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*Full Length Research Paper*

# Preliminary sampling of arthropod fauna of transgenic cassava in confined field trial

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**Water (Basin and pitfall) and sweepnet traps were used to ascertain the population dynamics of the arthropod fauna of transgenic cassava in a confined field trial (CFT) at National Root Crops Research Institute (NRCRI), Umudike, Nigeria. The trial took place from August to November, in 2009 and February to July, in 2010 to identify the major arthropods associated with the crop and to monitor changes in their populations for effective management. Trapped arthropods were sorted and identified by means of a hand lens and a taxonomic key and their relative abundance determined. Most of the order (seven out of the eight recorded) were trapped in the basin and sweepnet traps. Twenty families and numerous mostly unidentified genera and species were collected during the sampling period. Isoptera were the most abundant group, most of which were trapped while foraging and prospecting for nectar, mate, oviposition site, or were accidentally caught. This was followed by Coleoptera and Orthoptera. The least abundant order was Spirostreptida. Basin traps capture the highest number of arthropods of diverse families, followed by pitfall then sweepnet. A lower arthropod weekly mean abundance was recorded in 2009 (129.55) than in 2010 (132.08).**

**Key words:** Arthropod, fauna, pitfall, sampling, sweepnet, transgenic cassava.

## INTRODUCTION

Cassava (*Manihot esculanta* Crantz) is the third calories resources for humans and animals after rice and maize in the tropical and sub-tropical regions (Huang et al., 2001). It supplies about 70% of the total calories intake of over 60 million Nigerians (Ezulike et. al., 2006) who ate it at least once a day (Phillip et al., 2005). The leaves are nutritious vegetables, the leaves and storage roots can be used as animal feed (Okereke and Oti, 1988), and the stem can be sold as planting materials (IITA, 2000). The storage roots can be processed into various food products and starch for the production of adhesive and glue for use in paper industries and the production of ethyl alcohol (Asiedu, 1989). BioCassava Plus is a research partnership between the Donald Danforth Plant Centre (DDPSC), USA, National Root Crops Research Institute, Umudike, Nigeria, the Kenya Agricultural Research Institute (KARI), and three other advanced Research Institutes (ARIs). The goal is to develop nutritionally enhanced cassava through genetic transformation. Pro-Vitamin A enhanced cassava is crucial to improve the health and nutrition of a largely poor population in tropical Africa.

Yields of cassava in farmers' fields are usually low, between six and twelve tons per hectare (Nweke and Lynam, 1997). Such low yields are partly caused by pest and diseases (Guthrie, 1990)

Cassava is not indigenous to Africa; therefore most of the arthropod pests associated with the crop have been introduced to Africa. Arthropods make up 80% of described living species and they are one of two animal groups successful in dry environments (http://en.wikipedia.org/wiki/athropod, retrieved October 5, 2011). They contributes to human food supply both directly as food and more importantly as pollinator of crops, although they also spread some of the most severe diseases and do considerable damage to crops, livestock and man (Adesiyun, 2009). Few African insect

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and mites' species attack cassava, probably because of its high hydrocyanide (HCN) content and because it is generally grown in association with maize, beans and vegetables (Hahn et. al., 1979)

## Some arthropods associated with cassava and their damage

The variegated grasshopper (Orthoptera: Pyrgomorphidae); is distributed throughout West and Central Africa (Page, 1978). Since its reported pest status in Nigeria in 1970, it has remained a pest of cassava in the south West and South East of the country. The dry and wet season generation of *Z. veriagetus* attacks a variety of crops especially cassava. Adults and late instars may even strip the bark off plants, causing frequent defoliation which can reduce yield up to 60% especially when the crop is infested in the first 6 or 7 months of growth (COPR, 1974)

The cassava green mite (*Mononychellus tanajoa* Bondar) (Acari; Tetranychidae) is an exotic pest introduced from South America into Africa in the early 1970s and it's known to attack cassava only (IITA, 1990). Since the first outbreak, the pest has also been reported in Nigeria (Akinlosotu and Leuschner, 1979). Heavy infestation occurs in the dry season (Nyiira, 1972). All stages are active except the egg and feed on sap causing yellow spotting of leaves (Chlorosis) and leaves dry-out and fall-off. Leaf damage show mottled symptom which is usually mistaken for cassava mosaic virus, in severe damage causing a characteristic 'candle stick' appearance (Hahn et. al., 1979). It is mostly carried by wind and movement of planning materials (IITA, 1990). Yield loss can be up to 80% (Theiberge, 1985)

