Issued December 4, 1912.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ENTOMOLOGY—CIRCULAR No. 162.

L. O. HOWARD, Entomologist and Chief of Bureau.

THE POTATO-TUBER MOTH.

A PRELIMINARY ACCOUNT.

BY

F. H. CHITTENDEN, Sc. D.,

In Charge of Truck Crop and Stored Product Insect Investigations.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1912

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United States Department of Agriculture,

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L. O. HOWARD, Entomologist and Chief of Bureau.

THE POTATO-TUBER MOTH.[1]

(*Phthorimæa operculella* Zell.)

By F. H. CHITTENDEN, Sc. D.,

In Charge of Truck Crop and Stored Product Insect Investigations.

INTRODUCTORY.

For many years the potato-tuber moth, known scientifically as *Phthorimæa operculella* Zell., has been the worst potato pest in California. It has now reached the State of Washington and menaces adjacent States. This insect feeds also upon tomato, eggplant, and tobacco, which do not, however, as a rule, suffer much injury. When it occurs on tobacco it is known as the splitworm.

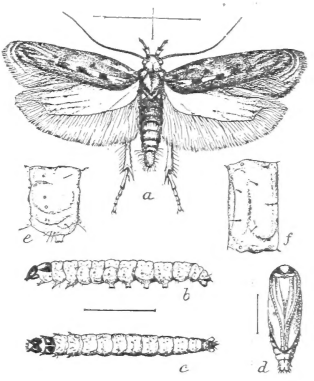

FIG. 1.—The potato-tuber moth (*Phthorimæa operculella*): *a*, Moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, pupa; *e*, *f*, segments of larva enlarged. (Redrawn from Riley and Howard.)

The mature moth of this species, which is quite small and grayish in color, is shown in figure 1, *a;* the larva is shown in *b* and *c;* and the pupa in *d*. Sizes are indicated by the size lines in the figure.

The eggs may be laid upon the leaves or on other parts of the plants, and the minute caterpillars or worms quickly bore between the surfaces of the leaves or into the potato skin, which they mine in every direction, finally devouring the exterior. It is believed that there are two or more generations in the course of a summer, and certainly another one can be produced in store. It thus happens that this insect belongs to both truck-crop and stored-product insect pests.

An example of injury by this species to potatoes is shown in figure 2. At *a* is a section showing the eggs at the top; at *b*, a badly infested

[1] The account here given is preliminary in character and issued with the purpose of warning potato growers and giving general information in regard to remedies. Work has begun on this species and will continue.

potato in section; at the left is a section containing two pits, *d* and *f*, in which the larva has been at work, while at *b* and *c* are shown the egg, highly magnified.

DISTRIBUTION.

This species is widespread in its distribution, but in this country, until the present year (1912), we did not know of its rapid dissemination. Abroad it is well known in Hawaii, all portions of Australia, New Zealand, Algeria, and many other countries, including southern Europe. As an enemy to tobacco it has been known for several years in Florida and in North Carolina, South Carolina, and Virginia.[1]

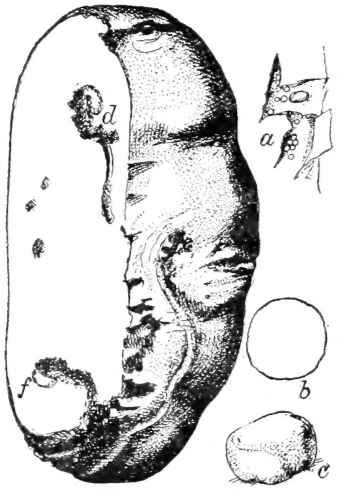

FIG. 2.—Work of the potato-tuber moth: *a*, Section of tuber, showing eye and eggs deposited about it; *b*, egg in outline; *c*, egg, lateral view; *d*, *f*, mines of larva in potato. *a*, Natural size; *b*, *c*, greatly enlarged; *d*, somewhat reduced. (Redrawn from Riley and Howard.)

The directions for applying remedies which follow are for the benefit of persons inquiring in regard to means of control. Which of these should be used can be best determined by trial in the different localities under the different conditions in which the insect exists. This applies especially to the question as to the best material for fumigation.

EVIDENCE OF IMPORTANCE.

As evidence of the importance of the pest a few quotations or notes should be made.

