Argemone mexicana L. and *Argemone ochroleuca* Sweet – Mexican poppy

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ABSTRACT

Mexican poppy is the collective common name in Australia for the closely related species *Argemone mexicana* and *Argemone ochroleuca* (Papaveraceae). Three potential prospects for biocontrol were identified. Two species of Languriidae *Languria sanguinicollis* and *Languria convexicollis* are common, damaging and probably specific on *Argemone* spp. in Mexico. The root weevil *Conotrachelus leucophaeatus* is also very common, widespread and damaging especially on *A. ochroleuca* in Jalisco State. Further effort into the evaluation of these insects has been suspended as these weeds are considered to be low priority in Australia. However, they remain serious weeds in other warmer parts of the world and biocontrol efforts could lead to useful outcomes there.

Key words: Papaveraceae, invasive weeds, agent selection

INTRODUCTION

In Australia, Mexican poppy is the collective common name for the closely related species *Argemone mexicana* L. and *Argemone ochroleuca* Sweet (Papaveraceae). *Argemone mexicana* is now a pan-tropical invader, but *A. ochroleuca* is the most common species in Australia (Figure 1). They are annual prickly herbs to 1 m tall. In the native range of North America, centred in Mexico, they grow through the dry winter season, but elsewhere, including Australia, they may grow all year round provided there is soil moisture.

Members of the genus *Argemone* are readily identified by the presence of yellow sap. The two species are distinguished by the colour of their petals: bright yellow in *Argemone mexicana* and pale yellow in *A. ochroleuca* (Figure 2). In Australia *Argemone mexicana* can also be confused with *A. subfusiformis* G.B.Ownbey, American poppy. Both have bright yellow petals, but those of *A. mexicana* are 1.7-2.5 cm wide while those of *A. subfusiformis* are 2.8-3.3 cm wide. Mexican poppy produces large numbers of small seeds most of which fall beneath the parent plant resulting in a locally dense population, while other seeds are spread by water, animals or machinery (Parsons and Cuthbertson 1992). The majority of seeds normally do not germinate during their first season, but instead enter the seed bank, and continue to produce seedlings for several years (Karlsson *et al.* 2003).

These two ubiquitous tropical weed species have no obvious restriction to particular agronomic or environmental situations (Karlsson *et al.* 2003). They are serious weeds of river channels and crops in many parts of Australia. They are not particularly aggressive competitors of crops or established pastures as they persist only until the crop or perennial species become established and then gradually disappear (Parsons and Cuthbertson 1992). However they have become a problem weed of various crops in parts of Africa, Asia and South America. They are highly toxic to humans resulting in many deaths particularly associated with consumption of contaminated mustard oil (Babu *et al*. 2006). Plants are unpalatable and so rarely eaten by stock, but plant material mixed with hay or seed mixed with grain may poison animals eating such products (Holm *et al*. 1977).

BIOLOGICAL CONTROL HISTORY

Exploration in the native range for natural enemies was undertaken from 1998 to 2002. The project was terminated prior to fully testing any agents as there were doubts that this weed would cause sufficient impacts to warrant a biocontrol program (Grace *et al*. 2006).

South Africa has more recently developed a biocontrol program against this weed and has begun to import agents into quarantine for testing. Two species of curculionid beetles preliminarily identified as *Conotrachelus* cf. *leucophaeatus* Fahraeus and *Sirocalodes* cf. *wickhami* (Champion) were field collected in Mexico and brought into

South Africa for evaluation. Preliminary host-specificity trials seem to indicate a clear preference for the target weed (Van Der Westhuizen 2011).

PLANT TAXONOMY

Argemone is a monophyletic genus with a centre of distribution in Southwest USA and northern Mexico, but which has diversified into other parts of the Americas (Schwarzbach and Kadereit 1999). Three species occur in Australia: *A. mexicana*, *A. ochroleuca* and *A. subfusiformis*. *A. mexicana* was determined as diploid (n=14), *A. ochroleuca* as hexaploid (n=42) with a regular meiosis, and *A. subfusiformis* as a triploid (n=18-20) with an irregular meiosis (Lozzia *et al*., 2006).

