

PLANT PATHOLOGY DEPT.

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Conifer and Deciduous Trees
W. G. Litchinger & G. J. Siddings.

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THE PRINCIPAL INSECT DEPREDATIONS AND
DEPREDATORS NOTED IN THE STATE.

A Study of Agricultural Conditions in West Vir-
ginia and the Needs of Entomolog-
ical Work.

Relation of Forest Conditions
By A. D. HOPKINS.
to Life Zones



[From the Ninth Annual Report of the West Virginia Agricultural
Experiment Station—1896.]

REPORT

N. J. Siddings

OF THE

ENTOMOLOGICAL DEPARTMENT.

PART II.

The Principal Insect Depredations and Depre-
dators Noted in the State During the
Past Five Years.

By A. D. HOPKINS.

The principal insect depredations may be considered under eight separate heads, as follows:

First—Those affecting forest and shade trees.

Second—Those affecting farm and garden crops.

Third—Those affecting fruit trees and fruits.

Fourth—Those affecting flowering and ornamental plants.

Fifth—Those affecting live stock.

Sixth—Those affecting commercial articles and manufactur-
ing industries.

Seventh—Those affecting household articles and personal
comfort.

Eighth—Those affecting museum specimens.

While the common or ordinary depredations upon farm, gar-
den and fruit crops, ornamental, flowering and other plants,
live stock, etc., by old and new insect pests, have, from time
to time, attracted more than usual attention in different sec-
tions of the State during the past six years; the depredations
upon forest trees and forest products during this time have

Dying Hemlock. A considerable quantity of hemlock timber has been observed in different sections of the Spruce and Hardwood region that had died or was dying. This trouble is apparently caused by a flat-headed bark-borer,¹ similar to the flat-headed apple tree borer. The trouble has not as yet assumed a serious character, but it is one that may cause considerable loss of timber in the future.

Defects in Wood Caused by Insects. This is a common trouble, occurring in living and dead standing timber and in saw logs throughout the State, the extent and serious character of which is not fully appreciated by owners of timber. These defects are caused by a large number of different kinds of wood boring beetles and grubs.²

Pinholes in Chestnut is a serious trouble causing an immense loss of otherwise valuable timber wherever the chestnut tree grows. This trouble is caused by the chestnut timber worm.³

Dying Oak Timber. There is a trouble affecting the oaks which has been in progress in this and other eastern and western States since 1893, and appears to be gradually on the increase.⁴ The trees die in July, August and September, the leaves turning a light brown and remaining on the tree during the winter and following spring. This, or a similar trouble, was observed in Wisconsin, Indiana and Ohio in August, 1893, and was especially prevalent at Madison, Wisconsin, where large numbers of dead and dying oaks were observed. Dying oak trees have been observed in different sections of the Western Pine area and in the Hardwood area; and it is believed that the trouble is pretty well distributed over these areas.

All of the dying trees that I have examined, show evidence of having been killed by the destructive oak bark beetle.⁵

Defoliation of Forest Trees. In July, 1893, I observed at the head of Cranberry river in Greenbrier county, 75 to 100 acres of forest, principally of oak, where all of the trees and under-

1 *Melanophila fulcoguttata*, Harr.

2 See Bulletin 35.

3 *Lymexylon sericeum*, Harr.

4 An abatement of this trouble was noted in the summer of '96.

5 *Ayrilus bilineatus*, Web.

growth were as bare of leaves as they are in winter. This trouble was caused by a small span worm.¹ Last fall (1895) I observed at different points along Laurel Hill, the mountain range which separates Monongalia and Preston counties, that the leaves on the oak trees presented a ragged appearance, caused by a leaf eating insect, but it was too late to find any of the insects. This trouble extends for some 20 miles along the summit of the mountain. It may be the starting of a serious insect outbreak.²

Forest, Shade and Fruit Trees are often stripped of their first leaves by May Beetles,³ which occurs in immense swarms during warm evenings in May and June. Serious damage to oak timber was reported from Lewisburg, June 6, 1891, by the editor of the Greenbrier Independent, and to fruit and shade trees at Ridgeville, Mineral County, on May 10th, 1894, by Arnold Bros.

The May Beetles are the parents of the white grub worms that are so destructive to grass and growing grain, and one or more species doubtless occur in every section of the State where these staple products are cultivated.

Trouble Affecting the Heartwood of Living and Dead Trees. Trees of all kinds in all sections of the State that have been injured by fire or other causes, sufficient to induce a diseased condition of the wood adjoining the wound, often have the heartwood literally ruined by the destructive heartwood borer.⁴ This pest extends its destructive depredations to the sound wood, which results in the final decay of all of the inner portion. This is quite a serious trouble and causes the loss of a large amount of timber.

Tan Bark Destroyed by Insects. Quite a serious trouble affecting old chestnut-oak tan bark was called to my attention by Mr. T. Paunall, at Romney, Hampshire county, and was subsequently reported by the same gentleman from New

1 *Geometrid sp.*

2 Observed in the summer of 1896 but not so marked.

3 *Lachnosterna sps.*

4 *Centrodera decolonata*, Harr.

PLANT PATHOLOGY DEPT.

Creek. I have also observed the same thing at Morgantown. This trouble is caused by the destructive tan bark borer.¹

Wormy Chestnuts and Hickory Nuts. This is a common and quite serious trouble which causes the loss of vast quantities of nuts and a considerable loss of money to dealers in these products. This trouble is induced by one or more species of nut weevils which belong to the same family of insects as the plum curculio. These insects appear to be common wherever the nut trees grow.

Defoliation of Shade Trees. In 1890 and 1891 a trouble affected the shade trees in Fairmont and Morgantown, caused by the white marked tussock caterpillar.²

The trees are defoliated and the caterpillars are annoying by their disgusting presence on the street and in houses.

While all of the insect depredators mentioned above are native species, we have the following introduced defoliators of forest and shade trees:

*The Bag Worm.*³ This is apparently a new pest in West Virginia, and has not as yet spread to any great extent. Its presence may be known by the occurrence of silken cocoons about 1½ inches long, covered with bits of leaves and twigs and hanging on the twigs and branches of the trees, often in great numbers. It was reported from Williamstown, Wood county, in 1890; Parkersburg in 1893; Shepherdstown, Jefferson county, Salama, Pleasants county, and Hico, Fayette county, in 1895. This insect appears to attack all kinds of fruit, forest and shade trees.

A New Shade Tree Pest. *The Elm Leaf Beetle*⁴ is another insect that originally came from Europe and has evidently found its way into our State. I have not observed it, but from the reports and specimens of leaves received from Ohio and Brooke counties it would appear that it has become established there.

1 *Phymatodes variabilis*.

2 *Orgyia leucostigma*, Sm. & Abb

3 *Thyridopteryx ephemeraeformis*, Haw.

4 *Galerucella luteola*, Mull.

This is a serious enemy of elm shade trees in towns, cities and parks in the east, and if it has, as we think, become established west of the mountains, it may prove extremely destructive.

There are a number of other European shade and forest tree pests which have become established in the eastern states, and an enormous amount of money is being expended for their suppression. It is only a matter of time when some of these dreaded pests will find their way into this State. If their first appearance is noted, it may be possible to check their spread without much expense, but if allowed to become established, it will be a difficult if not an impossible task to accomplish.

A Trouble Affecting Seasoned Wood. Seasoned oak, hickory and other sap-wood is often found eaten into a fine powder. This trouble is especially frequent in hickory spokes and handles, but occurs also in furniture, building material, etc.; and in all kinds of wooden articles made from sap-wood. It is caused by the powder post beetle* which is an introduced pest that has long since become established in this State. There is a similar trouble affecting the sap-wood of old lumber and the wood in barns and outbuildings, caused by several species of beetles which appear to be indigenous to this country.

FARM AND GARDEN INSECTS.

But few special outbreaks above the ordinary have been noted or reported with reference to farm and garden insects, and but few new pests have, to my knowledge, appeared within the past five years.

Cut Worms. These are probably entitled to head the list, on account of their occurrence in excessive numbers and the great damage done by them. In the spring of 1895, they were especially common and destructive in the western section of the Western Pine Area, and also in the western section of the Hardwood Area. Corn, potatoes, tomatoes and sweet potatoes suffered severely, it being often impossible to get a stand of these plants until after the worms went into the ground to change to the pupae.

**Lyctus striatus*, Melsh.

White Grubs are common pests and have done immense damage to pastures, meadows and lawns, also to corn and potatoes, especially in the hardwood and southern pine areas (see Ent. Rep Part III.) The adult form of the common white grubs, the May beetles, are also common and destructive to the foliage of fruit, forest and shade trees.

The Wireworm is another grass and corn pest which is abundant in all clayey lowlands, particularly in the western pine area and the hardwood area.

*The Clover-leaf Beetle*¹ is a comparatively new pest which made its appearance first in Berkley and Hampshire counties, where it caused considerable alarm in the spring of 1894. It has been also observed in the western section of the hardwood area and doubtless occurs in the northern section of this region. Its presence is indicated by a ragged appearance of the clover leaves in May. The insects feed at night.

The Grain Plant Louse.² A small, green louse on the heads of wheat and oats. This insect was especially abundant in 1890 and '91 in the different grain growing sections of the State and was the subject of much inquiry.

*The Chinch Bug*³ was reported the past summer from Petersburg, Grant county, and Old Fields, Hardy county, in the eastern pine and hardwood region, where it did much damage to wheat and oats and caused considerable alarm; said to have been common in this section for three years—1893 to 1895.

*The Potato Scab Gnat*⁴ is a newly discovered pest that caused an immense loss of potatoes in Wood and Monongalia counties and evidently in other sections in the fall of 1891 and 1892, but since that time the summer and fall drouths have been unfavorable for its work. It causes one form of the scab and also destroys the tubers*.

1 *Phytonomus punctatus*.

2 *Siphonophora avenae*.

3 *Blissus leucopterus*.

4 *Epidapus scabiei*, Hopk.

*The wet season of 1896 was favorable for the breeding of this pest and it was primary and secondarily the cause of serious loss of tubers.

