Establishment, Spread and Impact of *Pareuchaetes pseudoinsulata* (Lepidoptera: Arctiidae) an Exotic Predator of the Siam Weed, *Chromolaena Odorata* (Asteraceae: Eupatoriae) in Ghana

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Abstract

Following the failure of an earlier attempt in the 1970s, a renewed effort towards the biological control of the Siam weed, *Chromolaena odorata* using the arctiid moth *Pareuchaetes pseudoinsulata* began in 1989 at the Crops Research Institute (CRI), Ghana. The objective was to reduce populations of *C. odorata* to non-economically damaging levels in a sustainable and environmentally friendly manner to enhance biodiversity. The natural enemy, *P. pseudoinsulata* was imported, mass reared and released on *C. odorata* fields after two years of studies on its biology and host specificity. Post release studies indicate that *P. pseudoinsulata* established in Ghana in 1994 and has reduced the populations of *C. odorata*/unit area from a mean of 85.0% in infested fields to 37.0% in areas under control. The Populations of other herb species have increased from 13.0 to 36.4% and grasses from 2.0 to 26.6%. Plant species diversity per unit area has also increased from an average of 3 in previously infested *C. odorata* fields to 6 in controlled fields. About 37.9% of the total land area infested with *C. odorata* in Ghana is under varying degrees of control. The reduction of the competitiveness of *C. odorata* by *P. pseudoinsulata* has positively enhanced forest regeneration and biodiversity in Ghana.

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Introduction

From its Central and South American/Caribbean origin, *C. odorata* (L.) King and Robinson (= *Eupatorium odoratum*) spread to Sub-Saharan Africa Via the Old World in the 1960s (Bennett and Rao, 1968; Crutwell, 1988. In Ghana, the weed was first discovered in 1969 (Hall *et al*., 1972) and by 1991 it had colonised two-thirds of the total land area of the country. The introduction of this noxious weed into Ghana led to the gradual suppression and reduction of the natural vegetation. It has also caused severe bush fires in the forest regions. Its effects on agriculture, forestry, game and wildlife, animal husbandry and the environment at large have been documented (Timbilla and Braimah, 1996). Despite the menace caused by *C. odorata* (Timbilla, 1996) it is claimed to be of some use in agriculture, land conservation and medicine. This notwithstanding, the ecological damage caused by the weed necessitated its biological control in the early 1970s.

This first attempt failed, however, a renewed effort began in 1989 at the Biological Control Unit of CRI (former International Institute of Biological Control-West African Sub–Station) in collaboration with the University of Guam, U.S.A. Field releases of *P. pseudoinsulata* began in September 1991 with the insect establishing in 1994.
This paper discusses the performance of *P. pseudoinsulata* and resultant impact in the biological control of *C. odorata* in Ghana.

**Objective**

The broad objective of the study was to reduce populations of *C. odorata* in infested regions of Ghana below economically damaging levels. This was aimed at:

- Reducing the cost of production of food and commercial crops associated with the weed and thus increase farmers’ profits,
- Reducing the hazards of environmental pollution and poisoning posed to farmers and their livestock, fresh water bodies and beneficial organisms from the use of herbicides in the control of the weed,
- Preventing its further spread and reduction of its competitiveness with other flora, particularly in forests, pasturelands and game reserves,
- Reducing the pestilence of *Zonocerus* grasshoppers, through reduction of breeding sites under *C. odorata* and other factors that it provides to enhance their survival against natural enemies, and enhancing biodiversity and regeneration of secondary forests.

**Materials and Methods**

Field releases of the control agent, *P. pseudoinsulata* began in September 1991. This was preceded by a survey to demarcate release sites. The insects were mass reared to the 2nd or 3rd instars before releases. Prior to releases, larvae were counted into grey baft covered wooden cages measuring 30 x 30 x 30cm and fed with fresh *C. odorata* leaves. Adult *P. pseudoinsulata* were placed in similar cages of size 45 x 45 x 75cm. Field release of the control agent was done between 1800 and 2000 HRS. GMT. in large luxuriant *C. odorata* fields to help the nocturnal insects adapt better. After the releases, field surveys were carried out at two to four weekly intervals to ascertain the establishment and performance of the insect.

The percentage of *C. odorata*, grasses and other plants in fields previously defoliated by *P. pseudoinsulata* was estimated by means of 5 x 5 meter square quadrats. This was to ascertain the extent to which the feeding activities of *P. pseudoinsulata* on *C. odorata* had influenced the species diversity of the field. Data on the number of plant species per unit area and records on new plants emerging were also taken. The population of *C. odorata*, grasses and other plants was determined prior to the commencement of the study.

**Results and Discussion**

**Field Establishment, Spread and Performance of *P. pseudoinsulata***

A total of 119,256 larvae and 6,265 adult *P. pseudoinsulata* were released within an area of about 3km² between 1991 and 1993 in an experimental field of the Crops Research Institute, Kumasi. This led to an initial establishment of the insect in 1994. No release of the natural enemy was made in 1994 following the loss of the culture in the laboratory. A further release of 192,325 larvae and 7,591 adults were made from 1995 to 1997 at Abesea and Assin Dadieso (fig. 1). The continuous release of the insects within a small area led to their establishment. Ghana is the first country in Sub Saharan Africa to achieve this level of establishment of *P. pseudoinsulata* on the field.

