Notes of Some Rheophytes and Riparian Species of Seed Plants in Taman Negara Kuala Tahan, Pahang

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Abstract. The wet and fast-flowed rivers in the lowland and hill forest at Taman Negara provide a suitable habitat for the rheophytes and riparian flora of seed plants. Fourteen species of rheophytes and riparian are listed and discussed in this paper, of which some taxa are locally common along the riverbanks of Sungai Tahan and Sungai Tembeling.

1. Introduction
The complex terrestrial ecosystem on earth covers many unique ecosystems from the tropical rain forest to tundra. Among them is the riparian forest which is one of the biosphere’s most complex ecological systems [1] [2]. The term ‘riparian’ derives from a Latin word ‘riparius’ meaning “of or belonging to the bank of a river” and refers to biotic communities living on the shores of streams, rivers, ponds, lakes, and some wetlands [3]. The complexity of riparian forest which has an influence on the pattern of seasonal flooding, flowing river water and fertile soils was reported in various studies such as by Naiman and Décamps [2] and Miller [4]. This forest zone has a high diversity with vascular plants species which relate to frequency of floods, topography, soils, variation in climate and disturbance scale [5].

In Peninsular Malaysia, riparian forests are the edaphic vegetation which occur in the river mouth of mangrove forest up to the montane forests [6]. The structure and composition of the forest are very complex and dependent on the influence of tide and subsidence, flow rate of river flows, tributary widths, riverbank height and diversity of flora that populate this habitat [7].

Certain species of plants have special adaptations to the wet condition and fast-flowed current stream. These species are called riparian species and rheophytes. A rheophyte is an aquatic plant that lives in fast moving water currents in an environment where few other organisms can survive.
Taman Negara Kuala Tahan, which is drained by several important rivers such as Sungai Tahan, and Sungai Tembeling, is also inhabited with many taxa of riparian and rheopytes species (Figure 1). The complete account of rheophytes in the world was given by van Steenis [8]. In this paper, we have listed some species of riparian and rheophytes which were gathered from the previous herbarium collections and our short survey along Sungai Tahan and Sungai Keniam in September 2020.

2. Materials and Methods
During the scientific expedition in September 2020, we made a short survey along Sungai Tahan and Sungai Keniam to collect the data of rheophytes and riparian species of seed plants. Then, the status of riparian and rheophytes species was confirmed from previous literature such as *Tree Flora of Malaya* [9][10][11][12], *Forester’s Manual of Dipterocarps* [6], *Rheophytes of the World* [8], *Flora Malesiana* [13][14]. We also examined the herbarium specimen lodge in the herbarium of Forest Research Institute Malaysia (KEP), herbarium of University of Malaya (KLU), herbarium of Universiti Kebangsaan Malaysia (UKMB) and herbarium of Rijksherbarium (L). Additional information from the herbarium labels such as the habits, general morphology, and occurrence of the taxa in their locality were also extracted.

![Figure 1](image1.jpg)

**Figure 1.** Riparian forest along Sungai Tahan at Taman Negara. A. The sand deposition on the riverbanks and the occurrence of lowland rain forest behind the riparian forest. B. Rocky stream bed which is suitable for certain rheophyte species such as *Ficus ischnopoda* and *Syzygium salictoides.*

