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The pines on the island of Nantucket (Pinus rigida Miller), set out some twenty or thirty years ago, are fast dying in large numbers from a cause hitherto unknown. A great many have already perished, and most of the living trees look sickly. On the "Old South Road," from Nantucket to Siasconset, all the trees on one side of the road are quite dead, or fast dying, while upon the opposite they are comparatively healthy-looking, although seriously affected.

On Sept. 19, 1876, I went to this spot to discover, if possible, the difficulty. I chose first a dead tree on Mr. Crosby's land, and cut it down, carefully examining the trunk, boughs, twigs, bark, and roots; there was no sign of the work of any insect sufficient to have caused the death of the tree, — none more than would be found on any healthy tree. Next, I selected a tree that was nearly dead, the uppermost boughs only being in leaf, and a few bunches of needles appearing at different points on the trunk. I cut this down, and examined the trunk, boughs, bark, and roots as before, with negative results; but when I searched the living twigs I found, always at the extreme tips, a great many recently dead needles, and in connection with them a small lepidopterous insect, and in such numbers, both here and on hundreds of trees afterwards examined, as to leave no room for doubt that this insect is the sole cause of the trouble. The only other insect at all common was the larva of a geometrid moth, which had nibbled the leaves extensively, but not enough to cause serious damage, or to strike

at all at the life of the tree; wherever the mark of the blight was found upon living trees, the first-mentioned insect was present in vast numbers, and very nearly all the damage that had been inflicted was directly traceable to its devastations. It is a minute moth of the family of Tortricidae, referable to the genus Retinia (or Coccyx of some authors), and may be described as follows:

Retinia frustrana nov. sp. (Fig. 1.)

Head covered, especially above, with hoary tipped, smoky brown scales, giving it a speckled appearance; palpi rather longer than the head, the middle joint expanding into a compressed, disk-like plate, half as large as the head, and covered with silvery gray scales, which are dusky toward the base, the apical joint minute, slender, dusky; antennae equally and narrowly annulated with dark brown and white. Thorax and patagia of much the same color as the summit of the head, but the front portion of each tinged with pale umber, while the hinder portion inclines to silvery gray, sometimes to a decided degree.

The ground color of the front wings is divided between a dull yellowish umber and a deep reddish umber, deepening at points to a bright ferruginous. The former prevails in the lower half of the outer two-thirds of the wing, and in an oblique subapical band, subparallel to the outer margin. The latter elsewhere, but becoming subinfuscated in the basal third of the wing; the brightest parts of this tint are found in a large quadrate patch depending from the middle of the costa, and an oblique, slightly arcuate streak, directed inward from the apex, and often continued a little out of line over the lower half of the wing, breaking the lower pale patch in the middle of the outer half of the wing. Both of these umber tints are overlaid by frequent transverse, perfect or broken stripes of lustrous pearly gray, which, with the diversity of the ground color, give the insect a very variegated appearance. Nearly all of these pearly stripes run at right angles to the costa, and are distributed as follows: The most important and persistent are the two broadest, which divide the wing into nearly equal

thirds, the outer striking the inner angle of the wing, where the fringe terminates; another, nearly as constant, crosses the wing a little beyond the middle, is slightly bowed outward, and united at the middle with the outer of the two already mentioned, forming with it an H, with one straight and one bowed leg; often, on the left wing, it more nearly resembles a K; besides these there are numerous, often partially confluent, short bars or stripes on the upper half of the wing, and, next the inner margin, very brief similar bars, increasing in size toward the base, and on the basal third forming a dull pearly patch. The whole of the basal third or fourth of the wing is traversed irregularly by transverse pearly lines, often nearly or quite confluent; and in some individuals the whole basal half is of a nearly uniform pearly hue. Many of these pearly scales appear to have fuliginous bases, so that where the patches are broadest, the color is usually duller. The outer edge of the wing is marked by scattered black scales, edged within, and sometimes without, by a delicate white line; and the fringe, which is very long, especially below, is pearly fuliginous, often deepening apically to black, and with all the scales minutely white tipped, forming transverse lines of white upon the darker ground.

Hind wings very pale silvery gray, slightly infuscated, the fringe infuscated only at base, outside of a silvery hue. Legs silvery gray, the tarsi infuscated above at the base of all the joints. Abdomen silvery gray, more or less infuscated above, or sprinkled with brownish fuscous scales.

Expanse of wings, 12–14 mm.; length of body, 4.75–5.75 mm.; length of antennae, 3.5 mm. Described from twenty specimens.

