BIOTYPE MATCHING OF CHROMOLAENA FOR MORE SUCCESSFUL BIOLOGICAL CONTROL

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Abstract

Many phytophagous insects and pathogens are highly specific in their host requirements, and will develop sub-optimally or not at all on biotypes of a plant species dissimilar from that on which they are collected. This clearly has major implications for the success of biological control.

Chromolaena odorata has a native range stretching from the southern USA to northern Argentina. The species displays wide phenotypic variation, both across its range and within localised areas. Until 1997, the biotype of chromolaena invasive in southern Africa had not been found to match that of any plants from its native range. Such matching was considered a priority because of the low success of some agents in the biocontrol programme in South Africa. Since 1997, increasing evidence has accumulated indicating that the southern African chromolaena biotype originates from one or more of the islands of the Greater Antilles in the northern Caribbean. Taking into account findings in the field as well as colonial links, Jamaica seems the most likely origin.

Recent surveys of both Jamaica and Cuba have revealed a relatively poor diversity of insects on chromolaena relative to the South American mainland. It is thus still considered necessary to target insect species from the latter area, if it can be shown that they are not biotype-specific.

Keywords: alien invasive organisms, Greater Antilles, biological control, biotype matching, chromolaena, weeds

Introduction

Chromolaena odorata (L.) King & Robinson (Asteraceae), commonly called triffid weed or chromolaena, is a scrambling shrub from the Americas, with a native range stretching from the southern USA to northern Argentina (King and Robinson, 1970). It is considered the worst alien invasive plant in the subtropical areas of South Africa, where it invades a wide variety of habitats and impacts negatively on biodiversity and ecotourism, agriculture and forestry (Goodall and Erasmus, 1996). Chromolaena was introduced into South Africa either deliberately (as an ornamental) or accidentally, during or before the 1940s. It was first recorded as naturalised in South Africa in the late 1940s, when specimens were collected near Ndwedwe north of Durban (Liggitt, 1983). Since then it has spread throughout the coastal area of KwaZulu-Natal (KZN) and into the Eastern Cape, Mpumalanga and Limpopo provinces, as well as to neighbouring countries Swaziland and Mozambique.

Chromolaena is also considered one of the worst alien invasive plants in many other parts of the humid tropics and subtropics of the Old World, including west and central Africa, India, southern China, the whole of south-east Asia from Burma to Papua New Guinea, and several islands of the Pacific (Holm *et al*., 1977; McFadyen, 2002).

A climate-matching exercise has shown that the invasion front from central Africa is likely to meet that from southern Africa in east Africa, which is climatically well suited to chromolaena (McFadyen and Skarratt, 1996). The morphology, chemistry, growth-form and aspects of the biology of the 'biotype' of chromolaena invading southern Africa differs from that invading other parts of the Old World and, until six years ago, no biotype identical to the southern African chromolaena had been located in the Americas. Chromolaena displays wide phenotypic variation through its native range.

Biological Control

Although individual chromolaena plants are easy to kill, the reproductive output and growth rate of the species and the enormity of the infestation make it impractical to use conventional methods of control. Biological control ('biocontrol'), in which natural enemies (insects, mites and pathogens) associated with the species in its region of origin are used to decrease the growth, reproduction and survival rate of the plant where it is invasive, is widely recognised as being a critical element in any successful long term control strategy for chromolaena (Goodall and Erasmus, 1996).

Internationally, the biological control programme on chromolaena was initiated in the late 1960s, when a survey of the insects feeding on the plant in Trinidad was conducted (Cruttwell, 1974). Although a few of these were introduced as biocontrol agents in the 1970s and 1980s in several countries, only the defoliating moth *Pareuchaetes pseudoinsulata* Rego Barros (Lepidoptera: Arctiidae) established permanent field populations. Part of the low success of this programme during this period can be attributed to chromolaena being a problem mainly in developing countries which lacked resources for the initial, expensive stages of biocontrol (McFadyen, 1996).

Biotype Matching

South Africa's biocontrol programme began in 1988. One of several factors hampering this programme has been compatibility problems between southern African chromolaena plants and the candidate biocontrol agents imported into South African quarantine (Zachariades *et al*., 1999). These had, of necessity, been collected on other biotypes of chromolaena in the Americas, as the southern African biotype had not been located. Incompatibility manifested in several agents through slower growth rates and higher mortalities. It was thus realised early in the programme that in order to obtain success in the chromolaena programme, locating the origin of the southern African chromolaena biotype was a priority.

Early attempts at this included comparisons of isozymes, macro- and micromorphological features of herbarium specimens and live plants, flowering phenologies and bioassays using fungal pathogens (Zachariades *et al*., 1999). These studies generally suffered from using small sample sizes and gave no consistent indications as to origin. In 1997, a chromolaena cutting collected by S. Neser of ARC-PPRI in Jamaica was grown out and proved to be identical in appearance to the southern African biotype. Fungal pathogens collected at the same time on chromolaena from Jamaica were also among the first to develop well on the southern African biotype (den Breeÿen, 2002).

