Volume 5, Issue1, August 2012

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Sudan Journal of Science (SJS)

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Host Selectivity by Cicada for Final Stage of Moulting

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Abstract

This study was conducted to find out the factors that might influence cicada choice of substrate for its final moult. The factors considered included DBH (Diameter Breast Height) of the trees, plant height, type of plant, plant species and canopy cover above final moult area. Thirty five plots were sampled in an area of 875m^2 in Kibale Forest, Uganda. The number of cicada skins found on each plant species of the site was recorded. The characteristics of the plant species (height and DBH) and the canopy cover of the plots were also measured. It was found that cicadas have a higher affinity to sites with high canopy cover, plants of height less than 1.5m and tree saplings of DBH less than 10 cm for the final stage of their moulting. The highest number of cicada nymph skins was found on *Palisota* sp. However it was concluded that this observation did not translate into cicadas having a high selectivity to *Palisota* sp. for the final stage of moulting. It was thus concluded that cicadas do not have a preference on where to carry out their final moult on emergence from the soil but rather climb up the first plant they encounter.

Introduction

The order Homoptera contains such well known insects as cicadas, leaf hoppers, aphids and the scale insects etc. The Homopterans are traditionally divided into two series: the Auchenorrhyncha and Sternorrhyncha. Cicadas belong to the series Auchenorrhyncha (Skife, 1992).

There are several thousand different species of cicada, found chiefly in the warmer regions of the world. There is currently no published research on the life history of African cicadas in detail but from observations made in research done in other continents (Borror *et al*, 1976).

In some cicadas it may take several years to complete their life cycle. This was first ascertained by studying the intervals between the appearances of the various broods. The immature cicadas construct curious chimneys, or cones, of earth particles glued together by saliva; these project 10 cm or so above the surface of the ground. They are closed at the top and hollowed inside. The cicadas live inside this for some weeks before breaking a hole at the base and emerging. The chimney is thought to protect individuals which have been forced to come to the surface prematurely due to extreme temperatures. The young cicada resembles its parents but is stouter and has two front legs with greatly enlarged spiny projection and shanks that serve as digging implements. At birth, the emergent cicada drops to the ground and burrows beneath the surface. It spends its entire immature life tunneling through soil in search of the tender young roots (especially those of perennial plants) upon whose sap it feeds (Borror *et al*, 1979) .When the nymph is fully grown, it burrows its way upwards to the surface and out into the light and air. It climbs a few centimeters up a nearby object, digs its claws in and clings there motionless for some time. Its skin then splits down the back and the adult cicada struggles laboriously out of the nymphal skin. After its wings have expanded and dried, it flies away and spends a few brief weeks in the reproductive adult stage. Generally the greater part of the cicada life is spent in one of the pre-adult stages (Pinhey, 1968). The principal damage done by cicada to plants

occurs during egg laying when the adult lays numerous eggs in the trunks of young trees and nursery stocks causing much harm to the them.

Initial observations indicated that cicadas only did their final moulting on the trunks of large tree species of a particular DBH and those cicadas actively searched for such trees for the final stage of their moulting. A pilot observation showed that there was no cicada fidelity to particular tree species of a certain DBH for moulting but rather on a wide variety of trees, shrubs, herbs and climbers where they were found to occur on the under-surface of their leaves. This observation inspired this study and we looked for evidence of preferred final moult substrates for cicadas.

The aim of this study was to detect the factors that might influence cicada choice of substrate for its final moult.

The objectives were to: determine factors that influence selectivity of cicadas on host objects for the final stage of their molting and the factors considered included DBH of the trees, plant height, type of plant or species and canopy cover above final moult area.

Null hypothesis

Cicadas do not have a preference on where to carry out their final moult on emergence from the soil but rather climb up the first plant they encounter.

Materials and Methods

The study was conducted in Kibale National Park, western Uganda (0 º13` to º41`N and 30º19`to 30 º 32`E) in an area predominately consisting of secondary and lightly logged forest, around Makerere University Biological Field Station. The forest lies at an altitude of 1110-1590m above the sea level and covers an area of 560km² (Kasenene, 1987) . Data collection was carried out from July13-19, 2009.

