A SURVEY OF THE POPULATION OF THE AFRICAN WEAVER ANT, *OECOPHYLLA LONGINODA* (HYMENOPTERA:FORMICIDAE) IN CONTRASTING HABITATS IN ILE-IFE, SOUTH-WESTERN NIGERIA.

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(Received: August, 2011; Accepted: October, 2011)

ABSTRACT

The occurrence and abundance of the African weaver ants, *Oecophylla longinoda* were monitored in five sites in Obafemi Awolowo University, Ile-Ife, southwestern Nigeria in 1992 and 2005. The five sites were: Biochemistry Car Park (BCH), Biological Sciences Car Park (BSP), Parks and Gardens (PG), Forest Reserve (FR), and Teaching and Research Farm (TRF).The trees in these sites which supported the population of *Oecophylla* were noted and nests were subsequently collected from these trees during each sampling period. Results showed that the abundance of these weaver ants was higher in 1992 than in 2005. In 1992, nests of *O. longinoda* were found in all sites while in 2005, they were not found in BCH and TRF. The mean number of ants per nest in FR was significantly higher ($P < 0.05$) in 1992 than in 2005 while the number of ants collected from PG and BSP were comparable in the two years. Stability in population of *Oecophylla* in BSP and PG over 13 years suggests that weaver ant communities in these sites might be resilient to human and anthropogenic disturbances while the absence of these ants in BCH and TRF in 2005 could be traced to site disturbance and pesticide application respectively. Three tree species (*Terminalia catapa, Blighia sapida, and Myrianthus aboreus*) are reported for the first time as potential hosts of *O. longinoda* and their potential in re-infesting tree crops with *O. longinoda* in a biocontrol programme is stressed.

Keywords: Weaver Ants, Human Disturbance, Abundance, Nigeria

INTRODUCTION

The tailor or weaver ants of genus *Oecophylla* (Hymenoptera: Formicidae) are eusocial insects. They are obligately arboreal and are known for their unique nest building behaviour where workers construct nests by weaving together leaves using larval silk. Colonies can be extremely large with a mature colony containing between 100,000 and 500,000 workers (Hölldobler and Wilson, 1978), and may cover as many as 12 trees and contain up to 150 nests (Way, 1954). *Their* colonies are monogynous, with a single queen living for up to eight years (Hölldobler, 1983). There are two sub-castes of *Oecophylla workers, the* minor workers and the major workers. Minor workers usually remain within the brood chambers where they tend larvae, while the major workers defend the colony (Hölldobler, 1983; Dejean, 1990), assist with the care of the queen, and forage for food (Hölldobler and Wilson 1990; Lokkers, 1990). The major workers are more numerous than minor workers, a feature unique to this genus (Hölldobler and Wilson, 1990). *Oecophylla* species attack most arthropods they encounter, and consequently reduce the numbers of other insects on the trees they inhabit (Lokkers, 1990). Consequently, they have been used as biological control agents to reduce the damage caused by insect pests in coconut, cashew, tea, mango, cocoa and citrus trees (Dwomoh *et al*., 2008; Peng and Christian, 2004; Way and Khoo, 1992).

The weaver ant *Oecophylla* has two species namely, *O. longinoda* and *O. smaragdina*. The former is found in Africa while *the latter* is found in Asia and Australia (Way, 1954; Lokkers, 1986).While much is known on the biology of this genus, and its use as biocontrol agent (Dwomoh *et al*., 2008), to the best of our knowledge, very little information is available on its ecology. The only available information is on the Australasian species, *O. smaragdina* which is a sister species and ecological equivalent of *O. longinoda*. Lokkers (1986) found that individuals of *O. smaragdina* were found in the coastal areas in Northern Australia and at average minimum temperatures above 17°C, suggesting that temperature affects the occurrence of *Oecophylla*. Lokkers (1986) also reported that the ants preferred trees with thick leaves for nest building. However, a study on the temporal changes in their ecology is necessary in the light of ecological changes in the environment which are more apparent in the last fifty years. This study was therefore designed and executed to gather information on the occurrence and changes in the population of *O. longinoda* in Obafemi Awolowo University campus in Ile-Ife, Nigeria. In this ecological area, the original seasonal tropical rain forest has been fragmented as a result of erection of buildings in-between a mosaic of managed Parks and forest patches with varying levels of human interference providing basis for comparative evaluation.

