UNIVERSITI PUTRA MALAYSIA

MORPHOLOGICAL ASSESSMENT OF POLLEN FORAGED BY *Apis dorsata* Fabricius AND SPATIAL DISTRIBUTION OF POLLEN SOURCES USING REMOTE SENSING IN MARANG, TERENGGANU, MALAYSIA

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MASTER OF SCIENCE
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Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

November 2012

Salam kasih dan sayang buat:

Suami dan anak-anak tercinta,

Mak Abah dan keluarga yang sangat memahami

dan mendoakan kejayaan.

&

Guru-guru yang tidak jemu menabur ilmu

serta

Kawan-kawan seperjuangan yang sama-sama

mencorakkan masa depan

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

MORPHOLOGICAL ASSESSMENT OF POLLEN FORAGED BY *Apis dorsata* Fabricius AND SPATIAL DISTRIBUTION OF POLLEN SOURCES USING REMOTE SENSING IN MARANG, TERENGGANU, MALAYSIA

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IZZAT FATANAH BINTI IBRAHIM

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Chairman: Siva K. Balasundram, PhD

Faculty: Agriculture

Apis dorsata is one of the important honeybee species in tropical and subtropical regions that forage on various plants including herbs, grasses, forest trees and plantation trees. However, information on the favored bee plants in the study area in terms of identity, quantity and mapping of various pollen sources found in pollen cells collected by *Apis dorsata* bees is lacking. The objectives of this study were: i) to identify pollen source and determine the pollen type and number preserved in pollen cells, ii) to develop a pollen atlas of selected important foraging plants for *Apis dorsata*, and iii) to map the distribution of the major bee plants in Marang, Terengganu.

For the first objective, the pollen cell samples from twenty one different colonies of *Apis dorsata* combs were collected, identified and quantified based on several reference materials. In this study, a total of twelve different pollen types were identified in the samples, which are: *Acacia* sp., *Durio zibethinus, Elaeis guineensis,*

Ixora sp., *Cocos nucifera, Mikania cordata, Mimosa pudica, Melaleuca cajuputi, Garcinia* sp., *Mimusops elengi, Avicennna alba* and *Moringa pterygosperma*. The two most commonly found pollen types were *Elaeis guineensis* (54%) and *Mimosa pudica* (29%).

For the second objective, a pollen atlas was developed. Pollen sizes were in the range of 8-9 µm x 38-40 µm, comprising five different shape classes. In this study, inaperturate granulum pollen grains were observed in *Ceiba petandra* (Bombacaceae) and *Garcinia hombroniana* (Guttiferea), while rugulae grains were found in *Mangifera indica* (Anacardiaceae). Pantoporate, syncolpate, and pericolpate pollen grains with reticulum to microreticulate exine patterns occurred in *Acacia auriculiformis* (Fabaceae), *Melaleuca cajuputi* (Myrtaceae) and *Ixora congesta* (Rubiaceae). *Elaeis guineensis* has trichotomosulcate pollen grains with a microreticulate sexine. Pantocolpate areola pollen was found in *Mimosa pudica* (Mimosaceae), while granulum pollen was observed in *Cocos nucifera* (Palmae). *Anacardium occidentale* (Anacardiaceae) showed a disulcate grain with a striate sexine pattern. Pollen grains of *Averrhoa carambola* (Oxalidaceae) and *Dimorcarpus longan* (Sapindaceae) were tricolpate, and fossulate perforate to striate perforate.

For the third objective, the acquired SPOT 5 satellite imagery was enhanced, classified and vectorized using ENVI software for the purpose of bee plant mapping. Using image classification, the bee plants were categorized into six classes. Ten plots of 10 x 10 m size for each bee plant classes were determined using a randomized sampling technique. Results showed that *Melaleuca cajuputi* covered 2,398.8 ha (5.5%), *Acacia* sp. 11,377.8 ha (25.9%), *Elaeis guineensis* 19745.1 ha (44.9%), non-

vegetation 4,647.2 ha (10.6%), water bodies 973.5 ha (2.2%) and cloud/haze/shadow 4830.5 ha (10.6%). The overall classification accuracy was 91.5% and the Kappa coefficient was 0.8.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENILAIAN MORFOLOGI DEBUNGA YANG DITEROKAI OLEH *Apis dorsata* Fabricius DAN TABURAN SPASIAL BAGI SUMBER DEBUNGA MENGGUNAKAN PENDERIAAN JAUH DI MARANG, TERENGGANU, MALAYSIA