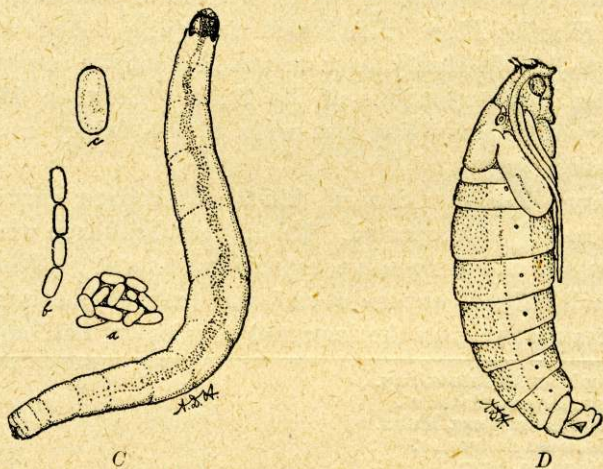
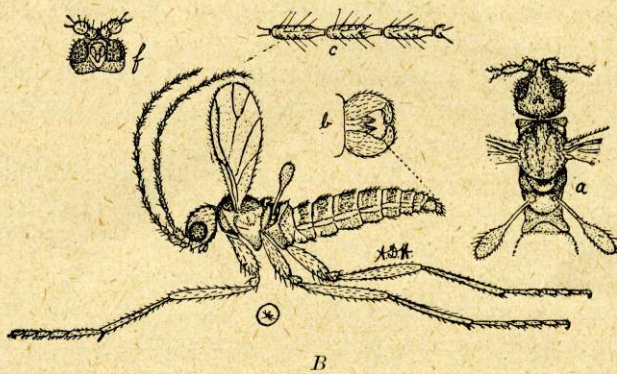
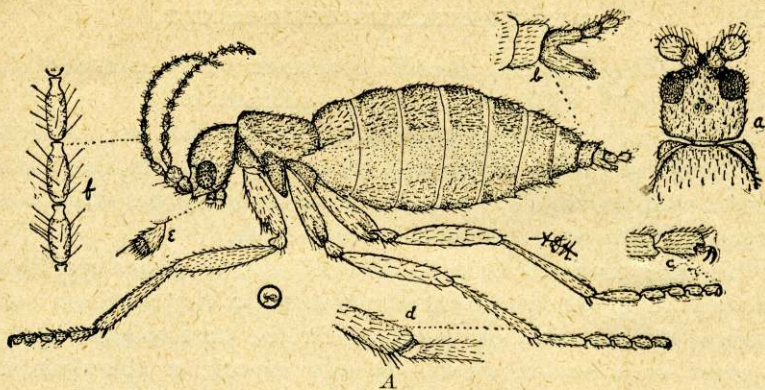


PLATE VII.—Potato Scab, Gnat greatly enlarged. A—Female. B—Male.
C—Larva. D—Pupa.

*The Colorado Potato Beetle*¹ continues to do considerable damage, but is not as serious a pest as formerly.

*The Black Potato Beetle or Blister Beetle*² has been abundant and destructive in some sections, especially in the hardwood region, due to the prevalence of grasshoppers upon the eggs of which the young of this beetle feeds.

Grasshoppers and Locusts. The red legged species has, from time to time, appeared in great numbers in the northern portion of the eastern pine area and in the hardwood area and caused considerable alarm. It was especially abundant in Mineral county (Patterson's Depot), in May, 1891, and near Morgantown in August, 1895.

Grain Weevil. Several species of grain weevils and moths have been observed and reported, but none, it appears, have caused serious damage.

*Corn Ear Worms.*³ A common pest which attacks the young growing ears of corn. In the summer of 1895 this insect did very little damage to the ears, but owing to the early appearance of the moth, before the ears had commenced to form, it attacked the central shoot of the stalk of corn, and was also quite injurious to green peas and beans; the pods of which it entered for the purpose of feeding upon their contents.

*The Hessian Fly.*⁴ This insect was quite abundant in the spring of 1895, in Hardy, Jackson and Monongalia counties, and doubtless in other sections of the State. Between 1890 and 1894 very little complaint was made of the injury caused by this insect.

Cabbage Worms. Several kinds of cabbage worms have been observed and reported. The imported cabbage worm⁵ being common and destructive, especially in small gardens.

A small striped cabbage worm⁶ was extremely common and more destructive than the imported species in 1891 and 1892,

1 *Doryphora 10-lineata*, Say.

2 *Epicauta pennsylvanica*.

3 *Heliothis armigera*, Hubn.

4 *Cecidomyia destructor*.

5 *Pieris rapae*, Schr.

6 *Evergetis rimosalis*, Gn.

but in 1893 and 1894 was not so common and even rare at Morgantown. The native cabbage worm,¹ a large, striped worm, that was common before the imported species appeared, became almost extinct after the imported one came; however, it appeared in considerable numbers on the Experiment Station grounds in September and October, 1895; also in Jackson county in October of the same year. In 1890 I took one specimen in the Allegheny Mountains, near the head of Cheat river, which was the only living specimen I had seen up to the fall of 1895.

*Cabbage Maggot.*² This is a destructive cabbage insect, attacking the stem of young plants beneath the surface of the ground. It was first observed in Brooke county in 1891, and has since become common.

*The Harlequin Cabbage Bug*³ is a new pest originally from Texas. It was observed by me in Wood county in 1890, in Mason county in 1891; was extremely abundant at Morgantown in 1894, and during 1895 was reported from Kanawha, Putnam, Cabel, Mason, Grant and Wayne counties, as especially destructive to cabbage.

*Melon Plant Louse.*⁴ Small, green lice on the under side of melon leaves. Destructive to musk melon vines in Wood county in July, 1894.

*False Chinch Bug.*⁵ A small, greyish bug on leaves and tips of shoots of melon vines. Abundant near Morgantown in the summer of 1895, causing serious damage.

*The Striped Cucumber Beetle.*⁶ A well known and common insect wherever melons and cucumbers are grown.

*Squash Bug.*⁷ This pest was common at Morgantown in 1894 and '95, and has been complained of in different sections of the State.

1 *Pontia protodice*, Boisd.

2 *Phorbia brassiae*, Bouch.

3 *Murgantia histrionica*, Hahn.

4 *Aphis cucumeris*, Forb.

5 *Nysius destructor*, Riley.

6 *Diabrotica vittata*, Fabr.

7 *Anasa tristis*.

*Squash Borer.*¹ A white worm boring in squash and pumpkin vines; common in Wood and Monongalia Counties in 1890 to 1895, and doubtless is also common in other sections.

*Flea Beetle.*² A small, brown flea beetle has been abundant and quite injurious to the foliage of tomatoes, egg-plant, potatoes, and tobacco at Morgantown.

Plant Lice. These are serious pests, attacking almost all kinds of vegetable and flower garden plants in all parts of the State.

*Stalk Borer.*³ A striped caterpillar boring in the stalks of all kinds of soft stemmed plants, and often causing serious damage to garden and field crops—common in Wood and Monongalia counties.

*Bean and Pea Weevils.*⁴ Within the past three years the bean weevil has been especially common and destructive to stored seed and other beans. The pea weevil has also been common, but not complained of nearly so much as the bean weevil, the latter, apparently, being thoroughly distributed over the greater part of the State.

FRUIT INSECTS.

*Wormy Apple Caused by the Codlin Moth.*⁵ A common pest and the principal enemy of the apple fruit; apparently common wherever apples are grown.

Shot Holes in the Bark of Fruit Trees caused by the *Imported Fruit Bark Beetle.*⁶ A small black beetle common in Wood, Jackson, Monongalia, Harrison, Putnam, Brooke, Jefferson, and doubtless in all of the counties in the Pine and the Hardwood areas. It is capable of causing the death of apple, peach, cherry, and pear trees; also attacks the buds on living, wild and cultivated cherry and apple trees, causing the leaves to die as if killed by blight.

1 *Melittia ceto*, Wester.

2 *Epitrix parvula*, Fab.

3 *Gortyna nitela*, Guen.

4 *Bruchus obsoletus*, Say.

Bruchus pisi, Linn.

5 *Carpocapsa pomonella*, Linn.

6 *Scolytus rugulosus*, Ratz.

*The apple leaf blight.*¹ A disease often mistaken for the work of insects; a common trouble; the twigs and small branches dying, the dead leaves remaining on them. This is the work of a bacterial disease which causes a fermentation of the sap.

There is also a similar disease of the pear and quince which is commonly mistaken for the work of insects. It has been the subject of inquiry from Ritchie, Wood, Jefferson, Randolph and Monongalia counties.

*The Apple Tree Borer.*² A common and destructive insect to young apple trees, boring into the base of the tree, especially destructive in Upshur county, but evidently common wherever apples are grown; it has been also observed in Wood, Jackson, Harrison and Monongalia counties.

*Scale Insects.*³ Waxy scales of various sizes attached to the bark and leaves of the infested plants.

*The Oyster Shell Bark Louse*⁴ on apple trees was reported Greenbrier County in April, and from Pocahontas County in May, where it was said to be very common.

*A Scale on Peach Trees*⁵ reported from Parkersburg, Wood County. Several trees died presumably from its attack.

A White Scale on Black Cap Raspberries. *The Rose Scale*⁶ has been observed in Wood and Monongalia Counties, and reported from Hancock and Ohio Counties.

A NEW FRUIT TREE PEST IN WEST VIRGINIA.

*The San Jose Scale.*⁷ This dreaded pest was reported with specimens from Wellsburg, Brooke County, and Georgetown, Monongalia County, in January, 1896, where it was introduced from New Jersey on nursery stock. *This is one of the worst fruit tree pests known*, and every one having fruit trees purchased from eastern nurseries should examine them thoroughly, and if small, dandruff like scales are found on the bark, we should be notified at once and specimens sent for identification.

1 *Micrococcus amyloporus.*

2 *Saperda candida.*

3 *Chrysobothris femorata.*

4 *Mytilaspis pomorum.*

5 *Lecanium persicæ.*

6 *Diaspis rosæ.*

7 *Aspidiotus perniciosus.*

This is a matter demanding earnest and serious attention by every one interested in the growing or consumption of fruit.

Galls on Plum Twigs. Clusters of small roundish objects at the base of the last annual growth of the twigs, caused by the *Plum Twig Gall Mite*,* a recently discovered pest that has evidently been common on plum trees for many years, but owing to the small size of the galls the pest has been overlooked. It was discovered by me in Morgantown in 1895, and has been observed in different sections of Monongalia County, in fact I have found it in abundance on plum trees wherever they have been examined and is evidently common throughout the State.

Wormy Plums and Cherries caused by the plum curculio¹ is a common trouble in most sections of the State. It appears from some evidence I have obtained that plums in some localities are never seriously affected by this insect. I am particularly anxious to learn of as many such localities as possible, in order that I may investigate and determine, if possible, why the plums in such localities are not attacked. If it is true that such localities exist, it is an important question for investigation.

A Defoliation of Gooseberries and Currants. A common trouble over the greater portion of the State, caused by the *imported currant worm*.²

The *currant borer*³ is a comparatively new pest reported from Brooke County.

Gouty Enlargements on Raspberry Canes. A common trouble affecting raspberry, blackberry and dewberry canes, caused by the Raspberry Gouty Gall Beetle.⁴ Serious loss to berry growers is often occasioned by this insect in different sections of the State.

Young Raspberry and Blackberry Canes Girdled near their tops, usually at two places, about an inch apart; the

**Phytoptus phloecaptes*, Nalepa.

1 *Conotrachelus nenuphar*, Hbst.

2 *Nematus ventricosus*, Klug.

3 *Egeria tipuliformis*, Linn.

4 *Agrilus ruficollis*, Fab.

tops dying and the cane infested by a small borer; first observed in this State in the summer of 1892. The trouble has since become common in Monongalia County, and has been observed in other sections. This injury is caused by the *raspberry cane girdler* or *pruner*.¹

Fruit Trees Defoliated and Young Fruit Destroyed by the May Beetles and the Rose Beetle;² the latter destroying the young fruit of apples, peaches, cherries, grapes, etc. Common pests wherever there is suitable sandy soil in which they breed; by the *bag worm*, reported from different sections, and by the *apple tree tent caterpillar*,³ a common and serious pest in Upshur, Wood, Hampshire, and many other sections of the State.

