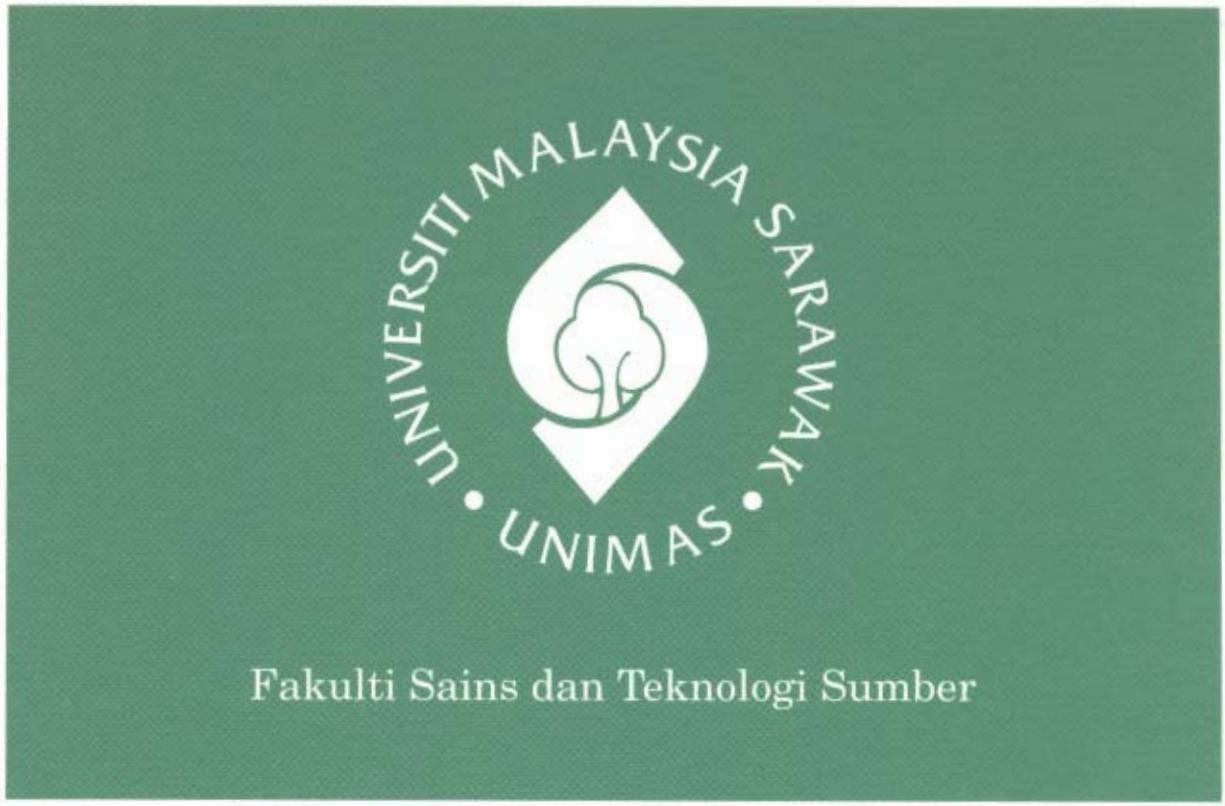

ECOLOGY OF *CRYPTOCORYNE FERRUGINAE* ENGLER IN SARAWAK

Mazzyah Binti Basrol @ Masrol

Bachelor of Science With Honours
(Plant Resource Science and Management)
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This project is submitted in partial fulfillment of the requirements for the degree of
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ABSTRACT

The ecological study of Cryptocoryne ferruginae Engler was carried out in three locations, vis in Sabal Kruin, Balai Ringin and Sungai Kerait. The leaf weight ratio (LWR), petiole weight ratio (PWR) and root weight ratio (RWR) were not significantly differed between locations, while the specific leaf area (SLA) was significantly differred ($p<0.05$) between locations. However, the comparison of leaf area ratio between Balai Ringin and Sungai Kerait was not significantly differed, while the others had significant difference. Thirty trees species (118 individuals) were recorded at Sabal Kruin and 18 trees species from 88 individuals at Balai Ringin were recorded within five plots of 20m x 10m. The estimation total above ground biomass was 94.26ton/ha in Sabal Kruin and 128.64ton/ha in Balai Ringin. The basal areas were 1936.42m^2/ha and 2336.75m^2/ha in Sabal Kruin and Balai Ringin respectively. Forest at Sabal Kruin was dominated by Neonauclea syukorynes (Iv=32.64), followed by Pychopxis arborea (Iv=22.42), Ilex cymosa (Iv=11.15), Glochidion littorale (Iv=11.09) and Shorea seminis (Iv=10.31). However, forest at Balai Ringin was dominated by Ptychopxis arborea (Iv=45.09), followed by Baccaurea bracteata (Iv=41.33), Neonauclea syukorynes (Iv=35.65), Litsea nidularis (Iv=29.48) and Aglaia rubiginosa (Iv=23.23). Both water at Balai Ringin and Sungai Kerait were in acidic condition, with the pH of 5.24 and 5.11 respectively. The temperatures were 25.5°C and 25.4°C, while the dissolved oxygen capacity were 1.36mg/l in Balai Ringin and 2.06mg/l at Sungai Kerait. The highest CEC (62.23+cmol/kg) was recorded at Sabal Kruin, followed by Balai Ringin (39.79+cmol/kg) and Sungai Kerait (19.80+cmol/kg). Sungai Kerait have the highest percentage of clay (14.51%) compared to Sabal Kruin (9.36%) and Balai Ringin (7.59%).
Keywords : Cryptocoryne ferruginae, total above ground biomass, forest composition, water, soil.

