Journal of Nature Studies 11 (1&2): 96-102
ISSN: 1655-3179

POLLEN CONTENTS OF *Apis mellifera Linn.* HONEY FROM DAVAO CITY, PHILIPPINES

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Abstract A total of 21 pollen types belonging to 10 families were identified from eight honey samples from *Apis mellifera* honey in Davao City. *Strobilanthes* sp. Bl.. *Cocos nucifera* L. and *Mimosa pudica* L. were the predominant pollen sources while the secondary pollen sources were *Momordica charantia* L., *Entada phaseoloides* (L) Merr. and *Sesbania cannabina* (Retz) Pers. Thirty-six percent of the pollen types identified were important minor sources and 20% were minor sources. Results showed that Davao City still provides *Apis mellifera* with variety of food sources and a good potential for sustainable beekeeping.

Keywords: *Apis mellifera Linn., pollen, honey, Davao City*

INTRODUCTION

The European bees, *Apis mellifera* was introduced in the Philippines as early as 1913 by Schultz. (Otanes, 1950; Gabriel, 1981) and became popular in early 90s due to various technologies developed by the University of the Philippines through its bee program (Fajardo and Cervancia, 2012). Technologies are focused on management and utilization of bees for pollination and bee product processing. Among the bee products, honey and pollen are the most popular. Bees convert the nectar gathered from flowers into honey. They also gather pollen for protein and energy source. As bees transfer from one flower to another, pollen grains from the anther are deposited into the stigma and pollination is effected.

Honey was the first bee product used by humankind in ancient times. The world honey consumption has been increasing. In 2008, Bogdanov et al. mentioned that worldwide honey consumption has already reached 1.2 million tons. In the Philippines, supply of honey is coming from almost every region, with the Davao Region accounting for about 31% (Go et al., 2005). In this region, Davao city, the largest city in the Philippines and the most progressive city in Mindanao, provides a very good site for beekeeping. The city is approximately 946 km southeast of Manila covering a land area of 244,000 has. It is divided into three congressional districts with 11 administrative districts divided into 182 towns (http://www.davaocity.gov.ph). Almost 50% of its total land area is timberland or forest, while agriculture utilizes about 43%, consisting mainly of banana, pineapple, coffee, and coconut (DAVAOAMAD, 2012; http://www.davaocity.gov.ph). According to the official government site of Davao City (2012), the city enjoys a mild tropical climate compared with other parts of the Philippines. It has a uniform distribution of rainfall (167.33-194.1 cm), temperature (ave. 28-29°C), humidity, and air pressure, which makes this area a good potential for sustainable beekeeping venture.

In establishing apiary either for honey and pollen production or pollination, pollen and nectar sources should be available to the bees. One way to determine the pollen spectra of bees is through mellissopalynology, or pollen analysis in honey or bee bread. Present in the honey are small amount of pollen which the bees also get when they collect nectar from a certain flower. The pollen grains present in the honey reflects the nectar sources of a specific honey sample, the plants preferred by honeybees, and the pollen spectrum of the area from where the honey comes from (Tiwari et al., 2012; Bhargava et al., 2009 Payawal et al, 1989; 1991; Tilde and Payawal 1987; 1992). Furthermore, besides being

To cite this paper: Cunanan-Deyto, R. A., Manila-Fajardo, A. C. and Cervancia, C. R. 2012. Pollen Contents of *Apis Mellifera Linn.* Honey From Davao City, Philippines. *Journal of Nature Studies*. 11 (1&2): 96-102

a quality criterion, identifying pollen sources of honey may also aid in the determination of the honey's physico-chemical characteristics. Information on these characteristics is supportive; however, this was not done in the study. Honey characterization was only focused on the diversity of plants available for bees and selected by the bees. The study paid more attention on the knowledge of bee plants which is the most important factor in bee management, survival of honey bees and good yield of honey. In this study, the pollen content of Davao City honey was identified to determine the forage resources of the European bees, *A. mellifera*.

