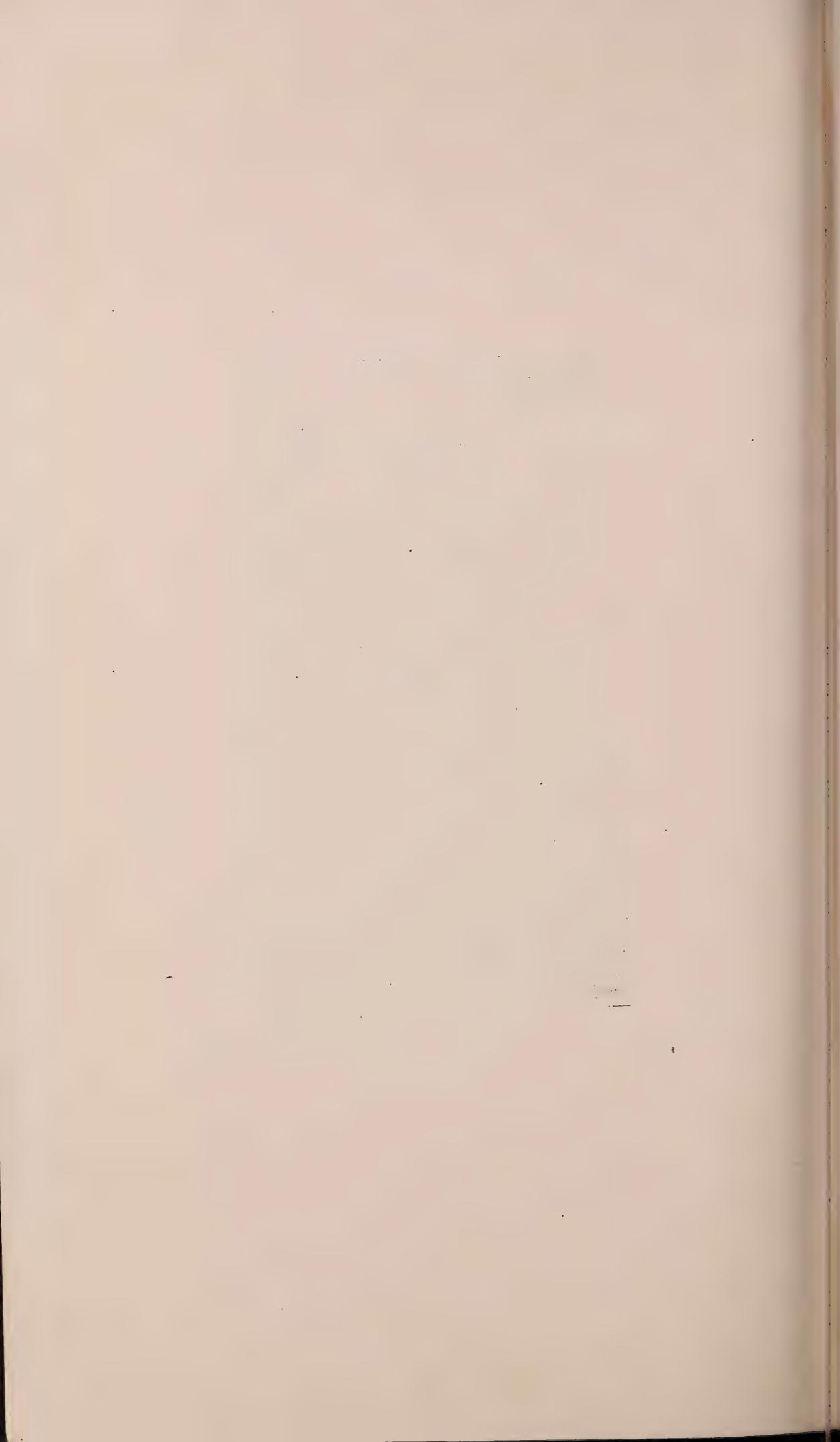


FIG. 5.—Pine cones spread out to dry, in order that seed may be extracted.



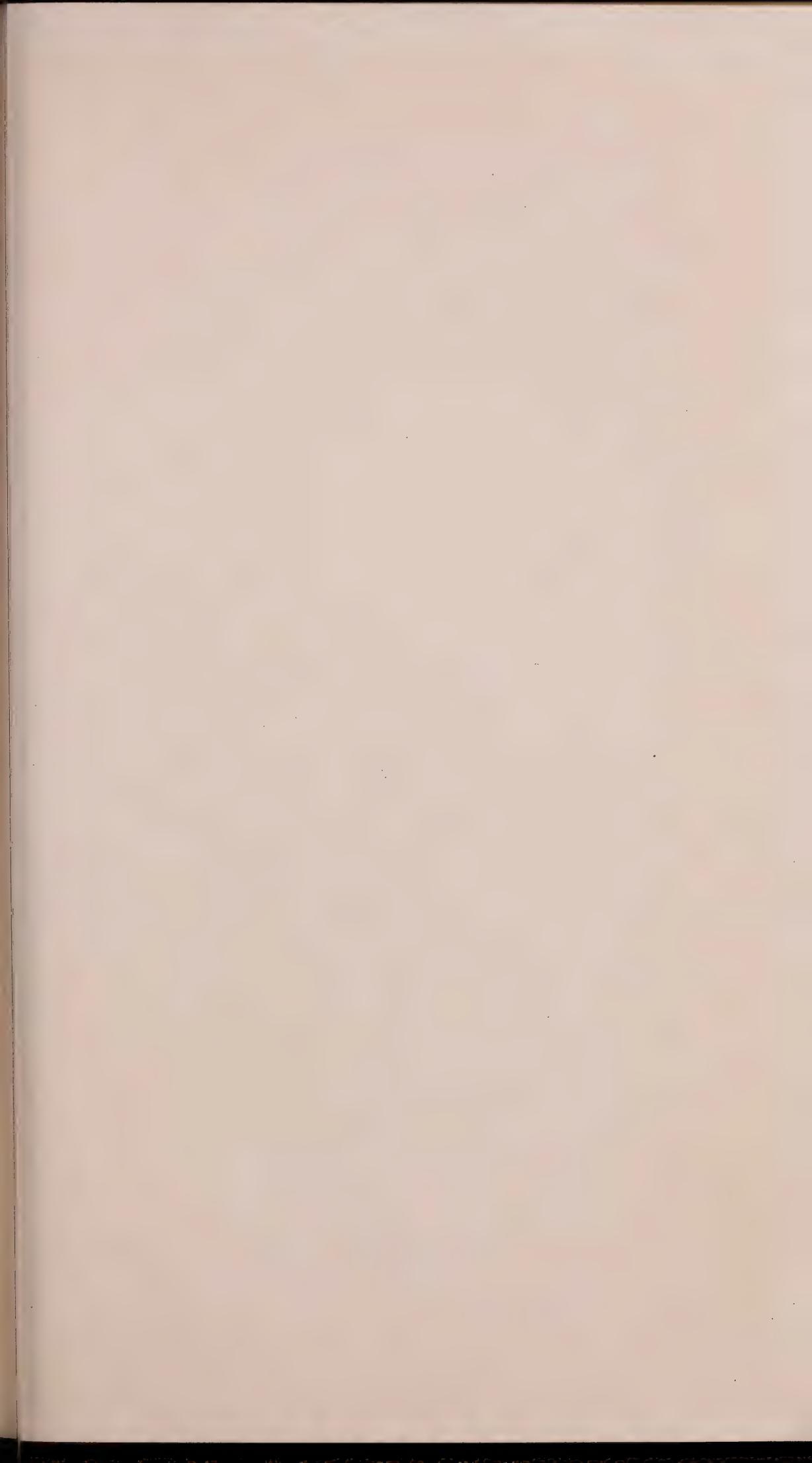




FIG. 6. — A bed 12 by 4 feet, containing about 10,000 one-year white pine seedlings.

Raising Transplants from Seed.

Level or gently sloping well-drained land should be selected for a nursery, the soil being preferably a sandy loam, free from stones. Any length of bed is practicable, but the most convenient width is 4 to 6 feet, with walks 2 feet wide between the beds. The seed is planted in drills or broadcast, according to whether it is desired to leave the seedlings in the bed two years or three years before transplanting. The system that has proved most efficient in our nursery practice in Massachusetts is the construction of 12 by 4 foot beds, with a frame made of lath and fine-mesh chicken wire. The lath gives the young seedlings the proper proportion of light and shade, and the fine-mesh wire protects both seed and seedlings from mice and birds. A burlap cover is used for shading in place of leaves until the seed germinates and appears through the soil, at the end of which time the burlap may be removed for a portion of each day, and finally dispensed with, rolled up and stored for the following season.

A bed 12 by 4 feet takes approximately three-quarters of a pound of seed and produces from 5,000 to 15,000 seedlings, according to the kind of seed used and the success with which they are germinated. Seed may be planted in April or May, but it is usually more convenient to wait until June, when the season for digging transplants is over and more time can be devoted to the work of seeding and care of the new crop.

The seed germinates in about three weeks' time and makes its first year's growth within a couple of months. The seedlings are usually left in the original bed for two years, then transplanted into longer beds and spaced from $1\frac{1}{2}$ to 2 inches apart to prevent crowding. They remain here for two years more, and are then ready for permanent planting on waste land.

A tree so planted is called a four-year transplant, and is the ideal tree for use in reforestation. In old pastures, where the grass is short and there is no great quantity of brush, the two-year seedling may be used with success.

REFORESTATION.

How Trees should be planted.

HEELING IN.

When trees have been properly handled at the nursery they will arrive in good condition, packed in damp moss and tied in bundles of 25, 50 or 100, depending on the size and species. Scotch and Austrian pine are more bulky, as a rule, than white pine and spruce. The trees should be heeled in as soon as possible after their arrival. This requires the digging of a trench about 1 foot wide and 1 foot deep, and laid out as nearly as possible east and west. If only a few trees are involved in the shipment, and planting can be accomplished in a few hours' time, no trench will be necessary. It is advisable to first cover the roots with a light layer of earth, pour on a few pails of water, and then cover thoroughly with earth, leaving the tops exposed to light and air. Care should be taken not to cover any portion of the needles with earth, and in the event of dry weather the trees should be watered daily. A covering of burlap or paper will protect them from excessive heat, and will hold back the buds until the trees can be planted. One thousand trees require a trench about 12 feet long.

REQUIREMENTS FOR PLANTING.

We have experimented with various kinds of planting instruments, such as planting irons, bars, spades, etc., and find that the grub-hoe, or mattock, is the most practical instrument for all kinds of soil. Some of our foremen prefer the double-headed mattock, which on one side resembles an axe, and on the other an adz. The axe is used for cutting out a square hole in the sod or leaf-mold approximately 1 foot square, and the adz-like edge for lifting out the earth to a depth of 6 to 8 inches. The average man prefers the single-bladed adz-like mattock, similar to the one shown in Figs. 8 and 9. The most efficient crew consists of two men, one to make the holes and the other to do the planting. The trees are carried in a pail, which should be kept about half full of a mixture of water and



FIG. 7.—Two-man planting crew at work.





FIG. 8. — First step in making the hole.



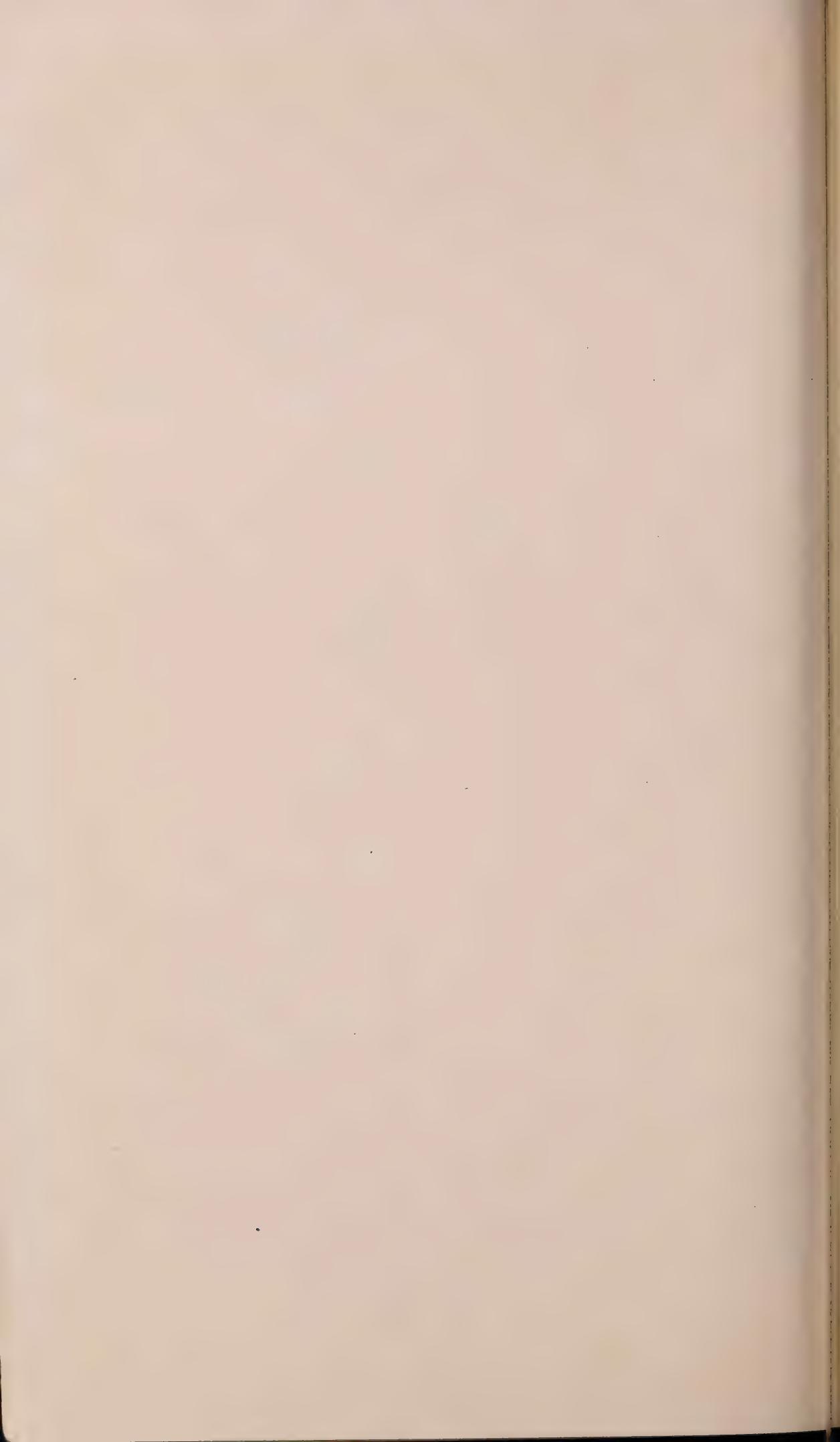
FIG. 9. — Second step in making the hole.



FIG. 10. — Setting the seedling and covering the roots.



FIG. 11. — Firming the soil by pressure of the foot.



loam. The bundles should be untied before placing them in the pail. Sod should not be replaced, and each tree should be firmly set by pressing the earth about it with the foot. An experienced two-man crew can plant from 800 to 1,000 trees per day.

SPACING.

The best practice is to space the trees 6 feet apart each way. This method produces a tall, straight bole and prevents undue spreading. Flags may be set up at the end of the field as a guide to the crews, and moved over 6 feet as the end of the course is reached.

On moist situations Norway spruce or balsam fir may be planted alternately with white pine. If the pine is set 6 by 6 feet, and the fir or spruce set in the centers of the squares thus formed, the trees will be evenly spaced 3 feet apart. In from eight to ten years the fir and spruce will yield an incidental revenue if cut and sold as Christmas trees. It has the added advantage of rendering a plantation comparatively safe from any local disease or insect attack that may seriously deplete any one of the species used. And in this connection it may be said that the forest planter would do well to use at least two species of trees, even in the 6-foot spacing. When planting pine the combination recommended is white pine, alternated with red, Scotch or Austrian pine. Spruce may be alternated with hemlock, tamarack or balsam fir.

Number of Trees required per Acre.

SPACING.	Trees.
3 by 3 feet,	4,840
4 by 4 feet,	2,722
5 by 5 feet,	1,742
6 by 6 feet,	1,210
7 by 7 feet,	888
8 by 8 feet,	680
10 by 10 feet,	435

TIME TO PLANT.

Planting should be undertaken as soon as the frost is out of the ground in the spring, the months of April and May being preferable, in order that the young roots may get started before the dry season sets in. Spring planting is preferable to fall planting, as the roots having started will not be as likely to be heaved out by the frost; although under certain conditions fall planting is sometimes resorted to, as in a case where a piece of land is too wet to work in the spring, but becomes dry during the summer and fall. The time for fall planting depends largely on the season. The months of September and October are usually best in this State.

Care of the Young Plantation.

An ideal plantation requires very little care until it is old enough to be thinned, which under ordinary conditions would be at about the twentieth year; but preparation against possible disappointment and failure is as necessary in the matter of trees as in the raising of an agricultural crop, and weed-trees choke out a plantation in much the same way that witch-grass chokes out grain.

With the exception of old fields, described on another page, waste land will, in a short space of time, develop hardwood sprouts of questionable value; and even the old fields will occasionally reproduce unexpected crops of gray birch and popple seedlings, to the great detriment of the planted pine.

Most plantations must, therefore, be brushed over, in order that the young pine shall not be shaded out before it has "topped" the less valuable species growing around it. Nature has provided that, in the long run, the conifers will win in the struggle for supremacy, on account of longevity and general good health. But the struggle may last for centuries. The desired result can be obtained in less time through the medium of proper assistance on the part of man. The amount of cost will depend on whether the hardwood brush is simply lopped and left on the ground, or whether it is piled and burned. The latter is the better and safer method, but where the fire hazard is negligible the former is recommended.

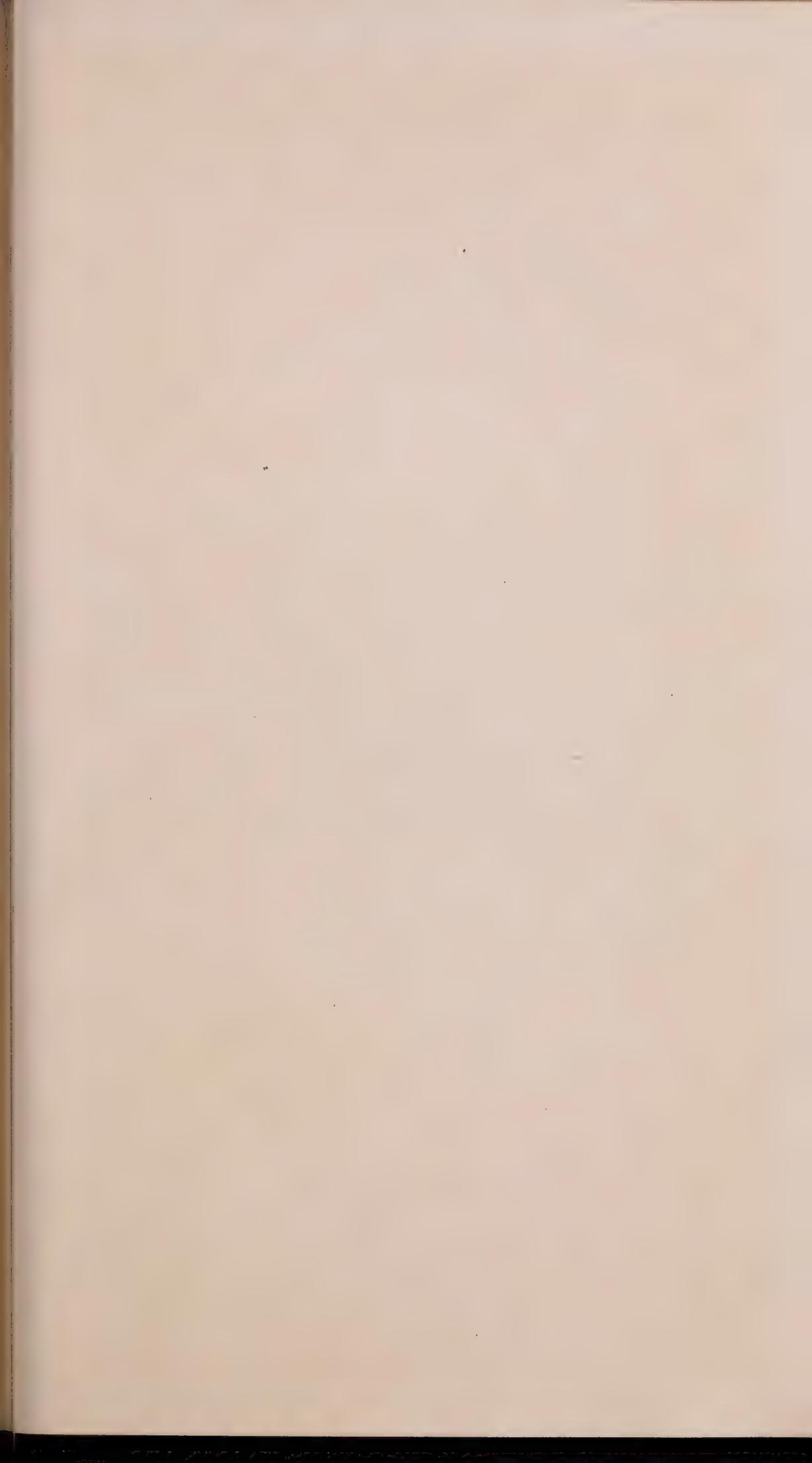




FIG. 12.— White pine transplants that were set in the open spaces among scrub oak following a forest fire. The small trees were four years old when set three years ago, and have grown on an average of from 1 to 2 feet each year during the past two years. They will undoubtedly overcome the oak.

Species most easily controlled.

Gray birch and popple, while abundantly prolific, do not cast a dense shade. Where these trees persist, money can be saved by liberal use of the bush scythe on portions of the lot where these trees are abnormally thick. Scattered birch and popple in the young plantation will often do good by supplying a light shade during summer, by rubbing off the lateral branches of the pine, and by helping to develop a long, straight leading shoot. In many cases it is advantageous to go over the plantation with a pair of pruning shears, snipping only the lateral branches of the hardwoods that interfere with the top-most branches of the pine. This method saves expense and develops good pine lumber.

Another species that may be classed under this head is oak, which, while it casts a very dense shade, is slow-growing and may be surpassed in height by the pine, provided the latter is given a reasonable amount of assistance. Where oak alone is involved, one thorough brushing will often meet the requirements, and the pine will gain the ascendancy. The better grades of oak may be handled by "limbing up." Scrub oak is an inferior species and should be cut clean. Scrub oak following a fire may sometimes be crowded out in the course of time by planting the pine in the open spaces. This applies especially to certain portions of Cape Cod and Martha's Vineyard. (See Fig. 12.)

Species Difficult of Control.

The trees most difficult of control in the young plantation are the chestnut and the soft maple, on account of their very rapid growth. The chestnut bark disease cannot be depended upon to kill off sufficient sprouts to protect the pine, as sprouts will continue to spring up so long as there is any life in the old stump. Maple is equally fast growing, has no destructive enemies, and casts a dense shade. Repeated brushing is the only protection for a pine plantation made among maple sprouts.

Suggestion for making a Pine Plantation among Dense Hardwood Sprouts.

When pine is greatly desired on land offering strong resistance by reason of its dense hardwood sprout growth, cuttings may be made about 12 to 15 feet apart, and the pines planted in these paths with the usual spacing. It is of course necessary to keep the area on which the pine is planted free from brush. In time a mixed stand will result, composed of protected pine and the best specimens of the prevailing natural hardwoods, in parallel sections. The State Department of Forestry has not undertaken this practice on any large scale, but recommends it on the basis of experiments thus far made.

Another good method which has been tried with success on several of our reforested lots is as follows: with a bush scythe or bill hook cut all hardwood sprouts around each pine over a space about 5 feet in diameter. This allows the pine to keep its main shoot free to the light, and results in a good mixed stand of pine and hardwood.

Fire Lines.

In event of undue fire hazard a good means of protection is to make a fire line around the plantation on the side where the greatest danger lies. This is done by cutting the brush and clearing the ground of all inflammable material on a strip about 50 feet wide. Warning notices may be obtained by application to the State Forester. The fire line is not practicable unless it is kept clean, but when cared for it often proves a vantage point from which destructive fires approaching from a distant area may be turned back and ordinary brush fires may be easily managed.

Types of Land Suitable for Reforestation.

The total area of Massachusetts is about 5,321,787 acres, of which 2,672,950 acres is land adapted only to the growing of trees. Of this area there are about 700,000 acres which at the present time constitute practically worthless tracts, being simply a tax to the owners, who at a very small outlay could bring

the land back into profitable forest growth, as well as add to the scenic beauty of the section.

