# Effect of Natural Aerial Crown Connections between Leaves and Branches of Coconut Palms and Interplanted Citrus Trees on Interactions between *Pheidole megacephala* Fabricius and *Oecophylla longinoda* Latreille.

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## Abstract

*The effect of natural aerial crown interconnections between coconut palms and interplanted citrus on survival and movements of Oecophylla longinoda colonies between the trees was studied in a coconut-citrus plantation at Kiimbwanindi in Tanzania. The overlapping leaves and branches of coconut and citrus trees facilitated movements of* ***O. longinoda*** *from the citrus trees to coconut palms and effected control of the coconut bug* ***Pseudotheraptus wayi.***

*Crown connections also enabled* ***O. longinoda*** *to forage between citrus trees and coconut palms aerially by by-passing the ground nesting inimical ant,* ***Pheidole megacephala.*** *In the absence of crown connections* ***P. megacephala*** *normally prevented establishment of* ***O. longinoda.*** *Moreover when crown connections were lost an* ***O. longinoda*** *colony became isolated and was easily displaced by* ***P. megacephala.*** *Interplanting coconut with citrus is economically useful and is also a sustainable way of managing* ***P. wayi*** *through the encouragement of* ***O. longinoda.*** *Smallholder farmers are strongly advised to adopt the cultural practice in order to effect protection of their coconut from* ***P. wayi.*** *It is a cost effective method because farmers do not have to use insecticides to reduce populations of* ***P. megacephala.***

Key words: *Oecophylla longinoda, Pheidole megacephala, Pseudotheraptus wayi*, colony, forage.

## Introduction

In Tanzania, coconut is a smallholder crop cultivated mainly along a coastal strip 50 km wide. It is the backbone of the economy of most of the inhabitants of the coast and it provides food and shelter. Coconut production in Tanzania and elsewhere in Eastern Africa, with the exception of the Mozambique, is seriously affected by the coreid bug *Pseudotheaptus wayi* Brown (Heteroptera, Coreidae) (Way, 1953). The insect pierces young nutlets between the ages of 1 and 4 months, causing abortion and falling of nutlets within two weeks of the attack. Such nutlets bear several characteristic lesions and can easily be distinguished from those falling from normal physiological causes such as water stress, etc. Serious *P. wayi* damage can cause total loss of the potential crop due to premature nutfall. In medium infestations losses can be as high as 50-80% (Way, 1953, 1954; Vanderplank, 1959a). In some cases, attacked nuts may survive and develop into mature nuts, but they are often significantly undersized and highly contorted and fissured. Such nuts may be discarded or when they are collected dehusking becomes very difficult (Way, 1953; 1983). They are also not very suitable for seednuts because the hard exocarp hinders smooth emergence of the plumule and roots. Sustainable con-

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trol of *P. wayi* is by its naturally occurring predator ant, *Oecophlla longinoda* Latreille Hymenoptera, Formicidae) which nests on various broad leaf host trees notably citrus, mango, clove, jackfruit, soursop, *Syzigium spp* and several other cultivated and wild trees (Seguni, 1997; Varela, 1992). Coconut farmers are therefore advised to interplant coconut with suitable host trees to encourage the presence of *O. longinoda*. The host trees are favoured by the ants because they harbour the necessary homoptera which produce honeydew necessary as a supplementary diet for *O. longinoda*. Secondly, the broad leaves are suitable nesting sites for the ants which are therefore able to build strong colonies. Thus *O. longinoda* gains access to palms by moving from the host trees in pursuit of prey and in this way offer protection by either distracting *P. wayi* feeding on inflorescences or by preying on nymphs (Mainush, 1991; Varela, 1992). In this study, investigations are made on the role of crown interconnections between host trees and coconut in facilitating survival and movements of *O. longinoda* between trees. Advantage was taken of a mixed coconut-citrus plantation in which there were natural aerial connections between leaves and branches of the interplanted trees and many of which were colonised by *O. longinoda* and foraged by *P. megacephala*. The objective of the investigation was to determine how the natural aerial connections affected the viability of colonies of *O. longinoda* in the tree crowns, in the presence of inimical ants, *P. megacephala*, on the ground.

