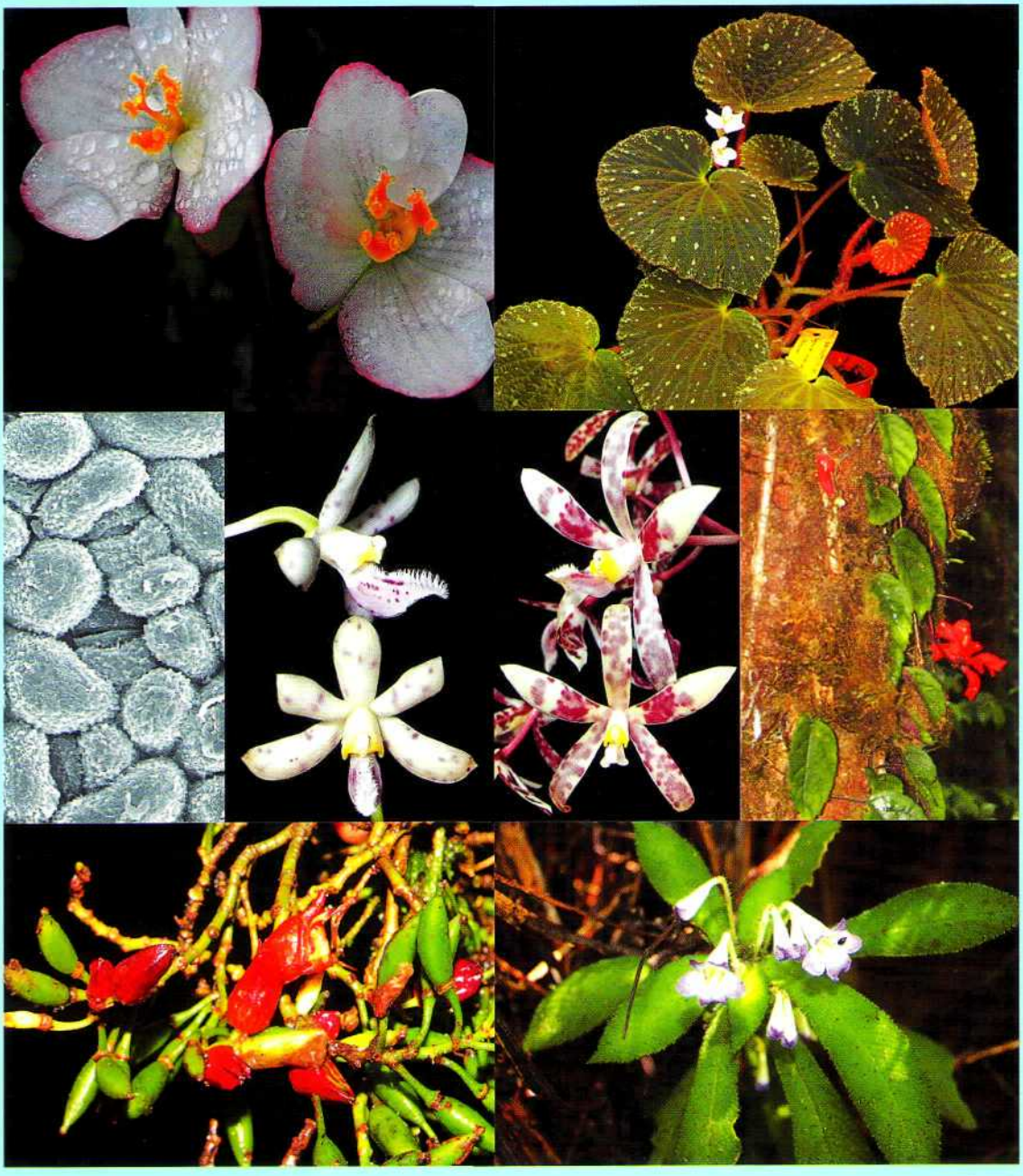
LIPI

REINWARDTIA

A JOURNAL ON TAXONOMIC BOTANY, PLANT SOCIOLOGY AND ECOLOGY

ISSN 0034 – 365 X



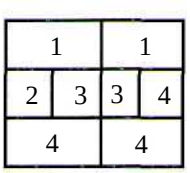
2014 14 (1)

REINWARDTIA

A JOURNAL ON TAXONOMIC BOTANY, PLANT SOCIOLOGY AND ECOLOGY

Vol. 14(1): 1-248, December 23, 2014

Correspondence on editorial matters and subscriptions for Reinwardtia should be addressed to:
HERBARIUM BOGORIENSE, BOTANY DIVISION,
RESEARCH CENTER FOR BIOLOGY- INDONESIAN INSTITUTE OF SCIENCES
CIBINONG SCIENCE CENTER, JLN. RAYA JAKARTA - BOGOR KM 46,
CIBINONG 16911, P.O. Box 25 Cibinong
INDONESIA
PHONE (+62) 21 8765066; Fax (+62) 21 8765062
E-MAIL: reinwardtia@mail.lipi.go.id



Cover images: 1. *Begonia holosericeoides* (female flower and habit) (Begoniaceae; Ardi *et al.); 2.* Abaxial cuticles of *Alseodaphne rhododendropsis* (Lauraceae; Nishida & van der Werff); *3. Dipodium puspitae, Dipodium purpureum* (Orchidaceae; O'Byrne); 4. *Agalmyla exannulata, Cyrtandra coccinea* var. *celebica, Codonoboea kjellbergii* (Gesneriaceae; Kartonegoro & Potter).

The Editors would like to thanks all reviewers of volume 14(1):

Abdulrokhman Kartonegoro - Herbarium Bogoriense, Bogor, Indonesia
Altafhusain B. Nadaf - University of Pune, Pune, India
Amy Y. Rossman - Systematic Mycology & Microbiology Laboratory USDA-ARS, Beltsville, USA
Andre Schuiteman - Royal Botanic Gardens, Kew, UK
Ary P. Keim - Herbarium Bogoriense, Bogor, Indonesia
Barry Conn - Royal Botanic Gardens National Herbarium of New South Wales, Sydney, Australia
Dato' Abdul Latiff Mohamad - Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia
Daniel Potter - Department of Plant Sciences, University of California, Davis, California, USA
Deby Arifiani - Herbarium Bogoriense, Bogor, Indonesia
Ferry J. W. Slik - University of Brunei Darussalam, Brunei
Henti H. Rachmat - Conservation and Rehabilitation Research and Development Center, Bogor, Indonesia
Ian M. Turner - Royal Botanic Gardens, Kew, UK
Iskandar Z. Siregar - Bogor Agricultural University, Bogor, Indonesia
Jay H. Bernstein - Kingsborough Community College, Brooklyn, New York, USA
Jens G. Rohwer - University of Hamburg, Hamburg, Germany
Joan Pereira - SAN Herbarium, Sabah Forestry Department, Sabah, Malaysia
Kuswata Kartawinata - Herbarium Bogoriense, Bogor, Indonesia
Lars H. Schmidt - University of Copenhagen, Copenhagen, Denmark
Mark Hughes - Royal Botanic Gardens, Edinburgh, UK
Masahiro Kato - Kyoto University, Kyoto, Japan
Nuril Hidayati - Herbarium Bogoriense, Bogor, Indonesia
Ong Poh Teck - Forest Research Institute Malaysia, Kepong, Malaysia
Peter C. van Welzen - National Herbarium Netherlands, Leiden University Branch, Leiden, Netherlands
Reuben Nilus - Sabah Forestry Department, Sabah, Malaysia
Rugayah - Herbarium Bogoriense, Bogor, Indonesia
Ruth Kiew - Forest Research Institute of Malaysia, Kepong, Malaysia
Uwe Braun - Institut für Biologie Bereich Geobotanik und Botanischer Garten, Halle (Saale), Germany
Yasuaki Sato - Osaka-Sangyo University, Osaka, Japan

REINWARDTIA
Vol 14, No 1, pp: 193 − 210

FLORISTIC COMPOSITION AND STRUCTURE OF A PEAT SWAMP FOREST IN THE CONSERVATION AREA OF THE PT NATIONAL SAGO PRIMA, SELAT PANJANG, RIAU, INDONESIA

Received December 09, 2013; accepted September 25, 2014

YUSI ROSALINA
Program Studi Biologi Program Pascasarjana, FMIPA UI, Depok 16424, Indonesia & PT Sampoerna Agr Tbk., Jln. Basuki Rahmat 788, Palembang, 30127, Indonesia. E-mail: yusi.rosalina@sampoernaagro.com.

KUSWATA KARTAWINATA
Integrative Research Center. Field Museum, 1400 S. Lake Shore Drive, Chicago, Illionis, 60605-2496, U.S.A. & Herbarium Bogoriense, Botany Division, Research Center for Biology-LIPI, Cibinong Science Center, Jln. Raya Jakarta-Bogor Km. 46, Cibinong 16911, Bogor, Indonesia. E-mail: kkjak@indo.net.id

NISYAWATI
Program Studi Biologi Program Pascasarjana, FMIPA UI, Depok 16424, Indonesia.

ERWIN NURDIN
Program Studi Biologi Program Pascasarjana, FMIPA UI, Depok 16424, Indonesia.

JATNA SUPRIATNA
Program Studi Biologi Program Pascasarjana, FMIPA UI, Depok 16424, Indonesia.

ABSTRACT
ROSALINA, Y., KARTAWINATA, K., NISYAWATI, NURDIN, E. & SUPRIATNA, J. 2014. Floristic composition and structure of a peat swamp forest in the conservation area of the PT National Sago Prima, Selat Panjang, Riau, Indonesia, *Reinwardtia* 14(1): 193 – 210. — We studied the floristic composition and structure of the logged-over peat swamp forest in the PT National Sago Prima of PT Sampoerna Agro Tbk. group for future management of the conservation area that has been set aside by the company. In January - February 2012, 25 quadrats of 20 m × 20 m were laid out systematically along a transect, thus covering a sampled area of 1-ha. The results showed that the study site was a regenerating and developing secondary peat swamp forests having high plant species richness. The total number of species recorded was 73 species of 38 families, consisting of 49 species (30 families) of trees (DBH≥ 10 cm), 42 species (24 families) of saplings (H > 1.5 m and DBH < 10 cm) and 41 species (27 families) of seedlings and undergrowth. Tree density was 550 individuals/ha and total tree basal area was 18.32 m^2. The Shannon-Wiener's Diversity Index for trees was high (3.05) Two tree species with the highest Importance Values (IV) were *Pandanus atrocarpus* (IV = 45.86 %) and *Blumeodendron subrotundifolium* (22.46%). The tree families with the highest IV were Pandanaceae (45.86), Myrtaceae (40.37) and Dipterocarpaceae (39.20). Forest structure dominated by trees with a diameter below 20 cm amounting to 408 trees/ha (74.05%). D and E strata with height of less than 20 m, and density of 431 trees/ha (78.36%). Jaccard Similarity index among species, showed strong association between *Pandanus atrocarpus* and *Blumeodendron subrotundifolium* and based on this association combined with high IVs, the two parameters of species characterized the forest, hence the forest could be designated as the *Pandanus atrocarpus–Blumeodendron subrotundifolium* association. Primary forest species with high economic values were still present in the forest. Eleven species can be included in the IUCN Red List, of which *Shorea rugosa* is in the category of Critically Endangered, *Shorea teysmanniana* Endangered and *Gonystylus bancanus* Vulnerable, hence they should be protected.