Mr. J. E. Graf, working under the direction of the writer, wrote:

> In September, 1912, an unusual outbreak of this pest occurred at El Monte, Cal., due entirely to a combination of circumstances. Thousands of acres of potatoes were planted in southern California—many more than the market would stand. This meant that the market was continually clogged and the prices were poor, so that the crop was worked off very slowly. The tuber moth (*Phthorimæa operculella*) is always found here, but the crop is generally handled so quickly and carefully that small loss results. This year, however, careless work and the leaving of potatoes in the ground too long have given the insect a tremendous start, and now its ravages are greater than ever before. A combination of the moth and low prices has so discouraged many of the growers that they are leaving their potatoes to rot, and as these are becoming infested there will be a great number of moths waiting for the fall potatoes. * * *

Later, September 17, 1912, Mr. Graf wrote in regard to this species that two growers near El Monte, Cal., lost $90,000 and $70,000, respectively, on potatoes that year. Items of this kind show the necessity of investigating the problem.

[1] It is somewhat doubtful if the splitworm on tobacco and the potato-tuber moth are the same insect, although they appear to be identical according to the best authorities on the subject. This is a matter to be settled later.

Aside from numerous similar complaints, including the usual number from California for the past two years, this species has been received from Eagle Lake and Hallettsville, Tex.; San Jose, Costa Rica; Seattle, Auburn, and Yakima, Wash.; New York City, where it has not become acclimatized so far as known; Fort Collins, Colo.; and Larimore, N. Dak. These records include only occurrences on potato.

In the case of the last report the tuber moth was stated to have been imported into southern California in potatoes from China. It is doubtful if the species has been introduced into North Dakota, but inquiries have been made in regard to the danger of its being introduced there as well as into Minnesota and some other States.

REMEDIES.

The potato-tuber moth is a difficult insect to control. It is not possible to reach the tuber worms in their mines in the potatoes or in the stalks or tubers growing in the field, which makes it necessary to proceed against the pest by other methods. Of these, several must be employed to insure success.

The first measure consists in the maintenance of clean methods of cultivation. This implies that all infested potato plants and solanaceous weeds, such as ground cherry, bull nettles, horse nettles, and volunteer potato plants, growing in the same vicinity as the potatoes, must be destroyed. This can be done by prompt burning as soon as insect infestation is manifest. The burning of the weeds will eliminate places for the breeding of the insect or for its successful hibernation. Domestic animals such as sheep and hogs are valuable for the destruction of remnants and may be utilized by merely turning them into the field.

Crop rotation, as in most other cases of insect injury, is desirable where possible, and the cooperation of all potato growers of the neighborhood is practically a necessity. In certain cases, as, for example, in a county where many potatoes are grown, it might be possible by legislation to enforce the discontinuance of potato planting for a year, requiring at the same time the destruction of the weeds which serve as food plants. There are several alternate food crops which do not suffer materially from this insect. About the best of these are leguminous crops, like beans, peas, cowpeas, alfalfa, and clover. These possess a dual value, as they all act as soil restorers. Sugar beets, celery, and crucifers are also good as alternate food crops. Grains may serve in the same way, as they are not attacked by the tuber moth. Care in digging is advisable in order not to cut into the tuber or leave dug potatoes in the field over night where reinfestation could occur.

FUMIGATION.

While all of these remedies are of value, the best remedy is the fumigation of infested tubers with bisulphid of carbon or hydrocyanic-

acid gas. If bisulphid of carbon is used, it should be at the rate of 3 pounds to 1,000 cubic feet of air space, including the potatoes; 1 ounce to a barrel of 96 pounds' capacity would not be excessive. With an exposure of not more than 24 hours, no harm should be done to the potatoes for planting. The bisulphid should be evaporated in

