Controlling the spread of one of the world’s worst alien weed species, *Chromolaena odorata*, in South Africa,

by

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*Chromolaena odorata* (L.) King & Robinson is a perennial shrub which originated in the North, Central and South Americas and the West Indies (Henderson, 2001). It has, however, become established in the tropical and subtropical regions of Europe, Asia, Africa and the surrounding islands. According to Macdonald (2002), *Chromolaena* has all the characteristics of one of the world’s worst alien weed species. These include: dispersal by wind, man and other agents; fast growing; capable of vegetative regeneration; difficult to detect; allelopathic; promotes fires and is itself promoted by fire; shows numerous genetic strains, has many close relatives and is a prolific seeder. Macdonald (2002) also commented that *Chromolaena odorata* has invaded the tropical and subtropical forested areas of the world. These areas are mostly found in the less developed countries and are the repositories of most of the world’s biodiversity. *Chromolaena*, being very competitive and allelopathic, possesses the ability to suppress existing vegetation and natural succession, ultimately reducing species richness (Goodall and Zacharias, 2002). Biodiversity has contributed in many ways to the development of human culture, and has ecological, economic, ethical and scientific roles (www.wikipedia.org, 2005). There is therefore a need to manage the spread of *Chromolaena odorata* to conserve biodiversity. In Jamaica, Chromolaena is commonly referred to as “Jack-in-the-bush” and “Christmas Bush”. Here, it is used to make teas for cold and fever.

Description

*Chromolaena odorata* is sparsely hairy and stands at least 3m in the open and up to 10m when climbing vegetation. The shrub often forms dense thickets (see figure 1) with their opposite, wide-spreading branches (Henderson, 2001) which prevent the establishment of other species [Pacific Islands Ecosystem at Risk (PIER), 2004]. The leaves of *C. odorata* are ovate, petiolate and tri-nerved from the base, (figure 2). The florets range from white, as shown in figure 3, to pale blue and are present in terminal (Henderson, 2001) oblong capitula or heads (Retief, 2002). The seeds can be produced apomictically (Zachariades pers. com.) and are found in achenes about 50mm long (Henderson, 2001). Each achene (figure 4) has a ring of hairs (pappus) that has barbellate bristles (Retief, 2002) which can cling to hair and clothing [Pacific Islands Ecosystem at Risk (PIER), 2004] and facilitate wind dispersal. Many easily-dispersed seeds can be propagated from a single *C. odorata* plant. van Rijn (2000) reported as many as 93 000 and GISP Interactive Maps (2003) reported more than a million seeds per plant. These wind-dispersed, light-weight (2.54 ± 0.11 mg) seeds have facilitated the rapid spread of *Chromolaena* (Witkowski, 2002).
Impacts and Threats in Invaded Countries

The weed threatens subsistence and semi-commercial farming activities practiced by 85% of the population of Papua New Guinea. It threatens crops such as coconuts, coffee, cocoa and oil palm, which alone account for 30% of the national export income annually. *Chromolaena* affects a number of other land uses, namely: pastures for cattle grazing; subsistence food gardens; disturbed forests, roadsides and fringes of settlements and villages (Orapa et al. 2002).

Most people in Indonesia are dependent upon small-scale traditional agricultural systems and free range and tethered grazing of cattle. Here, cropping farmers are limited to the area of land that can be hand-cleared and maintained weed-free, while opportunities for grazing animals are reduced as valuable pastures are replaced by *C. odorata*. Fire
is frequently used to clear infested lands but this threatens villages, forests and plantations that are surrounded by the highly flammable weed (Wilson and Widayanto, 2002).

The negative impacts of *Chromolaena odorata* on biodiversity in South Africa are expressed in several ways. Some of these have been described by Zachariades and Goodall (2002).

1. The spread of *C. odorata* suppresses indigenous grassland and savannah vegetation through physical smothering and allelopathy.
2. It forms a higher plant biomass than the indigenous vegetation on forest ecotones\[^i\]. This increases the fuel load and causes seasonal fires to burn with greater intensity in invaded ecotones. *Chromolaena* grows particularly well on forest margins and rapidly colonises forest gaps created by dead trees and tree falls (see figures 5 and 6). It can even cause death of a tree and forest canopy collapse. The weed therefore poses a threat to forest biodiversity, given the small percentage of land covered by natural forests in South Africa.
Figure 5: *C. odorata* infesting forest: in the foreground are many young plants (bright green) re-growing after being slashed (could also be new plants growing from seed after a clearing operation). In the background, the *Chromolaena* is dead, where it has been severed at the base. When it is growing under a tree/in shade, it climbs up through the tree and grows out on top, to obtain maximum sunlight (Courtesy of ARC-PPRI)

![Image of *C. odorata* infesting forest]

Figure 6: *C. odorata* infesting forest (aerial view): the bright green regions indicate where *Chromolaena* has invaded forest gaps and replaced the forest. (Courtesy of ARC-PPRI)

*Chromolaena* also threatens the habitats of some high profile animal taxa. A study from 1994-1997 by Leslie and Spotila (2002) showed that the alien is posing a serious threat to the continued survival of the Nile crocodile, *Crocodylus niloticus* (Laurenti) (Reptilia: Crocodylidae) in Lake Saint Lucia. The study showed that the crocodiles were selecting open, sunny, sandy areas to deposit their eggs, due to the fact that the nests were being shaded by *Chromolaena*. A large number of shaded sites contributes to the production of a female-biased sex ratio and possibly prevent embryonic development altogether. *Chromolaena* has also hindered the digging of egg chambers due to the fact that the crocodiles were unable to dig through the fibrous mat of roots. Unless immediate action is taken a female-biased sex ratio will result in eventual extinction of the species.