Key words: High species richness, *Pandanus atrocarpus*, peat swamp forest, Riau.

ABSTRAK
ROSALINA, Y., KARTAWINATA, K., NISYAWATI, NURDIN, E. & SUPRIATNA, J. 2014. Komposisi dan struktur flora hutan rawa gambut di kawasan konservasi PT National Sago Prima, Selat Panjang, Riau, Indonesia, *Reinwardtia* 14(1): 193 – 210. — Kami mempelajari komposisi dan struktur hutan rawa gambut bekas tebangan di PT National Sago Prima milik PT Sampoerna Agro Tbk. Group untuk manajemen kedepan pada kawasan konservasi yang telah disiapkan oleh perusahaan. Pada Januari - Februari 2012, 25 kuadrat dari 20 m × 20 m dibuat secara sistematik sepanjang transek, yang menutupi kawasan contoh sebesar 1-ha. Hasil penelitian menunjukkan bahwa kawasan yang diteliti merupakan hutan rawa gambut dengan tingkat kekayaan jenis yang tinggi. Jumlah jenis yang tercatat sebanyak 73 jenis dari 38 suku, terdiri atas 49 jenis (30 suku) pohon (DBH≥ 10 cm), 42 jenis anakan (24 suku) (H > 1.5 m dan DBH < 10 cm) dan 41 jenis (27 suku) bibit dan semak. Kerapatan pohon 550 individu/ha, dan jumlah area basal pohon seluas 18.32 $m^{2.}$ Indeks Keragaman Shannon-Wiener untuk pohon cukup tinggi (3.05). Dua jenis pohon dengan Nilai Kepentingan (NK) tertinggi adalah *Pandanus atrocarpus* (NK = 45.86%) dan *Blumeodendron subrotundifolium* (22.46%). Pohon dengan

NK tertinggi adalah Pandanaceae (45.86), Myrtaceae (40.37), dan Dipterocarpaceae (39.20). Struktur hutan didominasi oleh pohon dengan diameter dibawah 20 cm sebanyak 408 pohon/ha (74.05%), strata D dan E dengan tinggi kurang dari 20 m dan kerapatan 431 pohon/ha (78.36%). Indeks Kesamaan Jaccard diantara jenis, menunjukkan adanya asosiasi yang kuat antara *Pandanus atrocarpus* dan *Blumeodendron subrotundifolium* dan berdasarkan asosiasi yang dikombinasi dengan NK yang tinggi. Oleh karena itu kedua parameter tersebut dapat digunakan untuk mengkarakterisasi hutan tersebut, maka hutan tersebut dapat dilihat sebagai asosiasi antara *Pandanus atrocarpus-Blumeodendron subrotundifolium*. Jenis-jenis yang tumbuh di hutan primer dan mempunyai nilai ekonomi yang tinggi masih ditemukan. Sebelas jenis dapat digolongkan masuk kedalam IUCN Red List, dimana *Shorea rugosa* berada dalam kategori terancam punah, *Shorea teysmanniana* dalam kategori terancam dan *Gonystylus bancanus* dalam kategori rentan, sehingga jenis-jenis tersebut perlu dilindungi.

Kata kunci: Hutan rawa gambut, kekayaan jenis yang tinggi, *Pandanus atrocarpus*, Riau.

INTRODUCTION

The peat swamp forest in Indonesia covers a total area of 20.6 million hectares or 10.8% of the total land area of the country. In the Riau Province it is the most important and main ecosystem, covering about 7.2 million hectares or 45% of the total land area of the province (Wahyunto *et al.,* 2005). The National Sago Prima Company (PT NSP), a sago plantation company located in the Kepulauan Meranti Regency in the Riau Province, within its concession area, has set aside a conservation area covering a total area of 2,088 hectares of forest. It consists of logged-over peat swamp forest and was initially part of the production forest concession area of the PT. National Timber and Forest Product (PT. NTFP). This conservation area is considered important for sustainable use of peat land as sago plantation. It could contribute to the preservation, maintenance and improvement of biodiversity of the peat swamp forest in the region.

To date there has been no ecological studies in the secondary swamp forest developed after logging, which is very important and interesting (Kartawinata, 2005). Earlier vegetation studies on peat swamp forests in Sumatra were undertaken by Anderson (1976), Sambas *et al.* (1994), Purwaningsih & Yusuf (1999), Mogea & Mansur (1999), Istomo (2002), Siregar (2002), Saharjo & Nurhayati (2007), Partomihardjo *et al.* (2011), and Purwaningsih (2011).

For the purpose of developing a management scheme of the conservation area, the company needs to secure field biodiverity data. In this respect a study on the floristic composition and structure of the peat swamp forest in the conservation area was initiated and reported in this paper. Such data are important for measuring the suitability and the priority of conservation (Keel *et al.,* 1993) and are also important to maintain the carbon balance and other environmental functions (Istomo *et al*., 2009).

METHODS

The study was undertaken from January to February 2012 at one of the peat swamp forest strips dividing the sago plantation of the PT. National Sago Prima (PT NSP), a subsidiary of the PT Sampoerna Agro Tbk. The strips have been designated as the conservation area. The plantation is located at Selat Panjang, the Tebing Tinggi District, Kepulauan Meranti Regency, Riau Province at 0°31 S - 1°08' N and 101°43' - 103°08' E, with the altitude of 0-50 m asl.

The study site (Fig. 1) is part of the peat swamp forest that forms a corridor of 300 m wide extending for 40 km from south-east to north-west along the northern border of PT NSP. It was a forest concession selectively logged during the periods of 1974–1994 and 1995–2003 by the PT National Timber and Forest Product (PT NTFP). It was further converted into the Industrial Timber Estate and then into the sago industrial forest plantation. The area was also illegally logged by local community in 2000-2005.

The topography is more or less flat with the slope of 0-8 %. In the Schmidt dan Ferguson (1951) scheme, the rainfall at the site belongs to the rainfall type B with the ratio of the number of dry months over the nunber of wet months, Q = 33.3%. The annual rainfall is 1966 mm. The total rainfall on the year 2008 at Kota Selat Panjang, the capital of the Kepulauan Meranti Regency was 1409 mm with the total rain days of 65 (RKU NSP 2010), meanwhile the normal rainfall data of 28 years was 2395 mm (Berlage, 1949) (Fig. 2). In the USDA (1975) classification, the soils of the area belong to Tropohemists and Troposaprists (peat soil), and Tropaquents (PT National Sagu Prima, 2010).

The study site was sampled with 25 quadrats of 20 × 20 m each, making the total area sampled of 1-ha. The quadrats were systematically laid out at 30 m intervals along a transect extending from south-east to north-west at the above-mentioned

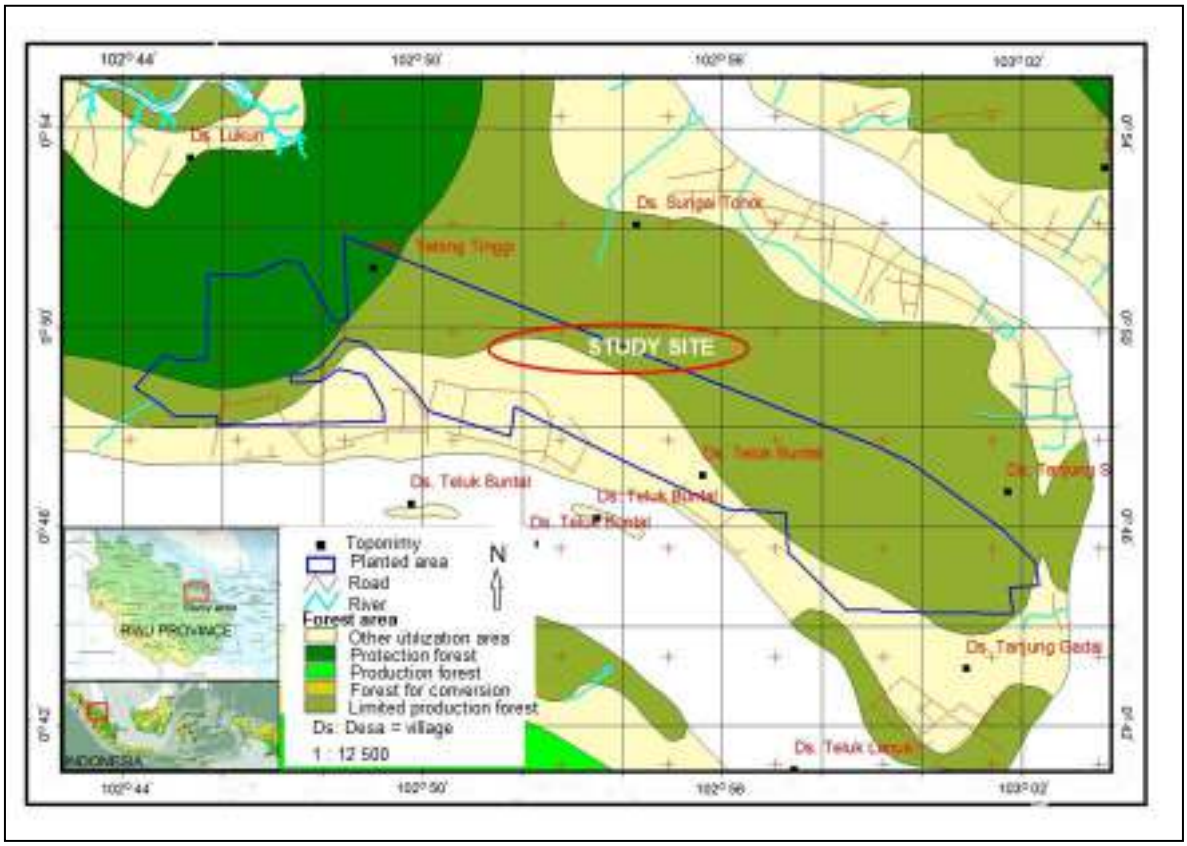


Fig. 1. A map showing the study site in a logged-over peat swamp forest at Selat Panjang, Riau.