This land lies in tracts varying in size from one to thousands of acres. Practically every farm has a portion which at one time or another has been cut off, burnt over or allowed to lapse into a condition where it is no longer a source of revenue, — a piece of property which brings in no return, though it is still taxable. Lumbermen, mill owners, water-right companies and farmers all have some land which falls under one of the following types, and it is this sort of land which, fortunately, furnishes ideal conditions for forest planting.

CUT-OVER LAND.

Undoubtedly every lumberman in the Commonwealth owns one or more tracts of land which he has cut off, but which has not come back into any profitable growth and which gives no promise of a future crop.

Where the land cut off was previously growing pine it is not always advisable to reforest it the first or second season following, on account of the damage that is almost sure to result from the pine stump beetle (*Hylobius pales*). This beetle breeds in the bark of recently cut pine stumps, but dies out as the bark decays. It chews the bark of young conifers, girdling and sometimes killing them, and damages the lateral branches of larger growth.

Where the land cut off was previously growing hardwoods it is advisable to reforest as soon as possible, as the sprout and hardwood growths, if allowed to gain too great a headway, will hold the transplants in check, and expensive brushing will become necessary. In some cases hardwood sprouts are so persistent as to make reforestation a doubtful investment. Where doubt exists as to the advisability of planting such land, an application should be made to the State Forester for an examination.

BURNED LAND.

On land which has been subjected to repeated fires, destroying the growth and ground cover, the soil is left free to the action of the weather, to be quickly dried out by the sun, or,

if on a side hill, to be washed into the valley by rains. The seed or seedlings which may have been on the ground have been destroyed, and the land might lie for a long period of years before it would reseed itself naturally. Land of this type, therefore, should be set with considerable care, in order to obtain the best results. It is generally advisable to set a four-year-old transplant here rather than seedlings.

RUN-OUT FIELDS.

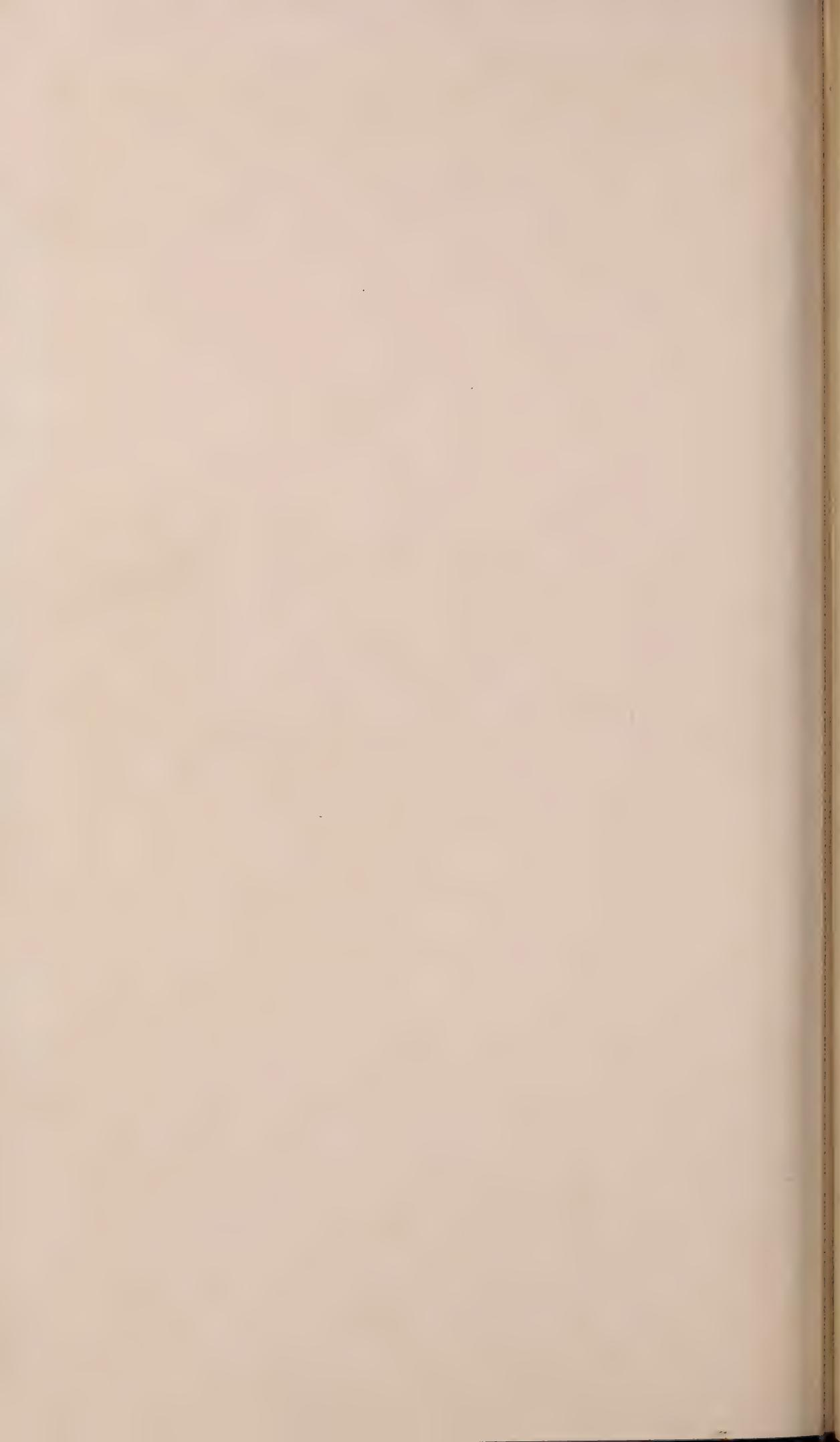
Many of the farms throughout the State have been allowed to decline, and are growing up to brush and undesirable hardwoods. Pasture lands especially are being encroached upon by some of our less valuable trees, such as chokecherry and gray birch, which so overshadow the ground that good pasturage runs out, and the lot is abandoned for fields affording better forage. In many cases scattering white pines have crept in, and probably in time would seed in the whole piece; but the advanced growth, while doing good work in reseeding, would be of little value, as, growing so scattered, they would develop large lateral branches instead of giving a clear, straight bole so desirable in the best grade of lumber. If the lot could be set out with seedlings, and the trees allowed to grow in sufficiently dense stands, the lower branches would die off naturally, and smooth, clear lumber would be assured.

Underplanting in Thinned Stands.

Where woodland has been extensively thinned to eliminate undesirable species, or for the purpose of marketing the mature timber, underplanting is practicable and advisable. For this purpose a tolerant (shade-enduring) tree is necessary, and among the best species may be named the Norway spruce, the hemlock, the tamarack and the balsam fir. They should be planted in the open spaces as much as possible, or in such a way that they may not grow into the branches of other trees. Otherwise they must be released in a few years' time by cutting the older growth, and damage will result from felling.



FIG. 13.—A thinned stand of hickory. Ready for *underplanting* with spruce or hemlock, or with pine in the more open spaces.



Reforestation Work done by the State.

Under "An Act to provide for the purchase of forest land and for reforestation," passed by the Legislature of 1908, provision is made whereby private landowners may deed tracts of land suitable for reforestation purposes to the State, to be planted and handled under practical forest management, such owners reserving the right to redeem the land at any time within ten years for the actual amount expended. Provision is also made for the distribution of seeds and seedlings at not less than cost to landowners who are citizens of the Commonwealth.

The State has now acquired over 150 tracts of land under this act, comprising in all about 6,000 acres. The number of trees required in planting these areas, and in supplying the State institutions, the Metropolitan Water Board, the cities, the towns and the schools, has been so great that few, if any, have been left over for the private landowner until the present year. During the spring of 1918, however, we distributed at cost more than 500,000 four-year transplants of white and Scotch pine to citizens in all parts of the State. The price charged for these trees was \$7 per 1,000, representing the actual cost of raising them in our nurseries.

ACTS OF 1908, CHAPTER 478.**Reforestation Act.**

SECTION 1. For the purpose of experiment and illustration in forest management, and for the purposes specified in section five of this act, the sum of five thousand dollars may be expended in the year nineteen hundred and eight, and the sum of ten thousand dollars annually thereafter, by the state forester, with the advice and consent of the governor and council, in purchasing lands situated within the commonwealth and adapted to forest production. The price of such land shall not exceed in any instance five dollars per acre, nor shall more than eighty acres be acquired in any one tract in any one year, except that a greater area may so be acquired if the land purchased directly affects a source or tributary of water supply in any city or town of the commonwealth. All lands acquired under the provisions of this act shall be conveyed to the commonwealth, and no lands shall be paid for, nor shall any moneys be expended in improvements thereon, until all instruments of conveyance and the

title to be transferred thereby have been approved by the attorney-general, and until such instruments have been executed and recorded.

SECTION 2. The owners of land purchased under this act, or their heirs and assigns, may repurchase the land from the commonwealth at any time within ten years after the purchase by the commonwealth, upon paying the price originally paid by the commonwealth, together with the amount expended in improvements and maintenance, with interest at the rate of four per cent per annum on the purchase price. The state forester, with the approval of the governor and council, may execute in behalf of the commonwealth such deeds of reconveyance as may be necessary under this section: *provided, however*, that there shall be included in such deeds a restriction requiring that trees cut from such property shall not be less than eight inches in diameter at the butt.

SECTION 3. The state forester may in his discretion, but subject to the approval of the deed and title by the attorney-general as provided in section one, accept on behalf of the commonwealth gifts of land to be held and managed for the purpose hereinbefore expressed. A donor of such land may reserve the right to buy back the land in accordance with the provisions of section two, but in the absence of a provision to that effect in his deed of gift he shall not have such right.

SECTION 4. Land acquired under the provisions of this act shall be under the control and management of the state forester, who may, subject to the approval of the governor and council, cut and sell trees, wood and other produce therefrom.

SECTION 5. All moneys received by or payable to the commonwealth or any one acting on its behalf under the provisions of this act shall be paid into the treasury of the commonwealth.

SECTION 6. Land acquired under the provisions of this act, and subsequently reconveyed under the provisions of sections two or three, shall not be exempt from taxation on account of any plantation of trees set out or planted while it was held by the commonwealth.

SECTION 7. For the purpose of assisting in reforestation a portion, not exceeding twenty per cent of the money authorized by this act to be expended may be used by the state forester for the distribution at not less than cost of seeds and seedlings to land owners who are citizens of the commonwealth, under such conditions and restrictions as the state forester, subject to the approval of the governor and council, may deem advisable.

SECTION 8. The state forester shall replant or otherwise manage all land acquired by the commonwealth and held by it under the provisions of this act, in such manner as will, in his judgment, produce the best forest growth both as to practical forestry results and protection of water supplies.

SECTION 9. All acts and parts of acts inconsistent herewith are hereby repealed.

SECTION 10. This act shall take effect upon its passage.

FORM OF APPLICATION USED IN ASKING FOR AN EXAMINATION OF WOODLAND.



**Massachusetts State Forester,
State House,
Boston.**

The State Forester is charged with the work of promoting the perpetuation, extension and proper management of the forest lands of the Commonwealth, both public and private (1904, Chap. 409, Sect. 2). The department is open for consultation on forest and shade tree planting, woodlot management, wood and lumber markets, prices, the control of insects and diseases affecting woodland and shade trees, taxation, and all matters pertaining to the care of woodland and ornamental trees. In matters pertaining to fruit growing, however, go to your local county agricultural agent. While good advice can be given through correspondence, office interviews and publications, often a personal examination of the property or trees, themselves, by one of my technical assistants where the advice can be extended on the ground, is the only satisfactory method of procedure. The only charge for such service is the traveling expenses of the forester making such examination. If you care to have such an examination, fill out the attached application blank and mail to our office. A brief description of the land and the problem involved will assist us.

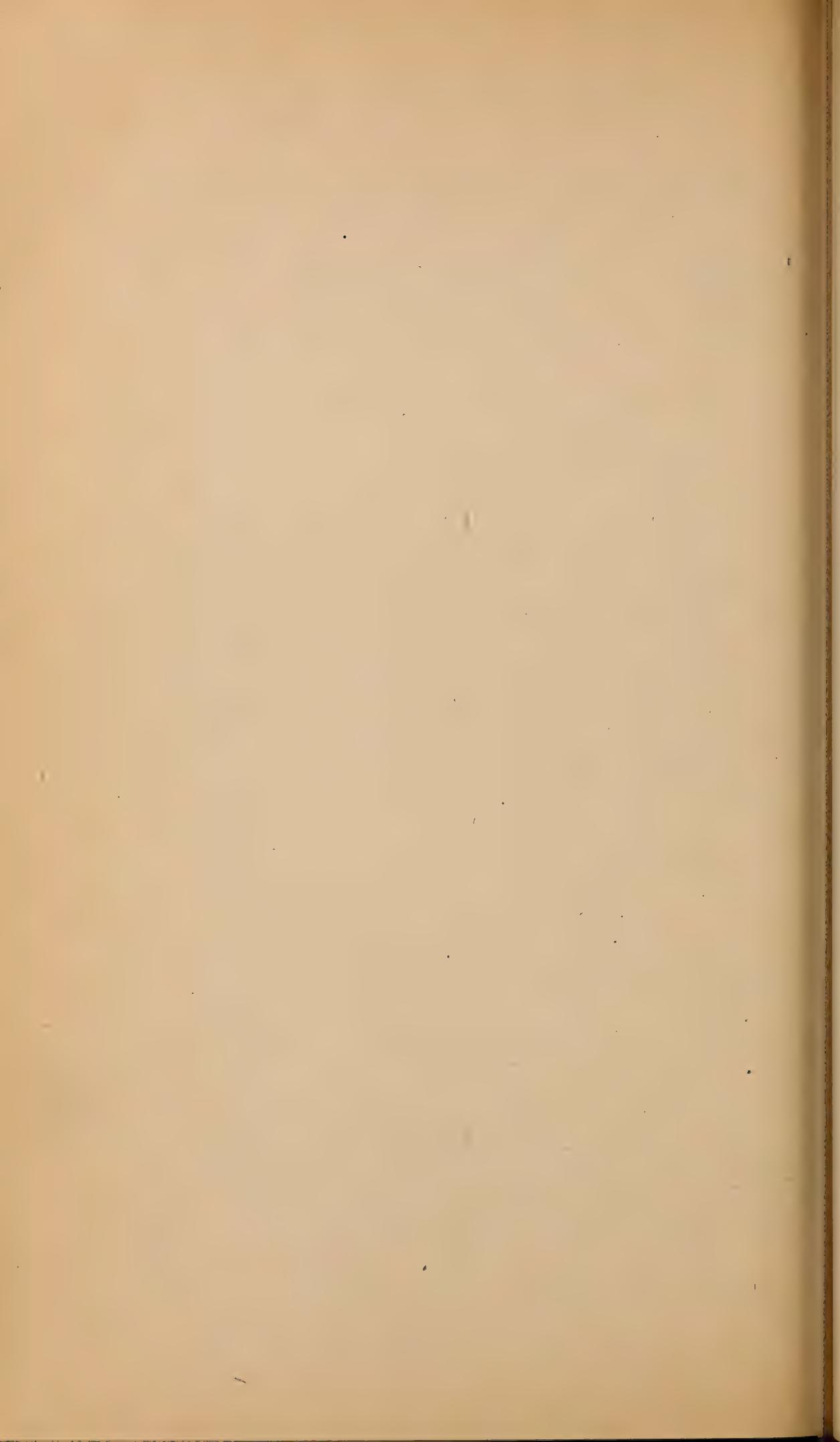
F. W. RANE,
State Forester.

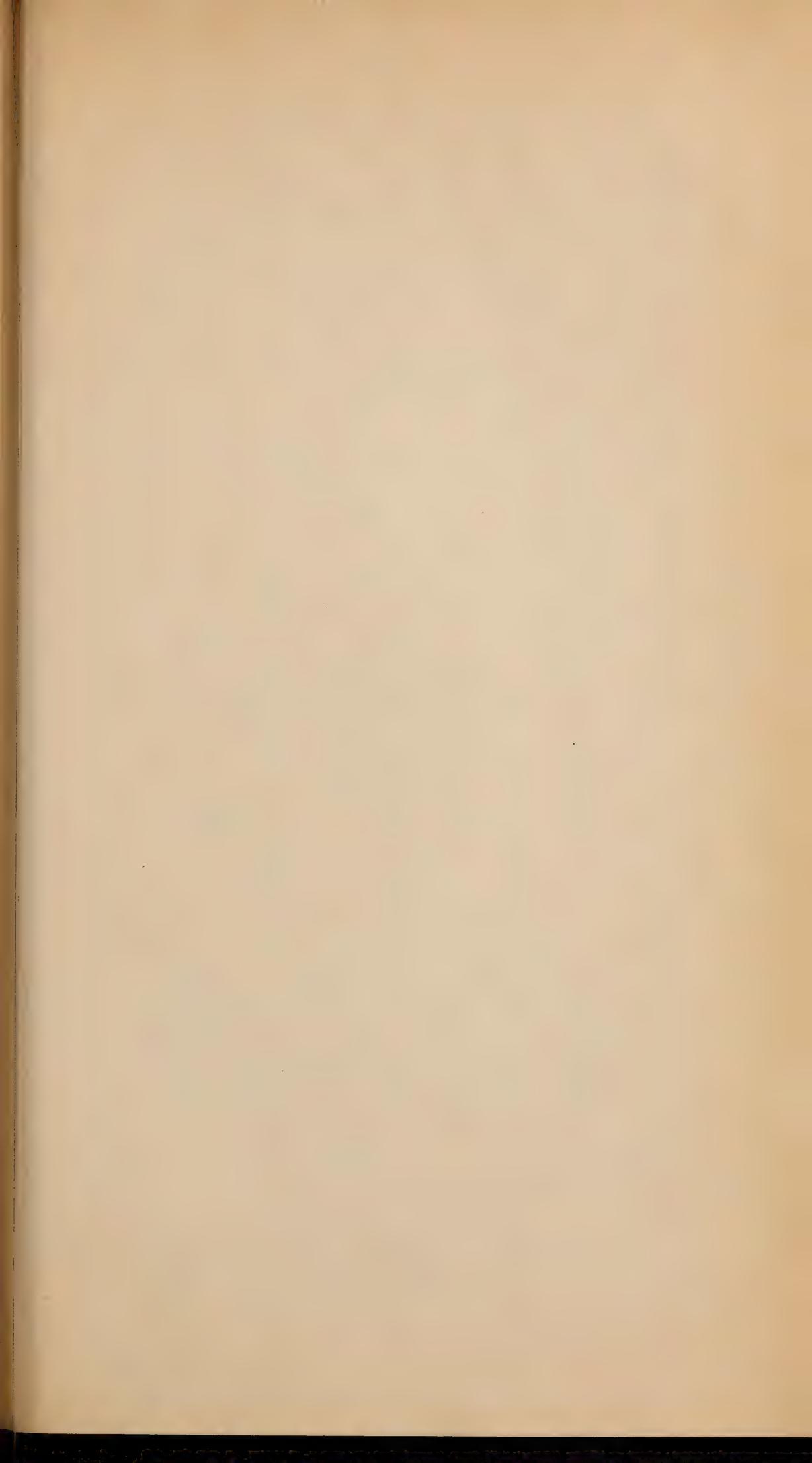
APPLICATION FOR AN EXAMINATION.

Understanding the condition named above, I desire to have an examination made of a tract of land of approximatelyacres located in the town of, State of Massachusetts.

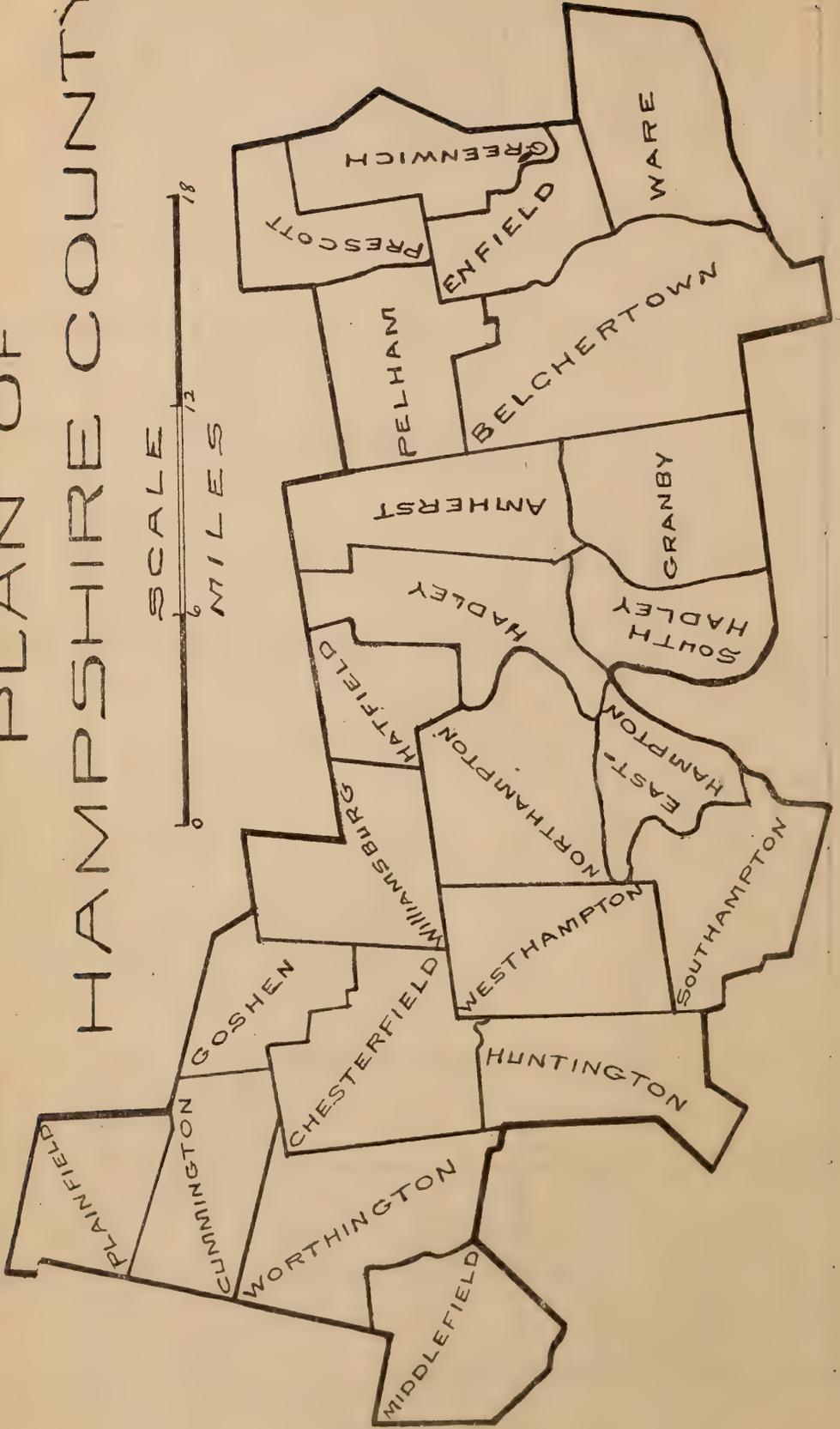
Signed
Address
Telephone

Date.....191 .





