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# Observations on field parasitism of the subterranean termite *Pseudacanthotermes* sp. (Termitidae: Macrotermitinae) by *Megaselia scaralis* (Diptera: Phoridae) in Uganda

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## Abstract

We carried out continuous field sampling, laboratory culturing and dissecting over two maize growing seasons in 1997 and 1998 to establish the status of the phorid fly, *Megaselia scaralis* as a parasitoid of the subterranean termite *Pseudacanthotermes* and it's relative abundance in Iganga and Wakiso districts of Uganda. Evidence was obtained that under field conditions the phorid is a primary parasitoid and probably a significant mortality factor in populations of *Pseudacanthotermes* species. *M. scalaris* was more abundant at Namulonge (Wakiso) compared to Ikulwe (Iganga) and percentages of parasitised termites higher in surface foragers under mulch than in underground nesting termites. To follow-up on this preliminary work, we recommend studies on the biology and ecology of the insect focussed on assessing whether it's activity could be of practical use in an integrated management strategy for termites in maize-based cropping systems in Uganda.

***Key words:*** *Megaselia scalaris*, termites, Uganda, *Zea mays*

## Introduction

The termite *Pseudacanthotermes* sp. is among the important termite pests of crops in Uganda. Recent studies have indicated that this termite often causes more damage than other genera to crops in eastern and central Uganda, contributing significantly to crop losses in maize (Sekamatte, 2000). The termite feeds virtually on every part of the maize plant; prior to the green-cob stage the termite attacks prop roots, the lower leaf sheath, and the stem base, causing plants to lodge. Later, the termites burrow into the plant stems. The species *P. militaris* and *P. spiniger* commonly forage on crop residues used as mulch and are probably responsible for the rapid breakdown of mulches in plantain crops. Results of farm surveys of five major maize producing districts of Uganda indicate high levels of damage (up to 80%) to maize plants by *Pseudacanthotermes* species (Sekamatte *et al.* 2001).

Attack levels vary between the central and eastern regions of Uganda but the reasons are not yet known. Predation especially by Myrmicin ants, however, has recently been observed and presumed to a major factor contributing to this location variation (Sekamatte *et al.* 2001). Termite predation by ants has been fairly better documented (Wheeler, 1936; Weber, 1964; Longhurst *et al.*, 1978; Lapage and Darlington, 1984; Cornelius and Grace, 1996) compared to mortality due to pathogens and parasites (e.g. Grace, 1997). In particular, there has been almost no research on parasites and their role in termite côntrol is very poorly understood. Nevertheless, phoretic mites and nematodes have frequently been mentioned (Phillipsen and Coppel 1977; Costa-Leonardo and Soares 1993).

A wealth of information exists on the invasion of laboratory termite cultures by phorid parasitoids, including species of *Megaselia* (Disney, pers. comm.). Notable among the notorious phorid species recorded in the tropics is *Megaselia scaralis* which, however, is only documented as a secondary invader of laboratory cultures. Observations in Uganda indicated that *M. scaralis* is abundant in maize fields and in places with decomposing crop residues where termite activity is also noticeably high but its relationship with the termitidae is not known. To obtain insight into this phorid-termite relationship, the present study was carried out. The objectives of the study were: (a) to establish the relative incidence of *M. scaralis* in two major maize agroecologies in Uganda and (b), to ascertain the relationship between *M. scaralis* and the termite *Pseudacanthotermes* under field conditions.

## Materials and methods

*Sampling and laboratory handling of termites*

The study was conducted at Ikulwe (Iganga district) and Namulonge (Wakiso district), in East and Central Uganda respectively, during the second (short) rainy season of 1997 and the long rains in 1998. The first samples were taken from a heap of decomposing bamboo (*Guadua angustifolia* Kunth) on a verandah of the termite laboratory and from experimental plots of maize at Namulonge. During the second trial season (first rainy season of 1998), termite samples were obtained from decomposing stover in maize fields and from soil. Soil samples were collected by digging up to 30 cm deep pits during destructive sampling in 15m x 20 m experimental plots of maize at Namulonge and Ikulwe Farm Institute in Iganga district. The soil samples were collected in plastic trays and processed in the laboratory.

In the laboratory, soldier and worker castes were carefully sorted out and samples of different castes, each containing 10 termites, were placed onto petridishes. Each petridish was lined with moistened filter paper, and a double layer of toilet paper to serve as food for the termites. The petridishes were covered with a lid, labelled and kept in a dark chamber. Laboratory temperatures were uncontrolled and were usually 23 - 25°C. The termites survived under these conditions up to 14 days.