Ewuim (1998) reported the presence of termites (Isoptera: Termitidae) in cassava sites. They are eusocial (live in colonies) and are economically important pest that causes damage to crops and forest plantations. They attack cassava mainly in the tropical lowlands. They feed on propagation materials, growing plants and roots. Principal damage appear to be loss of cutting and plant establishment especially during prolonged dry periods (Nweke and Lynam, 1997)

The cricket (Orthoptera: Gryllidae) are omnivorous and scavengers feeding on organic, decaying plant materials, fungi and some seedling plants (Gorochov and Motovsk, 2008). In earlier works, Ewuim (1998) reported the presence of cricket in cassava plots. The tiny scale insects (Hemiptera: Diaspididae) live under waxy covers produced by females, beneath which it feeds on its host plant. Crawlers move along stem or leaves, using their piercing mouthparts to suck juices from the plant and causing leaf yellowing and plant stunting. The adverse effect of scales on the sprouting of cassava cuttings during dry season has been previously reported (CIAT Annual Report, 1974).

The millipedes (Spirostreptida: Spirostreptidae); constitute a major component of the soil-litter macrofauna, but some species occur in the forest canopy and in epiphytes (Picado, 1913; Hoffman, 1975; Hoffman and Howell, 1983). They are mostly herbivorous and abundant in moist unhygienic fields where they fulfill their role in breaking down decaying plant materials. Interviewed farmers in north eastern Uganda also named cassava as host to millipedes (Ebregt et al., 2004a, b, 2005).

Other arthropods include, Coleoptera which are beetles that constitute 25% of all known life form and about 40% of all described insect species (Harmmoud, 1992; Powell, 2009) and Hymenoptera namely; wasps (Vespidae), bees (Apidae) and ants (Formicidae) were present accidentally or were foraging and prospecting for nectar, mate, oviposition site.

Investigations on surface active arthropod associated with transgenic crops are scarce in literature. The study of Lasebikan (1977, 1985) emphasized more on Collembola and Acarina mites while those of Ewuim (1996, 1997), Ewuim et al. (1997) focused only on the ant fauna from forest and agro-ecosystems. The pitfall traps captured species in different proportions (Greenslade, 1964) depending on the animal behavioral cover density (Hinds and Rickard, 1973). The purpose of this study was to generate background information on some arthropods of the Classes; Insecta, Myriapoda and Arachnida associated with transgenic cassava cv. 60444 in a CFT in NRCRI, Umudike in relation to their abundance and diversity.

## MATERIALS AND METHODS

This experiment was conducted at the confined field site, NRCRI, situated in Umudike (N05° 29.008°N, E07° 31.92° within Abia State and at 122 m above sea level), during the cropping seasons of July to October, in 2009 (for fifteen weeks) and February to June, in 2010 (for twelve weeks). Weather data for Umudike in 2009 and 2010 are shown in Table 1. The site occupies one hectare. A pollen buffer of 4 rows of the 60444 variety (which can also be obtained locally at Umudike) was planted all around the plot at a spacing of 1 m apart within and between rows. The plots had five events (rows), six plants per event, and three replications for a total of 15 plots and 90 plants. Plant spacing was 1.5 m between rows and 1 m within rows. The entire experiment of transgenic plants covered an area of 105 $m^2$ (that is, 21 × 5 m). Recommended agronomic practices were carried out on the test (labeled) plots (excluding the pollen buffer) and there was routine application of insecticides to reduce whitefly pressure.

### Arthropod study

The study was conducted using water (Basin and pitfall) traps and sweepnets. The sampling started three weeks after planting and operated at weekly intervals for a period of three months.