EXPLORATION

Native range

A total of 23 specimens of *Argemone* collected during exploration work in Mexico have been identified by Jerzy Rzedowski, of the Instituto de Ecología, Pátzcuaro, Michoacán, Mexico. Most were *Argemone ochroleuca* and *A. mexicana*. *Argemone mexicana* occurs in Veracruz and west coast. *A. ochroleuca* is distributed more centrally (Figure 3). Other species encountered include *A. grandiflora* Sweet subsp. *grandiflora*, *A. arida* Rose and *A. echinata* G.B.Ownbey.

A total of 115 sites were surveyed for agents. Some sites were visited multiple times resulting in a total of 126 collections (a collection refers to an event of stopping at a site and collecting all insects and fungi found). Most sites were in Mexico with fewer in Guatemala, Venezuela, Puerto Rico and the Dominican Republic (Figure 4). Mexican sites were in the states of: Veracruz, Tabasco, Morelos, Puebla, Tlaxcala, Estado de Mexico, Hidalgo, Queretaro, Guanajuato, Michoacan, Jalisco, Colima, Oaxaca and Chiapas.

Insects were collected directly from the plant, and plant material including seeds, flowers, and stems was collected to rear internally feeding insects. Where possible, the plant part that an insect was using was noted. Species were defined as phytophagous based on field observations, rearing from plant material and information in the literature. Surveys for natural enemies were primarily conducted by staff at the CSIRO Mexican Field Station particularly Ricardo Segura, Moisés

Martínez and Manuel Juárez. Occasionally Australian based scientist Tim Heard participated in the surveys.

The majority of species were identified to species by taxonomic specialists (see acknowledgements for details), although some could only be identified to genus, or higher. Unidentified species were grouped into morphospecies.

CANDIDATES

Natural enemies (native range)

A total of 698 specimens were collected. Of these 274 were sent for identification, the remainder were held at the Mexican Field Station. The specimens were identified into 36 taxa. Thirteen of these species were excluded as they were not herbivores, leaving a total of 23 natural enemies (Table 1). The few insect species collected from species other than *A. mexicana* and *A. ochroleuca* are not included in Table 1. For example *Neoterpes ephelidaria* (Hulst) was collected only from *Argemone arida*.

A pathogen identified by H Evans as *Cercosporidium guanicence* (F. Stevens) Deighton (synonym= *Passalora guanicensis* (F.Stevens) U.Braun & R.F.Castañeda) was found on one collection. It is reported from other countries in tropical America often in association with the pathogen *Deightoniella argemonensis* Pollack and Matthews (Pollack and Matthews 1976); both pathogens may have potential as agents although, in our observations, they attacked older and senescent leaves.

Agents released

No agents have been released in Australia or any other country. In Australia, the project ceased before it reached this stage (Grace *et al.* 2006). The continuing project in South Africa may result in agent releases.

Promising agents

***Languria sanguinicollis* Chevrolat (Coleoptera: Languriidae).** *Languria sanguinicollis* was very common in our collections with 95 specimens collected in 18 collections in the Mexican states of Veracruz, Oaxaca, Chiapas, Puebla and Queretero. All collections were made on *A. mexicana* with the exception of one individual from *A. grandiflora* subsp. *grandiflora* Sweet. *Languria sanguinicollis* breeds in the roots and adults eat all plant parts including pollen (Figure 5). It has one

or maybe two generations per year. This species has a more southern and or eastern distribution than *L. convexicollis* the other common species on *Argemone* in Mexico (see below).