ABSTRAK

Kajian ekologi Cryptocoryne ferruginae Engler dilakukan di tiga lokasi iaitu di Sabal Kruin (01°08'45.11"B, 110°53'31.9"T), Balai Ringin (01°02'58.3"B, 110°45'29.1"T) dan Sungai Kerait (01°03'01.5"B, 110°39'16.1"T). Kadar berat daun, petiol dan akar di antara tiga lokasi tersebut didapati tidak signifikan ($p>0.05$), sementara luas daun spesifik didapati signifikan ($p<0.05$) antara satu sama lain. Namun, kadar luas daun antara Balai Ringin dan Sungai Kerait didapati tidak signifikan, manakala yang lain adalah signifikan. Tiga puluh spesies pokok dengan 118 individu didapati dalam plot seluas 20m x 10m di Sabal Kruin manakala sebanyak lapan belas spesies dengan 88 individu direkodkan di Balai Ringin. Berat kering pokok di Sabal Kruin dan Balai Ringin masing-masing 94.26tan/ha dan 128.18tan/ha; manakala luas basal adalah 1936.42m^2/ha dan 2336.75m^2/ha masing-masing. Hutan di Sabal Kruin didominasi oleh Neonauclea syukorynes (Iv=32.64), diikuti oleh Pychopxis arborea (Iv=22.42), Ilex cymosa (Iv=11.15), Glochidion littorale (Iv=11.09) dan Shorea seminis (Iv=10.31). Bagaimanapun, hutan di Balai Ringin didominasi oleh Ptychopxis arborea (Iv=45.09), dan diikuti oleh Baccaurea bracteata (Iv=41.33), Neonauclea syukorynes (Iv=35.65), Litsea nidularis (Iv=29.48) dan Aglaia rubiginosa (Iv=23.23). Kedua-dua air sungai di Balai Ringin dan Sungai Kerait berada dalam keadaan berasid iaitu pada pH5.24 dan pH5.11 masing-masing. Manakala kadar oksigen terlarut di Sungai Kerait adalah lebih tinggi di Sungai Kerait (2.06mg/l) berbanding dengan 1.36mg/l sahaja di Balai Ringin. Suhu air di Balai ringin dan Sungai Kerait adalah 25.5°C dan 25.4°C masing-masing. Kadar pertukaran kation dalam tanah dicatatkan paling tinggi di Sabal Kruin iaitu 62.23+cmol/kg, berbanding hanya 39.79+cmol/kg dan 19.80+cmol/kg di Balai Ringin dan Sungai Kerait
Kata kunci : Cryptocoryne ferruginae, berat kering, komposisi hutan, air, tanah

INTRODUCTION

Cryptocoryne (Araceae), which locally known as kiambang batu (Melayu Sarawak), kelatai (Iban), hati-hati paya (Semenanjung Malaysia) and tropong ajer (Banjarmasin, Kalimantan) are native in shaded Malaysian's forests. It is a soft-tissue throughout plant that reside in open pools and slow-running water channels of freshwater swamps (Wong,1997).

Cryptocoryne are very well-known to people who kept aquarium (Holttum,1969) as it is a popular aquatic plant in aqua scaping (Jacobsen,1976; Rataj & Horeman,1977; de Wit,1993). It has unique leaves and the flowers of various species come in different attractive colors and these factors explain its ability as a popular horticulture flower (Kiew, 1994).

Most of the *Cryptocoryne* species that are located in Sarawak are endemic and increasingly facing possibility of extinction (Jacobsen,1985; Mansor,1994). *Cryptopcoryne* are very sensitive to changes that occur in its surroundings. Some factors had been identified as the main reasons for its extinction. Besides pollution and deforestation (Douglas et. al.,1993), disturbance to the *Cryptocoryne* habitat is also the main factor (Jacobsen,1985; Mansor,1994).

According to Jacobsen (1985), *Cryptocoryne ferruginea* that is unique by its spathe shape, is usually found in the inner part of the freshwater tidal zone, usually in deep mud. Research on this plant and eventually the species itself is very little in Malaysia. For several years, the study on *Cryptocoryne ferruginea* had faced problems due to the immature specimen of spathe and not having much information on it (Jacobsen, 1985). The taxonomy research on *Cryptocoryne* in Sarawak is considered very little. Jacobsen (1985) noted that there are only 11 species reported by Jacobsen (1985) within the limited area. The plasticity of the *Cryptocoryne* species is considerably high (Ipor et. al., 2003 in press) and the morphology variation depend on the

surroundings. Due to this condition, the process of identifying the *Cryptocoryne* species precisely will be facing difficulty. The present study was conducted to gather information on morphology, anatomy and the ecological details of *Cryptocoryne ferruginea* for updating its present taxonomic status.