### *Water traps experiment*

Nine orange basins traps (45 cm in diameter) were placed on a

**Table 1.** Mean monthly rainfall (mm), temperature (°C) and relative humidity (%) of Umudike, Abia State in 2009 and 2010.

| Month | 2009 | | | 2010 | | |
|---|---|---|---|---|---|---|
| | **Rain (mm)** | **Temperature(°C)** | **R.H (%)** | **Rain (mm)** | **Temperature(°C)** | **R.H (%)** |
| January | 62.8 | 28 | 61.5 | 0 | 28.6 | 60.75 |
| February | 62.8 | 29 | 67 | 78.2 | 29.4 | 62.55 |
| March | 47.8 | 29 | 67 | 34.1 | 29.25 | 65.2 |
| April | 100.5 | 28 | 67 | 129 | 29.3 | 69.45 |
| May | 416.2 | 28 | 75 | 213.3 | 28.45 | 76.9 |
| June | 237.6 | 27 | 77.5 | 427 | 26.75 | 82.3 |
| July | 306.3 | 26 | 82.5 | 310.2 | 26.3 | 81.6 |
| August | 287.4 | 26 | 83 | 376.2 | 26.25 | 82.75 |
| September | 205.5 | 26 | 79 | 303.3 | 26.15 | 82.0 |
| October | 311.1 | 27 | 77 | 34.9 | 26.8 | 82.15 |
| November | 237 | 27 | 66 | 77.8 | 27.15 | 79.25 |
| December | 0 | 28.5 | 62.5 | 0 | 27.25 | 62.10 |

Source: Meteorological unit, NRCRI, Umudike, 2010

stand 1 m high and nine pitfall traps consisting of small cups of 9.0 cm diameter and 10.0 cm depth fitted into large plastic cup of 9.5 cm diameter and 11.5 cm depth buried in the ground, such that the lip of the inner cup was leveled with the ground surface. To preserve the catch (arthropods), the basins and cups were half filled with 4% formaldehyde solution. They were placed in a diagonal transect within the main test plots with basin and pitfall alternating with each other. A wooden cover was supported above each trap to prevent entry of rain water, reduce evaporation and deter vertebrates from falling into the traps.

### *Sweep-net trap experiment*

The test plots were divided into groups of 15 and the surrounding 10 plots to make a total of 25 plots. The net's rim was 0.3 m (12 inches) in diameter with a wooden handle of 1 m long, the net bag was made of a strong muslin cloth to withstand pressure when sweeping. Ten sweeps were made per plot every two weeks. The arthropods were preserved in a jar containing 70% ethanol as conservative. They were then poured into a Petri-dish and labeled. Adults of arthropods were sieved, using a 16 × 16 mm fine plastic mesh and residues containing the arthropods were spread on a white plastic tray (Ewuim et al., 2010). Further sorting and counting was done in the plant protection laboratory of NRCRI, Umudike. Voucher specimens were kept for future identification, while the remaining was disposed off appropriately.

Insect identification was done usually to ordinal levels except for a few that have known genera and species. This was done with the aid of a hand lens and dichotomous key, visual and pictorial methods (Bland and Jaques, 1978). Common features used included wing structures, mouth part, antennae, ovipositor etc. The Student's *t*-test was used for testing whether statistical differences existed between arthropods trapped in 2009 and 2010. Number of adults trapped weekly was transformed to square root values before subjecting to two-way analysis of variance using Genstat release 7.2 version. Significant means were separated using LSD at 5% error limit.

## RESULTS

Eight arthropod orders were found to be associated with the transgenic cassava at the CFT, (NRCRI) Umudike in 2009 and 2010 (Table 2). Seven of them were trapped in the basin and sweepnet traps. About twenty families and numerous mostly unidentified genera and species were collected during the sampling period. Isoptera (Termitidae) were the most abundant group followed by Coleoptera (Scarabaeidae) then Orthoptera (Gryllidae). The least abundant order was Spirostreptida. Lower mean number of arthropod was trapped weekly in 2009 (129.55) compared to 2010 (132.08) (Table 2).

The four abundantly trapped arthropod orders collected from Basin, pitfall and sweepnet traps in 2009 and 2010 are shown in Figures 1 and 2, respectively. Basin traps caught the highest number of arthropod order compared to pitfall and sweepnet traps in 2009, whereas, in 2010, the pitfall traps collected most, while the sweepnet trapped the lowest number in both years. Arthropods with low level of abundance in water traps included Spirostreptida, Odonata and Lepidoptera in both traps in 2009 and 2010.

