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The Use of Poison in the Control of the Boll Weevil

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Circular No. 154.

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The recent publication of Agriculture Bulletin No. 731 entitled: "Recent Experimental work on Poisoning Cotton Boll-weevils" gives an interesting record of increased yields of cotton secured through applying poison late in the season. No explanation is there offered why this same poison, applied earlier in the season, invariably fails to give satisfactory results. It is known that the success of late-season applications of poison rests upon the habit of the weevil to drink water collecting upon the poisoned leaves as the result of the formation of dew. But such poisoned water had been available early as well as late in the season, and only late in the season have there been found to result any decidedly favorable results. What is the reason? To me it looks that as long as the cotton plant is succulent, the weevils secure enough moisture in feeding on squares and young bolls as to need little if any water collecting upon leaves. Or, partly also, early in the season, if water be needed, enough will condense as dew within the bracts where poison cannot be successfully applied.

If this explanation is correct, it will mean, it would not be possible, at least not to any great extent, to poison the weevils shortly before hibernation time, if it were attempted to concentrate them upon an abundant supply of squares that would be found upon a small patch of cotton planted purposely about two months after the regular time, for these squares would be nearly if not quite succulent enough to do away with the weevil's need for water. Unless the weevils, which because of new growth on

the old plants in response to possible fall rains have been rapidly multiplying, can be reduced by further poisoning, great numbers would enter hibernation under this plan of control.

The yield secured as the result of the application of poison as given was secured as a late crop, the illustration in the Bulletin of fields ready for picking serving as tests being taken between October 12 and 30. The present official system of controlling the boll weevil has for its chief reliance the early destruction of the plants in the fall. Aside from what effect this late presence of food and breeding material has upon weevil abundance the following year under this method of control, the question arises to what extent the poisoning of the leaves, through poisoning natural enemies of the boll weevil decreases the presence of these natural enemies the coming year, together with what effect such poisoning of the cotton crop as a whole has upon beneficial insects in general, and also upon all other insects, for most injurious and neutral ones are in a certain degree beneficial through feeding upon the flowers of plants and thus promoting their fertilization.

Thus it becomes a serious question, no matter how grand the immediately apparent results from the use of poison might be, how much harm has been done to the cotton crop and to crops in general of the ensuing year. The writer of Bulletin No. 731, Mr. B. R. Coad, concludes with this statement on page 13: "With the present lack of information on so many important points, any attempt to poison the weevil by the inexperienced may very easily result in actual loss."

Compare this plan of using poison with the plan of control described by me in my Circular No. 152, pp. 1 to 16. In substance this plan consists in using poultry the year around in connection with a trap patch of late-planted cotton. Suppose you have a cotton field 1000 feet square. At planting time mark off a square 100x100 feet in the center of the field. This space, for now only the one hundredth part of the field is to be planted at such a late date, as to produce squares in abundance after the main patch has reached the age at which, normally, it would

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have plenty of fruit but no squares. By keeping poultry in sufficient numbers to enable them to have an appreciable effect upon insects, on this crop, other crops, and also land not under cultivation—quite feasible since they secure most of their substance by merely being given the run of the land—and feeding them some grain at frequent intervals in this trap patch, the poultry will steadily secure adults and will also steadily pick on fallen infested squares. If the main patch under this arrangement does not, because of weevil presence or because of other causes, as a consequence produce till frost, it is to be cut off with the stalk cutter. This then leaves the trap patch as attractant with the weevils present there in large numbers up to and well after frost, the adults during cool spells being hidden under fallen leaves and readily found by poultry. During winter, poultry, by frequently patrolling the field and the surroundings, keep on reducing the number of weevils and of other insects. In the spring the weevils come mostly from the side which offered the best winter quarters. By feeding poultry slightly but frequently alongside that edge or these edges of the field, they will secure most of the adults then feeding in the tips of the young plants and keep this up all over the field later on. Of course they thus secure a vast amount of other insects, many of which are not amendable to the use of poison. In this way insects such as boll weevils and sucking bugs, will as far as they are concerned, be unable to prevent the plants to begin early to set fruit and keep this up till frost.