During the period 1991 and 1993, *P. pseudoinsulata* exhibited a seasonal pattern in
abundance on the field. Populations of the insect always increased dramatically between April and October and decreased to near absence between November and March. These periods coincide with the rainy and dry seasons in Ghana. However, following the establishment of the insect, the trend has changed. *P. pseudoinsulata* can now be found on the field at anytime of the year but with much difficulty during the dry season.

The period with high densities of the insect also coincides with high damage to *C. odorata*. The weather conditions therefore seem to influence the populations of the insect on the field.

Defoliation of *C. odorata* by the control agent covered an estimated 2,025km² in 1994. Subsequently, *P. pseudoinsulata* has spread and established in wider areas, causing extensive but selective damage to the weed. The damage included destruction of terminal and axillary buds, resulting in the death of the *C. odorata* plants. Only a few plants show signs of rejuvenation after the ravages of *P. pseudoinsulata*. Notable ecological set ups where the control agent was observed causing damage to *C. odorata* leaves included arable crop

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**Fig. 1.** Land area infested by *C. odorata*, release sites and spread of *P. pseudoinsulata* in Ghana.

Legend:
- Land area infested by *C. odorata*
- Release sites
- Spread of *P. pseudoinsulata* in 1995
- Spread of *P. pseudoinsulata* in 1996
- Spread of *P. pseudoinsulata* in 1997
- Spread of *P. pseudoinsulata* in 1998
farms, plantations, fallow lands, roadsides, forest margins and in open spaces within forests (Figs. 2a-d). The selective damage caused by *P. pseudoinsulata* in arable farms (see Figs. 2a and 2c) is a demonstration of the specificity of the control agent.

The spread of the insect was estimated to about 6,097km² in 1995 and 12,195km² in 1996. Between 1997 and 1998, the insect had almost doubled its area of spread from 28,367 to 52,349km² respectively (Fig. 3). As of now *P. pseudoinsulata* has established in an
estimated 37.9% of the total land area infested by *C. odorata* in Ghana with a considerable degree of control (Fig. 1).

The feeding activities of the insect reduced the competitiveness of *C. odorata*. This has given rise to the growth of other plant species such as *Pennisetum purpureum* (grass) and *Asphilia* spp. (herb) which are fodder plants for game and domestic animals. The successful control of *C. odorata* in areas where *P. pseudoinsulata* established has also led to the development of secondary forests in some areas. Studies carried out in the Lama forest of Benin, (Ottmar Fischer, Pers. comm., 1996) indicate that many forest species are found growing under *C. odorata* thickets. Thus the efficacy and specificity demonstrated by *P. pseudoinsulata* in reducing the competitiveness of *C. odorata* would enhance forest regeneration of African forests infested by the weed.

**Impact of Biological Control of *C. odorata* by *P. pseudoinsulata* on Weed Biodiversity**

Following the establishment of *P. pseudoinsulata* the population of *C. odorata* has reduced from an average of 85.0% per unit area in infested fields to mean figures ranging from 32.9 to 40.2% in fields where the insect established and effected damage from 1995 to 1998. On the other hand the population of grasses have increased from an estimated 2.0% in *C. odorata* infested fields to between 24.2 and 28.3% over the same period.

With respect to other broad leaved plants, there has been an increase from an initial estimated 13.0% in *C. odorata* infested fields to 38.0% in 1995, 36.9% in 1996, 31.5% in 1997 and 39.4% in 1998 (Fig. 4). Thus the mean proportions of *C. odorata*, grasses and other broad leaves in previously dominated *C. odorata* fields from 1995 to 1998 stands at 37.0, 26.6 and 36.4% respectively. Generally, there has been an increase in the number of plant species per unit area from 3 in previously colonized *C. odorata* fields to 6 in areas where the insect has established and effected control of the weed.

![Fig. 4. Change in percent vegetative cover of *C. odorata* infested fields following establishment of *P. pseudoinsulata* and suppression of *C. odorata* (1992-1998)]
C. odorata is known to decrease the carrying capacity and species diversity in grassland and forests (Pickworth, 1976; Liggit, 1983; MacDonald, 1984; Erasmus, 1985; Byford-Jones, 1989; Erasmus, 1991a).

The results of the study therefore indicates the possibility for the improvement on the species diversity of grasses and other broad leaves which would in turn increase the fodder base for game and domestic animals. Further to this, the pestilence of Zonocerus grasshoppers in Africa as a result of a non-nutritional relationship existing between C. odorata and the insect (Boppre, 1991; Timbilla et al. 1996) would also reduce.

Conclusions

- *P. pseudoinsulata* has established on *C. odorata* in Ghana and its feeding activities have effectively reduced the competitiveness of the weed.
- The establishment of the insect has led to a considerable reduction in *C. odorata* population from an initial 85.0% to a mean of 37.0%. This has resulted in an increase in the vegetative cover of grasses and other plants from an initial 2.0 and 13.0% to 26.6 and 36.4% thus increasing the fodder base for domestic and game animals.
- The diversity of plant species per unit area has also increased from 3 to 6.
- The overall impact of the successful establishment of *P. pseudoinsulata* in Ghana has led to an increase in the carrying capacity of hitherto infested *C. odorata* fields.

References


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