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THE PHENOLOGY AND HABITAT CHARACTERISTICS OF *NYPA FRUTICANS* IN KELANTAN DELTA, MALAYSIA

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Special dedication for my mother, father, brothers and my late sister

&

to my best friends who always be with me through my stressful period of time

Thank you :)

Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu in fulfillment of the requirements for the degree of Master of Science

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Until today, there are no studies were conducted for the phenological event on *Nypa fruticans* in the east coast of Peninsular Malaysia. Therefore, this study was done in order to determine the timing and duration of leaf formation, flowering, and fruiting of *N. fruticans,* to identify potential pollinators for *N. fruticans* and to determine characteristics of *N. fruticans* habitat in Kelantan Delta, Kelantan.

Three stations were identified, namely; Tanjung Kuala, Pulau Kambing and Pulau Che Minah in Kelantan Delta. The selection of the sampling location was based on availability of natural stands and should be in intact condition with no harvesting activities of *N. fruticans*. In each station, three sampling plots (20 x 20 m) further subdivided into 4m x 4m 25 subplots. Phenological observations were conducted for one year (May 2010 to April 2011) on leaf formation, flowering and fruiting phenology within these plots. Numbers of individual palm were counted at each plot. It is considered that a clump of leaves with the youngest leave in the middle regarded as one individual. The density of the individual palm was calculated. After that,

monthly observation was made to record the number of immature, mature and dead leaves for leaf formation. Meanwhile for flowering and fruiting, observation was based on the phenological growth developmental stages scale for female and male flower with eight and five stages respectively. Other than that, samples of potential pollinators, sediment, hydrological parameters and flora association data were also collected.

Density of *N.fruticans* was found to be highest at Pulau Kambing (5,156 individual palm ha^{-1}), followed by Tanjung Kuala (3,564 individual palm ha^{-1}) and Pulau Che Minah (2,066 individual palm ha^{-1}). For the phenological growth stages of the male and female flower, in term of leaf formation, there are three development stages of leaf can be found in all year round. The phenological cycles for female flowers takes 9.33 months to complete from the initial development of the bud until the last stage which is fallen fruit. The calendar documented that female flower duration; (Stage 1:12 days, Stage 2:36 days, Stage 3:15 days, Stage 4:12 days, Stage 5:33 days, Stage 6:66 days, Stage 7:105 days). For the male flower, average cycle duration was 2.85 months (Stage 1:5 days, Stage 2:37 days, Stage 3:11 days, Stage 4:7 days, Stage 5:26 days). Thirteen identified potential pollinators were found visiting the flower, namely; Chloropidae (grass flies), *Drosophila* sp, *Fanniia* sp, *Tabanus* sp, Tephritoidea (fruit flies), *Musca* sp, Calliphoridae, *Leptocera* sp, *Apis* sp, *Trigona* sp, *Vostox* sp, *Macrodactylus* sp and *Orius* sp. Several environment parameters might affect growth conditions of *N. fruticans* such as rainfall, ambience temperature, relative humidity, wind speed, evaporation, water pH, water temperature, dissolve oxygen and salinity were identified. During premonsoon season, silt type of sediment was found dominated in Tanjung Kuala, Pulau Kambing

and Pulau Che Minah ; Tanjung Kuala (sand : 9.81%, clay : 26.61%, silt : 63.57%), Pulau Kambing (sand : 17.86%, clay : 34.40%, silt : 47.91%) and Pulau Che Minah (sand : 31.97%, clay : 32.24%, silt : 38.87%). However, during post monsoon season, silt type of sediment was found dominated in Tanjung Kuala, Pulau Kambing but Pulau Che Minah was dominated by sand ; Tanjung Kuala (sand : 7.79%, clay : 38.82%, silt : 53.18%), Pulau Kambing (sand : 9.99%, clay : 41.62%, silt : 52.22%) and Pulau Che Minah (sand : 42.54%, clay : 21.64%, silt : 35.79%). Three species were found associate with *N.fruticans*; *Rhizophora apiculata*, *Sonneratia caseolaris* and *Avicennia alba*. Two flowering development stages was strongly correlated with ambience temperature, water temperature, dissolve oxygen (DO) and salinity which are, stage 2 (totally unopened inflorescence buds) and stage 3 (young flower still enclosed by bract).

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FENOLOGI DAN CIRI-CIRI HABITAT *NYPA FRUTICANS* DI KELANTAN DELTA, MALAYSIA

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Sehingga kini, tiada kajian yang telah dijalankan berhubung dengan fenologi *Nypa fruticans* di pantai timur Semenanjung Malaysia. Oleh itu, kajian ini bertujuan untuk menentukan masa dan tempoh perkembangan daun, bunga dan buah *N. fruticans*, untuk mengenal pasti potensi agen pendebungaan *N. fruticans* dan untuk menentukan ciri-ciri habitat *N. fruticans* di Kelantan Delta, Kelantan.

