TEXAS AGRICULTURAL EXPERIMENT STATION.

BULLETIN NO. 31.

JUNE, 1894.

INSECTS INJURIOUS to STORED GRAIN

Agricultural and Mechanical College of Texas.

POSTOFFICE,

COLLEGE STATION, BRAZOS CO., TEXAS.

All Bulletins from this Station are sent free to citizens of the State on application to
J. H. CONNELL, DIRECTOR,
P. O. College Station, Texas.

TEMPLE, TEXAS:
COX & VENNEY, PRINTERS.
1894.

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ERRATA.

Page 467, first paragraph, for Tusch Life, read Insect Life.
" " " " for 1894, read 1890.

Page 468, third paragraph, pupiating, read pupating.
" " description of fig. 4, for Angumois, read Angoumois.

TEXAS AGRICULTURAL EXPERIMENT STATION.

INSECTS INJURIOUS TO STORED GRAIN.

R. H. PRICE, B. S.

The injury done to stored grain and seed by weevils and a few other insects is too well known in many Southern states to scarcely need comment. Weevils are more injurious in warm climates. Corn has been shipped here from several sections of the Northern part of this state with only a few weevils in it, and but a month or two would elapse till scarcely an uninjured grain could be found on many ears. I have reasons to believe that such grain is not wholesome to stock. If it be planted the "stand" will not be perfect. If a weevil eaten seed comes up the young plantlet will be robbed of much of its food placed in the seed by nature for its nourishment till it can draw its sustenance from the soil and atmosphere. Poor seed will greatly affect the total yield of a crop. Samples of wheat have been received from McKinny and Galveston entirely ruined by weevils.

The following was received from Mr. Geo. Mitchell, Galveston, Tex., February 10, 1894: "The mill and elevator people take special pains to keep the weevils out of their places, but grain and feed dealers are bothered a great deal with them." In a letter received February 26th Mr. Mitchell states: "The manager of the Star Mills Elevator says that when he receives wheat with traces of weevil, which he often does, he runs it through his screens, turning on a very strong current, and effectually "blows" them out. Once or twice he has found some weevils in a bulk of grain in the bins. In such a case he sets all hands to work and runs it through the screens. He cleans out the bins thoroughly and then dusts them out well with lime and they are ready to receive grain again with safety. Generally he has no further trouble with them."

The following was received from Mr. E. L. Huffman, Fort Worth, Tex., February 9, 1894: "Two kinds of weevils are the destroyers of our stored grain. The importance of mastering our insects I regard as being of much more importance than mastering our railways. I think when you consider the annual loss to Texas from the injury done to corn in the field, wheat in the shock and grain in the bins it will amount to hundreds of thousands of dollars. In collecting material for our State Fair for several years and preserving it I have had constant warfare against these insects. I have found nothing which would destroy the in-

sects but what would also destroy the germinating power of the grain. I have tried bi-sulphide of Carbon It will do for a while only."

During the past fall and winter we have conducted experiments in testing different substances for keeping weevils out of seed, and also their effects upon the germination of seed. All the insects mentioned in this bulletin have been collected in this state by us and identified. With the following figures and short descriptions I think any observing farmer will be able to identify insects which may occur in his seed and stored grain, and knowing something of the injury done will lose no time in applying a sure remedy.

THE GRANARY OR CORN WEEVIL.

CALANDRA GRANARIA, LINN.

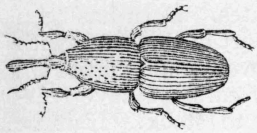


Fig. 1. Granary Weevil Enlarged.

This insect is one of the true weevils, being provided with a long beak or snout at the end of which the mouth parts are placed. The antennae are situated on the beak and are elbow or geniculate in shape, pointing towards the front end of the beak. This weevil differs very much from the grain beetle, which also injures corn and wheat, being heavier bodied and of a very dark brown or black color; hence it is sometimes called the "black weevil." Minute indentations occur upon the surface of the body which are arranged in rows. The eggs are deposited singly upon the grain and the small footless larvae (worms) soon hatch out and eat their way into the inside where they pupate (change from the worm to the dormant period, after which comes the full grown weevils). In a few days during warm weather the full grown weevils come out. This weevil has been found in corn and wheat. Its injury to an ear of corn presents an appearance similar to that of Fig. 4, and doubtless is familiar to most farmers of the state.