PLAN OF HAMPSHIRE COUNTY



THE FORESTS OF HAMPSHIRE COUNTY

The Results of a Forest Survey
of
Twenty Towns in the County



By R. B. PARMENTER

Under the Direction of W. A. L. BAZELEY, State Forester

DEPARTMENT OF CONSERVATION
DIVISION OF FORESTRY

BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
32 DERNE STREET
1922

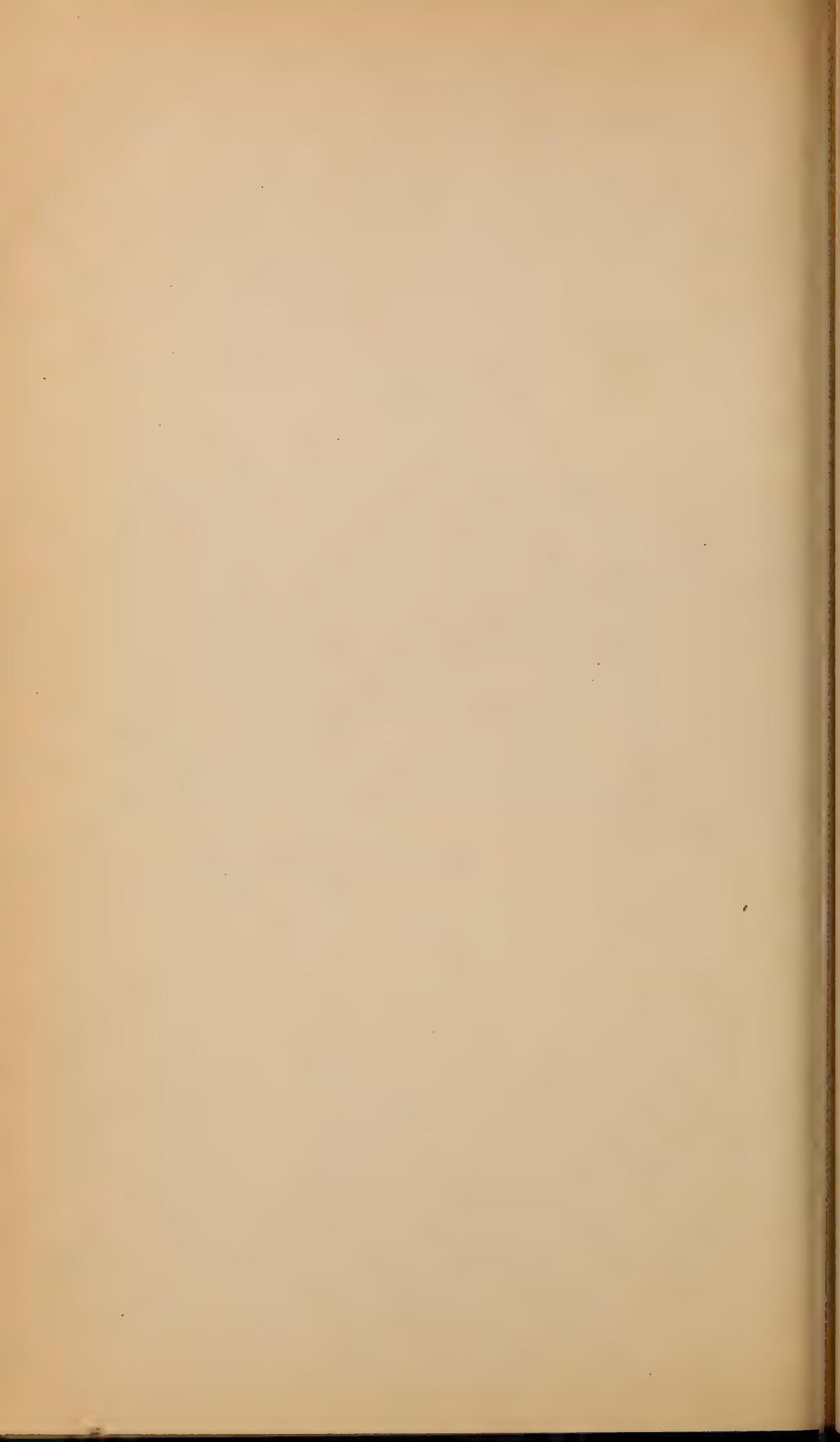
PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

FOREWORD.

We are presenting herewith the results of the forest survey of Hampshire County, the third county to be so studied. The field work of collecting the data here was carried out under the general direction of Mr. R. B. Parmenter, assistant forester. The men collecting the field data were students from forestry schools. The work of compilation and arranging the data in the form of a bulletin was undertaken by Mr. R. B. Parmenter.

Similar surveys of Worcester and Plymouth counties have already been made and the results published. It is hoped to continue this work until all the counties in the State are covered. It is believed that the data so derived will prove valuable to those interested in the forestry development of the Commonwealth.

WILLIAM A. L. BAZELEY,
State Forester.



THE FORESTS OF HAMPSHIRE COUNTY.

EXPLANATION OF SURVEY.

The survey of the several towns of Hampshire County was made during the summer months of 1920 and 1921. This was done in continuation of the policy of the State Forestry Department to make a complete survey of all the counties of Massachusetts.

In the Worcester County bulletin the reasons for making forest surveys of the different counties of Massachusetts were explained in detail, but it will not be amiss here to review briefly some of the main reasons.

Every manufacturing concern or business of any kind at some time or other takes an inventory of its stock. Without such an inventory no business can be carried on to the best advantage. The stock, or raw material, of forestry work is forest land; and since the State Forestry Department of Massachusetts is just what its name implies, the raw material with which this Department must deal is the forest lands of Massachusetts.

If the woodlands of Massachusetts were made up of but one or two species of trees, or if the various species of trees were all of the same height or diameter size, this inventory would be a comparatively simple matter. But such conditions do not exist. Scattered throughout the State are many different kinds of trees, differing greatly in importance, value, life habits, etc., from each other. Moreover, since the woodlands have been repeatedly cut over at different times for many years, we find existing a varied collection of trees of all sizes and conditions; in fact, nearly every woodlot differs to a greater or less extent from others.

METHOD OF SURVEY.

For the main part, the methods followed in making this survey were similar to those followed in Worcester County. The men worked by compass and pace, using a copy of the United States Topographical Map as a guide map for each town. Each

man would start at some convenient point on a road or edge of a pond and run a straight line through to the town line and then back to the opposite town line on a course parallel to the first, but one mile distant. These lines were laid off in such a way as to cut the roads as much as possible at more or less right angles. This was done in order to obtain a more accurate average of the forest conditions. If the lines were parallel to the roads, more tillage land would be noted than forest area; consequently, the results would be out of proportion to actual conditions.

For convenience and brevity in the field, symbols were used denoting the various types, and size classes were numbered from 1 to 4.

In order to hasten the work and lessen the expense, a central boarding place was chosen, and from there the men were taken by auto to the point in the town where they commenced mapping. As the automobile belonged to one of the men in the Department who supervised the work, no additional expense was incurred, and thus the men were enabled to cover more territory in a day than under the old system. Often the work was five to ten miles from the boarding place. As soon as one locality was mapped the crew was transferred to another.

EXPLANATION OF DATA.

Size Classes.

In this survey four size classes were used, but Class 4 was divided in two by underlining the figure 4 in order to differentiate the brush plantation land from plantation land all ready to plant without brushing. Except for the purposes of the Forestry Department, it is unnecessary to distinguish between these two. Following is an explanation of the various classes: —

Class 1 forms the largest size class, and contains species whose diameters, breast high, average 10 inches or better, and whose height will average 60 to 80 feet.

Class 2 represents trees whose average diameters run from 8 to 10 inches, and whose height will average about 50 to 70 feet.

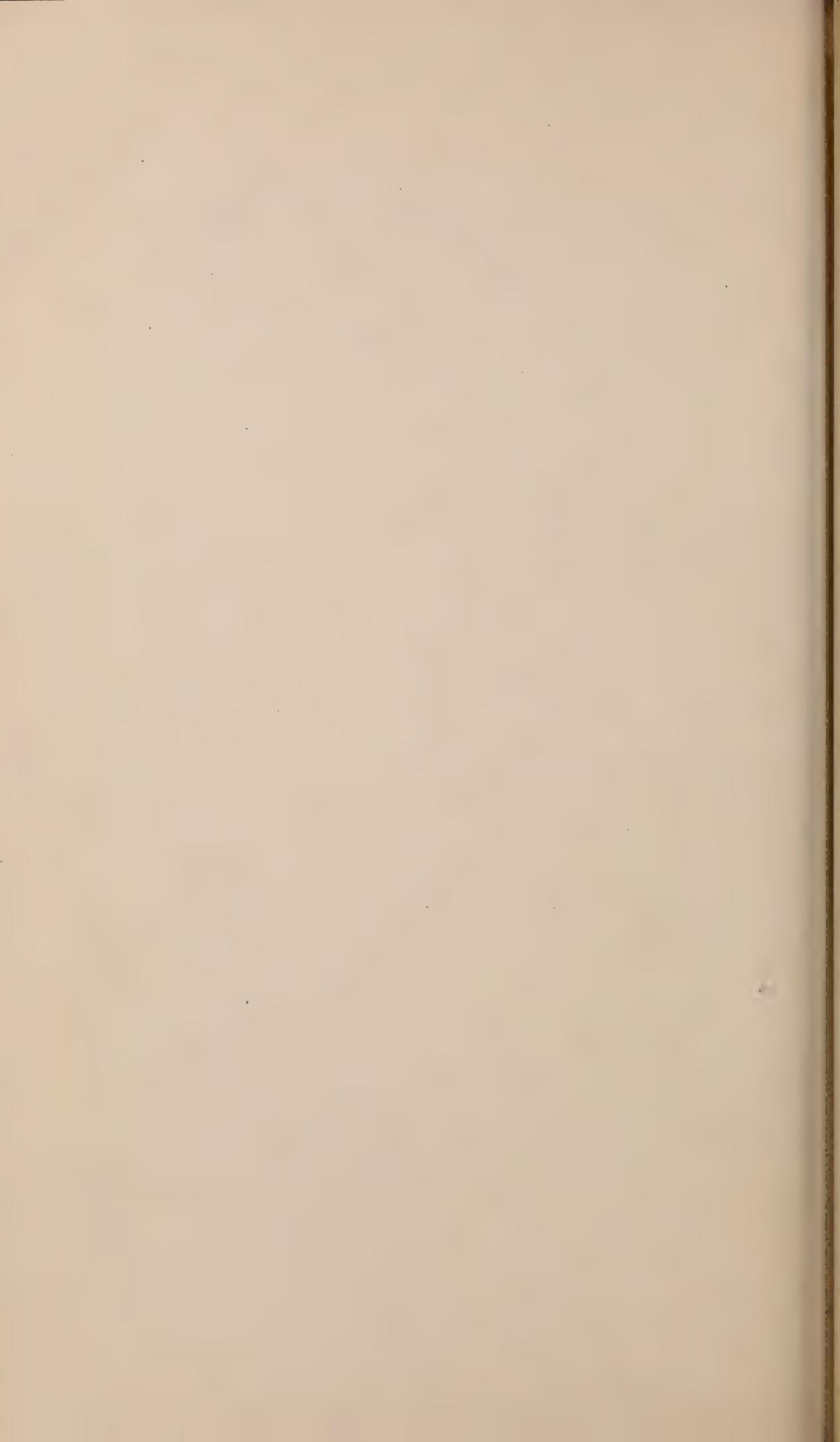
Class 3 constitutes the cordwood size, and species of this class average about 3 inches in diameter and 40 to 50 feet in height.



Oak sproutland type.



Hemlock and hardwoods type. Diameters, 6 to 12 inches or larger; heights, 50 to 60 feet.
(Classes 3, 2 and 1.)



Class 4 is sproutland on which the species are not over 2 inches in diameter and 10 to 15 feet in height.

Class 4 is sproutland with scattered open areas which should be planted so as to bring the land up to 100 per cent production.

Forest Types.

On account of the difference in topographical and climatic conditions, the types of Hampshire County vary considerably from those of Worcester and Plymouth counties. Following is a list of types, and a brief explanation of each.

White Pine. — This type consists of white pine in pure stands, that is, in stands made up of 80 per cent or more of the species. There is still a considerable amount of this type found throughout the county, but the greater part consists of cordwood size and smaller. Nevertheless, many thousand feet of merchantable pine may yet be cut on small areas scattered throughout the county.

Pine and Hardwoods. — Stands of this kind are made up of 40 to 60 per cent, or more, of white pine and hardwoods in mixture, with white pine usually predominating. It occurs in small stands.

Oak Sproutland. — This type is exactly what the name signifies. It is found in areas of considerable size throughout the county on land formerly covered with chestnut. As the chestnut was removed and the resulting sprouts killed by disease, this oak has come in to take its place.

Hemlock and Hardwoods. — This type occurs in considerable quantity throughout the county, but principally on the higher elevations. Fully 65 per cent of the total amount is in the smaller size classes. It is similar to the pine and hardwood type in that the hemlock, like the pine, usually predominates. There is considerable merchantable timber in this type.

Northern Hardwoods. — This type covers large areas throughout the county, consisting of beech, birch, maple, oak and ash. This occurs in the smaller size classes, with some merchantable stands scattered over the county. It is found principally on the higher elevations.

Maple and Birch (Red Maple and Gray Birch). — This type is taking the place of better timber. On all cut-over lands and

abandoned fields this type is predominating. Very little is merchantable, although 25 per cent of it is cordwood size. This type can be used advantageously as an overstory for white pine plantations. A good proportion of this type is found on low wet land where the larger size classes are found.

Other Softwoods. — This consists of pitch pine and red cedar. Pitch pine is found along the Swift River valley in considerable quantity. Cedar is found to a great extent in pastures. Both are found in almost pure stands. It is not a valuable type.

Spruce. — Found on the higher elevations along the northern border of the county. But few stands of pure spruce were seen.

Spruce and Hardwoods. — Similar to the hemlock and hardwood type, and found in the same locality as the spruce type. Consists mostly of the smaller size classes.

Brush Pasture. — Consists of waste land and pasture land growing to brush, this brush consisting of sweet fern, hardhack, blueberry bushes and some young growth of birch, maple and conifers. Much of this land has open areas scattered through it which can be planted. This land will in the future revert to one of the other forest types.

Brush. — Land similar to that in brush pasture, but so completely covered with young reproduction of some kind as to leave no areas for planting.

Non-Forest Types.

Agriculture. — Land covered by this heading is all under cultivation. Included in this type are all the swales which are cut for hay, as well as all the mowing lands.

Open Pasture. — This includes only such lands as are used for this purpose. This county has a considerable proportion of this land, as it is largely interested in dairying.

Brush Swamp. — Alder swamps, wet areas having a sparse growth of young reproduction, as well as wet areas comprised of worthless species, come under this heading. Land worthless unless drained.

Residential. — This term explains itself. It also includes business sections, cemeteries, fair grounds, etc.

Water. — All inland waters fall under this classification: ponds, lakes, rivers and brooks. The figures are a little lower

than those of the Waterways Commission; but considering the necessarily rough method in which they were obtained, the results are very satisfactory.

HAMPSHIRE COUNTY.

Hampshire County lies in the central and western part of the State. Northampton is the county seat. There are four railroads crossing the county, — the Central Vermont, Boston & Maine and the New York, New Haven & Hartford, running through the eastern part, while the Boston & Albany cuts the southern part. The northwestern part is isolated from railroads on account of the topography being so rugged as to make it expensive to build a railroad across it.

The principal industries of this county are agriculture, dairying and lumbering. Some of the most fertile lands in the State are in the central section along the Connecticut River. The principal crops are tobacco, onions, corn and hay. Manufacturing is carried on to some extent in the larger towns, the products being paper, cotton, woolen goods and silk.

Lumbering is carried on to some extent throughout the western and northwestern sections. The central section in the Connecticut valley is almost entirely agricultural, while the eastern section is wooded, but the timber has been pretty well culled out.

Topography.

Hampshire County lies between the divide formed by the hills in Worcester County and the Berkshire Hills in Berkshire County. In fact, the western part of the county lies on the eastern slope of the Berkshire Hills. The principal streams draining this county are the Connecticut, Ware, Swift and Westfield rivers.

The topography of this county is very rugged for the most part, except along the Swift and Connecticut rivers, where the land is flat. The ridges run north and south, the highest elevations being in the western half, where they average 1,500 to 1,700 feet above the sea level. In the eastern half the elevations average between 500 to 1,200 feet above sea level. From these elevations they grade down to 100 feet above sea level at the Connecticut River.

Mount Tom, with an elevation of 854 feet above sea level, is one of the high points in the central section, as well as a popular summer resort.

Soil.

The soil of Hampshire County varies from clear sand through the Swift River valley to bare rock in the western part. In many places in the Swift River valley the soil reminds one very much of Cape Cod, — clear sand with few stones, distinct from any other. In the Connecticut valley section of the county the soil is deep loam, while in the western part the soil becomes poorer, with outcropping of rock occurring frequently. A few swamps were encountered containing muck, but all had an outlet. Taken as a whole, the county is well drained.

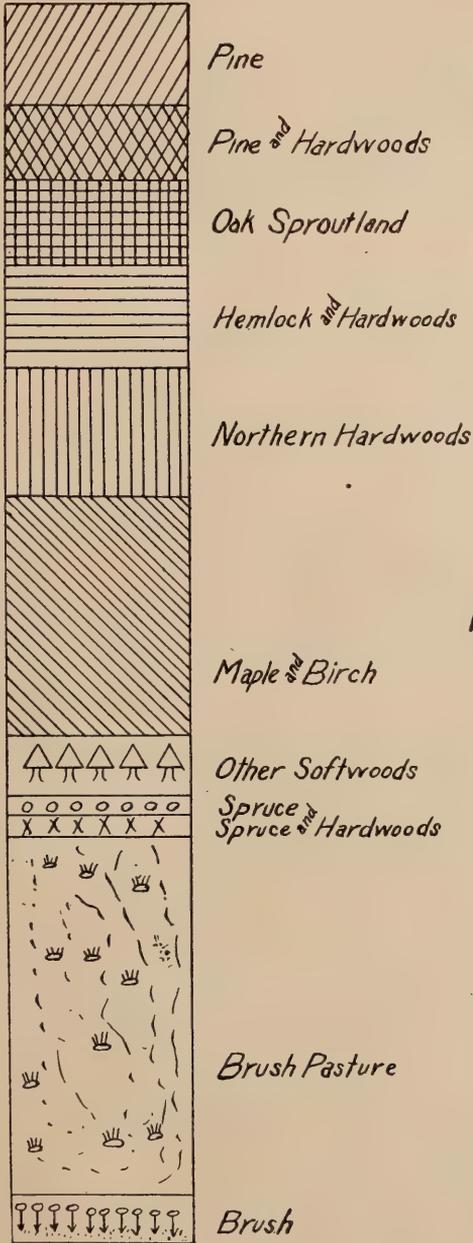
Forest Conditions.

Hampshire County lies both in the white pine region, which contains, as hardwoods, oak, hickory, gray birch and red maple, and, as conifers, white pine, pitch pine and cedar, and the spruce and hardwoods region, whose type of trees includes, for hardwoods, beech, white and yellow birch and rock maple, and, for the conifers, spruce and hemlock. Lying as it does in these two regions, its forest flora is extensive. As explained before, it has been necessary to group these various species into types, and we give herewith a table showing the area of these forest types and non-forest types for the whole county. It will be seen from this table that the forest area covers more than two-thirds of the county, or 69 per cent.

Three towns — Amherst, South Hadley and Hadley — were not surveyed on account of the large amount of agricultural land. If this had been done, the percentage of agricultural land would have been higher, a few of the forest types would change, while brush pasture would be lower.

The chestnut was considered as an extinct species, so wherever chestnut had occurred it was considered as brush or oak sproutland. It will be noted that 50 per cent of the forest cover is in brush, brush pasture and worthless red maple and gray birch. This fact should not be taken as a discouraging feature, as much of this area is a potential forest, and in a few years will produce valuable saw material, because there is bound to be some valuable species in mixture. Sixty-five per

FOREST 69%



NON-FOREST 31%

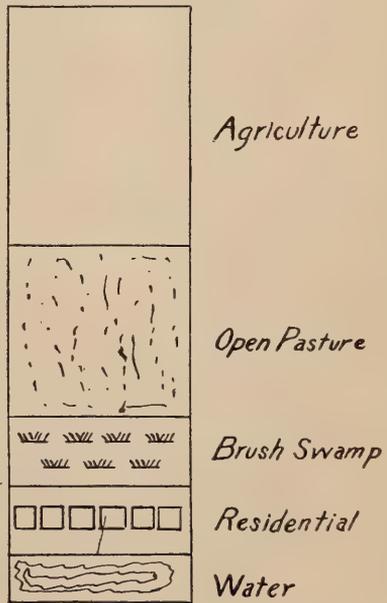


DIAGRAM SHOWING PROPORTION OF LAND TYPES FOUND IN HAMPSHIRE COUNTY.

cent of the forest area is below cordwood size; but that fact, again, should not alarm one, as naturally stands which have attained merchantable size are soon cut down, and the proportion of the larger sizes must always be low.

Total Land Types.

[Total 20 towns.]

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
	Acres.	Acres.	Acres.	Acres.	Acres.		
FOREST TYPES.							
Pine	5,500	7,862	5,306	554	19,222	8	-
Pine and hardwoods	7,135	5,950	541	-	13,626	6	-
Oak sproutland	10,837	4,876	736	1,116	17,565	7	-
Hemlock and hardwoods	5,755	10,028	4,772	11	20,566	9	-
Northern hardwoods	9,911	12,018	4,438	222	26,589	11	-
Maple and birch	34,363	13,534	1,103	24	49,024	20	-
Softwoods other than pine and spruce.	4,265	4,339	2,140	332	11,076	5	-
Spruce	792	845	454	-	2,091	1	-
Spruce and hardwoods	1,857	1,184	39	-	3,080	1	-
Brush pasture	65,257	-	-	-	65,257	29	-
Brush	6,205	-	-	-	6,205	3	-
Total	151,877	60,636	19,529	2,259	234,301	-	-
Percentage	65	26	8	1	-	100	69
	NON-FOREST TYPES.						
Agriculture					49,574	-	14
Open pasture					36,960	-	11
Brush swamp					10,205	-	3
Residential					5,837	-	2
Water					4,322	-	1
Total area of 20 towns					341,199	-	100

BELCHERTOWN.

This town does a very small amount of lumbering, as most of the merchantable timber has been cut off, the principal industries being dairying, agriculture and fruit growing. However, in the southern part of the town manufacturing and bleaching are carried on, thus developing the water power somewhat. Three railroads run into the town, thereby facilitating transportation.

The lumbering is done by two mills which cut pine, chestnut and oak. These manufacture lumber, ties and cordwood.

In the northeastern section of the town are many abandoned farms where reforestation may be done to advantage. There is also considerable cut-over land to be reforested. The soil and topography both lend themselves favorably to forest growth. There is considerable pine of the smaller diameter classes which should be properly managed so as to bring it to full timber capacity. This pine, together with reforestation work, should bring this town back to its former place as a timber-producing community.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
	Acres.	Acrès.	Acres.	Acres.	Acres.		
Pine	671	1,882	702	122	3,377	17	-
Oak sproutland	504	413	27	-	944	5	-
Northern hardwoods	47	212	193	-	452	2	-
Maple and birch	4,964	2,996	200	-	8,160	42	-
Softwoods other than pine and spruce.	652	413	71	-	1,136	6	-
Brush pasture	5,520 ¹	-	-	-	5,520	28	-
Total	12,358	5,916	1,193	122	19,589	-	-
Percentage	63	30	6	1	-	100	56
NON-FOREST TYPES.							
Agriculture					8,051	-	23
Open pasture					6,437	-	18
Brush swamp					864	-	2
Water					293	-	1
Total area of town					35,264	-	100

¹ Nine per cent of brush pasture is fit for planting without brushing.

CHESTERFIELD.

The principal industries of this town are farming, dairying and lumbering. At present there are four stationary mills of importance running. One at Bisbee Mill manufactures shingles and whip butts. There are two mills at West Chesterfield, one which manufactures ash baskets for laundry purposes, and the other saws lumber entirely. There is also a wood-turning plant called the "Nutshell," where the owner turns out picture

frames, napkin rings and various other souvenirs. In the north-western section of the town, on the Worthington line, there is a wood-turning mill which uses 25,000 to 30,000 feet of lumber annually in the manufacture of drum hoops, banjo and tambourine hoops, embroidery hoops, and frames for Christmas wreaths. The drum hoops are made from maple, and the banjo hoops from beech, birch and maple. There are also a few portable mills in operation here.

The town is well timbered with hemlock and beech, but on the whole it is so difficult to log that in all probability much of the timber will be allowed to remain. It is located on steep hillsides along the banks of the river, and in the bottom of deep gorges. There is more use for the hardwoods, so the hemlock is left. Four or five wood distillation plants were found, but these have been idle for many years.