*Chromolaena* also is threatening the endangered black rhinoceros, *Diceros bicornis* (L.) (Mammalia: Rhinocerotidae) in Maputaland, an important centre of endemism (Zachariades and Goodall, 2002). Here, *Chromolaena* has reduced the natural food supply of the rhinoceros population; *C. odorata* itself is unpalatable. As a
result, up to $US 3 million is spent per year to clear the reserve of 10 000 ha, and it is estimated that, at the present state, it will take approximately 5 years before clearing is finished (Zachariades pers. com.).

*Chromolaena* has several other negative impacts in South Africa. Having a greater biomass and higher rates of transpiration compared to the indigenous vegetation, it reduces water run-off in water catchments by about 7%. It has decreased the livestock carrying capacity in both commercial and subsistence farming situations and reduced profit margins due to infestations along drainage lines and field margins. Commercial farms can afford the cost of sustained chemical control of infestations, but economic consequences are serious for subsistence crop agriculture (Zachariades and Goodall, 2002).

Biological control and Management

To successfully control the spread of *Chromolaena odorata*, biological control is becoming the only adequate method. Biological control, instead of eliminating the target organism, aims to establish an equilibrium which maintains its population at a level of negligible harm (Bani, 2002). Although the chemical control of *C. odorata* is effective, the growth rate and spread of the plant make it impossible to contain in the long term. Biological control would therefore serve as a means to reduce the vigour and reproductive output of the weed to a level at which other means of control become cost effective (Zachariades et al., 1999). Due to the northern Caribbean origin of the South African biotype, natural enemies that stunt the growth of *C. odorata* in Jamaica are particularly desirable as biological control candidates. These include the stem-tip killing fly, *Melanagromyza eupatoriella* (Diptera: Agromyzidae), *Polymorphomyia basilica* (Diptera: Tephritidae) and the stem-tip galling moths *Mescinia* sp. (Lepidoptera: Pyralidae) and *Dichrorampha* (Lepidoptera: Tortricidae). The adult stage of each species is shown in figures 7, 9, 11 and 13, respectively.

Biological control candidates

*Melanagromyza eupatoriella*

The female inserts a single egg into the midrib on the underside of the second or third leaf below the shoot tip, close to the petiole. The shoot tip is inspected for previous oviposition so that usually only a single egg per shoot tip is laid. The larvae bores into the vein at the site of oviposition, creating a characteristic spiral tunnel down the shoot tip, cutting the vascular bundles and causing the tissue above the larvae to wilt and die, as shown in figure 8. Before pupating, the larvae create a window in the stem (Zachariades et al., 1999).
**Polymorphomyia basilica**

Eggs are deposited into the internodes of young, actively growing stems and spiral-shaped galls (see figure 10) are formed with a single larva per gall. The pupal stage attaches to the epidermal ‘window’ formed by the larvae prior to pupation (Strathie and Zachariades, 2004).
**Mescinia sp**

The eggs of this species hatch within 5 to 6 days and the larvae wander over the leaves until they encounter a terminal bud. Unlike *M. eupatoriella*, several eggs are laid on one leaf and up to seven larvae may enter the same bud. The apical meristem is destroyed by the feeding of the larvae and all upward growth ceases, although affected stems may increase in circumference. The larvae feed until mature in the tissues of the stem tip, tunnelling downwards as much as 2cm. Frass is ejected through a hole at the tip (Cruttwell, 1977) as shown in figure 12.

**Figure 11:** *Mescinia* (pinned)

(Courtesy of ARC-PPRI)

**Figure 12:** Frass ejected from damaged shoot tips

(Courtesy of ARC-PPRI)

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**Dichrorampha sp**

This stem-tip-galler creates smaller galls than those of Mescinia, extrudes less frass and is almost always present on terminal shoot tips (figure 14). The larva exits the gall to pupate on an adjacent leaf. Here, it folds over the leaf and creates a small envelope in which it pupates (Zachariades pers. com.)
Contract work at the Department of Life Sciences of UWI Mona Campus will involve field surveys to determine the host-specificity of the insects that are associated with *C. odorata*. The highest priority with respect to biological control agents for the current study is *M. eupatoriella*, as it is widespread and abundant in the Americas, has a short life cycle, high fecundity and is likely to be host specific (C. Zachariades, pers. com.).

References


[i] Allelopathic: Describes a plant which produces specific chemical compounds that can induce suffering in, or give benefit to, another plant.

[ii] Capitula (*sing.* Capitulum): a head of flowers

[iii] Apomictically (from the word Apomixis: production of an embryo in plants without fertilization or meiosis)

[iv] Achene: small, dry, indehiscent, one-seeded fruit with a thin wall

[v] Ecotone: zone of distribution of an organism across the boundaries of which the individuals of a species become progressively fewer, less productive and sometimes smaller

[vi] Frass: faeces