There seems to be no colorational distinction between the male and the female, but considerable general variation both in the markings and in the tints of this beautiful but destructive insect. Some individuals occur in which the deeper colors are intense, while, at the other extreme, the pearly scales have spread so widely, and at the same time the more brilliant tints have become so subdued, as to give the whole insect a

drab appearance. The two shades of umber, also, grade into each other in all cases, being seldom sharply separated. The markings as above described are those most prevalent.

The *larva* (fig. 4) is slender, cylindrical, slightly depressed, of a pale brown color above, the thoracic segments slightly darker, with a faint pale mediodorsal line, which broadens and becomes somewhat yellowish on the two hinder segments, on the last occupying nearly the whole breadth of the segment; the lower part of the sides and the under surface are dirty luteous. The head varies from castaneous to pitchy castaneous, is broader than long, obscurely subcordate, the lateral hemispheres being tumid above, and separated by a deep and narrow groove; the antennae and most of the mouth parts are pale luteous, the ocelli black. The prothoracic shield is of the color of the head, transversely obovate, more than twice as broad as long, and divided by a pale mediodorsal stripe; the hinder margin is broadly rounded, the front margin nearly straight, and the lateral margins rounded subangular, posteriorly melting into the hind margin. The anal plate is scarcely darker than the body, small, almost semicircular, but less than twice as broad as long, and slightly tumid. The legs are of the color of the under surface of the body, but are marked with fuscous, the claws reddish; the prolegs are also fuscous, and the spiracles edged with piceous. The body is uniformly, but rather sparsely, clothed with microscopic hairs, scarcely perceptible with a good lens; and besides these has longer and stouter, but still delicate, pale hairs, about as long as the width of the body, scattered over the upper surface, arising, one each, from minute piceous warts, which are definitely arranged on both sides of the body: — two on a segment in a dorso-pleural row, two on a segment in a ventro-pleural row, and one on a segment in a stigmatal row. There are similar hairs scattered more irregularly on the head and prothoracic shield.

Length, 13 mm.; breadth, 2 mm.

The *chrysalis* (figs. 2, 2 *a*, 3, 3 *a*) is almost uniformly castaneous, with wing-cases, eye-covers, antennae, and sometimes some

of the hinder edges of the dorsal scuta of the abdomen dusky. The rostrate prolongation of the anterior extremity of the body (fig. 2) is bent downward at a slight angle, preserving above the curve of the head, pretty strongly and uniformly compressed, docked apically, triangular as viewed laterally, the sides hollowed, and the upper surface slightly sulcate, its lateral edges a little elevated or margined, and all the ridges marked with black. The pronotum is depressed below the surface of the head, but bounded posteriorly by a sharp, elevated, backward directed ridge, higher than the mesosternum. All the abdominal segments behind the first (fig. 2*a*) are furnished with anterior and posterior dorsal transverse rows of minute, sharp, conical tubercles or points, the rows nearly equidistant, those of the movable segments longer than the others, and with the points directed backward. The anterior row is a little more extended than the other, and is formed on most of the segments of larger and more distant points; in advance of it, at the line to which the posterior edge of the preceding segment reaches, is a shorter, delicate, fine-edged ridge; and a similar but blunter ridge continues the posterior row of tubercles around the body. The very tip of the abdomen (fig. 3 *a*), which is truncated and blunt, bears a slight coronet of points similar to those of the transverse rows.

Length, 6 mm.; breadth, 1.25 mm.

The eggs seen were not described.

The moth appears to be most nearly allied to the European species R. duplana Hübn. and R. sylvestrana Curtis. From specimens of the former, which Professor Zeller was kind enough to send me from Germany, it differs by its much smaller size, and the much greater irregularity of its markings, these being almost always clustered into four or five narrow, equidistant, transverse belts in R. duplana; a tendency to such a transverse disposition of the markings exists also in R. frustrana, as indicated above, but mostly confined to two comparatively broad belts. From R. sylvestrana, as far as I can judge by descriptions, and by a pair of English specimens

sent me for comparison by Professor Fernald, it differs by its slightly lesser size, the color of the head and palpi, the different disposition of the markings of the wing, and their more brilliant and more highly variegated tints; in R. sylvestrana the stripes are numerous, very slender, and tend toward confluence on the basal half of the wing, giving it a somewhat hoary appearance, in which respect it resembles R. duplana rather than R. frustrana. The pupa of R. frustrana also agrees with that of R. duplana, and is distinguished from that of other Retiniae (that of R. sylvestrana is not known) in the rostrate prolongation of the anterior extremity of the body (see figs. 2, 3); the close affinity of R. frustrana to the two above-mentioned species will therefore be readily granted.