3. Results and Discussion
A total 12 species of rheophytes and two species of riparian flora were listed in this study. The figures of all rheophyte species are shown in Figure 2-5 while for riparian species are shown in Figure 6. *Syzygium* comprises four species out of five species of this genus in Peninsular Malaysia which are categorized as rheophytes [15]. Another species, *Syzygium rheophyticum* is considered as very rare and only recorded in Terengganu. The species from Meliaceae, viz. *Aglaia yezermannii* and *Dysoxylum angustifolium* are two species that can grow together and greatly resemble each other in general form [8] and commonly confused in the field. But the former species have lesser stature, smaller, imparipinnate leaves with fewer leaflets, tiny flowers, and small indehiscent orange-pink fruits each with 2 seeds [14]. The latter have more stature, paripinnate leaves with more leaflets, larger flowers, and capsule splitting fruits with 2-6 seeds [13]. *Ficus ischnopoda* is solely rheophytes in genus *Ficus* [8]. This species inhabits the rocky streams as reported in previous studies in Peninsular Malaysia such as in Tembat Forest Reserve [16] and Gunung Basor Forest Reserve [17]. Based on the first author’s personal observation, this species was also found in Sungai Sedim Recreational Forest, Kedah, Gunung Tebu Forest Reserve, Terengganu and Ulu Sat Forest Reserve, Kelantan. The riparian species of
Dipterocarpus oblongifolius is common in all rivers in east coast of Peninsular Malaysia and usually leaning across the rivers. Henderson [18] reported that 87 species of epiphyte (mainly orchids and ferns) were recorded in a single stem of D. oblongifolius. The unique observation was reported by Ahmad Fitri [16] in Tembat Forest Reserve which Dipterocarpus oblongifolius trees was not found in the upper stream as a lot of rare species of Altingia excelsa trees recorded. Meanwhile, the number of A. excelsa has decreased in the lower stream whereby the D. oblongifolius is dominant. Ficus obpyramidata is also a common riparian species in Peninsular Malaysia in the lowlands to lower montane forest [19]. A study by Ahmad Fitri [20] also found out that this species is common along the riverbanks of Sungai Kuantan in Remen Cereh Forest Reserve, Pahang.

3.1 Rheophyte species
3.1.1 Aglaia yzermannii Boerl. & Koord. (Meliaceae)

Aglaia yzermannii Boerl. & Koord., Ic. Bogor. (1901) t. 87; Steenis, Rheophytes (1981) 287, t. 31; Pannell in Tree Fl. Malaya 4 (1989): 227; Kew Bull., Add. Ser. 16 (1992): 244. A. saliticifolia Ridley, J. Str. Br. Roy. As. Soc. 54 (1910): 32; Fl. Malay Penins. 1 (1922): 403; Corner, Wayside Trees 1 (1940): 457; ed. 3, 2 (1988): 496, Burkill, Dictionary (1935): 76.

**Taxon description:** A small tree 3-5 m tall with broad irregular crown. Bark pale brown. Branches from near the base, usually patent and projecting horizontally from the riverbank over the water, sometimes ascending. Twigs slender, with numerous to densely covered with brown or yellowish-brown stellate scales, especially towards the apex. Leaves 14.0-30.0 cm long, imparipinnate; leaflets blade linear, linear-lanceolate, or narrowly lanceolate, leathery, 3.0-16.0 cm x 0.5 cm –3.0 cm, slightly curved, petiolules 0.2-0.7 cm long, rachis and petiolules with few to numerous scales like those on the twigs; apex acuminate or caudate, base cuneate, glabrous or with a few scales on lower surface, particularly along the midrib secondary nerves 9-17 pairs. Male inflorescence up to 17 cm long and 12 cm wide; peduncle up to 1 cm, peduncle, rachis, branches, and pedicels with numerous to densely covered with scales like those on the twigs. Male flowers, small, c. 0.1 cm in diam.; pedicels up to 0.1 cm. Calyx densely covered with stellate scales on the outside. Petals 5; anthers 5, broadly ovate, inserted just below the margin of the tube. Female inflorescence and flowers similar to those of the male but the inflorescence smaller, flowers fewer, up to 2 mm in diam, pedicels up to 0.2 cm. Infrutescence up to 15 cm long. Fruit ellipsoid or subglobose, indehiscent, orange-brown or orange-pink during fresh, densely covered with stellate scales like those on the twigs; inner surface of pericarp pink 2.0 cm x 2.0 cm, 1-2 locules, each containing 1 seed, aril translucent.

**Distribution in Peninsular Malaysia:** Perak, Kelantan, Terengganu and Pahang.

**Habitat:** On the banks of rocky rivers. Panell [14], stated that this species is found mainly in the Malay Peninsula where it seems to be restricted to the banks of relatively deep stretches of otherwise stony, fast flowing rivers.

**Local names:** Bekak

**Uses:** According to Burkill [21], the Semang people in Kuala Lipis, Pahang, pound the leaves in cold water and use the extract to wash the body after childbirth. The arils are edible [14].