MATERIALS AND METHODS

Study area

This study was carried out on five sites in Obafemi Awolowo University Ile-Ife Campus, south western Nigeria (Fig. 1) located between Latitude $7^{\circ} 30' - 7^{\circ} 35'$ N and Longitude $4^{\circ} 30' - 4^{\circ} 35'$E. Ile-Ife area has a rainy season of eight months (March-October) and a dry season of four months (November/February), a mean annual precipitation of 1000-1250 mm (Oguntoyinbo, 1982), and a mean annual temperature of about 27°C (Ndifon and Ukoli, 1989). The description of the sites is given below;

Site 1: Biochemistry Car Park (BCH)

The site is bounded on three sides by buildings (Departments of Biochemistry and Microbiology; Biological Sciences Lecture theatre C (BOOC); and Anatomy Department) and on the fourth side by a tarred road. It is about 1,500 m^2. The only species of plant in this site was *Terminalia catapa*. The trees were planted to provide shade for cars parked in the park. The

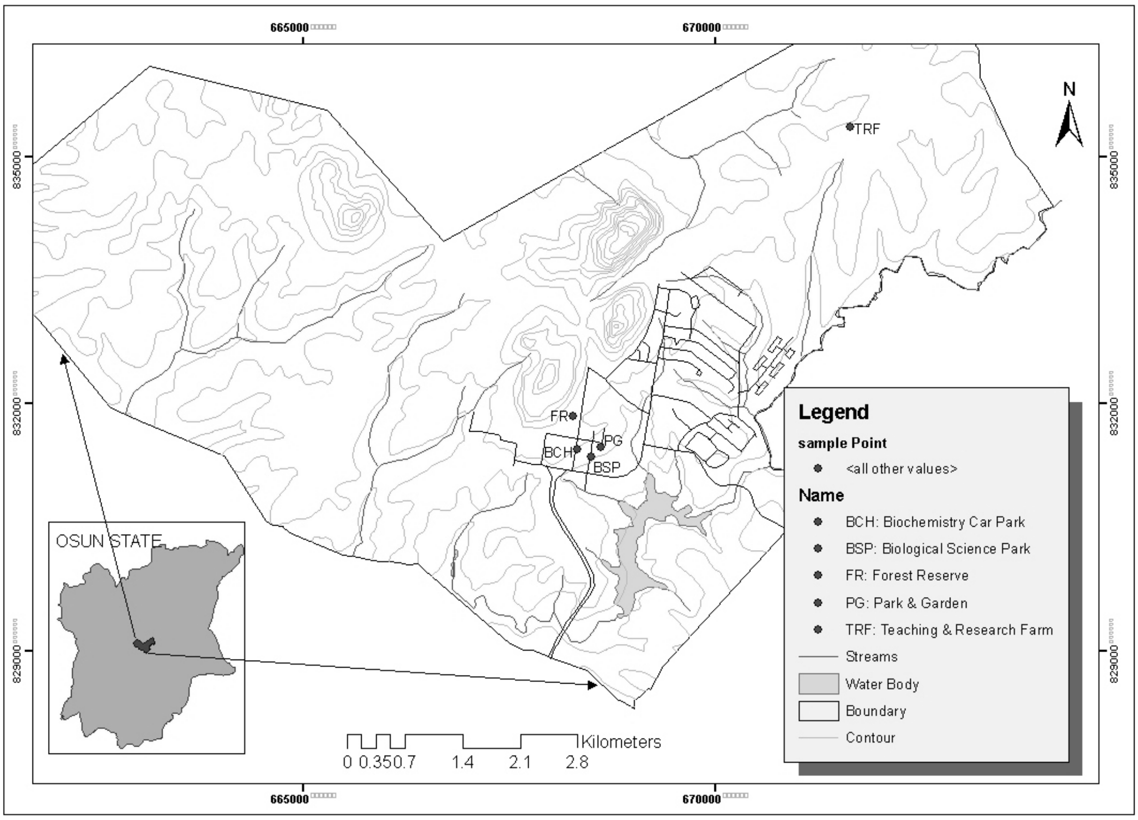

Figure 1. Map Showing Sampling Points in Obafemi Awolowo University, Ile-Ife, South Western Nigeria