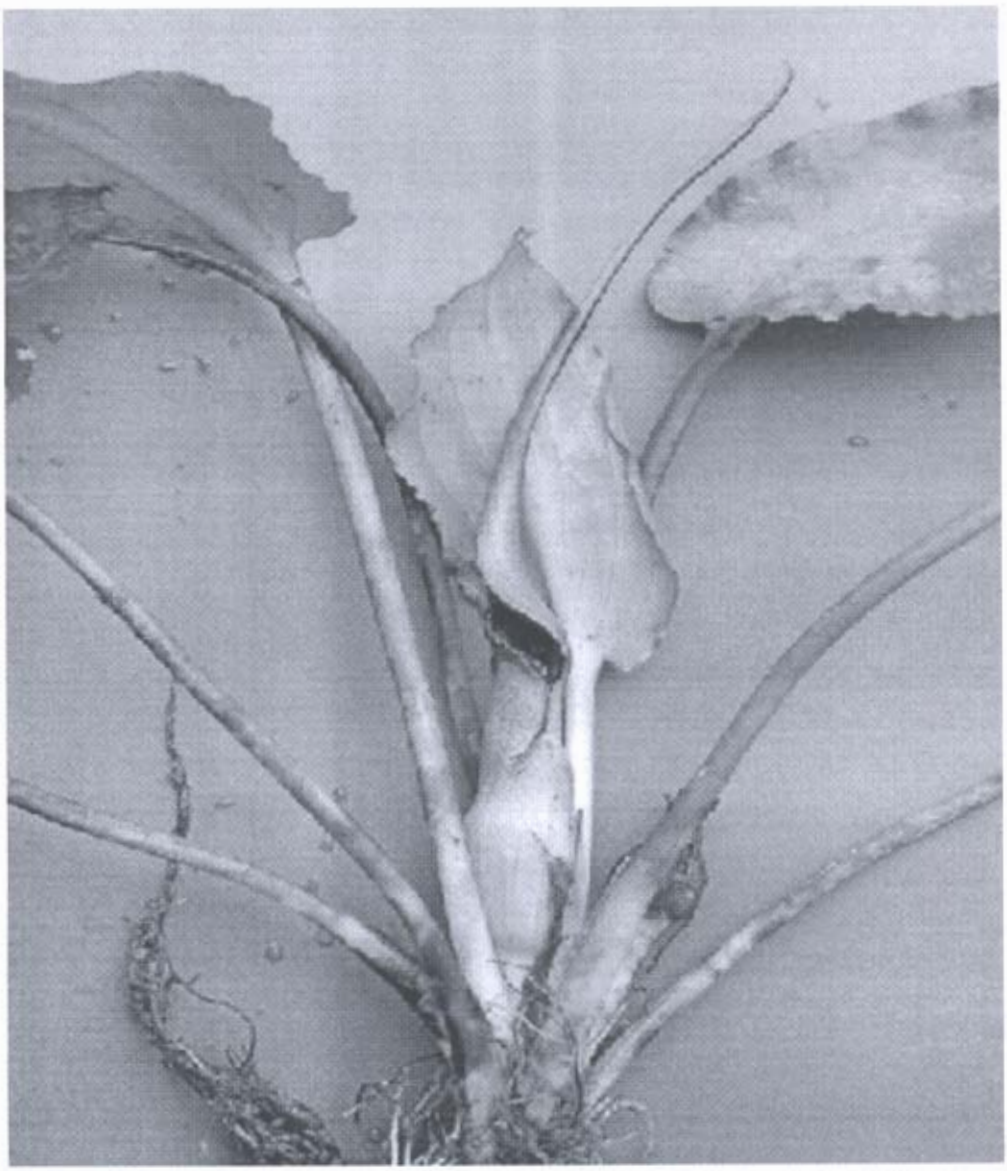


Figure : *Cryptocoryne ferruginae* Engler recorded at Balai Ringin, Serian Sarawak

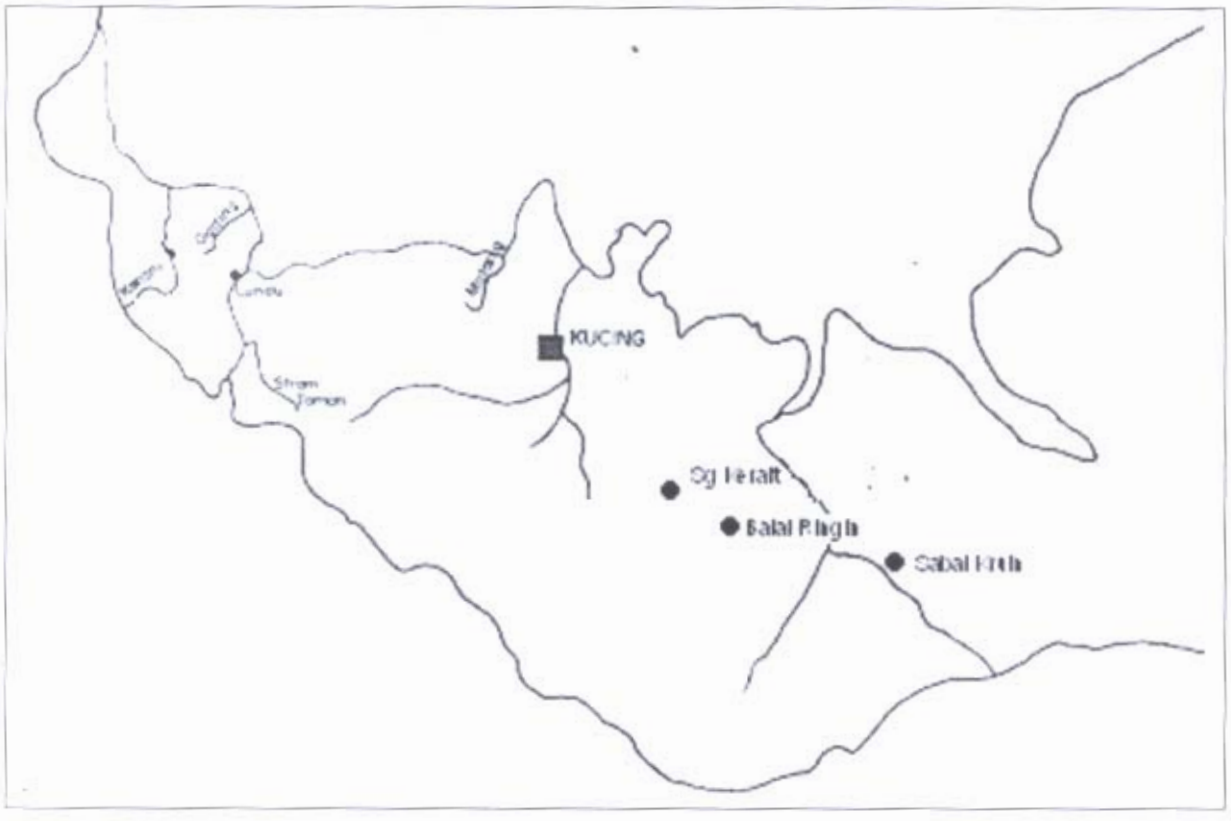


Figure : The study sites of *C. ferruginae* at Sabal Kruin, Balai Ringin and Sungai Kerait

MATERIALS AND METHODS

All studies were conducted in Balai Ringin, Sabal Kruin, and Sungai Kerait in Serian in Samarahan District.

Morphological characteristics of *C. ferruginea*

Fertile specimen will be taken in field for morphological identification and measurement. The morphological characteristics, such as leaves (size, color, shape, , cataphylls, rhizome and inflorescences (kettle, tube, limb, spadix, stamen, stigma) then were recorded.

Anatomy of *C. ferruginea*

The anatomy of *C. ferruginea* studies were carried out only on the matured leaf, rhizome and petiole. The method of Cutler (1978) was employed in this study. Leaf discs of $1cm^2$ were cut from three parts of the leaf, such as the apex, middle and base part with three duplicate. The slide is studied under the light microscope with the 10 x 40 enlargement. This is to identify the epidermis cells, the type of stomata and the distribution frequencies of epidermis cells, guard cells and subdiarize cells that present. The middle part of the leaf lamina will be cut into small squares of $1cm^2$. Both the dry specimens and preserved materials were used. Using the data from the studies on the stomata cells, the stomata index (I) was counted according to the formula by Salisbury (1927);

$$\text{Stomatal Index (SI)} = [S/(S+S)]$$

Whereby, S= total stomata and E= total epidermis cells.

