SCIENTIFIC NOTE

Distribution of *Chromolaena odorata* and its Biological Control in Taiwan

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Abstract. *Chromolaena odorata*, introduced about 15 years ago to the southern part of Taiwan as a medicinal plant has become an invasive weed and has already spread to the counties of Pingtung, Kaohsiung, Tainan, Chiayi, Yunlin, Changhau, Taichung, and Taitung. An eriophyid mite, *Acalitus adoratus*, has been fortuitously introduced but is not effective in controlling *C. odorata*. Two effective natural enemies, a moth, *Pareuchaetes pseudoinsulata* and a gall fly, *Cecidochares connexa* have been imported from Guam into the quarantine facility at the National Pingtung University of Science and Technology for host-specificity testing and field release upon approval by the quarantine authority.

Key words: *Acalitus adoratus*, Biological control, *Cecidochares connexa*, *Chromolaena odorata*, Invasive alien plant, *Pareuchaetes pseudoinsulata*, Taiwan.

Chromolaena odorata (L.) R.M. King and H. Robinson (Asteraceae) is a neotropical plant that was introduced to Calcutta Botanical Gardens in 1845 (Voigt 1845) and escaped cultivation, becoming a weed problem in most of the humid tropical regions of Asia and Micronesia. It was introduced to West Africa in 1937 through the contaminated seeds of *Gmelina arborea* Roxb. (Verbenaceae) from Sri Lanka (Ivens 1974). About a decade later, a separate introduction to Durban, South Africa from the Caribbean occurred (Liggitt 1983). It was introduced to Taiwan in 1989 (Wu et al. 2004) as a medicinal plant but only a decade after its introduction it has already become a naturalized invasive weed in three counties of southern Taiwan (Peng and Yang 1998).

Chromolaena odorata is commonly known as chromolaena, Siam weed, paraffin weed, Christmas weed and by several other local names in different countries. It is a perennial scrambling shrub that invades open areas such as pastures, roadsides, river banks, disturbed forests, plantation crops, nature reserves and wildlife sanctuaries. Because of its high allelopathic properties (Ambika and Jayachandra 1980), it suppresses neighboring vegetation and prevents self-seeding of forest trees. It is toxic to domestic animals and wildlife (Biller et al. 1994). It produces lilac-colored flowers in November and December and the seeds are dispersed in January and February. Subsequently, the shoots dry up and the plant becomes a fire hazard, as it readily burns (Muniappan et al. 2005). When a fire goes through a chromolaena-infested area, the tops of this plant burn, but the stumps remain alive and sprout immediately after the onset of rain.

Distribution: Peng and Yang (1998) listed distribution of chromolaena in 1998 as being primarily in the counties of Pingtung, Kaohsiung, and Tainan in southern Taiwan. Our recent survey indicates that it has extended its range into Chiayi, Yunlin, Changhua, Taichung,

and Taitung counties (Fig. 1). Survey was done by driving to different habitats in these provinces and observing the presence or absence of chromolaena. Peng and Yang (1998) described chromolaena as occurring at low altitudes in alluvial soils of river valleys, and in association with several other introduced weeds. We have observed it to grow at an elevation of 1,200 m in Wutai, Pingtong. Chromolaena is known to replace other weeds such as *Lantana camara* L. (Verbenaceae) and *Imperata cylindrica* (L.) Beauv. (Poaceae) and to become the single dominant species in an area.

Biological control: While mechanical control using hand tools is employed in developing countries, such a control method is expensive and in Taiwan it is prohibitively expensive. Chemical control using herbicides is an option available in plantation crops. However, most of the herbicides currently available are nonselective and require repeated applications. Therefore, it is not economical and environmentally safe to use in areas such as disturbed forests, roadsides, riverbanks, pastures and vacant lands.

Biological control of chromolaena was initiated in the early 1960s when the Nigerian Oil Palm Research Institute requested the Commonwealth Institute of Biological Control (CIBC) (now CABI Bioscience) to take up a project for exploration, identification and introduction of the natural enemies of *C. odorata*. Over 200 species of arthropods were identified as feeding on *C. odorata* in this study, mainly in Trinidad but also in other parts of the native range of *C. odorata* (Cruttwell McFadyen 1988), of which about a quarter were found to be host specific (Waterhouse, 1994). Of the several species tested, the moth *Pareuchaetes pseudoinsulata* Rego Barros (Lepidoptera: Arctiidae) and the gall fly *Cecidochares connexa* Macquart (Diptera: Tephritidae) have proven effective and have been utilized in several countries. A mite, *Acalitus adoratus* Keifer (Acarina: Eriophyidae), was accidentally introduced to Malaysia from Trinidad in the early 1970s (McFadyen 1993) and from this introduction, it has fortuitously established in most countries in south and southeast Asia including Taiwan and Micronesia. Even though it produces erinia on the lower surface of the leaves and sometimes causes distortion of the leaves, its efficacy in reducing the vigor and growth of the plant is limited.

