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THE BIOLOGICAL CONTROL OF PATERSON'S CURSE, *ECHIUM PLANTAGINEUM*: NORTHERN HEMISPHERE STUDIES

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ABSTRACT

The European program against the boraginaceous weed *Echium plantagineum* L. is described. The biology and effectiveness of the following insects which are restricted to *Echium* and its boraginaceous relatives will be discussed: the gracillariid leaf-miner, *Dialectica scalariella* (Zeller); the halticines, *Longitarsus aeneus* Kutsch and *L. echii* Koch.; the weevils *Ceutborrbynchus geographicus* Goeze and *C. larvatus* Schultz; the gelechiid moth, *Ethmia bipunctella* F.; the tingid bugs, *Dictyla echii* Schr. (F.) and *D. nassata* Pr.; and the cerambycid stem-borer, *Phytoecia coerulescens* (Scop.)

INTRODUCTION

Paterson's curse, *Echium plantagineum* L. (Boraginaceae), is an invasive weed of pastures in high rainfall (400 to 1000 mm yearly average) areas of Mediterranean type climate of south-eastern and south-western Australia. Similar climatic areas of Europe and North Africa where the weed is native have been surveyed to discover agents for its biological control. Studies of some of the agents have been under way for several years and this paper summarizes the present state of the program.

THE WEED

The genus *Echium* has a centre of species radiation in the Iberian Peninsula where many species occur, a good number being endemic to that region (Tutin *et al.* 1972) and an associated group of species occurs in western North Africa (Quezel and Santa 1963). Additional subsidiary evolutionary radiations of the genus *Echium* are found in the isolated Atlantic Canary Islands (Lems and Holzapeel 1968). The number of *Echium* spp. declines sharply on passing eastwards in the Mediterranean region to the Middle East and only two species are recorded in Iran (Riedl 1967). Following the protocol established by Wapshere (1974) observations on biological control agents of *Echium* have been concentrated to date in the western Mediterranean region.

In this region, *E. plantagineum* is a long-lived annual. It germinates with the autumn rains and rapidly forms a large, flat, competitive rosette which continues to grow until late spring, the plant laying down reserves in the progressively thickening tap-root until then. In late spring the flower shoot bolts and grows rapidly upwards to flower and seed in early summer. The rosette dies off after the plant has bolted and the rest of the plant dies after seeding during the hot, dry Mediterranean summer.

THE BIOLOGICAL CONTROL AGENTS

Dialectica scalariella (Zeller) (Lepidoptera: Gracillariidae)

Larvae of this moth produce and feed in large blotch mines in the rosette leaves of *Echium* and other Boraginaceae in autumn and spring and attack the cauline leaves in summer. A single mine can destroy a good part of a leaf and

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two to three larvae can kill a leaf. The life cycle is short and there are several generations per year.

For this insect to be effective it must significantly reduce the translocation of photosynthetic products into the enlarging tap-root by building up heavy infestations in autumn and winter on the rosette plants.

Safety testing has shown that the moth is restricted to the Boraginaceae (Wapshere and Kirk 1977) and it has recently been introduced into Australia. The first Australian releases of this moth were made in June 1980 (Delfosse and Cullen 1981).

Longitarsus echii Koch and *L. aeneus* Kutsch (Coleoptera:Chrysmelidae)

These flea beetles (halticines) emerge from aestivation as adults in winter to feed and produce characteristic shot-holes in the rosette leaves of young seedlings of *Echium*. The eggs are laid on the soil around their host plant and the larvae descend into the ground to feed on rootlets and external layers of the rootstock (*L. aeneus*) or into the rootstock (*L. echii*) of *Echium* during winter and spring.

Larval feeding causes the principal damage to the plant; *L. echii* damaging the cortex of the tap root, and *L. aeneus* destroying the fine secondary rootlets (Wapshere, unpubl. data). Heavy populations are observed on *Echium* infestations in the northern hemisphere and if these occur in Australia they should reduce the amount of tap root material available to the plant for flower shoot production.

Safety testing has shown that both species are almost specific to *Echium* spp. and both have recently been introduced into quarantine in Australia.