A preliminary host specificity study was conducted at a field site called Actopan between Veracruz and Xalapa where *A. mexicana* occurs with the related plant *Bocconia frutescens* L. This test examined adult feeding and survival in a no-choice situation. Adults were put into bags on a leaf of a living plant for three days. The adults were then removed and counted and area of damage estimated. Three replications of each treatment were done. Adults of *L. sanguinicollis* survived on *A. Mexicana,* but died quickly on the test plant. Adult feeding was restricted to *A. mexicana*.

There are 14 members of the genus *Languria* in North American and another four species in Central America. They are generally bicoloured in North America (red thorax, dark elytra), but unicoloured in Central America (Vaurie 1948). The larvae of the Languriidae of North America are stem borers. The adults feed on pollen and leaves of the host plant. The only species to become an economic pest in North America is the clover stem borer *Languria mozardi* Latrielle which infests red clover and alfalfa (and many other species in various families) throughout USA, southern Canada and northern Mexico. Feeding by the larvae interferes with the vitality of the plant and sometimes the plant breaks off above the oviposition hole (Vaurie 1948).

Languria convexicollis **Horn (Coleoptera: Languriidae).** *Languria convexicollis* is less common than *L. sanguinicollis* in our collections with 24 specimens collected, all in the state of Jalisco. All collections were made on *A. ochroleuca* with the exception of one individual from *A. mexicana*. In the literature, *L. convexicollis* is also known from North America, recorded in British Columbia (Canada) and California, Arizona, Utah (USA). At the US National Museum there are 21 specimens from California labelled "borer in *Argemone platyceros* var. *hispida"*. The males of this species have a very convex thorax (Vaurie 1948). *Languria convexicollis*, like *L. sanguinicollis* breeds in the roots and the adults eat all plant parts.

Conotrachelus leucophaeatus **Fahraeus (Coleoptera: Curculionidae).** The root weevil *Conotrachelus leucophaeatus* breeds on roots and stems and the adults eat all plant parts including flowers (Figure 6). Feeding by the larvae can seriously damage

the host plant leading to premature collapse and death. *Conotrachelus leucophaeatus* is very common; during our surveys we collected over 100 specimens in 27 collections in the Mexican states of Jalisco, Guanajuato, Hidalgo, Oaxaca and Veracruz. It was recorded on the host species *A. ochroleuca*, *A. mexicana* and *A. echinata*. It is especially common on *A. ochroleuca* in Jalisco. *Conotrachelus leucophaeatus* has one or maybe two generations per year. It was successfully reared on Mexican poppy plants grown at the La Aguada field plot of the Mexican Field Station in 1999.

A preliminary host specificity study was conducted at a field site called Actopan between Veracruz and Xalapa where *A. mexicana* occurs with related plant *B. frutescens*. This test examined adult feeding and survival in a no-choice situation. Adults were put into bags on a leaf of a living plant for three days. The adults were then removed and counted and area of damage estimated. Three replications of each treatment were done. The results show that adult feeding by *C. leucophaeatus* is restricted to *A. mexicana*.

An artificial diet has been useful for rearing *C. leucophaeatus* and *Languria* spp. *Conotrachelus leucophaeatus* can be reared on diet for multiple generations. However, the adults often emerge deformed. The pupae appear very healthy and it appears that it is a physical problem related to eclosion rather than a nutritional deficiency.

***Sirocalodes wickhami* (Champion) (Coleoptera: Curculionidae).** The weevil *Sirocalodes wickhami* breeds in flowers, fruits and seeds and the adults eat the same. Feeding by the larvae can destroy a large proportion of the seeds. It is known only from Puebla and Oaxaca states in Mexico. It is univoltine. It was less common in our collections than *C. leucophaeatus* and the *Languria* spp. *Sirocalodes tescorum* (Fall) was locally common on *Argemone munita* Dur. and Hilg. at high elevations in California (Goeden and Ricker 1985).

