

# Longitarsus jacobaeae Aids Moth in the Biological Control of Tansy Ragwort

by  
R. B. Hawkes and G. R. Johnson<sup>1</sup>

## ABSTRACT

The cinnabar moth, *Tyria jacobaeae* (L.), was introduced into the United States in 1959 for the biological control of tansy ragwort, *Senecio jacobaea* L. This insect has now reached equilibrium with its host plant in the region around Fort Bragg, California, and while partial control has been achieved, the plant still persists as rosettes; in some cases in more dense stands than previous to cinnabar moth release.

*Longitarsus jacobaeae* (Waterhouse), a flea beetle, whose larvae attack the roots of tansy ragwort during the winter and early spring, has become well established from field releases made in 1969. Since the attack of the beetle complements that of the cinnabar moth, which is active in the spring and summer, much more stress is brought against the plant, and it is now almost completely controlled at sites in the Fort Bragg region. The major plant mortality occurs during the dry summer months. At one site, *L. jacobaeae* has reduced plant density from 71 rosettes/m<sup>2</sup> to 0.6 rosettes/m<sup>2</sup> in a period of 4 years. The flea beetle should be effective in the U. S. Pacific coastal areas where summer rainfall is low —

Tansy ragwort, *Senecio jacobaea* L., is an introduced weed infesting much of the pasture and rangeland of the Pacific coastal areas of northern California, Oregon and Washington in the U. S. The plant grows as a biennial or short-lived perennial (Munz 1959) and is toxic to cattle. Sheep can graze it to some extent without apparent ill effects. Although the plant is presently limited in its distribution to the more coastal areas, it appears to have the potential to survive in some of the inland regions, particularly maintain meadow type pasture land or stream courses.

In 1959, the cinnabar moth, *Tyria jacobaeae* (L.), was introduced from France in an attempt to control the plant. The initial releases were made near Fort Bragg, California, and subsequent re-

leases were made in Oregon and Washington (Frick and Holloway 1964). The comments made in this paper will be restricted to the Fort Bragg region since that is where most of our studies have been conducted. Populations of the cinnabar moth began to build up to large numbers in 1963, the larvae causing severe defoliation of the plant at some sites. Since that time the insect has spread naturally and/or has been released at new sites so that it now infests most of the tansy ragwort in the Fort Bragg area.

At the time of initial population increase, the cinnabar moth appeared to have the potential to be a good control agent (Hawkes 1968). Populations were very large and defoliation of the plants was severe to the point of being almost complete at some sites. Some regrowth from defoliated plants did occur, but it was assumed that continued defoliation pressure would eliminate the plant within a few years. In some instances it was controlled, but generally that was not the case. Once tansy ragwort is well established, it is extremely difficult to eliminate from pasture land and even total defoliation sometimes does not kill the plant (Poole and Cairns 1940). Regrowth and root sprouting occurs with the advent of autumn rains and ragwort is able to recuperate during the autumn and mild winter period prevalent along the northern California coast.

The cinnabar moth has been effective in reducing the size of the plant from stands that originally averaged ca. 75 cm in height and produced heavy flower and seed crops, to plants that are almost perpetual rosettes ca. 5-6 cm in height, and are producing relatively little seed. At the time of introduction of the cinnabar moth at the original release site, ragwort was producing an average of 18 flowering stems/m<sup>2</sup>, but by 1970 the insect had reduced the plant to 2.5 flowering stems/m<sup>2</sup> (Hawkes 1973). Some late season flowering and seed production do not occur after the cinnabar larvae have pupated, but this is small compared to the normal season seed crops. However, the resulting reduction in the seed crop has

<sup>1</sup> Biological Control of Weeds Laboratory, Agric. Res. Serv., USDA.

often been offset by a marked increase in numbers of rosettes. For example, at one site the cinnabar moth was introduced in 1966 and at that time the rosette density averaged 32.3/m<sup>2</sup>. By 1971, after five years of defoliation by cinnabar larvae, the density averaged 64.3 rosettes/m<sup>2</sup>. During the same period the number of flowering stems was reduced from 21.3/m<sup>2</sup> to 3.2/m<sup>2</sup> at the same site. At some sites the rosette density has either been reduced or remained essentially the same, depending on competing vegetation and cultural practices. On sites with poor competing vegetation, the root sprouting and regrowth has increased the plant to almost a complete carpet of ragwort rosettes. Overall the cinnabar moth has given partial control of ragwort in the Fort Bragg area, but if the insect were suddenly removed, on some sites ragwort would be a more serious problem than it was originally due to the increase in rosette numbers.