Ceuthorrynchus geographicus Goeze and *C. larvatus* Schultz (Coleoptera: Curculionidae)

These weevils aestivate as adults until winter when they emerge to feed on the leaves of well developed rosettes. Eggs are laid into the petioles of these leaves and emerging larvae bore down them into the crown of the plant where they feed, thereby destroying it.

These two insects are individually the most destructive of the *Echium* fauna and are relatively common on *Echium* spp. in the western Mediterranean region. They should be effective in Australia.

Safety testing is nearly complete and there is every indication that both insects will be shown to be restricted to the Boraginaceae.

Ethmia bipunctella Fab. (Lepidoptera:Ethmiidae)

The larvae of this moth are bud-webbers of *Echium* spp. and are first observed in spring before the flower shoot bolts.

There are probably several generations during the year and the larvae firstly destroy the main bud, and progressively later, buds which develop on the flower stem.

Although widespread on *Echium* and other Boraginaceae in the western Mediterranean region high population levels have not been observed.

The moth family Ethmiidae is considered to be limited to and to have co-evolved with the Boraginaceae (Sattler 1967). Although safety testing has not yet commenced there is every reason to consider theat this insect will be restricted to *Echium* and its relatives.

Dicyla echii Schr. (F.) and *D. nassata* Pt. (Hemiptera:Tingidae)

These two bugs are found beneath rosette leaves in spring and reach maximum

population levels as adults and nymphs on the flower shoot in summer. The shoot is seriously affected by the punctures of the feeding insects as these cause it to curl up and the flowers borne on it to abort. There is a continuous series of generations throughout the period of presence on the plant.

Because of the common and abundant occurrence of these tingids in the western Mediterranean region, and the damage they produce, they should be effective in reducing the weed's flower production in Australia.

The safety testing of these two bugs, which have only been recorded on *Echium* and its relatives (Stichel 1961), has just commenced.

Phytoecia (*Opsilia*) *coerulescens* (Scop.) (Coleoptera:Cerambycidae)

Larvae of this beetle bore out the fully developed flower stems of *Echium* in summer and cuts them at their base prior to overwintering in the dead root-stocks. Adults emerge in early summer and oviposit into the basal third of the flower shoot.

Larvae probably reduce seed production, particularly of thinner plants.

The safety of this species has been confirmed and it is limited to a restricted group of Boraginaceae (Kirk and Wapshere 1979). It has recently been introduced into quarantine in Australia (Delfosse and Cullen 1981).

DISCUSSION

The prognosis for biological control of *E. plantagineum* is good for several reasons. First, because the principal centre of evolution of *Echium* is found in an ecoclimatic region closely similar to the regions infested by the weed in Australia. At this centre a large group of specific or near-specific insects occurs on *Echium* spp., including those mentioned above.

Second, the plant is attacked at all stages of its life cycle by one or more apparently effective insects and all parts of the plant are attacked successively as they appear. For example, *D. scalariella* attacks early rosette leaves as well as later ones; *L. echii* and *L. aeneus* feed on young roots; *C. geographicus* and *C. larvatus* destroy older crowns; *E. bipunctella* damages the stem and flower buds; *D. echii* and *D. nassata* affect flower shoots; and *P. coerulescens* bores out the seedling stems.

In addition to those insects mentioned above, a similar number of insects apparently specific to *Echium* and its relatives are also known and these could be introduced eventually to add further to the stress imposed on the plant.

One point of considerable biological interest is the occurrence on *Echium* spp. of several groups of two or more species of the same insect genus utilizing the same resource at the same time in the life cycle of the plant. There is good evidence that the two halticines do not compete directly, as the larvae of the larger species, *L. echii*, attack the root cortex, whereas those of the smaller *L. aeneus* attack the rootlets (Wapshere, unpubl. data). However, to date no difference between the feeding position of the larvae of the two *Ceuthorrynchus* species has been demonstrated and the two *Dictyla* species occur together at the same sites causing similar damage to the flower stem. Further investigations of these ecological enigmas would be of interest.

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