Advances in Science and Technology, Vol. 1, No. 2 / 3, April - September 2007, pp108-115.

Ecological Roles of Insects on Siam weed, *Chromolaena odorata* (L.)

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(Submitted: July 14, 2007; Accepted: September 22, 2007)

Abstract

Insects associated with *Chromolaena odorata* (L.) R. M. King and H. Robinson in the undergrowth of an oil palm plantation were studied at the Nigerian Institute for Oil Palm Research, Benin City, between August and December 2004. The objectives of the study were to identify the local insect fauna associated with the weed in Nigeria and understand the ecological role of each of the insect species. The study consisted of an assessment of the number of *C. odorata* stands per five meters squared (5 m^2), types and number of insects associated with the plants as well as the activity or behaviour of the insects on the plants. The observations were made weekly throughout the period. Twenty species of insects belonging to eight Orders namely Coleoptera (*Lycus proboscideus* and *Lycus* species), Dictyoptera (*Blattella lobiventris* and *Mantis* species), Diptera (*Hemipyrellia fernandica*), Heteroptera (*Macrina* species), Homoptera (*Aphis spiraecola* and a Pseudococcidae), Hymenoptera (*Crematogaster africana*), Lepidoptera (*Acraea bonasia*, *Junonia clelia*, *Belenois calypso* and a Pyralidae), and Orthoptera (*Amphicremna scalata*, *Anacatantops notatus*, *Catantops spisus spisus*, *Tristria suturalis*, *Zonocerus variegatus* and *Phenaroptera nana sparsa*) were found to be associated with *C. odorata*. The ant, *Crematogaster africana* Mayr (Hymenoptera: Formicidae) were strongly associated (R^2=0.9192; P< 0.001) with *Aphis spiraecola* Patch thus 91.9% of the the variation in ants numbers can be accounted for by *A. spiraecola*. Regression analysis showed that 97.8 per cent and 78.2 per cent of total variation in infested and mottled *C. odorata* leaves per plant and infested and mottled *C. odorata* plants per 5m^2 respectively, can be accounted for by a linear function of *A. spiraecola*. The ecological roles of the insects encountered are discussed.

Keywords:*Chromolaena odorata*, *Aphis spiraecola*, oil palm plantation, insects, sampling.

1.0 Introduction

Chromolaena odorata (L.) R. M. King and H. Robinson (Asteraceae), a native shrub of South America and the Caribbean (Muniappan *et al*., 1988) was first reported in Nigeria in 1942 near Enugu (Lucas, 1989). It is wide spread in the Southern Regions of the country. It is particularly prominent in areas with an annual rainfall of about 2000mm and has become a major weed of arable and plantation crops, forests and rangelands thus constituting a serious threat to agriculture and biodiversity in West, Central and South Africa (Macdonald, 1983; Mcfadyen and Skarratt, 1996). The management of *C. odorata* in plantation crops such as cocoa, oil palm and citrus is known to contribute to about a third of the cost of production of such plantations. The high cost of maintenance and other problems associated with the management of the weed have forced some farmers to abandon their plantations (Timbilla and Braimah, 1996). The management and control of the weed using herbicides and slashing with cutlasses has led to rapid recolonization (Bennett and Rao, 1968). Muniappan *et al*. (1988) observed that the use of herbicides in the control of this weed is uneconomical in marginal lands and is very much limited in plantation crops because of the adverse effects such herbicides could cause to non-target species. Seibert (1989) noted that biological control is the only viable method for the management of *C. odorata* because of the large areas involved and the cost of chemical or mechanical control. In South Africa, eight insect and two mite