Reforestation would be extremely difficult and expensive, owing to the heavy growth of mountain laurel on cut-over areas.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
					Acres.		
FOREST TYPES.							
Pine	96	166	194	-	456	3	-
Pine and hardwoods	91	259	-	-	350	2	-
Hemlock and hardwoods	531	2,663	1,484	-	4,678	29	-
Northern hardwoods	480	1,361	881	-	2,722	17	-
Birch and maple	1,309	117	-	-	1,426	9	-
Softwoods other than pine and spruce.	312	570	223	-	1,105	7	-
Spruce	104	73	-	-	177	1	-
Spruce and hardwoods	104	-	-	-	104	1	-
Brush pasture	5,038 ¹	-	-	-	5,038	31	-
Total	8,065	5,209	2,782	-	16,056	-	-
Percentage	51	32	17	-	-	100	77
NON-FOREST TYPES.							
Agriculture					2,541	-	12
Open pasture					1,361	-	7
Brush swamp					635	-	3
Water					143	-	1
Total area of town					20,736	-	100

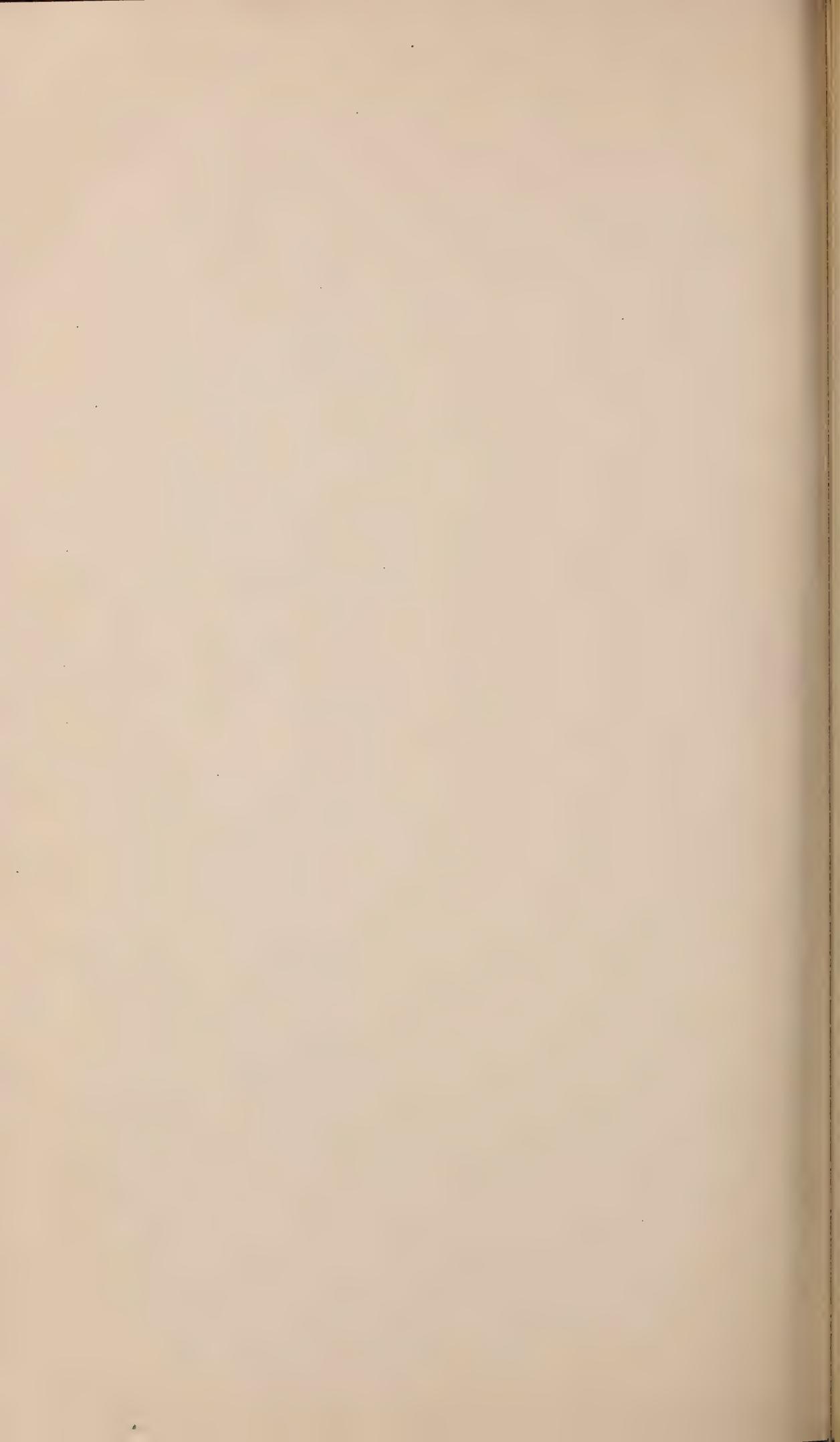
¹ Twenty-six per cent of brush pasture is fit for planting without any brushing.



Brush pasture type.



Brush swamp type.



CUMMINGTON.

The forests of this township consist chiefly of maple, beech, yellow birch and gray birch for hardwoods, and hemlock, spruce and white pine for softwoods. Other species found are white birch, poplar, oak, especially chestnut oak, and ash. The most prominent combinations are maple, beech and yellow birch in the valleys and on the slopes, and spruce and hemlock on the ridges. About 22 per cent of the forested land is cordwood size, 68 per cent is plantation land, and the remainder in the merchantable size classes. In the southeast corner of the town is a very good stand of merchantable hemlock. Another stand of pure beech is about two miles east of Cummington Center. On the Deer Hill State Reservation is a fine stand of chestnut oak.

At present there are almost no cutting operations going on except just north of the town, where there is some hemlock being cut. Many farmers own portable sawmills, but are not operating them at present. The L. L. Brown Paper Company formerly operated a mill in West Cummington, but in 1907 stopped work on account of lack of raw material. The Stevens Manufacturing Company cut about 160,000 feet of lumber in 1919.

About 37 per cent of the town is waste land or partially used for pasture. It lies almost entirely in the east, south and south central parts of the town. Most of this lies in one continuous strip in this town, and much more in Goshen and Worthington.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
	Acres.	Acres.	Acres.	Acres.	Acres.		
FOREST TYPES.							
Pine	45	52	30	7	134	1	-
Pine and hardwoods	126	89	30	-	245	2	-
Oak sproutland	22	26	67	-	115	1	-
Hemlock and hardwoods	754	639	215	11	1,619	15	-
Northern hardwoods	342	836	398	4	1,580	15	-
Maple and birch	1,882	451	104	-	2,437	23	-
Softwoods other than spruce and pine.	19	19	-	-	38	1	-
Spruce	178	236	152	-	566	5	-
Brush	3,856	-	-	-	3,856	37	-
Total	7,224	2,348	996	22	10,590	-	-
Percentage	68	22	9	1	-	100	73
NON-FOREST TYPES.							
Agriculture					624	-	4
Open pasture					2,571	-	18
Brush swamp					442	-	3
Residential					209	-	1
Water					156	-	1
Total area of town					14,592	-	100

EASTHAMPTON.

There is little or no merchantable timber in this town. The best timbered area is found in the northwestern part of the town, where trees of cordwood size and some isolated groups of merchantable timber occur. The rest of the town, fully 60 per cent, is either open land or grown up to brush, very thick in some sections. There is very little land available for plantation purposes. The land that is available for plantation purposes lies in the southwestern and central western part of the town. The chief species in large sizes are oak, maple, white birch and white pine. Other species are gray birch, pitch pine, hemlock and yellow birch. All chestnut is diseased or dead.

There are no lumbering operations in the town on account of lack of material. One lumber company (Pepin Lumber Com-

pany) consumes annually 50,000 to 75,000 board feet. This is cut outside the town. The Harris Automobile Wheel Company uses 10,000 feet of oak and 6,000 feet of hickory annually. The chief industry of this town is furnished by the West Boylston Mills, engaged in cotton weaving, and employing 3,000 hands. The remainder of the population are farmers, raising potatoes and tobacco.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine	51	210	95	-	356	9	-
Oak sproutland	1,181	203	25	-	1,409	34	-
Northern hardwoods	22	48	-	-	70	2	-
Maple and birch	800	-	-	-	800	20	-
Softwoods other than pine and spruce.	407	-	25	-	432	10	-
Brush pasture	1,003	-	-	-	1,003	25	-
Total	2,461	461	145	-	4,070	-	-
Percentage	80	15	5	-	-	100	45
NON-FOREST TYPES.							
Agriculture					2,079	-	22
Open pasture					1,989	-	21
Brush swamp					234	-	3
Residential					436	-	5
Water					344	-	4
Total area of town					9,152	-	100

ENFIELD.

The principal industries of this town are agriculture, dairying, lumbering and the manufacture of woolen cloth. At present the woolen mills are closed.

Although lumbering has been carried on extensively in the past, at present no mills of importance are running. In 1920 one portable mill, situated in the southeastern section of the town, cut 670,000 feet of lumber. On the same location cordwood is now being cut. This whole town has been cut over within the past five or six years, and has grown up to scrub oak, birch and maple.

The species found in this town are as follows: maple, gray birch, pitch pine, white pine, white birch, oak and dead chestnut.

Reforestation in this town would be expensive for two reasons, — first, because of the steepness of planting areas, and second, the crown density of sprout reproduction.

Poultry raising is one of the coming industries of this town. There are a number of large henneries, and from all reports good returns are being realized.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
Pine	Acres. 366	Acres. 248	Acres. 129	Acres. 3	Acres. 746	10	-
Oak sproutland	280	195	24	-	499	7	-
Maple and birch	1,602	719	-	-	2,321	30	-
Softwoods other than pine and spruce.	168	77	12	-	257	3	-
Brush pasture	3,839 ¹	-	-	-	3,839	50	-
Total	6,255	1,239	165	3	7,662	-	-
Percentage	82	16	2	-	-	100	68
NON-FOREST TYPES.							
Agriculture					2,025	-	18
Open pasture					1,027	-	9
Brush swamp					180	-	2
Residential					201	-	2
Water					1,027	-	9
Total area of town					11,200	-	100

¹ Ten per cent of brush pasture is fit for planting without brushing.

GOSHEN.

The principal industries of this town are berrying, agriculture and some lumbering. There are a few portable sawmills and one stationary mill on Dresser Pond in operation in this town.

The town is heavily wooded, containing mostly mixed hardwoods, though there are some good stands of pine, spruce, larch and hemlock. The species found in this town are hemlock, spruce, pine, beech, yellow birch and maple. Hemlock is the

predominating conifer in this section, with spruce second. Pine is scattered throughout the town, with an overstory of beech, maple and other hardwoods.

Reforestation can be carried on extensively in this town, as there are many acres now devoted to berry raising which could be planted with white pine, spruce or hemlock. Softwood reproduction has come in naturally on many of the cut-over areas.

There are also a number of pine plantations in this town. These are all growing rapidly and show what can be done along these lines.

Land Types.

FOREST TYPES.	APPROXIMATE SIZE CLASSES.				Total. Acres.	PER CENT.	
	4	3	2	1		Forest.	Town.
Pine	60	377	149	101	687	8	-
Hemlock and hardwoods	265	554	340	-	1,159	14	-
Northern hardwoods	284	794	469	-	1,547	19	-
Maple and birch	762	391	23	-	1,176	14	-
Softwoods other than spruce and pine.	121	173	403	50	747	10	-
Spruce	76	163	30	-	269	3	-
Spruce and hardwoods	44	6	-	-	50	1	-
Brush pasture	2,486 ¹	-	-	-	2,486	31	-
Total	4,098	2,458	1,414	151	8,121	-	-
Percentage	51	30	17	2	-	100	75
NON-FOREST TYPES.							
Agriculture					1,754	-	16
Open pasture					460	-	4
Brush swamp					403	-	4
Water					206	-	1
Total area of town					10,944	-	100

¹ Thirteen per cent of brush pasture is fit for planting without brushing.

GRANBY.

The soil of this town is better adapted for agriculture than for forestry. Consequently the practice of forestry is limited to such small area as to be of little importance.

The industries of this town are agriculture and dairying.

There are two stationary sawmills located here, but neither has been running for some time.

Reforestation can be practiced on the cut-over areas, but these are all limited in extent. Some of the areas now growing to gray birch or used for pasture should either be cultivated to farm crops or reforested in order to bring them back to their original value. Pine would grow well on these idle lands. As these lands stand at present, they are of no value.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
Pine	Acres. 490	Acres. 278	Acres. 100	Acres. 6	Acres. 874	12	-
Oak sproutland	585	478	-	-	1,063	14	-
Northern hardwoods	202	147	-	-	349	5	-
Maple and birch	1,684	705	113	-	2,502	33	-
Softwoods other than pine and spruce.	144	14	14	-	172	2	-
Brush pasture	2,532 ¹	-	-	-	2,532	34	-
Total	5,637	1,622	227	6	7,492	-	-
Percentage	75	22	3	-	-	100	43
NON-FOREST TYPES.							
Agriculture					6,433	-	36
Open pasture					3,044	-	17
Brush swamp					465	-	3
Water					166	-	1
Total area of town					17,600	-	100

¹ Eight per cent of brush pasture is fit for planting without brushing.

GREENWICH.

Forestry is practiced extensively in this town. The soil is very well adapted for forest growth, so the inhabitants have gone into forest management rather than agriculture. The family of William Walker have practiced forestry for more than a generation. They have used the selection system and thinned on a five to ten year basis. The stands of white pine are kept clear of brush and forest débris, so the fire hazard is kept down.

White pine is the principal species found in this town, represented by some very fine stands. Next in amount come pitch pine, maple, gray birch, oak, hemlock and dead chestnut.

The most important sawmill is owned and run by William Walker, together with a box factory. He keeps no tally, so no figures on amount cut are available. There are also many portable sawmills which have been operating, but at present have discontinued work.

This town has four large bodies of water, — Warner Pond, Curtis Pond, Greenwich Lake and Quabin Lake. On the shores of these lakes and ponds have been built many summer cottages, and on one there is a large summer camp called "Camp City," for Jewish orphans from New York, under construction.

One outstanding feature of the soil composition is the occurrence of large areas of completely barren sand. The edges of these areas are skirted with a belt of land on which hummocks of dry grass and sand are found, and back of this belt pitch pine is found and also stands of white pine. The soil, on the whole, is light loam.

Reforestation can be carried on in some parts of the town. Natural reproduction has taken hold well and is encouraged.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine	291	1,033	815	53	2,192	24	—
Oak sproutland	846	250	25	27	1,148	13	—
Maple and birch	1,067	695	—	—	1,762	20	—
Softwoods other than pine and spruce.	203	258	47	—	508	6	—
Brush pasture	3,364 ¹	—	—	—	3,364	37	—
Total	5,771	2,236	887	80	8,974	—	—
Percentage	64	25	10	1	—	100	70
NON-FOREST TYPES.							
Agriculture					1,943	—	15
Open pasture					1,104	—	9
Brush swamp					439	—	3
Residential					67	—	1
Water					273	—	2
Total area of town					12,800	—	100

¹ Fourteen per cent of brush pasture is fit for planting without brushing.

HATFIELD.

This is purely an agricultural town, as the woodland forms a very small part of the total area. The woodland is located on the hills along the western part of the town. Ties are produced, but not enough to be of any importance.

The town is situated on the bottom lands of the Connecticut River, and the soil is rich and fertile, the chief crops being tobacco, onions, corn and hay.

A white pine plantation is located on the border of the Northampton water commission's reservoir, in the northwestern corner of the town.

Reforestation should be practiced on the cut-over land on the hillsides.

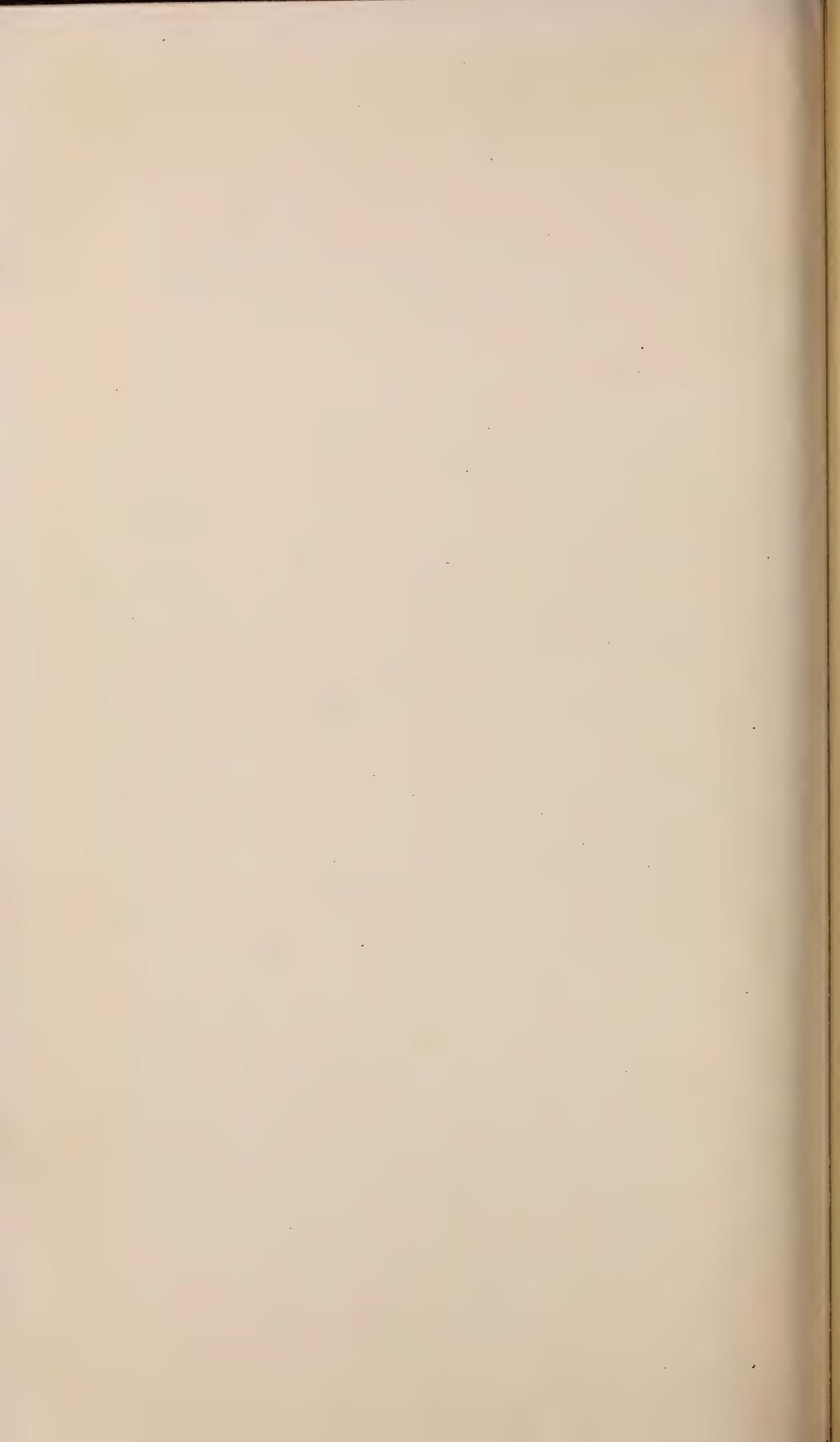
Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
	Acres.	Acres.	Acres.	Acres.	Acres.		
FOREST TYPES.							
Pine	51	6	-	-	57	1	-
Oak sproutland	165	201	37	-	403	10	-
Northern hardwoods	98	342	146	-	586	14	-
Maple and birch	644	85	-	-	729	18	-
Softwoods other than pine and spruce.	4	43	12	-	59	1	-
Brush pasture	2,290 ¹	-	-	-	2,290	56	-
Total	3,252	677	195	-	4,124	-	-
Percentage	79	16	5	-	-	100	37
NON-FOREST TYPES.							
Agriculture					5,626	-	51
Open pasture					159	-	1
Brush swamp					37	-	1
Residential					379	-	3
Water					747	-	7
Total area of town					11,072	-	100

¹ Two per cent of brush pasture is fit for planting without brushing.



Spruce type. Diameters, 6 to 10 inches; heights, 40 to 60 feet. (Class 2).



HUNTINGTON.

This town is chiefly concerned with lumbering. There are a stationary mill, three portable mills, two paper mills and a woolen mill in this town. The stationary mill belongs to H. E. Stanton, who manufactures lumber, box shooks and, in addition, frost blocks for the railroad. He uses chestnut in the manufacture of frost blocks. The portable mills are cutting in various parts of the town, but Mount Pisgah has been nearly all cut over, showing that a considerable portion of the timber was formerly on this mountain. There are many areas of good timber which have not as yet been cut.

On Mount Pisgah and in other places natural reproduction of pine and hemlock has come in. However, unless these cut-over areas are taken care of as soon as cut, laurel and brush grow up so as to make reforestation impracticable.

Northern hardwoods, consisting of yellow birch, beech, white birch and maple, comprise 30 per cent of the timbered area. Mixed hemlock and hardwoods are the next type of importance, comprising 22 per cent of the stand. Pine occurs in mixed stand with hardwoods, and to some extent pure, but only in the smaller-size classes.

There is also considerable land which has grown up to brush after being cut off. Fourteen per cent of this land is ready for planting without brushing, but there is also considerable land on which brushing must be done before reforestation will take place successfully.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total. Acres.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
Pine	247	239	140	7	633	5	-
Pine and hardwoods	129	297	39	-	465	4	-
Hemlock and hardwoods	916	1,329	755	-	3,000	22	-
Northern hardwoods	1,148	2,335	387	194	4,064	30	-
Maple and birch	329	-	-	-	329	2	-
Softwoods other than spruce and pine.	366	421	235	39	1,061	8	-
Brush pasture	3,893 ¹	-	-	-	3,893	29	-
Total	7,028	4,621	1,856	240	13,445	-	-
Percentage	52	34	13	1	-	100	77
NON-FOREST TYPES.							
Agriculture					2,516	-	14
Open pasture					1,226	-	7
Brush swamp					39	-	1
Water					182	-	1
Total area of town					17,408	-	100

¹ Fourteen per cent of brush pasture is fit for planting without brushing.

MIDDLEFIELD.

The timber found in this town consists of maple, beech, yellow, gray and white birch and poplars for hardwoods, and hemlock, spruce and white pine for softwoods. Other species found are willow, ash, butternut, linden and larch. About 48 per cent of the first group of species is in Class 4, 39 per cent in Class 3, and 13 per cent in Class 2. The merchantable species include, principally, maple, beech, yellow birch, hemlock, spruce and some white pine. Sixty-three per cent of the town is forested.

The chief industries are dairying and farming to a slight extent. Forest industries include cordwood operating, and one portable sawmill cutting pine, hemlock and hardwoods.

The soil conditions are of such character as to make agriculture almost impossible. Consequently, the land should be used for forestry. About 30 per cent of the town can be planted and thus bring the town up to its full forest capacity. Reproduction is coming in naturally on the cut-over and waste land.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine	380	-	30	-	410	4	-
Oak sproutland	753	655	20	-	1,428	13	-
Hemlock and hardwoods	891	1,664	721	-	3,276	30	-
Northern hardwoods	511	321	177	-	1,009	9	-
Maple and birch	1,867	838	151	-	2,856	26	-
Softwoods other than pine and spruce.	92	-	-	-	92	1	-
Spruce	13	66	52	-	131	1	-
Spruce and hardwoods	177	269	39	-	485	4	-
Brush pasture	1,263	-	-	-	1,263	12	-
Total	5,947	3,813	1,190	-	10,950	-	-
Percentage	54	35	11	-	-	100	71
NON-FOREST TYPES.							
Agriculture					318	-	2
Open pasture					2,209	-	14
Brush swamp					1,868	-	12
Water					143	-	1
Total area of town					15,488	-	100

NORTHAMPTON.

The forests of this town consist largely of stands of oak, maple and gray birch, with dying chestnut. These species are almost entirely of small size. Other species found are hickory, white birch and pine, mixed with hardwoods, elm, poplar, etc. There is very little merchantable timber left except a small stand of white pine of large size on the grounds of the State insane hospital, and a small amount of oak, dead chestnut, maple and birch of medium growth on the western slopes of Bald Hill in the southwest.

There are no lumber operations in this town. Two hundred and fifty cords of wood have been cut on Bald Hill by Leigh Gerick, a coal and wood dealer from Chicopee, Mass.

Land ready for planting lies in small isolated areas throughout the town. These should be reforested and all natural reproduction encouraged.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT. †	
	4	3	2	1		Forest.	Town.
	Acres.	Acres.	Acres.	Acres.	Acres.		
FOREST TYPES.							
Pine	408	260	248	16	932	8	-
Oak sproutland	2,628	200	48	-	2,876	22	-
Northern hardwoods	1,444	368	-	-	1,812	15	-
Maple and birch	3,460	280	-	-	3,740	30	-
Softwoods other than pine and spruce.	224	40	24	40	328	3	-
Brush pasture	2,672	-	-	-	2,672	22	-
Total	10,836	1,148	320	56	12,360	-	-
Percentage	88	8.6	3	.4	-	100	48
NON-FOREST TYPES.							
Agriculture					4,983	-	19
Open pasture					3,183	-	12
Brush swamp					672	-	3
Residential					3,639	-	14
Water					1,113	-	4
Total area of town					25,950	-	100

PELHAM.