Site 2: Biological Science Park (BSP)

This site is bounded on three sides by tarred roads and Zoology building on the fourth side. The site is about 5000 m^2. The few tall trees in the Park provide a near-entire canopy which permits light penetration in few places. The floor is covered with grasses. Decaying leaf litter is present at the base of the tall trees only. There is a labyrinth of foot-paths in the site. This site was cleared in 1972 leaving only big trees which provide shade in the area (Lasebikan, 1975).The main trees are *Blighia sapida, Newbouldia laevis, Trichilia heudelotii, Alchornea laxiflora, Blighia unijugata, Elaeis guinensis, Funtumia elastica and Cola milenii*. The site remained fairly unchanged until 2000 when a large number of bats *Eidolon helvum* invaded it. The rate of destruction on trees was such that many of the trees in the colony were observed to have lost about half of their branches within the first month of the arrival of the bats. The farmers in the vicinity incurred huge costs on protection of their crops from bats. Within the first three months of invasion, the bats had destroyed not less than 4 trees in the observed portion of the colony. The bats also stained people and facilities within the environment with their droppings (Oke, 2004)

Site 3: Forest Reserve (FR)

This is part of the lowland rain forest zone of Nigeria. It lies beside the Biological Gardens which is due north of the central campus. The site is about 800m^2. The canopy of the forest is not entire as there is penetration of sunlight in few places. The forest is a secondary regrowth situated about 800 meters to the Northwest of the Faculty of Agriculture. Oral evidence suggests that farming stopped in the forest in the 1930s. The oil palm and cocoa tree still present in this site is an evidence of previous farming activities. Typically, the vegetation of this forest is composed of herbs which make up the under-storey, climbers, and trees of various heights and girth. The tree species in the sampled area include *Funtumia elastic, Cola mileni, Antriaris africana, Elaeis guinennsis, Celtis zenkeri, Albizia zygia, Morus mesozygia, and Lecaniodiscus cupanioides*. Detailed description of this site has been given by Badejo (1982). Badejo (1994) reported a fire incidence in this site which occurred in 1993. Currently, Badejo and Akinwole (2007) reported other types of vegetation recorded as shrubs, tree seedlings, herbs and climbers, which include *Mallotus oppositifolius* (Geisel.), Mull. Arg., *Chromolaena odoratum* (Linn.), *Desmodium gangatum* (Linn.), *Morinda lucida* (Berth.), *Cnestis ferrugiana* (D.C.) J.F. *Combretum platypterum* (Welw.) Hutch and Dalz., *Sida acuta* (Burm.) *Cassia hirsuta* (Linn.), *Panicum maximum* (Hochst ex. A. Rich), *Mormordica charantia* (Descourt).

Site 4: Parks and Garden (PG)

This site is a horticultural garden established in 1962. It is manually weeded from time to time. The site contains many flowering plants and the floor is made up of grasses and other weeds. The predominant flowering plants in this site include *Hibiscus rosasinensis, Ixora cosinea, Conarium indica, Tecoma stans, Helianthus annum, and Acalypha* spp. The tree species include *Acacia nilotica, Mangifera indica, Daniella ogia, Delonix regia, Carica papaya* and *Chlorophora excelsa*. The site is about 3600 m^2.

Site 5: Teaching and Research Farm (TRF)

This site is located about 5 km from the central campus and is purposely used for teaching and research by the Faculty of Agriculture of the University. The four plots were used in this site are two cocoa plots, one mango plot and one citrus plot. The original history and description of these plots has been given by Badejo (1982). The cocoa plots were established in 1968 and 1969. The first plot has about 500 stands of cocoa, while the second has 331 stands at the time of establishment. The cocoa trees in the plot form a nearly entire canopy over the floor which is covered with a thick layer of fallen cocoa leaves and pods. Weeding and pruning of the branches occur regularly in these plots. In addition, Lindane was sprayed regularly in the plots during the first four years after planting the cocoa seedlings. Thereafter, Gamalin 20 and Vetex 85 were used to control pests in these plots. The citrus plot contains many orange trees which are widely spaced. The floor is covered with many species of weeds. The Citrus trees were planted between 1967 and 1968. Weeding in the plot is done manually. Pest control however was as in the Cocoa plot. The Mango plot forms an entire canopy. It is usually manually weeded and pesticides have never been used in this site.