Grape Leaves Dying with whitish blotches on the upper surface, caused by the grapevine leaf hopper;² a common and serious pest at Morgantown within the last two years.

There are a great number of other insects known to infest fruit trees and shrubs in the State, too numerous, in fact, to mention in this connection. There are also a number of old and new pests in the east that are liable to be introduced on nursery stock. Therefore, I would advise our fruit growers to purchase their stock, as far as possible, *from home nurseries* and BEWARE OF FRUIT TREE AGENTS unless you know them to be perfectly reliable and responsible for the stock they sell.

LIVE STOCK.

Insects cause a number of serious troubles to live stock, among which we may mention the following:

The Horn Fly,⁴ a foreign pest, made its appearance in West Virginia between 1889 and 1890 and rapidly spread to every part of the State where cattle and horses are kept in any considerable numbers. It is now well established, but does not appear to be as abundant as it was between 1890 and 1893 when it caused serious trouble in the different cattle growing sections.

1 *Oberea bimaculata*, Oliv.

2 *Macrodactylus subspinosus*, Fab.

3 *Clisiocampa Americana*.

4 *Hæmatobia serrata*.

Warbles. Caused by the *gad or warble fly*¹ which is an old and common trouble affecting cattle that are allowed to grow poor from insufficient food or an unhealthy condition.

Grub in the Head. Caused by the sheep gad fly;² is a common trouble affecting sheep apparently in every section of the State where sheep are kept.

*Sheep Ticks.*³ (Wingless flies); another common enemy of the sheep.

*The Sheep Scab*⁴ is caused by a tiny mite which is a most serious and destructive pest. It has given considerable trouble in Jackson and Harrison counties, and possibly in other sections. The wool comes off and the skin is covered with sores.

*The Head Scab*⁵ is a similar trouble caused by a mite that produces sore mouths and scabby heads among lambs and older sheep. This trouble has been observed in Jackson and Wood counties and reported from other sections.

Lice. All kinds of live stock, including poultry, are often seriously troubled by lice, different kinds attacking different kinds of animals. Lice on cattle and poultry probably give the most trouble in this State.

Internal Parasites. There are a great number of internal parasites that cause serious trouble to all kinds of live stock, and quite frequently cause the death of the infested animals. They are principally true worms, which are not classed with insects. They infest the lungs, liver, stomach, intestines, flesh and even the brain. Most of these creatures reach the stomach of the animal through stagnant or running drinking water. Hence, the advantage of well or pure spring water for stock.

FLOWERING AND OTHER ORNAMENTAL PLANTS.

The principal insects known to infest flowering and ornamental plants and shrubs are plant lice, scale insects, red spiders, mealy bugs and numerous leaf eating and stalk boring caterpillars and grubs.

1 *Hypoderma lineata*.

2 *Estrus ovis*.

3 *Melophagus ovinus*.

4 *Psoroptes communis*, Fursh. Var. *ovis*.

5 *Sarcoptes scabiei*, de Geer. Var. *ovis*.

Roses. The rose beetle, plant lice and the rose slug are the principal insect enemies of the rose. The latter is especially destructive to the foliage, the native species causing the seared and brown condition so common on neglected rose bushes, while the new or European species cause a ragged appearance of the leaves.

The Astor. The blister beetle is a serious and destructive enemy to the flowers of the astor, often stripping the plants of their beautiful bloom within a single day. This insect is common throughout the grazing regions of the State, or where grasshoppers occur in any abundance, since its young feed upon grasshopper (locust) eggs.

HOUSEHOLD PESTS.

Among the household pests we have in this State as the principal insect pests, the clothes moth, houseflies, the American and German cockroach, ants, worms in dried fruits and beetles in cured meats; also the pea and bean weevils which may invade the house from stored beans and peas.

Pests of Commercial and Manufactured Products Affecting Dried Fruit. Peaches, apples, figs and other similar products may be seriously injured by the dried fruit worm, as has been observed at Morgantown. The same thing also attacks candies containing fruit and nut kernels.

Grain Weevils. Weevils of various kinds have given some trouble in feed and grocery stores. Cigars, cigarettes and tobacco have been injured to some extent in cigar and other stores by the cigarette beetle,¹ and drugs of various kinds, especially iris root has been damaged considerably by the same insect. Leather is also attacked and injured by it.

Roaches and Ants are often troublesome pests in stores, dwellings and hotels.

*The Powder Post Beetle*² has caused considerable loss of stored wood material in buggy, handle, cooper and furniture factories.

¹ *Lasioderma serricorne.*

² *Lyctus striatus.*

NATURAL HISTORY COLLECTIONS.

Collections of Insects, birds and other similar specimens, as well as botanical specimens at the University and Station are attacked by several species of insects which would literally ruin the specimens if they were not carefully watched and every precaution taken to prevent their depredations.

REMEDIES.

Remedies and methods of dealing with the several troubles mentioned have not been included in the above list of principal depredations by insects, as we expect to issue a series of popular bulletins in which a full list of remedies will be found. A bulletin on Farm and Garden Insects, as the first number of this series will doubtless be ready to send out about the same time as this report,* and others will follow as soon as they can be written. In the meantime if information is desired by any of our readers upon any questions with reference to the insects mentioned in this report, or upon any other insects, we will take pleasure in replying by letter to an inquiries. In fact, it is our earnest desire to have correspondents in every section of the State who will notify us of the presence of common insect pests, as well as of the appearance of new or strange ones. When there is any doubt as to the species that cause the trouble, specimens of the different kinds associated with it should be mailed to us in tight tin or wooden boxes. If insects are not found, specimens of the injury, with a description of character, not shown by the specimen, would often be sufficient for us to identify the cause of the trouble. *It is always best and important to send specimens of the insect with all inquiries whenever it is possible to do so.*

It is important that we should know the exact distribution and range of all of the principal old and new insect pests in the State. Therefore, notices and specimens from any section of the State with reference to any insect will be thankfully received, and the sender will receive in return, any published or other information, we may have for distribution or can give by letter.

*Bulletin 44, "Farm and Garden Products," Distributed 1896.

REPORT
OF THE
ENTOMOLOGICAL DEPARTMENT.

PART III.

A Study of Agricultural Conditions in West Virginia and the Needs of Entomological Work.

By A. D. HOPKINS.

(Prepared for the general reader.)

The objects of the Entomological Department of the experiment station are:—*First* to acquire and *Second* to diffuse useful and practical information upon the insects that are destructive or beneficial in their relation to the agricultural interests of the State. In accordance with the first duty I have endeavored to obtain information upon the existing agricultural conditions and needs of West Virginia in order to determine what lines of entomological investigation would probably yield the most useful and practical results. From 1890 to 1892 three special trips were made for this purpose, and to obtain specimens for the collection. The first trip of 376 miles was made through the central counties between July 21 and 26th, 1890, as mentioned on page 153 of the third annual report of this station and in Bulletin No. 14. The second trip of 1,562 miles between July 6th and August 15th, 1891, was made through 26 counties, including Monongalia, Marion, Taylor, Preston, Tucker, Grant, Mineral, and Hampshire in the northern and north-eastern por-

tion of the State; thence, through Maryland and a portion of Pennsylvania to Hancock County, and through all of the Ohio River counties from Hancock to Wayne, through Putnam and Kanawha, on the great Kanawha river, and into Wirt county, on the little Kanawha river; thence through Ritchie, Doddridge, and Harrison counties to Marion. The third extended journey of about 600 miles from June 16th to July 1st, 1892, was through the Allegheny Mountain region of Preston, Barbour, Tucker, Randolph, Pocahontas, and Greenbrier counties; through the black spruce, white pine and other great forests on the waters of the Cheat and Greenbrier rivers; and also through the white pine and hard wood forests of Raleigh county.¹ Numerous special tours of investigation have been made among which we may mention the following:

An investigation in the spruce forest of Randolph county, August 25th to September 2d, 1890.² A second examination in the spruce forest of Tucker and Grant counties from March 26-31st, 1891.

On May 11th, 1891, a trip was made into Mineral county to investigate a reported outbreak of grasshoppers.

On May 25th, 1891, a trip was made into Jackson county for the purpose of studying fruit and locust tree insects, another, on June 15th, 1891, was made into Harrison county to study locust tree insects, and from there into Lewis and Upshur counties to investigate a serious trouble caused by the apple tree tent caterpillar; and from Upshur county into Wood, where I remained until July 1st, studying fruit and forest tree insects.

Between May 2d and 10th, 1892, a special investigation was conducted in the pine forests of Mineral, Hampshire, Grant, Hardy, and Pendleton counties, along the South Branch and North Fork of the Potomac river.

On May 19th, a trip was made into Wood county, for the purpose of investigating the disease of sheep, supposed to be caused by internal parasites.

In June and July, 1892, a thorough investigation of the trou-

1 Bulletin No. 30, pp. 110-114.—Notes on Travel in West Virginia.

2 Bulletin No. 17, and Third Annual Report, pp. 171-180.

ble in the pine and spruce forests caused by the destructive pine bark-beetle, was made during the third extended trip previously mentioned.

In 1893, special investigations and distributions of imported insects were made as follows:

May 15th to 16th, in Wood county, studying forest and fruit tree insects; April 25th to May 10th, in Kanawha, Raleigh, Pocahontas, and Webster counties, distributing imported insects in the white pine and spruce forests, and conducting investigations on pine and spruce insects. May 20th to 25th in Tucker, Randolph and Grant counties; distributing imported insects and investigating spruce tree insects; June 21st to July 1st, in Webster, Pocahontas, Greenbrier and Nicholas counties, studying forest tree pests, and distributing imported beneficial insects; August 8th, and September 8th to 12th, in Wood county; October 6th to 7th in Raleigh county, studying white pine, oak, and chestnut tree insects; October 9th to 11th, in Randolph and Upshur counties, also December 3d, investigating yellow poplar or tulip tree insects.

In 1894, special investigations were conducted as follows:

April 13th in Doddridge county, April 14th to 16th in Wood county; May 4th in Berkeley county, investigating a reported outbreak of the clover leaf beetle; May 5th to 10th in Tucker county, investigating pine and spruce insects; June 17th to July 1st, in Randolph and Wood counties, studying yellow poplar, chestnut and other forest tree insects; Wood county, July 12th, investigating work of insects in seasoned lumber; October 2d to 15th, in McDowell, Mercer, Summers, Greenbrier, Jackson and Wood counties, investigating forest and other insects; October 20th to 24th, in Tucker, Randolph and Grant counties conducting investigations in spruce forest.

Numerous collecting and investigating tours have been made in different sections of Monongalia, Preston and Marion counties, and in addition to the special tours of investigation, the State has been pretty thoroughly traversed during the winter months in attending some thirty farmers' institutes, and farmers' meetings in Greenbrier, Wood, Harrison, Berkeley, Pres-

ton, Monongalia, Marion, Brooke, Ohio, Marshall. Mineral and Kanawha counties. Thus every county but three in the State has been visited, and in so doing, an aggregate distance of over 10,000 miles has been traveled by rail, wagon, horseback and on foot in the State since March, 1890.