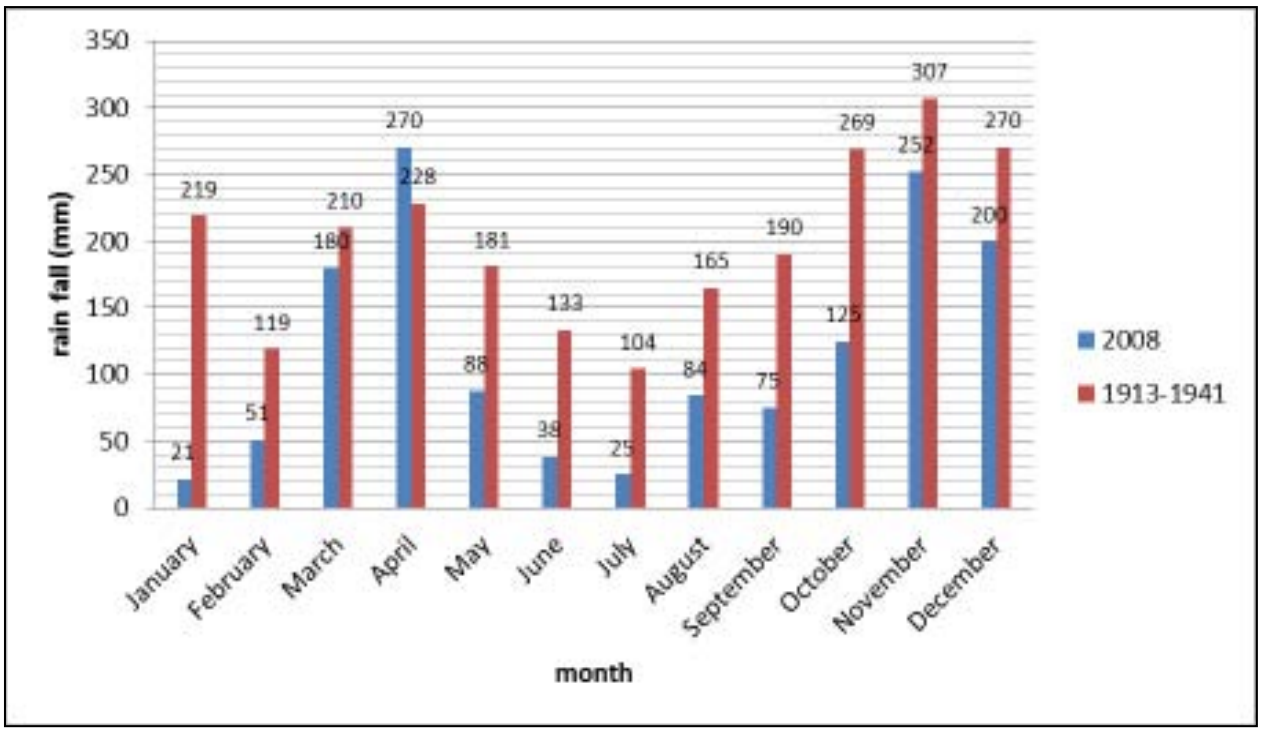


Fig. 2. The monthly rainfall Kota Selat Panjang on the year 1913–1941 and 2008 (source: Berlage, 1949 and RKU NSP, 2010).

forest corridor on the northern border of the PT NST plantation. The first quadrat was established at the coordinate of 00°48'53.5" N and 102° 53'44.3" E with the mean altitude of 16 m.

The 20 × 20 m quadrats were used to record trees with DBH (Diameter at Breast Height) ≥ 10 cm. Saplings, defined as trees with height (H) > 1.5 m and DBH < 10 cm, were enumerated in 5 × 5 m plots nested in the quadrats. All trees and saplings were indentified, their circumferences were measured at breast height (1.5 m above ground) and the numbers of stems of trees and saplings were counted. The diameter was calculated by converting the circumference using the formula Di = Circumference/3.14. The basal area (BA) of each tree and each sapling was calculated by the formula BA = 3.14 $Di^2/4$. Seedlings (defined as woody plants with more than two leaves and height of < 1.5 m) and other undergrowth species were sampled with 2 × 2 m subplots nested in the 5 × 5 m plots. The vegetation parameters of seedlings measured were number of individuals, cover, and species identity. Voucher specimens for all species were collected and identified at the Herbarium Bogoriense of the Research Center of Biology at Cibinong, Bogor.

Data analysis include the calculation of D (Density), RD (Relative Density), Do (Dominance) expressed as basal area, DoR (Relative Dominance), F (Frequency), FR (Relative Frequency) and IV (Importance Value = FR + DR + DoR) for each species of trees, saplings, seedlings and undergrowth (Cox 1967; Mueller-Dombois & Ellenberg, 1974). Shannon-Wiener's Diversity Index was calculated using the formula H' = -Σ pi ln pi, where pi = number of individuals of the species (Muller-Dombois & Ellenberg, 1974). Diversity can also be defined as richness of species and can be expressed as alpha diversity, *i.e.* diversity in individual sample units and beta diversity, *i.e.* diversity in a collection of sample units (Whittaker, 1972). On the basis of Jaccard's similarity between tree species composition of quadrats a dendrogram of quadrats was constructed using Multivariate Statistical Package (MVSP). Ordination of the quadrats was performed with Principle Component Analysis (PCA) based on dominance data using BioDiversity Professional (BDPro) software.

RESULTS AND DISCUSSION

Floristic composition

In the sampled area we registered 73 species and 38 families of trees, saplings and seedlings. For the trees we recorded 49 species and 30 families represented by 550/ha stems and a total basal area of 18.321 m^2/ha (Table 1 and Appendix 1). Meanwhile, in the sapling stage 42 species and 24 families were recorded with the total number of individuals of 6128/ha and basal area of 6.07 m^2/ ha in the seedling stage and undergrowth, we recorded 41 species of 27 families with a density 8576 individuals per hectare. The tree stand characteristics are summarized in Table 1.

The curve shows that the number of species increases steadily with the increase of cumulative area of the quadrats until it reaches the area of about 0.9 ha. Thereafter it levels off, indicating roughly the minimum area of 1 hectare and also the low species richness. This is due to the fact that the forest is a selectively logged-over forest, composed of the mixture of residual and regenerating primary forest species and invading secondary forest species filling up the gaps resulted from the logging. It is comparable to the species-area curve of the dryland secondary forest in East Kalimantan (Riswan, 1982). It differs, however, from the species-area curve of a dryland primary forest, where at 1-ha the species still increases sharply without any indication of declining (Kartawinata, 2005). The present study in 25 quadrats with a total area of 1-ha can be considered sufficient to represent the floristic richness of the selectively logged peat swamp forest in the area.

Table 2 shows that the data of other studies in both primary and secondary forests elsewhere (Mirmanto *et al.,* 1993; Purwaningsih & Yusuf, 1999; Sambas *et al.,* 1994) are relatively comparable to our data. Earlier investigation in the vicinity of the present study area (Wibowo,

Table 1. Stand characteristics of a 1-ha plot in a logged-over peat swamp forest at Selat Panjang, Riau.

Stand characteristics	Dipterocarps	Non-Dipterocarp	Total
Number of tree species	2 (4.08 %)	47 (95.92 %)	49
Tree density (stems/ha)	32	518	550
Mean tree density per quadrat	1.24	20.72	22
Tree basal area (m^2/ha)	4.67 (25.5%)	13.65 (74.5 %)	18.32
Mean basal area per tree (m^2/ha)	0.15	0.26	0.33

1995) recorded much poorer species, ranging from 34 to 41 species in 2.5 hectare. In the present study, about 38 years after logging, the forest has been regenerating and developing into a structurally more complex forest dominated by primary forest species and only a few secondary forest species were recorded, *i.e. Archidendron borneense, Ficus sundaica, Macaranga caladifolia, M. triloba*, *Pandanus atrocarpus, Pimeleodendron griffithianum* and *Timonius flavescens*. Canopy gaps created by fallen and uprooted trees were common. We recorded 251 uprooted trees in the entire 1 ha sampled quadrats. Furthermore, the above situation could be attributed also to the fact that at present the study site was more open than before, due to the disturbance resulted from illegal logging activities by local communities. These conditions led to the decrease of the density and dominance of trees as well as making the site more vulnerable to invasion by secondary forest species originally not present in the unlogged primary forest. The difference in the species richness could also be due to different degrees of disturbance in different primary and secondary peat swamp forests studied by various authors.

The basal area of 18.321 m^2/ha in the present study was lower than those in other peat swamp forests, ranging from 19.53 – 44.43 m^2/ha. but the density did not differ much, where elsewhere the range was 459-806 trees/ha (Table 2).

The range of alpha diversity of the tree stage was 6-14 and the beta diversity was 49. The Shannon-Wiener diversity index (H') of the community at the tree stage was 3.05, at sapling stage 2.09, and at seedling and undergrowth level 1.97. The index at the tree stage was high while those at sapling, seedling and undergrowth levels were lower. The pattern of declining diversity from upper to lower strata of a community is normal in a natural community. It may be inferred that the protected peat swamp forest of the PT NSP had a high plant species diversity value. Therefore, it should be maintained and managed properly and allowed to develop further following natural successions, which in time will lead to the diversity condition similar to that of an undisturbed community.

The species with highest IV, resulted from highest density, basal area and frequency, was *Pandanus atrocarpus*. It was a robust, big, tall and woody monocot with DBH > 10 cm, hence treated as a tree in the present study. Our observation showed that it occurred abundantly in the selectively logged and secondary forests near the study site. It thrives well and is dominant and common in primary peat swamp forests in Sumatra and Kalimantan (Ary Keim, pers. comm., 2013). Other species with high IVs included *Blumeodendron subrotundifolium Euodia aromatica* and *Syzygium lineatum*. They are common species occurring in peatswamp forests elsewhere (Anderson, 1963; 1976; Siregar & Sambas, 1999; Simbolon & Mirmanto, 1999; Purwaningsih & Yusuf, 1999; Sambas & Suharjono, 1994; Withmore, 1986).