Methods

Sampling Techniques

The survey of the whole campus was made between February and April in 1992 so as to identify sites where *O. longinoda* was present. Actual sampling later took place in May 1992. Subsequently, these sites were surveyed and sampled again in June 2005. Sampling was usually done between 10:00 and 13:00 h on all sampling occasions.

During each sampling, a pair of binoculars was used to count the number of nests per tree. Subsequently, a whole nest per tree was completely trapped undisturbed in a black polythene bag. The polythene bag was quickly opened into a standard killing jar containing chloroform. Within the killing jar was placed a Whatman filter paper, to prevent the ants from getting attached to the cotton wool placed at the base of the jar.

Sorting, Counting and identification

The content of the killing jar was then emptied into a large bowl and sorted out into different castes and brood. The castes consisted of adults which are major and minor workers. Sex differentiation into winged males and females was also done. The brood consisted of the larvae, pupae, semi-pupae and eggs.

After sorting them into different castes and brood, they were counted and their numbers were noted. The number of each group was recorded as number per group per nest. Whenever there was ambiguity in identification between the winged males and females, specimens were observed under a low power microscope for proper identification. Prior to the main sampling, the specimens were identified at the Natural History Museum, at Obafemi Awolowo University, Ile Ife, Nigeria.

More than 30 tree species were found in the sites during each sampling year.

Trees found in the two sampling year with at least four individuals in any of the years were selected for the estimation of percentage infestation and mean nest calculations. This was done to allow statistical evaluation of data. Data for rainfall patterns were collected from the Nigerian Meteorogical Station at Ede, a town about 35 kilometers away from Ile-Ife.

Statistical analyses

Data were subjected to test of normality and homogeneity of variance using Lillifor's and Levene's tests respectively. Since the data passed these tests, Student's t-test was used to determine if differences between numbers of ants per nest between the two years were significant at 95% confidence level. The statistical analyses were carried out with Statistica 7.0 software.

RESULTS

Fluctuations in the mean monthly rainfall in 1992 and 2005 are illustrated in Figure 2. In 1992, there was unimodal peak in September, while in 2005 the peak was in July with another mode in October. Rainfall was generally lower in 2005 when compared with 1992, except in June and July. It is remarkable to note that there was a sharp contrast in the amount of rainfall in September in both years.

The relative abundance of ants collected per nest in all the sites in 1992 and 2005 is presented in Figure 3. In 1992, the highest numbers (1650) of ants were collected in the FR and the lowest (178) from TRF. The total number of ants collected was 22,481in that year. In 2005, the highest number (565) was collected from PG and the lowest (168) from FR, while the ants were not found in BCH and TRF. Total number of ants collected was 12,143 in that year. Generally more adults were collected than broods in all sites for both years except for TRF where similar numbers of adults and broods were collected in 1992. The number of ants per nest collected from PG and BSP in 1992 was not significantly different ($P > 0.05$) from those collected in 2005. However, the numbers of ants collected from FR in 1992 were significantly higher ($P < 0.05$) than those collected in 2005.

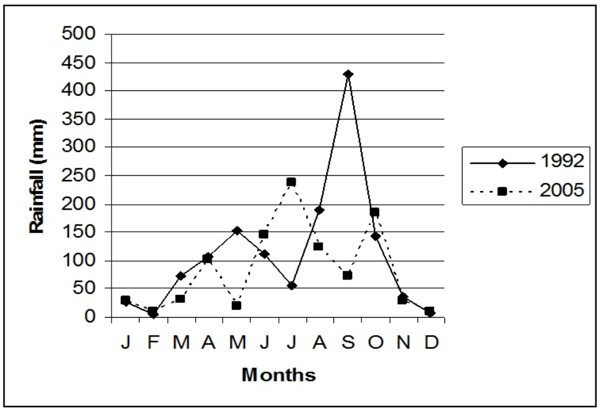

Figure 2. Mean Monthly Rainfall in Ile-Ife Area in 1992 and 2005.

