THE LIFE HISTORY AND BEHAVIOR OF THE FLEA BEETLE *Phyllotreta pusilla* Horn IN MANITOBA

A Thesis

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Master of Science

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by

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

Flea beetles are represented in Manitoba by several species.* Of those which attack cruciferae, Phyllotreta pusilla Horn** is the most abundant, widespread and destructive. The life history and behavior of the various species are known in general from studies in other localities, but no records of similar studies in Manitoba have been found. The economic importance of P. pusilla in Manitoba makes a biological study particularly important.

I. THE PROBLEM

Statement of the problem. It was the purpose of this study (1) to present an illustrated description of the different life stages; (2) to determine the life cycle of the insect in Manitoba; and (3) to study the behavior and habits of the insect.

Importance of the study. The flea beetle, P. pusilla is one of the most destructive insects attacking

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* Phyllotreta pusilla Horn
P. vittata (Fab.)
P. robusta Lec.
Psylliodes punctulata Melsh
Epitrix cucumeris Har.

** Phyllotreta pusilla Horn; Chrysomelidae, Coleoptera.

cultivated cruciferous crops in Manitoba. It is a major pest of radish, turnip, and cabbage. In years when the beetles are present in very large numbers, all cruciferous vegetables are damaged and, in addition, non-cruciferous vegetables such as beets may be attacked. Field crops, such as Argentine rape and sugar beets, are often severely damaged when the flea beetle is particularly abundant.

The greatest damage occurs in the spring due to the feeding of the adult on the cotyledons of seedling plants. In addition to this early spring damage, injury to foliage throughout the season causes a reduction in yield and quality of the crops.

The insect is a persistent pest and requires control every year, at a considerable cost to the producer, if high quality crop yields are to be obtained. Large losses have been sustained in the past. For example, in 1948, a commercial planting of twenty acres of cabbage, in the Winnipeg area, was reported totally destroyed by flea beetles. This serves to indicate the importance of basic studies on this pest.

II. DEFINITIONS OF TERMS USED

Flea beetle(s) or beetle(s). Unless otherwise specified, the terms flea beetle(s) or beetle(s), as used in

the text of this thesis, refer to the species Phyllotreta pusilla Horn.

III. ORGANIZATION OF REMAINDER OF THE THESIS

The remainder of the thesis is divided into five chapters. In Chapter II a review of the literature pertaining to the subject is presented. Chapter III deals with the materials and methods used in conducting the study. The description of the life stages of the insect, including a detailed technical description of the mature larvae, is presented in Chapter IV. In Chapter V the life history and habits of the insect are considered. Chapter VI is a summary of the thesis and is followed by a bibliography.

CHAPTER II

REVIEW OF THE LITERATURE

Literature on the genus Phyllotreta. Chittenden (1927)[2] presents a review of the literature on the genus Phyllotreta and in an account of the history of the genus, states that, "The genus Phyllotreta was defined by Foudras in 1859, but was evidently used, presumably as a manuscript name, by Chevrolat much earlier."*

The work of Chevrolat was apparently published by Dejean in his catalogue of Coleoptera and it was Chittenden's[2] view that, "Following the law of priority of publication, Dejean should be credited with the generic name."

In 1889, Dr. Horn[5] in his revision of the genus published the original description of the species P. pusilla Horn.

The taxonomic position of the species within the genus Phyllotreta is uncertain and systematists have been loath to make specific determinations. Chittenden,[2] in discussing the species of Phyllotreta states that:

> . . . The unicolorous species . . . are difficult of definition and of separation by means of tables. Where

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* Chevrolat, In Catalogue Coleopter Dejean, 1833 (1836), p. 391.