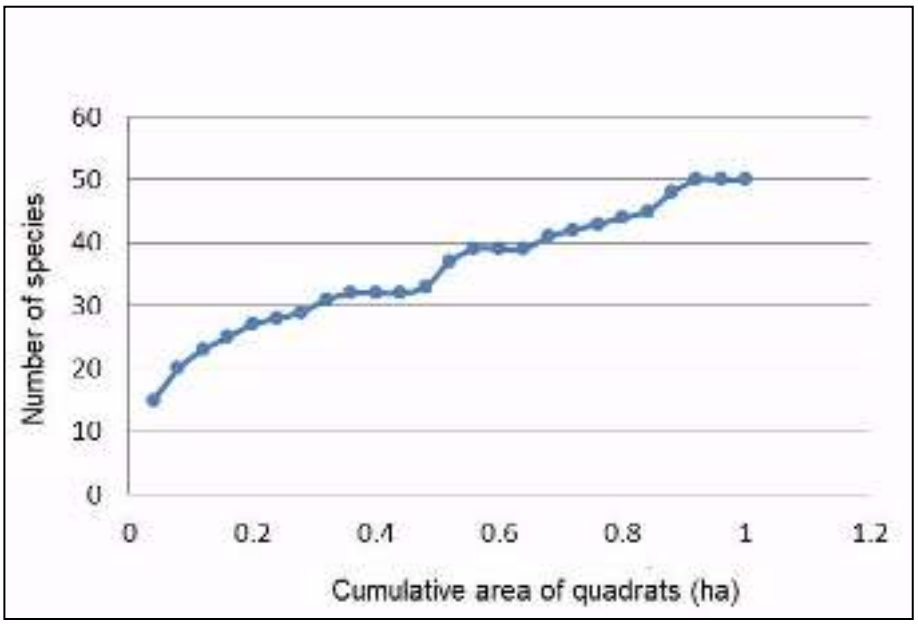


Fig. 3. Species –area curve for tree species in a total 1-ha sampled logged-over peat swamp forest at Selat Panjang, Riau.

Tabel 2. Comparison of the present study with those in peat swamp forests of Riau, Aceh and Kalimantan by various authors

Locality	Plot Size (ha)	DBH (cm)	Number of Species	Density (tree/ha)	Basal Area (m^2/ha)	References
Riau, Kepulauan Meranti , selectively logged forest	1	> 10	50	550	18.32	Present Study
Riau, Giam Siak Kecil-Bukit Batu Biosphere Reserve, Makmur, primary forest	1	>10	64	578	30.15	Partomihardjo *et al.* (2011)
Riau, Giam Siak Kecil-Bukit Batu Biosphere Reserve, Humus, primary forest	1	>10	48	556	29.75	Partomihardjo *et al.* (2011)
South Aceh, Gunung Leuser National Par, Suaq Belimbing, primary and secondary forest	1.6	> 10	44	806	44.43	Purwaningsih & Yusuf (1999)
Central Kalimantan *Vernonia-Macaranga* community, secondary forest	1.6	> 10	76	520	30.15	Mirmanto *et al.* (1993)
Central Kalimantan *Cratoxy-lum-Elaeocarpus* community, secondary forest	1.6	> 10	51	485	29.18	Mirmanto *et al.* (1993)
Central Kalimantan, *Shorea – Palaquium* community, primary forest	1.6	> 10	25	485	22.65	Mirmanto *et al.* (1993)
Sanggau, West Kalimantan, primary forest	1	> 10	60	513	17.67	Sambas *et.al.* (1994)
West Kalimantan, Sambas, primary forest	1.05	> 10	86	698	24.29	Siregar & Sambas (1999)

Tabel 3. Ten species at tree level having highest Importance Values (IV) with the associated values of Basal Area (BA), Density (D) and Frequency (F) in a 1-ha plot of logged-over peat swamp forest at Selat Panjang, Riau

No	Spesies	BA (m2/ ha)	D (trees/ha)	F (%)	IV (%)
1	*Pandanus atrocarpus*	3.79	101	0.76	45.86
2	*Blumeodendron subrotundifolium*	0.84	59	0.80	22.46
3	*Shorea teysmanniana*	2.98	14	0.32	21.69
4	*Euodia aromatica*	0.82	41	0.72	18.36
5	*Syzygium lineatum*	0.80	41	0.68	17.93
6	*Shorea rugosa*	1.69	18	0.56	17.51
7	*Diospyros javanica*	0.30	23	0.72	12.26
8	*Syzygium densiflorum*	0.60	25	0.48	12.11
9	*Tetramerista glabra*	0.79	12	0.40	10.06
10	*Knema laterifolia*	0.41	18	0.44	9.45

It is interesting to note that dipterocarp species did not constitute the dominant and only two species occurred here, *Shorea teysmanniana* and *Shorea rugosa*, which jointly had IV = 39.21%, thus trailing second after *Pandanus atrocarpus.* Table 3 shows that the two species of dipterocarps present in the sample constituted only 4% of the total number of species. In term of basal area, however they constituted 25.5% of the total basal area, due to the large size of the tree trunk with diameter range of 10-141 cm and the mean of 31.29 cm.

Myrtaceae was the richest, followed by Euphorbiaceae, Rutaceae and Sapotaceae, the rests had 2 or 1 species (Table 4; Appendix I). In terms of the importance value Pandanaceae had the highest, followed by Myrtaceae, Dipterocarpaceae, Euphorbiaceae, Rutaceae, Sapotaceae *etc*. (Table 5). Dipterocarpaceae was not the most important family in the community, occupying only the fifth in the list and was represented by *Shorea rugosa* and *S. teysmanniana*. In primary swamp forests in Sumatra and Borneo, Dipterocarpaceae is in general prevalent if not dominant in the community (Anderson, 1963, 1976; Ashton, 1982; Simbolon & Mirmanto, 1999; Whitmore, 1986). Anderson (1963) stated that *Shorea albida*, *S. platycarpa*., *S. rugosa* var. *uliginosa, S. scabrida* and *S. tesymanniana* were generally common and even dominant.

Jaccard's similarity indices among the 25 quadrats based on tree density were calculated using Multivariate Statistical Package (MVSP) to observe the degree of species compositional similarities as expressed in a dendrogram of quadrats (Fig. 4). The similarities among quadrats were mostly small, where 98.0 % of them were less than 0.5 as indicated in the dendrogram. It indicated that the forest under investigation was heterogeneous in term of floristic composition. Species diversity was relatively high, as indicated above that the Shannon-Wiener diversity index (H') was high (*i.e.* 3.05) and the range of alpha diversity was 6-14 and the beta diversity was 50. The dendrogram shows the clustering of the plots at different degree of similarities (A, B, C, D & E). This situation could be attributed to different habitat conditions of the quadrats, particularly the degrees and extent of past logging resulted in the formation of gaps of different sizes, since the habitat factors did not vary much. In each quadrat we measured that soil pH varied from 3.7 to 5.0, depth to water table from 0.8 to 2.0 m, organic carbon from 34.8 to 58.3% and nitrogen from 0.76 to 1.20%.

Jaccard's similarity index for distribution of species with frequency of greater than 50 % is presented in Fig. 5. *Pandanus atrocarpus* and *Blumeodendron subrotundifolium* had the highest degree of similarity of distribution in the quadrats (Jaccard Index of 0.64). Other species with relatively high similarities of distribution (Jaccard's Index of 0.50) were *Euodia aromatica*, *Diospyros javanica*, *Syzygium lineatum* and *Shorea rugosa*. *Pandanaus atrocarpus* is also a species with highest Importance Value (45.86%) followed by *Blumeodendron subrotundifolium* (22.46%).

Table 4. Ten families with highest Importance Values (IV) in a 1-ha plot of logged-over peat swamp forest at Selat Panjang, Riau.

No	Family	Number of species	IV (%)
1	Myrtaceae	7	40.37
2	Euphorbiaceae	4	36.79
3	Rutaceae	4	23.57
4	Sapotaceae	4	12.21
5	Dipterocarpaceae	2	39.21
6	Ebenaceae	2	14.67
7	Myristicacea	2	14.05
8	Pandanaceae	1	45.86
9	Theaceae	1	10.06
10	Hypericaceae	1	8.39

Based on the similarity of distribution and high importance values the two species could be used as character species for naming the community as *Pandanus atrocarpus-Blumeodendron subrotundifolium* association.

The decreasing number of species, density, basal area and frequency was definitely atributed to the selective logging activities in the early years followed by illegal logging in the later years. Dipterocarp species were the prime targets for selective logging operations as they were the most valuable trees economically. In selective logging practices trees with DBH ≥ 50 cm were extracted and later often times re-logging and illegal logging took place harvesting any residual trees of different sizes thought to have commercial values. Thus, the existing population of dipterocarp species in the present study were residual trees that have been growing since the time of last logging in 1974-1975 and 1984-1985 (Wibowo, 1995).

We observed the difference in species dominance in the primary and in logged-over forests in the same locality of the present study area compared to the conditions reported 17 years ago. Wibowo (1995) recorded that the prevalent species in the primary forest included *Calophyllum inophyllum, Cratoxylum arborescens, Shorea*

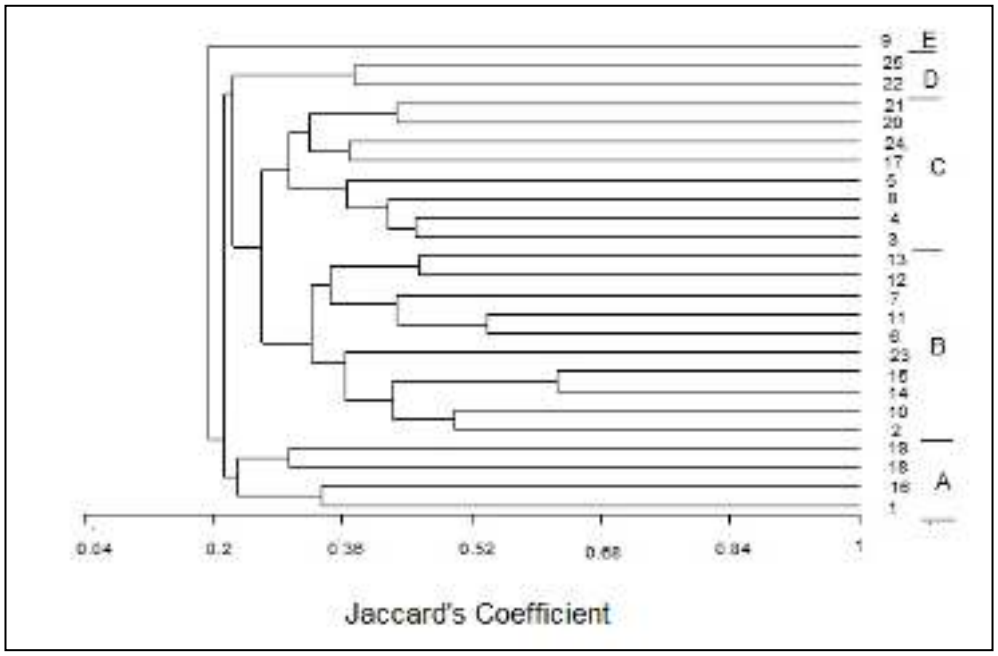


Fig. 4. Dendrogram of the 25 quadrats. constructed using Jaccard's similarity indices based on the species density in a 1-ha plot of logged-over peat swamp forest at Selat Panjang, Riau.

