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Echium plantagineum in Australia: Effects of a Major Conflict of Interest

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Abstract

Biological control of *Echium plantagineum* by CSIRO formally began in 1972. Four species were approved for importation and release in Australia: a leaf-mining moth, *Dialectica scalariella*; two flea beetles, *Longitarsus aeneus* and *L. echii*; and a stem-boring beetle, *Phytoecia coerulescens*. Seven other insects (two crown-boring weevils, *Ceutorhynchus geographicus* and *C. larvatus*; two cell-sucking bugs, *Dictyla echii* and *D. nassata*; a bud-feeding moth, *Ethmia bipunctella*; and two flower-feeding beetles, *Meligethes planiusculus* and *M. tristis*) complete the guild likely to be approved for introduction and release. Two pathogens (the powdery mildew, *Erysiphe horridula*, and the fungus, *Cercospora echii*) are also potential agents, but due to current restrictions against importation of these types of pathogens, they are unlikely to be approved. Three limited releases of *D. scalariella* were made in 1980. It showed signs of establishment at one release site, but host plants were eliminated by drought and grasshoppers. An injunction against importation and release of the *Echium* insects, granted on behalf of two apiarists and two graziers in July 1980, followed by a perpetual injunction accepted by CSIRO in June 1983, has prevented further releases or importations. The effects of this injunction and new legislation for biological control in Australia are discussed.

Echium plantagineum: Programme de Lutte Biologique en Australie Interrompu par une Injonction

Le contrôle biologique de *Echium plantagineum* par la CSIRO a officiellement commencé en 1972. L'Australie a approuvé l'introduction de quatre espèces d'insectes au pays: *Dialectica scalariella, Longitarsus aeneus* et *L. echii*, et *Phytoecia coerulescens*. Sept autres espèces d'insectes (*Ceutorhynchus geographicus, C. larvatus, Dictyla echii, D. nassata, Ethmia bipunctata, Meligethes planiusculus* et *M. tristis*) et une maladie (*Erisiphe horridula*) complètent la gamme des agents destinés aux essais de spécificité d'hôte en vue de leur introduction potentielle. *D. scalariella* a fait l'objet de trois essais limités d'introduction en 1980. Un site d'introduction a semblé être favorable à leur établissement, mais les plantes hôtes ont été détruites par la sécheresse et les sauterelles. En 1980, une injonction, faite à la demande de deux apiculteurs et de deux exploitants de pâturage, a mis fin au programme *Echium* et a arrêté l'introduction et l'importation d'agents biologiques. Le rapport traite des conséquences de l'injonction sur le programme.

Introduction

Echium plantagineum L. (Boraginaceae), Paterson's curse/salvation Jane, is a major winter-growing, herbaceous annual (occasionally biennial) weed in Australia (Delfosse and Cullen 1981). It is also a weed in Tunisia, Argentina, Morocco, South Africa and Uruguay (Holm *et al.* 1979). There are two other herbaceous, noxious *Echium* spp. in Australia, *E. italicum* L. (Italian bugloss) and *E. vulgare* L. (viper's bugloss), and several woody, ornamental *Echium* spp. (Piggin 1979). The genus originated in Mediterranean climatic areas of Europe and North Africa.

Tillyard (1928) first raised the possibility of biological control of *E. plantagineum* in Australia. Work on this program formally began by the CSIRO Division of Entomology's Biological Control Unit, Montpellier, France, in 1972 (Delfosse and Cullen 1981; Wapshere 1981). Delfosse and Cullen (1981) summarized the work done on this project to 1980, including a brief discussion of the conflict of interest, the most intense of any program in the history of biological weed control. Cullen and Delfosse (1985) expanded the discussion on conflict of interest of *Echium* in Australia, and described legislation (the *Biological Control Act 1984*) (Commonwealth of Australia 1984) which resulted from this conflict.

In this paper I discuss several recent aspects of this program, including the potential biological control agents, the effect of the 1980 injunction on the *Echium* program and biological control in Australia in general, and the likely effects of the legislation in Australia.