Although I have not been able to follow the history of this insect completely, it is probably double-brooded, and differs therein from the European species which it most resembles. R. duplana flies in Germany once a year only, appearing by the end of March or the beginning of April, and living some time into May; the larva is full grown by the end of June or the beginning of July, when it changes to pupa, and in this condition continues eight months in the year. R. sylvestrana is said to appear on the wing in England in June and July, and has a similar history to the preceding, excepting in its later changes. R. frustrana appears in Nantucket between these two periods, or toward the end of April,[1] and flies at least during May; probably most of the brood has emerged by the end of the first week in May. Eggs were seen in one instance May 15, and a nearly grown larva on June 18. Caterpillars may be found fully grown, together with an occasional chrysalid, in the middle of July; a little later chrysalids only can be found; and again, several years ago, I found larvae in great abundance, with an occasional chrysalid, about the mid-

[1] The earliest specimens obtained one year from chysalids only a week or two in confinement in a warm room appeared on April 25th; the earliest of those kept the same year in a cellar appeared May 8th. A single living moth, and another just dying, were discovered among the twigs confined in a box as late as June 23d; how long they had been out of chrysalis there were no means of judging, but not impossibly several weeks.

dle of September. Soon after that all change to chrysalids; for, in a subsequent year, Mr. S. Henshaw, who visited the island September 17–19, and examined the trees carefully, found not more than one sixth in the larval state, the rest in chrysalis. In all probability, then, the insect is double-brooded, flying in May and August, and wintering in chrysalis.

Curious as this difference in the number of broods between these allied species in Europe and America may seem, it is quite in accordance with what occurs in other Lepidoptera, where analogous species are found upon the two continents. I have not studied this subject in the nocturnal Lepidoptera, but among butterflies I have found that nearly all the species which are identical, or very closely allied, on the two continents have at least one brood per annum more in North America than in Europe. Specifications of half a dozen of these cases will be found in the American Naturalist, Vol. X. pp. 603, 604. This seems to be largely due to climatic causes; and it naturally follows that, when an injurious insect is imported from Europe to America, its ravages here are likely to surpass anything charged to it in its proper home, — a point which should be taken into account by students of economic entomology.[1]

Retinia, the genus into which this insect falls, is represented in Europe by no less than eleven species, four or five of which are common, and four were found by Ratzeburg more than forty years ago doing extensive injury.[2] They all feed upon coniferous trees, perhaps exclusively upon pines, and all live upon the twigs; according to Ratzeburg again, all are single-brooded with a single exception (R. resinella), where a generation of moths appears only once in two years. When I first

[1] Mr. C. V. Riley (2d Rep. Entom. Missouri) asserts that destructive insects introduced from America into Europe make no headway against their more "highly developed" allies on that continent; while the reverse is true of European pests introduced here, "the stronger and more favorably organized species overpowering and starving out from time to time their less vigorous and less favorably organized competitors." Unfortunately he gives no facts to support this highly organized theory.

[2] Three of these four have now been found on the Pacific coast of the United States.

observed the injury at Nantucket, no species of this genus had been found in this country; but since then one or two have been found in this section, and doing a considerable amount of injury to pines.[1] Now that attention has been drawn to them, no doubt other notices will follow, showing that we have to deal with a whole group of insects specially destructive to pines both in Europe and America; but our Nantucket species proves much more dangerous than the European R. duplana and R. sylvestrana.[2]

The different species of this genus attack the trees in somewhat different methods, but they all agree in selecting the tenderest growing shoots for their ravages, and in destroying this sensitive and essential part by boring into the heart, and devouring the sappiest and pulpiest portion at the base of the needles. Some, like a species recently found by Mr. Comstock of the Agricultural Department in Washington upon Pinus inops,[3] live a part of the time, at any rate, outside of the twig, for their webs may be seen enclosing the base of the bud and the surrounding new leaflets; but most of them, like R. frustrana, live entirely within the shoot from the moment they have bored their way into it, and undergo therein their transformations.

The injury done by R. frustrana to the pitch pine (Pinus rigida) of Nantucket is soon detected in the months between May and September by noticing the dead needles at the very

[1] A brief notice of these will be found in the Appendix.

[2] Fernald's Catalogue of Tortricidæ (1882) gives eight species, of which, however, only three, including R. frustrana, are found in the eastern United States. Of the five found on the Pacific slope, where the insect fauna has, as is known, a decidedly European aspect, four are believed to be identical with European species, and among them R. duplana and R. sylvestrana occur.