Muniappan et al. (2005) have reviewed the introduction and establishment of *P. pseudoinsulata* to different countries in Asia, Africa and Micronesia. *P. pseudoinsulata* lays eggs in batches varying from 2 to 40. Eggs hatch in about 7 days and larval development takes about 15 days. Larvae feed mostly at night on the plants and hide during the day. Pupation takes place in dried leaves either on the plant or on the ground (Muniappan et al. 1989).

Defoliation by the larvae of *P. pseudoinsulata* results in the death of plants that occur in thickets. It has effectively suppressed *C. odorata* thickets in countries in which it has been established (Muniappan et al. 1989, Seibert 1989, Desmier de Chenon et al. 2002). However, its effectiveness has been reduced by the insect-induced defense mechanism exhibited by plants occurring in scattered patches (Marutani and Muniappan 1991). In June 2004, a culture of *P. pseudoinsulata* was imported from Guam into the quarantine laboratory of the Institute of Tropical Agriculture and International Cooperation, National Pingtung University of Science and Technology, Taiwan. After host-specificity studies and upon receipt of the approval from the quarantine authority in Taiwan, this agent will be field released.

Cecidochares connexa was collected in Colombia, South America and imported into Marihat, North Sumatra, Indonesia in 1994 (Desmier de Chenon et al. 2002). Muniappan et al. (2005) have reported its introduction to various countries in Asia and Micronesia. A shipment of this fly was imported from Guam and it is being cultured in the quarantine facility at the Institute of Tropical Agriculture and International Cooperation, National Pingtung University of Science and Technology. After conducting host-specificity studies and upon receipt of approval from the quarantine authority, this agent will be field released in Taiwan.

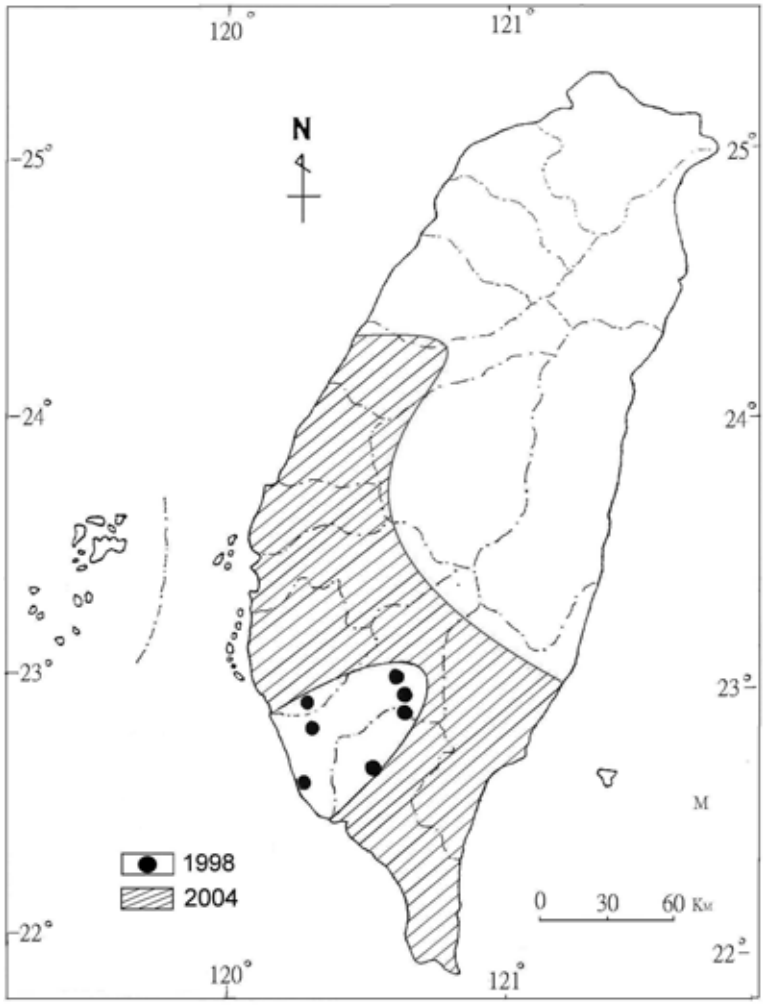

Figure 1. Distribution of *Chromolaena odorata* in Taiwan in 1998 and 2004.

Cecidochares connexa lays eggs in the vegetative shoot tips of *C. odorata*. Maggots tunnel into the tissue and form stem galls. The number of maggots in a gall varies from one to seven but most commonly three or four maggots are found in a gall. The galls act as nutrient sinks, resulting in a reduction in plant vigor and growth. Since the galls are in the terminal shoots, they reduce flower and seed production (Cruttwell McFadyen et al. 2003).

Recent evidence of effective biological control of chromolaena in Indonesia, Papua New Guinea, Pohnpei and Guam (Desmier de Chenon et al. 2002, Esguerra 1998, Muniappan, et al. 2005, Orapa and Bofeng 2004) indicates that comparable success can be achieved in Taiwan.

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