> the antennal joints are so nearly uniform in length some individual difference must be expected, and in small series some difficulty may be experienced in the detection of such characters as the minute apical tubercles in the last ventral segment. While many of these species are quite distinct, at least an equal number are very closely related to some similar one. . . .
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> In writing of the Halticini in 1889*, Dr. Horn remarked, "The entire tribe is one which presents many difficulties in its study. The characters of taxonomic importance are few, and these are so often interlinked as to make it almost impossible to decide to which priority of importance should be given." Dr. Horn might have gone much further in the discussion of some of the genera and especially of Phyllotreta. Great difficulty is experienced in separating the females of some species from related ones, and even in separating the males from the females of a given species, and there is an almost utter lack of uniformity in the case of the structure of the fifth ventral segment in the males of such common species as pusilla, while the equally common vittata presents characters which are almost baffling without minute study of a large series. . . .

Recently, Mr. W. J. Brown, Systematic Division, Department of Agriculture, Ottawa, has reviewed material from the Prairie Provinces and is of the opinion that the specimens correspond to the published description of Phyllotreta pusilla Horn. Dr. A. P. Arnason, Division of Entomology, Saskatoon, who is familiar with this insect in Saskatchewan also believes the species to be P. pusilla. The author has examined specimens from British Columbia,

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* Trans. Amer. Ent. Soc., Vol. XVI, 1889, p. 165.

Alberta, Saskatchewan, and Manitoba and in all cases the insects correspond very closely.

Literature on the biology of the species Phyllotreta pusilla Horn. A search of the literature* revealed only one paper, by Chittenden and Marsh (1920),[1] dealing with the biology of this species. In this paper, based on studies conducted in Colorado, various aspects of the biology of P. pusilla are discussed. The work deals with the nature of injury, description of the life stages, distribution of the species in the United States, reports of injury, food plants, seasonal history, life history and habits, natural enemies and control.

No attempt will be made to review the paper at this point. Instead, the results and observations of Chittenden and Marsh[1] will be discussed or compared separately under the appropriate sections of the present study.

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* Banks, N. Index of Amer. Econ. Ent. 1905-1914.

Colcord, M. Index II-VI of Amer. Econ. Ent. 1915-1939.

Hawes, I. L. Index VII of Amer. Econ. Ent. 1940-1944.

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Limitations of previous studies. The previous work on the biology of P. pusilla is limited to a single paper by Chittenden and Marsh (1920).[1] The scope of the study leaves many aspects of the biology of the insect untouched and in some cases, the phases considered are not complete.

There are important similarities and differences in the biology of this species, as reported for Colorado and that found in Manitoba. The variations may be attributable to a difference of response of the species to the different climatic conditions. However, there may also be two races represented. These variations are of sufficient importance from the standpoint of economic control to warrant investigations under Manitoba conditions.

CHAPTER III

THE MATERIALS AND METHODS

Two methods were employed in the study of the life history of the insect. In method I, rearing from egg to adult was carried out in successive steps entirely under laboratory conditions, whereas, in method II, the rearing was done in outdoor cages.

I. METHOD I

Oviposition cages. Two-quart glass sealers were employed as oviposition cages. The open end of each sealer was covered with fine mesh cheese cloth, held in place by an elastic band. Radish and turnip seedlings were transplanted into salve tins containing soil and these were placed in the sealers to provide a suitable place for oviposition as well as an adequate food supply. In addition, 1-inch lengths of glass tubing, stoppered at one end with a cork and at the other with absorbent cotton, were filled with water and placed in the sealers to provide a source of water for the beetles.

The flea beetles used were collected from a field plot of radishes, etherized just sufficiently to permit identification and ease of handling, and twenty introduced into each sealer.

This type of cage proved satisfactory for the purpose of obtaining sufficient eggs for the study.

Incubation. Considerable difficulty was encountered in obtaining a satisfactory method for the incubation of the eggs. During the first trials, eggs were placed in petri dishes, on blotting paper moistened with iodine water.* The petri dishes were placed in a rearing cabinet held at constant humidity of 65 per cent and at a temperature of 86°F. Under these conditions the eggs dessicated and mold formed. However, satisfactory results were obtained with each of the following three methods.