**Specimens examined:** Sungai Tahan, R.E. Holtum, SFN 20076, 23 August 1928, (KEP); Sow, KEP 41007, 18 July 1936, (KEP); E. Soepadmo, ES 867, 31 August 1970, (KEP); Mohd Shah & Ahmad Shukur, MS 2666, 14 August 1972, (KEP, SING); F.S.P. Ng, FRI 020892, 23 August 1928, (KEP); Sungai Tahan, Lata Berko, B.C. Stone, 11572, 16 August 1973, (KLU); Sungai Tahan, Lubok Simpon, B.C. Stone & M. G. Manuel, 13802, 15 July 1978, (KLU); Sungai Tahan, L.E. Teo & G. Pachiappan, KL 3145, 29 April 1975, (KLU); Sungai Tahan, Sungai Puteh, C.L. Lim et al., FRI 56379, 7 February 2007, (KEP), Sungai Tahan, Lubuk Lesong, R. Kiew, RK 2502, 2 April 1987, RK 2503, 2 April 1987, (KEP); RK 2489, 29 March 1987, (KEP); s. loc., Littke, W.R., WL 448, 2 May 1975 (UKMB), s. loc. R. Jaman, R 27, 26 April 1975 (UKMB), Sungai Tahan, A. Latiff, s.n. 25 October 1982, (UKMB); Ulu Sungai Sat, Mohd. Shah & Mohd. Noor, MS 1803, 11 July 1970, (KEP), Kuala Tahan, Sungai Teku, Mohd. Shah, MS 1341, 20 February 1968, (KEP).
Notes: The only rheophytic from *Aglaia* in Peninsular Malaysia [22]. Common along the riverbanks in Taman Negara Kuala Tahan.

3.1.2 *Calophyllum rupicola* Ridl.

*Calophyllum rupicola* Ridley Trans. Linn. Soc. 3, 4 (1893): 278; Fl. Malay Penins. 1 (1922): 182; Henderson and Wyatt-Smith, Gdn’s Bull. Sing., 1956: 346-347; Whimore, Tree Fl. Malaya 2 (1973): 168.

**Taxon description:** A much branch bush to 2 m tall without buttresses. Exudate slight, yellow coloured. Twigs 4-angled, pale brown when dry. Terminal bud narrow and pointed, minutely reddish tomentose, 0.4-0.5 cm long. Leaves narrow lanceolate, subcoriaceous, petiole short, apex acuminate, base tapered, 3.0-11.0 cm x 0.5-2.5 cm, both surfaces rather dull brown when dry, the lower surfaces paler. Venation obscure below, ridge and furrowed; midrib raised on both. Inflorescences in racemes, short and compact, few-flowered, mostly from the upper leaf-axils, rachis tomentose, pedicels slender, tomentose, flowers small, outer sepals broadly ovate acute, slightly pubescent outside, inner sepals narrowly obovate, 0.4-0.5 cm long, petals 0. Fruit small, ellipsoid-globose to globose, 0.8-0.9 cm long, on a slender pedicel, 1 cm long, orange or green during fresh, drying pale reddish, brown or bluish mauve, pericarp thin and brittle.

**Distribution in Peninsular Malaysia:** Kelantan, Terengganu, Pahang and Johor.

**Habitat:** On the banks of rocky streams and rivers east of the Main Range.

**Specimens examined:** Sungai Tahan, H.N. Ridley, 2636, 1891, (K); Sungai Tahan, Y.C. Chan, FRI 023808, 26 April 1975, (KEP); F.S.P. Ng, FRI 27017, 2 March 1977, (KEP); Sungai Tahan, Kuala Tenor, T.C. Whitmore, FRI 15985, 18 April 1971, (KEP); Mohd. Shah & Ahmad Shukor, MS 2670, 14 August 1972, (KEP); Lata Berkoh, van Balgooy, 2512, 23 April 1975, (BO); Sungai Tembeling, J. Wyatt-Smith, KEP 71945, 17 April 1973, (KEP); KEP 71944, 17 April 1954, (KEP); Chin, S.C., 1318, 3 August 1971, (KLU); F.S.P. Ng, FRI 020875, 24 February 1973, (KEP); Lata Berkoh, F.S.P. Ng, FRI 27316, 29 March 1982, (KEP); Sungai Tahan, E. Soepadmo, ES 865, 31 August 1970, (KEP); Sungai Tahan, F.G. Sow, KEP 41008, 17 July 1936, (KEP); Sungai Putih, C.L. Lim et al., FRI 56380, 7 February 2007, (KEP); Tahan Woods, Kuala Teku, T.C. Whitmore, FRI 4762, 20 February 1968, (KEP); Kuala Teku, Sungai Tahan, Mohd. Shah, MS 1330, 20 February 1968, (KEP); Kuala Tahan, Jeram Panjang, Mohd. Shah & Mohd. Noor, MS 2039, 22 July 1970, (KEP); Gunung Tahan, Y.K. Wong & J. Wyatt-Smith, W 22, February 1961.