Table 3 presents the mean weekly diurnal catches of arthropods (adult) on water (Basin) traps (July to October, in 2009). The cumulative catches show significant ($P \leq 0.001$) difference among arthropod orders caught in all weeks sampled. Isoptera (Termitidae, Termites) were the predominant group caught followed by Coleoptera. The others were poorly caught except for Acari that were conspicuously absent. Similar trend was observed in the weeks sampled, the mean number of Arthropods caught in weeks 1 and 4 were significantly ($P \leq 0.001$) higher than catches in the other weeks sampled. Whereas, arthropods trapped in weeks 13 and 15 had the lowest mean number. Table 4 shows the mean weekly diurnal catches of arthropod in February to June, in 2010. Significant ($P \leq 0.001$) difference existed in the total catches of members of the arthropod orders. Coleoptera

**Table 2**. Relative abundance of the arthropods trapped from the basin, pitfall sweepnet traps at CFT, Umudike, 2009 and 2010.

| Order | Family | Species | Total catches (2009) | Relative abundance (%) | Total catches (2010) | Relative abundance (%) |
|---|---|---|---|---|---|---|
| Coleoptera | Carabidae, Scarabaeidae, Cerambycidae, Chrysomelidae, Coccinellidae, Nitidulidae | Phyllophaga spp. Aromia spp. and others not identified | 445.00 | 22.90 | 303.00 | 19.12 |
| Isoptera | Termitidae | *Microtermes* spp. | 825.00 | 42.60 | 611.00 | 38.55 |
| Orthoptera | Gryllidae, Pyrgomorphidae, Acrididae | *Gryllus* spp *Zonnocerus* spp. | 339.00 | 17.45 | 462.00 | 29.15 |
| Odonata | Aeshnidae | *Anax* spp. | 143.00 | 7.36 | 18.00 | 1.14 |
| Hymemoptera | Formicidae, Vespidae, Apidae and other unidentified | *Pheidole* spp., *Camponotus* spp. *Acantholepsis* spp. | 121.00 | 6.23 | 147.00 | 9.27 |
| Lepidoptera | Papillionidae and other unidentified | Not identified | 42.00 | 2.16 | 6.00 | 0.38 |
| Hemiptera | Belastomatidae, Cydnidae, Aleyrodidae, Aphidiae | *Lethocerus griseus*, *Bemisia* spp., *Aphis* spp. | 21.00 | 1.08 | 35.00 | 2.21 |
| Spirostreptida | Spirostreptidae | Not identified | 7.00 | 0.36 | 3.00 | 0.19 |
| | | | 129.55[a] | | 132.08[a] | |

[a] Mean number of arthropods trapped weekly over the 12-week and 15-week sampling period of 2009 and 2010. + t-test not significant at 0.05 probability levels; $t_{0.05}$ = 1.63.