Of what use would it be if you could ever so successfully control the boll weevil by poisoning, but if you had enough of bugs, lice, grasshoppers, and spiders, rust, boll worms, stem- and root infesting insects, injurious ants, or others that either cannot be controlled by poison or at least would require a special application? Many of the biting insects are not readily amendable to the use of poison and the sucking insects of course, are not amendable at all. Poultry will take care of a majority of these, especially in conjunction with a trap patch, while aphids red spiders and rust can be kept down cheaper by the use of a

torch than by any other means.

As for aphid control the Bureau of Entomology in Farmers' Bulletin No. 914, p. 8, says that natural enemies keep the aphids down as a rule. Why then is made this rule on page 15 to be followed every year as a preventative measure: "All weeds in the vicinity should be kept down throughout the year..."? Any reasonably strong stand of pasture and meadow—and good farming requires that there be strong stands—will answer the same purpose. The same is said in Agriculture Bulletin No. 416, p. 60, in regard to the red spider. Since the Bureau gives 183 kinds of food for the red spider alone, if we were to cut out the wild food plants of each insect, we would not have a green thing growing to cover the ground not under cultivation and thus prevent erosion with its attendant evils.

Take grasshoppers. In cotton according to Farmers' Bulletin No. 890, p. 10 they "...usually advance from nearby waste places. Where young grasshoppers appear in great numbers, they may be controlled by kerosene, crude oil, trapped by the poisoned bait mentioned for cut worms..." Why not then patrol these waste places with poultry? The grasshoppers after having done damage to the cotton and when ready to oviposit usually lay their eggs, in sacks, outside of the field in waste places, slightly under the surface of the soil. Poultry given the run of these lands during fall and winter will, where these egg sacks are at all plentiful, secure large numbers of them, gaining a large part of their sustenance at this time of the year from this source alone. With the hatching of the eggs the young naturally become the continued subject of attack. It is manifest that poultry must be provided in quantity commensurate with the extent of work to be done.

On page 24 of No. 890 the Bureau speaks of the "double roll of ants," saying that many are helpful to keep down the boll weevil, chiefly by attacking larvae in fallen infested squares. But with the cotton belt rapidly becoming overrun by the Argentine ant to the exclusion of other ants and this ant on the whole highly injurious although it attacks boll weevil larvae, and

this ant finding its stronghold in uncultivated areas, whence to invade cultivated areas and houses and to foster the increase of aphids and scale insects, the question of its control as a means to prevent the resulting increase in the abundance of the cotton aphid and of aphids and scale insects in other plants becomes of prime importance. The Bureau has not the slightest suggestion to offer as to means of controlling the Argentine ant at large. The nearest approach to control the Bureau can give is by pointing to wild birds as feeding upon it. That wild birds under present agricultural development cannot cope with it, is shown by the fact that the ant rapidly spreads. Why not then make up this deficiency by an adequate use of domesticated bird life under the supervision of man? Moreover there is another side to wild bird life that must be considered. "...Damages (by birds) to fruits in Arizona and to rice in Louisiana were investigated and such remedies applied as were possible under existing laws..." (Agr. Yearbook 1917, p 91).

There need not be any mystery about what previous investigations along this line have shown. They have shown, for instance, the bobolinks go north in the spring and south in the fall. As agriculture became more and more developed, the bobolinks found when traveling south in the fall that man to make up for the destruction of much of their regular food supply had planted rice patches and they quickly adapted themselves to the abundant hospitality thus offered in spite of all the maledictions heaped upon them by the rice growers. It is the same with other grain- or fruit-eating birds, when their food has been either destroyed or been amplified by choicer kinds furnished by man. It simply means that wild birds, harmless under natural conditions, like insect or any other wild animal or plant, become pestif, if provided with unnatural conditions that favor their increase.

It is evident that the more agriculture is developed, the less benefit can be derived from wild birds and the more damage is to be expected. Their place must be more and more taken by poultry working under the supervision of man. Large flocks must be kept and these are to be used in field and forest wherever they

can be employed to advantage. The Bureau, for instance, records cases of decided benefit where poultry in appreciable numbers were used to attack the alfalfa weevil. The details of these cases, as given by the Bureau, go a long way to prove that it would have been highly profitable to carry out poultry farming under alfalfa weevil conditions on a much larger scale. In my Circular No 146, 1915, I went into detail showing how poultry can be made to control the New Mexico range caterpillar.