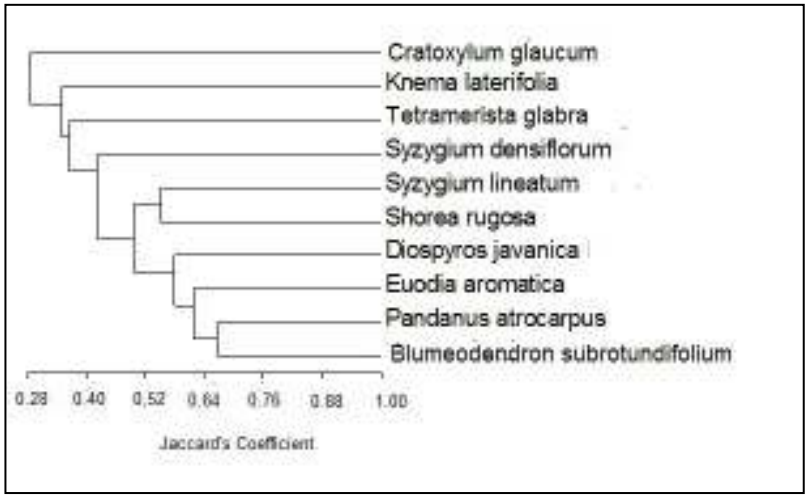


Fig. 5. Dendrogram of 10 tree species (F > 0.5), constructed based on Jaccard's similarity using tree density data in a 1-ha plot of logged-over peat swamp forest at Selat Panjang, Riau.

Table 5. Habitat data at the research site of a 1-ha plot of logged-over peat swamp forest at Selat Panjang, Riau.

Air temperature	23.8 – 30.6 ºC	Ca	0.43 – 2.85 ppm
Air humidity	66 – 98 %	Mg	3.61 – 5.04 ppm
Light intensity	54 – 9200 lux	K	0.20 – 0.33 ppm
Soil moisture	60 –86 %	Na	1.12 – 2.43 ppm
Depth to the water surface	0.8 – 2 m	CEC	41.3 – 82.9 cmol(+)/kg
Depth of peat	5 m – 6 m	Al	0.09 – 0.23 ppm
Soil pH	3.3 – 4.1	H	0.95 – 2.73 ppm
Organic C	34.1 – 58.3 %	Mn	10.1 – 28 ppm
Total N	0.76 – 1.53 %	Zn	2.51 – 11.5 ppm
C/N	36.7 – 45.4 %	Cu	1.68 – 4.99 ppm
Available P	10.5 – 29.8 mg/kg	Fe	170 – 410 ppm

Tabel 6. The conservation status of tree, sapling and herb species according to categories in IUCN Red List (ver. 2.3) in a 1-ha plot of logged-over peat swamp forest at Selat Panjang, Riau.

No	Species	IUCN Category
1	*Acronychia porteri*	Lower Risk/Conservation Dependent
2	*Aglaia macrocarpa*	Lower Risk/Near Threatened
3	*Brackenridgea palustris*	Lower Risk/Near Threatened
4	*Gonystylus bancanus*	Vulnerable A1cd
5	*Hanguana malayana*	Lower Risk/Least Concern
6	*Horsfieldia crassifolia*	Lower Risk/Near Threatened
7	*Maranthes corymbosa*	Lower Risk/Least Concern
8	*Nepenthes ampullaria*	Lower Risk/Least Concern
9	*Shorea rugosa*	Critically Endangered A1cd, C2a
10	*Shorea. tesymanniana*	Endangered A1cd
11	*Vatica rassak*	Lower Risk/Least Concern

parvifolia and *Shorea uliginosa*, while in the logged-over forest were *Calophyllum inophyllum*, *Campnosperma macrophyllia*, *Cratoxylum arborescens, Koompassia malaccensis*, *Palaquium burckii*, *Shorea parvifolia* and *S. uliginosa*. Today only *S. rugosa* var. *uliginosa* still remained. Other species could have been completely removed during the logging operations and illegal logging activities and were unable to regenerate in the large open gaps created by logging.

In the present study site we still observed economically valuable tree species with high importance values, such as *Shorea teysmaniana* and *S. rugosa*, *Gonystylus bancanus*, *Calophyllum canum*, *Campnosperma coriaceum*, *Cratoxylum glaucum*, *Dialium indum*, *Archidendron borneense*, *Palaquium ridleyi*, *P. gutta*, *P. walsurifolium* and *Tetramerista glabra*.

Using the IUCN (*Internasional Union for the Conservation of Nature*) Redlist, we identifed conservation status of 11 species present in the study area (Table 6). The above table shows that three species are classified as vulnerable (*Gonystylus bancanus*), critically endangered (*Shorea rugosa*) and endangered (*Shorea tesymanniana)*. Therefore, their conservation needs special attention in view of the fact that they belong to the group of most important commercial timber species, hence vulnerable to excessive exploitation. At present they occurred naturally in the unlogged and logged-over peat swamp forests, in the study area and elsewhere (Anderson, 1976).

The structure

We described the forest structure in terms of horizontal distribution, diameter class distribution

and vertical distribution. The 550 trees recorded in the quadrats were classified according to diameter classes (Fig. 6). It reveals that the majority of the trees (74.05%) were in the 10–19.9 cm diameter class and the rests were in the diameter class range of 20–99.9 cm. It indicates a condition of a developing and regenerating heavily disturbed forest. We recorded 8 (1.45%) trees with diameters of 50–79.9 cm, which were aparently the remnants of the unlogged primary forest trees.

Vertically the forest in the quadrat studied was dominated by trees with heights of less than 20 m totalling 431 trees (78.36%) (Fig. 7). They were dominated by *Pandanus atrocarpus*, *Blumeodendron subrotundifolium*, *Euodia aromatica* and *Syzygium lineatum*. Trees with the height of 20–49.9 m accounted for only 91 trees (16.55%) and were dominated by *Shorea rugosa*, *Cratoxylum glaucum*, *Tetramerista glabra* and *Palaquium ridleyi*, while those with diameters of 50–79.9 m were only 28 trees (5.09%) with *Shorea teysmanniana*, *Shorea rugosa*, *Campnosperma coriaceum* and *Gonystylus bancanus* as the dominant species. The tallest tree recorded in the study site was *Shorea teysmanniana* with the height of about 76 m. This is in line with observation of Anderson (1963) in Sarawak and Brunei, who indicated that the upper storey vegetation is dominated by species of Dipterocarpaceae. Fig. 8 shows the actual forest profile in the study site.

The carbon storage in the aboveground biomass and in the soil was also investigated in the study site and the result was reported elsewhere (Rosalina *et al.,* 2013). The total aboveground biomass and carbon storage in the research site indicate that the conservation area is a secondary peat swamp forest, with the biomass of 149.18 ton/ha and carbon stock of 70.12 ton C/ha. The aboveground biomass and carbon consisted of biomass and carbon of tree (83.97 ton/ha containing 39.47 ton C/ha, respectively), saplings (20.69 ton/ha containing 9.72 ton C/ha) and seedlings and undergrowth plants (0.03 ton/ha containing 0.01 ton C/ha), wood necromass (24.06 ton/ha containing 11.31 ton C/ha) and littter (20.44 ton/ha containing 9.61 ton C/ha). An allometric equation was developed for *Pandanus atrocarpus* providing an estimated total biomass and carbon of 5.16 ton/ha containing 2.42 ton C/ha. The underground C with the mean peat depth of 5.5 m, mean bulk density of 0.18 g/cm^3, and the mean organic C of 46.6 % was 464,895.94 ton C/ha. In the entire conservation forest area of 541 ha the total aboveground biomass and carbon

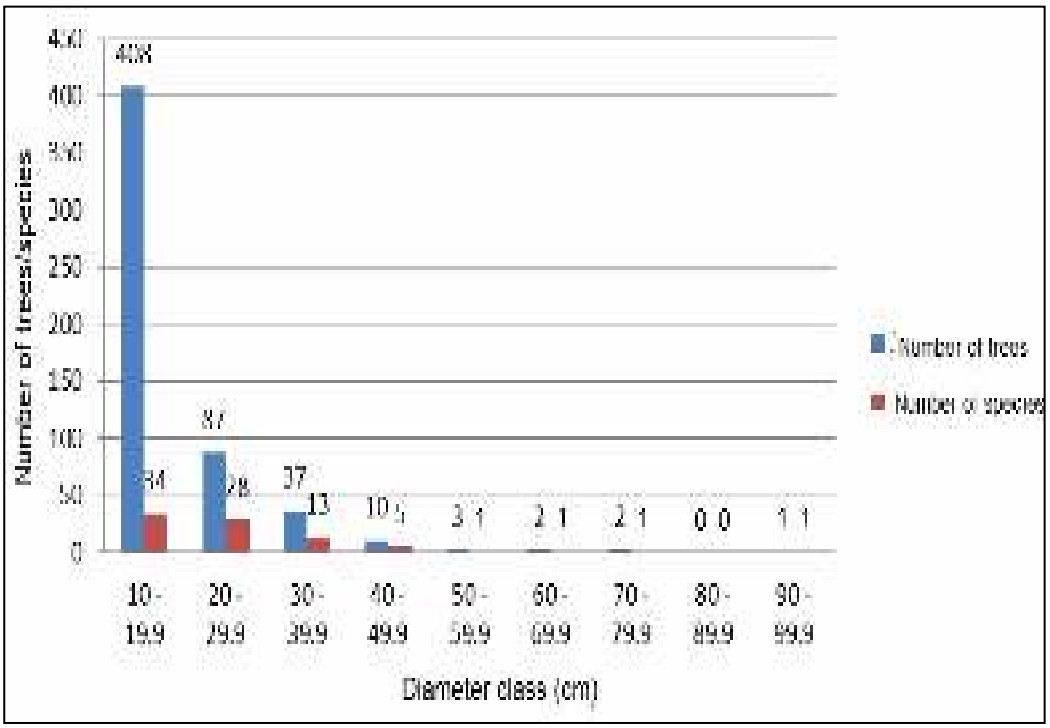


Fig. 6. Diameter class distribution of trees in 1-ha plot.