1. Eggs recovered by floatation (see page 14) from soil which had been exposed to flea beetles eleven days previously in outdoor rearing cages, were placed on moist blotting paper in a petri dish. These were kept at room temperature until they hatched.

2. The salve tins used for oviposition were removed from the sealers and the soil kept moist but otherwise left undisturbed for nine days. At the end of this period, eggs were recovered by floatation and placed on moist blotting paper in petri dishes. As in the first method, these also were kept at room temperature until the eggs hatched.

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* Two drops of 5 per cent iodine solution per quart of water.

3. The method of Searls (1928)[6] was also employed. This involved the use of cells made from celluloid tubing 1-inch in diameter cut in 1-inch lengths. These were stoppered at one end with a 1/8-inch thickness of plaster of paris. Freshly oviposited eggs obtained from the surface of the soil in the salve tins were placed in these cells and the cells in turn placed, open end upward, in moist sand to maintain a fairly constant moisture content. Incubation was carried out at room temperature. (Fig. 1, page 13.)

Methods 1 and 2 were essentially the same, except for the source of the eggs, and involved leaving the eggs in the moist soil during the greater part of the incubation period. This overcame the previous difficulties. The problem of dessication was overcome in method 3 but mold formation was not entirely avoided.

All three methods of incubation proved workable. Method 1 simulated natural conditions more closely than methods 2 and 3, but method 3 was simpler and rendered possible daily observation of the eggs.

Larval, prepupal, and pupal rearing. The method for larval rearing, in the laboratory, was also taken from Searls.[6] Plaster of paris was poured into petri dishes to form a thin layer over the bottom of the dish. Seedling cabbage, radish, or turnip plants were placed in the dishes, allowing the leaves to protrude over the side of the dish.

This was covered with blotting paper cut to fit inside the dish and the whole thoroughly moistened. To avoid excessive evaporation, pieces of glass were placed over the dishes. The food supply was changed daily or as required. The larvae were placed on the roots of the seedling plants and held at room temperature. (Fig. 2, page 13.)

The chief difficulty encountered, in rearing the larvae on the roots of seedling plants in petri dishes, was that newly-hatched or first instar larvae failed to establish themselves under these conditions. No difficulty was experienced in rearing larvae which had attained the second instar before being placed in the rearing dishes. These larvae were obtained from the outdoor rearing cages.

As the larvae approached the prepupal stage, they entered small holes formed by air bubbles in the plaster of paris, where they remained throughout the prepupal and pupal periods. Upon completion of the pupal period, the adults emerged from these holes or depressions.

II. METHOD II

This method was conducted under outdoor conditions. Flea beetles were confined in cages forced into soil to a depth of 4 inches over cruciferous plants, grown in flats. The cages were of original design constructed of tin, celloglass screen and wood. The base of the cage, 4 inches

square and 4 1/2 inches in depth, was made of tin. A 7 inch length of celloglass screen was attached to this base. A 4"x4"x1" piece of wood, containing a central hole 1-inch in diameter fitted with a cork stopper, formed the top of the cage. Holes were punched in appropriate areas of the celloglass screen to permit air circulation. (Fig. 3, page 13.)

The initiation of this method of rearing was delayed until June 12, due to the inadequate growth of the host plants, namely, cabbage, radish, and turnip. When the plants had attained an appropriate size, the cages were forced into the soil over the growing plants in a way such that the three varieties of plants were represented in each cage. Twenty beetles were introduced into each cage and allowed to remain for a period of 24 hours. The development of the insect was then followed by examining the soil from successive cages at intervals. The larvae recovered during these examinations were preserved in KAAD* for subsequent studies.

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* KAAD - Kerosene 1 part
Alcohol (ethyl) 9 parts
Acetic acid (glacial) 1 part
Dioxane 1 part