The timber growth of this town consists of maple, gray birch, pitch pine, white pine, hemlock, oak, white birch and dead chestnut. Two mills are cutting the chestnut, maple, birch, pine and oak into ties, posts, box boards, lumber and cordwood. Chaffee Brothers of Oxford are cutting 800,000 feet of timber at the present location, and expect to cut 4,000,000 feet before the job is completed. This mill's chief output is box boards, but ties and lumber are also produced.

Lumbering has gone on in this town for a number of years, and at the same time nothing has been done to replace the cut timber. Consequently there are large areas of cut-over land which are producing nothing but brush. This brush is left where it falls, thus increasing the fire risk.

Plenty of opportunity for reforestation is to be had on the cut-over areas. Forty-five per cent of the town is in the maple and birch type, which is the type coming in on the old

cut-over land. This type at best is only good for cordwood, and uses up the space which should be put to growing better timber.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine	258	736	669	63	1,726	13	-
Hemlock and hardwoods	28	71	-	-	99	1	-
Northern hardwoods	393	486	257	-	1,136	9	-
Maple and birch	2,345	3,419	43	-	6,007	45	-
Softwoods other than pine and spruce.	43	334	82	-	459	3	-
Brush pasture	3,924 ¹	-	-	-	3,924	29	-
Total	7,191	5,046	1,051	63	13,351	-	-
Percentage	54	37.6	8	.4	-	100	83
NON-FOREST TYPES.							
Agriculture					1,541	-	10
Open pasture					973	-	6
Brush swamp					199	-	1
Total area of town					16,064	-	100

¹ Eight per cent of brush pasture is fit for planting without brushing.

PLAINFIELD.

The forests of this town consist chiefly of maple, beech, yellow and gray birch for hardwoods, and spruce and hemlock for softwoods. Other species found are white birch, butternut, linden, poplar and cherry. Sixty-nine per cent of the forested area is in Class 4, 22 per cent in Class 3, while the remainder, mostly hardwoods, is in Class 2. Almost the only timber of merchantable size is beech and maple in small areas.

The plantation land lies in small scattered strips. Although it is in small strips, nevertheless it should be taken care of and reforested.

The industries of this town are a slight amount of farming, dairying and lumbering. Only one lumber mill is in the town, which is owned by G. L. Willcut, cutting 25,000 feet of maple from his own farm. He manufactures this maple into interior finish and flooring.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
	Acres.	Acres.	Acres.	Acres.	Acres.		
FOREST TYPES.							
Pine	-	-	115	-	115	1	-
Pine and hardwoods	182	-	200	-	382	3	-
Oak sproutland	1,089	-	-	-	1,089	9	-
Hemlock and hardwoods	160	344	74	-	578	5	-
Northern hardwoods	3,082	902	370	-	4,354	36	-
Maple and birch	1,521	474	227	-	2,222	18	-
Softwoods other than pine and spruce	115	105	41	-	261	2	-
Spruce	-	-	153	-	153	1	-
Spruce and hardwoods	1,065	695	-	-	1,760	14	-
Brush pasture	682	-	-	-	682	5	-
Brush	607	-	-	-	607	5	-
Total	8,503	2,520	1,180	-	12,203	-	-
Percentage	70	21	9	-	-	100	87
NON-FOREST TYPES.							
Agriculture					575	-	4
Open pasture					765	-	6
Brush swamp					317	-	2
Water					92	-	1
Total area of town					13,952	-	100

PRESCOTT.

The larger percentage of the town is composed of agricultural and cut-over lands. Of the remaining land, the forest cover is made up of the following species in order of their importance as to area covered: maple, gray birch, oak, pitch pine, white pine and hemlock.

Dairying is the largest industry, and is carried on in most places according to modern methods. Lumbering is a minor industry at present, there being but little timber of saw log size to be found, though there are a few small tracts that contain some fine white pine, hemlock and white oak. Cutting is chiefly confined to dead chestnut, and there seems to be a desire to clear cut all chestnut as rapidly as possible. Lumbering

has been carried on extensively during the past five years, but at present there seem to be no indications of further operations.

The soil conditions in the town are such as to make the growing of timber very profitable. Many old abandoned farms and cut-over areas should be planted so as to reforest the town. Some of the cut-over areas, however, would be expensive to plant because of heavy reproduction of scrub oak, laurel, etc.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine	178	540	750	85	1,553	17	-
Pine and hardwoods	39	135	-	-	174	2	-
Oak sproutland	153	402	170	-	725	8	-
Northern hardwoods	10	26	-	-	36	1	-
Maple and birch	1,166	762	-	-	1,928	20	-
Softwoods other than spruce and pine.	96	258	335	131	820	9	-
Brush pasture	3,878 ¹	-	-	-	3,878	43	-
Total	5,520	2,123	1,255	216	9,144	-	-
Percentage	61	23	14	2	-	100	78
NON-FOREST TYPES.							
Agriculture					1,468	-	13
Open pasture					1,012	-	8
Brush swamp					118	-	1
Total area of town					11,712	-	100

¹ Five per cent of brush pasture is fit for planting without brushing.

SOUTHAMPTON.

The forests of this town consist largely of oak, chestnut, gray birch, maple, pine, hickory and poplar. The largest per cent is in Class 4, but there is considerable oak, white birch, white pine and maple of Class 3. There still remain several good stands of white pine, oak, white and yellow birch and maple of Classes 1 and 2. The best timbered areas are in the western and northern sections. Fires have recently burned over several hundred acres in the north, which are now covered with a thick growth of juniper and ground hemlock. Almost all of the chestnut of Classes 2 and 3 has been cut or is now being cut.

Many small woodlot owners are cutting cordwood. Two operators in 1919 cut the following: H. J. Williams, 80,000 feet of chestnut, and E. K. Parsons, 500 feet of pine, chestnut, oak and birch.

Agriculture is carried on extensively by almost the whole population, corn, tobacco, and potatoes being the principal crops planted.

In the southeastern section of the town are several large tracts that are an absolute waste. Reforestation would take care of these admirably.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total. Acres.	PER CENT.	
	4	3	2	1		Forest.	Town.
	Acres.	Acres.	Acres.	Acres.			
FOREST TYPES.							
Pine	452	696	357	30	1,535	11	-
Oak sproutland	3,193	634	161	-	3,988	30	-
Northern hardwoods	71	-	24	-	95	1	-
Maple and birch	3,017	506	83	-	3,606	27	-
Softwoods other than pine and spruce.	220	250	161	12	643	5	-
Brush pasture	3,445	-	-	-	3,445	25	-
Brush	70	-	-	-	70	1	-
Total	10,468	2,086	786	42	13,382	-	-
Percentage	78	15.7	6	.3	-	100	77
NON-FOREST TYPES.							
Agriculture					1,316	-	8
Open pasture					1,630	-	8
Brush swamp					928	-	5
Residential					146	-	1
Water					70	-	1
Total area of town					17,472	-	100

WARE.

The greater part of this town is made up of agricultural, pasture and cut-over lands. On the remaining sections the following species are found in order of importance as to volume: maple, white pine, gray birch, pitch pine, hemlock, yellow birch, ash and dead or dying chestnut. Very little saw timber is left except on isolated areas, though there is a good reproduction

coming in, much of which, however, will be of inferior quality, comprising mostly birch and maple. There are a few good stands of pine of good quality, and a little spruce and larch, but not in any great quantity.

All available land has been cleared for agriculture, so there are few areas left for timber. All logging operations have been discontinued, although several sawmills are located here.

Manufacturing of cotton, wool and paper, together with farming, comprise the industries here. As the greater portion of the town is better fitted for other purposes, extensive reforestation is not advisable except in a few isolated sections.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
Pine	200	255	263	15	733	6	-
Oak sproutland	173	513	72	-	758	6	-
Maple and birch	2,448	696	40	-	3,184	26	-
Softwoods other than spruce and pine.	160	216	34	-	410	3	-
Brush pasture	7,212 ¹	-	-	-	7,212	59	-
Total	10,193	1,680	409	15	12,297	-	-
Percentage	83	13.9	3	.1	-	100	66
NON-FOREST TYPES.							
Agriculture					3,623	-	19
Open pasture					2,060	-	11
Brush swamp					515	-	3
Residential					238	-	1
Water					19	-	1
Total area of town					18,752	-	100

¹ Twenty-five per cent of brush pasture is fit for planting without brushing.

WESTHAMPTON.

The timber in this town has been cut off almost entirely, with the exception of a few woodlots owned by private individuals. On these lots are found pine, hemlock and hardwoods in the merchantable size Classes 1 and 2. On a greater portion of the land cordwood is cut, even to as small a diameter as 2 and 3 inches.

Lumbering is and has been for some time the principal industry here. Ties and lumber are the products manufactured. One mill of importance, owned by Frank Loud, cuts lumber, clapboards, shingles, etc.

The slopes in this town are very steep, in some places so much so as to make logging difficult and expensive.

Reproduction is good in the greater part of the town, thus making reforestation unnecessary.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.	Acres.	Acres.	Acres.	Acres.	Acres.		
Pine	167	67	222	47	503	3	-
Pine and hardwoods	191	227	-	-	418	3	-
Oak sproutland	36	238	-	-	274	2	-
Hemlock and hardwoods	233	1,240	572	-	2,045	13	-
Northern hardwoods	1,296	2,158	370	-	3,824	25	-
Maple and birch	728	12	-	-	740	5	-
Softwoods other than pine and spruce.	774	535	248	60	1,617	11	-
Brush pasture	5,740 ¹	-	-	-	5,740	38	-
Total	9,165	4,477	1,412	107	15,161	-	-
Percentage	60	30	9	1	-	100	85
NON-FOREST TYPES.							
Agriculture					1,144	-	6
Open pasture					1,223	-	7
Brush swamp					119	-	1
Water					145	-	1
Total area of town					17,792	-	100

¹ Twenty-six per cent of brush pasture is fit for planting without brushing.

WILLIAMSBURG.

The forest growth of this town consists largely of stands of maple, gray birch, hemlock, pine and oak, with considerable dead or dying chestnut. Other species found include hickory, yellow birch, butternut, beech and some white birch. Thirty-eight per cent of the wooded areas is in Class 4, although there are several good stands of mixed hardwoods and white pine of Classes 1, 2 and 3. Good stands of mixed hardwoods are found

on High Ridge, hemlock and mixed hardwoods on Petticoat Hill Reservation, and west of Unquomonk Hill is found a considerable stand of hemlock.

There is but one company operating at present in this town, which cut 400,000 feet of lumber in Williamsburg, and 600,000 feet from Goshen and Chesterfield in 1919. All of this timber was sawed into lumber at the Bradford Lumber Company's mill at Haydenville, and manufactured into crates, barrels, whip handles, etc. A mill at Searsville did not operate in 1919, but had a million feet of logs in the yard to cut in 1920. Hill Brothers Company uses 15,000 to 20,000 feet annually in the manufacture of spools, butter-tubs, etc. There are also a number of farmers owning portable mills and sawing ties and lumber during the winter.

There is a considerable area of plantation land in the southeastern part of the town extending over Day's and Shingle Hill, also along the northeastern border.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total. Acres.	PER CENT.	
	4	3	2	1		Forest.	Town.
FOREST TYPES.							
Pine	468	402	337	12	1,219	10	-
Pine and hardwoods	276	288	132	-	696	5	-
Oak sproutland	318	468	60	-	846	7	-
Hemlock and hardwoods	936	576	144	-	1,656	13	-
Northern hardwoods	1,337	813	192	24	2,366	19	-
Maple and birch	1,487	228	12	24	1,751	13	-
Softwoods other than pine and spruce.	72	192	73	-	337	3	-
Brush pasture	2,831	-	-	-	2,831	22	-
Brush	1,054	-	-	-	1,054	8	-
Total	8,779	2,967	950	60	12,756	-	-
Percentage	69	23	7	1	-	100	78
NON-FOREST TYPES.							
Agriculture					907	-	6
Open pasture					1,293	-	8
Brush swamp					717	-	4
Residential					522	-	3
Water					125	-	1
Total area of town					16,320	-	100

WORTHINGTON.

The forests of this town consist chiefly of maple, beech, yellow and gray birch for hardwoods, and hemlock and white pine for softwoods. Other species found are white birch, ash, linden, poplar and butternut. Fifty-nine per cent of the forested land is in Class 4, 25 per cent in Class 3, and the remainder in Classes 3 to 2 or 2. Mostly beech and maple are in Class 2. No large tracts of merchantable timber were found. A good stand of planted pine was found in the southeastern corner. Only about 40 per cent of the town is forested, but a considerable per cent of pasture land is growing up to a good growth of white pine. Most of the northwestern part of the township is covered with second or third growth timber. The northeastern part is mostly pasture or mowing, with small patches of brush or timber.

T. K. Higgins cuts and uses 10,000 feet annually in the manufacture of white ash baskets and novelties. Many farmers own and operate portable mills, cutting 10,000 feet annually, consisting chiefly of hardwoods. No large operations are carried on.

In the northeastern part of the township lie 400 acres of plantation land. Other areas of plantation land are scattered throughout the township.

Land Types.

	APPROXIMATE SIZE CLASSES.				Total.	PER CENT.	
	4	3	2	1		Forest.	Town.
	Acres.	Acres.	Acres.	Acres.	Acres.		
FOREST TYPES.							
Pine	621	300	93	-	1,014	6	-
Pine and hardwoods	601	300	140	-	1,041	6	-
Hemlock and hardwoods	1,041	948	467	-	2,456	15	-
Northern hardwoods	481	1,682	1,455	-	3,618	22	-
Maple and birch	1,081	160	107	-	1,348	8	-
Softwoods other than pine and spruce.	73	421	100	-	594	4	-
Spruce	421	307	67	-	795	5	-
Spruce and hardwoods	467	214	-	-	681	4	-
Brush pasture	3,645	-	-	-	3,645	22	-
Brush	1,295	-	-	-	1,295	8	-
Total	9,726	4,332	2,429	-	16,487	-	-
Percentage	59	26	15	-	-	100	79
NON-FOREST TYPES.							
Agriculture					107	-	1
Open pasture					3,204	-	15
Brush swamp					1,002	-	5
Total area of town					20,800	-	100

55.00
13872

COMMONWEALTH OF MASSACHUSETTS

GENERAL FOREST LAWS

*State Forests, Reforestation, Nurseries, Taxation, Shade Trees
Town Forests. Forest Fire Laws and Laws relating to
Gypsy Moths are published in separate pamphlets.*



DEPARTMENT OF CONSERVATION

FORESTRY DIVISION

Publication of this Document
approved by the
Commission on Administration and Finance

MASSACHUSETTS FOREST LAWS

DEPARTMENT OF CONSERVATION.

G. L., c. 21 § 1. **Organization of department.** There shall be a department of conservation, consisting of a division of forestry, a division of fisheries and game and a division of animal industry, each under the charge of a director. The department shall be under the supervision and control of a commissioner of conservation. The directors shall act as an advisory council to the commissioner.

G. L., c. 21, § 2. Amended Acts 1923, c. 369. **Appointment and salary of commissioner.** Upon the expiration of the term of office of a commissioner, his successor shall be appointed for three years by the governor, with the advice and consent of the council. The commissioner shall receive such salary, not exceeding six thousand dollars, as the governor and council determine.

G. L., c. 21, § 3. **Duties of commissioner.** The commissioner shall be the executive and administrative head of the department. He shall be designated by the governor as a director of one of the divisions, but shall receive no salary as such director. He shall supervise the work of the divisions, and shall have charge of the administration and enforcement of all laws which it is the duty of the department to administer and enforce, and shall direct all inspections and investigations.

DIVISION OF FORESTRY.

Appointment and Duties of State Forester.

G. L., c. 21, § 4. **Appointment, qualifications and salary of state forester.** Upon the expiration of the term of office of a director of the division of forestry, his successor shall, except as provided by the preceding section, be appointed for three years by the governor, with the advice and consent of the council. The director shall be known as the state forester. He shall be qualified by training and experience to perform the duties of his office, and shall, except as provided by the preceding section, receive such salary, not exceeding five thousand dollars, as the governor and council determine.

G. L., c. 21, § 5. **Appointment of fire warden and other assistants. Traveling expenses.** The director may, subject to the approval of the commissioner, appoint and remove a state fire warden and such experts, clerical and other assistants as the work of the division may require, and fix their compensation. The director shall be allowed necessary traveling expenses for himself and his employees incurred in the discharge of duty.

G. L., c. 132, § 1. **Duties of state forester.** The state forester, in this chapter called the forester, shall act for the commonwealth in suppressing the gypsy and brown tail moths; shall promote the perpetuation, extension and proper management of the public and private forest lands of the commonwealth; shall give such a course of instruction to the students of the Massachusetts Agricultural College on the art and science of forestry as may be arranged by the trustees of the college and the forester; and shall perform such other duties as may be imposed upon him by the governor and council.

G. L., c. 132, § 4. **Annual report.** The commissioner shall make an annual report of the acts of the forester. The report shall separate so far as practicable the expenditures on work against the gypsy moth from those on work against the brown tail moth in each town. It shall include the account of all money invested in each state forest and of the annual income and expense thereof, and the report of the state fire warden required by section twenty-eight of chapter forty-eight.

Advice to Owners.

G. L., c. 132, § 6. **Advice to owners of forests.** The forester may give to any person owning or controlling forest lands aid or advice in the management thereof. Any recipient of such aid or advice shall be liable to the commonwealth for the necessary expenses of travel or subsistence incurred by him or his assistants. The forester may publish the particulars and results of any investigation made by him or his assistants as to any lands within the commonwealth, and the advice given.

Forest Nurseries.

G. L., c. 132, § 9. **Maintenance of tree nurseries.** The forester may establish and maintain nurseries for the propagation of forest tree seedlings upon such lands of the commonwealth at any state institution as the superintendent or trustees thereof may set apart for this purpose. Superintendents of institutions where land is set apart therefor may furnish without charge the labor of their inmates necessary to establish and maintain said nurseries. Seedlings from these nurseries shall be furnished to the commonwealth without expense for use upon reservations set aside for the propagation of forest growths for other than park purposes. All stock grown in nurseries established under this section shall be used within the commonwealth and shall be furnished to state institutions without charge. The forester may distribute seeds and seedlings to land owners, citizens of the commonwealth, under such conditions and restrictions as he may determine, subject to the approval of the governor and council.

Reforestation.

G. L., c. 132, § 10, as amended by c. 271, Acts of 1921. **Lands for experiments in forest management.** The commissioner, with the advice and consent of the governor and council, for experiment and illustration in forest management and for reforestation as set forth in this section may expend annually such sum as is appropriated by the general court in purchasing lands situated within the commonwealth and adapted to forest production. Land so acquired shall be under the control and management of the forester, who may, subject to the approval of the governor and council, cut and sell trees, wood and other produce therefrom. The price of such land shall not exceed in any instance five dollars per acre, nor shall more than eighty acres be acquired in any one tract in any one year except that a greater area may so be acquired if the land purchased directly affects a source or tributary of water supply in any town of the commonwealth. All such lands shall be conveyed to the commonwealth, and no lands shall be paid for nor shall any money be expended in improvements thereon until all instruments of conveyance and the title to be transferred thereby have been approved by the attorney general, and until such instruments have been executed and recorded. For assisting in reforestation a portion, not exceeding twenty per cent of the money authorized to be expended under this section may be used by the forester for the distribution, at not less than cost, of seeds and seedlings to land owners who are citizens of the commonwealth, under such conditions and restrictions as the forester, subject to the approval of the governor and council, may impose. The owners

of land purchased under this section, or their heirs and assigns, may repurchase the land within ten years after the purchase, upon paying the price originally paid by the commonwealth, with interest at the rate of four per cent per annum, together with the amount expended in improvements and maintenance. The commissioner, with the approval of the governor and council, may execute in behalf of the commonwealth such deeds of reconveyance as may be necessary, and every such deed shall contain a restriction that trees planted by the commonwealth of less than eight inches in diameter at the butt shall not be cut from such property except with the approval of the forester.

G. L., c. 132, § 5. **Management of forest lands.** The forester shall replant or otherwise manage all land acquired by the commonwealth and held by it under section ten in such manner as will produce the best forest growth both as to practical forestry results and protection of water supplies.

Acts of 1923, chapter 288, allows the commissioner of conservation to sell or exchange under certain restrictions land acquired under section ten and to grant rights of way over such lands. See State Forest Law Section 34a.

Bequests and Gifts.

G. L., § 2, as amended by Acts of 1924, c. 284. The commissioner of conservation, in this chapter called the commissioner, with the approval of the governor and council, may accept on behalf of the commonwealth bequests or gifts to be used for the purpose of advancing the forestry interests of the commonwealth, under the direction of the governor and council, or for the laying out, construction or maintenance of state trails or paths, in such manner as to carry out the terms of the bequests or gifts. The commissioner shall forthwith transfer any such bequest or gift of money or securities to the state treasurer, who shall invest, reinvest and administer it in the manner provided by section sixteen of chapter ten and shall be liable on his bond for the faithful management thereof. The commissioner may, subject to the approval of the deed and title by the attorney general as provided in section ten, accept on behalf of the commonwealth gifts of land to be held and managed for the purpose provided in said section. A donor of such land may reserve the right to buy back the land in accordance with said section; but in the absence of a provision to that effect in his deed of gift he shall not have such right.

State Forest Law.

G. L., c. 132, § 30, as amended by Acts of 1923, c. 288. **State Forests.** The commissioner with the approval of the advisory council of the department of conservation, may acquire for the commonwealth, by purchase or otherwise, any hold, or, with the approval of the governor and council, may take in fee by eminent domain under chapter seventy-nine, any woodland or land suitable for timber cultivation within the commonwealth or any land necessary for the erection and operation of forest fire observation towers. The average cost of land so purchased shall not exceed five dollars an acre.

G. L., c. 132, § 31. **Management of state forests.** Lands acquired under the preceding section shall be known as state forests, and shall be under the control and management of the forester. He shall reforest and develop such lands, and may, subject to the approval of the commissioner and advisory council of the department of conservation, make all reasonable regulations which in his opinion will tend to increase the public enjoyment and benefit therefrom and to protect and conserve the water supplies of the commonwealth.

G. L., c. 132, § 32. **Approval for expenditure.** The forester, subject to the approval of the commissioner and advisory council of the department of conservation, may expend such sums as are annually appropriated for the necessary expenses incurred under section thirty-one.

G. L., c. 132, § 33, as amended by Acts of 1923, c. 288. **Purchase and development of state land.** In addition to lands acquired under section thirty the commissioner may purchase or, with the approval of the governor and council, take by eminent domain under chapter seventy-nine and hold for state forest lands within the commonwealth suitable for the production of timber to the extent of not more than one hundred thousand acres. The land shall be purchased before August fifth, nineteen hundred and thirty-five, at a rate not exceeding an average cost of five dollars per acre or at such price as the general court may from time to time determine. The forester shall reclaim the said lands by replanting or otherwise in order to produce timber and to protect the water supply of the commonwealth. The forester may employ temporarily such persons as foresters, assistant foresters, engineers, surveyors, forest fire observers and foremen as he deems necessary to assist him in carrying out his duties under this section, and the employment of such persons shall not be subject to chapter thirty-one.

G. L., c. 132, § 34. **Rules for use of state forests.** The commissioner may make rules and regulations relative to hunting and fishing or other uses of any such land, provided that such rules and regulations shall be consistent with all laws in relation to the protection of fish, birds and quadrupeds.

G. L., c. 132, § 34A. **Sale or exchange of lands and rights of way.** The commissioner with the approval of the governor and council, and after a public hearing, may sell or exchange any land acquired by the commonwealth under section ten, thirty or thirty-three, or under chapter three hundred and forty-four of the acts of nineteen hundred and twenty-one, and may in like manner grant rights of way for public highways over any such land, if in his judgment such sale, exchange or grant is advantageous to the commonwealth, and may execute such deeds of conveyance or other papers as may be necessary; and the commissioner may also grant over or across any such lands such locations as shall be found by order of the department of public utilities, after public hearing, to be required by public necessity or convenience for telephone, telegraph or electric light or power transmission lines, and as in his judgment are necessary and will serve the public interest, and may execute such papers as may be necessary; provided that no sale or exchange of any land or interest therein acquired by the commonwealth under said section ten, or grant either of right of way or location over or across the same shall be made prior to the expiration of the option of repurchase given by said section, unless the holder of the option joins in the sale, exchange or grant.

At the request of the commissioner, and after public hearing, the department of public utilities may by order alter or revoke any such location whenever in its opinion the public interest or the rights of the commonwealth so require; provided, that before so doing notice of said hearing shall be given to the grantee of the location and all persons interested, and provided, further that the grantee or any person interested in such order may appeal therefrom to the governor and council within fourteen days after the filing of a copy of such order as provided in the following paragraph:

The commissioner within fourteen days after granting any such location shall file a copy of the grant of the same, together with a copy of the order of the department of public utilities that the location is required by public necessity or convenience, in the office of the clerk of the town where the location is granted, and the department of public utilities shall file in the office of said clerk any order altering or revoking such location, and the clerk of such town shall receive and record the same.