With this survey of the State and a study of its agriculture, its forests and other natural resources, together with its people, we feel that our first object—acquiring information with reference to its conditions and needs—has been, to a certain extent, accomplished.

THE CONDITIONS AND NEEDS OF THE STATE IN THEIR RELATION TO
ECONOMIC ENTOMOLOGY.

In studying the conditions influencing and influenced by insect life within the State, it is necessary to have some knowledge of its geography, its geology and its climate; its plant and animal life and the distribution of the same; its forests, its agriculture, past and present; its progress and development together with transportation facilities and the probable future development of its agricultural and forest resources.

Geographic Conditions. Of the conditions which influence insect life and its distribution, the geographic conditions are of first importance, since these determine to a marked degree the kind of insect life which can exist within the State, and also has an important influence upon the multiplication and spread of certain pests introduced from other countries.

The State, occupying as it does a central position between the extreme northern and southern border of the eastern portion of the temperate zone of North America, with its varying elevations above sea level, from 272 to 4,860 feet, and its corresponding variation in temperatures, we may look for the greatest variety of plant and animal life and for a greater number of kinds of noxious insects, which have found their way here from similar regions in this and other countries.

Geological Conditions. These, in connection with those of a geographic and climatic character, have an important influence on the occurrence and distribution of different kinds of insect life in the State, and is a subject demanding special investiga-

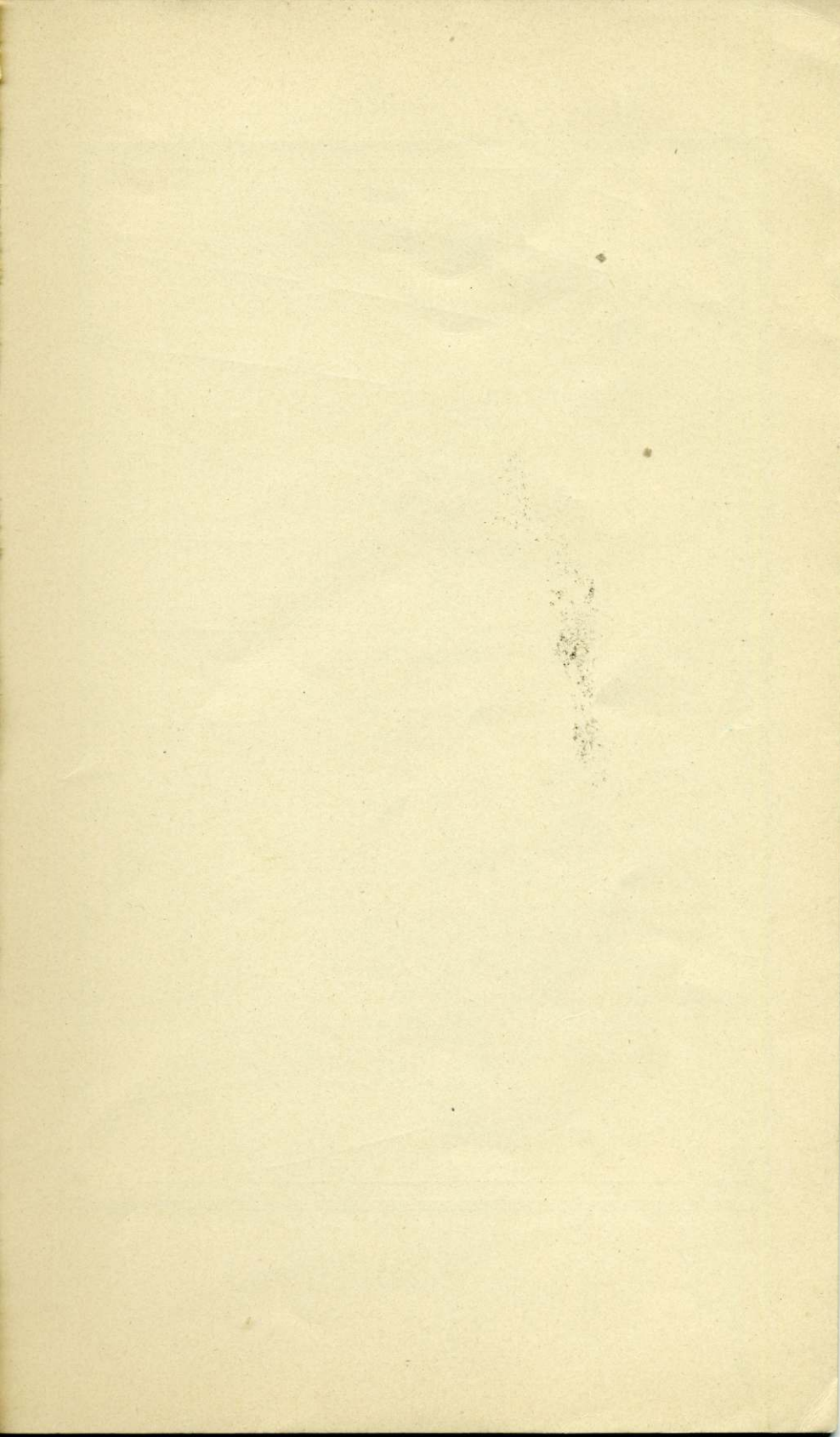
tion by geologists, biologists and botanists. Not only is this necessary in order to determine important questions in reference to the distribution of different species of insects, but to determine the regions best adapted to different kinds of domestic animals, farm crops, fruits and to forest products.

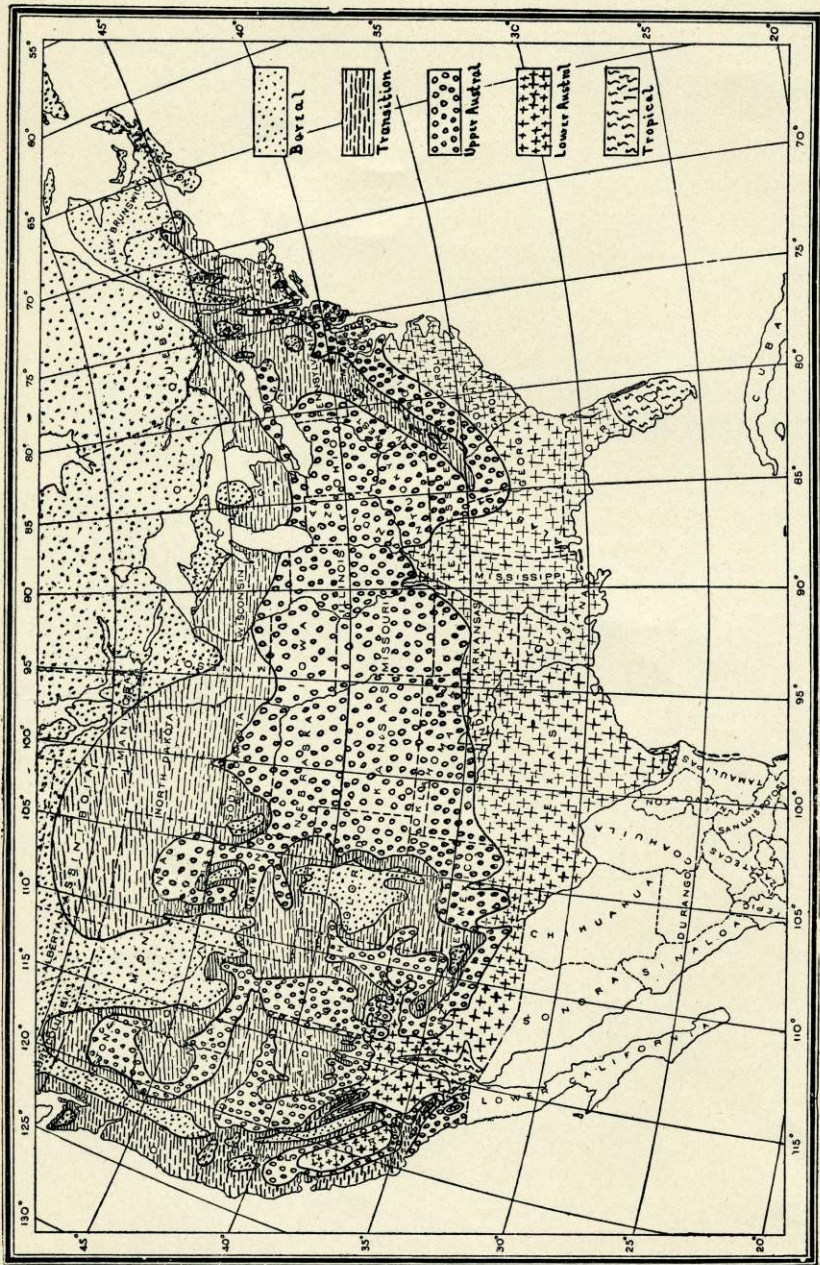
We find the alluvial sandy and gravel soils of the Ohio River Valley peculiarly suited to certain lines of grain and vegetable growing and to market gardening. The alluvial clay soils of the Great Kanawha Valley especially suited to the growing of hay, tobacco and other crops. We find, as noted by Prof. S. B. Brown, Professor of Geology in the State University, that the red Permian limestone soils in the northern Panhandle, a portion of Monongalia county and other sections of the State, is especially adapted to the growing of sheep, and the production of superior hard wood timber.

The level limestone soils of the eastern Panhandle, and of Greenbrier and Pocahontas counties, have been found best adapted to wheat growing and grazing. The limestone and other soils of the central counties are supporting magnificent hardwood forests, and where cleared, unsurpassed grazing land is found. The hilly region of the western portion of the State, with its red and yellow clay and sandstone soil, is suited to the growth of oak, walnut, hickory and pine timber; and to sheep and fruit industries. The hilly and mountainous regions of the southern portions of the State produce forest of mixed growth of oak, tulip, poplar, chestnut, pine and other commercial woods; and the cleared land is well adapted to stock raising. The mountainous portion of the eastern Panhandle produces a natural growth of chestnut, oak and pine; while the higher limestone and older rock formations of the Alleghanies produce a natural growth of black spruce, birch, maple, hemlock and wild cherry; and some of the valleys and summits of mountains in this region produce, when cleared, some of the best pasture lands in the State. Thus the geological conditions which favor the growth of indigenous and introduced plant life and certain kinds of wild and domestic animals, also favors the occurrence

of special kinds of beneficial and destructive insects. Hence, a knowledge of the causes and the range of this varied distribution of certain kinds of plant and animal life within the State is of prime importance in conducting our entomological investigations.

Climatic Conditions have an important influence upon insect life and especially upon the distribution and prevalence of noxious kinds. While certain kinds of insect pests may be found in every part of the State, others occur only in restricted areas. This is due in part to the geological and other conditions favorable to the growth and abundance of their food substances, but more perhaps, as has been determined by Dr. C. Hart Merriam, to laws of temperature and humidity. Thus we find restricted areas occupied by certain species of plants and animals which can not, or at least do not, naturally exist in other near by areas of higher elevation or in which a marked difference in temperature occur.





LIFE ZONE MAP OF THE UNITED STATES.

By kindness of Prof. Hart Merriam, U. S. Dept. Agr.

