

The Initiation of Biological Control of *Emex* spp in Australia

by

M. H. Julien and K. L. S. Harley¹

ABSTRACT

The distribution and importance of *Emex australis* and *E. spinosa* as weeds in Australia is outlined. An account is given of the liberation and monitoring of a potential biological control agent, the weevil *Apion antiquum* which was introduced in 1974. Other potential agents are discussed.

INTRODUCTION

Emex australis Steinheil and *Emex spinosa* Campdera, (Polygonaceae) are weeds exotic to Australia. Both are herbaceous annuals, infesting cultivated areas, pastures and waste land. They are generally winter weeds and, in Australia, are broadly confined to the temperate and Mediterranean-type climatic regions.

This account gives a brief description of the important aspects of the biology of these weeds and progress in their biological control species of *Apion*.

EMEX SPECIES BIOLOGY AND ECOLOGY

Emex australis

Emex australis is a native of South Africa and was introduced into Western Australia in 1830 by settlers coming from England via The Cape. It is reported that they used it as a vegetable (Anon. 1910, Turner 1912). Since its introduction *E. australis* has spread throughout most of Western Australia and to the southern and eastern states (Fig. 1). It was first recorded in South Australia in 1870, New South Wales in 1883 and Queensland in 1911 (Parsons 1973).

It has been recorded from New Zealand (Cheeseman 1906, Gardner 1930); California (Robins *et al.* 1951); Hawaii (Degener 1960) and India (Steinheil 1838).

E. australis has a prostrate growth habit. It initially develops as a rosette which as it matures produces radiating stems. Under favourable field conditions the mature plant may exceed two metres diameter, have up to eighteen stems and produce more than 500 seeds. However under stress con-

ditions when only two or three small rosette leaves develop and no stem formation occurs, the plant is still capable of producing a small number of seeds in the rosette crown.

Field sampling has indicated, that in cereal crops, densities of 25 and 460 plants per square metre can produce 2,300 and 16,000 achenes per square metre respectively, of which approximately 50% contain viable seeds (Julien and Weiss, unpublished data). The seeds may germinate over a prolonged period under favourable conditions, however it appears that dormancy and seed longevity mechanisms influence germination.

E. australis infests and competes with, pastures and crops for space, moisture and nutrients. Pearce (1969) demonstrated a 25% drop in cereal production owing to *E. australis* competition and Hawkins and Black (1958) attributed a 39% wheat yield reduction to *E. australis* competition for moisture and nitrogen. Gilbey (1974) demonstrated that a density of 100 *E. australis* plants per square metre caused a 50% reduction in wheat yields. It also infests orchards, horticultural and market garden areas, roadsides, playing fields, lawns and areas subject to flooding. The achenes with their hard spines are injurious to animals and man and contaminate harvested crops and hay (Gilbey 1974).

Because of the plasticity of this plant, its ability to produce seed early in its life cycle and maintain a soil seed pool through periods of adverse conditions, conventional control methods are expensive and often ineffective.

The density of *E. australis* tends to decrease with successive years of continuous pasture following cropping, especially if clovers are established (Parsons 1973, Gilbey 1974). However maintaining continuous pasture as a control measure is neither practical nor economic in many areas.

Gilbey (1974) estimated the annual loss of production caused by *E. australis* in Western Australia to be in excess of a \$5 million.

Emex spinosa

E. spinosa is a relatively unknown species of *Emex* in Australia. It is a native of the Mediterranean region (Steinheil 1838) and was first re-

¹Division of Entomology, CSIRO, Long Pocket Laboratories, Indooroopilly, Brisbane, Q. 4068. Australia.

corded in Western Australia in 1953 (Gilbey 1974). Apparently its introduction was accidental.

E. spinosa is recorded from Crete, Egypt, North Africa, Syria, Persia, Canary Islands and Brazil (Steinheil 1838. de Candolle 1857); Portugal and Morocco (Krauss 1963); California (Munz and Keck 1959), and Hawaii (De Bach 1964).