An area of 875m^2 was sampled for this study. Thirty five 5×5 metre plots were sampled within the primary and secondary forest of Kibale National Park. Four grids were sampled from either side of Butanzi road around K14 (grid U12, S10, B12, C11), two grids at K30 (U10, T8) and one grid near upper camp K30 (A27). Five plots were sampled in each grid. Plot measurements were made using a 30m measuring tape. In each plot canopy cover was estimated using a densitometer. The diameters at breast height (DBH) of all trees in the plot were also recorded using a DBH metre. A count was made of all plant species present and their abundance. The height of the plants in the plot was also noted and the plants placed into two classes according to their height: trees below 1.5m were placed in one category (Class 1) and trees over 1.5m were placed in another category (Class 2). All plant species in the plot were carefully examined for the occurrence of any cicada nymph skins either on their trunks or leaves. Plants with cicada nymph skins on them were noted and measurements made of the height of occurrence of the cicada nymphs and the number of cicadas per plant.

Data Analyses

Microsoft Office Excel^R was used to construct bar graphs and pie charts and MINITAB^R statistical package was used to perform the Kruskal-Wallis and Mann-Whitney tests on the data collected.

Results:

A total of 1443 plants were sampled within an area of 875m^2. Of this number 589 were trees, 498 were shrubs, 286 were herbs and 65 were climbers. Cicadas were found on 171 of these plant species. A total of 276 cicada skins were counted from this study. The skins were mainly found under the leaves of shrubs, herbs and tree saplings and on the trunks of trees with DBH higher than 20cm.

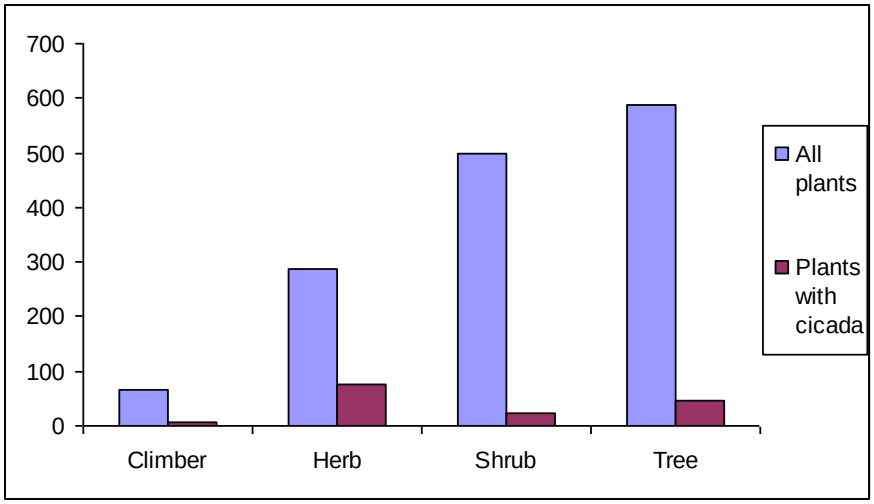

Fig 1 Comparison between types of plants sampled and the number frequency of occurrence of cicadas on each.

Factors affecting the selectivity of cicada nymphs to a host:

Plant species:

Large numbers of cicada nymphs were found on *Palisota* than any other species of plant (Fig 3). 52% of cicada skins found occurred on this herb. The next plants with the highest affinity were the trees *Uvariopsis congensis* and *Bosqueria phoberos* which had cicada occurrences of 7% each.

The plant height:

Cicada nymphs were significantly more abundant (Mann-Whitney test, p=0.001) between 0-1.5 m (class 1) than at heights greater than 1.5 m (class 2) (Fig. 4).

DBH of Trees

When considering trees, the selectivity of cicada nymphs was for DBH class 1 (0-10cm) and there was a significant difference (Kruskal-Wallis test using medians; H = 12.02, DF = 4, P = 0.017) between the DBH classes.

Canopy Cover

The following graph shows the effect of canopy cover class on cicada nymph skin numbers is significant difference (Kruskal-Wallis test, H = 8.59, DF = 3, P = 0.035) between the various canopy cover classes. The largest numbers of cicada nymphs were found in class 81-90%.

Discussion

Trees were the most abundant plant type that occurred in all the sites sampled. Shrubs, herbs and climbers followed in abundance respectively. However, it was observed that herbs had the highest occurrence of cicada nymph shells although they were not the most abundant component (Fig. 1). Apparently cicada nymphs prefer herbs to trees during the final stage of their moult.

Reasons to this preference included the soft succulent nature of herbs and shrubs which made it easier for cicada nymphs to bore and attach to the leaves and stems of such plants. It was also suggested that the succulent leaves of the herbs and shrubs provided an easy avenue for the cicadas to tap the sap (food for cicada) of these plants which provides them with energy.

