# Establishment and dispersal of dock moth *Pyropteron doryliformis* (Ochsenheimer) (Lepidoptera: Sesiidae) in Victoria

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**Summary** A biological control agent for docks (*Rumex* species) has been found in large populations in parts of northern Victoria, where it is dispersing widely and probably having a substantial impact. The Moroccan clearwing moth or dock moth (*Pryopteron doryliformis*) was released in Victoria from 1991 to 1999. Most of these releases were undertaken by inserting 'egg sticks' (toothpicks with moth eggs glued onto them) into the cut stalks of dock plants. The most successful dock moth populations in Victoria occur on *Rumex crispus*.

**Keywords** Moroccan clearwing moth, *Synansphecia doryliformis*, *Pyropteron doryliformis*, *Chamaesphecia doryliformis*, *Rumex* spp., biological control of dock.

## INTRODUCTION

The large-rooted docks *Rumex brownii* Campd. (an Australian native), *R. conglomeratus* Murray, *R. crispus* L., *R. obtusifolius* L., and *R. pulcher* L. (introduced from Europe) are troublesome weeds in high-rainfall and irrigated pasture in southern Australia (Parsons and Cuthbertson 1992).

In 1989 a Moroccan accession of the clearwing moth *Pyropteron doryliformis* (Ochsenheimer) (formerly *Synansphecia doryliformis* (see Kallies 2001)) (dock moth) was introduced from Europe into Australia as a biological control agent for docks by Agriculture Western Australia (Fogliani and Strickland 2000) following approval based on host specificity studies conducted in France (Scott and Sagliocco 1991b). Dock moth larvae complete their entire development by tunneling in the main roots of *Rumex* spp. and can cause considerable damage to plants, sometimes killing them. In Western Australia where *R. pulcher* is the most important dock, dock moth has been very successful as a biological control agent. Out of 12 sites at which it had been released between four and six years previously, dock density (plants $m^{-2}$) decreased by 75–100% at 11 sites and by 44% at the other site (Fogliani and Strickland 2000).

Over the decade following introduction, Agriculture WA supplied inoculum for more than 700 releases of dock moth in the southern States, facilitated by financial support from Meat and Livestock Australia. Releases were made in Victoria between 1991 and 1999 (Faithfull 1999), mostly by inoculating dock plants with eggs attached to bamboo toothpicks (Fogliani and Strickland 2000), but also in a small number of cases (from 1991 to 1993) by transferring neonate larvae onto the bases of dock stems. None of the latter releases resulted in establishment of dock moth (Faithfull 1996). Of the approximately 95 'egg-stick' releases (conducted between 1994 and 1999) few detailed or reliable assessments of establishment were undertaken prior to 2003. This was due to paucity of project resources and relatively short periods elapsed between most of the releases and the end of the Victorian component of the program in 1999.

This paper reports on establishment and dispersal of dock moth in Victoria based on assessments at 31 sites where releases were made between 1996 and 1999. Environmental factors which might have affected establishment and dispersal are briefly discussed.

## MATERIALS AND METHODS

**Establishment** From the start of December 2003 to mid February 2004, 31 dock moth release sites that represent most of the geographic and climatic ranges of such sites in Victoria were visited and assessed for evidence of the insect. Random samples of up to 50 plants (occasionally more) were first checked for the presence of puparia at their stem bases, and then dug up and their roots dissected to check for larvae and tunneling. Signs of dock moth and the species of each plant sampled were recorded. At some sites sampling of a particular species was restricted by plant availability to fewer than 50 plants. If less than 10 plants of a particular species were sampled, that observation was excluded from our analysis. These observations were plotted on a map of Victoria showing January average daily maximum temperature isotherms (Figure 1).

**Dispersal** If any signs of dock moth were found at a release site then dispersal was estimated by recording the maximum distance from the site at which dock moth could be found in a search of up to two hours undertaken on foot and by vehicle. The sampling

interval was approximately 200 m for distances up to 1 km from the release site and 1 km for distances greater than 1 km from the release site. Five to 10 dock plants were checked for dock moth at the end of each interval.

