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Candidate Insects for the Biological Control of *Rumex pulcher*

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Abstract

Rumex pulcher (Polygonaceae) is a major weed of pastures in Mediterranean-like climatic regions of southwestern Australia. The origin of the plant is probably the Mediterranean area and a search was made in the western part of this region for insects that attack the weed. Nine of the species found during this survey were selected for further study. Those judged most suitable for biological control purposes were the sesiid moths, *Bembecia chrysidiformis* and *Chamaesphecia doryliformis*. Larvae of these insects feed in the root, often causing death of the plant. The root-feeding weevil, *Lixomorphus ocularis*, and the stem-feeding weevils, *Apion (Perapion) violaceum*, *A. (Perapion) hydrolapathi*, *A. (Erythrapion) miniatum*, and *Lixus ferrugatus*, and the leaf-mining flies, *Pegomya bicolor* Wied. and *P. nigritarsis*, are also being studied but are considered to be of lesser importance or possibly unsuitable for biological control purposes depending on future work. Most of these insects feed widely on species of the subgenus *Rumex* and hence there is a possibility of Australian native *Rumex* of the same subgenus being attacked. This conflict of interest will need to be resolved before importations can be made.

Insectes Choisis pour la Lutte Biologique Contre *Rumex pulcher*

Rumex pulcher (Polygonacées) est une des principales plantes nuisibles des pâturages des régions à climat méditerranéen, du sud-ouest de l'Australie. La plante est sans doute originaire de la région méditerranéenne où on a effectué des fouilles pour trouver des insectes qui détruiraient cette plante nuisible. Parmi les espèces étudiées, on en a retenu huit en vue d'analyses supplémentaires. D'après les résultats, les sésies, *Bembecia chrysidiformis* et *Chamaesphecia doryliformis* constituent les agents biologiques les plus appropriés. Ces insectes, qui sont racidivores, entraînent souvent la mort des plantes. En outre, d'après la documentation et les essais de spécificité d'hôte, les sésies ne vivent que sur les plantes du sous-genre *Rumex*. Le charançon racidivore *Lixomorphus ocularis*, les charançons mangeurs de tiges *Apion (Perapion) violaceum*, *A. (Perapion) hydrolathium*, *A. (Erthrapion) miniatum*, et *Lixus ferrugatas*, et les mineuses des feuilles *Pegomya nigritarsis* et *P. bicolor* Wied. ont aussi été étudiées, mais sont moins efficaces ou ne se prêtent pas à la lutte biologique. Étant donné que la majorité de ces insectes ne choisissent que des plantes hôtes du sous-genre *Rumex*, les espèces indigènes du même sous-genre d'Australie risquent aussi d'être infestées. Ce conflit d'intérêts devra êtra réglé avant d'importer les insectes.

Introduction

Rumex pulcher L. (Polygonaceae) is a major weed in the Mediterranean-like climatic regions of southwestern Australia, which has proved difficult to control by chemical and cultural means (Allen 1974, 1975). Since *R. pulcher* is an introduced weed in Australia, it was decided by the Western Australia Department of Agriculture to investigate possibilities for biological control of this weed. The study started in late 1981 and concentrated on phytophagous insects in western Mediterranean countries. This region is the probable area of origin of the plant. This paper reviews the progress so far with this study.

Rumex species, but not *R. pulcher*, have been examined previously for biological control agents. A list of insects and pathogens, mainly from Italy, has been given for *R. crispus* L. with initial biological studies made of *Bembecia chrysidiformis* (Esper) (Lepidoptera: Sesiidae) and *Lixomorphus ocularis* F. (Coleoptera: Curculionidae) (Spencer 1981). An examination of the host plant specificity has also been made of the fungus *Uromyces rumicis* (Schum.) Wint. (Uredinales) on *R. crispus* (Frank 1973; Inman 1971). A list of possible biological control agents amongst fungi which attack the genus *Rumex* is given by Sedlar *et al.* (1983).

Two studies on biological weed control within the country of origin have been made on *R. obtusifolius* L. Garcia-Baudin and Santiago-Alvarez (1978) report on *Gastrophysa unicolor* Marsham (Coleoptera: Chrysomelidae) in Spain, and a list of insects (Miyazaki 1979) and a detailed study of *G. atrocyanea* Mots. (summarised in Miyazaki and Naito 1981) has been given for Japan.

Finally the Commonwealth Institute of Biological Control has examined a number of *Rumex* species in Pakistan in a search for biological control agents (CIBC, unpubl. repts.). None of the above studies have resulted in the release of insects or pathogens in countries where *Rumex* is a problem. The only releases of insects known to attack *Rumex* have been made for biological control of *Emex* spp. (Polygonaceae) (Julien 1981; Julien *et al.* 1984). However *Rumex* has not been reported to be attacked in the countries of release.

