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Pollinators of *Allanblackia stuhlmannii* (Engl.), Mkani fat an endemic tree in eastern usambara mountains, Tanzania

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ABSTRACT

Aspects of the pollination biology of Allanblackia stuhlmannii were investigated on four selected trees in Amani Nature Reserve. This study aimed at identifying the actual pollinators of Allanblackia stuhlmannii. Methods used included visual observations by recording the activities of visitors to the flowers and checking the presence or absence of pollen adhering on their bodies. Meliponula sp. was identified as the actual pollinators while, Apis mellifera and Formicidae were confirmed to be nectar- feeders. Sunbirds and Sphingids could not be proven so on their roles. Findings of this study suggest habitat conservation so as to keep intact natural habitat which increase abundance and diversity of pollinators. It is recommended that further studies be undertaken on sunbirds and sphingids to determine whether or not they are also pollinators.

Key words*: Allanblackia stuhlmannii, Pollinators, Meliponula sp.*

INTRODUCTION

Pollination in flowering plants requires the transfer of pollen grain by the agency of either biotic or abiotic vectors, from anther to the stigma[4] .This is an ecosystem service that is essential to support the production of a wide range of crops[7]. The higher production of crops requires the interaction of plants and pollinators so as to allow pollination process to be successful. The pollinators pay visits to the flowers due to the rewards they get and in turn facilitate the pollination process. *A. stuhlmannii* (Engl) is a rainforest tree that grows to the height of 35 – 45 meters tall and at an altitude of between 500 – 1600 m [24] found in moist Eastern Arc Mountain forests in Tanzania. The communities living around the Eastern Arc Mountains, particularly farmers, use the oil extracted from *A. stuhlmannii* nuts for food and soap production[18,19,20]. They also use dry leaves of this tree as medicinal tea to treat chest pain and smear heated seed oil on aching joints, rashes and wounds[14]. Recently, there has been increased interest in turning *A. stuhlmannii* into a significant commercial species for edible oil production[1]. Moreover, there has been an ongoing programme for the domestication of this species and others as well in different countries[23]. Apart from its distribution[22], flower and fruiting phenology[12], there is limited information on the other aspects of the biology of the tree.

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The present study was carried out to identify the key pollinators of *A. stuhlmannii* which have potential for the successful cultivation of the tree for the plant breeders, farmers and conservationists.

MATERIAL AND METHODS

Study area

The present study was conducted in Amani Nature Reserve (ANR) which is located between 5° 05'-5° 14'S and 38° 40'-38° 32' E in Muheza and Korogwe district[25]. Amani is the largest forested block covered with different vegetation types includes *A. stuhlmannii* trees which were the target for this present study (figure 1). The climate and vegetation of the region are widely influenced by its close proximity to the Indian Ocean. Mean annual rainfall is 1918 mm at Amani and is generally sustained throughout the year by constant flow of moist currents from the nearby Indian Ocean[5] .Humidity is high, and mean annual temperature at Amani is 20.6 °C[6].

