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Nectar Sources for the Honey Bee (*Apis mellifera adansonii*) Revealed by Pollen Content

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Abstract

Nectar sources for the African honeybee *Apis mellifera adansonii* were investigated. The work involved analysis of three honey samples bought from open markets in Lagos, Nigeria. The pollen sediment of the honeys was acetolysed, mounted on slides and pollen types were identified and counted to determine the relative frequency of the different pollen types in the honey samples. The proportion of pollen from each of the honey samples varied from 196 in sample A, 280 in sample B to 238 in sample C. The most abundant taxa identified from the honey samples were *Tridax procumbens* and *Elaeis guineensis* belonging to the families *Asteraceae* and *Palmae*. The highest proportion of Palm pollen grain was recorded in sample B with one hundred and ten (110) pollen grains per slide. The pollen grains in the families *Palmae* and *Asteraceae* are of great importance to the bees for honey production, this can be seen in the abundance displayed in sample B and C. Other pollen taxa recovered belong to the families *Mimosaceae, Euphorbiaceae, Sapotaceae* and *Anacardiaceae* providing a clue on the ecological origin of the pollen grains in the honey sample. Pollen analysis of honey proved to be useful in deciphering nectar sources of *Apis mellifera adansonii*.

Keywords: honey, nectar, acetolysis, pollen morphology, micrographs, Nigeria

Introduction

Honeybees visit diverse flowers of plant species, foraging for nectar and pollen grains. By doing so bees play a very vital role in making plant fertilization possible, as well as help in the conservation of biodiversity. When bees collect nectar from flowers, they obtain some quantity of pollen from the flower of the plant. After the nectar has been converted into honey in the hive, some of the pollen remains in the honey (Bell, 1986; Engel *et al.*, 2005; Morse and Calderone, 2000; Pankiw and Page, 2000).

Pollen is the bee's major source of protein, fat, minerals and vitamins, while nectar is the major source of carbohydrates from which honeybees obtain their energy. Pollen is an essential tool in the analysis of honey as it indicates the major and minor plant taxa utilized by honeybees. The presence of dominant pollen is used to name honey; it is mixed floral if none is dominant. Through common agreement, honey is characterized in terms of the number of grains per 10g of honey (Maurizo, 1975; Wilson, 2004).

With knowledge of major floral resources, a beekeeper can maintain healthy bees and increased honey production (Carol, 1999; Dafni, 1992; Jones and Bryant, 1992). Should honeybees die due to foraging on poisonous plants, analysis of their pollen loads or honey should indicate which taxa are responsible (Bryant *et al.*, 1990; Lieux, 1981). Additional reason for studying pollen in honey samples could be to study how far insects migrate. Under extreme circumstances, European honeybees have been known to forage as far as 8 miles from their hive (Gary, 1975). Pollen study in honey could also be aimed at studying allergies, climatic change or solving forensic riddles (Erdtman, 1969). The assessment of the resource value of different plant species to bees is a major objective of mellissopalynology (Bell, 1986; Bruce, 1979; Lieux, 1981).

The pollen percentage frequency, together with the total pollen assemblage from produced honey are useful indicators of the local and regional plant species visited by the honeybees as nectar sources. For a trained melissopalynologist, it is possible to distinguish between honeys from a particular town to another. He may also be able to say almost accurately, the time of the season a particular honey was produced.

The aims of this research was to find out from the pollen spectrum of the honey sediment, the species of plant that take part in the production of the designated honey samples, as well as to predict with accurate logic the geographical origin of the honey samples.

Materials and methods

Three pure honey samples were bought from different markets within the Lagos metropolis. The various hawkers reiterated that the honey samples were produced from nearby towns and villages. Slide preparation of the three honey samples followed the methods published by the international Commission for Bee Botany (Louveaux *et al.*, 1978) with minor modifications (Low *et al.*, 1989). In these modifications, 10g of honey was dissolved in 200ml of warm water and centrifuged at 3500 r.p.m. for 10 minutes. This was necessary to get maximum sedimentation of the pollen, especially those with low densities. Pollen sediment of the honey was acetolysed and mounted on slides with glycerin jelly (Erdtman, 1969).