In Australia its distribution appears to be restricted to a small region in Western Australia, several areas of South Australia, (Gilbey 1974), one area in Victoria (Weiss and Julien 1975) and a small area in southern Queensland (Fig. 1). Usually *E. spinosa* grows in association with *E. australis*.

E. spinosa has a more erect growth habit than than *E. australis*; its achenes are smaller with more delicate shorter pericarp spines. There are more

achenes clustered at each node and hence seed numbers are higher than those produced by *E. australis*. Counts of up to 25,000 achenes per square metre have been recorded (Julien and Weiss, unpublished data). Considerably less is known about the biology and ecology of *E. spinosa* than *E. australis*.

In the winter rainfall area of South Australia where *E. spinosa* occurs, its erect habit and small seed size allow it to be harvested with and contaminate cereal grain. Seed cleaning processes cannot reduce contamination to an acceptable level and, as a result, significant quantities of cereal grain have not been marketable.

It is considered that *E. spinosa* may have the potential to establish over a much broader and continuous distribution than at present. If this occurs

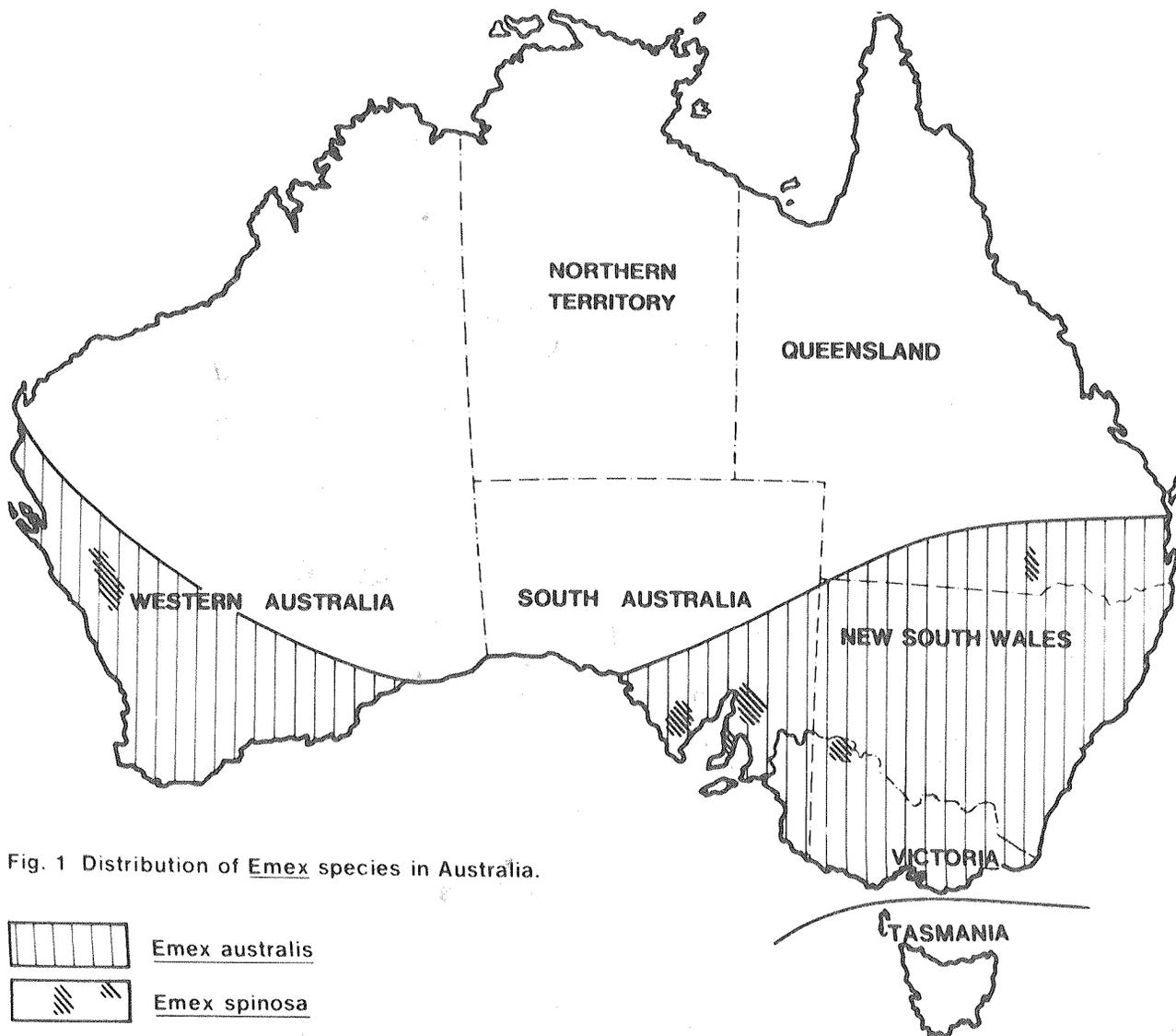


Fig. 1 Distribution of *Emex* species in Australia.

its effect on the cereal industry could be extremely serious.

BIOLOGICAL CONTROL

Hawaiian Introductions

In 1956 and 1957 *Apion antiquum* Gyllenhal (Curculionoidea), from South Africa, was released in the Hawaiian Islands on *Emex* species (Krauss 1963). Within three years Davis and Krauss (1962) observed significant reductions in *E. australis* at one site on Hawaii Island. Andres and Davis (1971) reported that the degree of control varied with altitude and between islands.

During 1960 and 1962, two other weevils *Apion violaceum* variety *harcyniae* Hubenthal from Portugal and *Apion neofallax* Warner from Morocco were released (Krauss 1963). To date establishment of these two species has not been confirmed (Davis, Pers. Comm.).

Australian Introduction

Colonies of *Apion antiquum* from South Africa were imported into Australia early in 1974. Harley and Kassulke (1975) demonstrated adequate host specificity and attack on both *Emex* species was observed.