Tiga stesen kajian telah dikenal pasti iaitu Tanjung Kuala, Pulau Kambing dan Pulau Che Minah di Kelantan Delta. Pemilihan lokasi persampelan adalah berdasarkan dirian semulajadi *N. fruticans* dan perlu berada dalam keadaan utuh dengan tiada aktiviti menuai ke atas *N. fruticans*. Dalam setiap stesen, tiga plot sampel (20 x 20 m) dibahagikan lagi kepada 4m x 4m 25 s ubplot. Pemerhatian fenologi telah dijalankan selama satu tahun (Mei 2010 hingga April 2011) terhadap pembentukan daun, bunga dan buah dalam plot ini. Bilangan individual pokok telah dikira di dalam setiap plot berdasarkan bahawa setiap rumpun dengan kehadiran pucuk muda di bahagian tengan sebagai satu individu. Kepadatan dirian *N. fruticans* telah dikira.

Selepas itu, pemerhatian bulanan dibuat untuk merekodkan bilangan pucuk muda, daun matang dan daun mati daun. Sementara itu, bagi bunga dan buah, pemerhatian adalah berdasarkan skala peringkat perkembangan fenologi untuk bunga jantan dan betina masing-masing mempunyai lapan dan lima peringkat perkembangan. Selain daripada itu, sampel potensi agen pendebungaan, sedimen, parameter air dan flora turut dikumpulkan dan direkod.

Kepadatan *N.fruticans* paling tinggi di Pulau Kambing (5,156 individu ha^{-1}), diikuti oleh Tanjung Kuala (3,564 individu ha^{-1}) dan Pulau Che Minah (2,066 individu ha^{-1}). Terdapat tiga peringkat perkembangan daun boleh didapati di sepanjang tahun. Kitaran fenologi untuk bunga betina mengambil masa 9.33 bulan untuk dilengkapkan dari pembangunan awal tunas sehingga peringkat terakhir iaitu buah gugur. Kalendar mendokumenkan bahawa tempoh bunga betina; (Peringkat 01:12 hari, Peringkat 02:36 hari, Peringkat 03:15 hari, Peringkat hari 04:12, Peringkat 05:33 hari, Peringkat 6:66 hari, Peringkat 7:105 hari). Bagi bunga jantan, kitaran perkembangan adalah 2.85 bulan (Peringkat 01:05 hari, Peringkat 02:37 hari, Peringkat hari 03:11, Peringkat hari 04:07, Peringkat 05:26 hari). Tiga belas potensi agen pendebungaan yang dikenal pasti ditemui melawat bunga, iaitu; Chloropidae (*grass flies*), *Drosophila* sp, *Fanniia* sp, *Tabanus* sp, Tephritoidea (*fruit flies*), *Musca* sp, Calliphoridae, *Leptocera* sp, *Apis* sp, *Trigona* sp, *Vostox* sp, *Macrodactylus* sp dan *Orius* sp. Beberapa parameter persekitaran yang mungkin mempengaruhi pertumbuhan *N.fruticans* seperti hujan, suhu persekitaran, kelembapan, kelajuan angin, sejatan, pH air, suhu air, oksigen terlarut dan kemasinan telah dikenal pasti. Sebelum monsun, jenis kelodak didapati mendominasi di Tanjung Kuala, Pulau Kambing dan Pulau Che Minah; Tanjung Lumpur (pasir:

9.81%, tanah liat: 26.61%, kelodak: 63.57%), Pulau Kambing (pasir: 17.86%, tanah liat : 34.40%, kelodak: 47.91%) dan Pulau Che Minah (pasir: 31.97%, tanah liat: 32.24%, kelodak: 38.87%). Walau bagaimanapun, selepas musim tengkujuh, jenis kelodak didapati mendominasi di Tanjung Kuala, Pulau Kambing tetapi Pulau Che Minah didominasi oleh pasir; Tanjung Lumpur (pasir: 7.79%, tanah liat: 38.82%, kelodak: 53.18%), Pulau Kambing (pasir: 9.99%, tanah liat: 41,62%, kelodak: 52,22%) dan Pulau Che Minah (pasir: 42,54%, tanah liat: 21.64%, kelodak: 35,79%). Tiga spesies ditemui hidup bersama dengan *N.fruticans*; *Rhizophora apiculata*, *Sonneratia caseolaris* dan *Avicennia alba*. Dua peringkat perkembangan bunga mempunyai hubungan yang kuat dengan suhu persekitaran, suhu air, larut oksigen (DO) dan kemasinan iaitu peringkat 2 (tunas bunga yang belum berkembang) dan peringkat 3 (bunga muda masih diselaputi oleh kelopak).