LIFE ZONES.

Since the varying geographic, geologic and climatic conditions in different sections of a country governs, to a marked degree, the kinds, distribution and range of its animal and plant life, it follows that there are numerous natural life areas which are called life zones.

Until recently little was known of the number and range of the specific life zones in the United States, or their significance to the agriculturalist. The great importance of an accurate knowledge of this subject, and the necessity of maps to show the range of the different distinctive life zones and their subdivisions has been plainly shown by the results of special studies and investigations conducted by Dr. C. Hart Merriam, chief of the Division of Ornithology and Mammalogy in the U. S. Department of Agriculture, whose work indicates, as set forth in the Yearbook of the Department for 1894, pp. 203 214, that the life zone areas may be correctly mapped so that "* * * the agriculturalist need only ascertain the formal area to which a particular crop or garden plant of limited range belongs in order to know beforehand just where it may be introduced with every prospect of success, soil and other local modifying influences being suitable, and, in case of weeds and of injurious and beneficial mammals, birds and insects, he would know what kinds were to be looked for in his immediate vicinity, and could prepare in advance for noxious species that from time to time suddenly extend their range. * * * In short a knowledge of the natural life areas of the United States and of their distinctive species and crops would enable our farmers and fruit growers to select the products best adapted to their localities, would help them in their battle with harmful species and would put an end to the present indiscriminate experimentation by which hundreds of thousands, if not millions of dollars are needlessly expended each year."

Dr. L. O. Howard, chief of the Division of Entomology U. S. Department of Agriculture, has varied this statement in

his studies of the distribution of noxious insects, especially in the dissemination of that dreaded enemy of fruit trees—the San Jose Scale.¹

Dr. Merriam concludes² that the fauna and flora of North America, north of the tropical portion, are properly divisible into only two primary life regions—a northern or Boreal and a southern or Austral, which is described by him as follows:

“The *Boreal Region* stretches from Nova Scotia and Newfoundland westward to the Pacific Ocean, and from northern New England and the Great Lakes northward to the pole and southward over the principal mountains of the United States and Mexico. It is subdivided into three principal belts or zones, Arctic, Hudsonian and Canadian. (1) The Arctic or Arctic-Alpine belt comprises Arctic America above the limit of tree growth, including Greenland and a narrow strip along the coast of Labrador and Newfoundland, and also the summits of the higher mountains above timber line throughout the United States and Mexico; (2) the Hudsonian Zone embraces the northern half of the great coniferous forest that reaches across the continent from Labrador to Alaska; (3) the Canadian Zone embraces the southern half of the great coniferous forest, stretching westward from northern New England and Nova Scotia to British Columbia.”

“The *Austral Region* is likewise subdivided into three trans-continental zones; (1) A Transition Zone; (2) an Upper Austral Zone; (3) a Lower Austral Zone, all stretching from the Atlantic to the Pacific and winding about sufficiently to cover areas of equal temperature. Each of the three Austral belts may be subdivided in an east and west direction into two or more areas, some of which are based on humidity instead of temperature. The eastern ends of these three belts have been long recognized by zoologists, and are known as the Alleghanian, Carolinian and Austroriparian faunas. It is easily shown by the division that the Austroriparian is the direct continuation of the arid Lower Sonoran fauna of the table-land of Mexico and the southwestern United States, and this same faunal belt occupies the interior valley of California and most of the peninsula of Lower California.”

As indicated by Dr. Merriam on the accompanying maps we have in West Virginia a portion of the Boreal Region represented by the Canadian Zone which covers the higher elevations of the Alleghany Mountains described by this author as follows:

¹ Bull. 3, New Series, Div. of Entomology, U. S. Dep. Agriculture.

² Yearbook U. S. Dept. Agr. for 1894, p. 213.

"The *Canadian Zone*¹ comprises the southern or lower part of the great transcontinental coniferous forest. It comes into the United States from Canada and covers the northern portion of Michigan, Vermont, New Hampshire and Maine. Farther south it is restricted to the summits of the higher Alleghanies. Among the characteristic mammals and birds are the porcupine, varying hare, red squirrel, white-throated sparrow and yellow rumped warbler. Counting from the north, this zone is the first of any agricultural consequence. Here white potatoes, turnips, beets, the Oldberg apple and the more hardy cereals may be cultivated with moderate success."

The *Austral Region* is represented in West Virginia by the Transition Zone, (see II Map 1), which covers a large portion of the eastern and southeastern third, and by the Upper Austral Zone, (see III Map 1), that occupies the remaining part of the State. The Transition Zone is described by Dr. Merriam as follows:

"The *Transition Zone* is the belt in which the Boreal and Austral elements overlap. It covers the greater part of New England, New York, Pennsylvania, Wisconsin and southern Michigan, and pushes south along the Alleghanies to extreme northern Georgia. Here the oak, hickory, chestnut and walnut of the south meet the maple, beech, birch and hemlock of the north. The same overlapping is found among mammals and birds, for the southern mole and cottontail rabbit, the oriole, bluebird, catbird, thrasher, chewink and wood thrush live in or near the haunts of the hermits and Wilson's thrushes, solitary vireo, bobolink, red squirrel, jumping mouse, chipmunk and star-nosed mole. In this zone we enter the true agricultural part of our country where apples (Oldberg, Baldwin, Greening, wealthy, seek-no-farther, and others), blue plums, cherries, white potatoes, barley and oats attain their highest perfection."

The Upper Austral Zone, formerly called The Carolinian Zone, is described by the same author as follows:

"The *Carolinian Zone*² covers the larger part of the Middle States except the mountains; on the Atlantic coast it reaches from near the mouth of Chesapeake Bay to southern Connecticut, and pushes still farther north in the valleys of the Hudson and Connecticut rivers. It is the region in which the sassafras, tulip tree, hackberry, sweetgum and persimmon first make their appearance, together with the opossum, gray fox,

1 Yearbook U. S. Dept. Agr. 1894, p. 209.

2 Yearbook, U. S. Dept. Agr., 1894, p. 211.

fox squirrel, cardinal bird, Carolina wren, tufted tit, gnat-catcher and yellow-breasted chat. In this zone the Ben Davis and winesap apples, the peach, apricot, quince, sweet potato, tobacco and the hardier grapes (such as the Concord, Catawba and Isabella) thrive best."

While detailed and extensive surveys and studies have been made by Dr. Merriam to determine the boundary lines of the several life areas in the western portion of the United States, I am informed by him that comparatively little has been done in the east, and practically nothing in West Virginia beyond the knowledge obtained from the result of government geological survey and meteorological work. Therefore, his map, as far as West Virginia is concerned, is intended to introduce only general features.

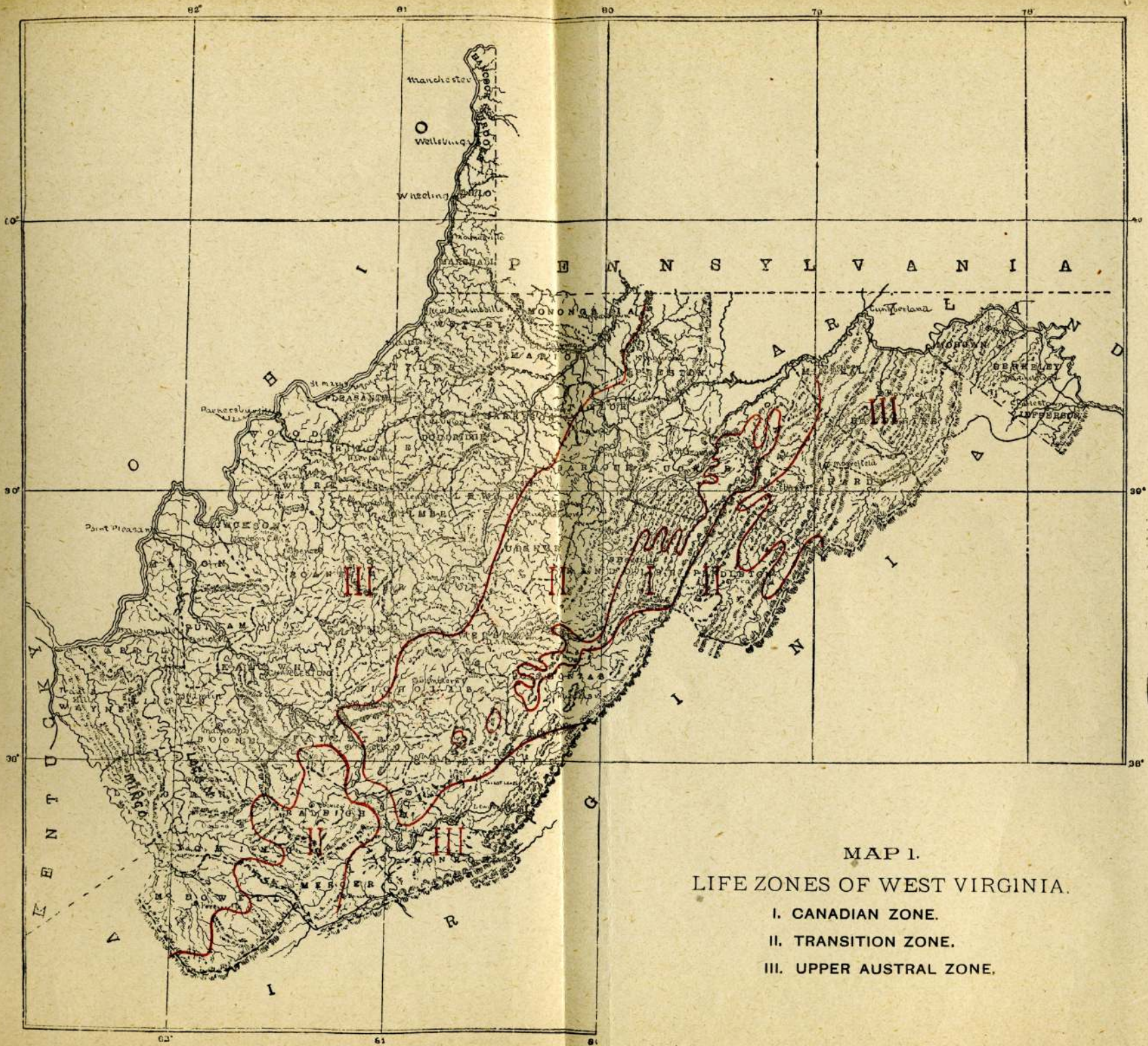
With a full realization of the importance of further information regarding the boundary lines and range of the several distinctive life areas in West Virginia, especially in its relation to future entomological research, I have given the subject considerable attention; and, being guided by the published work of Drs. Merriam and Howard. I have obtained sufficient evidence from my observations of the distribution of certain plants and animals as well as from geological and climatic conditions to enable me to present, herewith, preliminary maps (see Map 1 and 2) of what appears to be the approximate boundary lines and range of the three life zones mentioned by Dr. Merriam. My attention has been directed more especially to a study of the forest conditions and the evidence furnished in the distribution and prevalence of certain indigenous forest growths, which one confined to the several life areas.

DIVISIONS OF THE STATE AS INDICATED BY DIFFERENT KINDS OF
FOREST TREES.

