CENTRE FOR EVIDENCE-BASED CONSERVATION

Effectiveness of the Control of Ragwort (*Senecio*) Species Systematic Review Series:

SYSTEMATIC REVIEW Nᵒ· 5b.

"Can biological control by the use of natural enemies effectively control *Senecio jacobaea* (common ragwort)?"

SUMMARY REPORT

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February 2005

Title	Can natural enemies effectively control common ragwort (*Senecio jacobaea*)
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Date protocol first published on website	28th June 2004
Date review first published on website	March 2005
Date of most recent amendment	-
Date of most recent SUBSTANTIVE amendment	-
Most recent changes	-
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Systematic review No.	No. **5** part b
Sources of support	NERC, English Nature.
Conflict of interests	None reported.

SUMMARY

BACKGROUND

Biological control is the purposeful introduction of natural enemies (biocontrol agents) by land managers and scientists as a means to weaken and/or suppress invading plants or animals. Since the 1930s natural enemies, such as *Tyria jacobaeae* and *Longitarsus jacobaeae* have been used in an attempt to control *Senecio jacobaea* due to its potential to poison livestock and cause economic loss to agriculture. This systematic review uses explicit methodology to capture and evaluate primary evidence for the effectiveness of natural enemies as control agents of *S. jacobaea*.

OBJECTIVE

To assess the effectiveness of *T. jacobaeae* (cinnabar moth); *L. jacobaeae* (ragwort flea-beetle); or a combination of both for the control of *S. jacobaea* (common ragwort).

SEARCH STRATEGY

Electronic databases: ISI Web of Knowledge (WoK) containing ISI Web of Science and ISI Proceedings; Science Direct; JSTOR; Index to Thesis; UMI ProQuest Digital Dissertations; COPAC (incl. British Library); Natural History Museum Library; AGRICOLA and SCIRUS. English Nature (EN); Countryside Council for Wales (CCW) and Scottish Natural Heritage (SNH) publications were all searched online.

Other searches: Additional references not captured by the initial searches, were located via the inspection of all reference lists of studies accepted at full text.

SELECTION CRITERIA

Studies were included if they fulfilled the following selection criteria:

<u>Subject:</u> All studies which focused on *S. jacobaea* (common / tansy ragwort).

<u>Intervention:</u> The use of the natural enemy, *T. jacobaeae* (cinnabar moth); *L. jacobaeae* (ragwort flea-beetle); or a combination of both to control *S. jacobaea*.

<u>Outcome(s):</u> A measure of the ragwort population densities or a measure of an aspect of the plants characteristics (such as dry weight, capitula per plant or seed viability).

<u>Type of study:</u> All primary, quantitative studies and reports with a comparator of an appropriate control were included within formal meta-analysis. In addition time series studies which lacked a comparator were collated and the relative change in the *S. jacobaea* population was calculated.

DATA COLLECTION AND ANALYSIS

Both reviewers assessed study inclusion / exclusion, methodological quality & data extraction. Any discrepancies were resolved by discussion. Information on the population focus, methodology, interventions and outcomes were abstracted from the original studies into a specially designed, pre-tested spreadsheet. Data synthesis using

standardised mean difference (SMD), random effects model meta-analysis was performed by one reviewer, with the results being discussed by both reviewers.

MAIN RESULTS

Meta-analysis: Although the overall <u>density of *S. jacobaea* plants</u> (SMD d+ = -0.27; p = 0.4473 ns (positive sensitivity analysis) and SMD d+ = -0.27; p = 0.995 ns (negative sensitivity analysis)) is not significantly reduced by the *T. jacobaeae* treatment, certain plant characteristics are significantly reduced therefore affecting the reproductive ability of *S. jacobaea* plants: <u>capitula per plant</u> (SMD d+ = -8.71; sig. = 0.0076** (positive analysis) and SMD d+ = -7.90; p = 0.0455* (negative analysis)) and <u>seeds per plant</u> (SMD d+ = -693.92; p = 0.0174*).

Due to the limited sample sizes for the meta-analyses for *L. jacobaeae* and the combined *T. jacobaeae* & *L. jacobaeae* treatment no robust results could be calculated for their effectiveness in controlling *S. jacobaea.*

Time series: Results from the captured time series datasets show considerable variability in the reduction of the *S. jacobaea* using *T. jacobaeae*, with some sites even showing increases in plant densities. Using *L. jacobaeae* all sites showed a considerable decline (mean = 96.5%; range = 93.1% to 99.9%, n =2) in *S. jacobaea* densities. The combination treatment using both *T. jacobaeae* & *L. jacobaeae* again results in considerable decline (mean = 99.53%; range = 98.46% – 100%, n = 5) of *S. jacobaea* densities.

REVIEWERS' CONCLUSIONS

The best available evidence suggests that *T. jacobaeae* reduces the reproductive ability of *S. jacobaea* therefore potentially reducing the further spread of the plant. Although densities of *S. jacobaea* were reduced, the result was not statistically significantly. From the time series evidence *T. jacobaeae* showed vast variability for its effectiveness in controlling *S. jacobaea* densities.

There were insufficient datasets available to draw any robust conclusions from the meta-analyses for both *L. jacobaeae* and the combination of both natural enemies on *S. jacobaea*. The additional evidence provided by the time series shows that: *L. jacobaeae* caused major reductions of *S. jacobaea* densities and plant characteristics in all datasets. However, it is the use of the combination treatment; of both *T. jacobaeae* & *L. jacobaeae* that shows the greatest potential for the effective control of *S. jacobaea* densities.

The inclusion of time series datasets, without a comparator, within this systematic review allows for further tentative conclusions to be drawn for all three treatments. These results should be treated with caution due to uncertainty of confounding effects and the reduced methodological quality used to obtain the original datasets.

Further randomised control trials (RCTs) with multiple replicates and at least a two year time period are required to investigate the effectiveness of all three treatments on *S. jacobaea* densities and plant characteristics.