## Materials and Methods

The chosen plot of 90 trees was part of a 15 ha coconut plantation interplanted with citrus trees in the approximate ratio of three citrus trees to one coconut palm at Kiimbwanindi, about 70km south of Dar es Salaam city. The citrus trees, of an undetermined local variety, and the East African Tall palms were both about 14 years old and six and seven metres tall, respectively. They were grown either as rows of citrus only or citrus and coconut alternating in the row, at 8 m apart in the row and 9 m between the rows. The low shrub vegetation in the plot was controlled periodically by hand slashing using a bush knife and the grass on the ground was heavily grazed by cattle and remained sparse much of the year, sometimes leaving the soil almost bare. The proximity of the trees and their similar height enabled older coconut fronds to rest on and make crown contacts with adjoining citrus trees. Initial records of *P. megacephala* and of *O. longinoda* were made visually in October 1994 to determine their distribution and numbers at the tree bases, on the trunks and in the crowns of each tree in the plot and repeated at approximately six month intervals. The presence and abundance of *P. megacephala* was recorded on each tree using visual scores ranging from 0 to 5, where 0 = no ants seen during a five minute inspection; 1 = 1-20; 2 = 21-50; 3 = 51-100; 4 = 101-200; and 5 = 201-500 ants. The scores were then converted into numbers by taking the averages of the score-ranges thus, 1 = 10.5 (1-20); 2 = 35.5 (21-50); 3 = 75.5 (51-100); 4 = 175.5 (101-250) and 5 = 375 (251-500). Observations were made at the bases and on the branches and crowns of each tree. The number of active *O. longinoda* nests were also counted and scores made of worker ants foraging on the branches. The scores were as follows: 0 = no ants seen during a five minute inspection; 1 = 3 (1-5); 2 = 8 (6-10); 3 = 15.5 (11-20); 4 = 35.5 (21-50); and 5 = 75.5 (51-100).

Colony differentiation was achieved by interacting worker ants from adjacent trees and observing whether fighting took place (Varela, 1992). Ants of different colonies fight aggressively. A detailed record was also made of incidences of coconut fronds making crown connections to neighbouring citrus trees. The records were repeated at approximately six month intervals for 36 months.

## Results

Table 1 shows the status of the two species of ants during the study period. In October 1994, *P. megacephala* occupied the bases of most of the citrus trees and about half of the trunks in abundant numbers at tree bases and moderate numbers foraged the trunks and into the crowns. In March 1995, *P. megacephala* had occupied all citrus tree bases and most of their trunks. In October 1995, occupation of citrus tree bases by *P. megacephala* and numbers

Table 1. Occupation by *P. megacephala* and *O. longinoda* of interplanted coconut and citrus trees in a plot at Kiimbwanindi .

| *P. megacephala* | **Citrus** | October 1994 | March 1995 | October 1995 | March 1996 | September 1996 |
|---|---|---|---|---|---|---|
| | % of tree bases occupied | 93.5 | 100 | 96.8 | 100 | 100 |
| | % of tree trunks occupied | 51.6 | 92 | 72.6 | 100 | 85 |
| | Numbers/ tree base | 188.5 | 309.3 | 306 | 359 | 363 |
| | Numbers/ tree trunk | 100.2 | 247.2 | 209 | 282 | 295.3 |
| | **Coconut** | | | | | |
| | % of tree bases occupied | 96.7 | 100 | 100 | 92.3 | 100 |
| | % of tree trunks occupied | 80 | 86.7 | 93.3 | 84.6 | 85 |
| | Numbers/ tree base | 194.1 | 195.5 | 355 | 360.6 | 375 |
| | Numbers/ tree trunks | 87.5 | 120 | 186.6 | 181 | 198 |
| ***P. longinoda*** | **Citrus** | | | | | |
| | % occupied trees | 86.7 | 82.5 | 81.7 | 76.9 | 87 |
| | Numbers/ tree trunk | 30.2 | 37.6 | 38.7 | 28.7 | 23.9 |
| | Nests per tree | 4.9 | 5.48 | 4 | 5.1 | 3.1 |
| | **Coconut** | | | | | |
| | % occupied trees | 83.3 | 90 | 100 | 83.5 | 86.7 |
| | Numbers/ tree trunk | 20.5 | 9 | 20 | 8.6 | 10 |
| | Nests per tree | 1.1 | 0.9 | 1.4 | 0.9 | 0.5 |

per tree base and trunk remained high although the percentage of foraged trunks had decreased (Table 1). In March and September 1996, *P. megacephala* continued to occupy citrus in large numbers. In October 1994 most of the coconut bases and the majority of the trunks were foraged by large or moderate numbers of *P. megacephala*. In March 1995, occupation of palm bases and trunks by *P. megacephala* had increased (Table 1). In October 1995, *P. megacephala* occupied all coconut tree bases and foraged on most of the trunks in large numbers. In March and September 1996, coconut tree bases and trunks remained heavily foraged by *P. megacephala*. In both citrus and coconut trees occupation by *O. longinoda* remained high and fairly constant throughout the study period.