The ratio of winged males, winged females and workers is presented in Table 1. In all sites, except FR, winged females are less in number than the winged males. In 1992, males were as much as a factor of 11 to 77 higher in number, while in 2005, they were only a factor of 1.6-4.3 higher in number than the winged females. A reverse trend was seen in FR, where the winged female was a factor of 14 higher than the male counterpart in 1992. However, in 2005, they were only a factor of 1.6 higher. The proportions of workers were usually higher than those of the winged males and females even when summed together.

The percentage of tree species infested with *O. longinoda* as well as the mean number of nests per tree in the five sites for the two sampling years are presented in Table 2. There was generally higher intensity of infestation in 1992 than in 2005 for all sites except PG. In 1992, trees in BSP were the most infested, followed by those in FR, with the least infestation occurring in TRF. However, BCH has the highest mean number of nest and FR had the lowest. In 2005, trees in PG were the most

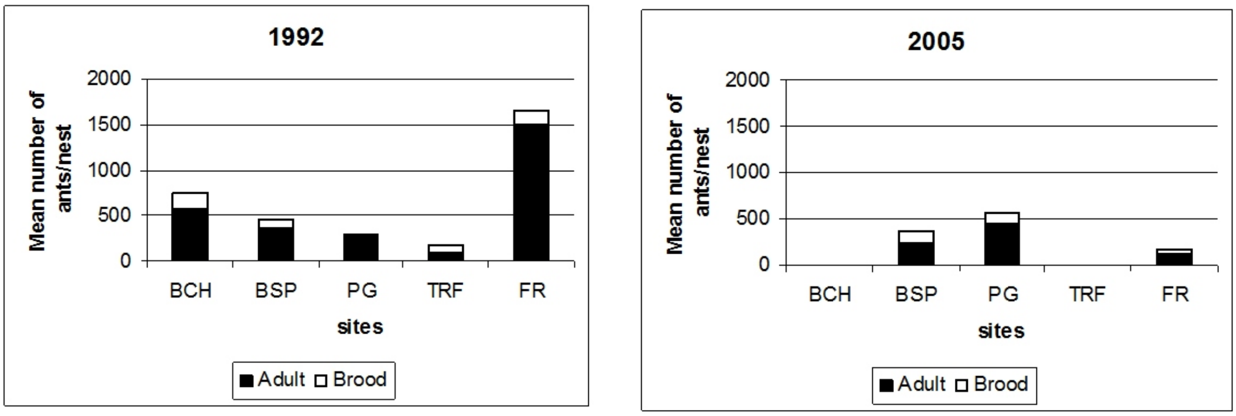

Figure 3. Relative Abundance of *Oecophylla longinoda* Collected per Nest from 5 sites in Obafemi Awolowo University, Ile Ife Nigeria in 1992(a) and 2005(b).

BCH-Biochemistry Car Park, BSP-Biological Science Park, PG-Parks and Garden, TRF-Teaching and Research Farm, FR-Forest Reserve.

Table 1. Proportions of winged males (WM), winged Females (WF) and workers (W) of *Oecophylla longinoda* collected from five sites in Obafemi Awolowo University, Ile-Ife, Nigeria in 1992 and 2005.

Sampling Sites	1992			2005		
	Winged Males	Winged Females	Workers	Winged Male	Winged Females	Workers
BCH	11.0	1.0	38.0	0.0	0.0	0.0
BSP	37.0	1.0	348.0	4.3	1.0	15.5
PG	16.0	1.0	115.0	1.6	1.0	74.0
TRF	77.0	1.0	642.5	0.0	0.0	0.0
FR	1.0	14.0	435.0	1.0	1.6	49.9

BCH-Biochemistry Car Park, BSP-Biological Science Park, PG-Parks and Garden, TRF-Teaching and Research Farm, FR-Forest Reserve.