Preliminary Investigations

Taxonomy of the Weed

Rumex is a world-wide genus of about 160 species divided into four subgenera: *Acetosa*, *Acetosella*, *Platypodium* and *Rumex*, the latter including *R. pulcher* as well as the weeds *R. crispus* and *R. obtusifolius*. The Australian continent has representatives of all four subgenera amongst a total of 17 species. Eight species are native and all belong to the subgenus *Rumex* (Rechinger 1984). *R. pulcher* belongs to the section *Simplices*, subsection *Obtusifolii* and has five subspecies but only two, *R. pulcher pulcher* and *R. pulcher divaricatus* (L.) Murb. occur in Australia (Rechinger 1984). Both subspecies are weeds in southwestern Australia but *R. pulcher divaricatus* appears to be the most important. This subspecies is typical of the Mediterranean region and is now widespread in areas of similar climate throughout the world. *R. pulcher pulcher* has a similar distribution and Rechinger (1984) observes that in some cases there is not a clear distinction between the two subspecies.

Biology and Economic Importance

The biology of *R. pulcher* largely remains undescribed. There should however be a number of similarities with the well-known species *R. crispus* and *R. obtusifolius*, which are also taxonomically closely related to *R. pulcher*.

One of the few studies of *R. pulcher* has been by Allen (1974), who established that this weed was the dominant *Rumex* species in pastures of southwestern Australia, except in wetter areas, where *R. crispus* was found. *R. pulcher* over-summers as a root stock and underground stem which produces leaves in early autumn, remains as a rosette through winter, with inflorescences appearing in spring. Seedlings appear throughout the growing season. The plant is perennial but the longevity is unknown.

Allen (1974) suggests that cultivation, which exposes the root stock to desiccation, would kill the plant. However he notes that the plants will regrow from severed root

stocks in autumn. Allen (1975) suggests the following control techniques: replacing cattle with sheep; establishing perennial grasses; and cropping, followed by a herbicide treatment. However these techniques are not practical in areas where cattle graze on annual legume-based pastures. Other alternatives were the use of low-dose herbicides followed by heavy grazing 1 wk later. However, herbicide treatment is usually detrimental to the legume which is the basis of the pasture. Overall, *Rumex* species were estimated to cost farmers $A400,000 p.a. in lost production (Allen 1975). Recently McGhie *et al.* (1983) suggested that *Rumex* species in pastures of southwestern Australia may be useful as feed for sheep early in the growing season and of doubtful usefulness late in the season and when mixed with hay.

Possible Biological Control Agents

Thirty-seven species of phytophagous insects were found feeding on *R. pulcher* during a search of the western Mediterranean region (southern France, including Corsica; Italy, including Sardinia and Sicily; Spain, Portugal, and Morocco) (Scott and Sagliocco, unpubl. data). Nine of these species were selected for further study after a consideration of pubished host plant records. Each of these species is considered below.

Apion (Perapion) hydrolapathi *Marsham (Coleoptera: Apionidae)*

Larvae of this weevil bore inside the stem and petioles; adults feed externally on leaves, petioles and stems of *Rumex* species. It is found throughout the littoral regions of Europe and the Mediterranean and has been recorded from *R. crispus*, *R. hydrolapathum* Hudson, *R. pulcher* (Hoffmann 1958) and *R. obtusifolius* (Radde 1974). This species is difficult to separate from *A.* (*Perapion*) *violaceum*, being morphologically and biologically similar. Work is needed to clearly differentiate these species before *A. hydrolapathi* can be considered for use in biological control.

Apion (Perapion) violaceum *Kirby (Coleoptera: Apionidae)*

As with the previous species, *A. violaceum* has larvae which bore inside the stem and petiole, and adults which feed externally on above-ground parts of many different *Rumex* species, chiefly of the subgenus *Rumex* (Hoffmann 1958). The insect is widely distributed in Europe and the circum Mediterranean region. The biology of the species in the Montpellier region of southern France has been examined (Scott, unpubl. data), and preliminary host-specificity tests have been made with a range of plants mainly from the Polygonaceae. Adults were found to feed on *Rumex* species, *Emex spinosa* (L.) Campd., *Rheum rhabarbarum* L. (Polygonaceae) and *Fagopyrum esculentum* Moench (Polygonaceae); eggs were laid on *Rumex* species, *E. spinosa* and *R. rhabarbarum*; and larvae developed on *Rumex* species and *E. spinosa*, but died in the first instar on *R. rhabarbarum*. An Australian native species, *R. dumosus* A. Cunn. ex Meisn., was amongst the most heavily attacked of the *Rumex* species. It remains to be seen if this insect can complete a whole generation on these plants, especially the Australian native *Rumex* species.