DISCUSSION

The fauna on *Argemone* appears to be depauperate with only 23 species of herbivores found. However of these, four species (17%) are likely to be highly specialised. Our

23 species is comparable with the 15 species on *Argemone corymbosa* Greene and *A. munita* in southern California (Goeden and Ricker 1985).

The four specialised species hold considerable promise as agents, but they are unlikely to be further tested in Australia unless Mexican poppy increases in importance. However, these agents may be beneficial to other countries where Mexican poppy is more important. Currently researchers in South Africa are pursuing two of these agents, or closely related ones.

To prove the host specificity of the promising agents, they will need to be imported into quarantine. It is difficult to do host specificity studies in Mexico as there are few other species of Papaveraceae there. The one species found in the field in Mexico, *B.occonia frutescens,* was useful in delineating the host range of the candidates, but more tests on other species of Papaveraceae and related families will be necessary.

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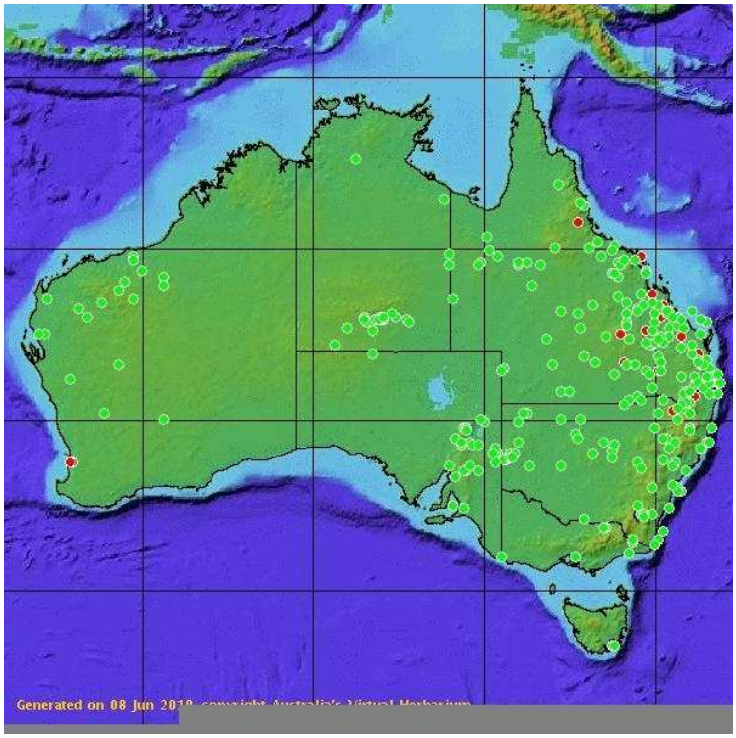

Figure 1. The distribution of *Argemone mexicana* (red dots) and *Argemone ochroleuca* (green dots) in Australia. Specimen data reproduced from Australia's Virtual Herbarium with permission of the Council of Heads of Australasian Herbaria Inc.

Figure 2. *Argemone mexicana* (left) and *Argemone ochroleuca* (right) growing together in experimental garden of the CSIRO Mexican Field Station. (Photo, R. Segura CSIRO).

Figure 3. The distribution of *Argemone mexicana* and *Argemone ochroleuca* from our surveys in Mexico.

Figure 4. Sites surveyed for natural enemies of *Argemone mexicana* and *Argemone Ochroleuca.*

