DISTRIBUTION AND ESTABLISHMENT OF TWO BIOLOGICAL CONTROL AGENTS FOR RAGWORT IN NEW ZEALAND

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Biological control agents were introduced against ragwort (*Senecio jacobaea*) as early as the 1920's (Miller 1970). However limited resources allowed few releases of each agent, thereby limiting their rates of spread. Cinnabar moth (*Tyria jacobaeae*) was released widely between 1929 and 1932. Later it died out in all areas apart from the southern North Island (Syrett 1983). This well-established population has since been the source of insects for rearing and re-distribution throughout New Zealand. Ragwort flea beetle (*Longitarsus jacobaeae*) has been employed successfully as a control agent of ragwort in North America. In 1981 beetles were imported from Oregon, USA, into quarantine at Lincoln for host-specificity testing, and in 1983 the first field releases were made (Syrett *et al* 1984). Ragwort seedfly (*Pegohylemyia jacobaeae*) was introduced and released in the central North Island and Nelson from 1928 to 1939 (Miller 1970). Fifty years later, seedfly still has only limited distribution (Syrett *et al* 1984).

Many of the insects used for weed control are slow to disperse naturally. Recently, however, a co-operative extension programme with Regional Councils (previously District Noxious Plants Authorities) and other organisations has enabled DSIR Plant Protection to release biological control agents at many sites. Additionally, valuable information has been obtained on survival and spread of such beneficial insects from these release sites. This programme began in 1987 following a 1985-6 pilot scheme in the Auckland and Northland regions. Progress to date is reported in this contribution.

On each occasion when insects were released, site location and description, and release details were recorded. Sites were thereafter revisited at intervals by DSIR Plant Protection and field staff of co-operating organisations. The number of insects observed, the time spent searching, the stage and approximate populations of ragwort plants, and prevailing weather conditions were recorded. Observers usually noted the furthest distance from the release point that a particular species was found. Plants were examined visually for insects and a sweep net was often used to collect adult flea beetles. Visits to sites coincided, where possible, with times of the year when insects were expected to be the most conspicuous. Ragwort plant density was recorded as the average of at least three counts of medium — large plants (>150 mm diameter) in a randomly selected metre square plot. Data were used only when successive records were collected at the same time of year.

Fig. 1 illustrates the distribution of release, recovery and establishment of cinnabar moth and ragwort flea beetle in New Zealand. From this there is yet to be a discernible pattern to establishment success. Tables 1 and 2 record insect recoveries and establishments according to the year of release. Totals of 135 releases of cinnabar moth were made at 106 sites, and 110 releases of ragwort flea beetle at 106 sites. Most flea beetle releases comprised 300 adult beetles while cinnabar moth was released in the larval stage (1000 + caterpillars). The ragwort flea beetle established at a higher proportion of release sites (75%) than cinnabar moth (35%).

After 2-3 years cinnabar moth adults or larvae were recovered on average only 20 m from the release point, although at one site caterpillars were recovered 1 km away. In 5-6 years they were found 200 m away. Ragwort flea beetles were found to have spread about 90 m after 2-3 years, and over 300 m in 4-6 years. At one site beetles were found 1 km from the release point 6 years after release.

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Fig. 1: (a) Sites where cinnabar moth, *Tyria jacobaeae* have been released in New Zealand. ○ released, ◐ recovered, ● established.
 (b) Sites where ragwort flea beetle, *Longitarsus jacobaeae* have been released in New Zealand. ○ released, ◐ recovered, ● established.

TABLE 1: Cinnabar moth (*Tyria jacobaeae*): summary of recovery and establishment from releases made at 106 sites.

Year released (summer)	82/3	83/4	84/5	85/6	86/7	87/8	88/9	88/90	90/1	Total
Number of sites (total)	2	2	4	1	3	38	16	14	26	106
From which insects										
recovered	2	1	2	1	1	19	8	8	11	53
Not recovered	0	1	2	0	2	18	8	4	9	44
Not known	0	0	0	0	0	1	0	2	6	9
At which insects										
established	1	1	1	1	0	8	2	0	0	14
Did not establish	1	1	3	0	3	13	5	0	0	26
Not known	0	0	0	0	0	17	9	14	26	66
Destroyed	0	0	1	0	0	2	2	0	2	7
% established (excluding unknowns)	50	50	25	100	0	38	29	-	-	35

TABLE 2: Ragwort flea beetle (*Longitarsus jacobaeae*): summary of recovery and establishment from releases made at 106 sites.