The distribution of the two species of ants in the citrus and coconut trees and the incidence of crown connections between the trees are shown in figures 1 a-e. In October 1994, (Fig. 1a) 68% of tree crowns were interconnected involv-

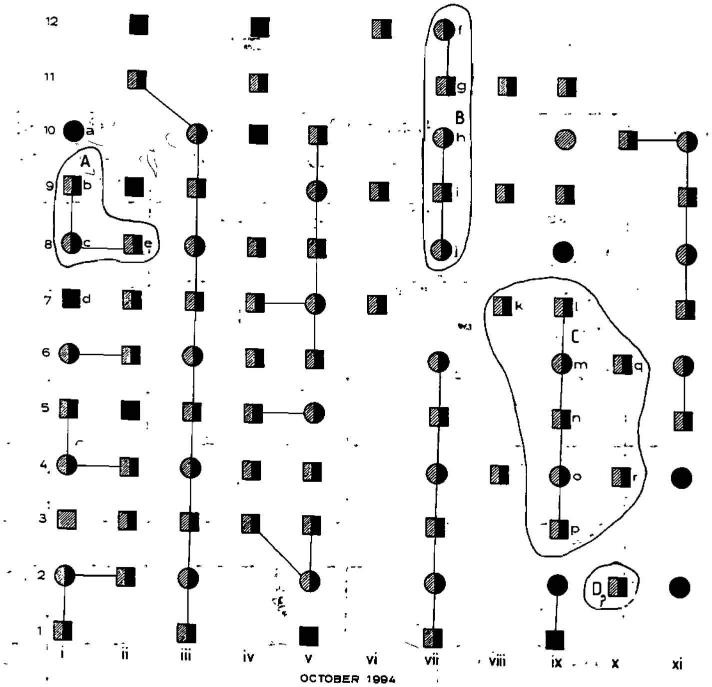


**Fig I (a)**
**Fig Ia-c:** Occupation by *P. megacephala* and *O. longinoda* of interplanted coconut and citrus trees and the incidence of crown inter-connections in a plot at Kiimbwanindi.

Squares represent citrus and circles represent coconut trees, cross hatching = *O. longinoda*, Solid colour = *P. megacephala* and solid + cross hatching = both ants

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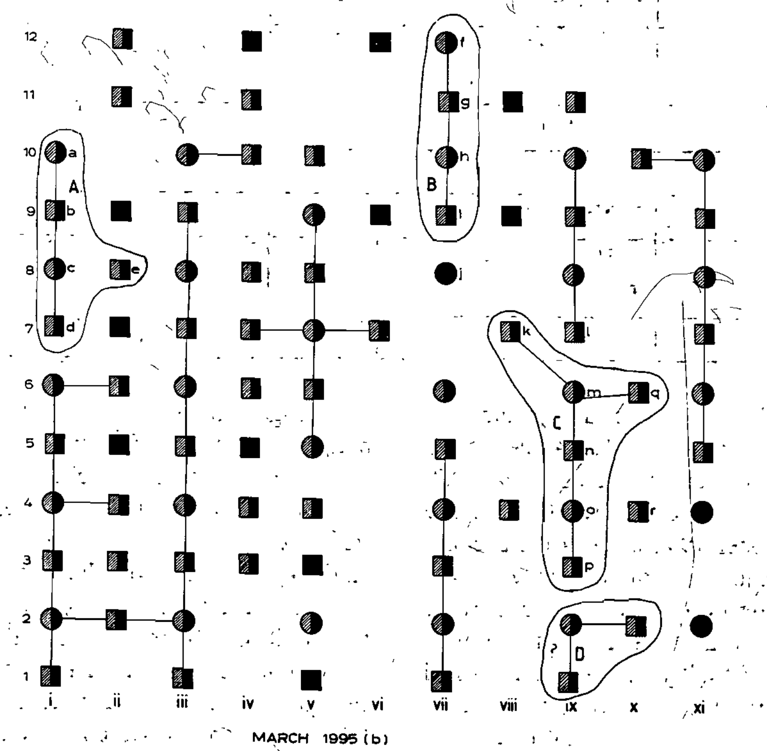