Poultry, by selection, has gained in weight, rapidity of growth and egg production, but has lost its power of ready flight; this makes them easily controlled by man, but makes them of use only for insects on or near the ground. In the case of cankerworms on fruit trees for instance, I had shown for five years past that these worms might be licked off by a slight hot air blast, to be eaten then by poultry on the ground. What is the use to spend a lot of time and money trying to kill such worms by poison, when a slight licking will make them drop, and poultry will put them where they do the most good?

Upon the publication of my Circular No. 152, which on pages 1 to 16 describes in detail my system of controlling the boll-weevil, an effort was made to get several of the southern State Entomologists to render an opinion as to the merits of the case. There was no response by any of them, although several Commissioners of Agriculture had displayed keen interest and had referred the matter to them for action. Only in one case was there elicited a statement of any sort, and it came from a State Horticulturist, referred to on page 26 of my Circular No. 152, who had previously expressed himself as much interested in the control of the boll-weevil, and who had been asked to get his State Entomologist to point out any soft spots that might be in the system of control as described by me. He said, under date of Aug. 2, 1918, I am wasting my time to discover a boll-weevil remedy that most of the people of his State care nothing about, and that it seems to him that there will not be enough boll wee-

vils in his State this year to go round; he said a man told him the crop this year promised nineteen million bales, and that another smarty had told him he is not interested in any system of boll weevil control. This led me to calling the attention of his Governor to this matter, that he might see how faithfully the interests of the people are looked after by the State officials in charge, and in time I received word from the State Horticulturist in question saying that I wrote to the wrong man when I tried to secure his dismissal. Well, I did not want his dismissal, at least not if he and the State Entomologist were willing to point out what soft spots there are supposed to be in my system of control. This they did not do. But the State Horticulturist said their colored cook, Aunt Hettie Dawson, says chickens won't eat boll weevil, whereupon I said, whereas he and the State Entomologist refuse to officially endorse Aunt Hettie's statement, if they wanted her to be the whole cheese, it would be only fair for the State Entomologist to do the cooking and let Aunt Hettie hold down his job. I also asked him to get a statement from Aunt Hettie whether or not chickens eat Argentine ant, preferably with his and the State Entomologist's endorsement. There was no reply. He had said previously he was working under the U. S. Department of Agriculture and was not appointed by the Governor. It is just because the Department does not want to talk that I made an effort to get the State Entomologists to talk, but you see they know that if they talk, either way, they are liable to be dropped off the pay roll.

So there you are; for my part I am in no hurry. If the Commissioner of Agriculture of your State wants to know the truth he can get it to his own satisfaction by having the Members of Congress from his State ask the U. S. Entomologist to make a statement. Any old statement will do, provided he then hears my side and then draws his own conclusions. The Department cannot hand me a crooked deal without handing a crooked deal to the people.

A similar effort was made with the State Officials of New Mexico in regard to the system of controlling the New Mexico

range caterpillar, described in my Circular No. 151. The State Biologist-Entomologist did not show any disposition to take this matter up, but after some effort on my part made these statements: "...I judge that the Department of Agriculture is perfectly able to decide on the practicability of methods of investigation of injurious insects. Matters that are in their hands I leave in their hands. In regard to your proposition for the control of the range caterpillar, I may ask if you know how many square miles are infested, what is the population of the infested territory, what is the nature of the country, the number of poultry that would be required to patrol this territory effectively, the number of natural enemies of the poultry, the number of accessible acres for the production of other food for the poultry, the amount of such food required on such a project, the expense, and, finally, the possibilities of marketing..."