species have been reported to feed and/or reproduce on *C. odorata* (Kluge and Caldwell, 1992). Among these herbivores, *Aphis spiraecola* caused the most striking damage to the weed. As the aphid feeds on the underside, the young leaves grow abnormally until they are completely distorted (Hall *et al*., 1972). Working with *Eupatorium conyzoides* (Compositae), De Wijs (1974) reported that no viral transmission is involved in this leaf damage by *A. spiraecola*. Biocontrol agents such as *Pareuchaetes pseudoinsulata* (Lepidoptera: Arctiidae), *Apion brunneonigrum* (Coleoptera: Apionidae), *Melanagromyza eupatoriella* (Diptera: Agromyzidae) and *Procecidochares connexa* (Diptera: Tephritidae) have been introduced into some African countries with little or no success (Cock, 1984; Julien, 1992; Kluge and Caldwell, 1996). A proper understanding of the insect fauna in the *Chromolaena* infested bush is vital to the success of any biological control effort. There is a dearth of information in the literature on the insect fauna of *Chromolaena* infested bushes in Nigeria. This paper attempts to provide such information from Benin City.

2.0 Materials and Methods

The study was conducted between August and December, 2004 in Field 13 of the Nigerian Institute for Oil Palm Research (NIFOR), Benin City. The oil palms numbering 6150 stands were planted in 1986 on 41 acres (16.5 hectares) of land. The survey was done weekly and at each sampling time five square meters (5 m^2) was measured randomly to form a quadrat with the aid of a measuring tape. The number of *C. odorata* stands within the quadrat was counted with each plant thoroughly examined for insects. In addition to the leaves, great attention was focused on the important parts of the plant (e.g., root, stems flowers and seeds) to recover leaf feeders, root and stem borers. The number and type of insects found were recorded while and severity of damage on the plants and other relevant biology information of natural enemies was also recorded. Some of the insects were collected with the aid of a sweep net or hand picked and preserved in an insect box while the soft bodied insects were preserved in 70 % alcohol after which they were identified. The number of fresh mottled leaves as well as the dry or wilted mottled leaves were also counted and recorded. The data collected were summarized as means, percentages and analyzed with correlation and regression using SPSS and Genstat statistical package to predict likely potential bio-control candidate(s) of the weed.

3.0 Results

Table 1 shows the species and parts of plant they were collected during the study period. The total numbers of species were 21 from 15 families in 8 Orders. Most of the species were collected from the leaves but young stem and flower feeders were recovered from *C. odorata* plants. No insects that attack the root were recovered. The Homopterans and Hymenopterans formed 90.8% and 7.2% of the insects recorded on Siam weed (Table 1). Figure 1 shows the relative abundance of the Homopterans with the aphid, *Aphis spiraecola* Patch. being the most frequently encountered while *Catantops spisus spisus* Walker was the most abundant Orthoptera recorded on Siam weed (Figure 2). The abundance of *Crematogaster africana* Mayr is shown in Figure 3.

Correlation and regression analysis of the data collected shows that there was a strong significant ($P< 0.001$) positive association between the numbers of *A. spiraecola* recorded and *Crematogaster africana* population (R^2=0.9192) (Figure 4), indicating that 91.9% of the variation in *C. africana* population can be accounted for by variation in the numbers of *A. spiraecola*. Consequently the slope of the regression line between both variable was significantly different ($P< 0.001$). Figure 5 shows that there was a significant ($P< 0.001$) strong linear relationship between numbers of *A. spiraecola* per *C. odorata* plant and infested/ fresh mottled *C. odorata* leaves per plant (R^2= 0.9788), indicating that 97.8% of the variation of the infested mottled leaves of *C. odorata* can be accounted for by variation in the number of *A. spiraecola*. Consequently the slope of the regression line was significantly different ($P< 0.001$). There was also a

strong significant (P< 0.001) linear relationship between numbers of *A. spiraecola* per 5m^2 and infested mottled (diseased) *C. odorata* plants per 5m^2 (R^2= 0.7856) (Figure 6), indicating that 78.5% of the variation in infested/mottled *C. odorata* plants can be accounted for by *A. spiraecola*. Also the slope of the regression line was significantly different (P< 0.001).

However, there was a weak association between *Phenacoccus* species recorded per plant and infested/ mottled leaves of *C. odorata* per plant (R^2= 0.201) as well as between *Phenacoccus* species per 5m^2 and infested/mottled *C. odorata* plants per 5m^2 (R^2= 0.056) (Figures 7 and 8). Consequently, both correlation coefficients were not significant. The number of fresh damaged and dead (dry) mottled leaves is shown in Figure 9. The dry leaves were more than the fresh leaves through out the sampling period.

