Structure and Species Composition in Logged-over Swamp Forest, Bengkalis, Riau

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Abstract. Peat swamp forest is a particularly stable ecosystem. This stability may regulate well-balanced water to maintain the existence of typical flora and fauna. The present study describes the structure and species composition from three different sites namely newly logged-over swamp forest, three years old logged-over swamp forest, and four years old-logged over swamp forest in Bengkalis, Riau, Indonesia. The study sites were predominated by four structural ensembles with their strata order from the highest to lowest: emergent trees, canopy, lower ensembles, and undergrowth. The emergent trees consisted of three tree species, and the canopy included four species, lower groups covered three species, and undergrowth had two species. Overall, the three sites composed of 26 species with 24 genera and 24 families. Dendrogram based on similarity of site index showed that newly and three years old logged-over forest joined into one cluster with Euclidean distance at 38.42. Furthermore, both sites joined with four years old logged over forest forming another cluster with 489.19 Euclidean distances. Present study, therefore, showing that four years old logged-over peat swamp forest turned out to have the greatest Euclidean distance value.

1 Introduction

Swamp forests exist in areas with saturated soil water. Swamp forest is situated in the coastal regions of Sumatra, Malaya, Borneo and western New Guinea; these forests often occupy areas once covered by mangrove forests [1]. As organic matter accumulates under water logged anaerobic conditions, and the leaves develop to decrease the salt-water intrusion, inland species begin to replace mangrove forest [2]. The so-called soil litter fall is so anaerobic that bacteria cannot convert fallen leaf matter into on the forest ground humus. These litters are converted instead into peat, which continues to build up continuously through the time. As the humus accumulates, the water reservoir alters and different forest species gain dominance [3].

The freshwater and peat swamp forests have been sustained decimation in Sumatera. These forests are highly productive and have been cleared off by logging concession, illegal logging, and slash-and-burn agriculture to establish plantations and agricultural fields [4]. The primary difference between freshwater swamp forests and peat swamp forests is the lack of deep peat, and the source of water is provided riverine rainwater [4]. Freshwater swamp forests distributed on fertile alluvial soils, and the wide variety of soils is reflected in a diversity of vegetation types that ranges from grassy marshes to palm or Pandanus-dominated forest and forests similar in structure and composition to lowland rainforests [5]. Trees with buttresses, stilt roots, and pneumatophores are common in some areas [3]. Trees in freshwater swamp forests withstand prolonged periods of flooding, causing the soils to be anaerobic [4]. Pneumatophore roots, referred to as specialized respiratory structures on the roots, are commonly found on many tree species, such as *Avicennia*or *Sonneratia*thus assisting the respiration during oxygen-deficient periods [6].

Despite the fact that the importance of structure and composition of swamp forest has not been previously available, therefore the present study aimed to investigate the structure and species composition in logged-over swamp forest with their carrying occurrence durations, i.e., newly, 3 years old, and 4 years old located in Bengkalis, Riau Province, Indonesia.

2 Materials and Methods

The study was conducted at Forest Concession Right (HPH) PT. Diamond Raya Timber, Bengkalis, Riau, Indonesia. Three different sites available were chosen: newly logged-over forest (NLF), three years old logged-over forest (3LF), and four years old logged-over forest (4LF). Three plots transect of 125 X 100 m was established and biologically repeated three times. All trees with diameter at breast height (dbh) greater than 20 cm, 130 cm above ground were measured. To verify field identification, voucher specimens were used for all trees and scientific name based on Index Kewensis 2.0 (Oxford University Press). For distance and similarity measure is used from MVSP plus version 3.1 program as earlier reported [5]

3 Results and Discussions

3.1 Structure and Floristics

In the overallstudy sites covering NLF, 3LF, and 4LF, their structure couldbecategorizedinto four ensembles, namelytree layer-emergenttrees, tree layer-canopy, tree layer-lower ensembles, and lowertree layer-undergrowth[7] (Table 1). Emergent trees (i.e., furthergoing up to the canopy) comprised *Shoreauliginosa* (Dipterocarpaceae), *Palaquium hexandrum* (Sapotaceae), and *Mezzetiaparvifolia* (Annonaceae) typically. The treesspeciesbelong to the canopy structure couldreach 20-26 m in theirheight. On the other hand, the specieshabituallyobserved in the canopy structure of entirelogged-over swampforest (LF, 3LF, and 4LF) werelocated 15-19 m in heightabove the ground. The species in thiscanopy structure consisted of mainly*Parastemonurophyllus* (Chrysobalanaceae), *Gonystylusbancanus* (Thymelaeaceae), and *Tetrameristaglabra* (Tetrameristicaceae), as alsodepicted in Table 1.