This State Entomologist professedly has nothing to do with this matter altogether, affecting as it does the people of his State more than any other insect, with the exception, possibly, of grasshoppers, in the control of which, at large, the use of poultry is undeniably the very best means, since it means employing natural enemies under the supervision and ownership of man. All the disputed points had been carefully discussed previously in my Circular No. 146. If the Department had been willing to take up the matter there would have been no need to try to have the State Entomologist take it up. The infested territory is a stock raising country. If a country can normally support cattle and sheep, why not poultry? In Department of Agriculture Bulletin No. 443, p. 4 you read: "...In many instances in addition to its damage to the range grasses, the range caterpillar has seriously injured cultivated grains and forage crops... As the range country of New Mexico is rapidly becoming a dry farming and irrigated agricultural district, it is evident that the range caterpillar, unless checked, is likely to become a serious pest to crops..." Thus to protect the farmers you need at least something better than to trust to control by natural enemies, which is the Department's only proposed system of controlling

the pest at large. On page 11 you read: "...Cultivated areas usually may be protected by winter burning the surrounding egg-bearing grass, weeds or other vegetation. However such burning destroys the grass crop for that year, and unless carefully conducted may result in the burning of buildings or timber in the vicinity." This is a highly expensive way, because such burning destroys the fertility of the soil and invites erosion. Such a plan carried out generally destroys the fertility of the hill lands and covers the lowlands with a sediment of silt as the result of erosion. While the population is thin, suppose the range caterpillar were to eat the range clean, there would then be more people than there is support for; on the other hand, if improved methods produce prosperity, there is no trouble getting the necessary people located. For instance, by expensive systems of pumping large tracts of cheaply bought land in New Mexico have been made to grow very profitable crops of alfalfa, and a much larger number of cattle than is normally possible is thus being raised.

The matter was explained to Governor Lindsey of New Mexico who referred it to Dr. A. D. Crile, President of New Mexico Agricultural and Mechanical College, at State College, for action. There was no action. Mr. Crile knows that he and the rest get their salt whether they earn it or not, anyway get it as long as the getting is good.

Some better results were obtained in response to an attempt to get the Louisiana State Entomologist to express an opinion in regard to the method of controlling the sugar cane borer moth, described by me in my Circular No. 151, pages 31 to 35, issued July 20, 1917. The method there described is given briefly on page 24 of my Circular No. 152 and, as there given, "rests upon the fact that the borer prefers succulent corn to cane for breeding, and the method also takes advantage of the fact that the moths hang on the plants during the day, thus enabling poultry to secure at least part of them. Trap patches of young corn are provided during the whole season, especially in late summer and fall, to attract and hold the last brood, which upon

going to hibernate in the ground," that is, in the root stock, "is then destroyed by plowing."

Soon after writing above I had concluded that the use of corn, as described, is alone amply sufficient to absolutely control the borer. To most effectively use corn, the main crop, for ears, is planted at the usual date. As this corn matures in July-August, small patches of succulent corn, planted at later dates, at intervals of about 30 days, are coming on. This corn serves as attractant and breeding ground for the moths. It is to be cut before it becomes too tough to serve as breeding material for the borer in the presence of cane. This corn can be cured for fodder, or fed green, or used for silage. The last patch to hold the hibernating brood, where practicable, can be allowed to stand to be eaten down by stock on the approach of frost.

With such a plan of control, permitting as it does of checking most effectively the 3rd and 4th generation, which are the ones that do the damage, it will readily be seen that the use of poultry to secure moths is not at all necessary: moreover the moths would in about half of the cases be out of reach of poultry anyway. At the same time, however, stress was laid upon the presence of the Argentine ant in the canefields. As far back as my Circular No. 147, pp 26 to 28, I had shown that there is available as a means of control nothing more feasible to keep down the Argentine ant than the use of poultry on a large scale in and about the canefields the year around. As is well understood this ant greatly facilitates the increase of the sugar cane mealy bug, it being estimated officially that its presence means on the average fivefold the normal damage by this bug. The U. S. Bureau of Entomology fully realizes the harm done by the Argentine ant in the cane fields. The U. S. Entomologist in his report of 1917 on page 8 says: "Methods of controlling the Argentine ant in sugarfields were tested, but on the whole the results were unsatisfactory and considerably further work is necessary." Just have your Representative in Congress ask the Entomologist whether he has tested out the use of poultry as a means of control, not only in the cane fields, but on the surround-

ing vegetation, wild and cultivated, as well. It is safe to say even now that they cannot find anything as good as the use of poultry.