[3] Since this was written Mr. Comstock has published his notices of this species (Rep. U. S. Dept. Agric., 1879, pp. 236, 237, pl. 5, fig. 2), which he considers, on Professor Fernald's authority, to be the same as that here described. There can be no doubt of their very close relationship, but the difference in the habits of the larvae in the two localities, both during active life and when about to undergo metamorphosis, would be very singular if they belong to the same species. The specimens carefully studied by him, also, were found on a different species of pine. I have made no comparison, but only desire here to call the attention of those who may hereafter study this insect to this fact. For further account of Mr. Comstock's observations, see the close of this paper.

tip of a shoot otherwise of a fresh green color, or only partially withered near the dead needles. The egg must be laid, as Ratzeburg presumes it to be in the European species, between the scales of the bursting bud, from whence the caterpillar eats its way at birth into the very heart of the bud near the extreme tip; for to this part are the youngest caterpillars confined. From this point the growing caterpillar burrows down the stem, often for from four to six centimeters, and thus eats the very life out of the tree; for with one of these insects at nearly every bud, as was the case in the tree I cut down, and in the accessible branches of many others examined at different times, the tree must speedily perish. As the caterpillar works downward, one by one the needles find their supply of nourishment cut off, cease their further growth, lose their color, and wither, — the change in coloration of the needles showing the progress of the pest. Fig. 6 shows the appearance of one of these twigs in which the caterpillar has bored a couple of centimeters. Some of the terminal needles, as may be seen by comparison with fig. 5, which represents an unharmed twig of the same tree, have scarcely had a chance to grow at all before being robbed of their means of support, and have turned quite yellow; further down the stem, where also they are wholly withered, they are a little longer; still further they are longer yet, and only partially withered, showing more recent attack; and it is not until the wholly green and fresh needles are reached that they are of the normal length. The difference between an uninjured twig and one that has been attacked is really greater than appears by comparison of figs. 5 and 6; for, as will be seen on comparing the lower normal needles of each, fig. 5 represents a shoot with much shorter needles than fig. 6 would normally have had throughout. The dome-shaped contour of the needle tips in the healthy shoots is well represented in fig. 5, and the contrast to this which fig. 6 exhibits is very marked, and tells the story of the damage done. The specimen represented in fig. 6 was chosen rather to exhibit this point, being perhaps more marked than usual. Generally the whole shoot is unnaturally swollen and disfigured by the pitch that has exuded from the injuries caused by the caterpillars, as may be seen on

removing the needles; this appears in fig. 9 of the plate, to compare with which a healthy shoot with the needles removed is shown in fig. 7.

As the insect is probably double-brooded, the second generation has to attack shoots already grown, or nearly grown, in which case, of course, the change of contour of the tip, seen on comparing fig. 6 with fig. 5, does not ensue; but the withered needles are all of nearly the full length, as shown in fig. 8. In this figure the stem has been cut longitudinally, to show the nature and extent of the borings of the caterpillar. The middle of the stem is found pierced by a slender cylindrical passage as far as the dead needles continue; the passage is lined with silk and foul with excrement, which has been removed from the specimen drawn. As far as the boring has been carried, the withered needles fall from their position on being touched, having nothing but a shell for their support.

When the caterpillar is fully grown it selects a place within its burrow wherein to change to chrysalis; this is usually at the bottom of the burrow, but, in a thick shoot, may be in any part, even toward the tip, where it can push a lateral passage obliquely toward the base of one of the needles. Such a burrow, vertical in this case and not oblique, may be seen in fig. 8 on the right hand of the regular burrow at the tip of the shoot. Several indeed may occupy different parts of the same shoot; the place selected is slightly enlarged to form a longitudinal cell, at the upper or outer end of which a passage is eaten into the open air, which may generally be seen without difficulty from the outside, if looked for near the base of the needles, while the nest is uninjured. The holes left by the fallen needles must not be taken for these outlets; these never seem to be taken advantage of, for from them usually exudes more or less pitch, closing the opening. To find on emergence from chrysalis that the means of egress of the moth was gone would prove disastrous to its life. Half through the eaten opening the chrysalis forces its way when about to change to the imago.

It appears then that this insect, by selecting for its food in the larval state the point where the greatest amount of nour-

ishment exists, has chosen well for itself but ill for the tree; the very richness of the nourishment of which it robs the tree tends to the immense abundance of the insect, which, attacking the tree at every growing point, effectually puts an end to its life. The nearly dead tree I cut down was not more than seven and a half centimeters in diameter, and perhaps four metres high; all but the very topmost boughs were dead, and here the foliage was extremely scanty, yet I could certainly have obtained forty or fifty caterpillars and chrysalids from this one tree.