In April 1976, colonies of *Apion neofallax* from Morocco and *Apion violaceum* from Portugal, infesting *E. spinosa* material, were imported into Australia. If pre-liberation studies of their biology and host specificity indicate that they are suitable potential control agents, they will be released against *E. spinosa*.

Apion antiquum Biology

Apion antiquum is a small dark weevil (ca 3mm long) which walks and flies actively. Development from egg to adult takes 31-36 days at $23^{\circ}\text{C}\pm 2^{\circ}\text{C}$ with females living an average of 56 days and producing 700 eggs (Harley and Kassulke 1975).

Eggs are laid singly on above-ground plant parts. Larvae initially feed and develop just under the epidermal tissue. However, as they grow, they chew all internal tissues and tend to move into the larger sections of the stems or petioles. The larvae are voracious feeders and cause severe damage to vascular tissues in stems and petioles leading to extensive die back and collapse of stems.

The adult weevils feed externally on all above-ground surfaces of the plant except the mature woody pericarp. Feeding causes shothole effect on the laminae and damages the epidermal and vascular tissues of leaf veins, mid ribs, petioles and stems.

Larval tunnelling is the main cause of plant damage but heavy adult feeding contributes to plant stress.

Field Studies

A. antiquum was approved for liberation in Australia in mid 1974.

It was first liberated at eight experimental sites each consisting of two plots, a liberation plot and a control plot. The sites are situated throughout the *E. australis* distribution and were selected to include broadly, the main eco-climatic regions involved.

500 *A. antiquum* were liberated on each of the experimental release plots in August 1974. At the same time a sampling programme to evaluate *A. antiquum* and its effects on *Emex* species was commenced.

Recoveries of adult weevils indicate that establishment in the 1974 season occurred at two sites. A further liberation of 2,000 weevils was made on each of the experimental plots, except one, during 1975. On this plot several adults were found in November 1975, the end of the *Emex* growing season. These weevils had apparently survived from one season to the next, including a period of approximately five months without host plants. It is interesting to note that *E. spinosa* is dominant in this area. Sampling during 1975 indicated that establishment was also occurring at three other sites including the two at which recoveries were made during the previous season.