FOUR SPOTTED BEAN WEEVIL.

BRUCHUS 4—MACULATA.

This weevil differs from the pea weevil in being some larger and having four conspicuous black spots on the wing covers. It occurred in abundance upon the cow peas; it seems to be the most injurious of all the other weevils to the cow pea.

A NEW BEAN WEEVIL.

BRUCHUS RUFIRMANUS, BOH.

This weevil differs decidedly from all the others mentioned in being

much larger. It has a dull, black color with a few slight grayish spots on the back. It was found on some beans we had put away last fall. "It has been bred from pea pods imported from Switzerland and also from peas distributed by the U. S. department of agriculture in 1894."—Tusch Life, Vol. 5, No. 3, p. 165.

THE RICE WEEVIL.

CALANDRA ORYZAE, LINN.

This weevil is also sometimes called "black weevil," but its more common name comes from the fact that it is very frequently found in rice. It resembles very much the granary weevil, the main difference being four reddish brown spots upon the wing covers and its somewhat smaller size. The life history of this weevil is about the same as that of the granary weevil. Frequently more than one weevil is found in a single kernel of corn. I have found it very abundantly in corn and wheat and am lead to believe it is the most injurious weevil in the State, owing to its abundance and the fact that it is said to feed upon several kinds of grain.

THE GRAIN BEETLE.

SILVANUS SURINAMENSIS, LINN.

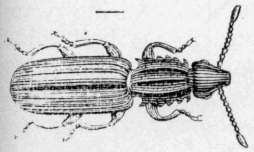


Fig. 2. Grain Beetle, Adult Enlarged.

Fig. 3. Larva of Grain Beetle Enlarged

This insect is not a true weevil since it does not possess the beak common to the weevil, though it is sometimes called the "saw-tooth" weevil from the fact that it possesses saw-teeth like projections on the sides of the thorax, which are shown in Fig. No. 2. Its general shape is more slender and oblong than that of either of the weevils mentioned previously. It has a reddish brown color. These facts easily distinguish it from the true weevils. The larva is yellowish white and possesses six legs. The mature insect and the larva feed upon corn and wheat, frequently occuring with the weevils upon the same ear of corn. The larva frequently pupates in the crevices of the bin where it may easily be overlooked and remain to infest other stored grain. In such cases it is a good idea to use carbon bisulphide in the bin before storing grain in it. The larva hatches in a short while after the egg is deposited and at once begins to feed upon the grain, but does not live all together upon a single grain. The adult and larva are so small that they are frequently overlooked. This insect has been found upon corn and wheat here in abundance.

ANGOUMOIS GRAIN MOTH.

GELECHIA CEREALLELA, OLIV.

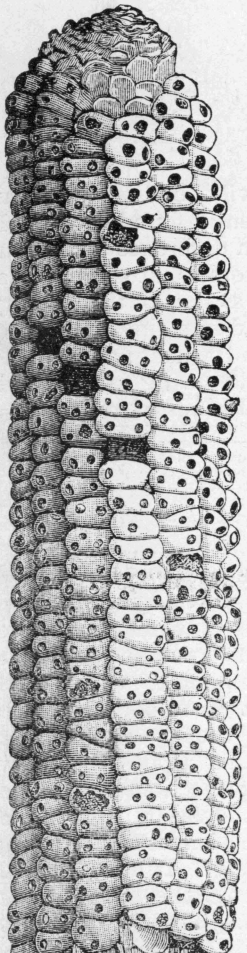


Fig. 4. Ear of Corn showing work of the Angumois Moth.

This insect is sometimes called "Fly Moth." It differs very much from all the insects previously mentioned. The adult Moth has a buff color with a "satiny luster." Its second pair of wings have a peculiar feathery edge. Its natural size is shown by the crossed lines under the adult moth in figure No. 5.