Structure and floristic composition of riverine forest with the occurrence of *C. ferruginae*

Five plots of 20m x 10m were be established randomly in the areas with the occurrence of *C. ferruginea.* All tree with the diameter of breast height (DBH) of 5.0 cm or more are enumerated and identified. The total leaf area, basal area, relative frequency, relative density, relative dominance and importance values (Iv) of the trees were determined according to the method described by Brower *et al* (1990) and Mustafa (1997) as stated below;

Relative frequency (Rf) = 100 x f / Tf
Relative density (Rd) = 100 x d / Td
Basal area (BA) = 3.14 x $(DBH / 2)^2$
Relative dominancy (RD) = 100 x BA / TBA
Importance value (Iv) =Rf + Rd = Rd

Whereby, DBH = Diameter of Basal Height, TBA = Total Basal Area, Tf = Total frequency, Td = Total Dominancy, D = Dominancy and F = Frequency

The total above ground biomass of woody plant was estimated by following the allometric formula generated by of Yamakura *et al* (1986);

Biomass estimation = $W_S + W_B + W_L$
W_S (Stem weight) = $2.0903 \times 10^{-2} (D^2H)^{0.9813}$
W_B (Basal weight) = $0.1192\ W_S^{1.059}$
W_L (Leaf weight) = $9.146 \times 10^{-2}\ W_{TC}^{0.7266}$
$\mu = 11.670(W_L)^{0.9412}\ m^2$

Whereby Ws= Stem weight, W_B= Basal weight, W_L=Leaf weight and μ = Leaf Area Index (LAI).

Growth pattern and biomass allocation of *C. ferruginae*

Quadrates of 1m x 1m were established randomly to determine the total number of plants, dry weight of the vegetative parts such as leaves, roots, petiole and rhizome as well as the plants in the entire quadrates. Ten plants from each quadrate were randomly selected for morphological assessment such as their height, total leaves and leaf area. The leaves, petiole and roots were severed and dried in oven at 60°C for 7 days to determine the total dry weight, leaf weight ratio (LWR), root weight ratio (RWR),petioles weight ratio (PWR) and specific leaf area (SLA) of the individual plant. The biomass distribution pattern will then be analyzed mathematically with the same method described by Peterson & Flint (1983).

Water and Soil Analysis

The water parameter is measured using *Horiba water checker U-10*. The conditions measured are pH, conductivity, dissolved oxygen, temperature, salinity and the condensed of the river. The formula of m1v1= m2v2 is used to prepare the buffer solution (Benefield et al., 1982). The *Atomic Absorbance Spectroscopy* (Perkin Elmer Model 3110) is used. The water sample will also be taken randomly to detect the occurrence of chlorine, nitrate and sulphate. The test is done using the *Hatch Kit Test* (N8-P Model, N-11 Model and HS-WR Model).

Sample of soils are taken from research plots. This samples will be send to Agricultural Research Centre (ARC) Semongok to be analyze chemically, which are the pH (Hesse, 1971 & Mc Lean, 1986), soil organic carbon (Dewis & Freites, 1970), nitrogen (N) amount (Anon,1980 & Beitz, 1974), kation exchange rate (CEC), calcium (Ca) ion amount, magnesium (Mg), kalium (K), natrium (Na) and basic saturate (BS) (Anon, 1980).

RESULT AND DISCUSSION

Morphology Characteristic

Morphological description of *C. ferruginae* collected from Sabal Kruin

Rhizome slender, often with long internodes; runners long, slender. Cataphylls only present in flowering specimens. Cataphylls 1-8cm. Leaves 3-11cm long, 1.5-5cm width; upper surface darker than lower surface, surface smooth, cordate to elliptic, apex acuminate, base truncate to cordate, margin serrulate, venation pinnate. Petiole 2-19cm, longer in submerged specimens. Spathe cm long, upper part purplish and lower part white; kettle 1-2.0cm long, inside purple, surface light purple; tube 1.5-3.5cm long, outside light purple; limb 4.5-9.0cm long, long and spiral, dark purple; collar dark purple. Spadix 1.0-1.5cm long, white. Stigma yellow inside, purple outside. Valve light yellow.

Habitat

At Sabal Kruin, *C. ferruginae* are found growing in the riverine habitat that proned to flash flooding after short tropical rainstorm. The water is muddy when rain and clear when it is not raining. In dry season, the stagnant clear water in the ditches is usually dried. The population can sustain the persistent dry season. The population formed in patches that ranged 0.5-12 cm^2 in size.

Morphological description of *C. ferruginae* collected from Balai Ringin

Rhizome slender, often with long internodes; runners long, slender. Cataphylls only present in flowering specimens. Cataphylls 1.5-2cm. Leaves 2-9cm long, 1-3cm width; upper surface darker than lower surface, shape elliptic, apex acuminate, base truncate to cordate, margin

serrulate, venation pinnate, surface smooth. Petiole 3-10cm, longer in submerged specimens. Spathe cm long, upper part purplish and lower part white; kettle 0.5-1.0cm long, inside light purple, surface light purple; tube 1.0-2.0cm long, outside light purple; limb 3.0-5.5cm long, long and spiral, dark purple; collar dark purple. Spadix 1.0-1.5cm long, white; Stigma yellow inside, purple outside; stamen yellowish white; valve light yellow.

Habitat

C. ferruginae are found growing in the riverine habitat that always flood after heavy rainfall. The frequent short inundation of the habitat after heavy rain is identified as one of the important factor in substantial population of *C. ferruginae*. Water is clear and flow steadily with litter fall washed out to the river system.

Morphological description of *C. ferruginae* collected from Sungai Kerait

Rhizome slender, often with long internodes; runners long, slender. Cataphylls only present in flowering specimens. Leaves; upper surface darker than lower surface, shape ovate to elliptic, apex acuminate, base truncate to cordate, margin serrulate, venation pinnate, surface smooth. Petiole longer in submerged specimens. Spathe; upper part purplish and lower part white; kettle 1.8cm long, inside light purple, surface light purple; tube 2.1cm long, outside light purple; limb 6.2cm long, long and spiral, dark purple; collar dark purple.