Palisota sp. was the most abundant plant species encountered during the study (Fig 2). The next most abundant species were *Uvariopsis congensis* and

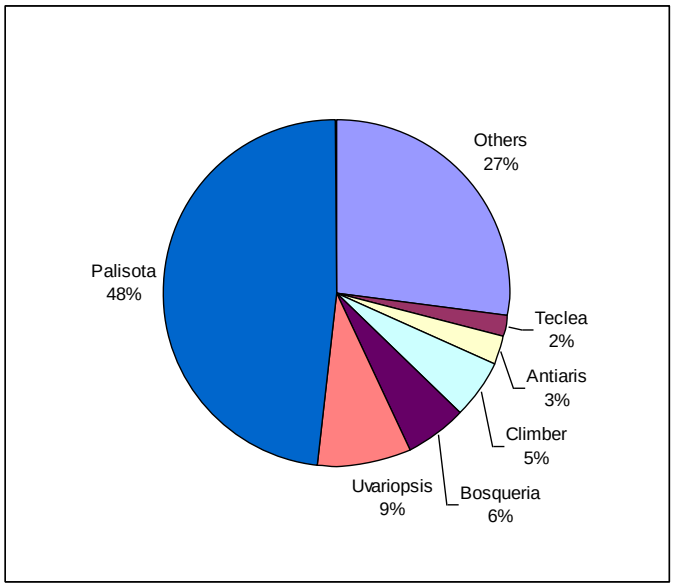

Fig 2 Frequency of occurrence of all plants sampled

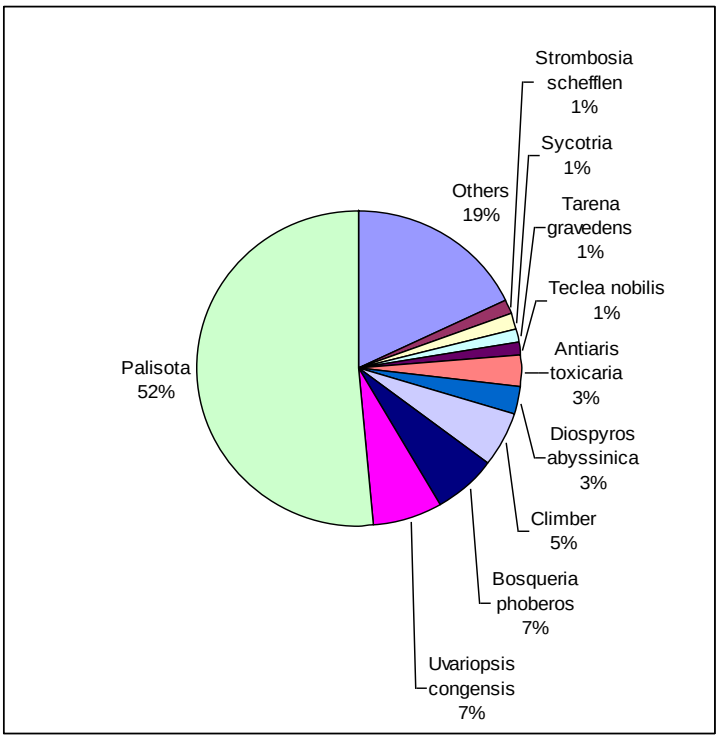

Fig 3 Affinity of cicada nymph to plant species

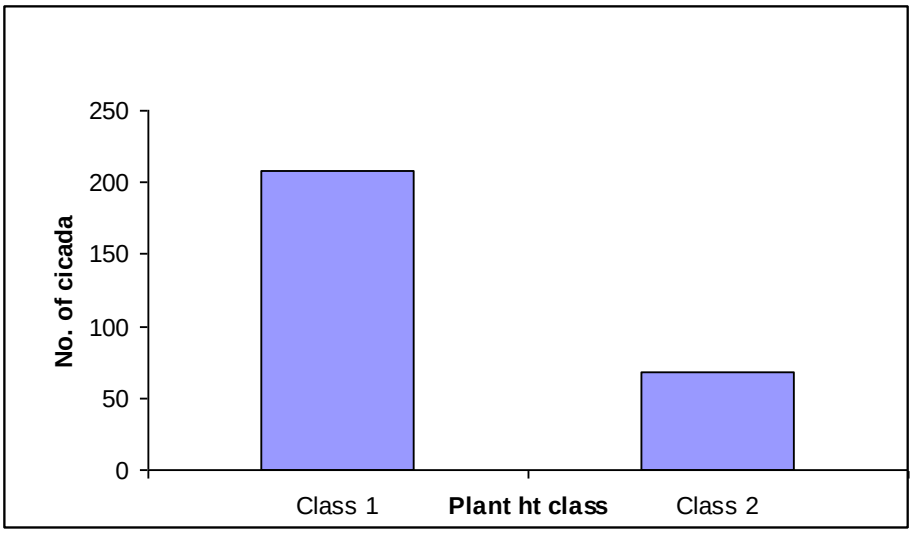

Fig. 4. Affinity of cicada to different plant heights.