Notes: Common along Sungai Tahan and Sungai Putih.

3.1.3 *Dysoxylum angustifolium* King

*Dysoxylum angustifolium* King, J. As. Soc. Beng. 64, ii (1895) 39; Ridley, Fl. Malay Penins. 1 (1922) 392; Corner, Wayside Trees 1 (1940) 461, t. 153; Steenis, Rheophytes (1981) 291, t. 33; Allertonia 4 (1987) 312; Corner, Wayside Trees, ed. 3, 2 (1988) 501, t. 156; Mabb. in Tree Fl. Malaya 4 (1989) 242. *Dysoxylum alliaceum* (Blume) Blume var. *laxiflorum* Ridley, Trans. Linn. Soc. Lond. II, Bot. 3 (1893) 285.

**Taxon description:** Small tree to 9 m, branching low down, bushy and straggly; bole to 10 cm DBH. Bark grey. Leafy twigs 0.4-0.8 cm diam.; buds densely adpressed fawn pubescent, with fist-shaped young leaves. Leaves 15-30 cm long, paripinnate, 4-5 pairs of leaflets, with terminal spike ca. 0.2 cm long, or its scar, glabrous. Rachis 4.5 cm, terete to angle when dried. Leaflets opposite, petiolules 0.3-0.6 cm, swollen, drying blackish, lamina very narrowly elliptic, 8.5-21.0 cm x 1.5-2.5 cm, glossy adaxially, apex acuminat bases cuneate, midrib sunken adaxially, prominent abaxially, secondary nerves ca. 10 pairs. Flowers onion-scented. Calyx ca. 0.25 cm diam., decurrent into pseudopedicel ca. 0.3 cm long, articulated with pedicel, shallowly cupular, shortly hairy without. Petals 4, linear-oblong, puberulous on both surfaces, white, valvate. Staminode glabrous, margin obscurely 8-lobed; anthers 8, glabrous. Disk cylindrical with fluted mouth, glabrous to sparingly pubescent on both surfaces. Ovary densely adpressed pubescent, style 4-angled, puberulous. Inflorescence to 1 m long. Capsules aggregated in distal part of infructescence, c. 7 cm diam., depressed-obovoid, whitish becoming pale.
purplish pink, downward-pointing, 4-valved. Seeds (1) or 2-6, plano-convex, exarillate, dangling from fruit on white strands 1-2 cm; sarcotesta bright orangered or red.

**Distribution in Peninsular Malaysia:** Kelantan, Terengganu and Pahang; endemic

**Habitat:** A common component of the neram vegetation of rivers, growing amongst the rocks and on the banks, to 300 m altitude.

