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Status of *Chromolaena odorata* biological control using *Pareuchaetes pseudoinsulata*, in Ghana

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Abstract. *Chromolaena odorata* was introduced to southern Ghana in 1969. Its present distribution is up to latitude 8°15' N. The weed has not yet invaded the drier areas further north. Despite the apparent medicinal and other useful attributes, the problem of *C. odorata* must be looked at in an ecological context. Biological control of the weed in Ghana failed in the early 1970s due to the lack of sustained effort. A renewed attempt at biological control was made in 1989 using the arctiid moth *Pareuchaetes pseudoinsulata*. Following field releases in 1991, the insect has now established. Pockets of establishment of the insect and noticeable control of the weed have been located up to 45 km from the sites of release. The prospects for biological control of the weed using *P. pseudoinsulata* are discussed.

Introduction

The siam weed, *Chromolaena odorata* (L.) King and Robinson (= *Eupatorium odoratum*) belongs to the family Asteraceae (Compositae). Its occurrence is said to be limited to latitudes 30°N and S and up to altitudes of about 1000 m, in locations with annual rainfall figures of about 2000 mm (Muniappan and Marutani 1988).

From its Central and South American and Caribbean origin, the weed spread to the Old World via ballast in ships from the West Indies, and was reported in Singapore and Malaya in the 1920s (Bennett and Rao 1968). By the late 1960s, *C. odorata* had become an important weed in Nigeria (since its introduction there in the 1940s) and it has spread to Ghana, Côte d'Ivoire and Cameroon. In Ghana, the weed was first discovered in February 1969 in old, abandoned, experimental plots in the Legon Botanic Gardens (Hall and Enti 1972). Timbilla and Braimah (1996) discuss the introduction of *C. odorata* to Ghana. By 1972 it had spread to the Greater Accra, central and western regions. The importance of this weed has given rise to about eleven local names in Ghana, particularly 'Acheampong' which is the name of a head of state whose regime coincided with the pestilence of the weed (Timbilla and Braimah 1996).

This paper comprises a report on recent advances made in the biological control of *C. odorata* in Ghana using the arctiid moth *Pareuchaetes pseudoinsulata*.

Distribution and weed status of *C. odorata* in Ghana

Ghana is located between latitudes 4°45' and 11°N and longitudes 3°15'W and 1°15'E with an area of 270500 km^2. The highest point is 886 m above sea level and rainfall of about 1750-2800 mm is reported in the High Rainforest Zone and 700-1040 mm in the Sudan Savannah Zone. The country is divided into ten administrative regions with six different ecological zones. These are the Sudan Savannah, Interior Savannah, Forest Savannah Transitional Zone, Coastal Savannah, Semi-Deciduous Rainforest and the High Rainfall Zone.

The present distribution of the weed is up to latitude 8°15'N (Timbilla and Braimah 1996). Its spread further north seems to be limited by the unimodal rainfall pattern. In its new habitats it spreads quickly and forms dense thickets and has become a weed which seriously interferes not only with natural vegetation, but also with forest, pastures and plantation crops. Other areas infested include abandoned fields, roadsides, riverbanks, cleared roads and forest margins.

Farmers have indicated that the weed has eliminated their chances of returning to harvested fields for remnant crops, particularly cassava, during the dry season which is a time of food scarcity. *Chromolaena odorata* is also known to suppress other

plants, and serves as an alternate host to nymphs of variegated grasshoppers and to aphids. *Chromolaena odorata* is one of the major causes of bush fires in the dry season (November-March) in the forest regions. Cultivated crops, especially young plantations are easily smothered. Cocoa farmers speculate that if the weed is not eradicated within the next few years, cocoa growing may be seriously hampered. Farmers claim that the wounds which result from *C. odorata* stumps develop into serious illnesses due to secondary infection, sometimes resulting in paralysis of the affected part. Death from possible secondary-infection has been reported in parts of the central and western regions. The weed is also said to cause skin irritations and rashes in people who show allergies to it.

Chromolaena odorata harbours rodents and other wild animals. It thus provides refuge for pests and vectors of diseases. The weed is also said to cause acute diarrhoea in cattle and other ruminants. Some cattle-breeders abandon land that is infested by *C. odorata* as the weed poses danger to their cattle after it has smothered most of the fodder grasses and shrubs. Finally, because of the aggressive growth habits of the weed, it is difficult to suppress and it thus increases the cost of maintenance of infested farms. There is the danger of extinction of other plant species which may have various uses in the maintenance of the ecosystem (Timbilla and Braimah 1996).

Despite its weed status, *C. odorata* is claimed to be of use in agriculture, conservation and medicine. It is contended that lands left fallow under *C. odorata* produce high yields of crops, such as maize and cassava. This is probably due to the high litter-fall and rapid recycling of nutrients which improves the soil organic-matter and thus improves its structure; this observation is however yet to be supported by scientific data in comparison to the situation before the introduction of *C. odorata*. In grassland areas, some farmers welcome the weed because it is comparatively easy to clear.