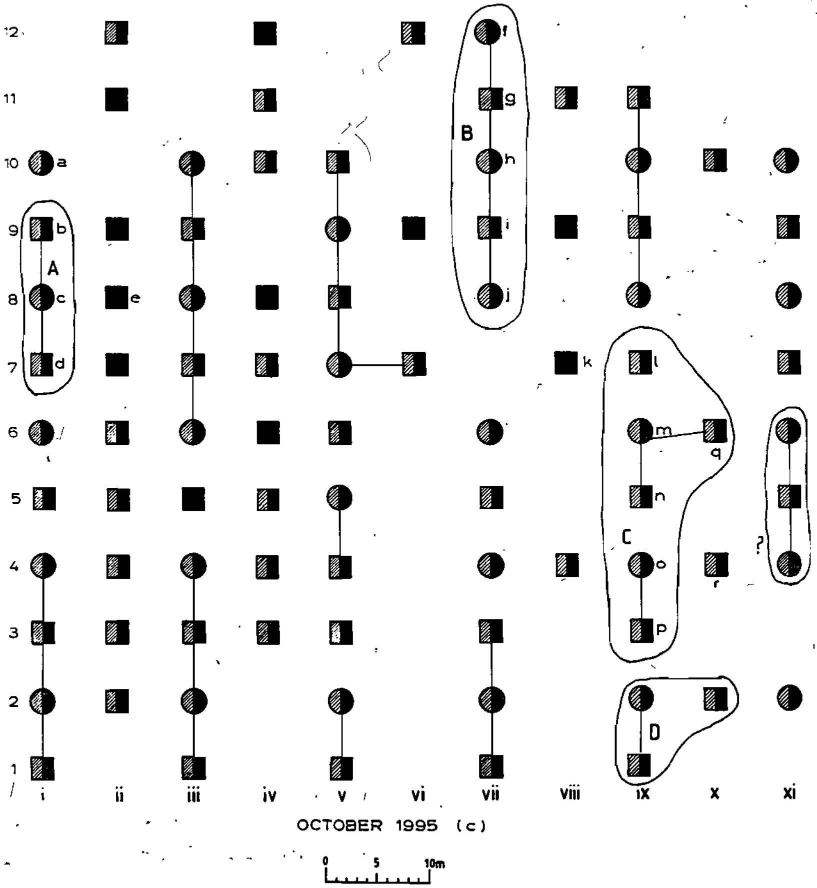

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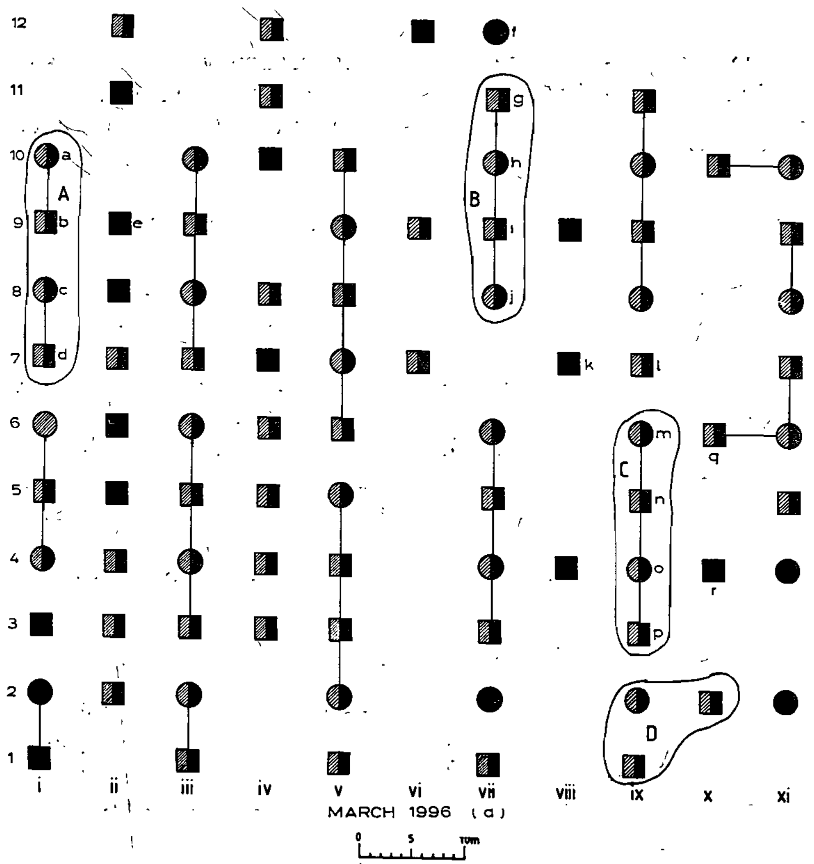