Further surveys by the author in countries surrounding the Caribbean confirmed substantial populations of the southern African chromolaena biotype in Jamaica, Cuba and Puerto Rico, in all cases occurring together with other biotypes. These northern Caribbean islands are close neighbours and, together with Hispaniola, are collectively known as the Greater Antilles.

Plants similar to the southern African biotype have also been reported anecdotally from the Bahamas ([1]personal communication). A DNA study was conducted using ISSR amplification and sequencing of the ITS region, but was inconclusive (von Senger, 2002). In a comparison of floral morphology, using a large number of herbarium specimens from throughout the world, the only specimens that matched the southern African biotype exactly were from Cuba and Jamaica.

Conclusions

The evidence presented above is considered sufficient to conclude with some confidence that the southern African chromolaena biotype originated from one of the Greater Antillean islands. It was recorded in the 1850s that chromolaena from Jamaica was being grown in the Cape Town Botanic Garden (McGibbon, 1858). A link between this and the KZN infestation has not yet been established, but may exist. Given that a great deal of exchange of plant material occurred during colonial times between British colonies, mainly through the Royal Botanical Garden at Kew, London (McCracken and McCracken, 1988), it seems most likely that the southern African chromolaena originated in Jamaica.

Ideally, chromolaena biocontrol candidates should from now on be collected only from the Greater Antilles, and from plants that match the southern African biotype. However, surveys on these islands have shown that, compared with mainland South America, the insect fauna associated with chromolaena is depauperate, and several insect species with considerable biocontrol potential are not present. It is thus necessary to continue work with species from other areas, in addition to those selected from the Greater Antilles. These will be screened to determine whether they have a sufficiently broad host range to perform well on the southern African chromolaena biotype.

Country-of-origin work is recognised as being of great value in weed biocontrol research. A contract is currently being negotiated with the University of the West Indies in Jamaica, and it appears likely that permission will be given for southern African chromolaena plants to be planted in field plots in Jamaica. This will allow the harvesting of insects and pathogens which choose to oviposit and/or develop on these plants in the field. Ultimately, this is the best way to ensure full host-agent compatibility in the field in South Africa.

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REFERENCES

Cruttwell RE (1974). Insects and mites attacking *Eupatorium odoratum* in the neotropics. 4: An annotated list of the insects and mites recorded from *Eupatorium odoratum* L., with a key to the types of damage found in Trinidad. *Techical Bulletin of the Commonwealth Institute for Biological Control* 17:87-125.

[1] IAW Macdonald, WWF-SA, Stellenbosch, 2000.

den Breeÿen A (2002). *Chromolaena odorata*: biological control using plant pathogens – a South African perspective. pp 167-169 In: C Zachariades, R Muniappan and L Strathie (Eds), Proceedings of the Fifth International Workshop on Biological Control and Management of *Chromolaena odorata*. Durban, October 2000. ARC-PPRI, Pretoria, South Africa.

Goodall JM and Erasmus DJ (1996). Review of the status and integrated control of the invasive alien weed, *Chromolaena odorata*, in South Africa. *Agriculture, Ecosystems and Environment* 56: 151-164.

Holm LG, Plucknett DL, Pancho JV and Herberger PD (1977). *The World's Worst Weeds. Distribution and Biology*. University Press of Hawaii, Honolulu.

King RM and Robinson H (1970). Studies in the Eupatorieae (Compositae). XXIX: The genus *Chromolaena*. *Phytologia* 20: 196-209.

Liggitt B (1983). *The Invasive Alien Plant* Chromolaena odorata*, with Regard to its Status and Control in Natal.* Monograph 2. Institute of Natural Resources, University of Natal, Pietermaritzburg, South Africa. 41 pp.

McCracken DP and McCracken EM (1988). *The Way to Kirstenbosch*. National Botanic Gardens. 125 pp.

McFadyen RC (1996). Biocontrol of *Chromolaena odorata*: divided we fail. pp 455-459 In: VC Moran and JH Hoffmann (Eds) Proceedings of the Ninth International Symposium on Biological Control of Weeds. UCT Press, Cape Town, South Africa.

McFadyen REC (2002). Chromolaena in Asia and the Pacific: spread continues but control prospects improve. pp 13-18 In: C Zachariades, R Muniappan and L Strathie (Eds), Proceedings of the Fifth International Workshop on Biological Control and Management of *Chromolaena odorata*. Durban, October 2000. ARC-PPRI, Pretoria, South Africa.

McFadyen R and Skarratt B (1996). Potential distribution of *Chromolaena odorata* (Siam weed) in Australia, Africa and Oceania. *Agriculture, Ecosystems and Environment* 59: 89-96.

McGibbon J (1858). *Catalogue of Plants in the Botanic Garden, Cape Town, Cape of Good Hope*. Saul Solomon and Co, Cape Town, South Africa.

von Senger I (2002). An assessment of the genetic diversity and origin of the invasive weed *Chromolaena odorata* (L.) King & Robinson in South Africa. MSc Thesis, Rhodes University, Grahamstown, South Africa.

Zachariades C, Strathie-Korrûbel LW and Kluge RL (1999). The South African programme on the biological control of *Chromolaena odorata* (L.) King and Robinson (Asteraceae) using insects. *African Entomology Memoir* 1: 89–102.