Oleh

IZZAT FATANAH BINTI IBRAHIM

November 2012

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Fakulti: Pertanian

Apis dorsata adalah salah satu spesies lebah yang terpenting di kawasan tropika dan subtropika, yang dijumpai mencari makan pada pelbagai jenis tanaman termasuk herba, rumput, pokok hutan dan pokok tanaman. Bagaimanapun, maklumat bagi tumbuhan kesukaannya di kawasan kajian dari segi pengenalan, pengiraan dan pemetaan bagi pelbagai sumber debunga di dalam sel yang dikumpulkan oleh lebah *Apis dorsata* masih kekurangan. Oleh itu, matlamat kajian ini adalah i) untuk mengenal pasti sumber debunga dan menentukan jenis debunga dan bilangan debunga yang terdapat di dalam sarang *Apis dorsata*, ii) untuk membangunkan atlas debunga bagi tumbuhan lebah yang penting, dan iii) untuk memetakan taburan bagi tanaman lebah yang penting di Marang, Terengganu.

Untuk matlamat pertama, debunga dari sel lebah daripada dua puluh satu koloni *Apis dorsata* yang berlainan dikumpulkan, dikenal pasti dan dikuantitikan berdasarkan beberapa bahan rujukan. Dalam kajian ini, secara keseluruhannya dua belas jenis

debunga yang berbeza dikenalpasti di dalam sampel iaitu: *Acacia* sp., *Durio zibethinus, Elaeis guineensis, Ixora* sp., *Cocos nucifera, Mikania cordata, Mimosa pudica, Melaleuca cajuputi, Garcinia* sp., *Mimusops elengi, Avicennna alba* dan *Moringa pterygosperma*. Dua jenis debunga yang menjadi penyumbang terbesar adalah dari *Elaeis guineensis* (54%) dan *Mimosa pudica* (29%).

Untuk matlamat kedua, atlas debunga dibangunkan. Saiz debunga adalah dalam julat 8-9 × 38-40 μm, dan terdiri daripada lima bentuk kelas yang berbeza. Dalam kajian ini, debunga inaperturate granulum diperhatikan terdapat pada *Ceiba petandra* (Bombacaceae) dan *Garcinia hombroniana* (Guttiferea), manakala debunga rugulae dijumpai pada *Mangifera indica* (Anacardiaceae). Debunga pantoporate, syncolpate, dan pericolpate dengan bentuk exine yang reticulum hingga microreticulate masing-masing terdapat dalam *Acacia auriculiformis* (Fabaceae), *Melaleuca cajuputi* (Myrtaceae) dan *Ixora congesta* (Rubiaceae). *Elaeis guineensis* menunjukkan debunga trichotomosulcate dengan sexine yang microreticulate. Debunga pantocolpate areola dijumpai pada *Mimosa pudica* (Mimosaceae), manakala debunga granulum dijumpai pada *Cocos nucifera* (Palmae). *Anacardium occidentale* (Anacardiaceae) menunjukkan debunga yang disulcate dengan corak striate pada sexinenya. Debunga *Averrhoa carambola* (Oxalidaceae) dan *Dimorcarpus longan* (Sapindaceae) menunjukkan tricolpate, dan fossulate perforate hingga striate perforate.

Untuk matlamat ketiga, imej satelit SPOT 5 yang diperolehi diperlakukan penambahan secara berturutan, dikelaskan dan divektorkan menggunakan perisian ENVI untuk memetakan tanaman lebah. Dengan menggunakan pengelasan imej,

tanaman lebah dikategorikan kepada enam kelas. Sepuluh petak dengan keluasan 10 x 10 m untuk setiap kelas tanaman lebah ditentukan menggunakan teknik persampelan rawak. Analisis menunjukkan *Melaleuca cajuputi* meliputi 2,398.8 ha (5.5%), *Acacia* sp. 11,377.8 ha (25.9%), *Elaeis guineensis* 19745.1 ha (44.9%), bukan tanaman 4,647.2 ha (10.6%), badan air 973.5 ha (2.2%) dan awan/kabus/bebayang 4830.5 ha (10.6%). Ketepatan keseluruhan pengkelasan adalah 91.5% dan kecekapan Kappa adalah 0.8.

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I certify that an Examination Committee has met on **21th of November 2012** to conduct the final examination of **Izzat Fatanah Binti Ibrahim** on her degree thesis entitled "**Morphological Assessment of Pollen Foraged by *Apis dorsata* and Spatial Distribution of Pollen Sources in Marang, Terengganu Using Remote Sensing**" in accordance with the Universities and University Colleges Act 1971 and Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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IZZAT FATANAH BINTI IBRAHIM

Date: 6th of May 201

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