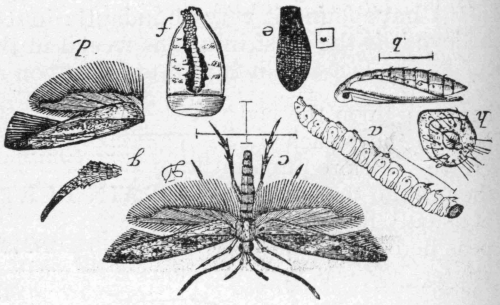


Fig. 5 Angumois Moth. a, the larva; b, the pupa; c, the moth; d, the wings; e, the egg; f, the kernel of corn showing the work of the larva; g, labial palpus of male, all enlarged except f.

The eggs are deposited on the grain, both in the field and in the granary. I have collected the moths here in stored grain in February. The eggs hatch in about seven days and the larvae burrow into the grain where they feed about twenty-one days when they pupate. Just before pupiating they eat a hole, generally through the top of the grain leaving a thin flap over it to close it. The adult insect can easily push this aside and escape.

This insect is one of our most serious pests, I have found it occuring only upon corn and wheat but it is said to occur upon oats, barley, sorghum seed and cow peas.

THE PEA WEEVIL.

BRUCHUS PISI, LINN.

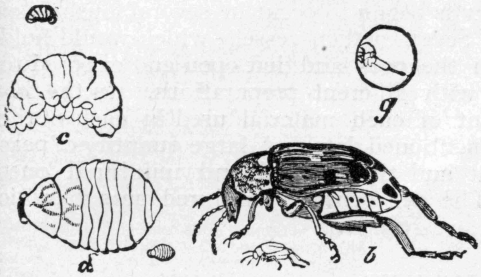
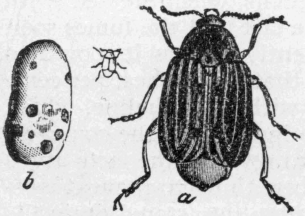


Fig 6. Pea Weevil; b., Adult; c.. Full Grown Larva; d., Pupa; g., Pea, showing exit hole. Natural size indicated by smaller figures.

The main difference between a pea weevil and a bean weevil is that the pea weevil is much larger and has a duller grayish color. It usually has several distinct markings on the back and very frequently has a white spot on the prothorax. Different stages of the insect are shown in Fig. No. 6. The natural size of the adult is shown in small figure just below the enlarged adult. Soon after the peas bloom the adult lays her eggs upon the pod. When they hatch the young larvae bore into the pod till they reach the young seed, into which they enter and live till full grown. Before pupating they cut a small hole near the outer coating of the peas so that the adult can readily eat its way out. Only one insect is usually found in a pea. A large number of beetles issued from the peas here in the fall, but also a large number remained in the peas over winter. It was very injurious upon our cow peas.

THE BEAN WEEVIL.

BRUCHUS OBTECTUS, SAY.



Fiß. 7. Bean Weevil; a., Adult; b, damaged bean, enlarged.

While this weevil differs from the pea weevil in being smaller, it differs also in being of a more yellowish gray color. The enlarged adult insect is shown in Fig. 7 and its natural size is given at the left of the enlarged adult. The damaged bean, represented at *b*, shows that several insects often occur in the same bean. Like the pea weevil it deposits its eggs on the pod while the beans are growing in the fields. The female also deposits her eggs upon the outside of beans when stored away and the larva soon hatch and bore their way into the bean and live to maturity. This weevil has been found in abundance here, occuring with the pea weevil upon cow peas and also upon beans. We are indebted to Dr. C. V. Riley for figures No. 4 and 5, and to Prof. M. H. Beckwith for the others.

EXPERIMENTS IN PREVENTING THE INJURY DONE BY WEEVILS.

First of September, 1893, weevils began to occur in several bushels of cow peas we had stored away. Seven earthen vessels, which would hold one peck each, were filled with the peas and left open and exposed to the weevils after being treated with different preparations. In the following table is given the amount of each material used in each of the treated quantities at the above mentioned date. A large quantity of peas from each vessel was taken out and the injured and uninjured ones counted January 11, 1894. The per cent of uninjured peas found is given at the right in the table:

TABLE NO. 1.