At first sight, certainly, there seems nothing to prevent this insect from continuing its ravages, and destroying every pine on the island. The only encouragement in this view is, that then, for want of pines, the moth must die. In the hope of finding some natural means of its destruction, I have sought for parasites which might at least keep it in check. One such I found the first day, feeding upon a larva; and by enclosing many infested twigs in a tight box I have obtained three kinds of hymenopterous parasites, — one a species of Bracon proper, another a minute Perilampus, both apparently undescribed. The latter is far the more abundant, but neither appears to be sufficiently common for us to place much reliance upon them, although they unquestionably serve, to a certain extent, to reduce the numbers of the moth. The only possible method of combating this evil is directly to destroy the Retinia in some one of its stages. Bonfires every day at dusk in the vicinity of the woods, during the last week in April and the first week in May, would doubtless destroy great numbers of moths laden with eggs, and would give healthy employment and no small delight to the small boys of the island. But apparently the only effectual means of destruction is one indicated by the history of the insect, but which would be useless on the main land, or without concerted action on the part of the inhabitants of the island. As already stated, the affected are speedily distinguished from the uninjured shoots soon after the caterpillar has commenced its work, by the presence of dead needles at the apex of an otherwise green shoot; the presence of the

enemy is thus infallibly disclosed. The month of June then is the time for operation; and the work to be done *can be done once for all by breaking or cutting from every pine-tree on the island every affected shoot.*

To be of any radical use this must be done during a single year, to leave none for propagation; for the same reason it must be done to *every* tree, great or small, from the topmost boughs of the tallest trees to seedlings just springing from the ground; every scattered tree or seedling upon the island must be searched. I examined one isolated tree about a metre high, growing a kilometer or thereabouts from the woods on the south shore, and it was thoroughly infested. To leave such a tree would be to have the labor and expense of the proposed assault in vain. The work must be completed within the month of June, since it is at this time that the caterpillar is only partly grown in its burrow, and will infallibly die if the shoot is removed from the tree; its sustenance will be gone, and it cannot crawl about sufficiently to find and enter another tree. This is not a part of its accustomed line of action, and it could not recover from so rude a shock as robbery of its home. There would be no absolute need of burning the broken shoots, but this might be done where there is any danger of their falling near seedlings, which it is possible the wandering outcasts might enter; and it should certainly be done if the operation has to extend into July, when the caterpillar might be ready to change to chrysalis, which it could do in its burrow whether the shoot were attached to the tree or fallen to the ground. Since some more advanced caterpillars might as early as June undergo such transformation, doubtless the most thorough way would be to have the work finished before the end of June, and to burn every broken shoot; to cut off any suspected shoot rather than to leave one affected, or even to remove *every* growing shoot.[1] But anything less

[1] I am told by good botanists that the tree would probably recover from this Caesarian operation, and it might be easier and more rapid than to select the affected shoots. It certainly would be safer. Dr. G. L. Goodale has called my attention to the following passage, which seems to him to indicate that the tree would survive. "The pitch pine, says Smith, differs from other trees of this family, its stump throwing up sprouts the spring after the stem has been felled, but these do not attain any considerable height. The fallen trunk throws out

radical than the means here suggested would be wasted labor. Leave them alone and the pine woods of Nantucket are doomed to destruction; to plant new trees would be to add fuel to flames. There is no possible escape but in some radical and concerted action such as is here suggested; and this is possible only because of the isolation of Nantucket, and the comparatively small extent of its little forest. Ten men, each armed with a pair of hedge shears, and ladders of some sort, ought to accomplish it in the month. Whether it will "pay" is for the Nantucket people to decide. But if they will not do it, their next best plan is to cut down the entire forest, sell the wood, and burn the brush, leaving not even a seedling anywhere; then to pasture the sheep upon the spot for two years, and carefully destroy every seedling that springs up outside the fences which confine the sheep. After that it would be safe to plant again by seed.

Will the good people of Nantucket take all this trouble to rid themselves of this pest? It seems extremely doubtful, especially since concerted action on the part of all the landowners would be necessary. Just here our impotence, under republican institutions, seems to be manifest. "Any single-minded and prolific worm," President Eliot has happily said, "is more than a match for man." But this is mainly because we fight it single-handed. No great success is to be expected in checking the ravages of insects in this country until the people are far better and more generally acquainted than at present with the simplest rudiments of the history of insects. I do not believe that five per cent of the people of Massachusetts above the age of twelve years can correctly state the

sprouts in the succeeding summer; and the bundles of leaves of both are remarkable for issuing from the axil of a single leaf, in the same manner as in the young plant." — MICHAUX, *N. Amer. Sylva*, Vol. III. pp. 89, 90, note (1853).