Biological Control Agents for *E. plantagineum*

Eleven insect species found in the western Mediterranean appear to have major potential for biological control of *E. plantagineum* (Table 1) (Wapshere 1981, 1983, 1985). Four of these were imported to Australia in 1979–80; one was released in the field. There are also two fungi known to attack *Echium* and other Boraginaceae. Many other species have been recorded on *Echium* spp. in the western Mediterranean (Wapshere 1985), some of which also have potential as biological control agents. The phytophagous guild on *Echium* spp. is discussed briefly below.

Coleoptera

Two univoltine flea beetle species have been approved by the Commonwealth Department of Health, Plant Quarantine, for importation and field release. *Longitarsus aeneus* Kutsch (Chrysomelidae) adults feed on *Echium* foliage, creating 'shot holes'; larvae produce the most damage to plants, and feed on rootlets and the external cortex of the tap root (Wapshere 1981, 1985). *L. echii* Koch adults also produce shot holes in leaves, but larvae feed internally in the main tap root. Adults of both species emerge from soil in autumn. Eggs are laid in winter, and pupation occurs in soil in spring.

Shipments of both species were sent from Portugal and France to Australia from December to March 1980. A rearing procedure was developed (Delfosse, unpubl. data), but it was decided to concentrate on *Phytoecia coerulescens* (Scopoli) (Cerambycidae) and *Dialectica scalariella* (Zeller) (Lepidoptera: Gracillariidae), and no further work was done on the *Longitarsus* spp. in Australia.

P. coerulescens is a univoltine stem-borer of Boraginaceae, especially *Echium* spp. (Kirk and Wapshere 1979). Adults feed on cauline leaves, and larvae feed in the stem in spring, and in the root in summer, thus reducing seeding. It is considered to be a useful member of the guild of biological control agents because it can reduce seeding of the thinner, multi-stemmed *E. plantagineum* found in dense stands; its effect is likely to be less on thick, single-stemmed plants which occur in less-dense stands of the weed (Kirk and Wapshere 1979).

P. coerulescens was received in Canberra from September to November 1979, having been collected originally near Montpellier. It was cleared of its parasites and diseases (Delfosse and Smith, unpubl. data), and was being mass-reared in live plants and artificial diets in preparation for releases in 1980–81. However, the interim injunction granted against the program prevented planned releases (see below) (Delfosse and Cullen 1981).

Table 1. Voltinism, damage and specificity of biological control agents for *Echium plantagineum* L. (Boraginaceae).

Species	Generations per year	*Echium* Stage attacked by: Adults	Nymphs or Larvae	Spores or Mycelia	Specificity
Coleoptera					
Cerambycidae					
[1] *Phytoecia coerulescens* (Scopoli)	1	leaves	stem, tap root	_	Boraginaceae
Chrysomelidae					
[1] *Longitarsus aeneus* Kutsch	1	leaves	diffuse roots & cortex of tap root	_	*Echium* spp.
[1] *L. echii* Koch	1	leaves	tap root	_	*Echium* spp.
Curculionidae					
[2] *Ceutorhynchus geographicus* (Goeze)	1-2	leaves, petioles	collar, tap root	_	*Echium* spp.
[2] *C. larvatus* Schultze	1-2	leaves, petioles	collar, tap root	_	*Echium* spp.
Nitidulidae					
[3] *Meligethes planiusculus* Heer.	unknown	flowers	flowers	_	probably Boraginaceae
[3] *M. tristis* Sturm.	unknown	flowers	flowers	_	probably Boraginaceae
Hemiptera					
Tingidae					
[2] *Dictyla echii* Schr.	2-3	shoot	shoot	_	Boraginaceae
[2] *D. nassata* Puton	2-3	shoot	shoot	_	Boraginaceae
Lepidoptera					
Ethmiidae					
[3] *Ethmia bipunctella* Fabr.	3	N.A.[4]	shoot & flower buds	_	probably mainly *Echium*
Gracillariidae					
[1] *Dialectica scalariella* (Zeller)	5-7	N.A.	leaves & stem epidermis	_	Boraginaceae
Fungi					
Moniliales					
[3] *Cercospora echii* Wint.	several	_	_	leaves	probably *Echium* spp.
Erysiphales					
[3] *Erysiphe horridula* (Wallr.) Lev.	several	_	_	leaves	probably *Echium* spp.