In spite of this 'conflict of interest', farmers support biological control programmes because of the costs involved in controlling the weed by either chemical or mechanical means. With chemical control the potential environmental hazards, the unavailability of chemicals at the right time, and harm caused to operators, make their use, even if affordable, unwelcome. Thus alternative, less costly, sustainable and safer methods are required.

Biological control of *Chromolaena odorata* in Ghana

Biological control of *C. odorata* in Ghana started in the early 1970s. This attempt failed due to the lack of sustained effort. Since 1989, a renewed attempt in the control of *C. odorata* began at the Biological Control Division (former CIBC; now IIBC West African Sub-Station) of the Crops Research Institute, in collaboration with the Agricultural Research Station, Guam, United States of America. Preliminary investigations included studies on the biology of the control agent *P. pseudoinsulata*, its host-range and specificity, and its disease- and pest-associations with *C. odorata*.

With the arrival of the control agent, *P. pseudoinsulata* in Ghana in November 1989, the biology of the insect was studied in the laboratory to verify results obtained elsewhere. Eggs were laid in batches on *C. odorata* leaves and on the walls of the cages in which the insects were reared. Batch-size varied from 2-68 eggs. The incubation period was about five days. Larval-size ranged from 2-22 mm. The larvae took about 21 days to develop and pupation took approximately nine days. Adults lived for an average of five days. Thus, the total life cycle of *P. pseudoinsulata* from egg to adult emergence was completed in about 36 days (Timbilla 1991).

Tests on the host-range and specificity of the insect were conducted in 1990 to ensure that no economic plant would be affected by the release of the moth. Of 44 plant species (belonging to 25 plant families) tested, none was attacked by *P. pseudoinsulata* and the larvae died of starvation within five days.

On completion of the preliminary investigations, mass-rearing and experimental field releases were done. The first insects were released in September 1991 in an experimental field at the Fumesua station of the Crops Research Institute, Kumasi (Table 1). Releases continued until October 1993.

Table 1. Numbers of *P. pseudoinsulata* released at Fumesua Station (Kumasi). The releases were made over an area of about 250000 m^2.

Year	No. of larvae	No. of adults
1991	19800	1489
1992	38832	3985
1993	60624	791
Total	119256	6265

Diseases and pests associated with *C. odorata* in Ghana

Timbilla (1991) identified a number of insects and mites associated with *C. odorata*. Fungal and bacterial pathogens were not observed, perhaps because the survey was conducted during the wrong season. Species of Lepidoptera, Hymenoptera (including some stem-borers), Coleoptera, Dictyoptera, Orthoptera, Heteroptera, Homoptera, Thysanoptera and Acarina were observed on *C. odorata*. The orthopteran, *Zonocerus variegatus*, was the most common and its nymphal stages are known to cause damage to *C. odorata*. The relationships of these organisms to *C. odorata* were not studied

Results

In September 1991, 615 adults were released at Fumesua. An additional 19800 larvae and 874 adults were released during October at the same site. The insects established and started to bring about some control. However, by mid-November when the dry harmattan winds set in, the insects disappeared from the field. In April 1992, 60 first- and second-instar larvae were observed in the field. By June 16 1992, spectacular damage (including damage to terminal and axillary buds) was seen within 50 m of the release site.

Between July and September, 1992, most of the *C. odorata* plants had died, but a few showed signs of regeneration. Some of the control agents had also migrated to a nearby *C. odorata* field. During the same period, 5592 third-instar larvae and 3400 adults were released at three other sites.

In October 1992, a total of 33240 third-instar larvae and 585 adults were released at these three sites. *Pareuchaetes pseudoinsulata* was observed at all four sites up to the end of November, and there was a gradual decline of their populations in December. From January to March 1993, there was virtually no damage recorded and only frass of the insects could be found. Between April and June 1993, 23667 third-instar larvae and 526 adults were released at the three secondary release-sites and an additional 36957 larvae and 265 adults were released at these sites in October 1993. This was the last release of *P. pseudoinsulata* at Fumesua. The events recorded in 1992 were repeated until April 1994, when the insects appeared again in the field.

Between October and December 1993, egg-hatch rates in the laboratory culture declined and eventually the culture was lost in February. Efforts were then made to secure *P. aurata aurata* from South Africa. The insects finally arrived but all were dead due to transport delays. There was, however, renewed hope when *P. pseudoinsulata* was seen again in the field in April 1994. Some of these insects were transferred to the laboratory and a culture has since been maintained. By September 1994 there was appreciable damage to *C. odorata* at three of the four release sites. At the one site, the insects brought about control over an area of about 8000 m^2; a second site was completely devastated by the control agent which had spread to a nearby village 2 km away; and at a third site, *P. pseudoinsulata* had successfully controlled *C. odorata* in a plantain field. The control success achieved gave rise to the growth of other plant species at two of the sites, and for the first time since 1991 the insect was observed in the field during the drier months i.e. from October to December 1994 and from January to March 1995.