Apion (Erythrapion) miniatum *Germar (Coleoptera: Apionidae)*

This weevil has larvae which feed in the lower stems of *Rumex* species; adults feed on leaves. It is widely distributed in Europe and the Middle East (Hoffmann 1958). This insect is not abundant and hence little study has been made of its biology and host plant specificity.

Lixomorphus ocularis *(F.) (Coleoptera: Curculionidae)*

Presence of larvae of *L. ocularis* (F.) inside roots of *R. crispus* was discovered and its biology briefly described by Spencer (1981). Previously its biology was unknown (Hoffmann 1950). Following from Spencer's work, Cassobasso and Murano (pers. comm.) have made a detailed study of its biology. The weevil's distribution is Algeria, Spain, Italy and Corsica (Hoffmann 1950). Its only known host plants are *R. crispus* (Spencer 1981) and *R. pulcher* (Scott and Sagliocco, unpubl. data). Spencer (1981) found no feeding preference for adults caged on *F. esculentum*, *R. rhabarbarum*, *R. crispus*, *R. acetosa* L., *R. scutatus* L., and *R. conglomeratus* Murray. In no-choice tests carried out in Montpellier, adults from Corsica fed readily on leaves of *R. pulcher*, *R. conglomeratus* and *R. acetosa*, and light feeding occurred on *R. rhabarbarum*; test bites were found on *R. obtusifolius*, *Daucus carota* L. (Umbelliferae) and *Beta vulgaris* L. (Chenopodiaceae). Both the above sets of tests were of a preliminary nature and consequently it is not possible to state the host-plant range of this insect.

Spencer (1981) considered that this species would not be a suitable biological control agent based on its biology and host-specificity tests. However more detailed work, especially on the feeding preference of larvae is needed.

Lixus ferrugatus *Olivier (Coleoptera: Curculionidae)*

Both the above name and *L. cribricollis* Boheman have been used for this weevil which has been introduced into Australia for the biological control of *Emex* species. In host plant specificity tests, *R. crispus* was found to be attacked by populations of the weevil from Morocco (Julien *et al.* 1984). Hence it is not surprising to find that it feeds on *Rumex* species in the northern part of this insect's range, where *Emex* does not occur.

Insects of this species which attack *Rumex* could be considered for introduction into Australia after assessing the success of the insects from Morocco. This large weevil (up to 14 mm long) is found throughout central and southern Europe, Algeria, Morocco and the Middle East (Hoffmann 1954). Its biology is described by Julien *et al.* (1984). Larvae make tunnels in flowering stems of *Emex* and *Rumex* species during May to July. The weevil is rare in the Montpellier region, but attacks mainly *R. pulcher*. However, the amount of damage inflicted seemed slight, as the insect lays eggs only when the flowering stem is well-developed (Scott, unpubl. data). This behaviour exists presumably so that the larvae will have sufficient material to complete development. Hence, it is doubtful, given this attack phenology, that this insect could reduce the plant population, given the densities of insects observed around Montpellier. However, once released in Australia the population density may well be different, and damage to plants may reduce seed production. Hence this insect should be re-examined to determine: (1) the extent of establishment in Australia, especially on *Rumex*; (2) the amount of damage caused to *Rumex* plants in nature and caged environments; and (3) if the host plant specificity of this insect on *Rumex* species and other Polygonaceae is the same as the population from *Emex* described in Julien *et al.* (1984).

Bembecia chrysidiformis *(Esper) (Lepidoptera: Sesiidae)*

This clearwing moth was initially considered for the biological control of *R. crispus* (Spencer 1981). The larvae feed inside the root and underground stem of the plant. In addition to *R. crispus*, this insect is known to attack *R. acetosa* (Popescu-Gorj *et al.* 1958) and was found in this survey in *R. pulcher*, *R. obtusifolius* and *R. conglomeratus*.

Host plant records of *Artemisia campestris* L. (Compositae) and *Helichrysum* sp. (Compositae) (Popescu-Gorj *et al.* 1958) are most probably erroneous. Adults may feed on nectar in flowers of these plants, which may have lead to the assumption that the plant was also the larval food plant. *A. campestris* has also not been attacked in host-specificity tests with larvae from France and Portugal (Scott and Sagliocco, unpubl. data).