Table 1: List of insects found on *C. odorata* in an Oil Palm undergrowth in Benin City.

Order*	Family	Genus/species	Part of plant found
Coleoptera (0.40%)	Lycidae	Lycus proboscideus Fab.	Leaves
		Lycus species	Leaves
	Meloidae	Mylabris dicincta Sert.	Flowers
		Mylabris species	Flowers
Dictyoptera (0.01%)	Blattellidae	Blattella lobiventris Sau.	Leaves
	Mantidae	Mantis sp.	Leaves and stem
Diptera (0.01%)	Calliphoridae	Hemipyrellia fernandica Mq.	Leaves
Heteroptera (0.03%)	Pentatomidae	Macrina species	Leaves
Homoptera (90.80%)	Aphididae	Aphis spiraecola Patch	Leaves and young stem
	Pseudococcidae	Unidentified (Phenacoccus species?)	Leaves and young stem
Hymenoptera (0.03%)	Formicidae	Crematogaster africana Mayr	Leaves and young stem
Lepidoptera (0.45%)	Acraeidae	Acraea bonasia Fab.	Flowers
	Nymphalidae	Junonia (= Precis) clelia Cramer	Flowers
	Pieridae	Belenois calypso Drury	Leaves
	Pyralidae	Unidentified	Leaves
Orthoptera (1.20%)	Acrididae	Amphicremna scalata Karsch	Leaves
		Anacatantops notatus Karsch	Leaves
		Catantops spisus spisus Walker	Leaves
		Tristria suturalis Karsch	Leaves
	Pyrgomorphidae	Zonocerus variegatus L.	Leaves and flowers
	Tettigonidae	Phenaroptera nana sparsa Stäl.	Leaves

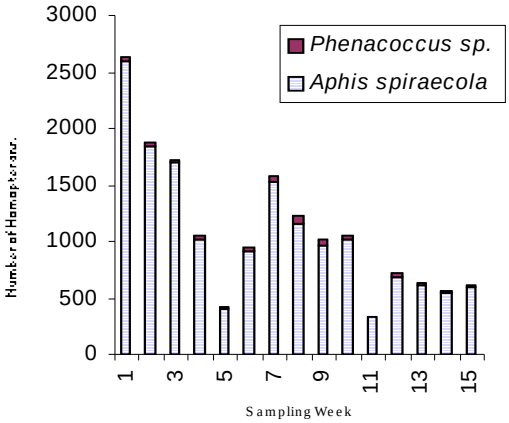

Figure 1: Abundace of Homopterans per *C. odorata* plant during the sampling period.

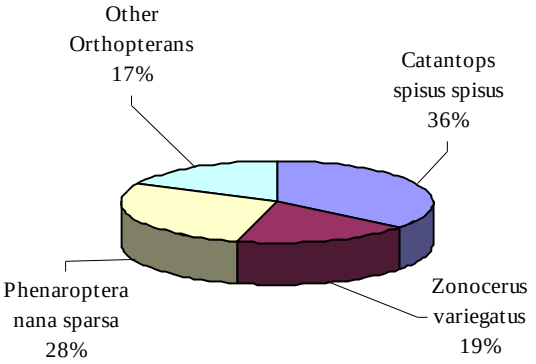

Figure 2: Percentage abundance of Orthopterans on *C. odorata*.

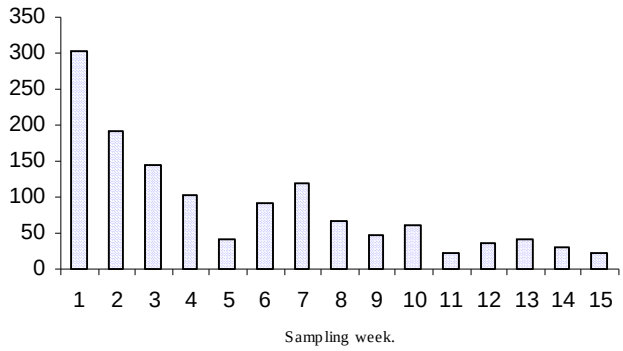

Figure 3: Abundance of *Crematogaster africana* per *C. odorata* plant during the sampling period.