During late 1974 and mid 1975, numerous secondary releases were made. These were designed as point releases which would yield basic information regarding establishment over a much wider area and under more diversified conditions. Also, following establishment, collections from these sites may be used for distributing the weevils to additional localities. Monitoring indicated establishment at three secondary sites during 1975.

At the end of the 1975 season a total of 32,000 weevils had been liberated at eight experimental and fourteen secondary sites.

Preliminary field cage studies have shown that, at experimental sites where establishment occurred, the population increase per female was between 100 and 600%. The variation correlates directly with the shoot weight of *Emex* available to the weevils.

CONCLUSIONS

Considering the relatively short duration of this project, it is encouraging that in-season establish-

ment has been observed at numerous sites and that survival over the summer period has been observed at one of these.

It is of note that the unsuccessful sites have longer summer arid periods extending into autumn and spring; the rainfall is lower, more evenly distributed throughout the year and less reliable. The successful sites have a relatively short summer arid period and a definite winter rainfall distribution.

It is too early to draw any firm conclusions regarding environmental effects on establishment. However available information suggests we should consider searching the South African interior for more suitable bio-types to supplement the present release material.

REFERENCES

- Andres, L. A. and C. J. Davis. 1971. The biological control of weeds with insects in the United States. Proc. 2nd Int. Symp. Biol. Control of Weeds. p. 11-25. C.I.B.C. Misc. Publ. No. 6.
- Anon. 1910. Noxious weeds and poisonous plants illustrated for the guidance of settlers W. A. Dept. Agric. Bull. No. 32 p. 7-9.
- Cheeseman, T. F. 1906. Manual of New Zealand Flora p. 1086.
- De Bach, P. 1964. Biological Control of Insect Pests and Weeds. p. 844 (Chapman and Hall: London).
- De Candolle, A. P. 1857. Prodrromus Systematis Naturalis Regni Vegetabilis.
- Degener, O. 1960. Flora Hawaiiensis. Book 2. Family 110.
- Davis, C. J. and N. L. H. Krauss. 1962. Recent introductions for biological control in Hawaii. Proc. Haw. Ent. Soc. XVIII (1) p. 125-129.
- Gardner, C. A. 1930. The doublegee. J. Dept. Agric. W.A. 7, 504-506.
- Gilbey, D. J. 1974. *Emex* species in Australia with particular reference to Western Australia. J. Aust. Inst. Agric. Sci. 40(2) 114-120.
- Gilbey, D. J. 1974. Estimating yield losses in wheat resulting from infestation by doublegee (*Emex australis*). Aust. J. Exp. Agric. Anim. Husb. 14(70): 656-657.
- Harley, K. L. S. and R. C. Kassulke. 1975. *Apion anti-quum* (Curculionoidea: Apionidae) for biological control of the weed *Emex australis*. J. Aust. Ent. Soc. 14: 271-276.
- Hawkins, H. S. and J. N. Black. 1958. Competition between wheat and three-cornered jack. J. Aust. Inst. Agric. Sci. 24: 45-50.
- Krauss, N. L. H. 1963. Biological control investigation of christmas berry (*Schinus terebinthifolius*) and *Emex* (*Emex* spp.) Proc. Haw. Ent. Soc. XVIII (2).
- Munz, P. A. and D. D. Keck. 1959. A California Flora. Uni. Calif. Press. p. 354.
- Parsons, W. Y. 1973. Noxious Weeds of Victoria. Inkata Press. p. 221-224.
- Pearce, G. A. 1969. Control of weeds in cereals. J. Dept. Agric. W.A. 10: 138-147.
- Robbins, W., Bellue, M. and Boll, W. 1951. Weeds of California. p. 130.
- Steinheil, A. D. 1838. Flora de Barbarie, in Annales des Sciences Naturalles. second serie. Vol. 9: 193-196.
- Turner, F. 1912. cited in Gilbey, D. J. 1974. p. 114.
- Weiss, P. W. and M. H. Julien. 1975. A comparison of two species of Spiny *Emex* (*Emex australis* and *E. spinosa*) in north-western Victoria. J. Aust. Inst. Agric. Sci. 41(3) 221-213.