With these facts in mind you will be prepared to judge correctly a statement made on Aug. 30, 1918 by Mr. W. E. Anderson, Acting State Entomologist, Baton Rouge, La: "The circular," (Nos. 151 and 152) "which you sent to the Commissioner of Agriculture with the request that he submit it to the State Entomologist to look over, has been gone over carefully. I am glad to say that the principle, which you advocate in using corn as a trap crop for the sugar cane borer, is being practiced in this State, and with good results. As to the poultry having free run in order to catch the moths when they first emerge, I do not think this is practical. I am sure that you could not get the cane growers to go into the poultry business, which would necessarily have to do in order to have enough chickens to cover the entire acreage of the plantation."

Mr. Anderson's statement that corn is used as a trap crop for the borer moth was something new to me. Because of this I wrote him, asking whether his Experiment Station or the Federal Government had published anything on this point, also asked him to express his opinion whether, with the Argentine ant generally present in Louisiana and infesting all crops, wild and cultivated, that sustain aphids and coccids, the extensive systematic use of poultry against this ant as described in my Circulars No. 147 to 152 is not a necessity. There was no reply.

As a matter of fact the U. S. Entomologist in his reports for 1916 and 1917 when speaking of the control of the sugar cane borer moth speaks of nothing but of experiments with poisons and introduced parasites. The fact that the Bureau of Entomology spends a lot of time on such an unpromising proposition as the use of poison for the borer moth shows how hard they are up for a satisfactory means of control. The borer moths emerge from hibernation during a period of about three months, 70 per cent of the egg clusters are deposited on the under side of the leaves, the young then make their way to the whorl of the plant conceal-

ing themselves in its funnel. As the whorl is rapidly developing and gathers water by way of dew and rain, it is readily seen that poison cannot be of practical value, since any one application cannot, at best, get more than a small part of the borers present.

But assuming the use of poison were successful, it can affect at most only borer and other biting insects. While cane has thus far been but little troubled with aphids, the presence of the Argentine ant indicates a rapid increase of damage from this source, another reason for the use of poultry on cane and vegetation generally.

Then in the way of new pests the weevil borers must be considered as possessing great possibilities for damage if left unchecked. The first specimen was found in 1910 in Louisiana. This was followed by discoveries at other points in that state and also at Brownsville, Texas in 1912. It is similar with the sugar cane beetle. Grasshoppers do heavy damage to cane or other crops as do other insects that might be controlled by the use of poultry and this at far less cost than any other means. If the U. S. Entomologist wants to call this theoretical, as usual, just have him come down to hard tacks and show what is theoretical.

Another matter has to be considered in this connection. It is the presence of the pink bollworm in Mexico and certain parts of Texas. Agriculture Bulletin No. 723, recently issued, gives some new information on the life history of the insect and explains how it is proposed to stamp the pest out in Texas and in Mexico as well. There is one big-little thing the U. S. Entomologist and his staff of scientists overlook, and that is that if the pink bollworm moth shows the same increase in capacity for flight the boll weevil is known to possess, when deprived of oviposition material, partly or entirely, we can expect these moths to be able to fly for hundreds of miles, if their oviposition material, squares and cotton bolls, be cut off in any given locality.

Experience in the case of the boll weevil has shown that it

flies no more than necessary to supply its needs, and that their movement may be on the average as little as 535 feet per day when feeding upon cotton plants having no squares, or may be an unknown number of miles when suitable oviposition material has become very scarce. During the invasion of Louisiana, for instance, vast numbers of weevils covered a 40 mile stretch of non-cotton producing territory without apparent difficulty. Even when squares are present, but the supply is plentiful, weevils move no more than is necessary to secure the desired food or oviposition material. Thus I had shown as far back as 1905 in my Circular No. 32, that, in a case recorded on page 87 of Entomology Bulletin No 45, and reprinted on page 115 of No. 51, a field of 35 acres upon newly broken land and situated in a comparatively isolated location was watched for progress of infestation that was considered likely to occur. There was a cotton storage house opposite the corner where infestation was subsequently found to have begun. When found on August 6 the infestation was still confined to a small area, the plot in the corner showing an infestation of 20%, the infestation growing less and less to nothing towards the center of the field. Hence, with the weevil coming from the storage house and not from the nearest infested cotton field, had not begun in July as Dr. Hunter thought, but had begun during the usual emergence period of February to June in South Texas and the weevils had from 2 to 4 months in which to spread. That the spread is usually much faster than in the case mentioned can be explained only upon the assumption that usually the infestation due to hibernated weevils is much heavier.