The pollen grains were counted to determine the relative frequency of the different pollen types in the honey samples. Measurements of pollen grains recorded throughout this study were achieved using the micrometer eyepiece and the micrometer slide (stage). For convenience, the pollen grains of different families were counted where the genera or species could not be determined with certainty. Pollen identification was based on relevant literature (Agwu *et al.*, 1989; Agwu and Uwakwe 1992; Kaya *et al.*, 2005; Engel, 1999; Engel *et al.*, 2009) and reference pollen samples at the Palynology Unit of the Botany Research Laboratory, University of Lagos. A comparative graph shows the variations in number of plant genera counted in the different honey samples.

Results

In addition to the pollen grains, which dominate the sediments, algal remains, fungal hypha and spores, palynodebris and remains of bees were also identified. Very many pollen grains of different plants are present in each honey sample and the number of plants that were involved

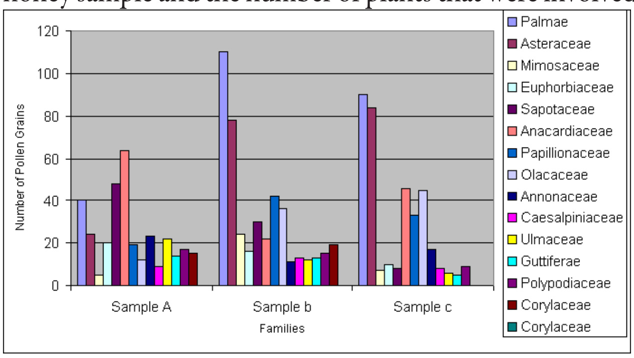

Fig. 1. Comparative bar chart showing the proportion of pollen grains in the honey samples

in honey production varies in the different samples. The most abundant taxa identified from the honey samples were *Tridax procumbens* (*Asteraceae*) and *Elaeis guineensis* (*Palmae*) (Fig.1.). Scanning Electron Micrographs (SEM) of selected recovered pollen grains is presented in Figs. 2-4.

The voucher specimen and the pollen sizes are presented in Tab. 1. The number of different pollen types recorded under the counting exercise is also presented (Tab. 2.)

Below is the description of some identified pollen grains.

Annona senegalensis (*Annonaceae*). This pollen occurs in tetrads. The tetrads are decussate. There is an ill-defined aperture (leptoma) on the proximal face of each grain. The tetrads measured about 69µm (length) and about 4.25µm (width). Each grain has polar axis of 30µm and equatorial axis of 42µm.

Acacia senegal (*Mimosaceae*). This is a polyad consisting of 16 cells, 8 forming a cube and the other 8 in a ring encircling the central cells. The 'circle' thus formed has a diameter of about 120µm. Each of the outer cells is triangular in shape and has it's broadest outside.

Lannae microcarpa (*Anacardiaceae*). The grain is spherical in outline. It is a tricolporate grain with elongated colpi, which is constricted on the equator. The polar axis is about 18.5µm and the equatorial axis is 14.8µm.

Cassia species (*Caesalpinaceae*). This is a tricolporate grain. Colpi are constricted on the equator, they may be as long as 38um and the equatorial axis 26.4µm. The exine thickness is about 1.5µm.

Vitelaria paradoxa (*Sapotaceae*). The pollen grain is spherical in the polar view and prolate in equatorial view. It has a polar axis measuring about 54µm and an equatorial axis measuring 36µm. It has a compound aperture with elongated colpi, pointed at both ends, while the pore is near spherical.

Synsepalum ducificum. This grain is similar to *V. paradoxa* morphologically but with smaller dimension. It has a polar axis measuring 30µm and equatorial measuring 24µm.

Elaeis guineensis (*Palmae*). This plant has more than one type of pollen grain. There are variations in shape, size and aperture among the grains. The sizes range from 36µm to about 40.5µm. Among the various shapes identified, the most common are the triangular ones with rounded angles and a 3-slit aperture. Others are elliptical with a uni-slit aperture.

Tridax procumbens (*Asteraceae*). This grain is iso-polar, radially symmetrical and spherical in shape with a diameter of about 31.5µm. The surface of each grain is covered with spines, which have pointed tips and broad bases and measured up to 3.0µm in length. The exine is about 1.0µm thick. There are three to four compound apertures arranged on the circumference in the polar view and zonally in the equatorial view. The aperture is the colporate type.

Discussion

The pollen grains identified in the honey samples exhibit different shapes and sizes (Tab. 1-2), they also have various types of aperture and exine thickness. *Elaeis guineensis* was noted for its variation, especially in shape, sizes, aperture types and exine thickness.