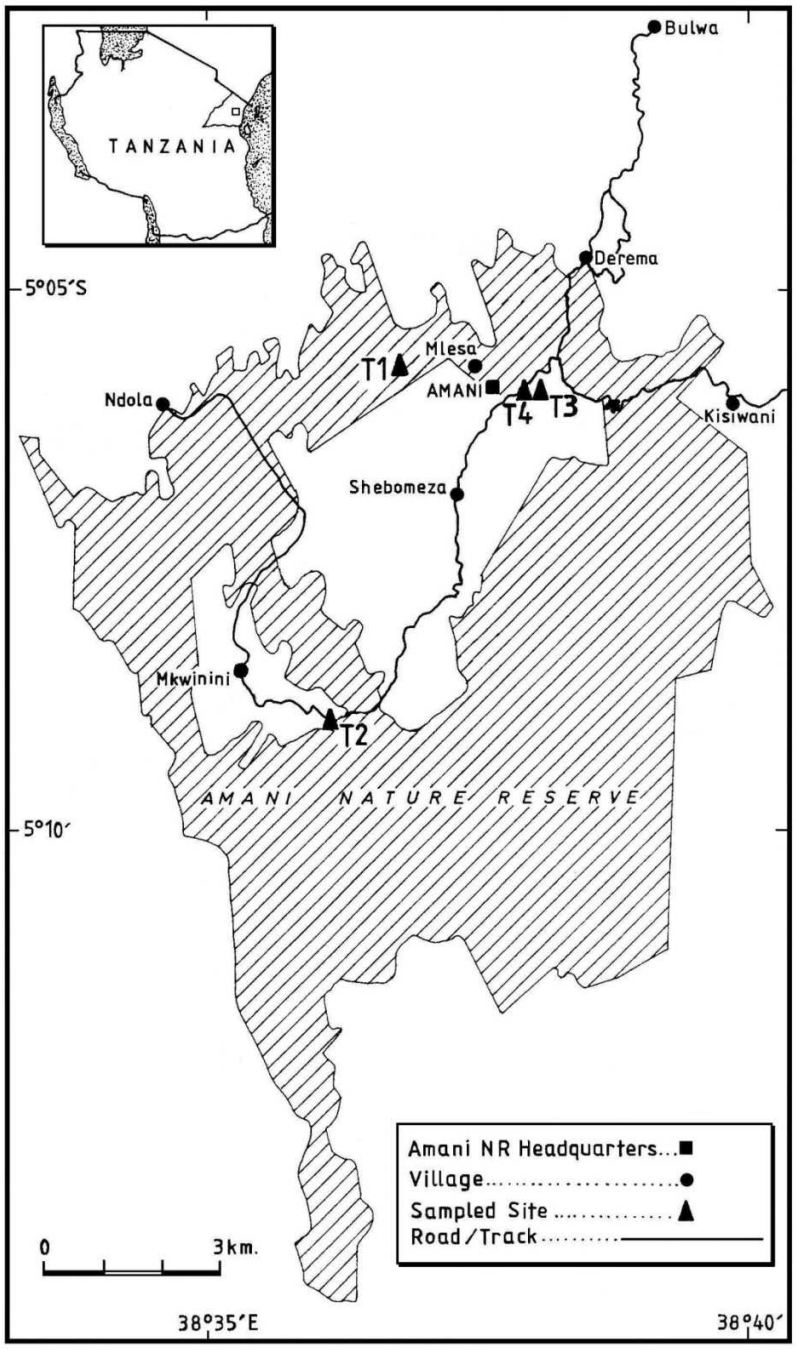

Fig. 1: Map of Amani Nature Reserve showing the study sites. Where T=Tree such as T1=Tree1, T2=Tree2, T3=Tree3 and T4=Tree4

M ETHODS

Four trees representing both sexes, male and female were selected randomly in an area where the *A. stuhlmannii* was abundant. Different methods were applied in assessment of pollinators, as follows:

Observation of visitors

Observations were conducted during the day and night (24 hours) whereby visitor counts were recorded for every two hours (06:00-08:00 hrs, 08:00-10:00 hrs etc). During the time the following were recorded: frequency of visits and visitors' behavior on individual flowers including the activity (e.g. feeding on nectar or collecting pollen). Additionally, binoculars were used to aid visual observations during the day while the torches assisted at night. The duration for sampling was two days at each tree.

Pollen Assessment

Flower visitors were collected by the use of sweep nets, a pair of forceps and a pooter afterward, examined whether or not pollen adhering to their bodies[13]. This was done by visual observation and brushing off their body for pollen using a simple brush. Other species collected were taken to the laboratory for more inspection under the microscope.

The collected samples were preserved in 70% alcohol. Two hundred and twenty one (221) specimens which were taken for pollen checking were dried up and preserved in envelopes and seven (7) specimens from the family Lepidoptera were also preserved in the envelopes. Only few lepidopterans were collected due to the fact that their visits on flowers were so brief and for short time as a result difficult in graping them.The sorting and identification were done at the Department of Zoology and Wildlife Conservation of the University of Dar es Salaam. The species were identified up to the lowest possible taxonomic level, typically species (or morpho species).