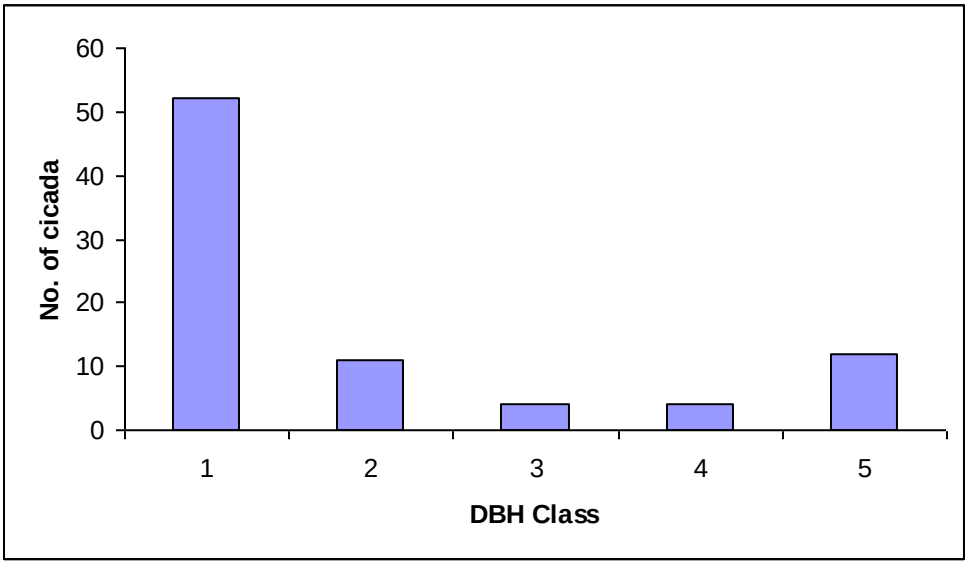

Fig 5 Affinity of cicada to different DBH classes

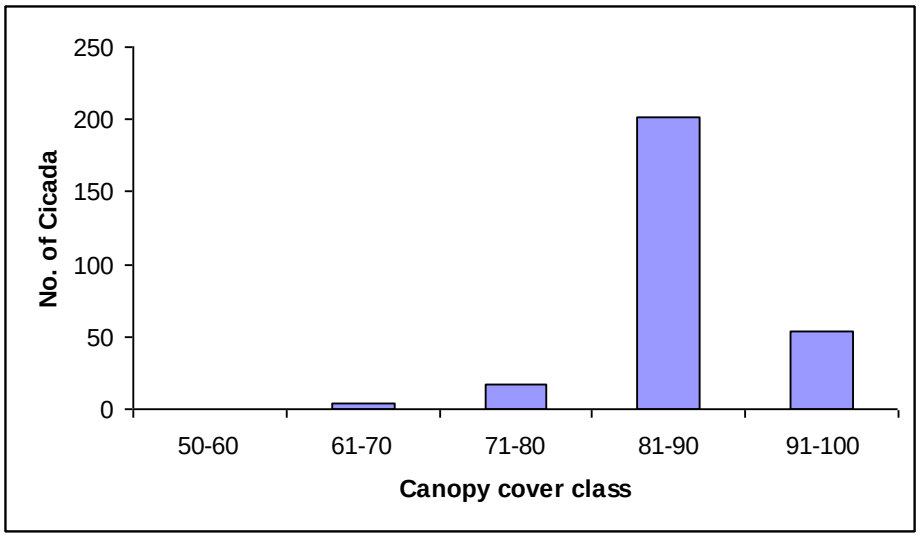

Fig 6 Affinity of cicada to different canopy cover classes

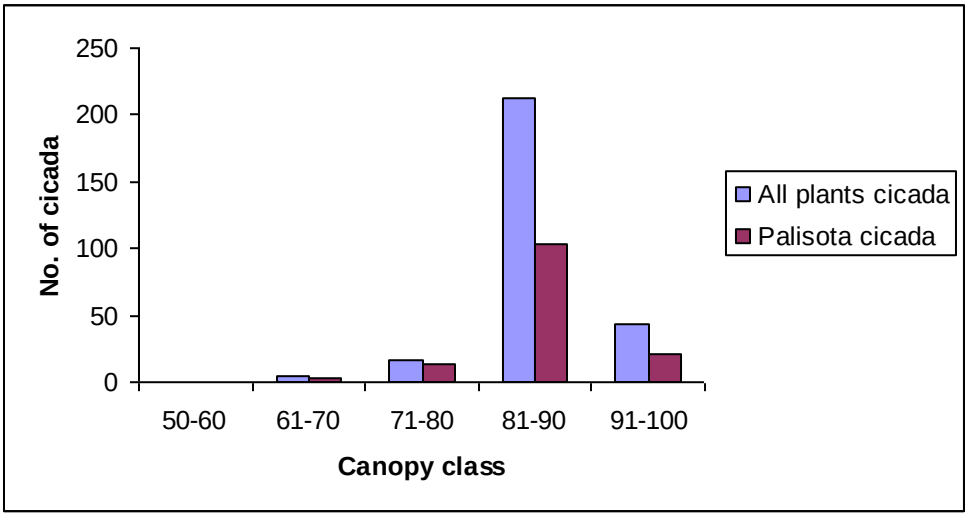

Fig 7 Comparison between frequency of occurrence of cicada on Palisota and on all plants sampled

Bosqueria sp. respectively. In a similar trend the highest numbers of cicadas were found on *Palisota* sp., *Uvariopsis* sp. and *Bosqueria* sp. respectively (Fig. 3). The most abundant plant species had the highest occurrence of cicada nymph skins. It can be inferredfrom such data that cicadas do not actively chose a particular plant species but rather climb up the first species they encounter for the final stage of their moulting. This debunks the assumption that cicadas prefer a particular type of plant species for the final stage of their moulting. Cicadas were also found to have a higher occurrence on plant species which were less than 1.5m high than plants greater than this height (Fig 4). Plants in such height classes constituted mainly herbs, shrubs, climbers and saplings of trees which had soft and succulent leaves and stems. This brought about the suggestion that cicadas

preferred such plant species because they could easily borrow holes into such species for attachment and also could easily have access to the sap of such plants. A similar trend was observed in Figure 1 where the cicadas were observed to have a preference to herbs and shrubs (soft and succulent parts) than trees (woody parts). This suggestion was bolstered by the observation of higher affinity of cicadas to tree saplings which had a DBH less than 10cm than older trees which had a DBH greater than 10cm (Fig. 5).