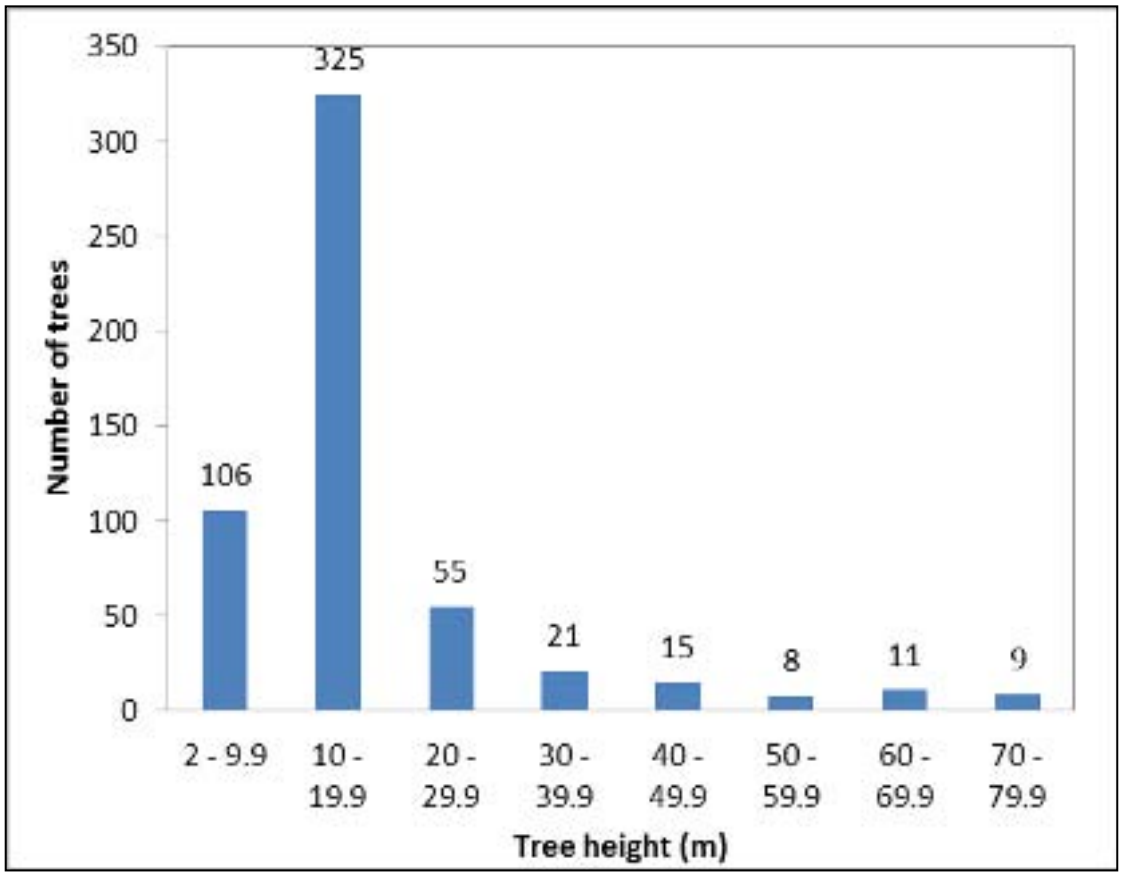


Fig. 7. Height class distribution of trees in a 1-ha plot of logged-over peat swamp forest at Selat Panjang, Riau.

Fig. 8. The profile of current logged-over peat swamp forest at the research site at Selat Panjang, Riau.

storage was estimated to be 80,708.64 ton and 37,934.00 ton C, while the total underground carbon was 238.96 million MTC.

Regeneration

We investigated the understorey stratum comprising the sapling community and the tree seedling and undergrowth community in relation to regeneration. Population structure, dominance and distribution of tree species at the sapling and seedling levels may indicate the state of regeneration of the community.

Table 7 presents the ten species with highest IV in the sapling community, Species with the highest IV (38.21%) was *Syzygium lineatum*, which was greater than that in the tree community (17.63%). Three other species with the same pattern were *Diospyros javanica*, *Knema laterifolia* and *Syzygium densiflorum*. Dipterocarps were represented by *Shorea teysmanniana* and *Vatica rassak* with IV=0.94% and 1.88% respectively, indicating poor regeneration. Considering the dominance of species and families as the regeneration indicator in the sapling community, it is predicted that in the future the protected area will be dominated by Myrtaceae (Family IV = 98.46) and Ebenaceae (Family IV = 48.32). This is comparable to the situation in the peat swamp forest of West Kalimantan (Sambas & Suhardjono, 1994; Sambas *et al.,* 1994).

In the seedling and undergrowth community we recorded 42 species of seedlings consisting of 34 species of tree seedlings and 8 herb and fern species. The herb and fern species were: *Hanguana malayana*, *Medinilla crassifolia*, *Micrechites serpyllifolius*, *Nepenthes ampullaria*, *Nephrolepis hirsutula*, *Psychotria sarmentosoides*, *Stenochlaena palustris* and *Tinomiscium phytocreniodes*.

The seedling and undergrowth stratum in the quadrats were dominated by a fern species *Nephrolepis hirsutula* with IV of 76.27% (Table 8; Fig. 10a). The dominant occurrence of this fern species was related to the substantial presence of fallen trees, left from the previous selective logging activites some 39 years ago. They are at present lying on the forest floor at different states of decomposition (Fig. 11). On the average each quadrat contained 10.6 fallen trees, with the smallest number (2) was recorded in quadrat no. 3 and the highest (43) in the quadrat no. 22. The fallen trees created large gaps, allowing light entering the forest floor, stimulating light demanding species to thrive well and abundantly, such as *Nephrolepis hirsutula*. This is in agreement with Richards (1996) who stated that in tropical forests, herbs occur abundantly only in natural or man-made open areas, but are sparse and even absent under the shade. Another herbaceous species common in peat swamp forest floors is *Nepenthes ampullaria*. It grows as a creeper on very poor soils and occurred in the quadrats with. somewhat high IV (11.54%). It occurs in the peat swamp forest of West Kalimantan (Mogea & Mansur, 1999) and it climbs over trees in open peat swamp forests (Anderson, 1963).

Table 7. Ten sapling species with highest Importance Values (IV) in a 1-ha plot of logged-over peat swamp forest at Selat Panjang, Riau.

No	Species	Family	IV (%)
1	*Syzygium lineatum*	Myrtaceae	38.22
2	*Diospyros javanica*	Ebenaceae	32.70
3	*Ilex pleiobrachinata*	Aquifoliaceae	28.45
4	*Timonius flavescens*	Rubiaceae	21.22
5	*Knema laterifolia*	Myristicacea	16.64
6	*Syzygium densiflorum*	Myrtaceae	15.18
7	*Syzygium acuminatissimum*	Myrtaceae	15.11
8	*Elaeocarpus ovalis*	Elaeocarpaceae	14.72
9	*Tristaniopsis obovata*	Myrtaceae	13.24
10	*Diospyros siamang*	Ebenaceae	10.43

Table 8. One undergrowth and nine tree seedling species with highest Importance Values (IV) in a 1-ha plot of logged-over peat swamp forest at Selat Panjang, Riau.

No	Species	Family	IV (%)
1	*Nephrolepis hirsutula*	Davalliaceae	76.27
2	*Calophyllum canum*	Clusiaceae	11.72
3	*Nepenthes ampullaria*	Nepenthaceae	11.54
4	*Syzygium lineatum*	Myrtaceae	11.35
5	*Syzygium acuminatissimum*	Myrtaceae	6.44
6	*Psychotria sarmentoides*	Rubiaceae	5.68
7	*Ilex pleiobrachinata*	Aquifoliaceae	5.30
8	*Archidendron microcarpum*	Fabaceae	4.70
9	*Diospyros* sp.	Ebenaceae	4.52
10	*Tristaniopsis obovata*	Myrtaceae	4.35

Table 9 shows the species with good regeneration, which will remain in the community and three of them were just beginning to invade the comunity, *i.e. Archidendron microcarpum, Diospyros* sp. and *Ilex pleichiobrachiata*. Species having most abundant regeneration at seedling stage were *Calophyllum canum* and *Syzygium lineatum* (Table 9).

In all the quadrats we recorded the following 14 tree species with poor regeneration at sapling and seedling stages *i.e. Aglaia macrocarpa*, *Beilschmiedia maingayi*, *Dillenia excelsa*, *Gonystylus bancanus, Horsfieldia crassifolia*, *Ilex wallichii*, *Macaranga triloba*, *Palaquium walsurifolium*, *Pimelodendron griffithianum*, *Polyalthia glauca*, *Shorea rugosa*, *Syzygium attenuatum*, *Tetractomia holttumii* and *Tetramerista glabra*. They were all likely on the way out leaving the community.

Six woody species present at the seedling stage but absent at the sapling and tree stages were *Archidendron microcarpum*, *Chassalia curviflora*, *Medinilla crassifolia*, *Sloetia elongata*, *Stemonurus secundiflorus* and *Sterculia coccinea*. They were just invading the community and would eventually establish themselves as members of the community provided there were no severe disturbances. Meanwhile, six species that were recorded in the sapling stage but absent in the tree and seedling stages included *Chaetocarpus castanocarpus*, *Diospyros maritima*, *Horsfieldia glabra*, *Syzygium fastigatum*, *Tristaniopsis whiteana* and *Vatica rassak*. They would definitely be unable to maintain themselves in the community.

The number of individuals in each species at tree, sapling and seedling stages are indicators of the ability of a forest to reproduce itself and to maintan its survival, stability and sustainability. A stable forest ecosystem would have optimum density and the individuals of each species are normally well spread along diameter classes. Tree density is categorized optimum if growth factor and space availability is optimally used and the diameter distribution form an inverted J-shape. Allowing a disturbed forest to grow naturally without disturbance will promote natural succession gradually leading to a forest similar to its original conditions. Natural succession, however, requires a very long time. It requires many years for soil organic matter to return to pre-disturbance condition. The rate of succession depends on the degree, intensity and frequency of disturbances, climate, habitat and availability of propagules surounding the disturbed community. The restoration method by means of exploiting and using as much natural processes and natural plant resources as possible to assist natural successions to proceed faster, is one of the most effective, efficient and fastest to revert the degraded forests to conditions similar to original forests.

Table 9. Tree species with highest regeneration in a 1-ha plot of logged-over peat swamp forest at Selat Panjang, Riau.