## RESULTS

Dock moth was detected at 13 sites, mostly in the northern regions of the State (11 sites) (Figure 1), and recovered most often from *R crispus* sites and from a higher proportion of *R. crispus* plants than any other species (Table 1). Dock moth was not recovered from *R. brownii* (one site) or *R. conglomeratus* (three sites) and was recovered from a very small proportion of *R. obtusifolius* plants (two sites) and *R. pulcher* plants (one site).

Substantial dispersal of dock moth was found only at 10 *R. crispus* sites and one site where the *Rumex* species was not identified. Estimated dispersal at these *R. crispus* sites ranged from 40 to 8000 m (mean 2337 m) and was 1020 m at the other site. These observations were all made in the northern regions of the State. In the south, only minor dispersal (40 m) was observed at a site infested with *R. pulcher* and *R. obtusifolius*, and at another site infested with *R. obtusifolius* dock moth was found only in the immediate vicinity of the release site.

## DISCUSSION

Limited establishment of dock moth in southern Victoria could be due to climatic factors, as the moth is known to prefer a more strictly Mediterranean climate, characteristic of its native range in Sicily, northern Africa and the southern Iberian Peninsula (Scott and Sagliocco 1991b). Dock moth has clearly prospered in northern Victoria (north of the Dividing Range) but not in the south. Areas of northern Victoria in which the moth has established generally have 2–6°C higher average maximum and minimum temperatures in summer than areas in the south where it has not established. Winter maxima and minima differ to a smaller extent, with the south having marginally lower maxima but marginally higher minima (ca. 2°C). Average annual rainfall in areas of establishment is generally 300–500 mm, in comparison with 600 mm or more in areas where the moth has not prospered. Northern Victoria may be more climatically suitable for the agent, which perhaps requires more degree-days and drier conditions than occur in much of southern Victoria. Scott and Sagliocco (1991b) observed that dock moth eggs only developed when kept dry.

The suitability of the particular populations of dock species in Victoria might also be an important factor, although in addition to *R. crispus*, *R. pulcher*

**Table 1.** Percentage of release sites where dock moth *Pryopteron doryliformis* was recovered and proportion of *Rumex* plants with dock moth damage based on assessments at 31 sites in northern and southern Victoria between December 2003 and February 2004.

| | *Rumex* spp. | | | | |
|---|---|---|---|---|---|
| | *brownii* | *crispus* | *conglomeratus* | *obtusifolius* | *pulcher* |
| | | | Northern Victoria | | |
| Percentage of sites where dock moth was recovered (n[A]) | 0% (1) | 77% (13) | No obs.[B] | No obs. | 0% (2) |
| Percentage of plants with dock moth damage[C] (No. of plants[D], sites) | 0% (nr[E], 1) | 48% (266, 8) | n/a (0, 0) | n/a (0, 0) | n/a (0, 0) |
| | | | Southern Victoria | | |
| Percentage of sites where dock moth was recovered (n[A]) | No obs. | 0% (1) | 0% (3) | 40% (5) | 11% (9) |
| Percentage of plants with dock moth damage[C] (No. of plants[D], sites) | n/a (0, 0) | n/a (0, 0) | n/a (0, 0) | 4% (72, 2) | 2% (41, 1) |
| Total number of plants sampled at all sites | nr | 318 | 123 | 229 | 580 |

[A] Number of sites assessed.
[B] No observations: sp. not present at any sites.
[C] Includes only observations from sites where dock moth was recovered from any species.
[D] Aggregate of all plants assessed from all sites where dock moth was recovered from that species.
[E] Not recorded, but at least 10 plants were sampled.

and *R. conglomeratus* are known as hosts for dock moth in the western Mediterranean region (Anon. 2004b). The main dock encountered in southern Victoria in our survey was *R. pulcher*. While most of these *R. pulcher* populations were in relatively cool regions (Figure 1) a few of the more westerly ones were in places that may be little different climatically from four westerly dock moth-infested *R. crispus* populations close to the January average daily maximum 28°C isotherm. If indeed *R. pulcher* in Victoria is a suitable host for dock moth, it might be reasonable to have expected to recover it from some of these more westerly (and relatively northern) *R. pulcher* release sites. Scott (1985) noted greater prevalence of dock moth in *R. pulcher* roots in Morocco than in the slightly cooler, more northerly climes of southern Spain and Portugal. If this trend is a response by dock moth to temperature, then our inability to find dock moth in southern Victoria may be due to an expression of the same response manifesting as an inability to establish. An insufficient number of *R. pulcher* samples in our survey occurred in Victoria's warmer climes to confidently judge whether *R. pulcher* in Victoria is suitable as a host.