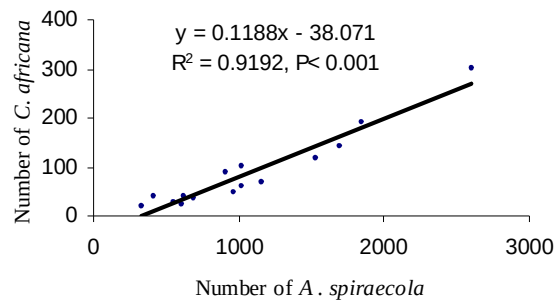

Figure 4: Number of *Crematogaster africana* regessed against number of *Aphis spiraecola* per *C. odorata* plant

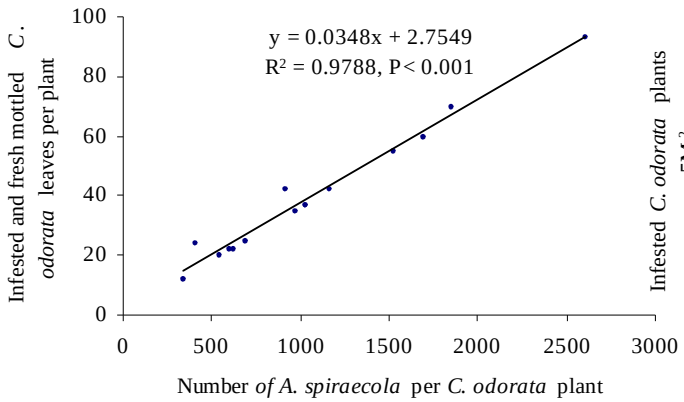

Figure 5: Relationship between *A. spiraecola* population and fresh mottled *C. odorata* leaves

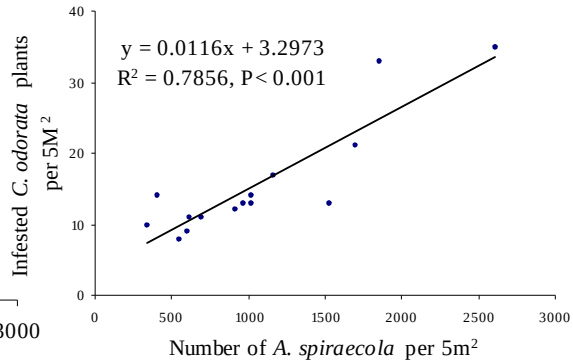

Figure 6: Relationship between *A. spiraecola* population and infested (mottled) *C. odorata* plants

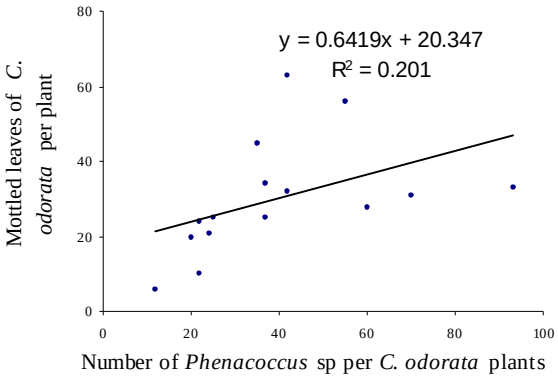

Figure 7: Relationship between *Phenacoccus* sp. and mottled leaves of *C. odorata*