**Local name:** Kulim air.

**Specimens examined:** Lata Berkoh, H.C. Ong & E. Soepadmo, Ong 151, 26 June 1990, (A, L); Sungai Tahan, Kiah, SFN 31733, 18 July 1936, (KEP); F.G. Sow, KEP 41006, 18 July 1936, (KEP); J. Wyatt-Smith, KEP 84988, 1 March 1958, (KEP); S. Mahmud & S. C. Chin, 1321, 4 August 1971, (KLU, L); Mohd. Shah, MS 1392, 22 February 1968, (KEP); F.S.P. Ng, FRI 27031, 2 March 1977, (KEP); C.M. Pannell, 1034, 5 March 1978, (KEP); Sungai Tahan, Lubok Lesong, R. Kiew, RK 2504, 2 April 1987, (KEP); Ulu Sungai Sat, Mohd. Shah & Mohd. Noor, MS 1807, 11 July 1970, (KEP); Sungai Keniyum, T.C. Whitmore, FRI 8515, 3 March 1968, (KEP); Sungai Tahan, Lubok Simpon, B.C. Stone & M.G. Manuel, 13801, 15 July 1978, (KLU); Ulu Sat, Tanjung Petir, T.C. Whitmore, FRI 15263, 12 July 1970, (KEP); Sungai Tahan, L.E. Teo & G. Pachiappan, KL 3143, 29 April 1975, (L); Sungai Tahan, Lata Berkoh, van Balgooy, 2506, 23 April 1975, (BO, L); s. loc., K.M. Wong & K. Khairuddin, FRI 32626, 18 August 1982, (KEP); Sungai Tahan, Y.C. Chan, FRI 023814, 22 April 1975, (KEP); Sungai Tahan, Chegar Anjing, T.C. Whitmore, FRI 20170, 13 June 1971, (KEP); Sungai Tahan, B.C. Stone, BCS 11570, 16 August 1973; Kuala Teku, Sungai Teku, M.Y. Chew et al., FRI 60234, 12 May 2008, (KEP); Sungai Tembeling, F.S.P. Ng, FRI 020879, 24 February 1973, (KEP); Sungai Tahan, J.W. Wyatt-Smith, KEP, 84988, 1 March 1958, (KEP); Sungai Kenyam, A. Latiff & A. Zainuddin, ALM 140, 16 Mac 1983, (UKMB); Sungai Terenggan, J. Wyatt-Smith, KEP 71956, 18 April 1954, (KEP); Kuala Tahan, Md. Haniff & Md. Nur, SFN 8098, 22 June 1922, (KEP).

**Notes:** Very common along Sungai Tahan. According to [23], the seeds are locally used as bait for fishing. Mabberley and Pannell [22] believed that the seed of this species are dispersed by fish. So, the fish flesh also has a strange flavour after ingestion of the seeds [24] [13].

### 3.1.4 Ficus ischnopoda Miq.

**Ficus ischnopoda** Miq. Ann. Mus. Ludg. 3 (1867): 229; *F. pyriformis* Hook. et Arn. Fl. Malay Penins. 3 (1923): 349; Corner. Wayside Trees (1940): 687; *F. pyriformis* var. *angustifolia* Ridley. Fl. Malay Penins. 3 (1923): 349.

**Taxon description:** Shrub 2-5 m tall, with internodes distinctly different in the length and leaves. Twigs white puberulous or glabrous. Leaves spirally arranged, sometimes subopposite or subverticillate; stalk up to 0.8 cm long; lamina narrow, lanceolate, 5.0-19.0 cm x 0.8-3.0 cm, apex pointed, base narrowed; secondary vein 7-20 pairs, tertiary vein reticulate. Figs solitary in leaf axils, pear-shaped, 1.2 cm wide, with 5-10 longitudinal ribs, stalk 0.8-2.5 cm long. green flushed pink, ripening dark red or purple, stalk 0.8 – 1.2 cm long.

**Distribution in Peninsular Malaysia:** central and north of Peninsular Malaysia.

**Habitat:** Common on rocky streams in the lowlands to montane forests.

**Local names:** Ara

**Specimens examined:** Sungai Tembeling, J. Wyatt-Smith, KEP 71946, 17 April 1954, (KEP); Gunung Tahan, Y.K. Wong & J. Wyatt-Smith, W 21, February 1961, (KEP); Sungai Tahan, Lata Berkoh, van Balgooy, 2507, 23 April 1975, (BO, L); Sungai Tahan, B.C. Stone, BCS 11568, 16 August 1973; Sungai Tahan, Mohd. Shah, MS 1401, 22 February 1968, (KEP); Sungai Tahan, F.S.P. Ng, FRI 27032, 2 March 1977, (KEP); Ulu Sungai Sat, Mohd. Shah & Mohd. Noor, MS 1818, 11 Julai 1970, (KEP); Sungai Teku, R. Kiew, RK 2490, 29 March 1987, (KEP).

**Notes:** Common in Sungai Tahan, sprawling in streambed.

### 3.1.5 Glycosmis perakensis Narayanas.

**G. perakensis** Narayanaswamy. Rec. Bot. Surv. India 14 (1941): 59.
**Taxon description:** Shrub 1-5 m tall. Leaves 10.0-20.0 cm long, rachis 5.0 -11.0 cm long, swollen at base. Leaflets 7-12, linear lanceolate, stalk 0.3-0.5 cm, lamina 4.5-10.8 cm x 0.7-0.9 cm, margin entire. Flowers small, petal greenish, ovary glabrous. Fruits to 0.4 cm x 0.3 cm, stalk 0.1 cm long, whitish turning orange or pink, drying brown.