Data Analysis

SPSS statistics versions 16.0 specifically descriptive statistics were used for assessing the actual pollinators of *A. stuhlmannii* by the use of species checklist, tables, percentages and graphic presentation.

RESULTS

Visiting Frequencies of Pollinators

On the identification of which are the exactly pollinators on *A. stuhlmannii* flowers, the visitors were observed with their rate of visiting the flowers. Five species, namely *Apis mellifera, Meliponula sp.*, Sunbirds, Sphingidae and Formicidae had a high visiting frequency, making them potential pollinators of *A. stuhlmannii* (Table 1).

Table 1: Pollinators of *Allanblackia stuhlmannii* flowers with their total visiting frequencies in Amani Nature Reserve

SPECIES	CLASS	ORDER	FAMILY	TF	%F
Apis mellifera (Honey bee)	Insecta	Hymenoptera	Apidae	889	33.970195
Sunbird	Aves	Passeriformes	Nectariniidae	504	19.258693
Meliponula sp (stingless bee)	Insecta	Hymenoptera	Apidae	365	13.947268
Formicidae	Insecta	Hymenoptera	Formicidae	378	14.44402
Sphingidae	Insecta	Lepidoptera	Sphingidae	158	6.0374475

TF=Total frequency %F=Percentage frequency

Individuals with or without the Presence of Pollen

Of the five potential pollinators (based on the frequency of visits), only members of *Meliponula sp* were observed to carry pollen on their bodies (Table 2).

Table 2: Species checked with the presence or absence of pollen collected from *Allanblackia stuhlmannii* (Engl.) flowers in Amani Nature Reserve

S/N	SPECIES NAMES	TOTAL NO INSPECTED	POLLEN PRESENT	POLLEN ABSENT
1.	*Meliponula sp*	75	23	52
2.	*Apis mellifera*	69	0	69
3.	Formicidae	77	0	77
4.	Sunbirds	None	None	none
5.	*Nephele comma (*Sphingid)	5	0	5
6.	*Hippotion eson* (Sphingid*)*	1	0	1
7.	*Temnora sardanus* **(**Sphingid)	1	0	1

Activity of Pollinators on Flowers

Flower visitors were observed with respect to the activities they were carrying out on the flowers. The activities recorded included whether they were moving from one flower to another, duration of the visit, and what they were collecting from the flowers.

Most of the visitors observed were not after pollen, this was observed in species such as Sphingidae,butterflies,dipteran, bettle,sunbirds and formicidae. *Meliponula sp* and *Apis mellifera* were the ones observed to pass around the pollen area apart from nectar feeding, but *the Apis mellifera* spent short time from one flower to another as compared to *Meliponula sp.* Table 3 summarizes this information for the five species identified as potential pollinators.

Table 3 Behavior, duration of visit, rewards collected and role in Pollination of the five potential pollinators identified on *A. stuhlmannii* (Engl.) flowers in Amani Nature Reserve

S/N	SPECIES	BEHAVIOUR	DURATION OF VISIT	REWARDS COLLECTED	ROLE IN POLLINATION
1.	*Apis mellifera*	Nectar thieves	1- 2mins	Nectar	Not Pollinators
2.	*Meliponula sp*	Passing on Pollen areas	1-5mins	Pollen and Nectar	Pollinator
3.	Sphingids	Hovering on flowers and nectar feeding	Few seconds	Nectar	Not sure?
4.	Sunbirds	Nectar feeding	1 -2mins	Nectar	Not sure?
5.	Formicidae	Nectar thieves	5mins and more	Nectar	Not Pollinators

DISCUSSION

Pollinators and Visiting Frequencies

Apis mellifera, Meliponula sp., Sunbirds, Sphingidae and Formicidae had high visiting frequencies on *A. stuhlmannii* flowers. These five species represent the potential pollinators of *A. Stuhlmannii* due to their frequency of visiting. A similar case was observed by[21] that species with high visiting frequencies were the effective pollinators. Similarly in the study done in northeastern China reported *Megachile japonica* as the dominant pollinator due to higher visiting frequency[8] .

