
Biological Control of *Chromolaena odorata*: Successes and Failures

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Abstract

Chromolaena odorata, a neotropical plant, has spread throughout humid tropical Asia, Africa, the Western Pacific and a small area in northern Australia. A Commonwealth Institute of Biological Control project in 1966 identified over 200 arthropod natural enemies of this weed. *Pareuchaetes pseudoinsulata* was one of the first natural enemies identified in this project. It was introduced to Ghana, Nigeria, India, Sri Lanka and Malaysia in the 1970s and early 1980s, but it established only in Sri Lanka. In the mid 1980s it was confirmed that *P. pseudoinsulata* had established in Malaysia from the earlier introductions and had fortuitously spread to Brunei and the Philippines. Introductions after the mid 1980s resulted in its establishment in Guam, Rota, Tinian, Saipan, Yap, Pohnpei, Kosrae, India, Indonesia and Ghana. Establishment did not occur following releases in Thailand and Ivory Coast. The success rate of *P. pseudoinsulata* establishment has increased from 17% in the 1970s and early 1980s to 75% from the mid -1980s onwards. The seed-feeding weevil, *Apion brunneonigrum* failed to establish after being released in Ghana, Nigeria, Malaysia, India, Sri Lanka and Guam. The eriophyid mite, *Acalius adoratus* has fortuitously established in South and Southeast Asia. The gall fly has established in Indonesia.

It is possible that the *C. odorata* in South Africa is a different biotype from those in Asia, the Western Pacific and the rest of Africa. The natural enemies established in the Old World could not be established in South Africa.

Keywords: *Chromolaena odorata*, biological control, successes and failures, natural enemies.

Chromolaena odorata (L.) R. M. King and H. Robinson, commonly known as Siam weed, is of neotropical origin. It was first introduced to Calcutta, India in 1845 as an ornamental plant. It has since escaped cultivation and spread throughout humid tropical Asia, Africa, the Western Pacific and a small area in northern Australia.

C. odorata forms scrambling thickets and grows to a height of 3 m. It is considered a serious weed in plantation crops such as oil palm, coconut, cashew, teak, rubber and citrus, disturbed forests, pastures and natural reserves. It is highly allelopathic and suppresses neighboring vegetation. During the dry season the dried stems of this plant readily burn, but the stumps remain alive and rapidly grow and cover the area in the succeeding rainy season. Attempts to control this weed by methods other than biological control are not economical, environmentally safe or effective.

Biological Control:

In 1966 the Nigerian Oil Palm Research Institute, recognizing the seriousness of *C. odorata*, requested Commonwealth Institute of Biological Control (CIBC) (now CABI Bioscience) to initiate a biological control program by conducting exploration for natural enemies in the neotropics. Cruttwell McFadyen (1988) identified 207 insect and 2 mite species that attacked *C. odorata* in the Americas. Of these, about a quarter are specific to *Chromolaena* (Waterhouse 1994).

Successes:

Pareuchaetes pseudoinsulata Rego Barros (Arctiidae) was one of the first natural enemies identified in the CIBC project. Its host specificity was tested in the late 1960s. Releases in Sabah, Malaysia from 1970-72 reported only temporarily establishment (Syed 1979). Releases in Sri Lanka in 1973 resulted in permanent establishment (Dharmadhikari *et al.* 1977). In the mid 1980s, it was confirmed that the introductions of the early 1970s resulted in establishment in Sabah. It has spread unaided to Palawan island in the Philippines and to Brunei (Waterhouse 1994). Subsequent releases in India in the late 1980s and early 1990s resulted in establishment (Joy *et al.* 1993). Releases were made and establishment obtained in Guam in 1985, Northern Mariana Islands in 1986-87 (Seibert 1989), Yap in 1989 - 91 (Muniappan *et al.* 1988), Pohnpei in 1988 - 90 (Esguerra *et al.* 1991) Kosrae in 1992 (Esguerra 1998) and Indonesia in 1991 (Cruttwell McFadyen 1994). Even though releases in 1970-78 in Ghana were not successful, releases made in 1991-93 resulted in establishment (Timbilla 1996).

Attempts to establish *P. pseudoinsulata* in South Africa in 1989 failed. However, recent releases of large numbers of larvae and adults seem to have resulted in establishment (Zachariades and Strathie-Korrübel 1999).

The eriophyid mite, *Acalitus adoratus* Keifer (Eriophyidae) was accidentally introduced to Malaysia from Trinidad through contaminated shipments of the natural enemy *Apion brunneonigrum* Beguin-Billecoq (Benthidae) (Cruttwell McFadyen 1995). It has spread fortuitously to Thailand, Indonesia, Philippines, Western Caroline Islands, Mariana Islands and India.