The proportion of pollen from each of the honey samples varied. *Palmae* and *Asteraceae* are the highest occurring pollen in the three honey samples. The highest pro-

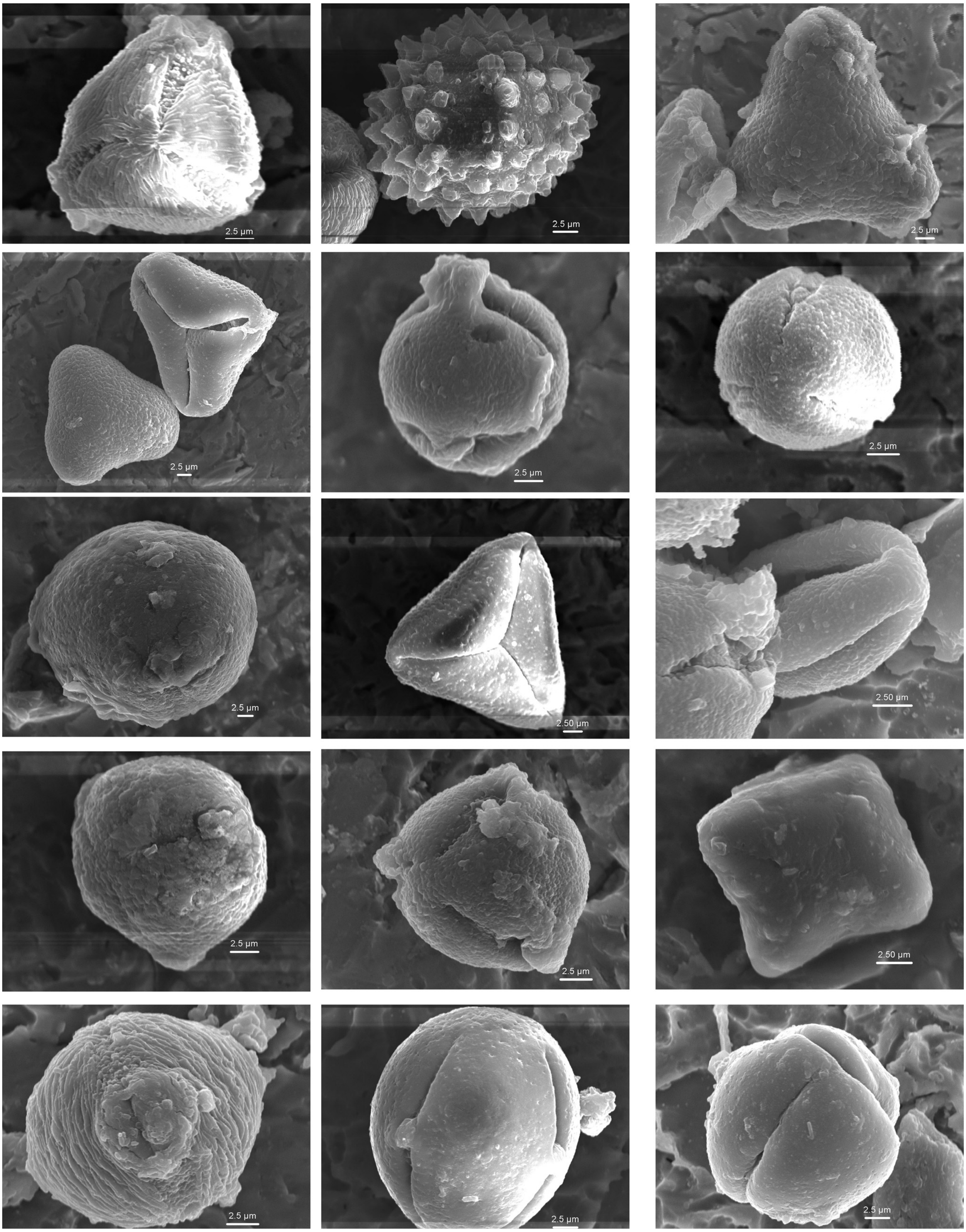

Fig. 2. a. *Papilionaceae;* b. *Tridax procumbense (Asteraceae)*; c.-d., h. *Elaeis guinensis (Aracaceae)*; e., g., j., m., *Olacaceae*; f. *Alchornea cordifolia (Euphorbiaceae)*; i. *Sapotaceae*, k.-m. *Euphorbiaceae*; n.-o. *Meliaceae*