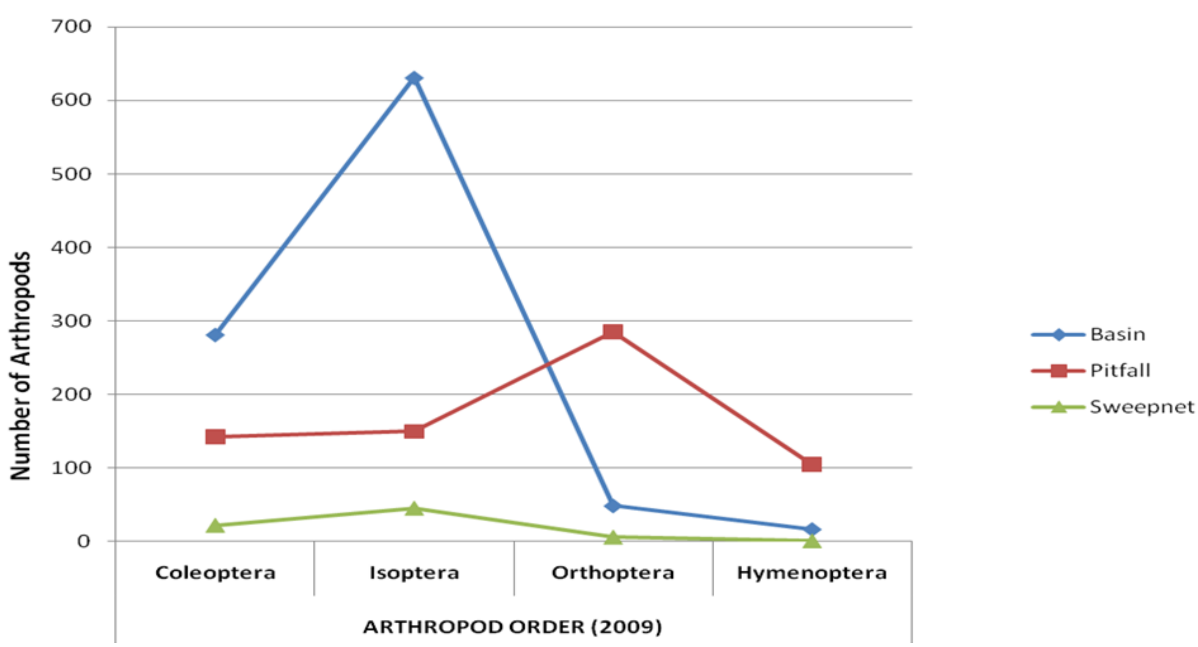


**Figure 1.** Dynamics of four relatively abundant arthropods (Order) captured in Basin, pitfall and sweepnet traps, in the CFT, Umudike (2009).

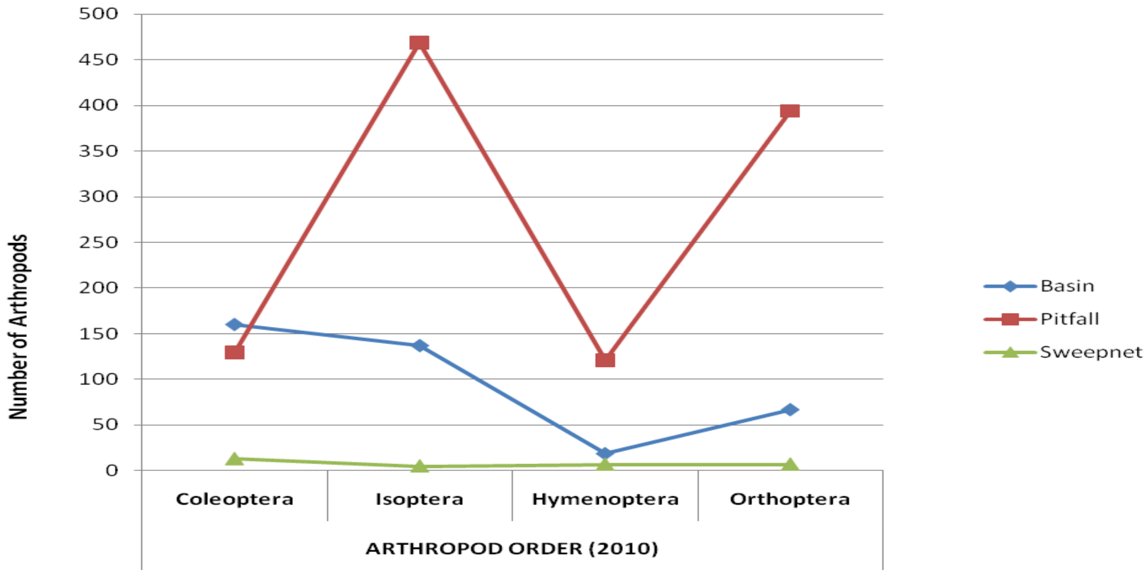


**Figure 2.** Dynamics of four relatively abundant arthropods (Order) captured in Basin, pitfall and sweepnet traps, in the CFT, Umudike (2010)