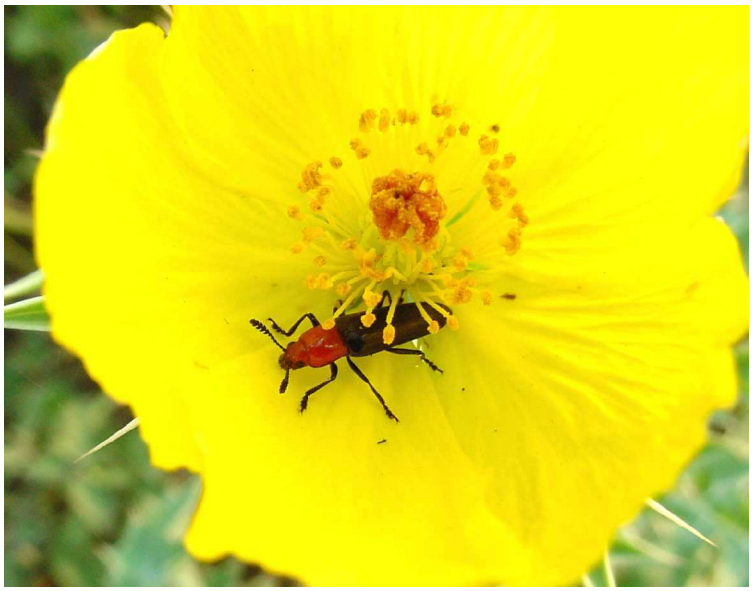

Figure 5. An adult of *Languria sanguinicollis* on a flower of *Argemone mexicana* in Mexico. (Photo, R. Segura CSIRO).

Figure 6. Adults of *Conotrachelus leucophaeatus* feeding on a fruit of *Argemone* sp. in Mexico. (Photo, R. Segura CSIRO).

Table 1. Natural enemies of species of *Argemone mexicana* and *Argemone ochroleuca* collected in surveys between 1998 and 2002. (Rare=1-2 specimens collected, Common=2-4 specimens collected, Abundant= >4 specimens collected)

Order	Family	Species	Abundance	Larval feeding site	Adult feeding site	Host specificity
Coleoptera						
	Chrysomelidae					
		Omophoita octomaculata Crotch	Rare	Leaf	Leaf	Polyphagous
	Curculionidae					
		Conotrachelus leucophaeatus Fahrs.	Abundant	Roots	All plant parts	Unknown
		Conotrachelus sp.	Abundant	Roots	All plant parts	Unknown
		Sirocalodes wickhami (Ch.)	Abundant	Fruits & immature seeds	All plant parts	Poss. Specific
		Curculionidae unidentified sp.	Common	Stem	Stem	Unknown
	Erotylidae					
		Erotylidae unidentified sp.	Common	Stem	Stem	Polyphagous
	Languriidae					
		Languria convexicollis Horn	Abundant	All plant parts	All plant parts	Poss. Specific
		Languria sanguinicollis Chrevrolat	Abundant	All plant parts	All plant parts	Poss. Specific
		Languria poss. *mozardi*	Rare	All plant parts	All plant parts	Unknown
	Tenebrionidae					
		Blapstinus sp.	Rare	Stem	Stem	Unknown
		Lobometopon sp.	Rare	Stem	Stem	Unknown
Hemiptera						
	Cicadellidae					

	Agrosoma bispinella Medler	Rare	Leaf	Leaf	Unknown
	Agrosoma syklis Medler	Common	Leaf	Leaf	Unknown
	Scaphytopius sp.	Common	All plant parts	All plant parts	Polyphagous
Coreidae					
	Largus cinctus Herrich-Schaeffer	Common	Leaf	Leaf	Polyphagous
Miridae					
	Lygus mexicanus Kelton	Rare	All plant parts	All plant parts	Polyphagous
Psyllidae					
	poss. *Mitrapsylla* sp.	Common	Apical growth	Apical growth	Poss. Specific
Rhyparochromidae					
	Atrazonotus umbrosus Distant	Rare	Fruit	Fruit	Unknown
Lepidoptera					
Noctuidae					
	Copitarsia sp.	Abundant	Leaf		Unknown
Tortricidae					
	Amorbia sp.	Rare	Leaf		Unknown
	Argyrotaenia sp.	Rare	Leaf		Unknown
	Clepsis sp.	Rare	Leaf		Prob. polyphagous
Hyphomycete					
	Cercosporidium guanicense (F. Stevens) Deighton	Abundant	Leaf		Poss. Specific