[1] Host-specificity testing completed, and importation to Australia occurred, before injunction granted in July 1980.
[2] Host-specificity testing completed, but importation and release permits not yet requested.
[3] Host-specificity testing not yet begun, but literature surveys and field examinations indicate host range as given.
[4] N.A. = No attack by this stage.

Two weevil species, *Ceutorhynchus geographicus* (Goeze) and *C. larvatus* Schultze (Curculionidae), have been tested for safety as potential biological control agents for *Echium* (Vayssiéres and Wapshere 1983). Adults feed on leaves and petioles; larvae cause the greater damage to the plant by feeding on the collar (mainly *C. larvatus*) and rootstock (mainly *C. geographicus*). Together, they are perhaps the most destructive of the *Echium* guild, and will be considered for introduction should the program proceed.

The last two species of Coleoptera that could be considered initially for introduction are the flower-feeding *Meligethes planiusculus* Heer. and *M. tristis* Sturn. (Nitidulidae). Both species feed on species of Boraginaceae, including *Echium* spp. (Wapshere 1985). Little work has been done on these species, but they will be examined in detail should the program proceed.

Hemiptera

The cell-sucking bugs *Dictyla echii* Schrank and *D. nassata* Puton (Tingidae) attack flowering shoots of *Echium* spp. in late spring to summer (Vayssiéres 1983). Both species spend autumn to spring under *Echium* rosette leaves. There are 2–3 generations/yr in Mediterranean Europe. Both species were found to be restricted to a small group of Boraginaceae in host-specificity testing (Vayssiéres 1983), with complete development occurring on five genera in addition to *Echium*. These species are capable of significantly reducing seeding of *E. plantagineum*.

Lepidoptera

D. scalariella is a small (adult body length *c.* 5 mm), fragile, multivoltine (5–7 generations/yr in Mediterranean Europe) moth whose larvae mine rosette and stem leaves, and the stem epidermis, of *Echium* spp. (Wapshere and Kirk 1977) and five other boraginaceous genera. As no Boraginaceae are of importance to Australian agriculture (other than weeds), importation/release permits were issued.

Seven shipments of *D. scalariella* (collected from Alcacer, Portugal, and Montpellier and Salagou, France) were received in Canberra from March–June 1980. A *Nosema* pathogen was cleared from one population, and an effective mass-rearing technique was developed (Delfosse and Lewis, unpubl. data). Preliminary releases to test overwintering survival and establishment were made at three sites in New South Wales in June and July 1980 (winter), in preparation for mass-releases, to begin in spring. On 10 July 1980, shortly after the third release of *D. scalariella*, a High Court of Australia injunction was granted on behalf of two graziers and two apiarists, which prevented further releases or importations of any *Echium* agents.

Four months post-release, a small population of *D. scalariella* was developing at one release site (Delfosse, unpubl. data). A severe drought began shortly thereafter, however, and a grasshopper plague (primarily *Phaulacridium vittatum* [Sjost.] and *Austroicetes vulgaris* [Sjost.] [Orthoptera: Acrididae]) invaded the area. The combination of drought and grasshoppers eliminated all *Echium* in the area, and prevented establishment of the moth. *D. scalariella* did not become established at the other sites.

Larvae of *Ethmia bipunctella* F. (Ethmiidae) attack the central bud of elongating *Echium* in spring, thus stopping growth (Wapshere 1985). Larvae of second and third generation moths attack developing flower buds in summer. This is the least common of the frequently-found species attacking *Echium* in Europe, and has more often been collected from the biennial plant *E. vulgare* (Sattler 1967), which is also a weed in

Australia (Delfosse and Cullen 1981). Host-specificity testing for *E. bipunctella* has not been conducted, but it is likely to be confined to mainly *Echium* spp. (A.J. Wapshere, pers. comm., 1984).

Fungi

In late winter, large *Echium* rosettes are attacked by the powdery mildew, *Erysiphe horridula* (Wallr.) Lev. (Erysiphales). The fungus can defoliate rosettes (Wapshere 1985). It attacks a large number of Boraginaceae, and would be a useful addition to the *Echium* guild. However, host-specificity testing has not been conducted on this species, because powdery mildews are presently not approved for importation into Australia as biological control agents by the Department of Primary Industry.