It should be noted that, not all flower visitors are always pollinators[4]. For the visitors to be pollinators, factors such as visiting frequencies, evidence of pollen on their bodies and activities on the flowers should be considered. The present study considered the mentioned factors.

Evidence of Pollen Carried on Individuals

In this study only Stingless bees (*Meliponula sp.*) were proven to be potential pollinators of *A. stuhlmannii* due to the evidence of pollen being found on their hind legs. In a different study carried out in Brazil by[3] also stingless bee were identified as efficient pollinators of sweet pepper. The finding of

this study also correlate with one done in Kenya, in which two varieties of strawberry required different stingless bee species for optimal pollination[2].

Apis mellifera, and members of Formicidae were proved not to be pollinators of *A. Stuhlmannii*. This was proved by absence of pollen on their bodies and the fact that they did not touch the anthers that carry pollen. Instead they concentrated their activity on nectar areas, thus showing that they were nectar thieves. In a study conducted in Ghana on *Luffa aegyptica* (Cucurbitaceae) it was noted that *Xylocopa olivaceae* was more efficient pollinator than *Apis mellifera* in terms of number of fruit set per single visit[15].

On the other hand the present study could not prove the role of Sphingids in the pollination of *A. stuhlmannii*. This was due to the fact that their visits on flowers were so brief and for short time as a result difficult in graping them. For the few species caught it was difficult to prove presence of pollen on their bodies as the nature of the body being scally, giving out dusty which made it difficult to see the presence or absence of pollen by the standard method of brushing. Studies carried out in Africa and other parts have confirmed the efficiency of Sphingids (Hawkmoth) as pollinators of plants such as *Aquilegia chrysantha*[16] and *Mystacidium venosum*[11]. Since the present study could not prove on sphingids as pollinators this calls for further study.

Similarly to Sunbirds it was not possible to prove its role as pollinators due to lack of technical skills such as the proper technique to use for capturing them as many of them visited the higher branches, hence they were not grabed and inspected. Other studies done in different parts of the world reported different species of sunbirds as pollinators on other species of trees such as *Grevillea robusta*[9] and montane mistletoe species[26]. Therefore the present study calls for further study to fill the gap which has been left and prove whether sunbirds could be pollinators as well.

Pollinators and Activity on Flowers

The present study verified that the animal species visiting *A. stuhlmannii* flowers varied on the activity they did. Stingless bees were the only species noted mainly with activity of passing around pollen areas and proven to carry pollen on their bodies. The observations showed that other species such of sunbirds and beetles were nectar feeders, and sphingids seen hovering around flowers and drinking nectar, while other species could possibly be predators or looking for breeding sites. All these could be due to the fact that, insects are occupying diverse niches and thus play many different functional roles important in sustaining the dynamics of ecosystem processes[25]. They could be herbivores (some of them are pests), predators and parasites (maintaining the population dynamic of herbivorous insects), pollinators (such as bees), decomposers (such as termites) and scavangers (beetles and flies) in such a way that each group or species within groups has distinct feeding habit[10,17] .However, it should be noted that sometimes the classification of flower visitors as 'robbers''thieves' or 'pollinators' often is not as simple as it seems, pollinators can act as robbers and vice versa.

CONCLUSION

Of all the animal species visited the flowers of *A. stuhlmannii* only *Meliponula sp* could be the possible pollinator based on the frequency of visit, activity on flowers, but also evidence of pollen found on their cobiculars. The findings of this study are highly important to advance the knowledge on the pollination ecology of *A. stuhlmannii* which was previously little known. Apart from that, findings obtained are also important on conservation plans and input for future research.

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