The gall fly, *Procecidochares connexa* (Macq.) (Tephritidae) was host specificity tested, released and established in Indonesia in 1996 (McFadyen 1999). It is currently being host specificity tested in Guam, Palau and the Philippines.

Failures:

The flower feeding weevil, *A. brunneonigrum* was released in Sabah, Malaysia in 1970, Nigeria in 1970 - 75, Ghana in 1975, India in 1972 - 73, 1983, Sri Lanka 1974 -76 and Guam in 1984, but it did not establish. *A. brunneonigrum* is difficult to rear as it only has a single generation per year. Field collected adults from Trinidad were therefore shipped to the receiving countries for direct field release.

A small number of moths of *Mescinia parvula* (Zeller) (Pylalidae) were released in 1984 and 1986 in Guam as attempts at laboratory rearing failed. Two shipments of this insect were received in India in 1986, but were not released since it could not be reared in the laboratory (Singh 1998).

The shoot borer, *Melanagromyza eupatoriella* Spencer (Agromyzidae) was imported to Thailand in 1978 but was not released (Napompeth and Winotai 1991). The shipment sent to Guam from Trinidad in 1987 was mostly parasitized and no releases were made.

Attempts to introduce and establish *P. pseudoinsulata* in Nigeria 1970-78, India 1973, 1978-84, Thailand 1986-88, and Ivory Coast 1993-94 failed. Experience gained in Guam in establishing *P. pseudoinsulata* revealed a large number individuals must be released in an area to overcome predatory pressure. Failure to establish in India in the early 1970s and 1980s has been attributed to predation from ants. On Guam the predation was by the ant, *Solenopsis geminata* F., many species of spiders, the toad, *Bufo marinus* L. and the brown skink, *Carlia furca* Dumeril and Bibran (Seibert 1989).

Discussion

The eriophyid mite, *A. adoratus* has established fortuitously in South and Southeast Asia. *P. pseudoinsulata* exhibited 17% successful establishment in the 1970s and early 80s (Crawley 1990) which has improved to 75% from the mid-1980s onwards. It has also fortuitously established in the Philippines and Brunei. Even though releases of *P. pseudoinsulata* in 1989 in South Africa failed to establish, re-releases based on the success in Ghana in 1993 of this insect have shown indications of establishment (Zachariades and Strathie-Korrübel 1999). Since the successful establishment of *P. pseudoinsulata* in Guam in 1985, four international workshops on the biological control of *C. odorata* were conducted at Bangkok, Thailand in 1988, Bogor, Indonesia in 1991, Abidjan, Ivory Coast in 1994 and Bangalore, India in 1996 and 13 *Chromolaena odorata* newsletters were published. A *Chromolaena* network and *Chromolaena* working group under the auspices of the International Organization for Biological Control have been established. These workshops, newsletters, network and working group have provided technical information to scientists working on *Chromolaena*, which has in turn helped improve the establishment rate of *P. pseudoinsulata*.

Efforts to establish *A. brunneonigrum* have failed in 6 countries. *Procecidochares connexa* has been successfully established in Indonesia and it will likely be established in the near future in Palau, Guam and the Philippines. Failure to establish *M. parvula* on Guam was not surprising as only a handful of the moths were field released. *Melanagromyza eupatoriella* shipments received in Thailand in 1978 and in Guam in 1987 were not released into the field. Rearing techniques for *M. eupatoriella* have recently been developed in South Africa and will enhance the future establishment rates of this insect. There is a need to develop rearing techniques for *M. parvula*. The butterfly, *Actinote antea*s (Doubleday and Howitson) (Acraeidae) has been host specificity tested in Indonesia and is expected to be field released soon.

South Africa has vigorously pursued biological control of *C. odorata*. The natural enemies *P. pseudoinsulata*, *Pareuchaetes insulata* (Walker), *Pareuchaetes aurata aurata* (Butler), *A. antea*s, *Actinote* sp. prob. *A. paraphelus* Jordan, *M. eupatoriella*, *Lixus* sp. (Curculionidae), *Longitarsus* sp. (Chrysomelidae), *Adaina* sp. (Pterophoridae) and some fungal pathogens are at various stages of testing and release (Zachariades *et al.* 1998). The limited success thus far achieved suggests that the South African form of *C. odorata* is different from the old world invader.

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References

- Crawley, M.J. 1990.** Plant life-history and success of weed biological control projects. pp 17-26. *In* Proceedings, VII International Symposium on Biological Control of Weeds, Delfosse, E.S. [ed.]. 6-11, March 1988, Rome, Italy. 1st. Sper. Patol. Veg. (MAF).
- Cruttwell McFadyen, R.E. 1988.** Phytophagous insects recorded from *C. odorata*. *Chromolaena odorata* Newsletter 2:5-23.
- Cruttwell McFadyen, R.E. 1994.** Biological control of *Chromolaena* in Indonesia: Progress with the Australian ACIAR project. *Chromolaena odorata* Newsletter 9:4.
- Cruttwell McFadyen, R.E. 1995.** The accidental introduction of the *Chromolaena* mite, *Acalitus adoratus*, into South-East Asia. pp 649-52. *In* Proceedings, Eighth International Symposium on Biological Control of Weeds, Delfosse, E.S. and R.R. Scott [eds.], 2-7 February 1992, Lincoln University, Canterbury, New Zealand. DSIR/CSIRO, Melbourne.
- Dharmadhikari, P.R., P.A.C.R. Perera, and T.M.F. Hassen. 1977.** The introduction of *Ammalo insulata* for the control of *Eupatorium odoratum* in Sri Lanka. Commonwealth Institute of Biological Control. Technical Bulletin 18:129-135.
- Esguerra, N.M. 1998.** The Siam weed infestation in the Federated States of Micronesia - Seven years of attempting to control it. pp 80-81. *In* Proceedings, Fourth International Workshop on Biological Control and Management of *Chromolaena odorata*, 1996, Bangalore, India.
- Esguerra, N.M., W.S. William, and J.R. Smith. 1991.** Status of biological control of the Siam weed *Chromolaena odorata* (L.) R.M. King and H. Robinson on Pohnpei, Federated States of Micronesia. Ecology and Management of *Chromolaena odorata*. BIOTROP Special Publication 44:99-104.
- Joy, P.J., K.R. Lyla, and N.V. Satheesan. 1993.** Biological control of *Chromolaena odorata* in Kerala (India). *Chromolaena odorata* Newsletter 7:1-3.
- McFadyen, R.E. 1999.** Successful control of *Chromolaena* achieved in north Sumatra, Indonesia. *Chromolaena odorata* Newsletter 13:1-2.
- Muniappan, R., M. Marutani, and G.R.W. Denton. 1988.** Introduction and establishment of *Pareuchaetes pseudoinsulata* Rego Barros (Arctiidae) against *Chromolaena odorata* in the Western Caroline Islands. *J. Biol. Control* 2:141-142.
- Napompeh, B., and A. Winotai. 1991.** Progress on biological control of Siam weed, *Chromolaena odorata* in Thailand. Ecology and Management of *Chromolaena odorata*. BIOTROP Special Publication 44:91-97.
- Seibert, T.F. 1989.** Biological control of the weed, *Chromolaena odorata* (Asteraceae) by *Pareuchaetes pseudoinsulata* (Lepidoptera: Arctiidae) on Guam and the Northern Mariana Islands. *Entomophaga* 34:531-539.
- Singh, S.P. 1998.** A review of biological suppression of *Chromolaena odorata* (L.) King and Robinson in India. pp 86-92. *In* Proceedings, Fourth International Workshop on Biological Control and Management of *Chromolaena odorata*, 1996, Bangalore, India.
- Syed, R.A. 1979.** An attempt on biological control of *Eupatorium odoratum* L. f. in Sabah, Malaysia. 2: 459-466. *In* Proceedings, Sixth Asian-Pacific Weed Science Society, Soerjani [ed.], 1977, Jakarta, Indonesia.
- Timbilla, J.A. 1996.** Status of *Chromolaena odorata* biological control using *Pareuchaetes pseudoinsulata*, in Ghana. pp.327-331. *In* Proceedings, IX International Symposium on Biological Control of Weeds, V.C.Moran and J.H. Hoffman [eds.], 19-26 January 1996, Stellenbosch, South Africa, University of Cape Town.
- Waterhouse, D.F. 1994.** Biological Control of Weeds: Southeast Asian Prospects. Australian Centre for International Agricultural Research, Canberra pp 302.
- Zachariades, C., and U.W. Strathie-Korrûbel. 1999.** Insects for the biological control of *Chromolaena odorata* in South Africa: Recent research and implementation. *Chromolaena odorata* Newsletter 13: 3-4.

Zachariades, C., R.L. Kluge, S. Nesser, and L.W. Strathie. 1998. Promising new candidates for the biocontrol of *Chromolaena odorata*. pp 73-79. *In* Proceedings, Fourth International Workshop on Biological control and Management of *Chromolaena odorata*, 1996, Bangalore, India.