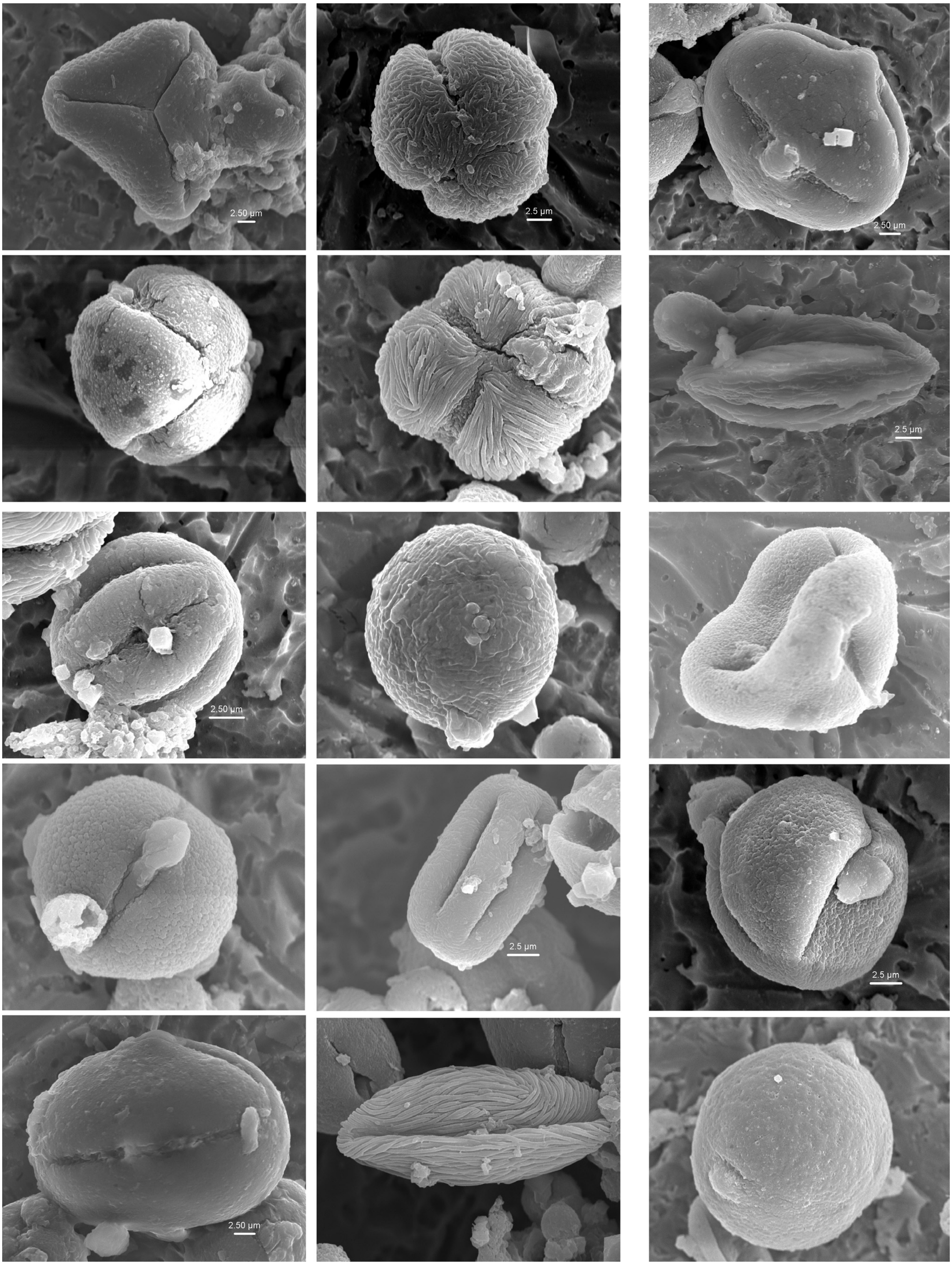

Fig. 3. a. *Elaeis guinensis (Aracaceae)*; b. and o. *Anacardiaceae*; c. *Sapotaceae*; d. and k. *Euphorbiaceae*; e. *Anacardiaceae*; f., g., m. *Sapotaceae*; h., i. *Elaeis guinensis (Aracaceae)*; j., l., o. *Malotus sp. (Euphorbiaceae)*