Table 2. Levels of Infestation of Tree Species with *Oecophylla longinoda* in Five Sites in Obafemi Awolowo University, Ile-Ife, Nigeria in 1992 and 2005.

Sampling Sites	1992			2005		
	Number of trees	% Infested with *O. longinoda*	Mean number of nests per tree	Number of trees	% Infested with *O. longinoda*	Mean number of nests per tree
BCH	8.00	50.00	11.25	8.00	0.00	0.00
BSP	9.00	77.77	7.14	10.00	25.00	1.92
PG	42.00	38.10	6.12	36.00	55.56	5.50
TRF	13.00	3.11	5.52	13.00	0.00	0.00
FR	20.00	60.00	3.50	17.00	26.47	3.35

BCH-Biochemistry Car Park, BSP-Biological Science Park, PG-Parks and Garden, TRF-Teaching and Research Farm, FR-Forest Reserve.

infested, and also with the highest mean number of nests, ahead of infestation in BSP and FR which were fairly similar.

To assess the frequency and intensity of infestation per tree species, data from all sites were pooled together. The numbers of tree species infested with *O. longinoda* as well as the mean number of nests on trees in the five sites are presented in Table 3. The percentage of trees infested and mean number of nest per tree in *Terminalia catapa* and *Blighia sapida* were at least 50% and similar for the two years. For *Theobroma cacao* and *Citrus spp*. only a few trees were infected in 1992, with a mean number of nests between 3 and 7. But there was no infestation in 2005. For *M. indica*, the percentage of infested trees rose in 2005 in comparison with 1992, and a similar pattern was seen for the mean number of nests.

Table 3. Levels of Infestation of Tree Species with *Oecophylla longinoda* and the Mean Number of Nests Collected per Tree from Major Trees Pooled from Five Selected Sites in Obafemi Awolowo University, Ile-Ife, Nigeria in 1992 and 2005

Tree Species	1992			2005		
	Number sampled	% Infested	Mean number of nests per tree	Number sampled	% Infested	Mean number of nests per tree
Terminalia catapa	8.00	50.00	11.25	8.00	50.00	13.85
Blighia sapida	3.00	66.67	5.50	2.00	50.00	5.50
Mangifera indica	44.00	4.54	8.00	42.00	38.09	2.00
Theobroma cacao	881.00	1.82	3.82	881.00	0.00	0.00
Citrus spp	360.00	6.11	6.86	360.00	0.00	0.00
Myrianthus aboreus	4.00	60.00	2.50	4.00	0.00	0.00

DISCUSSION

This study shows a general decline in the abundance and population of the African weaver ant, *O. longinoda* on trees in the Obafemi Awolowo University campus in a period of 13 years. There were no comparable data available in literature on population dynamics of these ants over time, and so comparison of our data with other data was not possible. However, these observations could be explained by differences in rainfall pattern and intensity between the two years. A previous study (Lokkers, 1986) suggested that rainfall as well as temperature can have indirect effects on the distribution of nests of these ants.

Although six tree species (*T. cacao, Citrus* spp*, M. indica, T. catapa, B. sapida,* and *M. aboreus*) were identified as susceptible to weaver ant infestation in this study, the infestation of *T. catapa, B. sapida,* and *M. aboreus* are reported for the first time. The intensity of infection was higher among these three tree species than *T. cacao, Citrus* spp*, M. indica,* for which evidence of infestation has been reported in literature. The lower intensity of infestation among these earlier reported tree species could be due to their location in TRF where pesticide use has been reported. The use of pesticides must have reduced infestation of these three tree species which are known to harbour *Oecophylla,* and ultimately led to the disappearance of these ants on *T. cacao* and *Citrus* spp*,* by 2005. Incidentally these three species in which the populations of *O. longinoda* were tremendously reduced over 13 years are tree crops.