Mr. George B. Emerson also says of the same tree: "Its stump throws up sprouts the spring after the stem has been felled. These continue to flourish, with apparent vigor, for several years; but I have never seen them attain any considerable height. The fallen trunk itself throws out sprouts in the succeeding summer; and the bundles of leaves of both are remarkable for issuing from the axil of a single leaf, in the same manner as is observed in the young plant." — EMERSON, *Trees and Shrubs of Mass.*, State ed., p. 73. 8vo, Boston, 1846.

general features of transformations in insects, or know that, practically speaking, all their growth comes by feeding in the larval stage. Without such knowledge one has not the means of learning how to prevent the ravages of an insect never before met with, but each specific case must be treated haphazard.

Good results would also flow from proper legislative action, but such action seems curiously abhorrent to the republican mind. Why our people should not protect themselves in this particular, as well as the more paternal governments of Europe guard the interests of their agriculturists, it would be hard to say; but it is probably owing to our not being awake to the real extent of the injuries done by insects, and the need in resisting them of concerted action, which only State authority can enforce. An enlightened public opinion in this matter is too far away. In towns immediately adjoining Boston one may every year see orchards completely overrun by caterpillars, while adjoining nurseries, properly cared for, are exempt. Why should the owner of the neglected plantation be allowed to put his neighbor to the additional pains and cost his neglect has caused? If he will not care for his trees, he should at least cut them down, and not make them special breeders of pests. By act of legislature such a man should be required to take all reasonable pains to prevent the increase of the insects which damage his own and his neighbor's property, and penalties should be rigidly enforced. Such legislation should certainly be restricted to enemies already known to be very harmful, and to such as bid fair to become generally dangerous. The decision of what should be included, especially in the latter class, and what means should be taken to prevent the increase and spread of insect pests, ought to be in the hands of a scientific commission, created by the State, composed of persons who are familiar with insects, and who should protect the interests of the agriculturist, the gardener, and the nurseryman, — just as the fish commissioners protect the fish supply, see that proper laws are framed, and that these are duly regarded and enforced.

The insect here considered may be taken as an example of

the necessity of such laws and such a commission. It has practically destroyed the timber of Nantucket, but has never yet been found on the adjoining main land, or in any other part of the State. A careful examination of the pitch pines at Wood's Holl, during the height of its devastations at Nantucket, revealed no trace whatever of this insect's operations. Should it once gain a foothold there, as it probably will, there is no apparent reason why it should not extend to the Penobscot, or as far as the pitch pine flourishes. The landed proprietors everywhere in Massachusetts have then a personal interest in preventing the advent of such an enemy, and may rightly compel the people of Nantucket to take, at their own cost, active measures for the destruction of this pest.

The time will certainly come when the people of Massachusetts will demand some such legislative action as is here indicated; the sooner it is reached the better for the material welfare of the Commonwealth.

As this paper was written three years ago, I have added, in an Appendix, an account of what has since appeared in print concerning the moths of this genus in the United States, as observed by Professor J. H. Comstock.

It may be added, in conclusion, that there is another boring larva, evidently belonging to the same family of Tortricidae, also found in the shoots of this Nantucket pine, which, on account of its greater size, would do far more damage than Retinia frustrana were it at all common. I have not succeeded in raising it, and have never seen more than six or eight specimens. It too has its insect foe, — a parasite belonging to the genus Campoplex, one of the Ichneumonidae.

APPENDIX.

In the Report of the Entomologist to the United States Department of Agriculture for 1879, as published in the Report of the Department for the same year, pp. 233–238, pl. 5, figs. 1, 2, Professor J. H. Comstock gives an account and descriptions of three species of Retinia, all attacking the pitch pine.

The first, described by Professor Fernald as Retinia comstockiana, was found in the vicinity of Ithaca, N. Y., boring into the twigs and small branches, and causing an exudation of resin. They often cause the death of the twig, especially when, as in many cases, more than one larva lives in a single twig; but the principal damage done was in disfiguring the shape of the tree by the destruction of the terminal shoots. They pass the winter in the larval state, and there are, apparently, two broods a year.