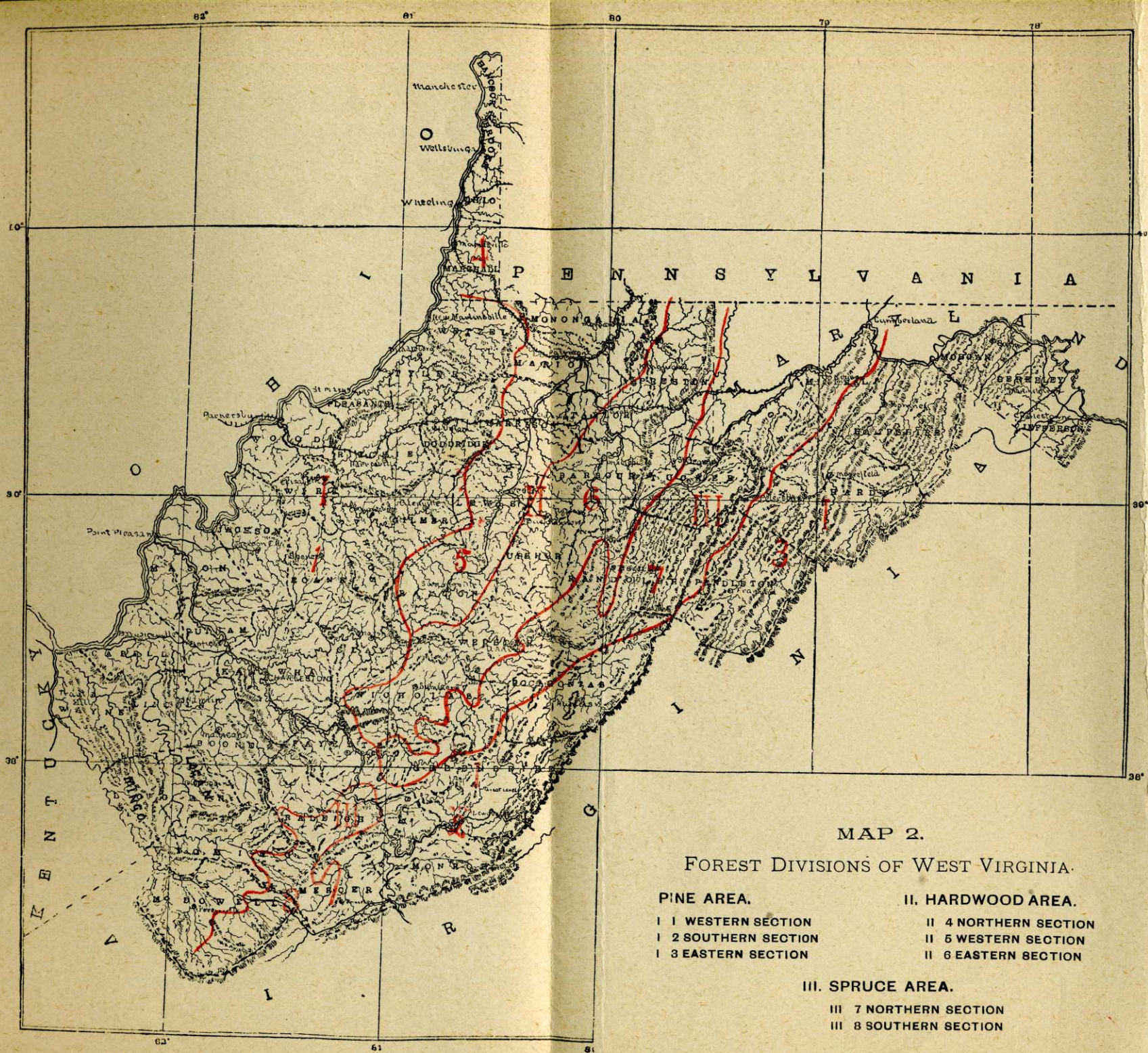
The Black Spruce Area (see III Map 2) in which the black spruce predominates.

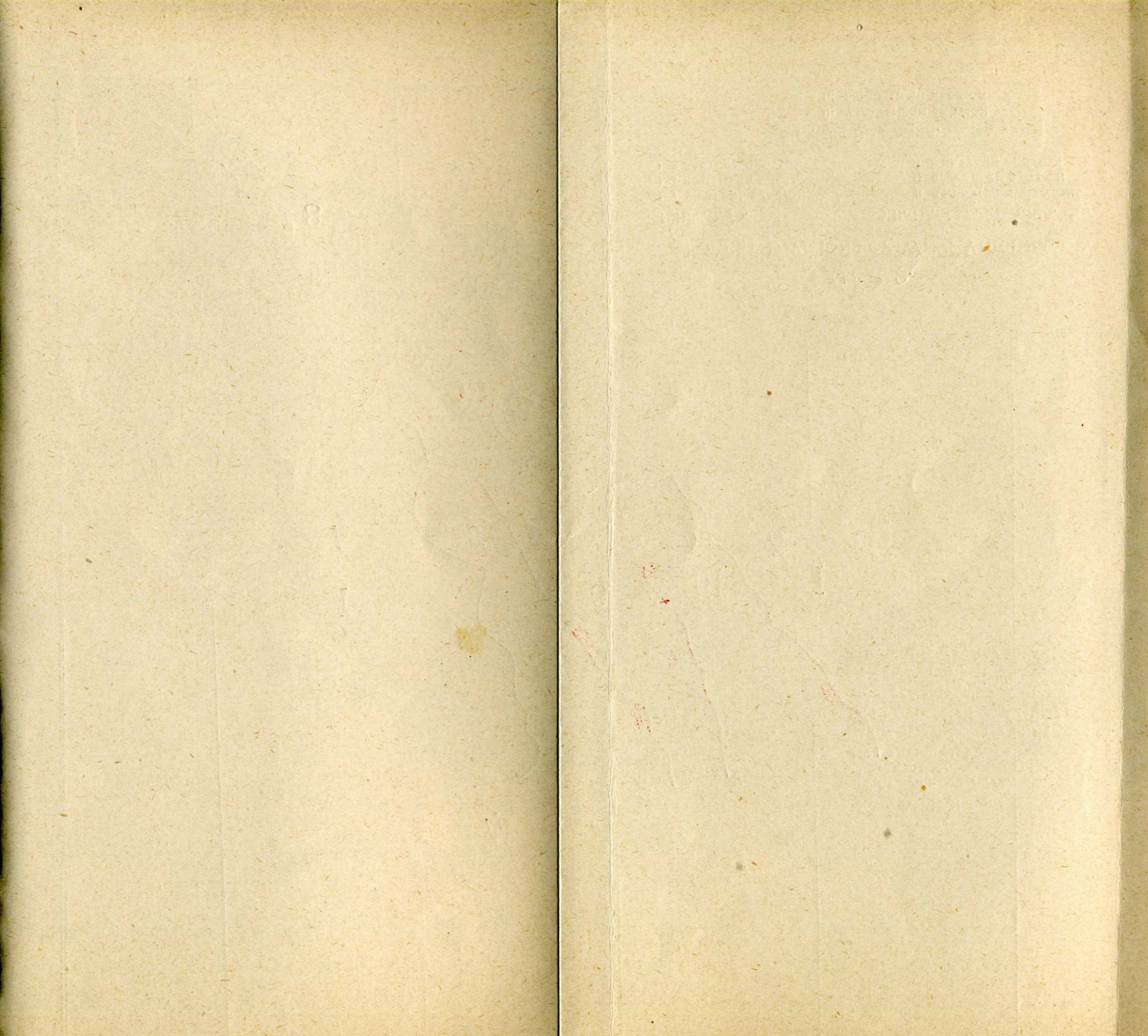
The Pine Areas (see I Map 2) in which three or more species of pine occur, frequent to common, mixed with hardwood and other deciduous trees.

The Hardwood Areas (see II Map 2) in which the hardwoods



MAP I.
LIFE ZONES OF WEST VIRGINIA.
I. CANADIAN ZONE.
II. TRANSITION ZONE.
III. UPPER AUSTRAL ZONE.





predominate and the hemlock is frequent to common while the spruces and pines are absent or rare.

The Black Spruce Area extends along the Appalachian range from Preston and Mineral counties in the north to McDowell and Mercer counties in the south; above an altitude of 2,400 feet and ranging from this to 4,860 feet. The pure or nearly pure forests of spruce occur at and above 3,000 feet elevation in Grant, Tucker, Randolph, Pendleton, Pocahontas, Webster and Greenbrier counties.

A line beginning at the northern limit of the Alleghany front near Cumberland, Md., and run nearly due southwest to the Virginia line near Bluestone Junction in Mercer county would mark the center of this region. Its average width is about 20 miles and its total length about 180 miles, making an area of about 3,600 square miles, or 2,304,000 acres.

While the black spruce is the predominating timber trees in this area, there are also great quantities of hemlock, white pine and hardwood. The area may be separated into a northern and southern section, the northern section extending northeast from New River in Fayette and Summers counties and embracing the area of pure spruce forests and principal river sources. The southern section extends southeast from New River in Raleigh and Summers counties where the spruce occurs, but is not common and the pure forests of white pine and pure and mixed forests of hardwood and hemlock predominates.

The Pine Areas of West Virginia includes all that portion of the State in which three or more of the natives pines grow and at present occur in a more or less continuous distribution in mixed or pure forests.

According to my estimation, these areas constitute about 15,520 square miles, which is equal to 9,932,800 acres of land. The total area is separated into three sections which may be referred to as *Western, Eastern* and *Southern Pine Areas*.

The Western Pine Area, (see I Map 2) about 11,400 square miles in extent, includes Wetzel county and all that portion of the State lying west of a line commencing at Seven Pines near

the eastern border of Marion county and running slightly southwest to the southern corner of McDowell county.

The Eastern Pine Area, (see III Map 2), is a region of about 2,900 square miles, and includes Pendleton, Hardy, Hampshire, Morgan, Berkeley, Jefferson and parts of Grant and Mineral counties.

The Southern Pine Area, (see II Map 2,) has an area of about 1,220 square miles, including the eastern portion of Pocahontas and Greenbrier counties, a portion of Mercer and all of Monroe.

The three areas, Western, Eastern and Southern, just described, possess each some characteristic features other than the occurrence of pine by which they are distinguished from each other and from the Spruce and Hardwood areas.

The Hardwood Area, (see II Map 2.) The portion of the State, designated as the Hardwood area, embraces all of the northern panhandle counties and all that portion of the State lying between the western pine area and the spruce area. It includes Monongalia, Marion, Preston, Harrison and the greater portion of Lewis, Barbour, Upshur, Braxton and a small part of Webster, Nicholas and Fayette counties. The area is about 5,500 square miles or 3,520,000 acres in extent. Within this territory very little if any pine, except some white and pitch pine, and no spruce occurs, so far as I have observed.¹ Here a considerable quantity of hemlock is found, but the oaks, maples, yellow poplar (tulip) and other so-called hardwood or broad leaved trees occur in abundance and attain perfect development. The region possesses numerous distinctive features other than that of the prevalence of hardwoods to separate it, as a whole, from the other designated areas of the State. The features which occur in the northern, eastern and western sections of this area differ from each other sufficiently to justify its separation into three minor divisions as follows:

The Northern Section, (see II, 4 Map 2), embraces Hancock, Brooke, Ohio, Marshall and the northwestern part of Monongalia counties.