No	Species	Family	Seedlings per ha	Saplings per ha	Trees/ha)		
					D = 10-19.9 cm	D = 20-29.9 cm	D = 30-39.9 cm
1	*Syzygium lineatum*	Myrtaceae	320	992	35	4	2
2	*Calophyllum canum*	Clusiaceae	352	16		1	4
3	*Syzygium densiflorum*	Myrtaceae	16	336	20	3	2
4	*Knema laterifolia*	Myristicacea	16	256	15	3	
5	*Eugenia clariflora*	Myrtaceae	16	256	9	2	
6	*Blumeodendron subrotundifolium*	Euphorbiaceae		144	58	1	
7	*Diospyros javanica*	Ebenaceae	64	576	22	1	
8	*Elaeocarpus ovalis*	Elaeocarpaceae	32	576	3		
9	*Timonius flavescens*	Rubiaceae	16	608	1		
10	*Diospyros siamang*	Ebenaceae	32	224	4		
11	*Syzygium acuminatissimum*	Myrtaceae	144	256	2		
12	*Ilex pleiobrachiata*	Aquifoliaceae	128	576			
13	*Archidendron microcarpum*	Fabaceae	240				
14	*Diospyros* sp.	Ebenaceae	224				

a b

Fig. 10. The undergrowth communities in the study site within the logged-over peat swamp forest were often dominated by *Nephrolepis hirsutula* (a) or *Nepenthes ampullaria* (b) .

a b

Fig. 11. Slowly decomposing fallen trees (a) and sawn timber (b) left after selective logging were encountered in the quadrats in the peat swamp forest and often invaded by herbs, particularly *Nephrolepis hirsutula*.

CONCLUSION

The study area was a developing and regenerating logged-over swamp forest with a high richness of primary and secondary forest species. This is further confirmed by the horizontal and vertical forest structures which were dominated by trees with diameter of less than 20 cm and height of less than 20 m. A few dipterocarp species typicaly dominating primary peat swamp forests were still present but were not dominant. The dominant species was a tree monocot *Pandanus atrocarpus* along with a woody tree *Blumeodendron subrotundifolium.* The two species showed a strong association and had highest importance values, justifying to designate them as character species for naming the forest as the *Pandanus atrocarpus – Blumeodendron subrotundifolium* association.

Based on families at the tree stage and regeneration it is predicted that in the future the peat swamp forest in the study area will be dominated by species of Myrtaceae and Ebenaceae. The forest succession should be allowed to proceed leading to a forest similar to the original one without any disturbance. It could be assisted and enhanced by ecological restoration program through planting trees typical to peat swamp forest, particularly rare and endemic species as well as those having high conservation values, such as the ones listed in the IUCN Red List. The protected peat swamp forest of the PT NSP had a high plant species diversity value. Therefore, it should be maintained and managed properly and allowed to develop further following natural succession which in time will lead to the diversity condition similar to undisturbed community.

ACKNOWLEDGEMENTS

The study constitutes a part of the M. Sc. thesis of the first author (YR) at the University of Indonesia. The authors wish to thank the Management of the PT Sampoerna Agro Tbk for funding the study. The first author also expresses her gratitude to IPN (Indonesian Peatland Network), a collaborative program of the Indonesian Climate Change Centre (ICCC) and the Centre for International Forestry Research (CIFOR), for providing her a grant under the Financial Support for Publication initiative.

REFERENCES

ANDERSON, J. A. R. 1963. The flora of the peat swamp forests of Sarawak and Brunei, including a catalogue of all recorded species of flowering plants, ferns and fern allies. *Gardens' Bulletin Singapore* 20: 131–228.

ANDERSON, J. A. R. 1976. Observation on the ecology of five peat swamps in Sumatra and Kalimantan. In: Proceedings of a Seminar on Peat and Podsolic Soils and Their Potential for Agriculture in lndonesia, Tugu, October 1976. Soils Research lnstitute, Bogor. Pp. 45–55.

ASTHON, P. S. 1982. Dipterocarpaceae. *Flora Malesiana* I 9(2): 237–552.

BERLAGE, H. P. 1949. *Regenval in Indonesië*. Verhandelingen No. 37, Meteorologische en Geophysiche Dienst Koninklijk Magnetisch en Meteorologisch Observatorium, Batavia.

COX, W. G. 1967. *Laboratory manual of general ecology.* WM. C. Brown Company Publisher, USA. Pp. 165.

ISTOMO. 2002. *Kandungan fosfor dan kalium serta penyebarannya pada tanah dan tumbuhan hutan rawa gambut (studi kasus di Wilayah Bagian Kesatuan Pemangku Hutan Bagan, Kabupaten Rokan Hilir, Riau.* Program Pasca Sarjana, Institut Pertanian Bogor, Bogor. (Disertasi; In Indonesian).

IUCN 2012. IUCN Red list of threatened species. Version 2012.2. (www.iucnredlist.org). (Accessed on 07 December 2012).

KARTAWINATA, K. 2005. Six decades of natural vegetation studies in Indonesia. In: SOEMODIHARDJO, S. & SASTRAPRADJA, S. D. (Eds.), Six decades of science and scientists in Indonesia, Naturindo, Bogor. Pp. 95–140.

KEEL, S., GENTRY, A. H. & SPINZI, L. 1993. Using vegetation analysis to facilitate the selection of conservation sites in Eastern Paraguay. *Conservation Biology* 7(1):66–75.

MIRMANTO, E., SUHARDJONO, SUSIARTI, S. 1993. Struktur dan komposisi pohon hutan gambut di Kalimantan Barat. In: Prosiding Seminar Hasil Litbang SDH 14 Juni 1993, Bogor. 273–285.

MOGEA, P. & MANSUR, M. 1999. Plant diversity of peat swamp forest in Riau Province, Sumatra. In: IWAKUMA, T., INOUE, T., KOHYAMA, T., OSAKI, M., SIMBOLON, H., TACHIBANA, H., TAKAHASHI, H., TANAKA, N. & YABE, K. (Eds.). Proceedings of the International Symposium on Tropical Peat Land, 22-23 November 1999. Bogor. Pp. 191−203.

MUELLER-DOMBOIS, D. & ELLENBERG, H. 1974. *Aims and method of vegetation ecology*. John Wiley & Son, New York. Pp. 547.

PARTOMIHARDJO, T, SADILI, A. & PURWANTO, Y. 2011. Preliminary studies on structure and floristic diversity of two permanent plots in peat swamp forest Biosphere Reserve Giam Siak Kecil and Bulkit Batu, Bengkalis, Riau. In: PURWANTO, Y. & MIZUNO, K. (Eds.), Proceedings of the international workshop on sustainable management of bioresources in tropical peat swamp forest, 19 July 2011, Cibinong Science Center, UNESCO Jakarta Office & The Indonesian MAB National Committee-LIPI, Jakarta. Pp. 47–57.

PURWANINGSIH. 2011. Regeneration analysis of plant species in peat swamp forest Suaq Belimbing, Gunung Leuser National Park, South Aceh. In: PURWANTO, Y. & MIZUNO, K. (Eds.), Proceedings of the international workshop on sustainable management of bioresources in tropical peat swamp forest, 19 July 2011, Cibinong Science Center, UNESCO Jakarta Office & The Indonesian MAB National Committee-LIPI, Jakarta. Pp. 112–118.

PURWANINGSIH & YUSUF, R. 1999. Vegetation analysis of Suaq Belimbing peat swamp forest, Gunung Leuser National Park-South Aceh. In: IWAKUMA, T., INOUE, T., KOHYAMA, T., OSAKI, M., SIMBOLON, H., TACHIBANA, H., TAKAHASHI, H., TANAKA, N. & YABE, K. (Eds.). 2000. Proceedings of the international symposium tropical peat land, 22-23 November 1999. Bogor. Pp. 275–287.

PT NATINAL SAGO PRIMA. 2010. *Rencana kerja usaha pemanfaatan hasil hutan bukan kayu hutan tanaman industri (sagu) jangka waktu 10 (sepuluh) tahun periode tahun 2010 s/d 2019.* Keputusan Menteri Kehutanan No. SK.353/Menhutt-II/2008 Tanggal 24 September 2008 jo No. SK.380/Menhut-II/2009 Tanggal 25 Juni 2009. Kabupaten Kepulauan Meranti, Provinsi Riau.

RICHARD, P. W. 1996. *The tropical rain forest: an ecological study (2nd ed.)*. Cambridge University Press, London. Pp. 575.

RISWAN, S. 1982. Ecological studies on primary, secondary and experimentally cleared mixed Dipterocarp forest and Kerangas forest in East Kalimantan, Indonesia. University of Aberdeen. (Dissertation).

ROSALINA, Y., KARTAWINATA, K., NISYAWATI, NURDIN, E. & SUPRIATNA, J. 2013. Carbon stock in the peat swamp forest conservation area of PT National Sago Prima, Kepulauan Meranti, Riau. *Buletin Kebun Raya* 6 (2): 115–130. (In Indonesian).

RUIZ-JAEN, M. C. & POTVIN, C. 2010. Tree diversity explains variation in ecosystem function in a Neotropical forest in Panama. *Biotropica* 42(6): 638–646.

SAHARJO, B. H., & NURHAYATI, D. 2007. Regeneration in peat. *Jurnal Tanah dan Lingkungan* 9(1): 27–36.

SAMBAS, E. N., SUSIARTI, S. & SUHARDJONO. 1994. Struktur dan komposisi hutan gambut di Kabupaten Sanggau, Kalimantan Barat. In: Prosiding. Seminar hasil Litbang SDH, 4 April 1994. Bogor. Pp. 344–350.

SAMBAS, E. N., SUSIARTI, S. & SUHARDJONO. 1994. Struktur dan komposisi pohon hutan gambut primer dan sekunder di Kabupaten Ketapang, Kalimantan Barat. In: Prosiding seminar hasil Litbang SDH, 4 April 1994. Bogor. Pp. 351–358.

SCHMIDT, F. H. & FERGUSON, J. H. A. 1951. Rainfall types based on wet and dry period ratios for Indonesia. *Verhandelingen No. 42,* Djawatan Meteorologi dan Geofisika, Djakarta.

SIMBOLON, H. & MIRMANTO, E. 2000. Checklist of plant species in the peat swamp forest of Central Kalimantan, Indonesia. 1999. In: IWAKUMA T, INOUE, T., KOHYAMA, T., OSAKI, M., SIMBOLON, H., TACHIBANA, H., TAKAHASHI, H., TANAKA, N. & YABE, K (Eds.). Proceedings of the international symposium tropical peat land, 22-23 November 1999. Bogor. Pp. 179–190.

SIREGAR, M. 2002. Pengaruh topografi mikro terhadap vegetasi hutan gambut di Bengkalis, Riau. *Berita Biologi* 6(3): 441–453.

SIREGAR, M. & SAMBAS, E. N. 2000. Floristic composition of peat swamp forest in Mensemat-Sambas, West Kalimantan. In: IWAKUMA T, INOUE, T., KOHYAMA, T., OSAKI, M., SIMBOLON, H., TACHIBANA, H., TAKAHASHI, H., TANAKA, N. & YABE, K (Eds.). Proceedings of the International Symposium Tropical Peat land, 22 -23 November 1999. Bogor. Pp. 153–164.

WAHYUNTO, S., RITUNG, SUPARTO & SUBAGJO, H. 2005. *Sebaran gambut dan kandungan karbon di Sumatera dan Kalimantan (buku 3)*. Wetlands International-Indonesia Programme. Bogor. Pp. 254.