**Distribution in Peninsular Malaysia:** Perak and Pahang; endemic.

**Habitat:** Near the streams of lowland forest.

**Specimens examined:** Sungai Tahan, Lata Berkoh, van Balgooy, 2509, 23 April 1975, (BO, L); Lata Berkoh, D. T. Jones & A. Zainuddin, 2472, 24 March 1984, (KLU, UKMB), Lata Berkoh, D. Jones, 2356, 22 September 1983, (UKMB), 2363, 22 September 1983, (UKMB), 2357, 22 September 1983, (UKMB), 2362, 22 September 1983, (UKMB), Lata Berkoh, A. Zainudin Ibrahim, AZ 1024, 22 September 1983 (UKMB), AZ 1303, 27 March 1984 (UKMB).

**Notes:** Locally common at Sungai Tahan and growing with other rheophytic Syzygium spp and Aглаia yezermanii.

3.1.6 *Hedyotis rivalis* Ridl.

Ridley, F.M.S. Mus. Vi 153; Ridley, Fl. Malay Penins. 2: 47.

**Taxon description:** A weedy herb to 1 m tall. Stem 0.2 cm, 4-angled. Stipules broad, triangular, mucronate, 0.3 cm long leaves linear lanceolate, apex acuminate, base narrowed to petiole, glabrous, subcoriaceous, 8.5 cm x 0.3 cm. Cymes dichotomous panicked, 0.2 cm long, in axillary and terminal with a few flowers at base and branches, 1.2 cm long with 3 flowers at end. Flowers white, 0.3 cm long, short pedicelled. Calyx campanulate, lobes longer than tube, ovate pubescent. Corolla cylindric, glabrous, twice as long as clayx-lobes, lobes oblong acute, pubescent. Capsule ovoid, 0.2 cm long.

**Distribution in Peninsular Malaysia:** Pahang and Johor.

**Habitat:** On rocks in river.

**Specimens examined:** Sungai Tembeling, Chin, S.C., 1339, 3 August 1971, (KLU).

**Notes:** This species is considered as rare and the only rheophyte in the genus.

3.1.7 *Homonoia riparia* Lour.

*Homonoia riparia* Lour., Fl. Cochinch. (1790): 637; Müll.Arg. in DC., Prodr. 15.2 (1866): 1023; Merr., Enum. Philipp. Fl. Pl. 2 (1923): 448; Ridl., Fl. Malay Penins. 3 (1924): 309; Burkill, Dict. Econ. Prod. Malay Penins. 1 (1935): 1186; Corner, Wayside Trees (1940): 258; Airy Shaw, Kew Bull. 26 (1971): 282; Whitmore, Tree Fl. Malaya 2 (1973): 103; Airy Shaw, Kew Bull. Add. Ser. 4 (1975): 136; Kew Bull. Add. Ser. 8 (1980): 121; Kew Bull. 36 (1981): 310; Steenis, Rheoph. World (1981): 241; Airy Shaw, Kew Bull. 37 (1982): 25; Welzen, Blumea 43 (1998): 138.

**Taxon description:** Habitat: Bush to 2 m tall. Outer bark grey-brown to red-brown, smooth to horizontally and vertically fissured; corky middle bark red; inner bark green to cream. Sapwood white, hard. Leaves: stipules 4.5- 6.0 cm x 0.5-1.0 cm, margin entire, apex acute, margin and upper surface glabrous except for some basal scale hairs, lower surface hirsute; petiole 0.4–1.2 mm long; blade elliptic to obovate, 3.5-21.0 cm x 0.5 -2.5 cm, above dark green, below silvery to whitish to glaucous, venation raised on both sides, secondary nerves 13–16. Inflorescences up to 7-10 cm long, green-yellow with a reddish tinge. Bracts 0.01 cm-0.2 cm x 0.07-0.17 cm; bracteoles 0.06-0.15 x 0.03–0.1 cm. Stamina flowers 0.4–0.5 cm in diam.; sepals ovate to elliptic, outside dark red, inside very pale reddish pink; androphore 0.3–0.5 cm high, white, connective dark red, anthers white to yellow. Pistillate flowers ca. 0.2 cm in diam.; sepals ovate, 0.1-0.2 cm x 0.04-0.1 cm, dull green tinged reddish; ovary globose, stigmas 0.1–0.4 cm long, red-brownish. Fruits 0.3-0.45 cm x 0.25-0.4 cm, yellowish red to brown or blackish; wall thin. Seeds 0.13-0.18 cm x 0.18-0.22 cm.