Adults emerge from pupae at the start of summer, mate, and lay eggs onto stems of *Rumex* plants that have flowered that year. After 6–12 days, depending on temperature, larvae eclose and climb down the stem to enter the plant about 1 cm below the soil. All subsequent development takes place within the root or the underground stem. By 2 wks larvae are in the third instar, and larval development is probably finished by the end of summer. By this time the root has been largely destroyed. Larvae pass winter in a silk-lined sack and pupate in mid- to late-spring. Adults feed on nectar of flowers.

Usually one larva is found/root, and up to 50% of larvae are parasitised by the fly, *Bithia modesta* (Meigen) (Diptera: Tachinidae).

The insect is widely dispersed in the northern Mediterranean and north-western European countries except Scandinavia. Percent infestation of plants varies considerably with location. However, an important part of mortality of plants more than 1-yr-old seems to be due to this insect, although regrowth and seed production of plants infected in the laboratory does occur. This aspect is currently being examined in laboratory and field experiments.

Host-specificity tests of the first instar larvae were made using insects from three widely separated sources; *R. crispus* from Rome, *R. pulcher* from Montpellier, France, and *R. pulcher* from three sites in central Portugal. Adults from these sites were mated, the eggs stored and newly hatched larvae were transferred onto stems of test plants. Five larvae for each of five test plants were used. Controls were the same number of larvae placed onto *Rumex* plants. Sixty-four test plants were selected for their taxonomic relationship to *Rumex* or for their agricultural importance to Australia. The plants were dissected after 2 wks, which is sufficient time for larvae to reach the third instar, and hence have initiated attack on the plant. This testing program is not yet finished, but so far larvae have initiated attack and grown, at least to the second instar, in *Rumex* species from the subgenera *Rumex*, *Acetosella* and *Acetosa*, but not *Platypodium*. Second instar larvae were also found on some plants of *Polygonum* sp. (Polygonaceae), *R. rhabarbarum*, *F. esculentum* and all *E. spinosa*. However, long-term host-specificity tests are needed to see if development can be completed in these plants. *E. spinosa* and *F. esculentum* are annual plants, so possibly would not be available to an insect that attacks its host plant in summer. All other plants not belonging to the Polygonaceae, with the exception of *Persea americana* Miller (Lauraceae), were not attacked. Out of 10 plants of *P. americana*, five exposed to larvae from France and five to larvae from Portugal, two had one second instar larva which had made a tunnel. Further tests over a longer period are needed for this species.

Chamaesphecia doryliformis *(Ochsenheimer) (Lepidoptera: Sesiidae)*

This clearwing moth is found in the western Mediterranean region but not north of mid-Portugal, Spain and Sardinia. Larvae are found in roots of *Rumex* species but the only host in the literature is *R. acetosa* (Rungs 1979). This insect was found commonly in roots of *R. pulcher* in Morocco but rarely in southern Spain and Portugal.

Adults emerge throughout May and June but mostly in May. Its biology and effect on the plant is similar to *B. chrysidiformis*. No host plant specificity testing has been done so far with this species.

Pegomya bicolor *Wied. and* P. nigritarsis *Zett. (Diptera: Anthomyiidae)*

Both *P. bicolor* and *P. nigritarsis* are found as larvae in leaf mines on *Rumex* species in spring and autumn in southern France. There appears to be a number of generations per year. Hennig (1973) lists the host plant records for each species. The chief host plants of *P. bicolor* are *Polygonum* species and *Rumex* species, with doubtful records for *Rheum* species and other Polygonaceae. *Begonia semperflorens* Otto & Link (Begoniaceae) has been recorded as a host plant. The chief host plants of *P. nigritarsis* are *Rumex* species with possibly some attack on other Polygonaceae. Attack on *B. semperflorens* by *P. nigritarsis* needs to be confirmed. Larvae of *Pegomya* species from *Rumex* leaves collected in the Montpellier region will form leaf mines if transferred onto *B. semperflorens* but most die before forming pupae. Further work is needed to distinguish between the larval stages of the two *Pegomya* spp. before any host-specificity testing can be done.

Discussion

No insects were found which are host-specific to *R. pulcher*, and in general the best degree of specificity that could be expected is to the subgenus *Rumex*. This implies that species on native Australian *Rumex* will be exposed to attack. Unfortunately, aside from the taxonomy (Rechinger 1984), nothing is known about the biology of these species, except that some occur as weeds in pastures, while others are rare. It is evident that some attack on Australian native *Rumex* species will have to be accepted if biological control is to be attempted on *R. pulcher*.

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