In the case of the pink bollworm moth we are told that although apparently capable of prolonged flight, they prefer to go no farther than the first cotton field (D. A. Bull. 723, p. 13.) But why should they want to go farther? The nearest cotton field may be 100 feet or 100 miles away. "The eggs are laid singly or in small groups on the green bolls or in the flowers" (p 12). Evidently the moth, like the boll weevil, wants to oviposit only eggs in such numbers on a given square or boll as each of the

resulting larvae will have a chance to mature. If so this means, as in the case of the boll weevil, an increase in distance of flight corresponding with the scarcity of oviposition material.

The main infestation in Mexico is in the Laguna district. The boll weevil for many years, supposedly because of elevation, had been unable to get established there, but is established there now, showing thus its capacity for adaptation from a new angle. The Laguna district has an extent of about 1200 square miles and is located about 200 miles south of the Texas border, the intervening space being covered with mountain ranges, and the whole of this district is infested by the pink bollworm, "Gough, in Egypt, found the larvae would remain in a quiescent condition for over two years" (p. 12). Thus suppose no cotton is grown in the Laguna district for 3 years. A moth usually lives about 17 days. A moth finding no cotton upon emergence goes in hunt for it. It has no other object in life than to oviposit in cotton, or, if unable to find cotton, to oviposit in some other plant likely to make it possible to mature a new generation. The Bureau has published nothing as to what food these moths take. The inference is they feed normally upon the pollen of cotton flowers, and in its absence upon nectar obtainable about cotton plants. In the absence of all cotton, there can be but little doubt that they can readily subsist for the normal period of 17 days upon pollen and nectar secured from malvaceous plants, and, if necessary, upon pollen of flowers of many other plants. Many malvaceous plants are growing wild. Cotton in Mexico grows wild, that is, the valleys in the mountain ranges to the north harbor cotton plants. These if as yet uninfested, would thus become infested. Under such conditions the moths necessarily will develop their inherent capacity for long distance flight. Hence with an average length of life of 17 days for moths that are ovipositing, which indicates a longer period of life for moths that are not ovipositing, we cannot but conclude that a moth unable to find ovipositing material will bring to naught all protection by cotton-free zones, even with a width of 50 miles at the Texas border and another 50 miles added at the

Mexico border, and thus all the enormous expense and loss it is proposed to incur in an effort to stamp out the pest will be for nothing. "...In the case of Hearne the quarantined" (cotton-free) "area included a territory within a radius of 3 miles from the mill..." (p 24). What can you expect from a cottonfree strip of 3, or 30, miles in the case of a moth that habitually swarms for 2 or 3 hours in the evening?

It is generally held by biologists that the boll weevil originally bred in the bolls of wild cotton, that thus there was originally only one or two generations a year. With access to improved cultivated varieties injuriousness has corresponding increased and the weevil has accelerated reproduction by breeding in squares and as a result there are now 3 to 6 generations. There is every reason to believe that the pink bollworm moth was thus similarly originally a comparatively harmless pest in its native home and that its injuriousness increased by access to improved varieties, grown under improved conditions. Under original conditions the food supply is never suddenly cut off, at least not over any great territory, and the pink bollworm, as did the boll weevil, thus naturally accustomed itself to feed and breed upon cotton exclusively. The boll weevil is, apparently because of attempts to starve it out, adapting itself both to feed and breed in plants related to cotton and to go without food obtained from cotton for a great length of time after late summer. With all cotton destroyed the weevils can yet feed upon pollen and nectar secured from related plants. And if these were absent, pollen from most other plants would probably fairly well answer. The fact is, that if food of any kind were untobainable the boll weevil could secrete itself in cool places, as in cracks of live bark, and thus enter a quiescent state.