**Distribution in Peninsular Malaysia:** Pahang northwards.

**Habitat:** Common on river banks and in rocky (fast running) stream beds. Soil usually (temporarily) inundated, in some areas for months (van Welzen 2020). Flowers are presumably wind pollinated. The seeds are very hard and durable; they sink in water and may be transported by the river. This species bears flowers and fruits throughout the year.
Uses: In northern Perak, pounded leaves and fruits are used against skin diseases too, either in a poultice and/or as a decoction to be drunk.

Local names: champenai, kelereh, kayu suarah, mempenai, kelerai.

Specimens examined: Kuala Kenyam, van Balgooy, 2566, 28 April 1975, (BO, L); Kuala Tahan, Sungai Tembeling, S. C. Chin & S. Mahmud, 1637, 5 August 1971, (KLU, L); Sungai Kenyam, H.C. Ong & E. Soepadmo, Ong 170, 26 June 1990, (A, L); Sungai Tahan, B.C. Stone & M. G. Manuel, 13803, 15 July 1978, (KLU); Sungai Tembeling, K.M. Wong & K. Khairuddin, FRI 32639, 19 August 1982, (KEP); Sungai Tembeling, B. Everett, FRI 14470, 14 July 1970, FRI 14466, 14 July 1970, (KEP); Sungai Tembeling, F.S.P. Ng, FRI 1401, 9 August 1966, (KEP); Sungai Tahan, F.S.P. Ng, FRI 27024, 2 March 1977, (KEP).

Notes: Common in Sungai Tembeling.

3.1.8 Neonauclea pallida (Reinw. ex Havil.) Bakh.f. ssp. malaccensis (Gand.) Ridsdale
Bakh.f. Fl. Java 2 (1965): 303. Nauclea calycina sensu Corner. Waysi de Trees (1940): 552. Wong, Tree Fl. Malaya 4 (1989): 383. Nauclea purpurascens auct. non Korth. King & Gamble, J. As. Soc. Beng. 75, II (1903) 124. Nauclea purpurascens sensu K. & G., Ridley. Fl. Malay Penins. 2 (1923): 9. Neonauclea purpurascens Ridley, Fl. Malay Penins. 5 (1925)314, p.p. Nauclea malaccensis Gand., Bull. Soc. Bot. Fr. 65 (1918) 34. Risdale, Blumea 34 (1989): 199.

Taxon description: Bush to 2 m tall or becoming a small tree up to 12 m, bark grey brown, smooth. Ultimate branches. Terminal vegetative bud ovoidal, strongly flattened. Stipules usually persistent on the first 3 nodes, ovate to ellipsoidal, rarely obovate, 0.08 -0.2 cm x 0.06-0.1 cm, keeled, pubescent at base. Leaves lanceolate to elliptic-oblong, 5.0-30.0 cm x 3.0-6.0 cm, above and below glabrous, apex acute to acuminate, base acute to cuneate, less frequently rounded, secondary nerves 6-10 pairs. Petiole glabrous, up to 2.5 cm. Flowering heads solitary, axis up to 12 cm. Mature flowering heads with diameter across calyces 0.1-0.2 cm. Receptacle hairy, interfloral bracteoles present, conical. Hypanthium 0.1 cm, glabrous or with a few scattered hairs. Calyx divided almost to the base, persistent part ovate, 0.1-0.15 cm, slightly hairy, semi-persistent; upper apical portion pyriform, summit conical, orange to ochre coloured, papillate, 0.04-0.1 cm. Corolla 0.7-1.0 cm, lobes ovate, 0.1 cm, glabrous. Style exserted for 0.6-1.0 cm. