THE BIOLOGY OF *PTINUS VILLIGER* (REIT.)

A Thesis

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ABSTRACT

Laboratory experiments were carried out to study the development of the hairy spider beetle, Ptinus villiger (Reit.) on four foods at three temperatures and three relative humidities. Eggs were reared individually on whole wheat, bran, ground wheat, and vitamin enriched flour since these materials are typical of stored commodities infested by the hairy spider beetle.

Insects were reared at 48°, 68°, and 80°F., and at 40, 60, and 80 per cent relative humidities. In most cases 36 replicates were used for each food, temperature and relative humidity. Insects were examined as often as possible to record significant observations and life cycle changes. In this way an accurate life history was kept of each individual insect as it progressed through the larval and pupal stage and emerged as an adult. Newly emerged adults were weighed and sexed; some were replaced for further observation. The majority were paired and exposed to low temperatures in an attempt to induce egg laying.

Generally, temperature had the greatest effect on development. Relative humidities of 60 and 80 per cent had no significant effect on development. Ground wheat and bran were significantly better for development than whole wheat kernels and vitamin enriched flour. Some larvae went into diapause at each temperature and humidity. More larvae went into diapause on flour at 60 and 80 per cent relative humidity when the

temperature was $68^{\circ}F$. Adults subjected to $35^{\circ}F$. showed no ill effect. They laid no eggs at $35^{\circ}F$., $48^{\circ}F$., $68^{\circ}F$., and $80^{\circ}F$.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

The present work comprises an attempt to evaluate the effect of food, temperature, and relative humidity on the life cycle of the hairy spider beetle, Ptinus villiger (Reit.). This information can be used to predict the areas where the species could exist and to compare them with the existing world distribution. Also, and of economic importance, the results of this study may be used to decide whether P. villiger is likely to become a major pest in any particular place. During the past twenty years serious damage has been reported by flour dealers, storekeepers, and milling companies, particularly in the Prairie Provinces. One of the main objects of investigating the biology of insect pests of economic importance is to determine how rapidly the insect population will grow. The figures obtained normally include the duration of development of the species reared on particular foods at several temperatures, and relative humidities, at each stage of life. In addition, the effect of these conditions on egg-hatching, mortality, and incidence of diapause will be evaluated. Lastly, adults obtained will be subjected to various temperatures in an attempt to find out preferred temperatures for ovipositing.

The principal form of spider beetle damage is the lowering of quality due to the presence of live or dead insects, excreta, and cocoons. The nutritional value of food may readily be affected by the presence of large numbers of the insect. Besides the actual damage caused by the insects in the infestation of stored food products there is the psychological effect of the customer's aversion to contamination of any kind in such products. The layman has been educated to regard all foreign matter in food as dirty and unwholesome Financial losses may result from loss of patronage and from the necessity for salvaging infested cereals or selling them at reduced prices.

Zacher, in 1939 claimed Ptinus villiger (Reit.) to be an eastern Siberian species. It spread to Canada possibly via the United States in 1915 and to Silesia and Germany in 1931. Earlier, Hellēn in 1925 had recorded it from Finland. In recent years it has been found occasionally at British ports on Canadian produce, especially flour, but also many other foodstuffs.

Gray (1933) pointed out that the hairy spider beetle occurs in practically the entire list of foodstuffs handled by milling companies. This includes flour (patent, whole-wheat, graham and rye), cornmeal, rolled oats, oatmeal, farina, as well as feeds such as bran, shorts, and various meal preparations. It is also able to feed in wheat.

In 1932 an elevator company encountered these insects in its sample boxes at Morden, Manitoba. The same condition was found in ten other elevators, two of which showed some signs of infestation in the bins. The use of country elevators for storage purposes over long periods of time, coupled with the ability of this insect to live in grain, constitutes a potential threat to grain in country storage.

Smallman and Gray (1948) have pointed out that in Manitoba the adult beetle commences egg-laying in mid-April. It continues for three months, reaching its peak of oviposition in mid-July. Many larvae complete their feeding during the summer. Some form a pupal cocoon, pupating and becoming adults before the winter. Others pass the winter as free larvae. Generally those adults emerging in the autumn do not lay eggs until the following spring. Thus it appears that either the adult beetles require an exposure to low temperatures before they can lay eggs or the pre-oviposition period of sexual maturation is comparatively long.

Observations in the laboratory indicate that the pre-oviposition period of sexual maturation is relatively long. Gray (1933) considers P. villiger to have only one generation per year in Canada. Indeed some individuals may require two years for development before ovipositing, spending one winter as a larva and the next one as an immature adult.

Gray and Watters (1954) stated that spider beetles are the most important insect pests of flour storage warehouses in Canada. Of these, several species occur in cereal warehouses, the hairy spider beetle, P. villiger (Reit.), being the most predominant. It was found that products that sell slowly and tend to remain in warehouses from one year to the next could become heavily infested and serve as a source of infestation.

MATERIALS AND METHODS

Eggs were obtained from two sources:

1. Laboratory cultures set up with adults captured from warehouses in May, 1956.
2. Test sacklets containing flour set up as oviposition sites in infested warehouses. These two-pound sacklets were collected after an exposure of approximately three weeks and their contents sifted for eggs.

Generally South-Western Manitoba was the main site of these warehouses.

Eggs were incubated in cubicles ½ inch in diameter and ¼ inch deep. These cubicles were made by pressing six circular depressions in 1/64 inch acetate sheeting cut in specially designated sizes of three inches by one and five-eighths inches. In this way they could be stored upright in microscopic slide boxes. These boxes were cut in half, each half able to hold six acetate strips, or the sum total of thirty-six cubicles. Each cubicle was used as an individual rearing cell, one egg being placed on food in each cubicle.

Two slide boxes, each containing thirty-six cubicles, were stored in a small desiccator. Four slide boxes were stored in a large one. The reason for such a set up was both practical and time-saving. In this manner six replicates could be quickly and accurately examined under a binocular microscope. Figure 1 shows a diagrammatic plan of a group of six cubicles on acetate sheeting. Figure 2 shows how six of these groups fit into a slide box referred to as a lot. Figure 3 illustrates four lots in a large desiccator. Figure 4 shows two slide boxes in a small desiccator.

Eggs obtained for cultures were put into 48°F. incubation rooms if they could not be used the same day. This slowed down their hatching process. When ready they were placed on the food in the cubicles with a soft camel's hair brush. Only eggs that looked viable were used. Generally viable eggs showed a characteristic pearly opalescence. Non-viable eggs usually were of a dull brown color or wrinkled. Newly hatched larvae were able to feed on the food immediately.

Insects were reared at 80°F. in a constant temperature cabinet. This cabinet was fitted with an electric fan to maintain air circulation. Two germination rooms kept at 68°F. and 48°F. were used to rear insects at those temperatures.

The humidity was controlled at 40, 60, and 80 per cent. This was accomplished with desiccators containing sulphuric acid and water solutions mixed in appropriate proportions as outlined by Solomon (1951). For a relative humidity of 40 per cent, 30.1 ml. of sulphuric acid were added slowly to 50 ml. of water. Nineteen ml. of sulphuric acid slowly added to 50 ml. of water gave a relative humidity of 60 per cent. Eleven and one-third ml. of sulphuric acid slowly added to 50 ml. of water gave a relative humidity of 80 per cent. The amount of solution required for small desiccators was 200 ml. The amount of solu-

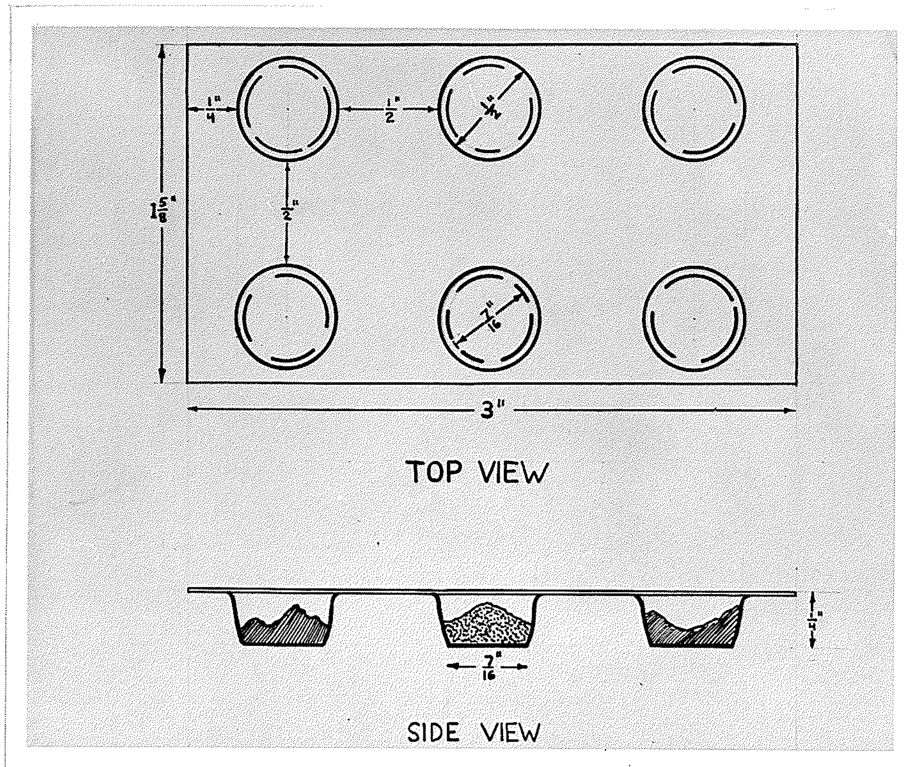

Figure 1. Diagrammatic plan of a group of six cubicles on acetate sheeting.