MATERIALS AND METHODS

Eight honey samples from Davao City were subjected to pollen analysis following the procedure for acetolysis proposed by the International Commission for Bee Botany (Louveaux et al., 1978). Slides were prepared from the acetolyzed samples and were subjected to microscopical analysis for identification. Pollen grains were counted and identified up to the species level whenever possible. Identification of the pollen types from the honey samples was facilitated by comparing them with the reference pollen slides, technical monographs, and identification plates. Photomicrographs of each pollen type were also taken.

The relative importance of the pollen types was determined by counting at least 250 pollen grains and calculating the relative frequency of the pollen types in each sample. Four frequency classes were used as described by Louveaux et al. (1978):

Predominant pollen	> 45%
Secondary pollen	16–45%
Important minor pollen	3 – 15%
Minor pollen	< 3%

The frequency of occurrence of pollen types was determined from the appearance of the pollen types in each sample. The following terms used by Louveaux et al. (1978) were adapted to classify the frequency of occurrence:

Very frequent - grains present in > 50% of the total samples
Frequent - grains present in 20 – 50% of the total samples
Infrequent - grains present in 10 – 20% of the total samples
Rare - grains present in < 10% of the total samples

The degree of similarity of pollen among the honey samples was determined using the equation for the Similarity Coefficient (%):

$$SC\ (\%) = \frac{\text{Number of times a species appeared}}{\text{Total number of samples}} \times 100\%$$

The similarity coefficient was statistically analyzed and subjected to dendrogram analysis using Ward's Method in the Statistical Package for the Social Sciences (SPSS, 1998). This method will quantify the comparative similarities and will show the hierarchical clustering or grouping patterns of the pollen spectra from each sample.

Pollen identification was conducted at the Institute of Biological Sciences, University of the Philippines Los Banos.

RESULTS AND DISCUSSION

The eight honey samples, amber in color and viscous, had a total of 21 pollen types belonging to ten families (Table 1). Three predominant pollen sources were *Mimosa pudica* L., *Cocos nucifera* L. and unidentified pollen type. There were four pollen types which were classified as secondary sources, namely: *Strobilanthes* sp. Bl., *Momordica charantia* L., *Entada phaseoloides* (L.) Merr. and *Sesbania cannabina* (Retz.) Pers. *Mimosa pudica* L. was found to be a secondary pollen source in one sample while *C. nucifera* L. was a secondary pollen source in two samples. Majority of the pollen types (36%) were important minor sources which indicate a diverse nectar sources in the area. This study is similar to the pollen analysis conducted by Shubharani et. al. (2012) in Coorg honeys of Karnataka State, and Tawari et. al. (2012) in India. The study area has mixed vegetation and all the honey samples were found to be multifloral. Among these pollen types,

Cocos nucifera L. and *Mimosa pudica* L. were the most frequently occurring. Both were very common in almost all samples and they constituted the greater part of the pollens

Table 1. Pollen types identified from Apis mellifera honey samples from Davao City, Philippines.

Pollen Types	Code number	Frequency of Occurrence of Pollen Class			
		Predominant Source	Secondary Source	Important Minor source	Minor source
Acanthaceae					
Justicia sp. L.	1	-	-	-	1
Strobilanthes sp. Bl.	2	-	1	-	-
Apocynaceae					
Apocynaceae types	3	-	-	1	-
Asteraceae					
Tegetes erecta L.	4	-	-	-	2
Convolvulaceae					
Ipomoea sp. L.	5	-	-	-	3
Cucurbitaceae					
Momordica charantia L.	6	-	1	1	-
Cyperaceae					
Carex baccans Nees	7	-	-	1	-
Euphorbiaceae					
Euphorbia sp. L.	8	-	-	2	-
Poaceae					
Chloris sp. Kunth	9	-	-	1	-
Panicum sp. Roxb.	10	-	-	1	-
Rhynchelytrum sp. (Willd.) C. E. Hubb.	11	-	-	1	-
Zea mays L.	12	-	-	2	-
Poaceae types	13	-	-	1	-
Fabaceae					
Albizia sp. Durazz	14	-	-	-	2
Albizia sp. (Roxb.) Benth	15	-	-	1	-
Caesalpinia pulcherrima (L.) Sw.	16	-	-	-	1
Entada phaseoloides (L.) Merr.	17	-	1	-	-
Sesbania cannabina (Retz.) Pers	18	-	1	-	-
Mimosa pudica L.	19	3	1	1	-
Arecaceae					
Cocos nucifera L.	20	3	2	3	-
Unidentified types	21	1	-	5	1