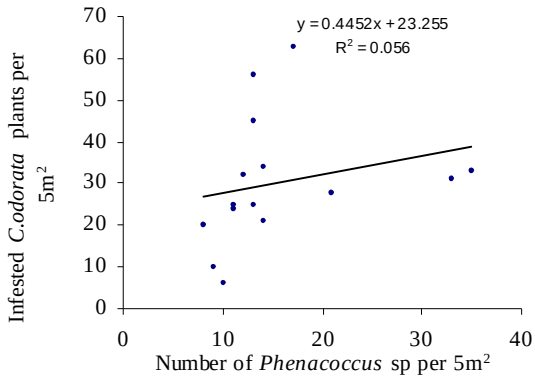

Figure 8: Relationship between *Phenacoccus* sp and infested *C. odorata*

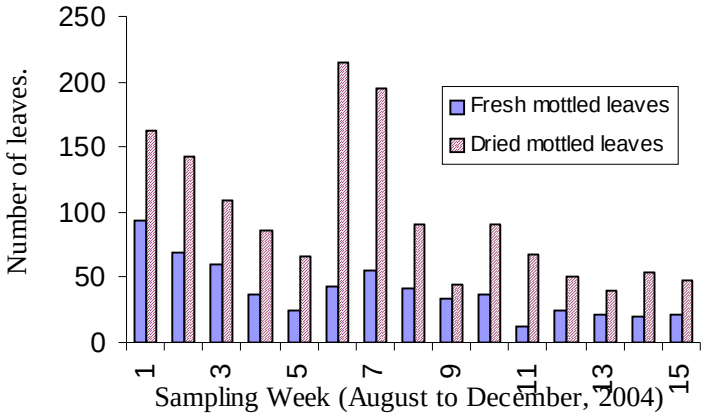

Figure 9: Number of fresh and dried mottled leaves per *C. odorata* plant during the sampling period.

4.0 Discussion

The *C. odorata* bush studied had a rich insect fauna, the most important of which is *A. spiraecola*. Both nymphs and adults of this insect fed on the young succulent tissues at the terminal end of the plant, and their feeding activities always results in the mottling of *C. odorata* leaves . *Aphis spiraecola* Patch has long been recognized as a crop pest and vector of many plant diseases (Pirone, 1978). Hall *et al*. (1972) reported that the number of this aphid per *C. odorata* leaf varies very greatly from 16 in low infestation to over 150 in severe attack, an estimate which is lower than our findings. The study shows a perfect dependence of leaf damage on the number of the aphid per plant thus as the number of *A. spiraecola* increases, the number of mottled (damaged) leaves also increases. The study has also showed a perfect dependence of infested/mottled plants on the number of aphid per $5m^2$ thus as the number of *A. spiraecola* increases the number of infested plants increases. Since *A. spiraecola* impacts negatively on *C. odorata*, the aphid is seen as a promising new candidate for bio-control of the Siam weed. Since every attacked plant fails to produce flowers it is clear that the healthy plants around still produce enough seeds to ensure the rapid spread of the weed, this is in agreement with the reports of Kluge and Caldwell (1992) in South Africa and Hall *et al*. (1972) in Ghana. Regrettably, *A. spiraecola* only feed on the young succulent tissues at the terminal end of the plant and also it has been reported as pest hence can not be use as a suitable candidate for the biological control of *C. odorata*. The widespread occurrence of *C. odorata* on plantation floors raises the fear that *A. spiraecola* may be an important pest or vector of some tree crop diseases in the future. *Aphis spiraecola* was recorded all through the sampling period, this strongly support the study of Pfeiffer (1991) who reported that the aphid breeds continuously during the Summer and Autumn months. An unidentified mealybug *Phenacoccus* species (Pseudococcidae) and the ant, *Crematogaster africana*, were always found on the plants with *A. spiraecola*, suggesting a very close ecological relationship between these species. We believe that the aphid and the mealybug are tended by the ant. The ant was seen moving around the infested parts of the plant feeding on the honey dew. The relationship between ants and Homopterans is mutualistic with the homopterans providing energy rich honey dew for the ants which in turn protects and transports the former (Nixon, 1951; Strickland, 1951a, b). The only one ant species found tending the Homopterans in our study contrasts the report of Hall *et al.* (1972), who reported three different species in Ghana (*Pheidole megacephala* (F.), *Camponotus fulvemerginatus* Mayr and *Camponotus acvempimensis*) tending the aphid. However, the highly significant positive correlation between the number of *A. spiraecola* and *C. africana* per plant shows that this ant is very efficient in protecting and transporting the aphid and on the other hand the presence the aphids provides the ants with source of food. Thus when the number of the aphid increases, the number of ants also increases. The very low number of

the mealybug compared with that of the aphid suggests that *C. odorata* may not be a very good source of nutrient for the insect or that the feeding activities of the aphid which change the physiology of the plant also affect the ability of the mealybug to utilize the plant as a source of nutrients for growth and reproduction. The non significant weak association between the mealybug and mottled leave suggests that it was not responsible for the leaf damage of *C. odorata*.