Two millilitres of distilled water were added to each petri-dish after every other day to keep the filter paper constantly moist. Water continued to be added until parasitoid emergence from termite cadavers was noticed.

To establish whether the fly actually acted as a primary parasitoid, the sample size was increased to 20 termites per petridish during the 1998 season. One set of such samples was for regular dissection of the termites. The termites were dissected under a binocular microscope to recover the early stages of the parasitoid before death of the host.

*Data analysis*

Parasitism rates (seasonal means for all castes) were compared between samples collected from pits and those from under mulch or surface foragers. The data on *M. scalaris* incidence at Namulonge and Ikulwe were plotted and also compared using t-test and analysis of variance. The data on termites with immature phorid larvae together with those on larvae emergence from cadavers were used to measure the level of field parasitism.

## Results

Incidence of *M. scaralis*

Emergence of *M. scaralis* from termite cadavers was significantly ($P<0.05$) greater at Namulonge compared to Ikulwe (Fig 1., Table 1). There were fewer parasitised individuals from Ikulwe throughout the season than from Namulonge. Mean (± S.E) peak parasitism of termites was 23.7±2.89 individuals at Ikulwe against 96.8.0±10.3 individuals at Namulonge; ($t = 4.44$; $P < 0.01$) between 10 and 11 weeks after maize germination (Fig. 1).

Qualitative differences were not apparent among sampling dates in samples collected from under mulch at Namulonge. Phorid abundance was higher in the second season of 1997 than in the first season of 1998 (Table 1), presumably because of the heavier rains in the later season. There were significantly greater numbers of parasitised termites under mulch than from any other source (t-value = 8.97, $P<0.01$) (Table 1). In both seasons, the mean percentages of termites parasitised by *M. scaralis* under mulch were significantly ($P<0.05$) greater at Namulonge than at Ikulwe. Parasitism rates in mulch collected samples varied over time, but in all cases were consistently higher than those from pit collected samples.

*Larvae recovery in dissected termites*

Differences between mulch samples and pit samples were further reflected in parasitism rates in dissected major soldiers and worker termites (Table 2). Single immature phorid larvae were found just underneath the pronotum of major soldiers where the eggs are apparently deposited by the female fly. Most immature phorid larvae were recovered from major soldiers and were more frequently found in samples collected from Namulonge than Ikulwe and more in samples collected under mulch. No parasitised minor soldiers were found.

*Table 1. Megaselia scaralis emergence from termite cadavers collected from pits and under mulch at Namulonge and Ikulwe during the short rainy season of 1997 and long rains in 1998.*

| Caste | Namulonge | | Ikulwe | |
|---|---|---|---|---|
| | Pit | Mulch | Pit | Mulch |
| *1997 Season* | | | | |
| Major soldier | 14.5 ± 1.3 | 59.0 ± 3.5 | 6.1 ± 1.6 | 16.1 ± 2.9 |
| Worker termites | 13.4 ± 1.4 | 49.9 ± 3.64 | 2.8 ± 0.7 | 3.8 ± 0.07 |
| Minor soldiers | 0.2 ± 0.2 | 0.4 ± 0.2 | 0.1 ± 0.7 | 0.1 ± 0.1 |
| General mean | 9.37 | 36.43 | 3.00 | 6.43 |
| *1998 Season* | | | | |
| Major soldier | 0.5 ± 0.1 | 14.8 ± 3.3 | 1.6 ± 0.1 | 5.1 ± 0.9 |
| Worker termites | 0.0 ± 0.0 | 9.8 ± 1.6 | 0.9 ± 0.1 | 2.2 ± 0.5 |
| Minor soldiers | 0.0 ± 0.0 | 0.4 ± 0.2 | 0.0 ± 0.0 | 0.0 ± 0.0 |
| General mean | 0.17 | 8.33 | 0.83 | 2.43 |

*Table 2. Mean percentage of immature larvae of Megaselia scaralis obtained from dissected termite samples collected from Namulonge and Ikulwe in1998.*

| Caste | Namulonge | | Ikulwe | |
|---|---|---|---|---|
| | n | % | n | % |
| Major soldier | 360 | 52.5 | 482 | 14.6 |
| Minor soldiers | 235 | 0 | 370 | 0 |
| Worker termites | 240 | 32.1 | 430 | 6.9 |

## Discussion

This study has established the status of *Megaselia scalaris* as a primary parasitoid of *Pseudacanthotermes* sp in Uganda. The phorid was more prevalent in heaps of decomposing crop residues in which it gets greater opportunity to oviposit in termites and the larger sized caste, the major soldiers are more vulnerable to attack by the phorid.