contained in the samples. These pollen types belong to the most preferred sources of pollen grains of *A. mellifera* in the country (Payawal et al., 1991; Payawal, 1992). Other pollen types cited by Payawal et al. (1991) as the predominant pollen sources in the country which are not present in the samples, except Asteraceae pollen types, are *Muntingia calabura* L. (aratilis), Myrtaceae pollen types, and *Leucaena leucocephala* (ipil-ipil). They are the most common nectar sources of bees because these plant species flourish in the apiary site and most

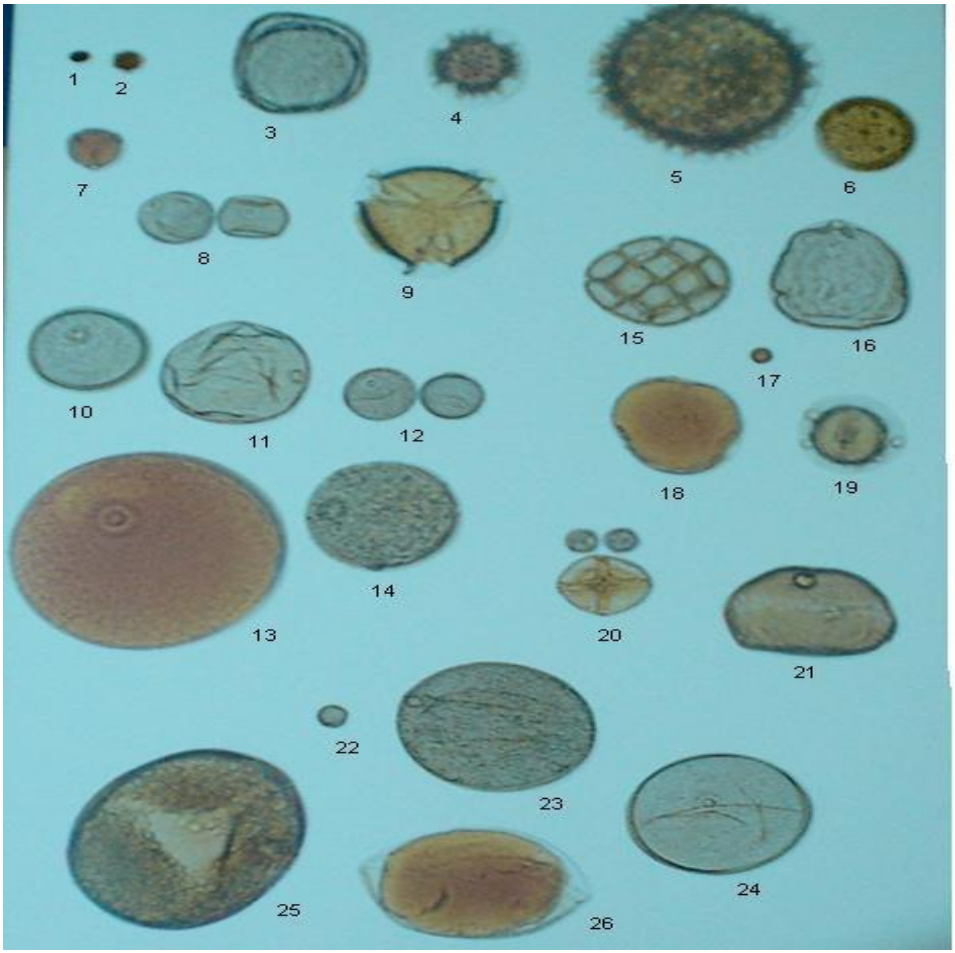


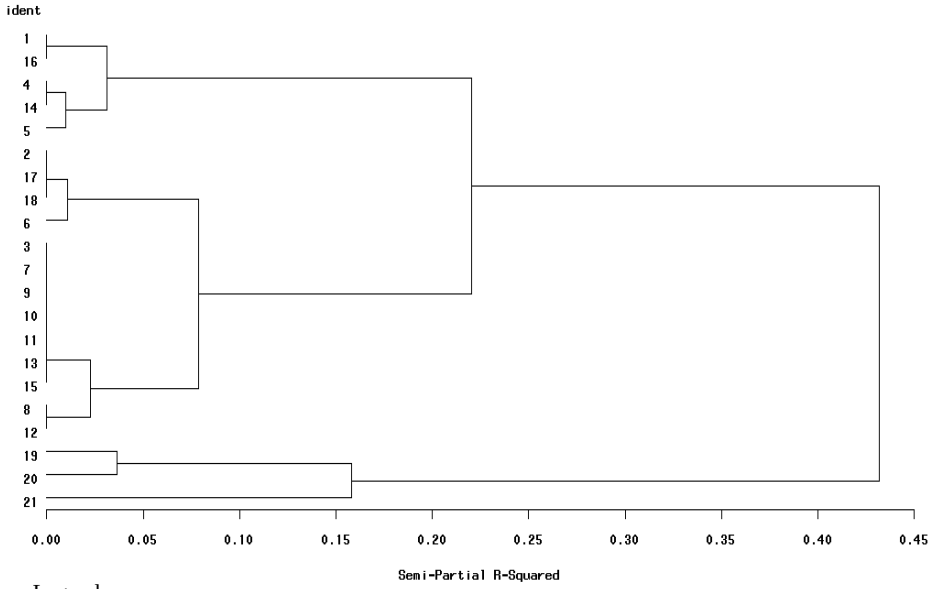
Figure 1. Photomicrographs of some pollen types identified from the samples: 1-2 Acanthaceae types; 3 Apocynaceae type; 4 Tagetes erecta; 5-6 Ipomoea sp.; 7 Momordica charantia; 8 Carex bacans; 9 Euphorbia shouanensis; 10-14 Graminae types; 15-19 Leguminosae types; 20 Mimosa pudica; 21 Cocos nucifera; 22-26 Unidentified types. 600x; 1, 2, 6, 8, 11, 12, 17, 22 & 23, 300x.

of them flower at intervals throughout the year. In addition, *M. pudica* L. produces head-type of inflorescences abundantly with exposed stamens which allow easy access for foraging bees in collecting pollen grains.

Photomicrographs of pollen types identified from the samples are shown in Figure 1.

Cocos nucifera L. was observed to be present in all samples. *C. nucifera* L. produces pollen profusely. More than half of the three million hectares of coconut plantations in the Philippines, which includes those from Davao City, bear flowers and fruits year-round. This is the reason why honeybees' colonies are common in coconut plantations. Bees also are very much attracted to the taste and smell of coconut nectar. A coconut tree can produce one liter of nectar on the average and honeybees can gather 8 – 10 kilos of coconut nectar per day.

In the dendrogram (Fig. 2), two large clusters were generated when pollen type is plotted against their coefficient similarity within the samples. Majority of the identified pollen belonged to one big cluster (Cluster 1). It consisted more than 80% of the pollen types identified. Cluster 1 is divided into two sub-clusters. The larger of which comprised of pollen types which were observed to have appeared only once in the honey as an important minor source. The smaller sub-cluster is mainly composed of the minor pollen sources. These pollen sources are the ones visited by the bees only when the predominant or secondary sources are limited or absent.