G. L., c. 132, § 7. **Labor on state forests.** The forester, in the reforestation, maintenance and development of lands purchased under section thirty or thirty-three, shall, so far as practicable, obtain the labor necessary therefor under sections eighty-three and eighty-four of chapter one hundred and twenty-seven.

G. L., c. 132, § 36. **Appropriations.** To meet the expenditures authorized by sections thirty-three to thirty-five, inclusive, the said department may expend before August fifth, nineteen hundred and thirty-five, such sums not exceeding three million dollars as the general court may from time to time appropriate.

Note: Private property erected on state forests is subject to local taxation payable by the owner. See Acts 1922, chapter 216.

STATE TRAILS.

G. L., c. 132, § 38. The commissioner may lay out, construct and maintain trails or paths through or over lands in state forests and in public reservations and trails or paths leading to important mountains and other objects and places of special interest and beauty and he may connect such trails or paths in order to make them continuous so far as practicable. The commissioner on behalf of the commonwealth may purchase such lands or easements therein as may be necessary for the aforesaid purposes. He may post such trails or paths, erect signs thereon and construct suitable rest camps or shelters at appropriate places. He may by special permit in writing allow portions of such trails or paths to be enclosed and used by the owner of adjoining land, for any use not interfering with public passage on foot, during the whole or any part of the year upon such conditions as the commissioner may prescribe and such permits may be revoked at his pleasure. The commonwealth shall not be liable for injury or damage sustained on such trails or paths.

SECTION 39. The mayor, selectmen or road commissioners, or the board or officer having charge of the maintenance and care of highways, if so authorized by the city council or by the town, may agree in writing, on behalf of such city or town, to contribute money, labor or materials toward the laying out or construction of any state trail or path which the commisioner may lay out and construct within such city or town.

TOWN FOREST LAW.

G. L., c. 132, § 35. Amended Acts of 1924, c. 24. **Forests in cities and towns.** Towns may acquire by purchase, gift or bequest lands for the purpose of forestation and may reclaim and plant such lands. The said department may upon application in such form as the forester may prescribe furnish such towns free of charge with seedlings for the planting of their lands.

G. L., c. 45, § 19. **Laying out and use of public domain.** A town, by a two-thirds vote at an annual town meeting, or a city, by a two-thirds vote of the city council, may determine to take or purchase lands within its limits, which shall be a public domain, and may appropriate money and accept gifts of money and land therefor. Such public domain shall be devoted to the culture of forest trees, or to the preservation of the water supply of such city or town, and the title thereto shall vest in the city or town in which it lies, except that cities or towns owning land within the territorial limits of other cities and towns for water supply purposes may, as herein provided, convert such land into a public domain and retain the title thereto.

G. L., c. 45, § 20. **Taking by eminent domain.** If a city or town has determined to take land for a public domain as provided by the preceding section, the aldermen or the selectmen shall within ten days adopt an order for the taking of such land in fee by eminent domain under chapter seventy-nine.

G. L., c. 45, § 21. **Management of town forests.** In each city or town which has a public domain as defined under sec. 19, the mayor or selectmen shall appoint a forester, who may appoint one or more keepers. Said forester shall have the management and charge of all said public domain. But a town,

by a two-thirds vote at an annual town meeting, or a city, by a two-thirds vote of the city council may place all such public domain under the general supervision and control of the state forester, who shall thereupon, upon notification thereof, make regulations for the care and use of such public domain and for the planting and cultivating of trees therein; and the city or town forester in such cases and his keepers, under the supervision and direction of the state forester, shall be charged with the duty of enforcing all such regulations and of performing such labor therein as may be necessary for the care and maintenance thereof. The city or town forester and his keepers within such public domain shall have the powers of constables and police officers.

G. L., c. 45, § 22. **Building on town forests.** Any city or town owning a public domain may lease any building thereon, and it may erect thereon any building for public instruction and recreation; provided, that if such public domain has been placed under the supervision and control of the state forester under the preceding section, no such building shall be erected unless his approval shall first be obtained. All sums derived from rents or from the sale of the products of any such domain shall be applied, so far as necessary, to the management thereof.

G. L., c. 45, § 23. **Expenditure limited.** No land shall be taken or purchased for a public domain, no building erected thereon and no expenditures authorized or made or liability incurred therefor until an amount sufficient to cover the estimated expense thereof has been appropriated therefor as provided in section nineteen, and all contracts made for expenditures in excess thereof shall be void. The expenditures shall not exceed the appropriations therefor.

G. L., c. 44, § 7. **Incurrence of debt for acquiring public domain.** Cities and towns may incur debt, within the limit of indebtedness prescribed in section ten, for the following purposes, and payable within the periods hereinafter specified: (2) For acquiring land for public parks or public domain under chapter forty-five, thirty years; but no indebtedness incurred for public domain shall exceed one-half of one per cent of the last preceding assessed valuation of the city or town.

SHADE TREE LAW.

G. L., c. 87, § 1. **Public shade trees defined.** All trees within a public way or on the boundaries thereof shall be public shade trees; and when it appears in any proceeding in which the ownership of or rights in a tree are material to the issue, that, from length of time or otherwise, the boundaries of the highway cannot be made certain by records or monuments, and that for that reason it is doubtful whether the tree is within the highway, it shall be taken to be within the highway and to be public property until the contrary is shown.

G. L., c. 87, § 2. **Powers of tree wardens.** The tree warden of a town may appoint and remove deputy tree wardens. He and they shall receive such compensation as the town determines or, in default thereof, as the selectmen allow. He shall have the care and control of all public shade trees, shrubs and growths in the town, except those within a state highway, and those in public parks or open places under the jurisdiction of the park commissioners, and shall have care and control of the latter, if so requested in writing by the park commissioners, and shall enforce all the provisions of law for the preservation of such trees, shrubs and growths. He shall expend all money appropriated for the setting out and maintainance of such trees, shrubs and growths, and no tree shall be planted within a public highway without the approval of the tree warden; and in towns until a location therefor has been obtained from the selectmen or road commissioners. He may make regulations for the care and preservation of public shade trees and establish fines and forfeitures of not more than twenty dollars in any one case for violation thereof; which, when posted in one or more public places, and, in towns, when approved by the selectmen, shall have the effect of town by-laws.

G. L., c. 87, § 3. **Cutting of public shade trees.** Except as provided by section five, public shade trees shall not be cut, trimmed or removed, in whole or in part, by any person other than the tree warden or his deputy, even if he be the owner of the fee in the land on which such tree is situated, except upon a permit in writing from said tree warden, nor shall they be cut down or removed by the tree warden or his deputy or other person without a public hearing at a suitable time and place, after notice thereof posted in two or more public places in the town and upon the tree at least seven days before such hearing, and after authority granted by the tree warden therefor. Any person injured in his property by the action of the officers in charge of the public shade trees as to the trimming, cutting, removal or retention of any such tree, or as to the amount awarded to him for the same, may recover the damages, if any, which he has sustained, from the town under chapter seventy-nine.

G. L., c. 87, § 4. **Hearing on removal of tree.** Tree wardens shall not cut down or remove or grant a permit for the cutting down or removal of a public shade tree, if, at or before a public hearing as provided in the preceding section, objection in writing is made by one or more persons, unless such cutting or removal or permit to cut or remove is approved by the selectmen or by the mayor.

G. L., c. 87, § 5. **Cutting down of bushes and small trees.** Tree wardens and their deputies, but no other person may, without a hearing, trim, cut down or remove trees, less than one and one-half inches in diameter one foot from the ground, and bushes, standing in public ways; and, if ordered by the mayor, selectmen, road commissioners or highway surveyor, shall trim or cut down trees and bushes, if the same shall be deemed to obstruct, endanger, hinder or incommode persons traveling thereon. Nothing contained in this chapter shall prevent the trimming, cutting or removal of any tree which endangers persons traveling on a highway, or the removal of any tree, if so ordered by the proper officers, for the purpose of widening the highway, and nothing herein contained shall interfere with gypsy and brown tail moth suppression, as carried on under the direction of the state forester and the United States department of agriculture, except so much as relates to the cutting and removal of trees, shrubs and growths that are one and one-half inches or more in diameter one foot from the ground.

G. L., c. 87, § 6. **Penalty.** Violations of any provisions of the three preceding sections shall be punished by forfeiture of not more than five hundred dollars to the use of the city or town.

G. L., c. 87, § 7. **Planting of shade trees.** Towns may appropriate money to be expended by the tree warden in planting shade trees in public ways, or, if he deems it expedient, upon adjoining land, at a distance not exceeding twenty feet from said public ways for the purpose of improving, protecting, shading or ornamenting the same; provided, that the written consent of the owner of such adjoining land shall first be obtained.

G. L., c. 87, § 8. **Trees on state highways.** The division of highways of the department of public works, in this chapter called the division, shall have the care and control of all trees, shrubs and growths within the state highways, and may trim, cut or remove such trees, shrubs or growths, or license the trimming, cutting or removal thereof. No such tree, shrub or other growth shall be trimmed, cut or removed by any person other than an agent or employee of the commission, even if he be the owner of the fee in the land on which such tree, shrub or growth is situated, except upon a permit in writing from the division. Any person injured in his property by the action of the division as to the trimming, cutting, removal or retention of any such tree, shrub or other growth may recover the damages, if any, which he has sustained, from the commonwealth under chapter seventy-nine.

G. L., c. 87, § 9. **Signs and marks on shade trees.** Whoever affixes to a tree in a public way or place a notice, sign, advertisement or other thing, whether in writing or otherwise, or cuts, paints or marks such tree, except for the purpose of protecting it or the public and under a written permit from the officer having the charge of such trees in a city or from the tree warden in a town, or from the division in the case of a state highway, shall be punished by a fine of not more than fifty dollars. Tree wardens shall enforce the provisions of this section; but if a tree warden fails to act in the case of a state highway within thirty days after the receipt by him of a complaint in writing from the division, the division may proceed to enforce this section.

G. L., c. 87, § 10. **Injury to trees on state highways.** Whoever without authority trims, cuts down or removes a tree, shrub or growth, within a state highway or maliciously injures, defaces or destroys any such tree, shrub or growth shall be punished by imprisonment for not more than six months, or by a fine of not more than five hundred dollars to the use of the commonwealth.

G. L., c. 87, § 11. **Injury to trees of another person.** Whoever wilfully, maliciously or wantonly cuts, destroys or injures a tree, shrub or growth which is not his own, standing for any useful purpose, shall be punished by imprisonment for not more than six months or by a fine of not more than five hundred dollars.

G. L., c. 87, § 12. **Injury to shrubs, trees and fixtures.** Whoever wantonly injures, defaces or destroys a shrub, plant or tree, or fixture of ornament or utility, in a public way or place or in any enclosure, or negligently or wilfully suffers an animal driven by or for him or belonging to him to injure, deface or destroy such shrub, plant, tree or fixture, or whoever by any other means negligently or wilfully injures, defaces or destroys such shrub, plant, tree or fixture shall forfeit not more than five hundred dollars, one half to the use of the complainant and one half to the use of the town in which the act was committed; and shall in addition thereto be liable to the town or to any person having an interest in said shrub, plant, tree or fixture for all damages caused by such act.

G. L., c. 87, § 13. **Duties of tree wardens in cities.** The powers and duties conferred and imposed upon tree wardens in towns by this chapter shall be exercised and performed in cities by the officers charged with the care of shade trees within the limits of the highway.

G. L., c. 40, § 5. **Town appropriations for planting shade trees.** A town may at any town meeting appropriate money for the following purposes: (10) For planting shade trees in accordance with section seven of chapter eighty-seven.

Forest Taxation Law

ACTS 1922, CHAPTER 360.

SECTION 1. The General Laws is hereby amended by striking out chapter sixty-one and inserting in place thereof the following:—

CHAPTER 61.

TAXATION OF FOREST PRODUCTS AND CLASSIFICATION AND TAXATION OF FOREST LANDS

Section 1. Qualifications of eligible land. An owner of forest land, valued on the town tax list of the preceding year for land and growth at not more than twenty-five dollars per acre, and which does not contain more than twenty cords per acre on the average, but which is so stocked with trees as to promise a minimum prospective average yield per acre, exclusive of water, bog or ledge, of twenty thousand board feet for soft woods, or eight thousand board feet for

hard woods, or for mixtures of the two, such volume between said limits determinable by the relative percentages of the two classes of growth, may apply in writing to the town assessors to have said land listed as classified forest land, and such application shall contain a description of said land sufficiently accurate for identification.

Section 2. Within thirty days after the receipt of said application the assessors shall decide whether the property fulfills the requirements for classification, and shall notify the owner of their decision, giving their valuation of the tract as land alone, and if within ten days of notification the owner accepts their decision the assessors shall give him a certificate containing the name of the owner and a description of the parcel to be classified, and stating that the land described conforms to the requirements for classification under this chapter. Upon the recording of this certificate by the owner in the registry of deeds for the county or district where the land lies, the parcel shall become classified forest land. Each parcel of land so classified shall thereafter be designated in the annual valuation list of the town, in the column provided for the description of each parcel of land, as classified forest land so long as the parcel remains so classified. The valuation and tax annually assessed upon land classified under this chapter shall not include the value of forest trees growing thereon. When classified forest land is sold or otherwise changes title, the obligations and benefits of this chapter shall devolve upon the new holder of the title.

Section 3. Product tax and other taxes. The standing growth on classified forest land shall not be taxed, but the owner of such land, except as hereinafter provided, shall pay a products tax of six per cent of the stumpage value upon all wood or timber cut therefrom, and one-tenth of such taxes collected by the town shall be paid to the state treasurer. Trees standing on such land shall not be included in the town valuation in apportioning the state or county tax among the towns. But an owner of classified forest land may annually cut, free of tax, wood or timber from such land, not exceeding twenty-five dollars in stumpage value; provided, that such wood or timber is for his own use or for that of a tenant of said land only. Buildings or other structures standing on classified forest land shall be taxed as real estate with the land on which they stand. Classified forest land shall be subject to special assessments and betterment assessments. The owner shall make a sworn return to the assessors before May first in each year of the amount of all wood and timber cut from such land during the year ending on the preceding April first.

Section 4. Limit classification period. When in the judgment of the assessors classified forest land contains on the average per acre twenty-five thousand board feet for soft woods, or ten thousand board feet for hard woods, or for mixtures of the two such volume between said limits determinable by the relative percentages of the two classes of growth, they shall notify the owner that two years from date of notification the forest products tax of six per cent of the value of the standing timber based on the above volumes will be levied and that the land and timber will at that time be taken from the classified list and placed in the general property tax list. Should the owner elect to reduce within two years, the volume of timber below the volume mentioned in the preceding sentence the land shall remain classified, but, if at the end of five years from time of cutting, the growing stock on the tract does not meet the requirements for classification contained in section one, the tract may be taken from classification by the assessors, and any taxes due thereon collected. An owner may withdraw his land from classification at any time by the payment of the land tax, and the forest products tax of six per cent on the estimated value of the standing timber. Within thirty days after an owner requests to withdraw his land from classification the assessors shall determine the taxes due thereon, which shall be paid before the land is taken from the classified list. When in the judgment of the assessors classified forest land becomes more valuable for other use than the production of trees, they may, after thirty days'

notice, withdraw said land from classification, and any taxes due thereon shall be paid at the time of withdrawal; provided, that the owner may appeal from such withdrawal to the commissioner, whose decision shall be final. Whenever land is withdrawn from classification, the assessors shall record in the registry of deeds for the county or district where the land lies a certificate setting forth such withdrawal, and containing reference by book and page to the record of the certificate under which said land was classified.

Section 5. Appeals to state forester. In case of dispute as to the eligibility of land for classification, or as to the volume of wood or timber contained on such land or cut therefrom, either party may appeal to the state forester, who shall examine the property and hear both parties, and whose decision shall be final.

Section 6. Any owner of classified forest land who fails to comply with the requirements of this chapter shall, upon conviction thereof, be punished by a fine of not less than ten dollars nor more than five hundred dollars, and in addition to said penalty the land may be withdrawn from classification by the assessors.

SECTION 2. Notwithstanding the passage of this act, all land and the trees, wood and timber thereon which are, on the date when this act takes effect, subject to the provisions of chapter sixty-one of the General Laws shall continue to be subject thereto in accordance therewith.

Forest Trespass.

G. L., c. 266, § 5. **Setting fire to woodpile, etc.** Whoever wilfully and maliciously burns or otherwise destroys or injures a pile or parcel of wood, boards, timber or other lumber, or any fence, bars or gate, or a stack of grain, hay or other vegetable product, or any vegetable product severed from the soil and not stacked, or any standing tree, grain, grass or other standing product of the soil, or the soil itself, of another, shall be punished by imprisonment in the state prison for not more than five years or by a fine of not more than five hundred dollars and imprisonment in jail for not more than one year.

G. L., c. 266, § 7. **Wanton or reckless injury to woods by fire.** Whoever by wantonly or recklessly setting fire to any material, or by increasing a fire already set, causes injury to, or the destruction of, any growing or standing wood of another shall be punished by a fine of not more than one hundred dollars or by imprisonment for not more than six months.

G. L., c. 266, § 113. **Cutting of timber.** Whoever wilfully cuts down or destroys timber or wood standing or growing on the land of another, or carries away any kind of timber or wood cut down or lying on such land, or digs up or carries away stone, ore, gravel, clay, sand, turf or mould, from such land, or roots, nuts, berries, grapes or fruit of any kind or any plant there being, or cuts down or carries away sedge, grass, hay or any kind of corn, standing, growing or being on such land, or cuts or takes therefrom any ferns, flowers or shrubs, or carries away from a wharf or landing place any goods in which he has no interest or property, without the license of the owner thereof, shall be punished by imprisonment for not more than six months or by a fine of not more than five hundred dollars; and if the offence is committed on Sunday, or in disguise, or secretly in the night time, the imprisonment shall not be for less than five days nor the fine less than five dollars.

G. L., c. 266, § 116. **Picking of berries, etc., by unnaturalized persons.** Whoever, being an unnaturalized, foreign born person, picks wild berries or flowers, or camps or picnics upon any land of which he is not the owner, within the counties of Barnstable or Plymouth, between April first and December first, without first obtaining a written permit so to do from the owner or owners

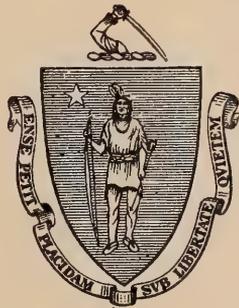
of the land, shall be punished by a fine of not more than fifty dollars or by imprisonment for not more than one month, or both. The said written permit shall not be transferable, and shall be exhibited upon demand to the forest warden, or his deputies, of the town wherein the land is located, or upon demand of any sheriff, constable, police or other officer authorized to arrest for crime. Failure or refusal to produce said permit upon such demand shall be prima facie evidence of a violation of this section, and any forest warden or any duly authorized deputy forest warden, sheriff, police or other officer authorized to arrest for crime, may arrest without warrant any person who fails or refuses to display for inspection the said permit upon the demand of any of the officials named in this section.

G. L., c. 2, § 7, as amended, Acts of 1925, c. 112. **Mayflower law.** The Mayflower (*epigaea repens*) shall be the flower or floral emblem of the commonwealth. Any person who pulls or digs up the plant of the Mayflower or any part thereof, or injures such plant or any part thereof, except in so far as is reasonably necessary in procuring the flower therefrom, within the limits of any state highway or any other public way or place, or upon the land of another person without written authority from him, shall be punished by a fine of not more than fifty dollars; but if a person does any of the aforesaid acts in disguise or secretly in the night time he shall be punished by a fine of not more than one hundred dollars.

55.08
M38p.
23

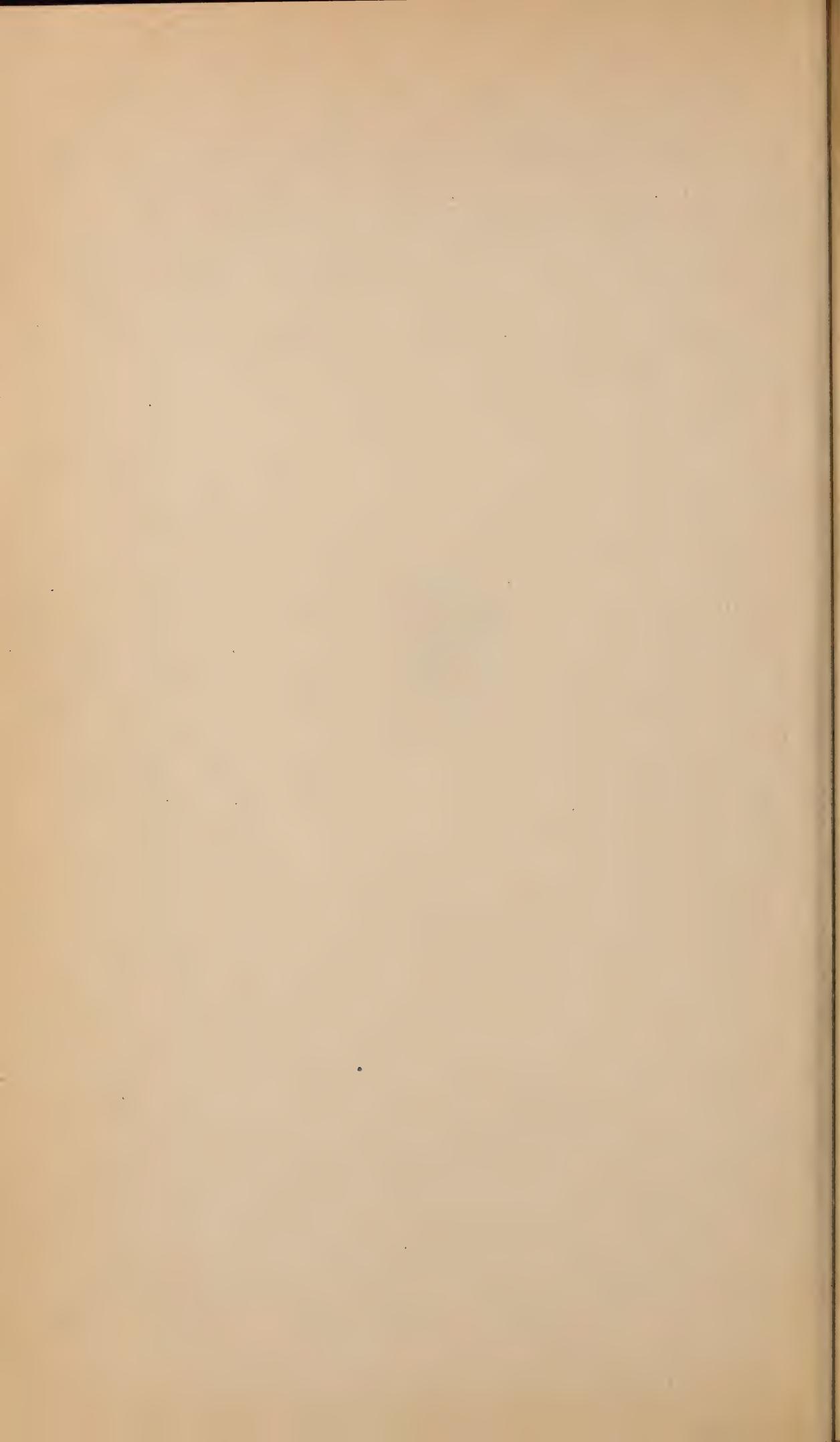
COMMONWEALTH OF MASSACHUSETTS

LAWS RELATING TO GYPSY AND
BROWN-TAIL MOTHS



DEPARTMENT OF CONSERVATION
DIVISION OF FORESTRY

PUBLICATION OF THIS DOCUMENT
APPROVED BY
THE COMMISSION ON ADMINISTRATION AND FINANCE



LAWS RELATING TO GYPSY AND BROWN-TAIL MOTHS

G. L., c. 132, § 1. **Duties of State Forester.** The state forester, in this chapter called the forester, shall act for the commonwealth in suppressing the gypsy and brown tail moths; shall promote the perpetuation, extension and proper management of the public and private forest lands of the commonwealth; shall give such a course of instruction to the students of the Massachusetts Agricultural College on the art and science of forestry as may be arranged by the trustees of the college and the forester; and shall perform such other duties as may be imposed upon him by the governor and council.

G. L., c. 132, § 4. **Annual Report.** The commissioner shall make an annual report of the acts of the forester. The report shall separate so far as practicable the expenditures on work against the gypsy moth from those on work against the brown tail moth in each town. It shall include the account of all money invested in each state forest and of the annual income and expense thereof, and the report of the state fire warden required by section twenty-eight of chapter forty-eight.