Habitat

C. ferruginae occurred along the small river of Sungai Kerait. It formed in small patches due to frequent strong current during heavy rain. The population is constantly treated by fishing activities in traditional ways by the local people.

Table 1 ; The morphological characteristics of *C. ferruginae* at Sabal Kruin, Balai Ringin and Sungai Kerait.

Characteristics		Sabal Kruin	Balai Ringin	Sungai Kerait
Leaves Total		458	1207	914
Trees total		149	283	223
Rhizome		5.59cm	1.75cm	1.7cm
Cataphylls		3.86cm	1.94cm	-
Leaves				
Color	Upper	Dark green	Light-dark green	Green
	Lower	Light green	Light green	Light green
Shape		Ovate to elliptic	Ovate to elliptic	Ovate to elliptic
Apex		Acuminate	Acuminate	Acuminate
Base		Truncate to cordate	Truncate to cordate	Truncate to cordate
Length		6.58 ± 0.46 cm	5.28 ± 0.56 cm	5.4cm
Width		3.15 ± 0.18 cm	2.18 ± 0.07 cm	2.6cm
Petiole	Color	Green	Light green	Light green
	Length	10.04 ± 1.08 cm	6.29 ± 0.39 cm	7.6cm
Surface		Smooth	Smooth	Smooth
Margin		Serrulate	Serrulate	Serrulate
Venation		Pinnate	Pinnate	Pinnate
Inflorescence				
Collar		Black purple	Black purple	Black purple
Kettle	Color	Purple inside	Purple inside	Purple inside
	Size	1.18cm	0.94cm	1.8cm
Tube	Color	Light purple	Light purple	Light purple
	Size	2cm	1.8cm	2.1cm
Limb		Long and spiral	Long and spiral	Long and spiral
	Color	Purple	Purple	Purple
	Size	5.4cm	4.4cm	6.2cm
Spadix		White	White	White
Stamens		Yellowish white	Yellowish white	Yellowish white
Stigma		Yellow, purple	Light yellow	Light yellow
Valve		Light yellow	Light purple	Light purple

Anatomy of *C. ferruginae*

The epidermis cells in Sabal Kruin, Balai Ringin and Sungai Kerait were isodiametric or isodiametric or isodiametric- rectangular. Surface ornamentation also presented on several cells of certain part of the leaf surface from Sabal Kruin, Balai Ringin and Sungai Kerait. The epidermis cells in Sabal Kruin have thickened areas on the middle of the epidermis cells. However, the thickened cells only occur on several parts of the leaf surface. The epidermis cells in Sabal Kruin, Balai Ringin and Sungai Kerait were arranged generally, or not randomly. The hexagonal or 6-sided cells and pentagonal, 5-sided cells present on several part of the leaf surface in Sabal Kruin, Balai Ringin and Sungai Kerait.

Three replicates were used to determine the total epidermis cells on the upper and lower surfaces of the leaf. The total epidermis cells on the upper surface and the lower leaf surface of *C. ferruginae* in Sabal Kruin, Balai Ringin and Sungai Kerait range between 72697 - 78505 cells/cm^2 and 69449 – 70029 cells/cm^2 respectively (Table 2). However, there were no significant differences of the total epidermis cells on the upper and lower leaf surfaces between Sabal Kruin, Balai Ringin and Sungai Kerait (Figure 2).

There were 76153 cells/cm^2 on the upper leaf surface and 69460 cells/cm^2 on the lower leaf surface of *C. ferruginae* at Sabal Kruin. The total epidermis cells on the upper and lower surfaces in Balai Ringin were 785050 cells/cm^2 and 69449 cells/cm^2 respectively. At Sungai Kerait, there were 72697 cells/cm^2 on the upper surface and 70029 cells/cm^2 on the lower surface. The upper leaf surface of *C. ferruginae* in Sabal Kruin, Balai Ringin and Sungai Kerait has more epidermis cells per cm^2 compared to the lower surface. The highest total epidermis cells on the upper surfaces was recorded in Balai Ringin (78505 cells/cm^2), while the highest total epidermis cells on the lower surface was recorded in Sungai Kerait with 70029 cells/cm^2.

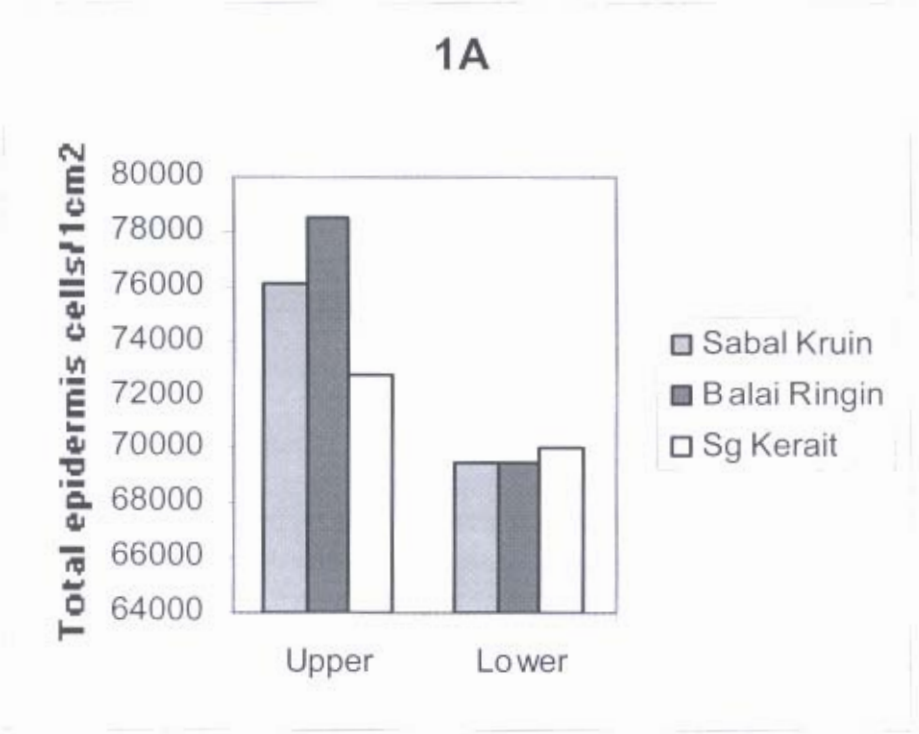


Table 1 : The comparison between the total epidermis cells within $1cm^2$ recorded on the upper and lower leaf surfaces of *C. ferruginae* collected at Sabal Kruin, Balai Ringin and Sungai Kerait