A second species, Retinia rigidana Fernald, was found in the same place, and on the same tree; but no account is given of its habits, further than that they are "similar" to those of the next species, and that the larva inhabits terminal shoots.

As the third species is considered by Professor Fernald to be the same as that described in this paper (but see above, p. 10, note), I append the account entire. A twig, the moth, larva, and chrysalis are figured in the Report, pl. 5, fig. 2.

"Infesting the new growth of Pinus inops and P. rigida (and perhaps of other species) spinning a delicate web around the terminal bud, and mining both the twig and the bases of the leaves; one or several small yellowish larvae, which transform within grayish cocoons, either in their burrows or fastened to the twigs, and become small copper-colored moths, with wing expanse of 12 mm. (.47 inch)."

"About the middle of May, 1879, the scrub-pines (Pinus inops) in Virginia, near Washington, were found to be greatly injured by small lepidopterous larvae. On many trees there was scarcely a new shoot to be found which was not infested at its tip by from one to four yellowish black-headed caterpillars. They were so completely concealed while at work that their presence would scarcely be noticed, and the effect of their work was hardly visible until the twig was almost completely destroyed. Upon close examination a delicate web was seen inclosing the base of the bud and the surrounding new leaflets, resembling much the nest of a small spider. When this web was removed, one or several little yellow caterpillars were seen either retreating into a mine in the bud or into the bases of the leaves, which were also mined, or, not infrequently, they dropped from the twig, suspending themselves by a silken thread. The bud was often so hollowed that it dropped to pieces almost at a touch.

"At the time when they were first noticed larvae of almost all sizes were to be found. Some were apparently almost full-grown, while others had evidently not been long hatched. The nearly full-grown specimens measured 8 mm. (.31 inch) in length. The first pupae were obtained early in June. Most of the larvae transformed within the burrows which they had made, first spinning more or less of a silken envelope about themselves. Others, however, issued from their mines, and spun rather tough grayish cocoons between the leaves. The pupae were short, stout, and brown in color, with each segment furnished dorsally with two serrated lines, one consisting of large, and one of fine teeth.

"The first moths issued June 13, the pupae having previously worked their way, by means of the spines just mentioned, into such positions that they could give forth the moths without injury to the latter, and a few weeks later almost every shoot had one or more of the empty pupa skins protruding from it. Specimens of the moths were sent to Professor Fernald, who determined them as identical with Mr. Scudder's manuscript species, Retinia frustrana. In August Mr. Scudder gave a short account of this insect before the entomological section of the American Association for the Advancement of Science, at Saratoga. He had found it in such numbers upon the island of Nantucket in the young trees of Pinus rigida, planted there some years ago to repair the damage done by burning during the war of 1812, as to seriously threaten the success of the experiment. Mr. Scudder

intends publishing an account of the workings of the insect in that locality very shortly.

"In the latter part of July specimens of the twigs of Pinus rigida were received from Mr. S. H. Gage, of Ithaca, which had evidently been infested by the same insect, although no living inhabitants were to be found. In September other specimens were received from the same gentleman, and this time two pupae and one larva were found. According to Mr. Gage, the insect is not very common in that locality.

"In the latter part of August, individuals of the second brood were very abundant in the scrub-pine in the vicinity of Washington. As before, they were found in almost every stage of growth, and the difference was even more marked. In one instance five larvae of greatly differing sizes were found in one shoot. The smaller ones were boring into the bases of the leaves, and the larger ones into the twig proper. The largest of the five had made quite a long channel from the tip of the bud down into the heart of the twig. Pupae were also found at this time, which did not give forth the moth till late in the winter.

"The usual mode of hibernation is in the pupa state. A thorough search in January in the field showed only pupae. The pupae collected in August and September did not begin to give forth the moths in the breeding cages before early January, though this was continued at intervals through January, February, and March, and was greatly hastened without doubt by the heat of the room. On February 15, however, a few twigs were collected, from one of which, on February 28, a full-grown larva had emerged, and was found crawling about the cage. This would seem to indicate occasional larval hibernation.

"As to remedies, the only one which I can suggest at present is that involving the somewhat arduous task of picking off the infested twigs in early winter and burning them. Whether the salvation of the trees will be worth this labor in greatly infested regions will depend entirely upon their value to those interested.

"As Mr. Scudder has prepared descriptions of all stages, we will not trespass upon his ground by appending further descriptions than we have already given. Our figure will assist in the recognition of the species."

ANALYSIS.

EXPLANATION OF THE PLATE.

[The original drawings, both plain and colored, were made by Mr. J. Henry Blake of Cambridge. The reproduction by chromolithography is the work of Messrs. Thos. Sinclair and Sons, of Philadelphia.]