¹ Black Spruce—Larch and red pine has since been observed by me in Preston county near Cranesville, May 9, 1897.

The Western Section, (see II, 5 Map 2,) includes all that portion of the area south of the northern section which lies between the western pine area and the lines that separate Monongalia, Marion, Harrison, Lewis and Braxton from Preston, Taylor, Barbour, Upshur, Webster and Nicholas counties.

The Eastern Section, (see II, 6 Map 2, occupies that portion of the Hardwood area between the Spruce area and the Western Section of the Hardwood area.

THE RELATION OF FOREST DIVISIONS TO THE LIFE ZONES.

It would appear from my studies of the divisions of the State as indicated by the different kinds of forest trees, that the northern and eastern portions of the Spruce area, which has an altitude of 2,500 to 3,000 feet, is distinctively Boreal and represents the Canadian Zone in West Virginia. The remaining portion of the Spruce area, together with the eastern section of the Hardwood area and that portion of the Southern and Western areas in which the white pine predominates, represents the range of the Transition Zone. While the northern and western sections of the Hardwood area and the portions of the western, southern and eastern sections of pine area, not included in the Transition Zone, represents the range of the Upper Austral Zone.

It would also appear that the different distinctive sections of the Spruce, Hardwood and Pine areas indicate the existence and range of the minor divisions of the principal life zones.

The species of forest trees which are of especial interest in furnishing evidence, by their distribution and prevalence in the State, of the occurrence and range of the different life zones, are the black spruce, the balsam fir and the scrub and yellow pines.

In this State the balsam fir, in its natural distribution, is confined exclusively to the Boreal region, the black and red spruce to the Boreal and the border line between the Boreal and Austral regions, while the areas in which these species prevail are included in the Canadian zone of the Boreal region. The pines are confined almost exclusively to the Austral re-

gion, with the exception of the white and pitch pines, which occasionally extends into the Boreal.

The scrub and yellow pines are confined almost exclusively to the Upper Austral, while the white pine predominates in the Transition and is sparsely distributed through the Upper Austral. The pitch pine extends throughout the Upper Austral and occasionally into and through the Transition, and the table mountain pine appears to be confined to the border of the Upper Austral and to the Transition in the eastern pine area.

While the hardwoods or deciduous trees such as maples, oaks, chestnut, walnuts, wild cherry, etc., are distributed through all of the divisions and life areas, they prevail to a marked degree and form pure hardwood forest in what I have designated as the hardwood area, about one-half of which is in the Transition and the other half in the Upper Austral. This prevalence of hardwood timber is evidently due quite as much to geological conditions as it is to that of temperature influences.

Some Geographical Features. It is evident, as has been noted by other observers, that the rivers, especially those emptying into the Atlantic, have a marked influence in extending the Upper Austral zone far beyond its normal limits. Thus we find that the influences extended by the Potomac and its numerous tributaries in the eastern pine area has been such as to push the border line (as indicated by the scrub and yellow pines and other conditions) back into the mountains, and up to elevations almost or quite equal to that at which the Transition joins the Canadian, in the valley of the Cheat River, just across the main Allegheny range; or, in other words, the Upper Austral apparently extends to an elevation of some 2,400 feet on the narrow mountain ranges along the south branch of the Potomac, while the transition finds its upper limit at the same elevation on the narrow mountain ranges along the Shaver and Dry Forks of the Cheat.

The extension of the Upper Austral so far up the valleys of the tributaries of the Potomac is evidently due to the higher average temperature, induced probably by warm currents of air coming up the valley from the ocean and from the South,

while the Cheat, flowing as it does northward through exceedingly narrow valleys, has but little influence upon the contour of the boundary lines of the Upper Austral and Transition.

Again we find in the valley of the Great Kanawha and its principal tributaries an exceedingly interesting feature in the marked influence exerted upon an extension of the Upper Austral Zone directly through a portion, if not all, of what has heretofore been considered the Appalachian and Transition barrier to the migration of certain Upper Austral forms of animals and plants from the South and East to the West.

It is true the Kanawha River does not empty into the Atlantic, but its valley extends eastward from the Ohio through the Austral Zone, and southward up the New River into North Carolina. The sources of its principal tributaries overlap those of the James and Roanoke, both of which open passes through the Blue Ridge barrier, and also with the Great Peedee and the principal source of the Santee, all of which flow through both the Upper and Lower Austral to the Atlantic. Thus with the influence exerted by all of these southern river valleys in extending the Upper Austral westward it would seem that it must join the eastward and southern extension of the same zone in the valley of the Kanawha. The distribution of the scrub and yellow pines along the valleys of the New, Greenbrier and Kanawha rivers, and their prevalence in the southern pine area, together with other indications here of an Upper Austral flora and fauna, is quite good evidence that such is the fact. This is a subject, however, which requires further special study in order to arrive at any definite conclusions. It seems probable that there is a gateway here through which eastern insect pests can readily find their way into our State. It is a region of special interest, and persons living in it should use every precaution to detect new pests and guard against their spread.

Some Biological Features. While I have numerous facts among my collecting notes with reference to the distribution of insects which are of interest in their relation to the subject of life zones, I desire to reserve them until others can be added,

that they may be presented in a special paper on the distribution of insects in the life zones of West Virginia. I may mention, however, that all of the localities from which the San Jose scale has been reported are Upper Austral.¹

The small, red squirrel which Dr. Merriam mentions as belonging to the Canadian Zone, is common in the spruce forests of the area designated on the map as Canadian. The varying hare has been frequently reported from the same area.

As additional evidence of the extension of the Austral Zone up the south branch of the Potomac, I may mention the fact that the chinch bug has at times been quite a pest in the Moorfield valley in Hardy county.

Some Phenological Features. The dates at which the oaks, dogwoods, chestnuts and other indigenous forest trees and shrubs show their first leaves and flowers in different localities and especially in different life zones will, I think, if carefully observed and recorded from year to year, furnish most valuable evidence in locating the boundary lines of the different life zones and minor life areas, particularly when such areas are established by laws of temperature and humidity.

My residence is within about two and a half miles and in full view of the boundary line between the Upper Austral and Transition zones, and in the spring the dividing line is quite distinctly marked along the western slope near the summit of the Chestnut Ridge mountain range. In March and April it is marked by the snow line and later by the trees. I noted here on April 29th, 1896, that the vegetation in the Upper Austral, especially in the valleys and on the foot hills along the mountain, was expanding its foliage and presented quite a green appearance. The white, black, red, scarlet and rock oaks were in bloom. The flowers of the dogwood (*Cornus Florida*) were commencing to decline, the red bud (*Circis Canadensis*) was fading, and those of the service-tree (*Amelanchier Canadensis*) had fallen; while at the edge of the Transition, at an

Dr. L. O. Howard concludes that this insect cannot continue to survive in the Transition, and all the available evidence goes to show that he is correct.

elevation of about 1,700 feet above sea level, the buds on the oaks were just beginning to open, the dogwood was not all out, and the service-tree was in full bloom. On May 6th the oak bloom had faded on trees in the Upper Austral, while it was just coming out on the same kinds of trees in the edge of the Transition. Further back in the Transition some two or three miles, even at a lower elevation than at the boundary line, the buds had not opened on the oaks; the trees presented the same appearance as in winter.

The white oak and chestnut will probably prove to be the most valuable trees to observe for evidences of climatic differences and location of distinctive life areas, since they are widely distributed throughout the State, occurring frequent to common in all of the life zones.

It would appear that a difference of one or at most two weeks in the appearance of the leaves or bloom on the average trees in two given localities is sufficient to indicate that they belong to different life zones; as, for instance the white oak trees in the Upper Austral will show their leaves and flowers one or two weeks in advance of those in the Transition, and two to four weeks in advance of trees growing in the Canadian zone.

These suggestions are made in this connection merely to call the attention of the general observer to this interesting feature and its possible value in locating distinctive life areas.

It has long been the practice of farmers to plant corn when the white oak leaves are the size of squirrels' feet and when the dogwood is in bloom, which indicates that the relation of the appearance of the leaves on the white oak or the flowers on the dogwood to certain important conditions of temperature has been correctly observed and utilized by the farmer.

Influence of Life Zones Upon the Characteristics of Plants.
Under this head I may mention the so-called thornless blackberry, *Rubus Millspaughii*, which was first discovered in this State by Dr. Millspaugh and the writer, near the upper boundary line of the Transition Zone, or possibly in the Canadian Zone, on Point Mountain in Randolph county. I have since found that examples of this species growing in the Canadian Zone and

upper borders of the Transition, is what the common name implies—almost entirely thornless; while examples growing near the lower borders of the Transition bear numerous thorns; and when the species extends into the Upper Austral, as it does in Monongalia county, it is quite thorny; in fact, almost as much so as the common species (*R. villosus*).

IMPORTANCE OF A DETAILED STUDY OF THE LIFE ZONES IN WEST VIRGINIA BY A BIOLOGICAL SURVEY.

While my observations and what is herewith presented with reference to the subject of life zones in West Virginia are of a preliminary character, they have been sufficient, in addition to the facts presented by Dr. Merriam and others with reference to the life areas in other sections of the country, to convince me that the subject, as related to this State especially, is one of vital importance to our agricultural interests, as well as to future scientific research.