An infestation of 1.82% on cocoa trees observed in this study in 1992 is lower than values reported in literature. Some studies have reported that *Oecophylla* infested 17% (Bigger, 1981) or 33% of the cocoa trees in West Africa (Jackson, 1984). It has been reported that in cocoa plantations, the weaver ants drive off a range of pests, including weevils *Pantorhytes* (Stapley, 1980), coreid bugs *Amblypelta* and *Pseudotheraptus* (Lodos, 1967) and capsids and myrids (Leston, 1970; Way and Khoo, 1991). In Citrus plantations, the ants were reported to control pests like the citrus stinkbug *Rhynchocoris humeralis*, the aphids Toxoptera, Coleoptera and various other pests (Yang, 1984; Van Mele *et al.* 2002). In mango plantations, they offer protection against pests like mango leafhoppers, thrips, seed weevils, fruit flies, and mealy bugs (Peng and Christian, 2004; 2005; 2007). As found out in our study and these other studies, *O. longinoda* could play a role in the biocontrol of pests especially for the tree crops.

Studies have shown that biological control of pest is more economical and environmentally friendly than chemical control of pests.Van Mele *et al.* (2007) argued that the role of predators such as *Oecophylla* spp in controlling major tree pests in Africa is promising and deserves more attention. Weaver ants, *O. smaragdina*, were reported to control over 50 species of insect pests on many tropical tree crops and forest trees (Way and Khoo 1992; Peng and Christian, 2004; Peng *et al.*, 1995). Barzman *et al.*(1996), Van Mele and Cuc (2000) and Van Mele *et al.* (2002) suggested that weaver ants could be used in citrus orchards in Vietnam. Since 1998, weaver ant colonies have been successfully used to control the main insect pests in cashew orchards in the Northern Territory of Papua New Guinea and Mozambique (Peng, *et al.* 1999a, b; Peng, 2001, 2002). The use of *O. smaragdina* to control insect pests in citrus orchards in southern China has also been practised for many years (Yang, 1984). The trend of declining populations of *O. longinoda* in the TRF, a teaching and research farm, suggests that the use of *O. longinoda* as biological agent is yet to be exploited.

Reduction in abundance of these ants in FR could also be explained by a fire incident which occurred in these sites in 1993 (Badejo, 1994). In a recent study of the effect of *O. longinoda* in controlling fruitflies in mango plantation in the republic of Benin, Van Mele *et al.* (2007) stressed the importance of bush fires and ecoclimatic conditions such as the annual harmattan (desert wind) on the geographical distribution of *O. longinoda* in Africa and called for further investigation into the direct effects. The reason for the disappearance of the ants in BCH in 2005 is not fully clear since little anthropogenic activities were observed or reported in this site.

The similarity in abundance of ants over 13 years in BSP and PG (Fig. 3) was probably as a result of resilience to human and animal disturbances in these sites. These disturbances definitely exclude pesticide use which the ants could not cope with in the TRF. In spite of the similarity in abundance in 1992 and 2005 in these sites, trees in BSP were more susceptible to infestation in 1992 than in 2005, while trees in PG were more susceptible to infestation in 2005 than in 1992 (Table 2). These apparent contrasts could be due to changes in population dynamics of these ant communities. However, it is not surprising that the population of these ants remained unchanged despite the invasion of BSP by bats in 2001 (Oke, 2004). Bats operate at the branches forming the top tree canopy levels and do not interfere with the activities of the ants which occupy lower branches, a good example of co-existence among organisms with different ecological niches.

Comparison of the populations or abundance of these ants across sites in each sampling year should be done with extreme caution because of the differences in tree species diversity in each site. Nevertheless, it appears that FR supported more ants than other sites in 1992. *O. longinoda* is known to prefer trees with entire canopy (Taylor and Adedoyin, 1978), a situation that is pronounced in FR and less so in the BCH.

This study has shown that the response of populations of *O. longinoda* to habitat perturbations in fragmented habitats over time is dependent on the nature of the perturbation. While pesticide application and bush burning could be deleterious, other activities may be tolerated. The study has identified three additional tree species (*T. catapa, B. sapida, and M. aboreus*) that serve as host to *Oecophylla* . This ant species could be exploited to re-infest the tree crops where pesticide application has reduced the populations of these ants in a bio-control programme.

ACKNOWLEDGMENTS

We acknowledge the significant roles played by Anthony Odia in 1992 and Olayinka Olabode in 2005 in data collection.

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