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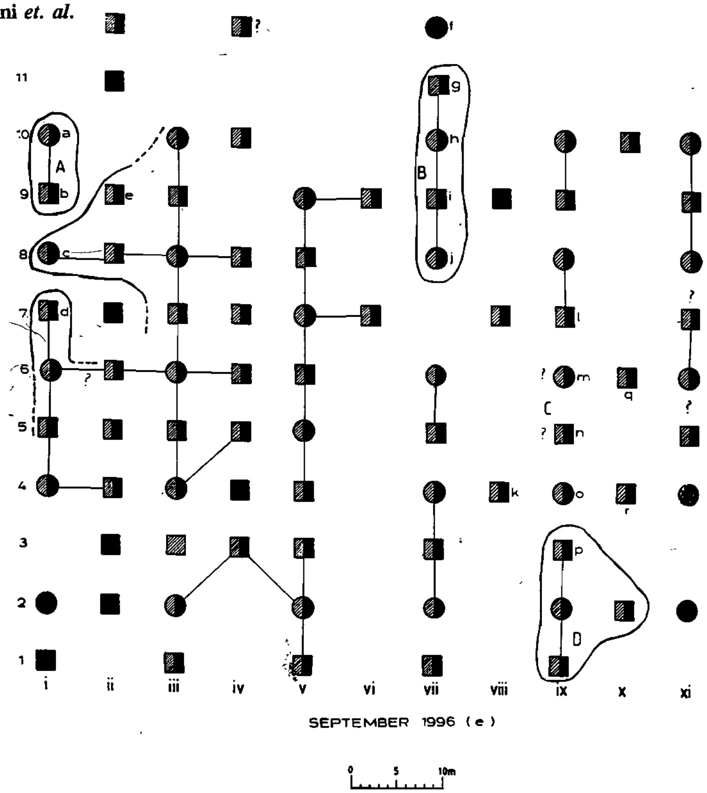


**Figure 1a - e: Occupation by *P. megacephala* and *O. longinoda* of interplanted coconut and citrus trees and the incidence of crow inter-connections in a plot Kiimbwanindi.**

ing 83% of the coconut palms with fronds extending to 60% of citrus trees. Of the interconnected trees, only one pair (row ix, tree 1 and 2) (Fig. 1a) lacked *O. longinoda*. In March 1995, the number of crown contacts remained similar although some were in different trees. All the interconnected trees had *O. longinoda* (Fig. 1b). Crown interconnections decreased in October 1995 and involved 77% of coconut and 42% of citrus trees (Fig. 1c). In March 1996, (Fig. 1d) 83% of the coconut crowns were interconnected to 44% of citrus, and only one place (row 1, trees 1 and 2) that lacked *O. longinoda*. In September 1996, 67% of the total trees were interconnected involving 80% of coconut palms and 59% of citrus trees (Fig. 1e).

The interactions of three colonies of *O. longinoda* **A**, **B** and **C** were followed. In October 1994, colony **A** occupied citrus trees **b** and **e** (rows i and ii) (Fig. 1a) interconnected via coconut palm **c**. In March 1995 (Fig. 1b), there were interconnections between trees **a,b,c**, and **d** and trees a and **d** became occupied by the *O. longinoda* colony A. At the same time, the interconnection with tree **e** was lost and the *O. longinoda* became isolated. One year later in October 1995 (Fig 1c), the interconnection to tree **e** remained severed and *P. megacephala* had displaced the *O. longinoda*. The interconnection to tree **a** was severed again but the *O. longinoda* persisted (Fig. 1c). In March 1996 (Fig. 1d), interconnections were restored between trees **a** and **b**, **c** and **d** but not with **e** which did not regain the *O. longinoda* (Fig. 1e). In September 1996, tree **c** lost connection to trees **a** and **b** (Fig. 1e) but formed new connections with new trees on rows ii and iii which were seemingly taken over and foraged by a seemingly new colony. Tree **d** also became separated from the original *O. longinoda* colony in trees **a** and **b** and formed new connections with trees in the same row (Fig. 1e) and those of an adjoining row. This tree therefore, must have had its original *O. longinoda* colony taken over by the new colony. In October 1994, colony **B** was in interconnected with trees **f,g,h,i** and **j** (row vii) (Fig. 1a). In March 1995 (Fig. 1b), tree **j** was disconnected to **f,g,h** and **i** and consequently *P. megacephala* displaced the *O. longinoda*. In October 1995, the interconnection to tree **j** was restored and *O. longinoda* re-occupied the tree (Fig. 1c). In March and September 1996, interconnections to **f** had been lost together with the *O. longinoda* in it (Figs. 1d-e). Colony C occupied six citrus and two coconut trees in rows viii ix and x (Fig. 1a). In March 1995, only six trees were covered by the colony as the connections to trees **l** and **r** had been severed. Tree **l** formed new connections in the same row and possibly became foraged by a different *O. longinoda* colony. Tree **r** became isolated but *O. longinoda* remained (Fig. 1b). In October 1995, the connections of trees k to m, n, o, and p were cut off and subsequently *P. megacephala* eliminated the *O. longinoda* (Fig. 1c). The connections of tree **l** and **r** were severed but retained their *O. longinoda*. In March 1996, trees **m,n,o** and **p** were still connected to each other but trees **k,l** and **r** remained isolated and **k** and **r** lost their *O. longinoda* (Fig. 1d). By September 1996, most of the trees in row ix lost their interconnections while tree **p** formed new connections to trees with probably a new *O. longinoda* colony (Fig. 1e).