**Table 3.** Mean weekly diurnal catches of arthropods (adult) on water (Basin) traps (July to October, 2009).

| Arthropod order | Sample period (Week) | | | | | | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| Acari | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Coleoptera | 3.21 | 2.94 | 2.70 | 2.96 | 2.89 | 2.70 | 2.31 | 2.24 | 2.35 | 1.79 | 1.91 | 1.90 | 2.21 | 2.43 | 1.79 | 2.42 |
| Deplopoda | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| Hemiptera | 0.67 | 0.33 | 0.81 | 0.00 | 0.67 | 0.00 | 0.67 | 1.00 | 0.33 | 0.33 | 0.67 | 0.00 | 0.00 | 0.33 | 0.33 | 0.41 |
| Hymenoptera | 0.67 | 0.00 | 0.33 | 0.67 | 0.81 | 0.47 | 0.00 | 0.33 | 0.00 | 0.00 | 0.33 | 0.67 | 0.33 | 0.33 | 0.00 | 0.33 |
| Isopteran | 4.27 | 3.66 | 4.69 | 5.32 | 3.82 | 3.57 | 4.64 | 4.24 | 2.80 | 3.35 | 2.03 | 2.13 | 3.09 | 3.25 | 3.26 | 3.61 |
| Lepidoptera | 0.81 | 1.14 | 0.33 | 0.33 | 0.33 | 0.67 | 0.33 | 0.00 | 0.00 | 0.81 | 0.67 | 0.81 | 0.33 | 0.67 | 0.00 | 0.48 |
| Odonata | 1.72 | 2.07 | 1.79 | 2.06 | 1.69 | 2.19 | 1.38 | 1.66 | 2.10 | 1.47 | 1.14 | 2.50 | 0..47 | 1.38 | 0.91 | 1.64 |
| Orthoptera | 1.19 | 0.81 | 1.28 | 0.81 | 0.67 | 1.19 | 1.14 | 0.81 | 0.47 | 0.67 | 0.81 | 0.91 | 1.14 | 0.81 | 0.67 | 0.88 |
| Mean | 1.39 | 1.22 | 1.33 | 1.35 | 1.21 | 1.23 | 1.16 | 1.14 | 0.90 | 0.94 | 0.88 | 0.99 | 0.84 | 1.02 | 0.77 | |

LSD = 0.20 (Arthropod Order) ***; LSD = 0.26 (Week) ***; LSD = 0.78 (Arthropod Order/ Week) ***; *** = significant at 0.1%, **1%, * 5% and NS = Not significant at 5% probability.

(Scarabaeidae, *Phyllophaga*) were the predominant Order of arthropod trapped followed by Isoptera (Termitidae, white termites) and Orthoptera when compared with the others. However, there were no significant differences in the mean number of weekly total catches

The mean number of arthropod caught in pitfall traps from July to October, 2009 show that there were significantly ($P \leq 0.001$) higher mean number of Orthoptera (Gryllidae, *Gryllus*, Crickets) caught followed by Isoptera (Termitidae) and Coleoptera (Carabidae). Members of the order Acari, Lepidoptera and Odonata were not trapped. The week mean catches of arthropod was also significantly ($P \leq 0.001$) different. Higher total number of Arthropods was caught in weeks 3, 4, 5 and 11, whereas weeks 13 and 2 gave the lowest (Table 5). There were significant differences in the mean number of arthropods caught in pitfall traps from February to June 2010. Hymenoptera (Formididae, *Camponotus*), followed by Orthoptera were the predominant Orders of arthropod trapped in pitfalls. Evidently, Odonata, Hemiptera and Acari were not trapped. The weekly total arthropod caught showed no significant ($P \geq 0.05$) differences (Table 6).

Table 7 shows the mean bi-weekly catches using the sweepnet traps in 2009. A significantly higher number of various families of the Order; Isoptera (Termitidae, white termites) were captured, followed by Coleoptera. However in 2010, significantly higher number of Coleoptera (Cerambycidae, *Aromia*) were trapped