Cicadas were found to be dominant in areas with canopy cover between 81-90% (Fig. 6). Such areas also recorded the highest number of *Palisota* sp. with cicadas on them. *Palisota* sp. is an herb which grows up to 2m and is usually found under the shade of closed colonizing and old forest, especially in wet forest (Synnott, 1985). It seems that cicadas are more inclined to a particular canopy cover range rather than the presence of *Palisota* sp. because there was a higher number of a cicada occurring on other species (than *Palisota* sp.) in this canopy range. The higher number of cicadas on *Palisota* sp. could just be attributed to their higher frequency of occurrence in this particular canopy range.

Cicadas are known to emerge from their final moulting stage at night when the light intensity is low. This could also be a reason why they are found in places of high canopy cover (low light penetration). It could be reflections of their affinity to dark areas which enable them avoid predation from their enemies. *Palisota* sp. had the largest sized leaves among all the plant species sampled and the cicadas were primarily found on the under-surface of its leaves probably seeking for protection its broad leaves can provide them against desiccation and predation.

Acknowledgement

We would like to express our sincere gratitude to TBA for choosing us for this course to undertake this research. We would also like to thank Chris for helping us identify the plant species and helping us throughout our data collection. Big thanks to our supervisor Martin who helped us in all situations both on site, during data analysis and in the hospital. Thanks to Clive for guiding us through this project. Thanks to Mike for conceiving this project topic.

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