Furthermore, the structure in the entirelogged-over swampforestcategorized as lowerstrata (so-calledlower ensemble) comprised mainly *Drypetes*sp., *Gynotrochesaxillaries*, *Cerberaodollam*, and *Eugenia* sp (Table 1). Meanwhile, the structure regarded as undergrowthconsisted of *Ilexcymosa* and *Adinadradumosa*. The former specieswascharacterized by deficientnutrient and growing on acid substrate soil [8].

In peat swamp forest that grew on a deeppeat layer situated in lake Pulau Besar (Riau), there are few species categorized in their structure as emergenttrees, such as *Palaquiumbuckii*, *P. ridleyi*, and *Glutaaptera*. Meanwhile, going over the top of this peat swamp forest, the so-called canopy structure was composedmainly of *Shorea*spp., *Callophylumsundaicum*, *Cratoxylumarborescens*, *Triptaniopsisobovata* and *Eugenia*species in more significant number. Meanwhile, mixed peat swamp forest growing on moderate layer contained particular species, for example, *Shoreaplatycarpa*, *Anisopteramarginata* and *Duriocarinatus*, which in all characterized the canopy-structure forest along the *Shorea* of lakePulauBesar, Riau [1].

The tree species in Tetrameristicaceae family considered as economic *T.glabra* (Punak). This tree can typically reach 19 m tall in a logged-over forest and is generally confined to fresh water peat swamp forest. Its hard and durable timber is suitable for indoor construction ceiling, flooring, beams, and door and window frame [9].

The primary tree species in Thymelaeaceae, which provides an excellent timberis *G.bancanus* (Ramin). Its white timber is highly pricede specially in the furniture industry. *G. bancanus*trees as the principal source of ram in timber grew typically in the coastal peat swamp forest. Meanwhile, in mixed swamp forest, *G. bancanus*grew as a single dominant species or might be associated with several *Shorea* species such as *S. teysmanniana* and *S.uliginosa*[9].

On the other hand, *Adinandradumosa*, under growth species that belongs Pentaphylacaceae is so small regarded as a commercial timber tree. However, its wood physically strong and resistant to insect attack. Furthermore, *A. dumosa* trees afford their tolerance in poorsoil and commonly grow in logged-over forest particularly along the roads. Their wood has been extensive uses as fuel wood. Furthermore, the species referred to as the member of Annonaceae usually exhibit their tree swith small to medium size. In the selected study sites, there grew *Mezzefiaparvifolia* (pisang-pisang) and other species which in the structural ensemble werecategorized as emergent trees. The former speciesis not uncommon, but in potential rarely abundant. Its timberis sometimes used for light interior construction, and small quantities of its are occasionally exported [9].

Table 1. Main species of selectedstudy sites in logged-over swampforest

No	Structural Ensembles	Species	Family
1.	Emergent tress	*Shoreauliginosa*	Dipterocarapaceae
		Palaquium hexandrum	Sapotaceae
		Mezzefiaparviflora	Annonaceae
2.	Canopy	*Parastemonurophyllus*	Chrysobalanaceae
		Gonstylusbancanus	Thymelaeaceae
		Shoreateysmanniana	Dipterocarpaceae
		Tetrameristaglabra	Tetrameristicaceae
3.	Lower ensembles	*Drypetessp*	Putranjivaceae
		Gynotrochesaxillaris	Rhizophoraceae
		Cerberaodollam	Apocynaceae
		Eugenia sp	Myrtaceae
4.	Undergrowth	*Ilexcymosa*	Aquifoliaceae
		Adinandradumosa	Pentaphylacaceae

3.2 Species Composition

The vegetation of swamp forest varied considerably in species composition as a response to wide variation in its soil [10]. In some areas, grassy marshes might form the natural vegetation. In other places were encountered some form of a palm or pandan-dominated species and yetothers forest type which in its structure and speciescomposition is similar to lowland forest. Few plant species were restricted in their growth to the swamp forest ecosystem, but the particular trees species theretended to be gregarious in size and to inflict species-poor associations [10].