Retinia frustrana and Pinus rigida.

Fig. 1. The moth, enlarged three diameters.

" 2. Side view of chrysalis, enlarged three diameters. 2 *a*. One of the abdominal joints, enlarged nine diameters, to show the rows of spines and ridges.

" 3. Front view of chrysalis, enlarged three diameters. 3 *a*. The terminal joints of the abdomen, enlarged nine diameters, to show the arrangement of spines and hairs at the tip of the body.

" 4. Full-grown caterpillar, enlarged four diameters.

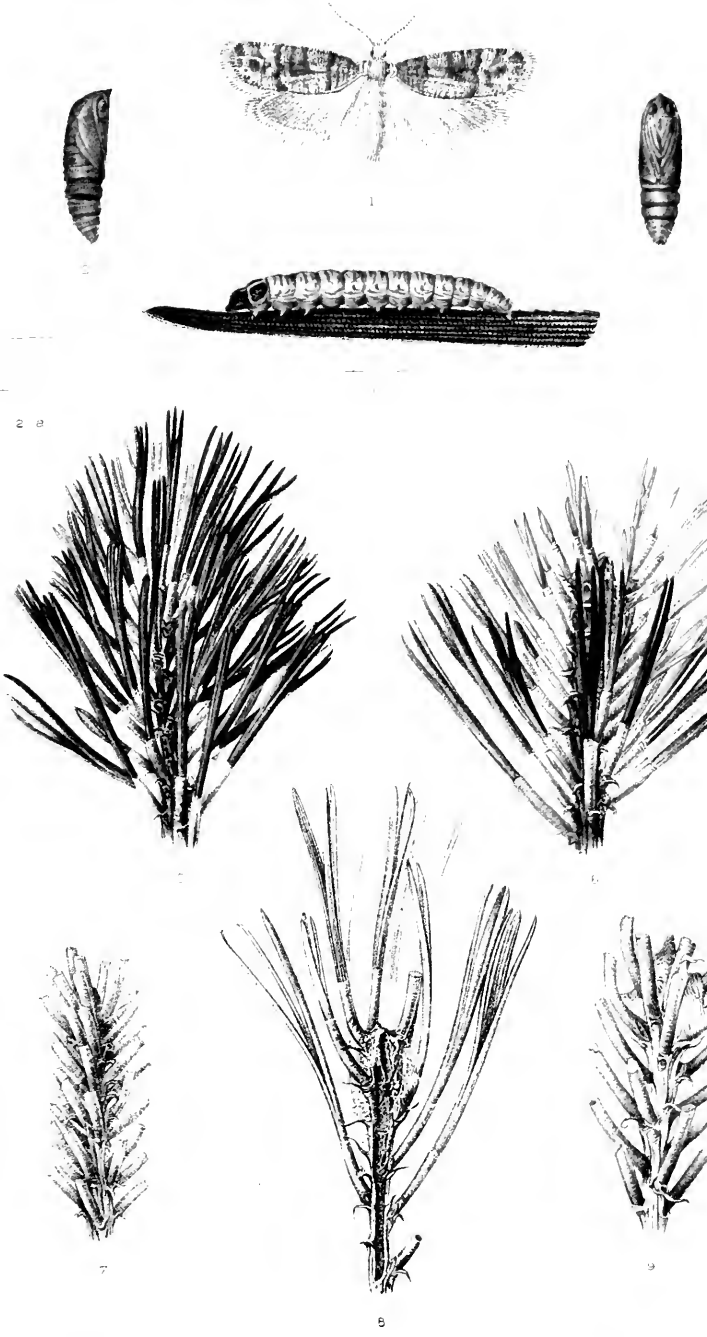
" 5. Terminal shoot of the pine in an uninjured, natural condition.

" 6. Terminal shoot which has been attacked by the insect when the apical leaves were only partly grown; away from the tip the needles have nearly or quite attained their full growth before the mining operations of the caterpillar had sapped their supply of nourishment.

" 7. Terminal shoots in a healthy condition, stripped of its needles, to contrast with fig. 9.

" 8. An infested shoot cut open to lay bare the mine of the caterpillar in its latest stage; the refuse which nearly fills it has been removed. The length of the terminal needles shows this shoot to have been well advanced in its growth before it was attacked.

" 9. A shoot similar to that represented in fig. 7, but which has been distorted by the attacks of the insect.



J Henry Blake, ad nat

T. Sinclair & Son lith. Phila

THE PINE-MOTH OF NANTUCKET.