On 20 June 1995, field-monitoring was initiated in towns and villages at various distances from the Fumesua station. This was to determine the extent of spread of the control agent. The towns and villages covered were Mamponteng, Effiduase and Ejisu-Besease. Indications were that the control agent had established and was effecting some control of *C. odorata*, in isolated patches. At Dumanafoo (32 km from Fumesua), larvae at all stages and adults were observed in the field on *C. odorata*. Some of the leaves had turned yellow due to the feeding activities of *P. pseudoinsulata*. There was spectacular damage at Wadie Ejumakase (38 km from Fumesua) where the dead *C. odorata* was giving way to the growth of *Centrosema* sp.. Twenty-five larvae were collected from this field. In this town, a farmer observed that *C. odorata* had invaded his cassava crop. A week later when he returned to weed the field, he noticed to his surprise that *C. odorata* had been devastated by *P. pseudoinsulata*. He remarked: "The caterpillar has weeded my farm for me".

Further monitoring was undertaken on 28 June 1995 through Kodie, Apagya-Essase, Danase, Aduman, Aboabogya, Ejumakase-Sese, Bonfa, Mampenase, Fawade, Mamponteng, Aboase, Abrade, Juaben, Bonwire and Ejisu in the Ashanti Region. *Pareuchaetes pseudoinsulata* was observed in all these towns and villages with severe damage to *C. odorata* at Bonwire, Mampenase and Abrade, 16, 39 and 40 km

respectively, from Fumesua. The present spread of the insect is estimated to be about 45 km from the release sites.

Discussion and conclusion

The fact that *C. odorata* smothers other plants in areas where it grows raises much concern about the fate of plant species, whose economic importance may not be known. *Chromolaena odorata* has been in Ghana for only 26 years and has infested about two-thirds of the total land area. Within this area the weed constitutes an estimated 20% of the flora. Before the introduction of *C. odorata*, there were other plant species, such as *Asphilia* sp., which also recycled nutrients. Unfortunately, because the Ghanaian human population 26 years ago was only about half the present number, lands could stay fallow for longer and farmers and researchers were not confronted with the current problem of soil fertility. Many do not think that the plants that were present before the introduction of *C. odorata* had any value in enriching the soil (a period when fertilizers were not available in the country and yet crop yield was high). Perhaps there is a need to quantify the soil-enrichment properties of *C. odorata* and of the plants that existed before its introduction, before any credit can be given to this dangerous weed.

To enhance biodiversity, there is a need to preserve our natural vegetation and hence the need to control *C. odorata*. Physical control is expensive, while chemical control is both expensive and potentially hazardous. Biological control and management are better alternatives that would strike a balance, since the weed would not be eradicated, but its further spread would be prevented and populations would be reduced below the economic injury level.

Boppré (1991) established that the variegated grasshopper, *Z. variegatus* has a non-nutritional association with *C. odorata*, particularly the flowers and roots, which provides the insect with pyrrolizidine alkaloids (PAs). These secondary plant compounds are stored and protect the grasshoppers and their diapausing eggs from predators and parasitoids. This gives rise, in the dry season, to pestilences of *Z. variegatus* in many parts of Africa. Without *C. odorata*, i.e. either before its introduction, or in areas where it is lacking, or in the wet season when *C. odorata* does not bloom, PAs seem to be limited and thus the grasshoppers' reproductive success may be diminished. A recent questionnaire inquiry (J.A. Timbilla *et al.* unpublished) in some 36 African countries confirmed the relationship between *C. odorata* and outbreaks of *Z. variegatus*. It has also been established in this survey that the mere presence of *C. odorata*, regardless of its weed status, is enough to cause *Z. variegatus* problems.

Field-monitoring, following releases of the moth, indicate that *P. pseudoinsulata* has potential in mitigating the menace of *C. odorata* in Ghana due to its specificity and through its effects as a defoliator. The damage caused by the insect to the terminal and axillary buds would greatly reduce seed production and consequently may reduce populations of the weed. If *P. pseudoinsulata* is not able to control the weed it must, at least, prevent its further spread. Secondly, the insect could be used to clear *C. odorata* that has established in open forests and allow forest trees to grow and thus restore Ghanaian forests, which are fast being depleted. Various degrees of control of *C. odorata* have been achieved in Guam and in parts of Asia. Thus, with the necessary support, a similar success could be achieved in Ghana and other countries.

Considering the profuse growth of *C. odorata*, it will require more than *P. pseudoinsulata* to achieve effective control. In its native South American home, *C. odorata* is not a weed because it co-exists with many natural enemies, thus maintaining an equilibrium. It would be disastrous to allow the weed to remain unchecked in exotic areas where it has become established.

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