Since one species of insect generally cannot be an effective control agent over the entire range of a pest plant, studies were initiated in a flea beetle, *Longitarsus jacobaeae* (Waterhouse), during the mid 1960's in an effort to improve the control program. Host specificity tests and biology studies were conducted at USDA, Agricultural Research Service laboratories in Rome, Italy and at Albany, California (Frick 1970a), and the insect was judged to be safe for introduction. Initial field releases of the beetle, from stock originally collected in Italy, were then made near Fort Bragg in the autumn of 1968 with subsequent releases in the autumn of 1969 (Frick 1970b; Frick and Johnson 1973).

### LIFE HISTORY AND BIOLOGY OF *LONGITARSUS JACOBAEAE*

*Longitarsus jacobaeae* is univoltine, but has two different biotypes; one from Italy and one from Switzerland, and Frick (1971) and Frick and Johnson (1973) give a detailed account of both. In general the life cycle of the Italian biotype begins with the adult beetles emerging in late May through June. The beetles feed actively for about two weeks and then go into aestivation throughout the summer. They become active again in September and feed heavily on rosette plant growth. Oviposition begins during early October, the eggs being laid singly around the plant crown and in the adjacent soil. Individual females were found to lay over 1100 eggs in the laboratory (Frick and Johnson 1973). At Fort Bragg, ovi-

position continues for at least 2 months and possibly longer. Adults have been found in the field as late as mid-March, but it is not known if these beetles were still laying eggs. The eggs hatch in 2-3 weeks, and the larvae enter the root crown and petioles of the rosette leaves where they develop during the late autumn, winter, and spring.

At maturity the larvae leave the plant and pupate in the adjacent soil. Pupation generally occurs during early May and new adults emerge ca. 3 weeks later; however, in mid-May, 1976 all stages of the insect (except eggs) were present at a site 8 miles north of Fort Bragg. Newly emerged beetles were common, and all 3 larval stages were still present inside the plant tissues. Beetle numbers have been high at this site, and the oviposition period has become quite extended. Thus, some oviposition apparently takes place during the early spring (1st instar larvae were still present in mid-May). A biotype of *L. jacobaeae* from western Switzerland differs from the Italian biotype in that eggs are laid in the spring, two to four weeks after adult emergence. These eggs diapause through the summer and do not begin development until late autumn (Frick 1970b).

Adult feeding by newly emerging beetles in the spring is relatively light and of little significance. However, adult feeding in the autumn by beetles coming out of aestivation is quite heavy and is of a characteristic shot-hole type. In some cases where ragwort growth has been limited because of a lack of autumn rain and populations of the beetle are high, this adult feeding has completely stripped the plants of green foliage. The larvae generally feed just under the epidermis of the root crown, but will feed throughout the crown. They also feed on the lateral roots, both internally and externally, thus causing death of the smaller roots and root hairs. Larvae of all stages have been found feeding in the leaf petioles and even out into the leaf proper, usually within the larger leaf veins. Heavy larval feeding in the petiole causes the leaves to turn brown and die.

### FIELD COLONIZATION AND POPULATION INCREASE

Field colonization was achieved at Fort Bragg from the 1969 autumn release of the Italian biotype beetles. In the spring of 1970 newly emerged beetles were common in the immediate vicinity of the release site. In 1971 beetles were abundant at the release site and could be found for ca. 30 m

away from the site. By 1972, they had moved up to 200 m from the site and were extremely abundant. At that time ca. 3000 beetles were collected and moved to new sites. By the autumn of 1973 the beetle populations were so large that they had almost completely eliminated ragwort over ca. 5 ha and could be found as far as 2 km from the original site. Thus in four generations the beetles had reached controlling populations from an original release of 257 males and 254 females.

Because of the life habit of *L. jacobaeae*, it is a bit difficult to get an accurate estimate of population density. Twenty-five rosette plants averaging 10-12 cm in diameter were sampled and dissected at the height of the population increase at the original release site in late March, 1972. All plants were infested, and the average was 32.1 larvae/plant. The high was 95 larvae in 1 plant, and the low was 4, and 50 or more larvae were found in several rosettes. In a similar sample taken at another site (Site 3; see subsequently) in May 1976, all plants were infested, the average was 31.7 larvae/rosette, the high was 78 larvae, and the minimum number was 4. At this site, the plant population is declining, and we expect control within a year. Apparently in the region of Fort Bragg, good control can be expected when beetle densities reach an average of ca. 30 larvae per rosette.