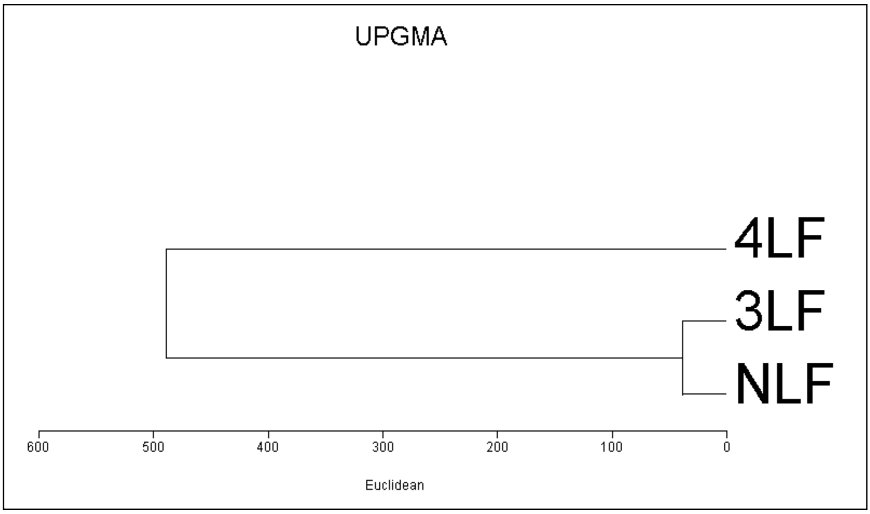
The present study site in profiles or characteristic seemed similar to lowland forest. We recorded that in NLF there were 12 species in 11 genera and 11 families of trees with their diameter at breath heights (dbhs) greater or equal to 20 cm. In that forest site,*P.hexandrum* (Sapotaceae), *P.urophyllus* (Chrysobalanaceae), *C.odollam* (Apocynaceae), *S.uliginosa* (Dipterocarpaceae), *S.teysmanniana* (Dipterocarpaceae), and *Eugenia*sp (Myrtaceae) found to be richest species. Meanwhile, in 3LF there were 16 species in 15 genera and 15 families of trees with their dbhsgreater or equal to 20 cm as well. Both *P. hexandrum* and *T. glabra* dominated this forest site. On the other hand, in 4LF, 21 species were detected in 17 families.

The study was relatedon survey on logged-over peat swamp forest in East Sumatra, taking place in three different sites, i.e. Suakandis (Jambi), Teban (Riau), and Halau (South Sumatera), the combination of dominant species in each location was as follows, situated in Suakandis: *Ganuamotleyana*, *Duriocarinatus*, *S. teysmanniana, Glutarenghas, Diospyros bantamensis,* and *Eugenia* sp; in Teban: *P. burckii, S. teysmanniana,* and *Eugenia*sp; and in Halauwas distributed:*S. parviflora, Dipterocarpuslowii, T. glabra, Macaranga triloba, S. uliginosa, Dyeralowii*[11].

Posa et al. [10] reported that in Sukalnating (West Kalimantan) the species composition prior to logging operation was dominated by *G. bancanus*, *Eugenia*sp, *Melanorrhoea*sp, *Hedyotisevenia*, *Camnosperma*sp, *D. lowii*, *Crytocarya*sp, *Tristania* sp, and *S. teysmanniana*. [11] has conducted a surveyon the composition of trees species in seven years old logged-over peat swamp forest and two years old logged-over peat swamp forest in Sei Mandar (West Kalimantan). In seven years old logged-over forest, the species were dominated by *Shoreapachyphylla, G. renghas,* and *Dactylocladusstenostachys*. On the other hand, in two years old logged-over forest was dominated by *S. pachyphylla*. The result of another research reported that the forest group Hanaut and SitirukRiver (Central Kalimantan) with the tree diameter at tree stage greater or equal to 15 cm contained 22 species in 17 families. Among of these species were *S.teysmanniana, Dipterocarpus malaanonan, Koompassiamalaccensis, Sandoricumemarginatum, D. lowii, Callophyllum grandiflora, Dactylocladossp*. [1]

3.3 Similarity Index among Study Sites

The similarity index among study sites was reflected from dendrogram that revealed the result of cluster analysis (Figure 2). Cluster analysis serves àmethod for generating classifications from a series of communityor group samples [12]. The communities maybe real or less similar to each other, and ecologists are often willing to express this similarity in term quantitative criteria, further used to classify communities associated with such similarity or relationship.



Note:
NLF = Newly logged-over forest
3LF = Three years old logged-over forest
4LF = Four years old logged-over forest

Fig. 1. Dendrogram generated from average linkage that clustered the unweighted pair-group method.

Figure 1 shows the similarity feature about the sites studied. The closer the sited are linked, then the more similar they are. The most similar pair of the site was the one between newly logged-over forest and three years old logged-over forest. Those two sites are together forming a cluster with the similarity criteria (Euclidean distance) at 38.42. Ultimately, they further combined the cluster with four years old logged-over forest at 489.19 Euclidean distances.

4 Conclusions

There were three diversity sites which have been assessed, NLF, 3LF, and 4LF. All those three sites can each be categorized into four structural tree layer, namely emergent tree, canopy, lower, ensembles, and undergrowth. 4LF peat swamp forest turned out to have the greatestEuclidean distance value, followed in decreasing order by 3LF and NLF.

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