Little practical good can be accomplished, however, from a utilization of these natural provisions of nature until the boundary lines of the principal life areas are accurately determined and mapped; and a detailed study of each is made. In order to accomplish this in anything like a reliable and satisfactory manner it will be necessary to have a knowledge of the geologic, geographic, biologic, meteorologic and other important conditions, which can be best acquired by the co-operative efforts of specialists in different branches of science. It is, in fact, a line of investigation properly belonging to a geological or biological survey, established by the Federal or State government.¹

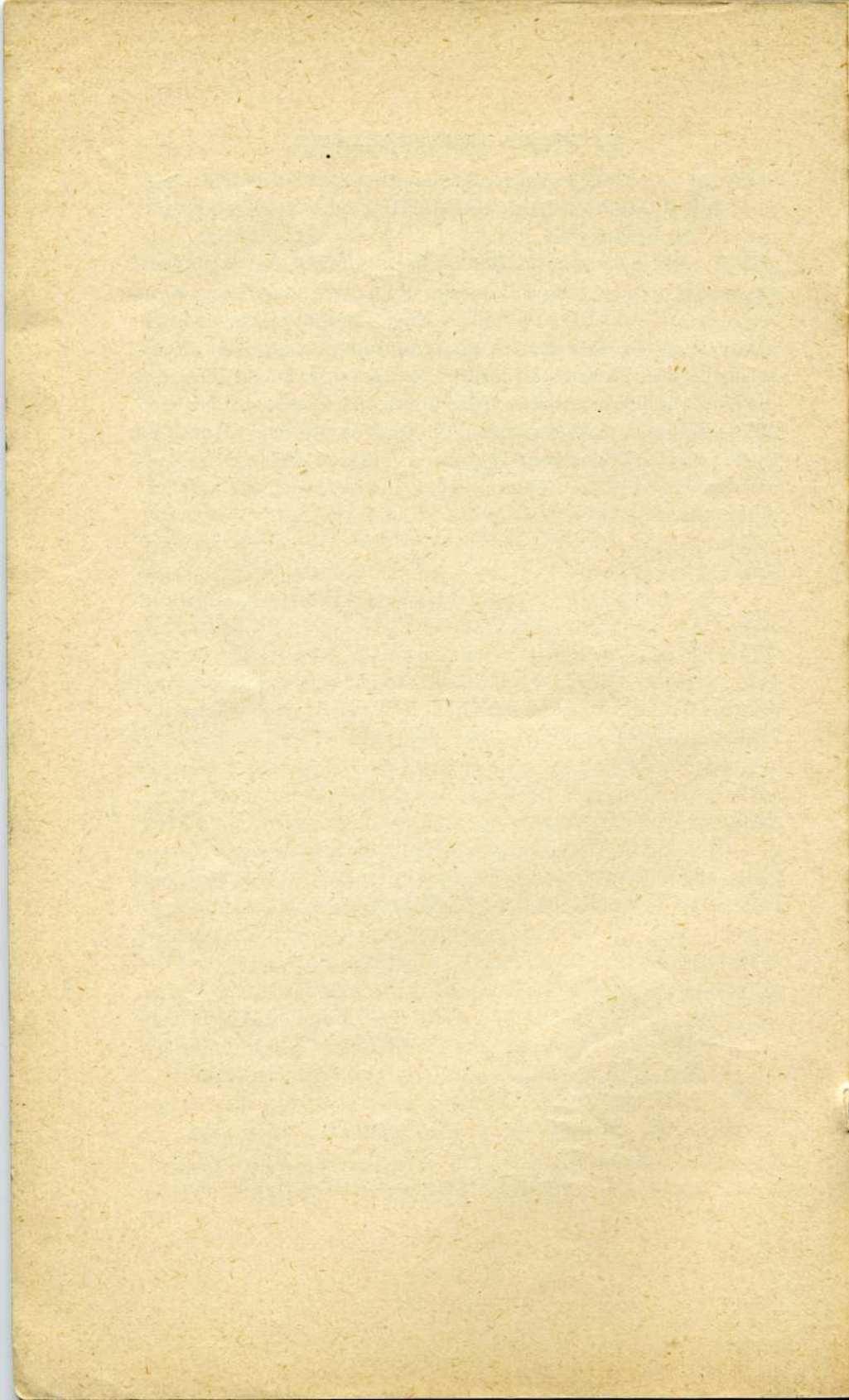
There is no one better fitted to carry on and superintend work of this character than Dr. C. Hart Merriam, who has charge of the biological survey established as part of the duties of his division of the United States Department of Agriculture.

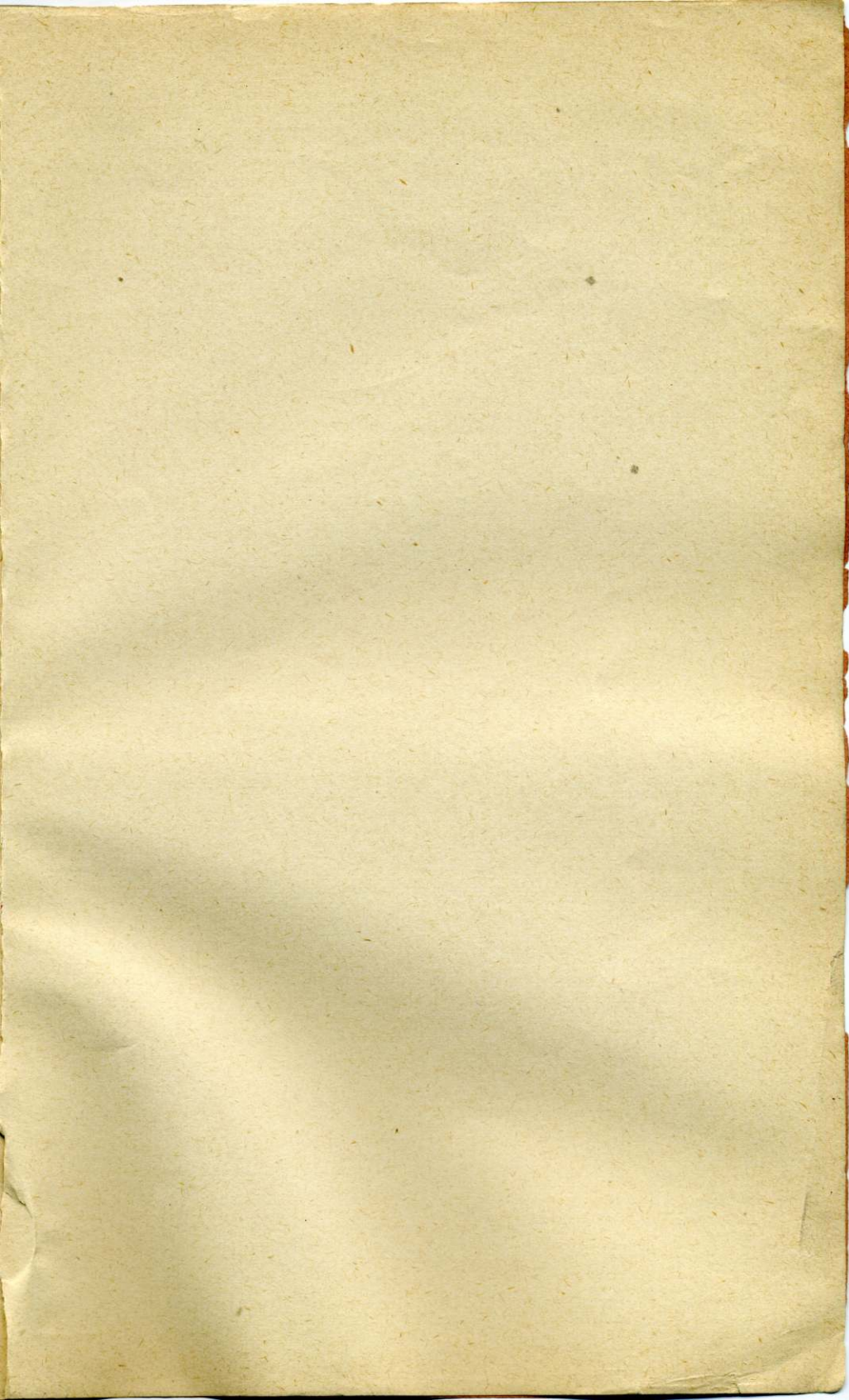
It is especially desirable that Dr. Merriam conduct some special investigations in our State at an early date, but since he has such a wide field to cover, it is probable that it will be

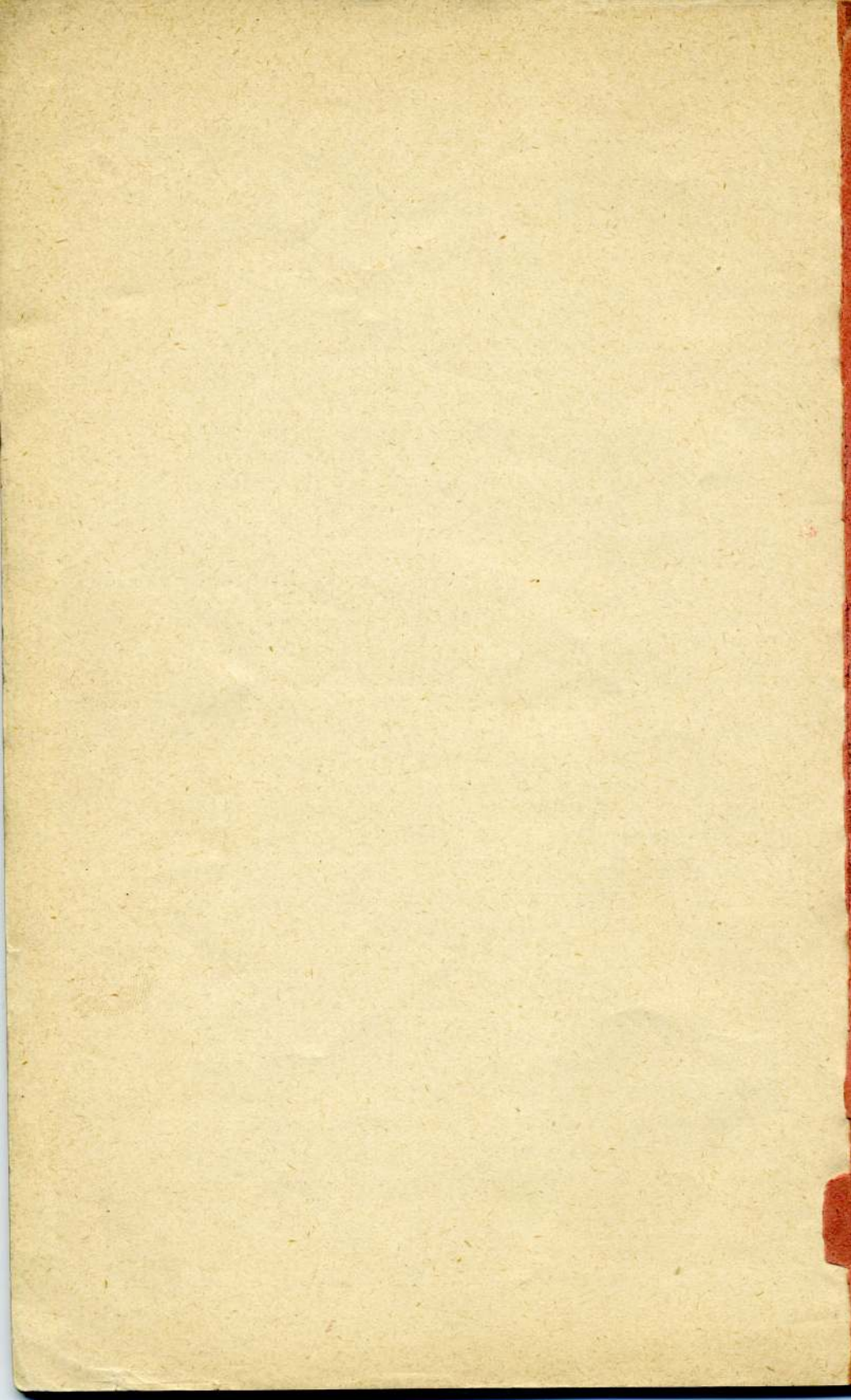
¹ Since this was written a State geological and economic survey has been established and work is to commence in 1898.

many years before he can render us much service in this direction, unless the State Legislature makes some provision to aid in carrying on the work.

This could be accomplished by the establishment of a State Biological Survey, which in co operation with the Government Surveys and the Meteorological Bureaus and other scientific divisions of the Department of Agriculture, could soon accomplish the desired end and lead to the early issuing of detailed maps of the life zones and their minor divisions, together with additional information which would enable the agriculturist to utilize to the best advantage our varied and rich natural resources.







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