WHITTAKER, R. H. 1972. Evolution and measurement of species diversity. *Taxon* 21: 213-251.

WIBOWO, H. 1995. *Studi struktur tegakan dan komposisi jenis pohon pada hutan rawa gambut PT. National Timber and Forest Product I, Riau.* Jurusan Manajemen Hutan, Fakultas Kehutanan, Institut Pertanian Bogor. Bogor. Pp. 70. (Skripsi).

WHITMORE, T. C. 1986. *Tropical rain forests of the Far East*. Oxford University Press, Oxford. Pp. 352.

Appendix 1. Density (D=tree/ha), Frequency (F), Basal Area (BA=m^2), and Importance Value (IV) of tree species and family in a 1-ha plot of logged-over peat swamp forest at Selat Panjang, Riau.

Family & Species	D	F (%)	BA (m^2)	IV (%)
1. Anacardiaceae			0.22	2.81
(1) *Campnosperma coriaceum*	3	0.12	0.22	2.81
2. Annonaceae			0.01	0.60
(2) *Polyalthia glauca*	1	0.04	0.01	0.60
3. Aquifoliaceae			0.05	1.33
(3) *Ilex wallichii*	2	0.08	0.05	1.33
4. Arecaceae			0.01	1.15
(4) *Cyrtostachys lakka*	2	0.08	0.01	1.15
5. Burseraceae			0.03	0.87
(5) *Dacryodes macrocarpa*	2	0.04	0.03	0.87
6. Chrysobalanaceae			0.20	4.72
(6) *Maranthes corymbosa*	8	0.24	0.20	4.72
7. Clusiaceae			0.45	4.79
(7) *Calophyllum canum*	5	0.16	0.45	4.79
8. Daphniphyllaceae			0.29	6.80
(8) *Daphniphyllum griffithianum*	15	0.28	0.29	6.80
9. Dilleniaceae			0.10	3.23
(9) *Dillenia excelsa*	7	0.16	0.10	3.23
10. Dipterocarpaceae			4.67	39.21
(10) *Shorea teysmanniana*	14	0.32	2.98	21.69
(11) *Shorea rugosa*	18	0.56	1.69	17.51
11. Ebenaceae			0.34	14.67
(12) *Diospyros javanica*	23	0.72	0.30	12.26
(13) *Diospyros siamang*	4	0.16	0.05	2.41
12. Elaeocarpaceae			0.03	1.44
(14) *Elaeocarpus ovalis*	3	0.08	0.03	1.44
13. Euphorbiaceae			1.38	36.79
(15) *Blumeodendron subrotundifolium*	59	0.80	0.84	22.46
(16) *Macaranga caladiifolia*	19	0.32	0.23	7.55
(17) *Macaranga triloba*	1	0.04	0.11	1.17
(18) *Pimelodendron griffithianum*	15	0.20	0.20	5.61
14. Fabaceae			0.22	3.36
(19) *Archidendron borneense*	3	0.08	0.07	1.63
(20) *Dialium indum*	1	0.08	0.15	1.73
15. Hypericaceae			0.41	8.39
(21) *Cratoxylum glaucum*	16	0.36	0.41	8.39
16. Icacinaceae			0.16	3.19
(22) *Stemonurus scorpioides*	5	0.16	0.16	3.19
17. Ixonanthaceae			0.01	0.59
(23) *Ixonanthes petiolaris*	1	0.04	0.01	0.59
18. Lauraceae			0.29	6.63
(24) *Beilschmiedia maingayi*	1	0.04	0.04	0.78
(25) *Cryptocarya crassinervia* Miq .	9	0.32	0.25	5.85

Appendix 1. Density (D=tree/ha), Frequency (F), Basal Area (BA=m^2), and Importance Value (IV) of tree species and family in a 1-ha plot of logged-over peat swamp foreswt at Selat Panjang, Riau (continued).

Family & Species	D	F (%)	BA (m^2)	IV (%)
20. Moraceae			0.17	3.29
(28) *Ficus sundaica*	5	0.16	0.17	3.29
21. Myristicaceae			0.66	14.05
(29) *Horsfieldia crassifolia*	8	0.20	0.25	4.60
(30) *Knema laterifolia* .	18	0.44	0.41	9.45
22. Myrtaceae			1.81	40.37
(31) *Eugenia claviflora*	11	0.20	0.23	5.03
(32) *Syzygium acuminatissimum*	2	0.08	0.02	1.17
(33) *Syzygium attenuatum*	3	0.12	0.11	2.22
(34) *Syzygium densiflorum*	25	0.48	0.60	12.11
(35) *Syzygium inopillum*	1	0.04	0.01	0.58
(36) *Syzygium lineatum*	41	0.68	0.80	17.93
(37) *Tristaniopsis obovata*	2	0.08	0.04	1.32
23. Ochnaceae			0.01	0.59
(38) *Brackenridgea palustris*	1	0.04	0.01	0.59
24. Pandanaceae			3.79	45.86
(39) *Pandanus atrocarpus*	101	0.76	3.79	45.86
25. Rubiaceae			0.01	0.59
(40) *Timonius flavescens*	1	0.04	0.01	0.59
26. Rutaceae			0.89	20.92
(41) *Euodia aromatica*	41	0.72	0.82	18.36
(42) *Acronychia porteri*	4	0.16	0.07	2.56
27. Sapotaceae			0.52	12.21
(43) *Palaquium gutta*	6	0.20	0.14	3.64
(44) *Palaquium ridleyi*	12	0.24	0.25	5.69
(45) *Palaquium walsurifolium*	1	0.08	0.10	1.42
(46) *Payena leerii*	3	0.08	0.04	1.46
28. Sterculiaceae			0.10	2.00
(47) *Sterculia gilva*	4	0.08	0.10	2.00
29. Theaceae			0.79	10.06
(48) *Tetramerista glabra*	12	0.40	0.79	10.06
30. Thymelaeaceae			0.49	5.56
(49) *Gonystylus bancanus* .	6	0.20	0.49	5.56
Total	550	11.16	18.32	300.0

INSTRUCTION TO AUTHORS

Scope. *Reinwardtia* is a scientific irregular journal on plant taxonomy, plant ecology and ethnobotany published in December. Manuscript intended for a publication should be written in English.

Titles. Titles should be brief, informative and followed by author's name and mailing address in one-paragraphed.

Abstract. English abstract followed by Indonesian abstract of not more than 250 words. Keywords should be given below each abstract.

Manuscript. Manuscript is original paper and represent an article which has not been published in any other journal or proceedings. The manuscript of no more than 200 pages by using Times New Roman 11, MS Word for Windows of A4 with double spacing, submitted to the editor through <reinwardtia@mail.lipi.go.id>. New paragraph should be indented in by 5 characters. For the style of presentation, authors should follow the latest issue of Reinwardtia very closely. Author(s) should send the preferred running title of the article submitted. Every manuscript will be sent to two blind reviewers.

Identification key. Taxonomic identification key should be prepared using the aligned couplet type.

Nomenclature. Strict adherence to the International Code of Botanical Nomenclature is observed, so that taxonomic and nomenclatural novelties should be clearly shown. English description for new taxon proposed should be provided and the herbaria where the type specimens area deposited should be presented. Name of taxon in taxonomic treatment should be presented in the long form that is name of taxon, author's name, year of publication, abbreviated journal or book title, volume, number and page.

Map/line drawing illustration/photograph. Map, line drawing illustration, or photograph preferably should be prepared in landscape presentation to occupy two columns. Illustration must be submitted as original art accompanying, but separated from the manuscript. The illustration should be saved in JPG or GIF format at least 350 pixels. Legends or illustration must be submitted separately at the end of the manuscript.

References. Bibliography, list of literature cited or references follow the Harvard system as the following examples.

Journal : KRAENZLIN, F. 1913. *Cyrtandraceae* novae Philippinenses I. *Philipp. J. Sci.* 8: 163-179.
MAYER, V., MOLLER, ML, PERRET, M. & WEBER, A. 2003. Phylogenetic position and generic differentiation of *Epithemateae (Gesneriaceae)* inferred from plastid DNA sequence data. *American J. Bot.* 90: 321-329.

Proceedings :TEMU, S. T. 1995. Peranan tumbuhan dan ternak dalam upacara adat "Djoka Dju" pada suku Lio, Ende, Flores, Nusa Tenggara Timur. In: NASUTION, E. (Ed.). Presiding Seminar dan Lokakarya Nasional Etnobotani II. LIP1 & Perpustakaan Nasional: 263-268. (In Indonesian).
SIMBOLON, H. & MIRMANTO, E. 2000. Checklist of plant species in the peat swamp forests of Central Kalimantan, Indonesia. In: IWAKUMA *et al.* (Eds.) Proceedings of the International Symposium on: Tropical Peatlands. Pp. 179-190.

Book : RIDLEY, H. N. 1923. *Flora of the Malay Peninsula 2.* L. Reeve & Co. Ltd, London.

Part of Book : BENTHAM, G. 1876. *Gesneriaceae.* In: BENTHAM, G. & HOOKER, J. D. *Genera plantarum 2.* Lovell Reeve & Co., London. Pp. 990-1025.

Thesis : BAIRD, L. 2002. *A Grammar of Kéo: An Austronesian language of East Nusantara.* Australian National University, Canberra. [PhD. Thesis].

Website : http://www.nationaalherbarium.n1/fmcollectors/k/Kostermans AJGH.htm). Accessed 15 February 2012.

Reinwardtia
Published by Herbarium Bogoriense, Botany Division, Research Center for Biology, Indonesian Institute of Sciences
Address: Jin. Raya Jakarta-Bogor Km. 46 Cibinong 16911, P.O. Box 25 Cibinong
Telp. (+ 62) 21 8765066; Fax (+62) 21 8765062
E-mail: reinwardtia@mail.lipi.go.id

REINWARDTIA Author Agreement Form

Title of article :

Name of Author(s) :

I/We hereby declare that:

- My/Our manuscript was based on my/our original work.
- It was not published or submitted to other journal for publication.
- I/we agree to publish my/our manuscript and the copyright of this article is owned by Reinwardtia.
- We have obtained written permission from copyright owners for any excerpts from copyrighted works that are included and have credited the sources in our article.

Author signature (s) Date

Name

REINWARDTIA
Vol. 14. No. 1.2014
CONTENTS
Page

Reinwardtia is a LIPI accredited Journal (517/AU2/P2MI-LIPI/04/2013)

Herbarium Bogoriense
Botany Division
Research Center for Biology - Indonesian Institute of Sciences
Cibinong Science Center
Jln. Raya Jakarta - Bogor, Km 46
Cibinong 16911, P.O. Box 25 Cibinong
Indonesia