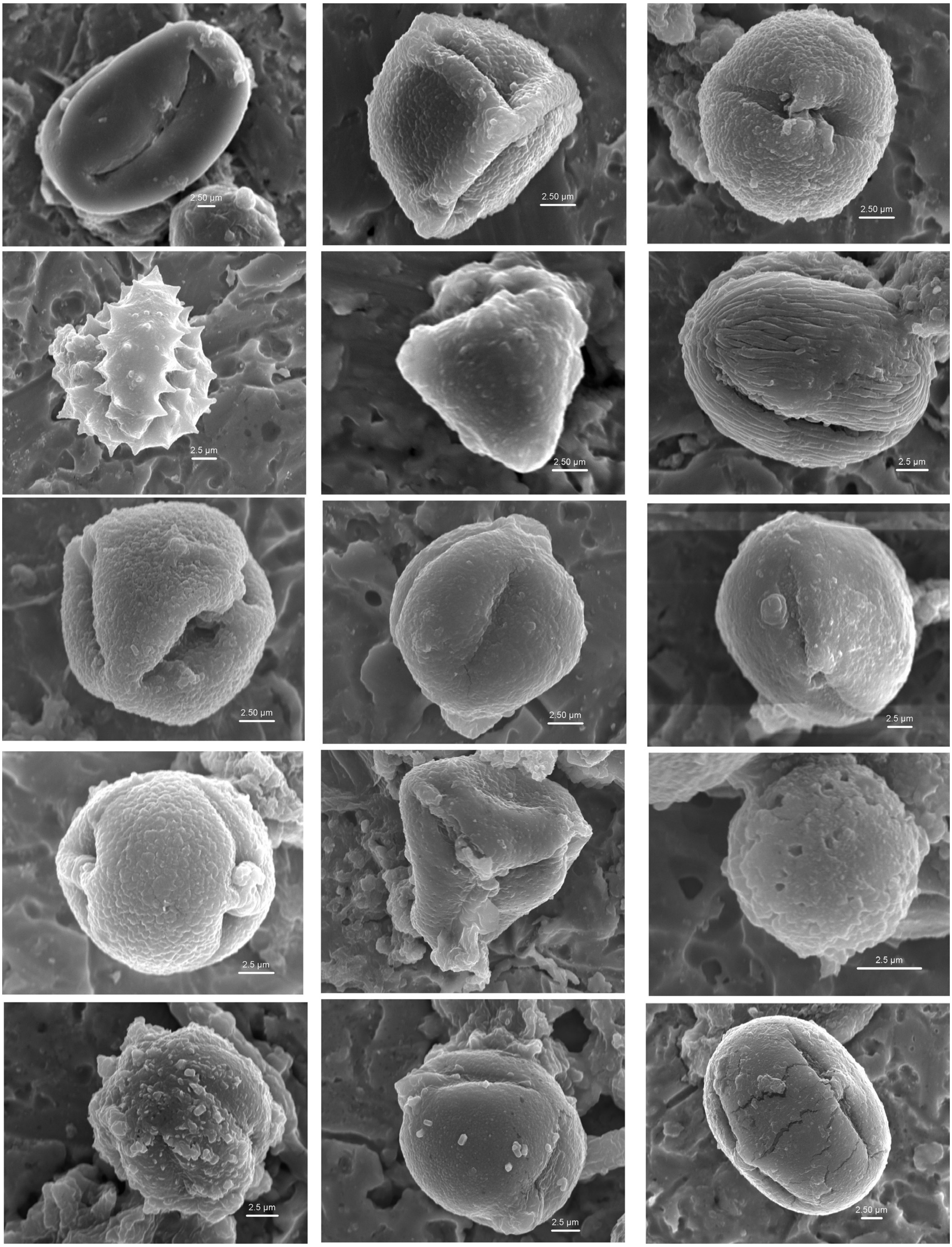

Fig. 4. a. *Euphorbiaceae*; b., c., e., g., h., i., j., k., n. *Papilionaceae*; d. *Asteraceae*; f. *Anacardiaceae*; l., m. Indeterminate pollen; o. *Sapotaceae* pollen