Material Used in Each Lot.	Quantity.	Per Cent. of Peas Not Injured by Weevils.
Carbon Bi-Sulphide	2 oz	9 Per Cent.
Wood ashes	2 Pounds.	75 Per Cent.
Napthaline	3 oz	91 Per Cent.
Persian Insect Powder	½ oz,	54 Per Cent.
Lime	¾ pound.	85 Per Cent.
Lime	2 pounds.	85 Per Cent.
Nothing		10 Per Cent.

The carbon bi-sulphide was placed in a small bottle and covered with a heavy cloth and placed about half way down in the vessel. The wood ashes, lime, Persian Insect Powder and Napthaline were each well mixed with the peas. They were examined in November and no odor of carbon bi-sulphide could be distinguished and the weevils were working. Naphthaline gave off a strong odor and no weevils were found working in it. This odor was very perceptible when examined on the 11th of January. The small per cent. of peas not injured by weevils when treated with carbon bi-sulphide must therefore be due to the fact that the fumes soon escaped, because no one who has tried it sufficiently doubts its power to kill the insects. It will be seen from the table that the highest per cent. of uninjured peas was found in the lot treated with Naphthaline, which must be due to its well known repulsiveness to insects and the comparatively long time the fumes remained. Reasoning from the facts given in the table Napthaline would seem to be the best thing to prevent weevils getting a hold, but after they have once gotten into stored grain the carbon bi-sulphide is undoubtedly the best thing to kill them. It is not necessary to place the carbon bi-sulphide down into the grain, but only to pour it over the top of the grain and the heavy fumes will go down on their deadly mission. It acts better if the bins are first well closed. As carbon bi-sulphide is highly inflammable it should be kept at a safe distance from all fire.

EFFECTS UPON GERMINATION.

It has been believed by many that carbon bi-sulphide destroys the germinating power of seed. We have carried on experiments, testing its effects upon germination of cow peas and wheat, and also the effects of napthaline and a mixture of sulphur and alcohol, the results of which are given in the following table:

TABLE NO. 2.

Seed Used.	Material Used.	Time Exposed.	Germinated.
Cow Peas.	Fumes of Carbon Bi-Sulphtide.....	Ten days.	100 per cent.
Cow Peas.	Immersed in Liquid of Carbon Bi-Sulphide...	Half hour.	100 per cent.
Wheat.	Fumes of Carbon Bi-Sulphide.....	Three days.	40 per cent.
Wheat.	Fumes of Carbon Bi-Sulphide.....	One day.	62 per cent.
Wheat.	Immersed in Liquid of Carbon Bi-Sulphide...	One day.	32 per cent.
Wheat.	Napthaline.....	Three days.	100 per cent.
Wheat.	Sulphur and Alcohol Mixed.....	One day.	70 per cent.

It will be seen from the above table that there is some danger of injuring the germinating power of wheat when it is exposed to the strong fumes of carbon bi-sulphide more than one day. In carrying on the experiment the fumes were corked up in a bottle for the time mentioned, and as the fumes would not be so closely confined in the bin *no harm is apt to result in an ordinary treatment.* Cow peas withstood the fumes much better than wheat, which may be due to the thicker seed coat of the former. The fumes of carbon bi-sulphide readily pass off when the seed are exposed to the atmosphere and do not at all injure them for food. Dead weevils and other insects which remain after treatment should be taken out before grinding the wheat for man or giving the corn to stock, as it is very probable they are injurious to the health of both. (See report of U. S, Department of Agriculture, 1884, p. 547). After feeding "weevily corn" to a horse for some time he became very poor and did not eat much. His appetite was not good for other feed, such as oats and bran, for some time afterwards.

SUMMARY.

1. Corn should be stored early before weevils get a strong hold on it.
2. Stored grain should be examined frequently for weevils. Their presence can be told frequently by the temperature of the grain rising as though fermentation had begun.
3. Napthaline should be sprinkled in the bins and over the grain to prevent weevils' getting a hold.
4. Weevils are more active during warm weather.
5. Carbon bi-sulphide will kill all insects injurious to stored grain.
6. If carbon bi-sulphide be used to keep weevils out it is often necessary to use more than one application.

7. Carbon bi-sulphide is not apt to injure the germinating power of seed unless used severely.
8. Carbon bi-sulphide is highly inflammable and should be kept at a safe distance from all fire.
9. All insects should be taken out of grain before it is ground for bread or fed to stock.