**Table 4.** Mean weekly diurnal catches of arthropods (adult) on water (Basin) traps (February to June, 2010)

| Arthropod order | Sample period (Week) | | | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| Acari | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Coleoptera | 2.77 | 2.23 | 1.58 | 2.08 | 2.44 | 2.14 | 1.63 | 1.88 | 1.63 | 2.10 | 1.13 | 1.99 | 2.05 |
| Deplopoda | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hemiptera | 1.38 | 0.81 | 1.28 | 0.67 | 1.14 | 0.33 | 0.81 | 0.33 | 0.67 | 0.47 | 0.81 | 0.67 | 0.78 |
| Hymenoptera | 0.67 | 0.00 | 0.67 | 0.33 | 0.81 | 0.33 | 0.00 | 0.67 | 0.33 | 0.67 | 0.81 | 0.67 | 0.50 |
| Isopteran | 2.37 | 2.06 | 2.83 | 1.88 | 2.23 | 2.06 | 1.72 | 1.82 | 1.22 | 0.91 | 1.63 | 1.38 | 1.84 |
| Lepidoptera | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 | 0.33 | 0.33 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.11 |
| Odonata | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.67 | 0.33 | 0.33 | 0.67 | 0.33 | 0.33 | 0.81 | 0.29 |
| Orthoptera | 0.00 | 1.72 | 2.02 | 1.72 | 1.52 | 1.38 | 1.00 | 0.81 | 1.24 | 0.81 | 0.81 | 1.14 | 1.18 |
| Mean | 0.80 | 0.76 | 0.93 | 0.78 | 0.90 | 0.81 | 0.65 | 0.69 | 0.64 | 0.59 | 0.72 | 0.74 | |

LSD = 0.20 (Arthropod Order) ***; LSD = 0.23 (Week) Ns; LSD = 0.70 (Arthropod Order/ Week) ***

**Table 5.** Mean weekly diurnal catches of arthropods (adult) on Pitfall traps (July to October, 2009)

| Arthropod order | Sample period (Week) | | | | | | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| Acari | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Coleoptera | 1.69 | 1.47 | 2.21 | 188 | 1.73 | 1.66 | 1.52 | 1.55 | 1.24 | 1.88 | 1.72 | 2.07 | 1.62 | 1.52 | 1.96 | 1.71 |
| Deplopoda | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.67 | 0.00 | 0.00 | 0.00 | 0.67 | 0.11 |
| Hemiptera | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hymenoptera | 1.28 | 1.47 | 2.29 | 1.99 | 2.07 | 1.14 | 1.38 | 1.38 | 0.91 | 0.94 | 1.58 | 0.81 | 0.91 | 1.14 | 1.38 | 1.38 |
| Isoptera | 2.21 | 1.63 | 1.82 | 1.93 | 1.91 | 1.88 | 1.47 | 2.36 | 1.79 | 1.49 | 1.88 | 1.24 | 1.28 | 1.79 | 1.72 | 1.76 |
| Odonata | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Orthoptera | 2.39 | 3.41 | 3.78 | 2.92 | 2.57 | 1.82 | 2.81 | 2.39 | 1.96 | 1.82 | 2.23 | 2.07 | 1.72 | 1.73 | 1.88 | 2.37 |
| Mean | 0.95 | 0.10 | 1.26 | 1.09 | 1.03 | 0.85 | 0.90 | 0.96 | 0.74 | 0.77 | 1.01 | 0.77 | 0.69 | 0.77 | 0.95 | |

LSD = 0.17 (Arthropod Order) ***; LSD = 0.23 (Week) ***; LSD = 0.66 (Arthropod Order/ Week) **

**Table 6.** Mean weekly diurnal catches of arthropods (adult) on Pitfall traps (February to June, 2010).

| Arthropod order | Sample period (Week) | | | | | | | | | | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| Acari | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Coleoptera | 1.61 | 1.38 | 1.99 | 1.90 | 1.93 | 1.79 | 1.96 | 1.66 | 2.15 | 1.93 | 1.88 | 2.06 | 1.85 |
| Deplopoda | 0.00 | 0.00 | 0.67 | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 |
| Hemiptera | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hymenoptera | 3.49 | 3.20 | 2.66 | 4.58 | 3.77 | 3.76 | 3.40 | 3.68 | 3.34 | 3.94 | 3.24 | 3.65 | 3.56 |
| Isoptera | 1.87 | 2.16 | 1.38 | 2.15 | 1.79 | 1.38 | 1.05 | 1.72 | 2.21 | 2.23 | 1.38 | 1.79 | 1.76 |
| Odonata | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Orthoptera | 4.09 | 4.11 | 2.63 | 2.28 | 2.55 | 3.24 | 3.27 | 3.45 | 3.49 | 3.20 | 3.45 | 2.91 | 3.22 |
| Mean | 1.38 | 1.36 | 1.17 | 1.36 | 1.26 | 1.27 | 1.21 | 1.36 | 1.40 | 1.41 | 1.24 | 1.30 | |

LSD = 0.17 (Arthropod Order) ***; LSD = 0.21 (Week) Ns; LSD = 0.60 (Arthropod Order/ Week) ***

followed by Hymenoptera (*Aphis* spp.). The other arthropods were poorly trapped excerpt Acari and Spirostreptida (Table 8).