## Discussion and Conclusions

The results demonstrate that the interplanting of coconut palms with citrus trees enables *O. longinoda* to spread aerially between the coconut palms and the citrus trees which usually contains high numbers of ants. In such cases *P. megacephala* prevents workers of *O. longinoda* from reaching neighbouring trees along the ground. Since *O. longinoda* was totally cut off from the ground by *P. megacephala,* the crown interconnections were critically important. This was evident when a connection was lost, when the isolated tree was taken over by *P. megacephala*. In contrast, when a new connection was made, *O. longinoda* was able to colonise it despite presence of *P. megacephala*. Crown interconnections would not be expected to be permanent as shown by variations during the present study. Wind and moisture stress which make palm fronds fold downwards and probably chance, may be involved in determining the abundance of crown connections. In the long term, the increasing height of palm trees will probably permanently separate the crowns from the adjoining citrus trees.

The results of the current study demonstrate the value of interplanting coconut with citrus trees in which the strong colonies of ants built can spread via the interconnecting branches and crowns of trees aerially, avoiding the competitor ant *P. megacephala* on the ground. Intercropping with citrus trees reduces the need to control the inimical *P. megacephala* with chemical baits such as Amdro, which is expensive, especially for low income smallholder farmers. Intercropping the coconut with citrus trees is therefore promising strategy for sustainable management of *P. wayi* in smallholder coconut cropping systems in Tanzania.

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## References

Mainusch, R. 1991. Final technical report on research on the biology and ecology of *Pseudotheraptus wayi* (Brown) Heteroptera: Coreidae). Annual Report National Coconut Development Programme (NCDP), Pest Control Section, Zanzibar, Tanzania.

Seguni, Z. 1997. Biology and control of *Pheidole megacephala* (Hymenoptera:Formicidae, Myrmicinae) especially in relation to use of *Oecophylla longinoda* (Formicidae, Formicinae) for biological control of *Pseudotheraptus wayi* (Heteroptera:Coreidae) in Tanzanian coconut cropping systems. PhD thesis, University of London , 246pp *(Unpublished)*

Vanderplank, F. L. 1959a. Studies on the coconut pest *Pseudotheraptus wayi* Brown (Coreidae) in Zanzibar. II. Some data on the yields of coconut in relation to damage caused by the insect. *Bulletin of Entomological Research* **50**: 135-149

Varela, A. M. 1992. Role of *Oecophylla longinoda* (Formicidae) in control of *Pseudotheraptus wayi* (Coreidae) on coconuts in Tanzania. PhD thesis, University of London , 231pp

Way, M. J. 1953. Studies on *Theraptus sp* (Coreidae), the cause of gumming disease of coconuts in East Africa. *Bulletin of Entomological Research* **44**:657-668.

Way, M. J. 1954. Studies of the life history and ecology of the ant *Oecophylla longinoda* Latreille, *Bulletin of Entomological Research* **45(1)**: **93-112**.

Way, M. J. 1983. Consultants Report for GTZ on the *Pseudotheraptus wayi* problem on coconuts in Tanzania. Silwood Centre for Pest Management, 82 pp (*Unpublished*)