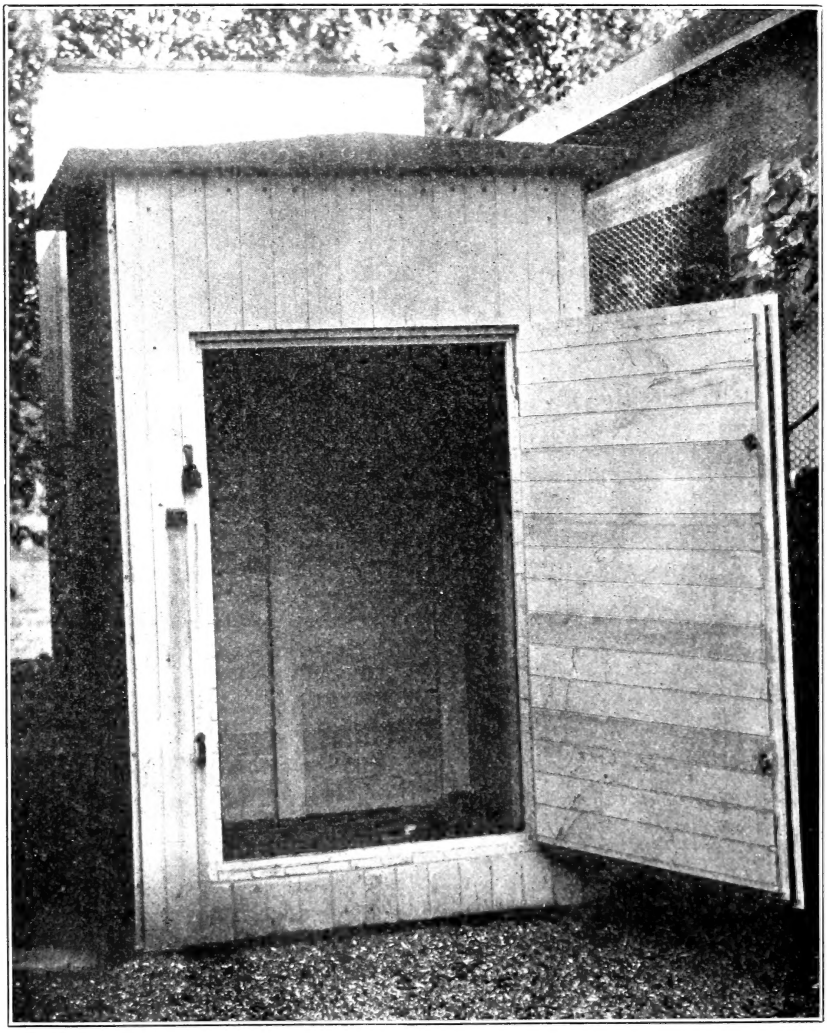

FIG. 3.—Fumigator used for stored products infested by insects. (Author's illustration.)

tins, like pie plates, and a cover should be placed on the top of the fumigating barrel or box so as to make it as nearly air-tight as possible. At the end of 24 hours the potatoes should be removed, placed in a fresh barrel, and closed up.

Where it can be conveniently done hydrocyanic-acid gas should be used in a specially constructed fumigator (see fig. 3), also gas-

tight. In the case of bisulphid of carbon there is great danger in bringing the chemical into proximity to fire, such as a lighted lantern or cigar, for the gas is highly inflammable and even explosive. Then, too, the bisulphid-of-carbon method costs slightly more than the hydrocyanic-acid-gas method.

Fumigation with hydrocyanic-acid gas, properly performed, is not dangerous, but if improperly performed is decidedly dangerous to human and other animal life, as the fumes are very poisonous and are deadly when inhaled in any amount. This gas is more penetrating than bisulphid of carbon and can be used by an intelligent person without trouble, if he first familiarizes himself thoroughly with the procedure by carefully studying the printed directions or assisting some one who has had experience in this work. The cubic contents of the receptacle to be fumigated, on which is based the amount of chemicals to be used, can be readily computed.

THE CONSTRUCTION OF A FUMIGATOR.

A building, box, or room (see fig. 3) of about 100 to 200 bushels' capacity suitable for the fumigation of a quantity of potatoes would contain about 500 cubic feet. A fumigator of this cubic capacity might be built 8 feet square by 8 feet in height. A good, and perhaps the best, means of preventing the escape of the gas would be to line the fumigator with sheet tin, with soldered joints, and over sheathing. Another method would be to sheath the room inside, cover the walls, ceiling, and floor with tarred or heavy building paper, with joints well lapped, and cover the inside with matched ceiling boards. The fumigator should always be equipped with a tight door in which the joints have been broken, similar to the door of a refrigerator or safe, and should close with two refrigerator catches against a thick felt weather strip, which should render it practically gas-tight. Thus constructed it would furnish sufficient space for the fumigation of about 200 bushels of material. There would also be sufficient space for the application and diffusion of the hydrocyanic-acid gas,[1] carbon bisulphid, or other fumigant from the top with a charge more than necessary for the quantity of potatoes treated.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *September 30, 1912.*

NOTE.—Fumigation with hydrocyanic-acid gas is considered in Circular No. 112, which will be sent to anyone who requests it, stating that it is to be used for the potato-tuber moth.

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