Tab. 1. List of voucher specimens and pollen sizes

Species	Family	Pollen size (μm)
Aspilia africana	*Asteraceae*	48.2±0.2 × 48.2±0.2
Annona senegalensis	*Annonaceae*	69.0±0.1 × 42.5±0.5
Acacia senegal	*Mimosaceae*	120.0±1.2 × 42.5±0.1
Vitelaria paradoxa	*Sapotaceae*	54.0±1.9 × 36.0±0.8
Synsepalum duciticum	*Palmae*	30.0±1.2 × 24.0±0.6
Elaeis quineensis	*Palmae*	38.0±1.9 × 38.0±0.1
Cassia sp.	*Caelsapiniaceae*	38.6±0.3 × 26.4±0.1
Lannea microcarpa	*Anacardiaceae*	18.5±1.2 × 14.8±0.1
Tridax procumbens	*Asteraceae*	30.5±0.1 × 30.5± 0.1
Celtis species	*Ulmaceae*	45.6±1.7×45.6±1.7
Euphorbia kamerunica	*Euphorbiaceae*	43.5±0.5×39.6±1.1
Malotus sp.	*Euphorbiaceae*	24.3±0.8×224.3±0.8
Symphonia sp.	*Guttiferae*	48.2±0.2 ×48.2±0.2
Pyrrosia sp.	*Polypodiaceae*	79.3±0.9×31.2±0.2
Citrus sp.	*Rutaceae*	31.2±0.5×31.2±0.5

portion of *Palmae* grains was recorded in sample B with one hundred and ten (110) pollen grains per slide.

The pollen grains in the families *Palmae* and *Asteraceae* are of great importance to the bees for honey production, this can be seen in the abundance displayed in sample B and C. *Palmae* and some members of *Asteraceae* are usually anemophilous. It is rather unexpected that such plants will be so important in honey production. Gary (1975) said that the bees are very intelligent and have a high retentive ability; therefore if they have visited a flower possessing a particular colour, they will return to it over and over. Similarly, if a scent is presented to them for a very short time, it will be remembered for several months or even for their life time.

It is obvious from these observations that when *E. guineensis, T. procumbens* or any other plant is flowering, the bees continues to visit them for pollen and nectar and the honey produced at that time contains a large number of pollen grains of the plant flowering at that period. Facts have also shown that bees are not very selective in their feeding, therefore the amount of pollen of a particular plant species present in the honey depends on the quantity produced at the time the bees visit and the number of those visits. Other insects, apart from the bees visit entomorphilous plant for nectar, and on such visits, some quantity of pollen grains are carried away. This subsequently reduces the amount of pollen grains present for foraging bees, assuming they visit and feed on both anemophilous and entomophilous plants at the same rate.

Tab. 2. The number of different pollen types recorded

Families	Sample A	Sample B	Sample C
Palmae	40	110	90
Asteraceae	24	78	84
Mimosaceae	-	24	-
Euphorbiaceae	20	16	10
Sapotaceae	48	30	8
Anacardiaceae	64	22	46
Papillionaceae	19	42	33
Olacaceae	12	36	45
Annonaceae	23	11	7
Caesalpiniaceae	9	13	8
Ulmaceae	22	12	6
Guttiferae	14	13	5
Polypodiaceae	17	15	9
Rutaceae	15	19	-

The oil palm *E. guineensis* is capable of regenerating within a disturbed forest, which could have come under the influence of fire. Its presence is therefore a good indication that there was once a more continuous forest cover. *E. guineensis* could be found within the forest, secondary forest and even savanna. The species of *Butryospermum, Acacia* and *Annona* are similarly found in farmland and savanna. *Tridax* and *Aspilia* both members of the family *Asteraceae* are weeds of cultivated lands or abandoned farmland. The families *Euphorbiaceae, Sapotaceae, Anacardiaceae* and *Mimosaceae* are also well represented in the savanna zone indicating the likely origin of the honey.

It is therefore possible to draw a logical conclusion that the geographical origin of the honey samples varies from the secondary forest to the savanna.

Conclusions

The three honey samples are multiflora, each containing more than one pollen type. 714 plant species were identified in the 3 honey samples. In each sample, *Palmae* and *Asteraceae* are mostly represented indicating that the bees frequently visit these families. Both of them have genera that grow well in the woodland savanna as well as the forest zones. On account of the high proportion of *Palmae* and *Compositae*, it could be inferred that those plants play important role in honey production.

The fact that bees collected pollen grains from non-nectar producing plants and wind pollinated plants such as members of Palmae shows that there is no direct correlation between the pollen collection and pollination of the plants.

Height of trees are no barrier to bees collecting pollen because from the result of this study, it can be seen that weeds such as *T. procumbens,* which are a few centimeters high are visited, alongside very tall trees such as *A. senegalensis* and *E. guineensis.*

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