*R. brownii* was encountered only once in our survey, at a site where *R. crispus* was sustaining a large and dispersed dock moth population, close to the 30°C isotherm in north-western Victoria (Figure 1). Dock moth was not recovered from *R. brownii* at this site and this observation may help to allay concerns (Scott and Sagliocco 1991b) that there could be significant impact on this Australian native species.

Another interesting observation from the survey was that dock moth was recovered (albeit in very small numbers) from *R. obtusifolius* at two sites. This plant appears not to be recorded in the literature as a host in the moth's native range (Anon. 2004a, Anon. 2004b, Bartel 1912, Rungs 1979, Scott and Sagliocco 1991b).

On the other hand, in our survey, dock moth was not recovered from *R. conglomeratus*, which is known as a host in Europe (Anon. 2004b). Similarly it was not able to be established in a series of releases conducted between 1994 and 1996, mainly on *R. conglomeratus*, in south western Victoria by the St Helens Shelterbelters Landcare group (Rowbottom no date).

Another species of clearwing moth, *Pryopteron chrysidiforme* (Esper) has been host specificity tested

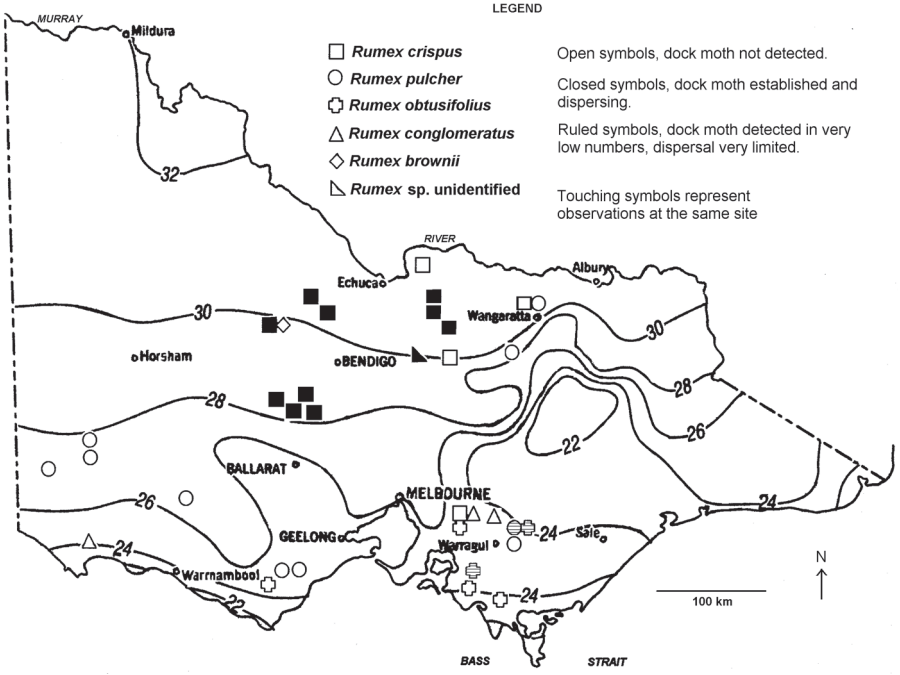


**Figure 1.** Presence or absence of signs of dock moth *Pyropteron doryliformis* on *Rumex* species sampled at 31 release sites in Victoria between December 2003 and February 2004 superimposed on January average daily maximum temperature isotherms (°C).

with a view to release in Australia (Scott and Sagliocco 1991a). This moth is native to central and southern Europe and would probably be better suited to the climate of southern Victoria than *P. doryliformis*. It is the obvious choice for an agent with potential to further reduce the impact of *Rumex* spp. in Australia.

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