G. L., c. 132, § 8. **Agents destroying gypsy moths may enter on any land.** The clerks, assistants and agents employed by the forester may, for the purpose of carrying out the provisions of this chapter relative to the suppression of gypsy and brown tail moths, enter upon any land; and any local superintendent appointed as provided in section thirteen or any agent or employee of such superintendent may enter upon any land within the said town for the purpose of determining if such land is infested with said moths or the extent to which such land is so infested.

G. L., c. 132, § 11. **Gypsy and brown tail moths declared public nuisances. Regulations for their suppression.** The forester may, subject to the approval of the governor, make rules and regulations governing all operations by towns or persons for the purpose of suppressing the gypsy and brown tail moths, their pupæ, nests, eggs and caterpillars, which are hereby declared public nuisances. He may make contracts on behalf of the commonwealth; may act in cooperation with any person, any other state, the United States, or any foreign government; may conduct investigations and gather and distribute information concerning said moths; may use and require the use of all other lawful means of suppressing said moths; may lease real estate when he deems it necessary, and, with the approval of the authority in charge, may use any real or personal property of the commonwealth; may at all times enter upon any land, and may use all reasonable means in suppressing said moths; and, in the undertakings aforesaid, may, in accordance with this chapter, expend the funds appropriated or donated therefor; but no expenditure shall be made or liability incurred in excess of such appropriations and donations. No owner or occupant of an estate infested by the aforesaid nuisances shall by reason thereof be civilly or criminally liable except to the extent and in the manner and form set forth in this chapter.

G. L., c. 132, § 12. **Penalty for interfering with moth work.** Whoever wilfully resists or obstructs the forester or any officer of a town, or a servant or agent duly employed by said forester or by any of said officers while engaged in suppressing the gypsy and brown tail moths, elm leaf beetle, or any other tree or shrub destroying pest, or knowingly fails to comply with any of the rules and regulations issued by the forester, shall be punished by a fine of not more than twenty-five dollars.

G. L., c. 132, § 13. **Local gypsy moth superintendents.** The mayor in cities and the selectmen in towns shall annually in the month of January appoint a local superintendent for the suppression of gypsy and brown tail moths. Said superintendents shall, under the advice and general direction of the forester, destroy the eggs, caterpillars, pupæ and nests of the gypsy and brown tail moths.

within their limits, except in parks and other property under the control of the commonwealth, and except in private property, save as otherwise provided herein. The appointment of a local superintendent shall not take effect unless approved by the forester; and when so approved notice of the appointment shall be given by the mayor or the selectmen to the person so appointed.

G. L., c. 132, § 14 as amended Acts 1923, c. 311 and c. 472. **Reimbursement of cities and towns.** When any city or town in which one twenty-fifth of one per cent of the valuation is more than five thousand dollars shall have expended within its limits city or town funds to an amount in excess of five thousand dollars in any one year ending November thirtieth in suppressing gypsy or brown tail moths, the commonwealth shall reimburse such city or town to the extent of fifty per cent of such excess above said five thousand dollars.

Cities or towns in which one twenty-fifth of one per cent of the valuation is less than five thousand dollars, and in which such valuation is greater than six million dollars, shall be reimbursed by the commonwealth to the extent of eighty per cent of the amount expended by such cities or towns of city or town funds in suppressing said moths in any one such year, in excess of said twenty-fifth of one per cent.

In towns in which the valuation is less than six million dollars, after they have expended in any one such year town funds to an amount equal to one twenty-fifth of one per cent of their valuation, the commonwealth shall expend within the limits thereof for the suppression of said moths such an amount in addition as the forester, with the advice and consent of the governor, shall determine. The commonwealth shall reimburse cities and towns every sixty days.

No city or town shall be entitled to any reimbursement from the commonwealth until it has submitted to the comptroller itemized accounts and vouchers showing the definite amount expended by it for the purpose of suppressing said moths, nor shall any money be paid out of the state treasury to cities or towns until said vouchers and accounts have been approved by the forester and the comptroller, nor unless said expenditure shall have been duly authorized and approved by the forester or shall have been made prior to December first, nineteen hundred and twenty-two.

For the purpose of this section and section sixteen, the valuation of a city or town shall mean the valuation of such city or town, as determined by the last preceding valuation made for the purpose of apportioning the state tax.

G. L., c. 132, § 16 as amended Acts 1923, c. 472. **Delinquent cities and towns.** When, in the opinion of the forester, any city or town is not expending a sufficient amount for the abatement of said nuisance or is not conducting the necessary work in a proper manner, the forester shall, with the advice and consent of the governor, order such city or town to expend such an amount as the forester shall deem necessary, and in accordance with such methods as the forester, with the consent of the governor, shall prescribe; provided, that no city or town where the valuation exceeds six million dollars shall be required to expend, exclusive of any reimbursement received from the commonwealth, during any one full year more than one fifteenth of one per cent of such valuation, and that no town where the valuation is less than six million dollars shall be required to expend, exclusive of any reimbursement received from the commonwealth, during any one full year more than one-twenty-fifth of one per cent of such valuation.

G. L., c. 132, § 17. **Emergency work.** Any city or town failing to comply with the directions of the forester in the performance of said work within the date specified by him shall pay a fine of one hundred dollars a day for failure so to do, said fine to be collected by information brought by the attorney general in the supreme judicial court for Suffolk county.

In case of emergency, or where there is great or immediate danger of the increase or spread of moths due to the neglect of any city or town to comply with the provisions of this chapter relating to the suppression of gypsy and brown tail moths, the forester, with the consent of the governor, may initiate or continue



SECTION 15. Every city or town in rendering the account required by the preceding section shall deduct from such amount as it has expended the total amount it has assessed for work performed under section eighteen during the term covered by the account, if such work was performed under such conditions as require reimbursement in whole or in part by the commonwealth.

the work of suppression within such city or town for such a period as he may deem necessary. The cost of such work, including that done on private estates, less any sum due from the commonwealth by way of reimbursements on account of said work, shall be certified by the forester to the state treasurer, and be collected by him as an additional state tax upon the city or town so failing to comply with the requirements of the law. The forester may also in case of emergency, subject to the approval of the governor, carry on wholly or in part such operations as may be necessary to check the spreading of the gypsy or brown tail moth in parks not under the control of the commonwealth, and in cemeteries, woodlands and other places of public resort. The amount to be so expended in any one year shall not exceed ten per cent of the appropriations made for the year by the commonwealth for the purpose of suppressing said moths. The forester may also take complete control of the work of suppressing the gypsy and brown tail moths in such cities and towns as may through the proper officials request it. The cost of such work shall be certified by the forester to the state treasurer, and shall be collected by him as an additional state tax upon the city or town wherein such work is performed; provided, that no city or town shall be required to pay more for such work than would have been its liability as defined by section fourteen.

G. L., c. 132, § 18. **Notice to land owners. Assessment of cost of work.** The mayor of every city and the selectmen of every town shall, on or before November first in each year, and at such other times as he or they shall see fit or as the forester may order, cause a notice to be sent to the owner, so far as can be ascertained, of every parcel of land therein which is infested with said moths; or, if such notification appears to be impracticable, by posting such notice on said parcels of land, requiring that the eggs, caterpillars, pupæ and nests of said moths shall be destroyed within a time specified therein. The publication of the notice in newspapers published or circulated in the city or town at least three times during the month of October shall be deemed a compliance with the law, if in the opinion of the mayor or selectmen such publication will be a sufficient notice.

When, in the opinion of the mayor or selectmen, the cost of destroying such eggs, caterpillars, pupæ or nests on land contiguous and held under one ownership in a city or town shall exceed one half of one per cent of the assessed value thereof, a part of said premises on which said eggs, caterpillars, pupæ or nests shall be destroyed may be designated in such notice, and such requirement shall not apply to the remainder of said premises. The mayor or selectmen may designate the manner in which such work shall be done, but all work done under this section shall be subject to the approval of the forester.

If the owner shall fail to destroy such eggs, caterpillars, pupæ or nests as required by said notice, the city or town, acting by the local superintendent appointed under section thirteen, shall, subject to the approval of the said forester, destroy the same and the amount actually expended thereon, not exceeding one half of one per cent of the assessed valuation of said lands, as heretofore specified in this section, shall be assessed upon the said lands; and such an amount in addition as shall be required shall be apportioned between the city or town and the commonwealth in accordance with section fourteen. The amounts to be assessed upon private estates as herein provided shall be assessed and collected, and shall be a lien on said estates, in the same manner and with the same effect as in the case of assessments for street watering.

G. L., c. 132, § 19. **Assessment of special benefits.** If, in the opinion of the assessors of a city or town, any land therein has received, by reason of the abatement of said nuisances thereon by said forester or by said city or town, a special benefit beyond the general advantage to all land in the city or town, then the said assessors shall determine the value of such special benefit and shall assess the amount thereof upon said land; provided, that no such assessment on lands contiguous and held under one ownership shall exceed one half of one per cent of the assessed valuation of said lands; and provided, that the owner or owners shall have deducted from such assessment the amount paid

and expended by them during the twelve months last preceding the date of such assessment toward abating the said nuisances on said lands, if, in the opinion of the assessors, such amount has been expended in good faith. Such assessment shall be a lien upon the land for three years from the first day of January next after the assessment has been made, and shall be collected under a warrant of the assessors to the collector of taxes of such city or town, in the manner and upon the terms and conditions and in the exercise of the powers and duties, so far as they may be applicable, prescribed by chapter sixty, and real estate sold under such warrant shall be subject to the provisions of said chapter relative to land sold for taxes.

G. L., c. 132, § 20. **Appeal.** A person aggrieved by such assessment may appeal to the superior court for the county where the land lies, by entering a complaint in said court within thirty days after he has had actual notice of the assessment, which complaint shall be determined as other causes by the court without a jury. The complaint shall be heard at the first sitting of said court for trials without a jury after its entry; but the court may allow further time, or may advance the case for speedy trial, or may appoint an auditor as in other cases. The court may revise the assessment, may allow the recovery of an amount wrongfully assessed which has been paid, may set aside, in a suit begun within three years from the date thereof, a collectors' sale made under an erroneous assessment, may award costs to either party, and may render such judgment as justice and equity require.

G. L., c. 132, § 21. **Abatement of assessment.** If, in the opinion of the assessors, the owner of an estate upon which an assessment has been made is, by reason of age, infirmity or poverty, unable to pay the assessment, they may upon application abate the same.

G. L., c. 132, § 22. **Application for abatement.** A person aggrieved by the taxes assessed upon him for the suppression of gypsy and brown tail moths, pursuant to section eighteen or nineteen, may, within six months after the date of the first tax bill issued on account of the taxes complained of, apply to the assessors for the abatement thereof, who may make such abatement as they deem reasonable.

G. L., c. 132, § 23. **Abatement.** The assessors shall not abate a tax under the preceding section except upon the written recommendation of the local superintendent who certified the assessment in question to the assessors or provided them with the information as to the work performed, upon which such tax was assessed, unless the error or excess complained of originated in the work of the assessors who laid the tax.

G. L., c. 132, § 24. **Record of abatement.** The assessors shall keep a record of all such taxes abated and shall preserve for three years all written recommendations received under the preceding section. They shall furnish the collector of taxes with a certificate of each abatement, which shall relieve him from the collection of the sum abated.

G. L., c. 132, § 25. **Tent caterpillar, leopard moth and elm beetle.** The city forester, superintendent or other person having charge of the suppression of gypsy and brown tail moths in each city and town in the commonwealth, or, when there is no such person, the tree warden may destroy within the limits of his city or town the tent caterpillar, leopard moth and elm beetle or any other tree or shrub destroying pest, if authorized so to do by the mayor and city council or by the selectmen in towns.

G. L., c. 132, § 26. **Entry on land. Assessment for cost of work.** The city forester or other officer designated in the preceding section may enter upon private land, and the owners of private land may be taxed for work done under said section as provided by sections eighteen and nineteen; provided, however, that nothing contained in this section shall require the commonwealth to pay any part of any such expense other than for the suppression of the gypsy and brown tail moth; that no land shall be assessed hereunder which has been assessed the maximum amount provided by said sections eighteen and nineteen for the suppression of the gypsy and brown tail moths, and that the aggregate

assessment on any parcel of private land for the suppression of the tent caterpillar, leopard moth, elm beetle and gypsy and brown tail moths shall not exceed the maximum provided by said sections.

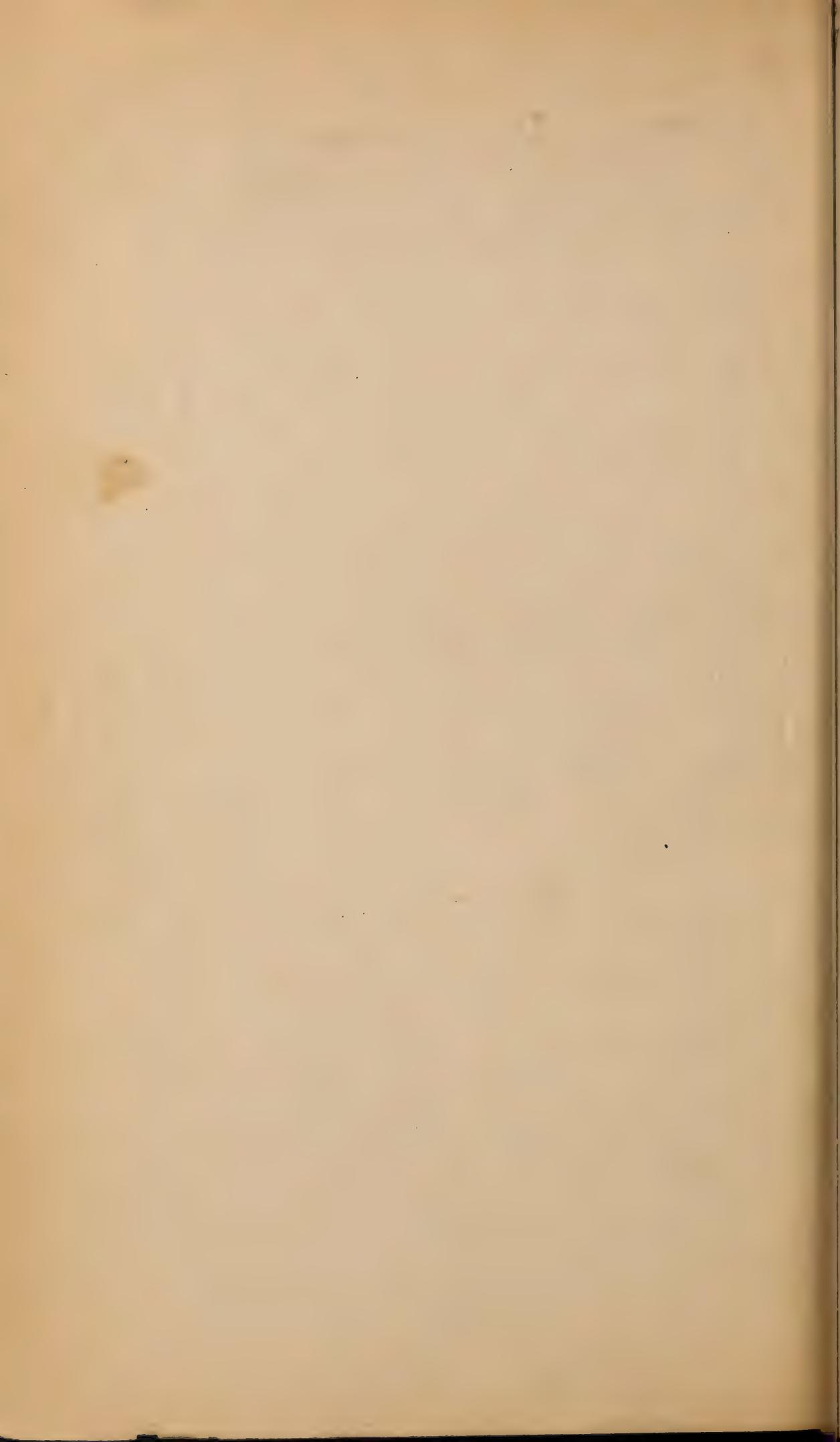
G. L., c. 132, § 27. **Arsenate of lead furnished at cost.** To assist in exterminating the gypsy and brown tail moths, the local moth superintendent in any city or town may furnish, at cost, to any owner of real estate situated within such city or town arsenate of lead. It shall be used only for the suppression of gypsy and brown tail moths and only upon land of the purchaser.

G. L., c. 132, § 28. **Method of payment for lead.** The amounts due for material furnished under the preceding section shall be charged by the local moth superintendent to the owners of private estates, and shall be collected in the same way as amounts assessed for private work, and shall be a lien on said estates in the same manner as said assessments. The amount thus charged shall be deducted from the total amount expended in each city or town in the suppression of the gypsy and brown tail moths as provided in section fifteen.

G. L., c. 132, § 29. **Forester to furnish arsenate of lead.** To assist in exterminating insect pests the city forester, local moth superintendent or tree warden in any city or town may obtain from the forester, at cost, arsenate of lead. It shall be used only for the suppression of gypsy and brown tail moths, the tent caterpillar, leopard moth and elm beetle, and only upon lands owned or controlled by the city or town. The cost of said material shall be certified by the forester to the state treasurer, and shall be collected by him as an additional state tax upon the city or town making such purchase.

G. L., c. 266, § 119. **Transportation of injurious insects.** Whoever knowingly brings the insects which are known as ocneria dispar or gypsy moth or as the brown-tail moth, or their nests or eggs, into the commonwealth, or whoever knowingly transports said insects or their eggs or nests from one town to another in the commonwealth, except when engaged in, and for the purpose of, destroying them shall be punished by a fine of not more than two hundred dollars or by imprisonment for not more than two months, or both.

G. L., c. 40, § 5. **Town appropriations for gypsy moths, etc.** A town may at any town meeting appropriate money for the following purposes; (23) For destroying and suppressing gypsy, brown-tail and leopard moths, tent caterpillars and elm beetles, under chapter one hundred and thirty-two.



3.08
384.

24

The Commonwealth of Massachusetts

LAWS RELATING TO FOREST FIRES



DEPARTMENT OF CONSERVATION
DIVISION OF FORESTRY

DIVISION OF FORESTRY.

Appointment and Duties of State Forester.

G. L., c. 21, § 4. Upon the expiration of the term of office of a director of the division of forestry, his successor shall, except as provided by the preceding section, be appointed for three years by the governor, with the advice and consent of the council. The director shall be known as the state forester. He shall be qualified by training and experience to perform the duties of his office, and shall, except as provided by the preceding section, receive such salary, not exceeding five thousand dollars, as the governor and council determine.

G. L., c. 21, § 5. **Appointment of Fire Warden.** The director may, subject to the approval of the commissioner, appoint and remove a state fire warden and such experts, clerical and other assistants as the work of the division may require, and fix their compensation. The director shall be allowed necessary traveling expenses for himself and his employees incurred in the discharge of duty.

G. L., c. 132, § 1. The state forester, in this chapter called the forester, shall act for the commonwealth in suppressing the gypsy and brown tail moths; shall promote the perpetuation, extension and proper management of the public and private forest lands of the commonwealth; shall give such a course of instruction to the students of the Massachusetts Agricultural College on the art and science of forestry as may be arranged by the trustees of the college and the forester, and shall perform such other duties as may be imposed upon him by the governor and council.

G. L., c. 132, § 4. The commissioner shall make an annual report of the acts of the forester. The report shall separate so far as practicable the expenditures on work against the gypsy moth from those on work against the brown tail moth in each town. It shall include the account of all money invested in each state forest and of the annual income and expense thereof, and the report of the state fire warden required by section twenty-eight of chapter forty-eight.

G. L., c. 132, § 6. The forester may give to any person owning or controlling forest lands aid or advice in the management thereof. Any recipient of such aid or advice shall be liable to the commonwealth for the necessary expenses of travel or subsistence incurred by him or his assistants. The forester may publish the particulars and results of any investigation made by him or his assistants as to any lands within the commonwealth, and the advice given.

G. L., c. 48, § 8, as amended by c. 274, Acts of 1921. **Appointment of Forest Wardens.** The mayor in cities and, except as provided in section forty-three, the selectmen in towns shall annually, in January, appoint a forest warden, and forthwith give notice thereof to the state forester, in this chapter called the forester. Such appointment shall not take effect unless approved by the forester. When so approved notice of the appointment shall be given by the mayor or selectmen to the person so appointed. Whoever having been duly appointed fails within seven days after receipt of such notice to file with the city or town clerk his acceptance or refusal of the office shall, unless excused by the mayor or selectmen, forfeit ten dollars. The same person may hold the offices of tree warden, selectman, chief of fire department and forest warden. Upon the failure of the mayor of a city or the selectmen of a town to make such appointment in the month of January, the forester shall notify the mayor or selectmen so to do, and if the mayor or selectmen fail to comply within fourteen days after receipt of such notice, the forester may appoint as forest warden in such city or town a suitable person, who shall be a resident thereof.

G. L., c. 48, § 9. **Back Fires in Woodlands.** If a fire occurs in woodland,

the forest warden of the town, or of a town containing woodland endangered by such fire, at a place in immediate danger therefrom, may set back fires and take necessary precautions to prevent its spread.

G. L., c. 48, § 10. **Appointment of Deputies.** The forest warden may appoint deputies to assist him in his duties, and may discharge them; and he or his deputies may, if in their judgment there is danger from a forest fire, employ assistants or require any male person in their town between the ages of eighteen and fifty to aid in its extinguishment or prevention, and may require the use of horses, wagons and other property adapted therefor, and shall keep an account of the time of all persons assisting them and a schedule of all property so used.

G. L., c. 48, § 11. **Penalty for Refusal of Aid.** Whoever, without sufficient cause, wilfully refuses or neglects to assist or to allow the use of his property as required by the preceding section, shall be punished by a fine of not less than five nor more than one hundred dollars, to be equally divided between the complainant and the town, and may also be imprisoned for not more than two months.

G. L., c. 48, § 12. **Compensation of Forest Wardens.** Payment shall be made to forest wardens, their deputies, and persons assisting them, and for property used under their direction at a forest fire, at a rate prescribed by the town or, in default of its action thereon, by the selectmen. No such payment shall be made until an itemized account, approved by the forest warden under whose direction the work was done or assistance furnished, shall have been filed with the officer making payment.

G. L., c. 48, § 13, as amended by c. 515, Acts of 1922. **Setting of Fires in the Open Air.** No person shall set, maintain or increase a fire in the open air between March first and December first except by written permission of the state fire marshal, within the metropolitan fire prevention district as defined in section twenty-eight of chapter one hundred and forty-eight, or, outside thereof, of the forest warden or chief of the fire department in cities and towns, or, in cities having such an official, the fire commissioner; provided, that debris from fields, gardens and orchards, and leaves and rubbish from yards may be burned on ploughed fields by the owners thereof, their agents or lessees, if such fire is at least two hundred feet distant from any sprout or forest land and at least fifty feet distant from any building and is properly attended until extinguished; and provided, further, that persons above the age of eighteen may set or maintain a fire for a reasonable purpose upon sandy land, or upon salt marshes or sandy or rocky beaches bordering on tide water, if the fire is enclosed within rocks, metal or other non-inflammable material. The forester may make rules and regulations relating to the granting and revocation of such permits binding throughout the commonwealth or any part thereof, outside the metropolitan fire prevention district. Such rules and regulations shall take effect subject to section thirty-seven of chapter thirty, when approved by the governor and council. The forest wardens in towns and officials performing the duties of forest wardens in cities shall cause public notice to be given of the provisions of this section, and shall enforce the same. Whoever violates any provision of this section shall be punished by a fine of not more than one hundred dollars or by imprisonment for not more than one month, or both.

G. L., c. 48, § 14. **Exceptions to Preceding.** The preceding section shall not apply to fires which may be set, maintained or increased within said metropolitan district in accordance with regulations and methods approved by the state fire marshal, nor to fires which may be set for the purpose of suppressing gypsy and brown tail moths in accordance with regulations and methods approved by the forester, nor to fires set or increased within the limits of any public way by the employees of the commonwealth or of any county, city or town in the performance of public work.

G. L., c. 48, § 15. **Arrest without Warrant.** The forester, the state fire

warden or any duly authorized assistant forester, forest wardens in towns and officials performing the duties of forest wardens in cities, or any duly appointed deputy forest warden, the director of the division of fisheries and game, fish and game wardens and deputy fish and game wardens may arrest without warrant any person found in the act of setting, maintaining or increasing a fire in violation of sections thirteen and fourteen.

G. L., c. 61, § 23. For services rendered under sections three, eight, nine, and thirteen, the forest warden of a town shall receive from the town the compensation provided by section twelve of chapter forty-eight.