Most of the epidermis in Sabal Kruin, Balai Ringin and Sungai Kerait were isodiametric, which mean the length and the width of the epidermis cells were almost equal with each other. Observation on the upper and lower leaf surface of *C. ferruginae* showed that the length and width of the epidermis cells varies slightly. The length of the epidermis cells Sabal Kruin, Balai Ringin and Sungai Kerait range between 8µm–22µm/cm^2, while the width range between 4µm-17µm/cm^2. The length and width range of the epidermis cells in Sabal Kruin, Balai Ringin and Sungai Kerait were showed in Table 3.

The length and width of the upper and lower leaf surface of *C. ferruginae* at Sabal Kruin, Balai Ringin and Sungai Kerait were range between 12µm–21µm/cm^2, 10µm–21µm/cm^2 and 13µm–21µm/cm^2 respectively. While the length of the epidermis cells on the lower surfaces at Sabal Kruin range between 10µm–20µm/cm^2, and the range were 8µm–21µm/cm^2 and 14µm–22µm/cm^2 for Balai Ringin and Sungai Kerait. The range varies slightly, and the length and width of the epidermis cells on the upper and leaf surfaces at the three different locations were almost equal or similar.

The width of the epidermis cells on the upper leaf surface of *C. ferruginae* were 5µm–15µm/cm^2, 5µm–14µm/cm^2 and 5µm–15µm/cm^2 for Sabal Kruin, Balai Ringin and Sabal Kruin respectively. The width of the epidermis cells on the lower leaf surface range between 5 µm–15µm/cm^2 in Sungai Kerait, while Sabal Kruin and Balai Ringin share the same range (5µm–14µm/cm^2). The width range between the upper and lower leaf surface of *C. ferruginae* at Sabal Kruin, Balai ringin and Sungai Kerait varies slightly with each other.

Table 3 : The length and width of epidermis cells on the upper and lower surfaces of *C. ferruginae* collected at Sabal Kruin, Balai Ringin and Sungai Kerait.

Locality		Length ($\mu m/1cm^2$)	Width ($\mu m/1cm^2$)
Sabal Kruin	Upper	12μm-21μm	5μm-11μm
	Lower	11μm-20μm	5μm-14μm
Balai Ringin	Upper	10μm-21μm	4μm-10μm
	Lower	8μm-21μm	5μm-14μm
Sungai Kerait	Upper	13μm-21μm	6μm-17μm
	Lower	14μm-22μm	5μm-15μm

Stomata cells present on both upper and lower surfaces of *C. ferruginae* at Sabal Kruin, Balai Ringin and Sungai Kerait, which mean *C. ferruginae* is amphistomatous. Amphistomatous plant were plants with stomata cells on both upper and lower surfaces of their leaves. The stomata cells that present on the leaves of *C. ferruginae* at Sabal Kruin, Balai Ringin and Sungai Kerait were paracytic. These stomata have two subsidiarize cells on both sides of the guard cells.

The total stomata cells recorded on the upper and lower leaf surfaces of *C. ferruginae* at Sabal Kruin, Balai Ringin and Sungai Kerait were in the range of 281-1143 stomata cells/$1cm^2$ and 378-1276 stomata cells/$1cm^2$ respectively. One-way ANOVA analysis was used between the upper and lower surfaces of *C. ferruginae* at Sabal Kruin, Balai Ringin and Sungai Kerait. The result showed that the total stomata cells on the upper and lower leaf surfaces of *C. ferruginae* had no significant differences between Sabal Kruin, Balai Ringin and Sungai Kerait (Figure 2).

The stomatal index for the upper and lower leaf surfaces of *C. ferruginae* at Sabal Kruin, Balai ringin and Sungai Kerait were shown in Table 4. The stomatal index for the upper and lower leaf surfaces at Sabal Kruin share similar value (0.012). It can be concluded that the total stomata cells on the upper and lower surfaces at Sabal Kruin were significant with each other. In

Balai Ringin, the stomatal index of the upper surface was lower than the stomatal index of the lower surface, which was 0.007 and 0.013 respectively. Sungai Kerait also recorded smaller stomatal index on the upper surface (0.008) compared to the lower surface of the leaf (0.012). The small value of stomatal index indicated small value of total stomata present on the leaf surface. Hence, the total stomata cells on the upper leaf surface of *C. ferruginae* at Balai Ringin and Sungai Kerait were higher than the total stomata cells on the lower leaf surface.