Legend:

Justicia sp. L.	1	Euphorbia sp. L.	8	Albizia sp. (Roxb.) Benth	15
Strobilanthes sp. Bl.	2	Chloris sp. Kunth	9	C. pulcherrima (L.) Sw.	16
Apocynaceae types	3	Panicum sp. Roxb.	10	E. phaseoloides (L.) Merr.	17
T. erecta L.	4	Rhynchelytrum sp. .	11	S. cannabina (Retz.) Pers	18
Ipomoea sp. L.	5	Z. mays L.	12	M. pudica L.	19
M. charantia L.	6	Gramineae types	13	C. nucifera L.	20
C. baccans Nees	7	Albizia sp. Durazz	14	Unidentified types	21

Figure 2. Dendrogram produced from the pollen identified from the Davao City honey samples

The other major cluster (Cluster 2), on the other hand, comprised only three pollen types, namely *C. nucifera*, *M. pudica* and the unidentified types. Based on Table 1, these pollen types are the predominant sources. They were found in at least three honey samples. *Mimosa pudica* was present in five samples while *C. nucifera* was present in all samples. Both plants were the most frequently occurring and the most preferred pollen sources of honey bees in Davao. These observations are also similar to that observed in Apis cerana by Tilde et al. in 2003.

The dendrogram depicts that although Davao City is mainly urbanized, its vast area still offers a wide array of amount and type of vegetation sufficient enough to provide pollen sources for the honey bees all year round. Selection though is still preferential for the bees to visit plants such as coconut and touch-me-not (M. pudica) as both supply remarkable quantity of nectar and pollen, a matter of energy conservation for the bees.

The abundance of pollen sources, such as coconut and wild plants (Mimosa spp) accounts for the successful establishment of beekeeping in the area. The absence of pronounced wet and dry season in Davao City makes it very conducive to agricultural and honey production. Beekeepers from Davao can harvest 35-40 kilos per hive because the climate allows year-round production of dark amber viscous honey.

Other regions in the Philippines have only two harvests which last for six months and stops during rainy season. Since there is a potential for high production of honey in Davao City, the quality of the beekeepers' honey produce should be secured so as to provide safe food and consequently protecting the beekeepers' livelihood. Sustaining coconut farming is also imperative to ensure continuous supply of bee forage.

SUMMARY AND CONCLUSION

The pollen sources of European bees, *A. mellifera* were identified through pollen analysis in honey following the procedure proposed by the International Commission for Bee Botany . The pollen grains were identified using reference slides and published literature. The relative importance and frequency of occurrence of the pollen types were determined. A dendrogram was constructed to highlight the clustering of the pollen. A total of 21 pollen types belonging to 10 families were identified from the honey samples. Four pollen types were secondary pollen sources: *Momordica charantia* L., *Entada phaseoloides* (L) Merr., *Sesbania cannabina* (Retz) Pers, and *Strobilanthes* sp. Bl. The important and minor sources were 36 % and 20% respectively. *Cocos nucifera* L. and *Mimosa pudica* L. were the predominant pollen sources identified. Both pollen types have been observed in majority of the samples, indicating that these are the most preferred pollen sources of honey bees. The abundance of coconut and diverse vegetation and uniform climate patterns favored the establishment of beekeeping in Davao.

ACKNOWLEDGMENT

The authors would like to thank the members of BEENET Mindanao from Davao City in providing the honey samples used in the study.

STATEMENT OF AUTHORSHIP

The first author performed the laboratory analysis, pollen identification and photomicrographs, discussions and preparation of manuscript. The second author aided in the collection of samples, verified pollen identification and other technical advice, and reviewed the manuscript. The third author aided in the collection of samples, gave technical advice and reviewed the manuscript. All authors contributed to the development of the manuscript.

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JOURNAL OF NATURE STUDIES
(formerly Nature's Bulletin)
ISSN: 1655-3179