Studies on the Biological Control of *Rumex obtusifolius* L., a Grassland Weed, by *Gastrophyssa atrocyanea* MOTS. (Coleoptera: Chrysomelidae)

II. Dispersal of Overwintered Adult Insects

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The native chrysomelid beetle, *Gastrophyssa atrocyanea*, is a possible agent for use in the biological control of dock, *Rumex obtusifolius*, which is a noxious grassland weed in Japan. Two dispersal tests were performed by releasing marked overwintered adults in grassland fields to assess their potential for biological control. The beetles dispersed over an area with a radius of almost 50 m around the release point. The farthest distance at which a beetle was recovered was 106 m from the release point. Based on this finding, two release points per hectare of overwintered adults would be sufficient for the establishment of a colony in virgin grassland or for increasing their numbers where there is a low population. Female adults dispersed to greater distances than the males. Beetles dispersed both by walking (crawling) and flying. Their flight was observed most often around noontime on warm, windless days.

INTRODUCTION

As already reported briefly, *G. atrocyanea* feeds selectively on dock, *R. obtusifolius*, a harmful grassland weed, and can control it effectively (Miyazaki and Naito, 1974; Naito and Miyazaki, 1974; Naito et al, 1979). The authors have been studying ways of using this insect for biological control purposes. One of the most important problems is how and at how many points the insect should be released in dock-infested grasslands. This problem cannot be solved without first clarifying the dispersal abilities of the insect. Data on the dispersal abilities of the insect would facilitate the placement and setting up of breeding bases or release points of the insect in grassland areas. In nature, dispersal of *G. atrocyanea* adults occurs twice a year, i.e., by overwintered adults which appear in March and April, and by newly emerged adults in June, before they enter dormancy. The following report is the result of our experiment on the collection and dispersal of overwintered adults.

MATERIALS AND METHODS

*Experimental insects*

Newly emerged adults were collected from the field in June of the previous year.
and put into porcelain pots at about 1,000 individuals per pot. Each pot was filled with soil to a depth of 15–20 cm and kept throughout the summer and winter in a room at outdoor temperature. In the spring, the overwintered adults emerged from the soil in the pots and were used for the dispersal tests. The overwintered adults usually began to appear about the end of February in the Kanto district, continuing to emerge slowly for 20 or more days under the conditions mentioned above. The emerged adults were held at 0°C to keep them inactive until April when they were to be released. In our tests, this period of refrigeration did not adversely affect the insects. When the temperature was raised to normal a few days before the release, all adults emerged at once from under the soil. These adults were marked on a part of the pronotum with white lacquer paint with a sharp pointed writing brush. The marked adults were again placed at a low temperature (about 10°C) until their release in order to prevent them from moving about unnecessarily.

**Release method and survey of dispersal**

Dispersal tests were carried out in 1973 and 1974 on two different grassland fields near our station, each more than 1.5ha (Fig. 1) and owned by the Jiyu Gakuen High School Farm. Both fields were heavily infested with dock.

Test I: Two release points, A and B, were set up near the center of a 2 ha field (280 m long, 75 m wide). The distance between the points was 33 m, as shown in Fig. 2. The short distance separating the points was chosen on the assumption that the insects would not disperse this far. The release of marked adults was made at 9:30 am on April 11, 1973. The number of insects released was 750 and 761 (total, 1,511) at points A and B, respectively. On April 17 and 18, six and seven days after the release, three workers marked on a map the locations of all marked adults collected.

Test II: For the second test, a field of about 1.5 ha (220 m long, 79 m wide) was selected, south of the field used for the first test. At a point near the center of the field 4,166 marked adults were released at 10 am on April 13, 1974. Four workers mapped the insect dispersal on the 5th and 6th, and 11th and 12th days after release in the same way as in the first test.

**RESULTS**

The findings obtained from the first test are shown in Fig. 2. Dispersion of adults 6 days and 7 days after the release was much wider than expected. Almost all were found in an area extending over 75 m east and west from the release points, and over about 100 m to the north and south. As a result, dispersion from points A and B overlapped
to such a large extent as to make it impossible to measure accurately the distance of dispersal from the release points. However, the shortest distance from either release point A or B to the point of recovery was 68.0 m maximum and 19.1 m average. No definite direction of dispersion was discernible.

The findings from the second test are shown in Figs. 3 and 4. In the second test, there was only a single release point and recoveries were made twice on two successive days, beginning on the 5th and 11th days. The resulting dispersal of the adults was much clearer than in the first test. The recovered adults were abundant within 10 to 20 m from the release point 5 and 6 days after release, and abundant around 30 m from the release point 11 and 12 days following release. In the first survey the average distance of dispersion was 16.1 m while in the second it was 27.9 m. The greatest distance at which an insect was recovered was 71 m from the release point in the first survey, and 106 m in the second survey.

According to the survey made 11 and 12 days after the release, more female adult were recovered 20 to 40 m from the release point (33.2 m average), while the males were more abundant around 10 to 30 m from the release point (22.6 m average). More marked insects were found in the east-west direction from the release point. This trend was seen more clearly on the 11th and 12th days after release than on the 5th and 6th days. Similarly, the dock weeds were found more in the eastern part of the field.
Fig. 3. Sites where marked beetles were discovered in the second test. Left: 6 and 7 days after release. Right: 11 and 12 days after release.

Fig. 4. Frequency distribution of the distances moved by overwintered adults of *G. atrocyanea* from the release point.
DISCUSSION

Gastrophysa viridula, a European relative of G. atrocyanea, also selectively feeds on dock weeds. According to Dr. G. F. Collet, who has been connected with biological control of the dock weeds at the Federal Agricultural Research Station in Lausanne, G. viridula is considered a possible agent for the biological control of dock in Europe. However, this insect is thought to have too low a dispersal ability to be an effective biological control agent (personal communication). Prior to our test, G. atrocyanea was also thought to have a poor rate of dispersal, but we have shown that its dispersal ability is sufficient to permit its spread throughout dock-infested grasslands. In our second test, the beetles were considered to have spread to their full extent 11-12 days after release. At this time many insects had dispersed an average of 30 m from the release point, completely covering an area with a radius of 50 m or more. Consequently, one or two release places per ha would be sufficient to distribute overwintered adults in a grassland area to facilitate their action against dock.

Gastrophysa atrocyanea disperses both by walking and flying. According to our observations, they can walk rather fast, averaging about 50 m per minute on the floor of a room at 20°C. If the beetles moved in a straight path, they would actually cover a greater distance. In the field, however, dispersal by crawling is limited by the complicated pattern of grass leaves that the beetles must traverse. On the other hand, the beetles can disperse readily by flying and, on a only clear windless day, we have seen adults flying for short distances of about 10 m around noon time. Once the ovaries have matured, the abdomen of the female swells and the flight activity of such female is totally inhibited. We shall refer further to flight in a separate report.

In our second test, beetle dispersal seemed to be greatest toward the eastern part of the release field. This movement corresponded with the greater abundance of dock weed in that area. Perhaps G. atrocyanea can recognize the existence of its host plant by some mechanism and orient toward it. Matsuda and Matsumoto (1975) reported that the organic acids contained in the plant could be a feeding stimulant. However, as these acids are non-volatile, there may be some other attractant in the plant as well.

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REFERENCES