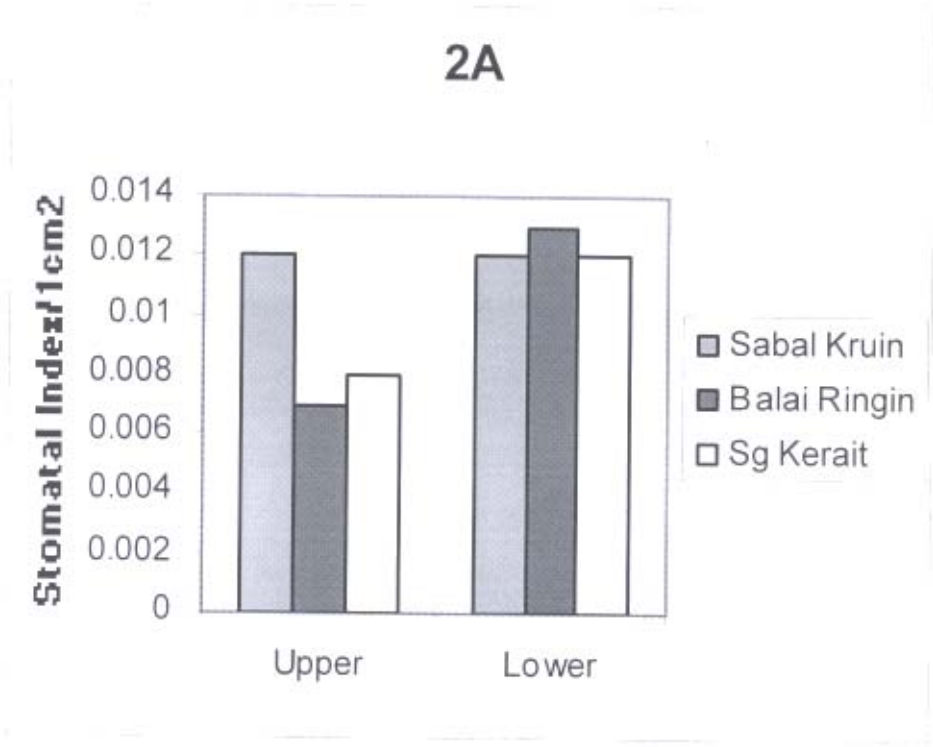
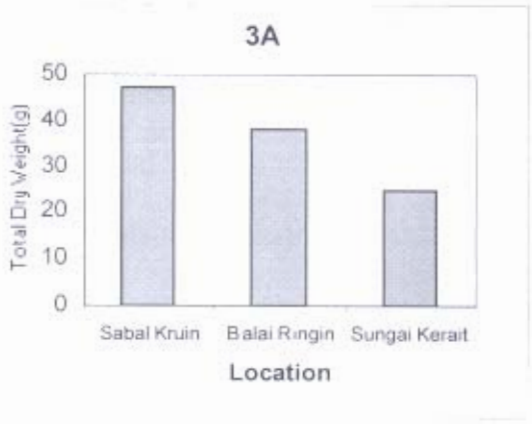
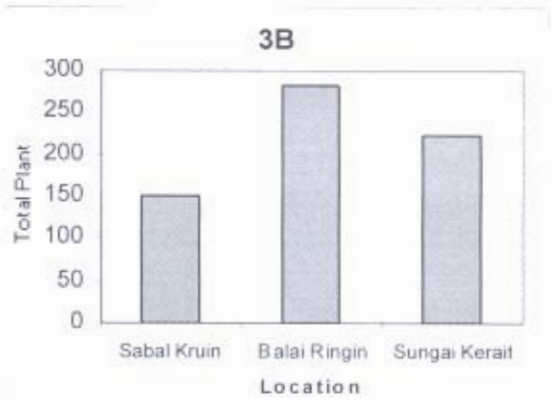


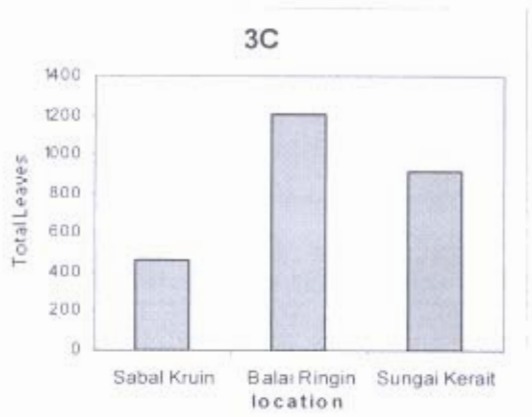
Figure 2A; Stomata Index (SI) of the upper surfaces and the lower leaf surfaces of *C. ferruginae* at Sabal Kruin, Balai Ringin and Sungai Kerait.

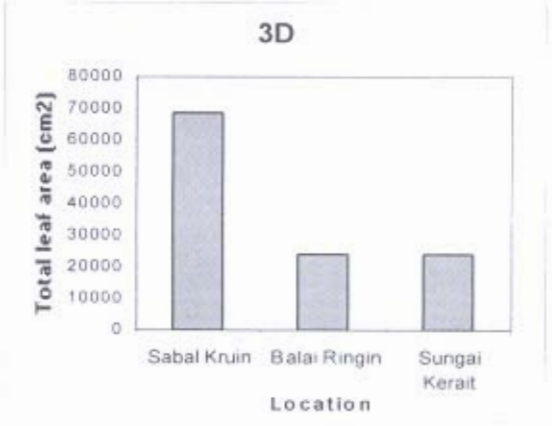
Growth pattern and biomass allocation of *C. ferruginae*

The total dry weight of $1m^2$ *C. ferruginae* in Sabal Kruin was 47.50g while in Balai Ringin was 38.12g and in Sungai Kerait was 24.83g from the total plants of 449, 283 and 223 respectively(Figure 3A). It was observed that only the population of *C. ferruginae* at Sungai Kerait occurred in the river system that directly affected by the water flow. The occurrence of *C. ferruginae* both at Sabal Kruin and Balai Ringin was located at the upper parts of river in region. Although Sabal Kruin has the highest total dry weight, the number of leaves per quadrate was lower than those from Balai Ringin and Sungai Kerait. The total leaves in Sabal Kruin was 458 leaves, while in Balai Ringin was 1207 leaves and 914 leaves in Sungai Kerait. It was stated before that Balai Ringin had the highest total number of plots and comparatively with smaller plants with those for Sabal Kruin. The total leaf area per quadrate in Balai Ringin was 68664.8 cm^2, while in Sungai Kerait was 24252.6 cm^2 per gram and in Sabal Kruin is 23779.2 cm^2 per gram (Figure 3D). The dry weight of leaves was highest in Balai Ringin (12.31g), followed by Sabal Kruin (9.33g) and Sungai Kerait (6.40g). The dry weights of petioles were 9.76g, 8.18g and 4.98g for Sabal Kruin, Balai Ringin and Sungai Kerait respectively. The dry weight of root was highest in Sabal Kruin (27.96g), 17.63g at Balai Ringin and 13.45g at Sungai Kerait.