Site 1.—Site 1 was the site of original release. It is ca. 5 ha of river bottom pastureland with a heavy grass vegetation that originally had a dense stand of ragwort. The pasture is grazed by sheep, and they did feed some on the ragwort, which undoubtedly aided in control. Plant density was determined by placing a frame (1 m<sup>2</sup>) on the ground every 5 paces along a transect and counting the plants within the frame. In 1969, 100 such counts showed an average of 15.3 plants (both flowering and rosettes)/m<sup>2</sup>. The site was not sampled again until 1975 when not one ragwort plant could be found in 100 samples. Even plants that had been growing in and around dense brush stands along the river had been eliminated, and these plants were inaccessible to sheep. Although small numbers of cinnabar larvae had been present at the site since 1968, they had never exerted appreciable stress on the plant.

Site 2.—Site 2 has not been grazed for many years and has a dense stand of velvetgrass, *Holcus lanatus* L., and several species of annual and perennial forbs. In 1966, the average density of ragwort, determined as at Site 1, was 32.3 rosettes

and 21.3 flowering stems/m<sup>2</sup>. The cinnabar moth was introduced in 1966, and by 1968 the larvae were causing severe defoliation, and had almost eliminated flowering by 1972. However, rosettes had increased to 71.1/m<sup>2</sup>. Therefore, ca. 2000 *L. jacobaeae* adults were released in October 1972. (A control site was set up ca. 500 m to the east where cinnabar larvae had been active for several years, though not to the same extent.) Table 1 shows the plant densities at Site 2 and the control from 1972 to 1976. Plainly, tansy ragwort has been all but eliminated. The few rosettes that re-

Table 1. Tansy ragwort densities at *L. jacobaeae* releases 2 and 3 and controls (1972-1976).

Date of Sampling	Densities (plants/m <sup>2</sup> ) of tansy ragwort			
	Site 2		Site 3	
	Release area	Control	Release area	Control
Autumn 1972 (release time)	71.1	36.1		
Spring 1973	61.0	32.3	18.3	7.7
Autumn 1973	39.5	35.7	11.7	12.6
Spring 1974	31.1	27.2	7.7	8.2
Autumn 1974	6.9	14.5	7.4	9.0
Spring 1975	—No samples taken—		—No samples taken—	
Autumn 1975	0.6	12.4	0.5	8.0
Spring 1976	0.6	5.5	0.2	2.7

main are very small and never reach more than ca. 5 cm in diameter. The control site selected proved to be too close to Site 2; in 1974, the beetles began to migrate into the site, and they have also significantly lowered plant densities there.

Site 3.—Site 3, like Site 1, is a river bottom pasture of ca. 5 ha. It is grazed closely by cattle, which normally do not feed on ragwort. Ca. 500 *L. jacobaeae* beetles were released there in October 1972. A control sample plot was established ca. 200 m west of the release point. Table 1 shows the results. As at Site 2, the control was established too close to the point of release; by 1974, beetles were found there, and by 1976, there was significant reduction in plants. *Tyria jacobaeae* had never been active to any extent at Site 3 until 1975. However, in 1975, extremely large numbers of *Tyria* larvae were present and caused very heavy defoliation of ragwort, adding to the control pressure. As noted earlier, *L. jacobaeae* larval populations at Site 3 averaged 31.7 larvae/rosette in the spring of 1976.

## DISCUSSION

When *L. jacobaeae* has been released at other sites in the vicinity of Fort Bragg, it has generally given results similar to those at Sites 1, 2, and 3. Apparently the beetles can increase to the point of controlling the plants in 3-4 years. They also can disperse quickly since they have been found 5-6 km from the closest known release point within 3 years. Cinnabar moth, in contrast, disperses very slowly, and large numbers must be manually moved if they are to be effective.

Thus *L. jacobaeae* can be an effective control agent for tansy ragwort at the conditions prevailing near Fort Bragg. It augments the damage caused by cinnabar moth by placing stress on the plant during the winter and spring, a period when cinnabar moth is not active and also a period during which the plant has a chance to recuperate from damage caused by cinnabar defoliation. Best control will probably be achieved by a combination of cinnabar defoliation or sheep grazing, either of which causes the plant to root sprout and send up small rosettes from the base, plus attack by *L. jacobaeae* on the resulting small plants.

On the basis of the plant density determinations, the major portion of plant mortality occurs during the dry summer months. Then since the attack by *L. jacobaeae* larvae normally continues through May, the plant probably cannot recover enough to withstand the dry period. Because the root damage inflicted by the larvae causes moisture stress during the summer, the beetle may not be as effective in areas with higher summer rainfall. Most

of the U. S. Pacific coastal region is subject to summer drought, and *L. jacobaeae* should be an effective agent in that area.

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