The orthopterans are polyphagous insects found in many bushes and grasslands. The nymphs and adults of *Catantops spisus spisus* Walker were seen feeding on the leaves of *C. odorata*, and have been reported as a serious pest in oil palm nurseries and newly established fields where they puncture and eat off the edges of the leaflets (Aisagbonhi *et al*., 2004). While the other acridids (*Tristria suturalis* Karsch, *Anacatantops notatus* Karsch. and *Amphicremna scalata* Karsch) fed on the young succulent tissues at the terminal end of the plant were seen feeding on *C. odorata* leaves, the tettigonid, *Phenaroptera nana sparsa* Stäl was observed to be feeding on leaves of the weed as well as grasses and other herbs. Both nymphs and adults of *Z. variegatus* were found feeding on the leaves and flowers of the weed, with the nymphs more attracted to the flowers than the adults. This confirms earlier reports by Modder (1984, 1986), Boppre (1991), and Chapman *et al*.(1986) which showed that these insects are polyphagous but prefers Siam weed bushes as breeding sites. The consistent higher number of dry leaves per plant compared with fresh leaves explains the fact that *C. odorata* is a fire risk.

Among the coleopterans, adult *Mylabris* species have been reported as sporadic pests of a wide range of ornamental flowers and agricultural crops, which they may also help to pollinate (Larsen, 1988; Aisagbonhi *et al*., 2004). The larvae are mostly predators on grasshopper eggs and are of potential benefit (Hill, 1975; Booth *et al*., 1990). Little is known of the biology of Lycidae, but some species found on flowers may feed on nectar or pollen while most species appear to be predaceous (Bocak and Bocakova, 1990; Booth *et al*., 1990; Hill, 1994).

The lepidopterans were seen flying around the Siam weed, but the moth species could not be identified. *Acraea* species feed as larvae on plants containing chemical compounds which appear to function as deterrents to herbivores. The compounds are stored in the body to make the butterfly unpalatable to predators (Scholtz and Holm, 1985). It is possible that the pyrrolizidine alkaloids in flowers of the Siam weed which *Z. variegatus* sequesters in its body for defense against predators (Idowu and Modder, 1998) also attracts *Acraea* species to *C. odorata*. Most species of Nymphalidae feed freely on flowers while the Pierids are defoliators (Hill, 1975; 1994).

Mantids are predatory insects found in the open field and bushes. They feed on a wide range of insects and other invertebrates. *Blattella lobiventris* was found on the leaves of *C. odorata*, but not much is known of its nutritional habits. Blatellids are found in a wide variety of habitats e.g. soil, leaf litter, under stones and bark or in tree (Brenner *et al*., 1988). They are omnivorous, unspecialized feeders (Scholtz and Holm, 1985). *Macrina* species are known to be pests of agricultural importance. Medler (1980) recorded *Macrina juventus* as the only species of this genus in Nigeria. Scholtz and Holm (1985) reported that *Hemipyrellia* species breed in decaying animal matter, but adults are attracted to sweet-smelling substances. We have successfully highlighted the insect fauna associated with alien invasive shrub, *C. odorata* in Benin City and the ecological role of some of the insects. We conclusively suggest that survey and identification of indigenous insects on Siam weed in other regions of the country should be given attention with a view to identifying any indigenous natural enemy (ies) of this invasive weed.

Acknowledgement

We are grateful to Prof. D. A. Enobakhare of the Department of Crop Science, University of Benin, Benin City, for the identification of *Aphis spiraecola*.

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