One other fungal species, *Cercospora echii* Wint. (Hyphomycetes), appears to have potential as a biological control agent for *Echium* spp. Its host range has also not been investigated for the same reason as given for *E. horridula*.

Effects of the 1980 High Court of Australia Injunction

Legal aspects of the injunction are discussed by Cullen and Delfosse (1985). The most obvious effect of the injunction on the *Echium* program was the prohibition of further releases or importations of the agents. Initially, this was very disruptive because mass-rearing of *D. scalariella* for releases scheduled to be made in spring 1980 had to be halted. Virtually overnight the change from a mass-rearing procedure to a low maintenance procedure had to be made: several thousand carefully reared *D. scalariella* had to be killed, and only a small colony retained. The injunction was less disruptive at this point to the *P. coerulescens* rearing, because many fewer individuals were being handled at that time during the development of a mass-rearing scheme.

However, a small number of *D. scalariella* were found on *E. plantagineum* plants at the CSIRO Division of Entomology site in March 1982. The plaintiffs were immediately informed, and demanded destruction of all remaining moths in quarantine. This disrupted all experiments then in progress. In an effort to retain the populations for possible future use, several hundred larvae and pupae of each of the three demes from the three original sources in Europe were sent back to Montpellier; the rest of the colony was destroyed in March 1982. Unfortunately, all three shipments were temporarily lost en route to Montpellier. By the time they arrived in Montpellier, adults had emerged and died in the shipment containers.

The plaintiffs also demanded destruction of all living *P. coerulescens*, despite assurances that all adults would be killed as soon as they emerged (in sealed test tubes). The colony was destroyed on 17 December 1982, just when three-year experiments on developing a mass-rearing procedure in artificial diet were reaching a satisfactory result. A perpetual injunction on the *Echium* program was accepted by CSIRO in June 1983 (Cullen and Delfosse 1985). If the inquiry into its biological control (see below) finds that the program would be in the national benefit, CSIRO can apply to the court for lifting of this injunction.

There were wider effects of the injunction than those described for *D. scalariella* and *P. coerulescens*. Biological control reserachers all over Australia became concerned that programs involving weeds with even a small degree of conflict of interest could have been halted by any individual with the smallest interest (in the legal sense) in the weeds' present status. This was probably an over-reaction, as legal standing would have to be established in each case before a court would grant an injunction; i.e., the

value of the weed to the plaintiff and any possible loss caused by its control would have to be clearly delineated. However, as conflict of interest could arise with many of Australia's major weeds, and in the absence of legislation protecting approved programs, it was considered a possibility that only those weeds with little or no associated conflict of interest would be investigated in the future.

Fortunately, CSIRO, while being concerned about the disruption of the *Echium* program and possible effects on other programs (both current and potential), continued to be supportive of biological control. There was some feeling that, in a time of diminishing resources for scientific research, resources should not be committed to programs which may be prevented from attaining fruition. However, since the *Echium* legal action began, several new biological control of weeds projects have begun, and a new overseas Unit has been established.

Likely Effects of the *Biological Control Act 1984*

Provisions of this *Act* are discussed in detail by Cullen and Delfosse (1985). With the passage of the *Act*, public benefit became a viable justification for biological control activities in Australia. The *Act* contains provisions for establishment of a *Biological Control Authority* (a Federal Minister, or a State Minister in a state that passes complementary legislation), procedures for obtaining declaration of *target organisms* (pests) and *agent organisms* (biological control agents), procedures for conducting public inquiries for both pests and agents, emergency declaration of pests and agents, appeals, compensation for persons adversely affected by biological control programs, and other matters.

The *Act* covers all biological control programs in Australia, not just those for weeds. There is no statutory requirement to obtain declaration of pests or agents under the *Act*, but if utilized, it provides protection for groups intending to conduct biological control of pests for which there is a likelihood of conflict of interest.

An inquiry will be held for *Echium* and its agents from late 1984–mid-1985. Whatever the outcome of the *Echium* inquiry, the result will set a precedent for biological control in Australia.

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