In the case of the pink bollworm no definite proof seems as yet to exist that plants other than cotton can support it, but: "...a statement has been published to the effect that the insect has been reared from a closely related plant belonging to the genus *Hibiscadelphus*" (p 14). This, if true, would make the attempts at extermination all the more hopeless. If not, as the

food supply under artificial conditions is apt to be suddenly cut off, we can expect, as is known to be the case with the boll weevil, an adaptation to related food plants by the pink bollworm. To try to make the public believe that the pink bollworm can be exterminated in Mexico, and at anything like a reasonable cost, on a par with the Bureau's claim of having a chance of exterminating the European pine-shoot moth, the European pine-sawfly, the white-pine blister-rust pest of New England and other rank humbug. Not a syllable has yet been published of what the Bureau expects to do should the pink bollworm, as is admitted to be possible, defy the efforts of the Bureau and of the State of Texas to stamp it out.

Given the correct principles of control the pink bollworm is an insect easy to control. "The pink bollworm affects the production of cotton in several ways. First a considerable number of squares and bolls are so injured that they fall to the ground. In case of heavy infestation 50% of the crop may be destroyed in this way..." (U. S. D. A., The pink bollworm, Aug. 7, 1914) or ...in the first place it destroys a certain number of bolls or portions of bolls in which case the lint produced is short and kinky..." (Bull 723, p. 5). That shows the need of attacking the pest at the earliest possible moment. "The moth is seldom seen in nature. Its habit is to hide during the day under stones and brush. The normal time of flight is from 6:30 to 8:00 p. m., The moth is so quiet in its habits and so easily overlooked that many may occur unnoticed in the field. In fact Mr. Busck states that frequently he walked through cotton fields in the Hawaiian Islands where many thousand must have been present without seeing a single one" [Bull. 723, p. 13]. It takes some imagination to combine stones and brush and cotton field. However a certain percentage of the moths may hide during the day under stones and brush near the outside of the field. The rest hide manifestly on the cotton plants. Using poultry exactly as recommended for the securing of hibernated boll weevils will decrease the number of moths. As squares and small bolls begin to fall, poultry forced to patrol the cotton field by being fed and

watered and held there, long and often enough to keep the pests under control, will attack these squares and bolls same as they are wanted to attack squares and bolls infested by the boll weevil. Inasmuch as older bolls do not fall, it is obvious that the most efficient work with poultry that can be put in is early in the season, the more so as then the moths, boll weevils, bugs and other insects acting as stemmothers are more easily found than later.

Another account: "The insect was very destructive to the American cotton" [in India]. "The egg is deposited in the germen at the time of flowering, and the larva feeds upon the cotton seed until the pod is about to burst, a little previous to which time it has opened a round hole in the side of the pod for air and at which to make an exit at its own convenience, dropping on the ground which it penetrates about an inch, and winds a thin web in which it remains during the aurelia state... The native cotton is sometimes affected by it" [Bull. 723. p. 2]. This shows the habit of the insect in bolls that do not fall at a time when yet another generation can be developed. These larvae and cocoons can to a certain extent be secured by poultry. The fact that the insect greatly prefers American cotton shows that the native is "resistant" simply through failing to offer the abundance of squares produced by American cotton. This then means that a trap patch of late-planted cotton as recommended for the control of the boll weevil and the bollworm [corn ear worm] will be the thing to keep the pest down to harmless numbers in the latter half of the summer and fall, thus insuring the crop.

Of course during the winter all seed not needed for the planting is to be utilized in such a way as to destroy any pink bollworms in them. These steps then will be amply sufficient to make it needless to go to the trouble to effectively fumigate the seed that is to be used for planting.

"...in Hawaii... the moths were clearly repelled by light. In Egypt experiments have shown some degree of attraction to light by the pink bollworm moths. but not enough to form the

basis for control measures" [Bull. 723, p. 13]. The light furnished by a torch used as a trap as described on pages 25 and 26 of my Circular No. 153 is little more bright than a ruddy glow and this light is confined within a small chamber, with darkness without. There is best of reason to believe that such a trap would readily trap those moths, if additional means of control were necessary.

If the facts here outlined are not taken into consideration, there will be waste of public funds, not by the proverbial barrel, but by the car load. Because of this it now looks as if it will not be nearly so big an undertaking to make Senator Gore, Chairman of the Senate Committee on Agriculture, and the U. S. Entomologist do their duty—or give the pair of them the bounce—than Senator Gore thought three years ago would be the case, a matter discussed in my Circular No. 148.

**The Reinlein
Knapsack
Gasoline Torch.**

*Patent No. 739,221.
Sept. 15, 1903*

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