Year released (summer)	82/3	83/4	84/5	85/6	86/7	87/8	88/9	89/90	90/1	Total
Number of sites (total)	2	3	14	9	11	32	24	5	6	106
From which insects										
recovered	1	3	12	8	9	22	16	5	0	76
Not recovered	1	0	2	1	2	4	7	0	0	18
Not known	0	0	0	0	0	5	1	0	6	12
At which insects										
established	0	0	10	8	6	13	7	0	0	44
Did not establish	2	3	4	1	2	2	1	0	0	15
Not known	0	0	0	0	3	17	16	5	6	47
Destroyed	0	0	1	0	1	2	1	0	0	5
% established (excluding unknowns)	0	0	71	89	75	87	88	-	-	75

Table 3 shows how abundance of ragwort close to release points apparently changed at sites where insects had been established in 1987 or earlier (where such data were recorded). At eight of the sites where ragwort flea beetle established, a decline in numbers of ragwort plants was observed over an increasing area as beetles spread out from the release point in successive years.

There are limitations to the precision of the information that can be gained from infrequent visits to release sites by a range of observers. Interpretations vary between observers and often there is a reluctance to provide nil returns. Nevertheless this method has yielded useful establishment data. The information on insect numbers observed per unit time proved successful, and almost all records were usable. However, plant population data were frequently either inadequate or omitted by observers. This explains the low number of sites included in Table 3. For biological control agents released more recently, recovery sheets are being modified to give a series of qualitative plant population classes. Observers will simply select the most appropriate class.

TABLE 3: Changes in ragwort plant populations at release sites where cinnabar moth and/or ragwort flea beetle were released in 1987 or earlier, and established.

	Increase	Decrease	No change
Ragwort flea beetle only	2*	11	2
Cinnabar moth only	2	2	4
Ragwort flea beetle and cinnabar moth	0	3	0

* At one of these sites there was a substantial decline in the beetle population.

Some species of control agent are more difficult to record than others. A trained observer can find ragwort flea beetle adults or larvae most of the year. Cinnabar moths and caterpillars are only obvious in the field for a few weeks during spring and summer respectively, but they are more conspicuous than ragwort flea beetles. Records for cinnabar moth are less complete because of the reluctance of observers to fill out nil returns.

Cinnabar moth probably has limited value as a control agent, although it may be effective in some areas (Harman *et al* 1989). In eastern Canada Harris *et al* (1978) showed that cinnabar moth was an effective control agent when early frosts made ragwort plants less able to recover from defoliation. Ragwort flea beetle together with

cinnabar moth, or ragwort flea beetle alone may be responsible for a reduction in populations of ragwort plants. Ragwort populations declined from 12-70 plants/m² to 0.0-0.18 plants/m² at sites in California 15-19 years after ragwort flea beetle was released. Both species were present at all sites (Pemberton and Turner 1990). McEvoy *et al* (1988) have shown in Oregon, USA that the two insect species are complementary in their impact on ragwort populations. Table 3 suggests similar patterns may be emerging in New Zealand. The impact of ragwort flea beetle on ragwort density is currently being determined in quantitative studies at five sites in New Zealand (P. McGregor pers. comm.).

Ragwort flea beetle and cinnabar moth are well established at a number of sites throughout New Zealand. Ragwort flea beetle has established more successfully and shows greater promise as a useful control agent than cinnabar moth. Ragwort flea beetle is spreading slowly and appears to be more mobile than cinnabar moth, although the data in this study indicate that several years are required for either species to disperse more than a few hundred metres. To enable both these insects to spread to ragwort infestations throughout the country, it is therefore necessary to release them at a large number of sites. To this effect, since the 1984/85 season, wide geographical coverage has been achieved. Additionally the number of new sites where the insects are established should increase in future as noxious plants officers learn to collect and redistribute beetles and caterpillars in the areas they are responsible for.

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