G. L., c. 266, § 8. **Negligence in Case of Fire.** Whoever wilfully or without reasonable care sets or increases a fire upon land of another whereby the property of another is injured, or whoever negligently or wilfully suffers any fire upon his own land to extend beyond the limits thereof, whereby the woods or property of another are injured, shall be punished by a fine of not more than two hundred and fifty dollars.

G. L., c. 266, § 9. Whoever, in a town which accepts this section or has accepted corresponding provisions of earlier laws, sets a fire on land which is not owned or controlled by him and before leaving the same neglects to entirely extinguish such fire, or whoever wilfully or negligently sets a fire on land which is not owned or controlled by him whereby property is endangered or injured, or whoever wilfully or negligently suffers a fire upon his own land to escape beyond the limits thereof to the injury of another, shall be punished by a fine of not more than one hundred dollars or by imprisonment in jail for not more than one month, or both, and shall also be liable for all damages caused thereby. Such fine shall be equally divided between the complainant and the town. This section shall not apply to cities.

G. L., c. 148, § 66, as amended by c. 485, Acts of 1921. **Fire Balloons.** Whoever liberates or flies a fire balloon shall be punished by a fine of not more than one hundred dollars or by imprisonment for not more than one month, or both.

G. L., c. 266, § 134. Whoever, between April first and October first, sets fire to a coal pit or pile of wood, for the purpose of charring the same, on any woodland in the cities of New Bedford or Fall River or in the towns of Dartmouth, Freetown, Fairhaven, Middleborough or Rochester, shall forfeit one hundred dollars. Whoever, between the times aforesaid, sets fire to any brushwood or bushes on any part of such woodland, or on land adjoining thereto, so as to cause the burning of such brushwood or bushes shall forfeit fifty dollars. All forfeitures under this section shall be equally divided between the city or town in which the offence is committed and the person who sues therefor.

G. L., c. 48, § 16. **Clearing Land of Slash.** Every owner, lessee, tenant or occupant of lands or of any rights or interests therein, except electric, telephone and telegraph companies, who cuts or permits the cutting of brush, wood or timber on lands which border upon woodland, or upon a highway or railroad location, shall dispose of the slash caused by such cutting in such a manner that the same will not remain on the ground within forty feet of any woodland, highway or railroad location.

G. L., c. 48, § 17. **Clearing Ways of Slash.** Any person who cuts or causes to be cut trees, brush or undergrowth within the limits of any highway, shall dispose of the slash and brush then and there resulting from such cutting in such a manner that the same will not remain on the ground within the limits of said highway.

G. L., c. 48, § 18. **Electric, etc., Companies to clear Land of Slash.** Electric, telephone and telegraph companies which, at the time of erecting their transmission lines, cut or cause to be cut brush, wood or timber on land which

borders upon woodland or upon a highway or railroad location, shall dispose of the slash caused by such cutting in such a manner that the same will not remain on the ground within forty feet of any woodland, highway or railroad location; such companies which after the erection of their lines trim or cut brush, wood or timber which has grown up since the line was erected, and which borders upon woodland or upon a highway or railroad location, shall, upon the request of the forester, and within a time limit set by him, dispose of the slash of second or subsequent cuttings if the same in his opinion constitutes a menace to adjoining property.

G. L., c. 48, § 19. **Forester, Forest Wardens, to enforce Preceding Sections.** The forester, or any duly authorized assistant, and the forest wardens in cities and towns are hereby authorized to inspect wood or lumber operations, and also the rights of way of electric, telephone and telegraph companies' transmission lines, to determine whether the slash and brush are disposed of in accordance with sections sixteen to eighteen, inclusive.

G. L., c. 48, § 20. **Penalty for Violations.** Violation of any provision of sections sixteen to eighteen, inclusive, shall be punished by a fine of not less than twenty nor more than one hundred dollars.

G. L., c. 48, § 20A, as amended by c. 252, Acts of 1922. **Operation of Portable Sawmills.** No person shall engage in any lumbering operations which involve the cutting of more than ten thousand feet, other than the cutting of cordwood, unless he has filed with the forester a statement giving the location and approximate size of the lot of land from which wood is to be cut and the approximate date when such operations are to be commenced. Any person, before operating any portable sawmill, shall notify the forester of the place of such intended operation and shall clear away and dispose of all slash and brush within seventy-five feet thereof. Violation of any provision of this section shall be punished by a fine of not less than five nor more than one hundred dollars.

G. L., c. 48, § 21. **Spark Arresters on Portable Saw Mills, etc.** Whoever, except when the ground is covered with snow, operates in or adjacent to forest or grass lands any portable steam saw mill, steam roller, steam shovel or steam tractor, which burns wood, coke, coal or other spark producing material as fuel, unless the same is provided with a suitable spark arrester approved by the forester, shall be punished by a fine of not less than fifty nor more than one hundred dollars. This section shall not apply to the metropolitan fire prevention district as defined in section twenty-eight of chapter one hundred and forty-eight.

G. L., c. 48, § 22. **Inspection of Saw Mills, etc.** The forester or his assistants may inspect all appliances described in the preceding section to determine if they are provided with suitable spark arresters.

G. L., c. 48, § 23. Towns may construct, in co-operation with other towns or with the commonwealth, forest fire observation towers, the situation and construction of which shall be subject to the direction of the forester.

G. L., c. 48, § 25. **Duties of Forest Wardens.** Every forest warden shall take precautions to prevent the spread of forest fires and the improper kindling thereof, and shall have sole charge of their extinguishment. He shall investigate the causes and extent of forest fires and the injury done thereby, and shall report thereon to the forester at such times and in such form as he requires. Every forest warden shall also post in suitable places in the town such warnings against the setting of forest fires and statements of law relating thereto as may be supplied to him by the forester. The engineers or other officers in charge of fire departments in cities and in towns which have so voted shall perform the duties and exercise the powers of forest wardens with respect to forest fires.

G. L., c. 48, § 26. **Penalty for destroying Notices.** Whoever wilfully and maliciously tears down or destroys any notice posted under the preceding section shall be punished by a fine of ten dollars.

G. L., c. 48, § 27. **Forest Wardens not liable for Trespass.** Forest Wardens, their deputies and assistants shall not be liable for trespass when engaged in the performance of their duties under this chapter or chapter one hundred and thirty-two.

G. L., c. 48, § 28. **Aid and Advice to Forest Wardens.** The state fire warden appointed under section five of chapter twenty-one shall aid and advise the forest wardens and their deputies in towns and the municipal officers exercising the functions of forest wardens in cities in preventing and extinguishing forest fires and in enforcing the laws relative thereto. The forester may designate not more than fifteen assistants to aid the warden. The state fire warden shall report annually to the forester upon his work and upon the forest fires occurring in the commonwealth. This report shall be included in the report of the commissioner of conservation relative to the acts of the forester.

G. L., c. 132, § 37. **Duties of Local Forest Wardens.** Every local forest warden, in addition to his duties prescribed by chapter forty-eight, shall investigate the values of forest lands, the character and extent of woodcutting operations, the prevalence of insect pests injurious to forest growths, and other matters affecting the extent and condition of woodlands in his town, and shall report thereon to the forester at such times and in such form as he requires.

G. L., c. 132, § 3. The forester shall from the money appropriated annually for the expenses of his office recompense the forest wardens for the time spent by them in making investigations under his direction, as required by section thirty-seven of this chapter and section twenty-five of chapter forty-eight; provided, that he shall not be liable to make any such payment except upon the presentation of a duly itemized account or to pay for such investigations at a rate greater than that approved by him or in excess of the appropriation available for such payment. He may also expend such sums as are annually appropriated in making necessary arrangements for conventions of forest wardens to be held at a place within the commonwealth and in paying wholly or in part the traveling expenses to and from their towns of such forest wardens who attend these conventions; provided, that no money shall be expended in paying the traveling expenses of any one warden to or from more than one convention in one year.

G. L., c. 130, § 9. **Duties in Respect to Forest Fires.** The director, a warden or deputy may arrest without a warrant any person found unlawfully setting a fire and may require assistance according to section ten of chapter forty-eight. They shall take precautions to prevent the progress of forest fires, or the improper kindling thereof, and upon the discovery of any such fire shall immediately summon the necessary assistance, and notify the local forest warden. The warden and deputies shall report to the state fire warden monthly their doings under this section; they shall report to him the situation and extent of any forest fire occurring within their respective districts.

G. L., c. 48, § 42. **Fire Departments in Certain Towns.** Towns accepting the provisions of this and the two following sections or which have accepted corresponding provisions of earlier laws may establish a fire department to be under the control of an officer to be known as the chief of the fire department. The chief shall be appointed by the selectmen, and shall receive such salary as the selectmen may from time to time determine, not exceeding in the aggregate the amount annually appropriated therefor. He may be removed for cause by the selectmen at any time after a hearing. He shall have charge of extinguishing fires in the town and the protection of life and property in case of fire. He shall purchase subject to the approval of the selectmen and keep in repair all property and apparatus used for and by the fire department. He shall have and exercise all the powers and discharge all the duties conferred or imposed by statute upon engineers in towns except as

herein provided, and shall appoint a deputy chief and such officers and firemen as he may think necessary, and may remove the same at any time for cause and after a hearing. He shall have full and absolute authority in the administration of the department, shall make all rules and regulations for its operation, shall report to the selectmen from time to time as they may require, and shall annually report to the town the condition of the department with his recommendations thereon; he shall fix the compensation of the permanent and call members of the fire department subject to the approval of the selectmen. In the expenditure of money the chief shall be subject to such further limitations as the town may from time to time prescribe.

G. L., c. 48, § 43. **Chief to act as Forest Warden.** The chief of the fire department shall act as forest warden in all such towns, and shall have authority to appoint deputy wardens and fix their compensation subject to the approval of the selectmen.

G. L., c. 48, § 44. The two preceding sections shall not affect the tenure of office nor apply to the removal of permanent and call members of fire departments in towns which have accepted chapter thirty-one or corresponding provisions of earlier laws. Said sections shall not apply to cities.

G. L., c. 40, c. § 11, as amended by c. 252 Acts of 1921. **Reimbursement to Towns.** A town which accepts this section, or has accepted corresponding provisions of earlier laws, may appropriate money for the prevention of forest fires to an amount not exceeding one tenth of one per cent of its valuation. Every such town with a valuation of one million seven hundred and fifty thousand dollars or less which appropriates and expends money, with the approval of the state forester, for apparatus to be used in preventing or extinguishing forest fires, or for making protective belts or zones as a defence against forest fires, shall, upon the recommendation of the state forester, approved by the governor, receive from the commonwealth a sum equal to one half the said expenditure; but no town shall receive more than two hundred and fifty dollars. A sum not exceeding five thousand dollars may annually be expended by the commonwealth for this purpose. Whenever it has been demonstrated to the satisfaction of the state forester that such equipment has been destroyed or has become unfit for use, the town shall be reimbursed by the commonwealth one half the cost of replacing the same; provided, that the amount paid to any one town in any one year shall not exceed fifty dollars. All equipment purchased under this section shall be in the custody and care of the town forest warden. The state forester or his deputies may inspect such equipment at such times as they may deem necessary.

G. L., c. 40, § 5. A town may at any town meeting appropriate money for the following purposes: (29) For erecting and maintaining forest fire observation towers, as provided by section twenty-three of chapter forty-eight.

G. L., c. 48, § 24. **Town Expenditures authorized.** Money appropriated by a town under section eleven of chapter forty, for the prevention of forest fires, and all fines received under sections eleven and thirteen of this chapter and section nine of chapter two hundred and sixty-six shall be expended by the forest warden, under the supervision of the selectmen, in trimming brush out of wood roads, in preparing and preserving suitable lines for back fires, or in other ways adapted to prevent or check the spread of fire; or such town may expend any portion of such money in taking by eminent domain such woodland as the selectmen, upon recommendation of the forest warden, consider expedient to prevent forest fires. Such taking and the payment of damages therefor or for injuring the property, other than by fire or back fire, shall be governed by chapter seventy-nine. Every town, the valuation of which does not exceed one million two hundred and fifty thousand dollars, which expends in any one year a sum equal to one-twentieth of one per cent of its valuation in the extinguishment of forest fires, shall, upon the recom-

mentation of the forester, approved by the governor, receive from the commonwealth one half of any additional sum expended by it in the extinguishment of forest fires, provided that the total amount paid by the commonwealth to any such town in any one year shall not exceed two hundred and fifty dollars.

G. L., c. 10, § 8A, as amended by c. 73, Acts of 1923. **Disposition and Expenditure of Funds received from the United States in Relation to Forest Fire Prevention or for Forestry Purposes.** He shall receive from the United States all sums of money payable to the commonwealth under any act of congress, providing for co-operation in the prevention of forest fires, by way of reimbursement for sums expended by the commonwealth on account of such prevention, or otherwise, and any sums allotted to the commonwealth for the purpose of protecting, preserving or developing its woodlands. The sums so received shall be held as the Federal Forestry Fund and be expended upon the order or approval of the division of forestry of the department of conservation without specific appropriation.

G. L., c. 160, § 234. Every railroad corporation shall be liable in damages to a person whose buildings or other property may be injured by fire communicated by its locomotive engines, and shall have an insurable interest in the property upon its route for which it may be so held liable, and may procure insurance thereon in its own behalf. If held liable in damages, it shall be entitled to the benefit of any insurance effected upon such property by the owner thereof, less the cost of premium and expense of recovery. The money received as insurance shall be deducted from the damages, if recovered before they are assessed; and if not so recovered, the policy of insurance shall be assigned to the corporation held liable in damages, and it may maintain an action thereon.

G. L., c. 160, § 235. Every corporation operating a steam railroad shall, subject to the approval of the department [Department of Public Utilities], install and maintain a spark arrester on every engine in its service in which wood, coke or coal is used as fuel, and shall, between April first and December first in each year, keep the full width of all of its locations over which such engines are operated, to a point two hundred feet distant from the center line on each side thereof, clear of dead leaves, dead grass, dry brush or other inflammable material, and shall not at any time leave any deposit of fire, hot ashes or live coals upon its locations in the immediate vicinity of woodlands or grass lands, and shall post in stations and other conspicuous places within its location and right of way such notices and warning placards as are furnished to it for the purpose by the state forester; provided, that this section shall not prohibit any railroad corporation from piling or keeping upon its location or right of way cross-ties or other material necessary for the maintenance and operation of its railroad.

G. L., c. 160, § 236. Any railroad corporation may, upon giving notice as herein provided, enter upon unimproved land adjoining any location or right of way upon which it operates engines burning wood, coke or coal, and may there, at its own expense and subject to the direction of the forest warden, or the officer or board having his powers, in the city or town where the land lies, clear such land of dead leaves, dead grass and dead wood to a distance of one hundred feet from the tracks, without thereby becoming liable for trespass; provided, that no railroad corporation shall, under this section, do any acts on unimproved land outside its location or right of way, unless it has within two months given fourteen days' written notice by mail or otherwise to the occupant of the land, and to the owner thereof, if he resides or has a usual place of business in the city or town where it lies, and if the land is unoccupied and the owner does not reside or have a usual place of business in the city or town, then, unless the railroad corporation has within two months published notice of its purpose once in three successive weeks in a

newspaper published in the county where the land lies, and unless it has within three days given at least twenty-four hours' notice to the forest warden, or the officer or board having his powers, in the city or town where the land lies of the location of the land which it intends to enter under this section, and of the time at which it intends to enter the same; and provided, further, that no notice hereby required shall be valid unless it sets forth the provisions of this section.

G. L., c. 160, § 237. Any engineer, conductor or other employee on a train discovering a fire burning uncontrolled on lands adjacent to the tracks shall forthwith cause a fire signal to be sounded from the engine, which shall consist of one long and three short whistle blasts repeated several times, and shall notify the next sectionmen whom the train passes, and the next telegraph station, of the existence and location of the fire. This section shall not affect the authority conferred upon the department by section one hundred and thirty-nine.

G. L., c. 160, § 238. Sectionmen or other employees of a railroad corporation receiving notice of the existence and location of a fire burning on land adjacent to the tracks shall forthwith proceed to the fire and shall use all reasonable efforts to extinguish it; provided, that they are not at the time employed in labors immediately necessary to the safety of tracks or to the safety and convenience of passengers and the public.

G. L., c. 160, § 239. Railroad corporations shall inform their employees as to their duties under the four preceding sections and shall furnish them with the appropriate facilities for reporting and extinguishing such fires.

G. L., c. 160, § 240. The five preceding sections shall not authorize any railroad corporation to enter upon, or to interfere in the management or care of, any public park or reservation.

G. L., c. 160, § 241. Any railroad corporation which, by its servants or agents, negligently, or in violation of law, sets fire to grass lands or forest lands shall be liable to any city or town where such fire occurs, for the reasonable and lawful expense incurred by such city or town in the extinguishment of the fire.

Cities and towns may recover in contract in the superior court sums to which they are entitled under this section.

G. L., c. 131, § 29. Whenever, during an open season for the hunting of any kind of game, it shall appear to the governor that by reason of extreme drought the use of firearms is likely to cause forest fires, he may, by proclamation, suspend the open season and make it a close season for the shooting of birds and wild animals of every kind for such time as he may designate, and may prohibit the discharge of firearms on or near forest land during the said time.

G. L., c. 131, § 30. During the time designated as above by the governor, all laws relating to the close season shall be in force, and whoever violates any provision thereof shall be subject to the penalty prescribed therefor. Whoever, during a close season proclaimed as aforesaid, discharges a firearm on or near forest land, or shoots any wild animal or bird, as to which there is no close season otherwise provided by law, shall be punished by a fine of not more than one hundred dollars.

G. L., c. 131, § 31. A proclamation issued under section twenty-nine shall be published in such newspapers and posted in such places and in such manner, under the direction of the department, as the governor may order.

G. L., c. 130, § 9. **Duties of Fish and Game Wardens in Respect to Forest Fires, etc.** The director, a warden or deputy may arrest without a warrant any person found unlawfully setting a fire and may require assistance according to section ten of chapter forty-eight. They shall take precautions to

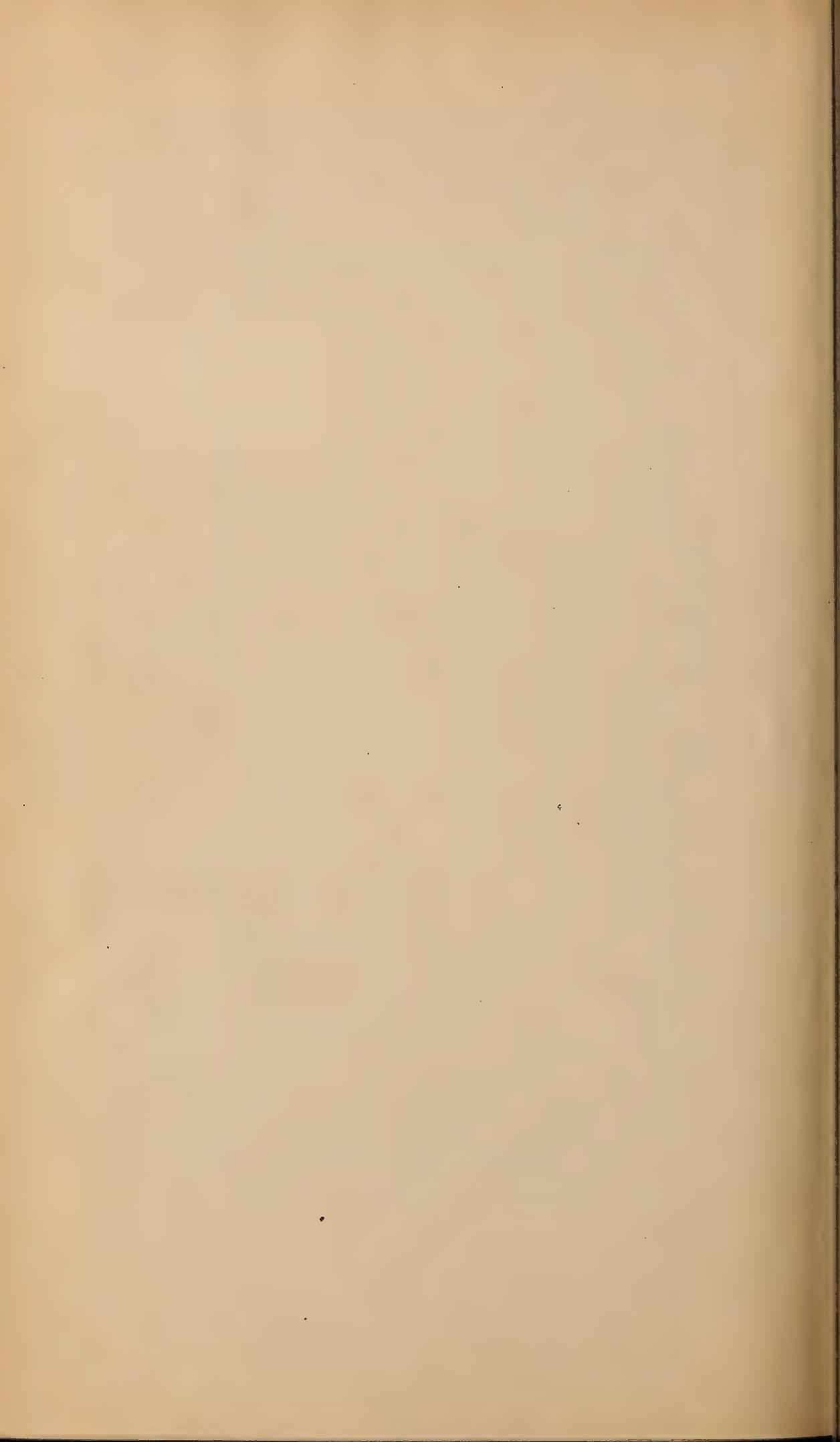
prevent the progress of forest fires, or the improper kindling thereof, and upon the discovery of any such fire shall immediately summon the necessary assistance, and notify the local forest warden. The warden and deputies shall report to the state fire warden monthly their doings under this section; they shall report to him the situation and extent of any forest fire occurring within their respective districts.

G. L., c. 266, § 5. **Setting Fire to Woodpile, etc.** Whoever wilfully and maliciously burns or otherwise destroys or injures a pile or parcel of wood, boards, timber or other lumber, or any fence, bars or gate, or a stack of grain, hay or other vegetable product, or any vegetable product severed from the soil and not stacked, or any standing tree, grain, grass or other standing product of the soil, or the soil itself, of another, shall be punished by imprisonment in the state prison for not more than five years or by a fine of not more than five hundred dollars and imprisonment in jail for not more than one year.

G. L., c. 266, § 7. **Wanton or Reckless Injury to Woods by Fire.** Whoever by wantonly or recklessly setting fire to any material, or by increasing a fire already set, causes injury to, or the destruction of, any growing or standing wood of another shall be punished by a fine of not more than one hundred dollars or by imprisonment for not more than six months.

G. L., c. 266, § 113. **Cutting of Timber.** Whoever wilfully cuts down or destroys timber or wood standing or growing on the land of another, or carries away any kind of timber or wood cut down or lying on such land, or digs up or carries away stone, ore, gravel, clay, sand, turf or mould, from such land, or roots, nuts, berries, grapes or fruit of any kind or any plant there being, or cuts down or carries away sedge, grass, hay or any kind of corn, standing, growing or being on such land, or cuts or takes therefrom any ferns, flowers or shrubs, or carries away from a wharf or landing place any goods in which he has no interest or property, without the license of the owner thereof, shall be punished by imprisonment for not more than six months or by a fine of not more than five hundred dollars; and if the offence is committed on Sunday, or in disguise, or secretly in the night time, the imprisonment shall not be for less than five days nor the fine less than five dollars.

G. L., c. 266, § 116. **Picking of Berries, etc., by Unnaturalized Persons.** Whoever, being an unnaturalized, foreign born person, picks wild berries or flowers, or camps or picnics upon any land of which he is not the owner, within the counties of Barnstable or Plymouth, between April first and December first, without first obtaining a written permit so to do from the owner or owners of the land, shall be punished by a fine of not more than fifty dollars or by imprisonment for not more than one month, or both. The said written permit shall not be transferable, and shall be exhibited upon demand to the forest warden, or his deputies, of the town wherein the land is located, or upon demand of any sheriff, constable, police or other officer authorized to arrest for crime. Failure or refusal to produce said permit upon such demand shall be prima facie evidence of a violation of this section, and any forest warden or any duly authorized deputy forest warden, sheriff, police or other officer authorized to arrest for crime, may arrest without warrant any person who fails or refuses to display for inspection the said permit upon the demand of any of the officials named in this section.



FEB 13 2001