The parasitism rates were higher in samples collected from mulch than in samples obtained from pits. The response of phorids to crop mulches was apparently mediated by a number of factors including food needs, aspects of habitat suitability and movement patterns of the host termite, *Pseudacanthotermes*. The higher parasitism under mulch was probably not due to the presence of mulch itself, but rather due to the modified behaviour of the termites. We observed that, instead of constructing surface soil tunnels, the termite forages for most of the time on or inside dry, hollow maize stalks which offer comparatively poor protection against the phorids compared to the continuous soil tunnels on unmulched ground.

The results suggest that termite parasitism by phorids is favoured by presence of mulch. The mulch presents a concentrated food source for the host termites and probably causes microclimatic changes such as increased relative humidity, lowered temperatures and reduction in wind turbulence that allows easy movement of the phorid fly. We have also observed in related studies that, termite mortality resulting from fungal infection of termites by a local *Beauvaria* isolate was greater under cover of mulch (Sekamatte *et al.*, 2000) suggesting that the phorid flies occasionally find 'sick', weak defenceless termites in this type of environment which they attack relatively easily.

Although the maize mulch and bamboo stalks in these experiments seem to be very important in increasing parasitism rates of *Pseudacanthotermes*, other factors may as well be influential. The cause

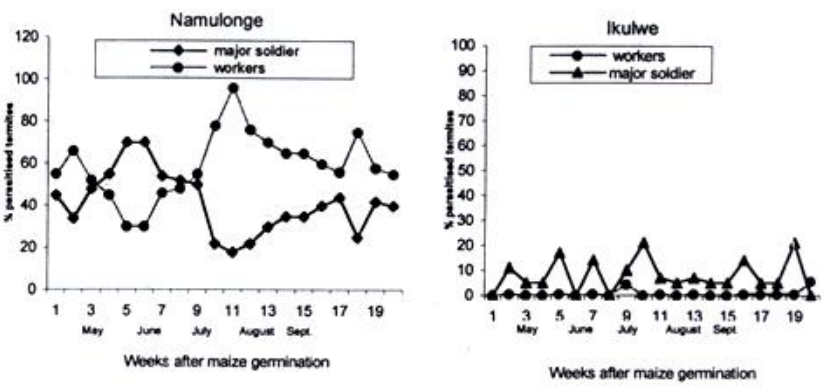


*Figure 1. Percent parasitised worker and soldier castes of Pseudacanthotermes termites by M.scaralis at Namulonge and Ikulwe, May-September 1998.*

and effect relationships of parasitism rates and the role of, for example, increased activity of *Myrmicin* and *Lepisiota* ants under mulch was not directly testable during these preliminary trials. It is suspected that activity of predatory ants was a confounding variable that was not controlled. This however seems to suggest the possibility of a complimentary role of ant predators and phorids.

Rates of phorid attack on the subterranean termites as determined by the present experiments provide the first recorded evidence of *M. scaralis* as a primary parasitoid of termites under field conditions. The greater parasitism rates observed at Namulonge compared to those at Ikulwe could be part of the reason for the substantially higher incidence of termite damage to maize at Ikulwe by this termite (Sekamatte, 2000). The parasitoid efficiency rates were significantly higher under mulch conditions on which higher activity of predatory ants was also recorded (Sekamatte *et al.*, 2000).

The high occurrence of higher numbers of termites under mulch compared to unmulched fields was expected and appears to agree partially with the resource concentration concept discussed in the review by Logan *et al.* (1990) but, the limited scope of our present studies cannot allow a fair prediction on how *M. scaralis* would perform under different conditions, for example, the different crop mixtures that characterise the smallholder maize-based cropping systems in Uganda.

We suggest the need for determination of the host range of *M. scalaris*, assessing the importance of alternative host, if any, and determine if it is likely to prove an effective parasitoid worth devoting further research effort. It is also necessary to determine whether it's incidence under the common conditions of the maize-based cropping systems which are mostly polycultural (Sekamatte, 2000), are due to prey densities or to other agro-ecosystem factors, causing microclimatic modifications in the habitat.

The major contribution of this study, however, is that it has provided an additional biological control option to be evaluated against termites in an overall integrated management strategy. Further, the study has provided some insight into possible mechanism underlying the theory of mulching, and termite damage to crops (Logan *et al.*, 1990). Based on these results, more focussed studies should be conducted on aspects of ecology of this phorid and elucidate it's potential for further development as an agent for either classical biological control or enhancement through various cultural practices against termite pests. In general, however, these results have revealed that research on the potential of biological control options against termites could be worthwhile.

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