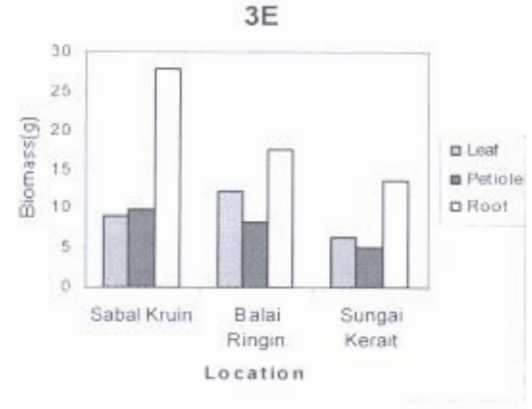


Figure 3; The vegetative characteristics of *C. ferruginae* sampled in 1m x 1m quadrate from different locations, such as Sabal Kruin, Balai Ringin and Sungai Kerait. (3A= Total Dry Weight, 3B= Total Plants, 3C= Total Leaves, 3D= Total Leaf Area and 3E=Dry weight of leaves, petioles and roots).

The leaf weight ratio, petiole weight ratio and root weight ratio between Sabal Kruin, Balai Ringin and Sungai Kerait had no significant different (Figure 4). The mean leaf weight ratio in Sabal Kruin was 0.29g, and similar value for Balai Ringin (0.27g) and Sungai Kerait. The mean petiole weight ratio was 0.20g, 0.18g and 0.16g for Sungai Kerait, Sabal Kruin and Balai Ringin respectively. The plants at Balai Ringin tended to assimilate more biomass to the root as demonstrated by its root weight ratio value (RWR). The RWR exceeded half of the total amount of the entire plant biomass. RWR were 0.56g, 0.53g and 0.52g for Balai Ringin, Sabal Kruin and Sungai Kerait respectively. The leaf area ratio at Sungai Kerait (161.53g/g), was significantly higher than those from Balai Ringin of followed by Balai Ringin (130.20g/g) and Sabal Kruin (83.98g/g). There was no significant different between leaf area ratio of Balai Ringin and Sabal Kruin. Similar trend of specific leaf area was recorded through out the study. However the mean of specific leaf area was significantly different between Sungai Kerait (598.97g/g), Balai Ringin (475g/g) and Sabal Kruin (293.0g/g).

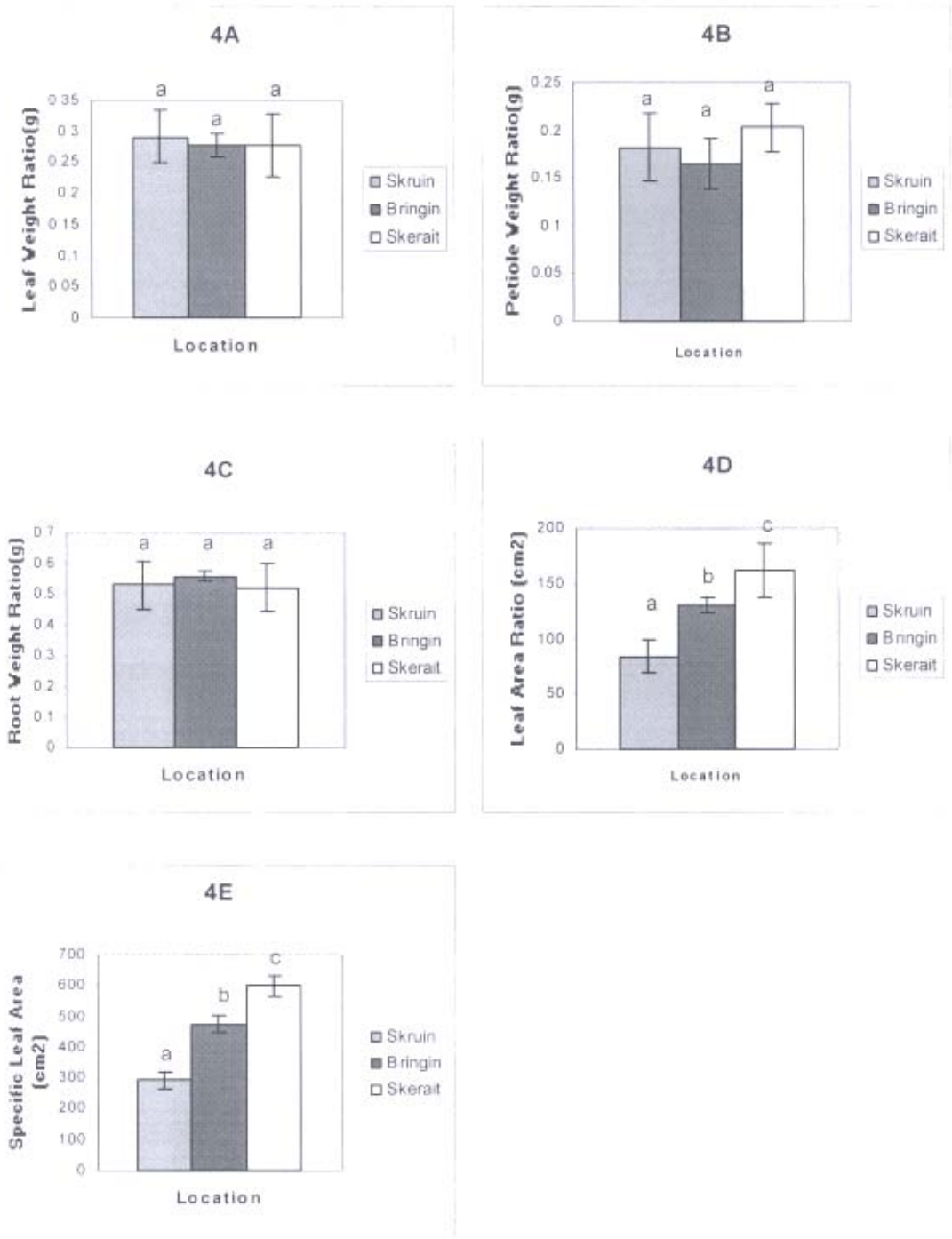


Figure 4; The vegetative characteristics of *C. ferruginae* from different locations, which are at Sabal Kruin, Balai Ringin and Sungai Kerait.[4A=Leaf Area Ratio(LAR), 4B=Specific Leaf Area(SLA),4C=Leaf Weight Ratio(LWR),4D=Petiole Weight Ratio(PWR) and 4E=Root Weight Ratio(RWL)].