## DISCUSSION

This study reveals that variation existed among the

**Table 7**. Mean bi-weekly diurnal catches of arthropods (adult) on sweepnet traps (July to October, 2009).

| Arthropod order | Sampling period (Week) | | | | | | Mean |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| Acari | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Coleoptera | 0.47 | 0.67 | 1.14 | 1.63 | 0.81 | 0.81 | 0.92 |
| Deplopoda | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0.0 |
| Hemiptera | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 0.33 | 0.11 |
| Hymenoptera | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 | 0.06 |
| Isoptera | 1.72 | 1.63 | 1.90 | 0.00 | 0.94 | 2.06 | 1.37 |
| Lepidoptera | 0.00 | 0.81 | 0.33 | 1.81 | 0.00 | 0.33 | 0.55 |
| Odonata | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Orthoptera | 0.33 | 0.33 | 0.67 | 0.00 | 0.33 | 0.67 | 0.39 |
| Mean | 0.28 | 0.38 | 0.50 | 0.38 | 0.31 | 0.47 | |

LSD = 0.24 (Arthropod Order) ***; LSD = 0.19 (Week) Ns; LSD = 0.58 (Arthropod Order/ Week) ***

**Table 8.** Mean bi-weekly diurnal catches of arthropods (adult) on sweepnet traps (February to July, 2010).

| Arthropod order | Sampling period (Week) | | | | | | Mean |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | |
| Acari | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Coleoptera | 0.67 | 0.67 | 0.67 | 081 | 0.00 | 1.14 | 0.66 |
| Deplopoda | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hemiptera | 0.00 | 0.47 | 0.00 | 0.00 | 0.00 | 0.00 | 0.08 |
| Hymenoptera | 0.81 | 0.67 | 0.67 | 0.00 | 0.00 | 0.33 | 0.41 |
| Isoptera | 0.67 | 0.00 | 0.00 | 0.00 | 0.00 | 0.67 | 0.22 |
| Lepidoptera | 0.33 | 0.00 | 0.00 | 0.00 | 0.33 | 0.00 | 0.11 |
| Odonata | 0.00 | 0.67 | 0.33 | 0.33 | 0.33 | 0.67 | 0.39 |
| Orthoptera | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 0.06 |
| Mean | 0.28 | 0.28 | 0.19 | 0.13 | 0.07 | 0.35 | |

LSD = 0.24 (Arthropod Order) ***; LSD = 0.20 (Week) Ns; LSD = 0.59 (Arthropod Order/ Week) Ns

different arthropod orders trapped using the basin, pitfall and sweepnet traps. Adults were basically trapped rather than their larva and pupal forms which have their own niches, and do not compete with adults for food, is not only suggestive of their reduced locomotor activity, but of the transient nature of their association with the soil (Ewuim, 1998).

The predominant families of arthropod captured by the basin water traps were Scarabaeidae and Termitidae, in the pitfall traps Grylidae and Formicidae, while the sweepnet traps captured Ceranbycidae, Termitidae and Papillionidae. However, the family of Termitidae trapped in basin differs from those trapped in pitfall traps. Termitidae are group of termites who are active fliers (winged), whereas Formicidae are group of wing and wingless ants that can be distinguished by the structure of their petiole which consist of one or two segment bearing little nodes or scales and a geniculate antennae (Lale, 2006). Basin traps effectively trapped winged arthropods, while the pitfall trapped unwinged arthropods with high locomotor activity.

The fluctuations in the number of arthropod captured in 2009 and 2010 in basin traps were due to weather, whereas, in pitfall traps the catches fluctuates without any obvious relationship to weather (Greenslade and Greenslade, 1973) but to their locomotor activity, except for the subterranean termite, whose activity is correlated to a considerable extent with soil moisture and temperature (Johnson and Whiteford, 1985).

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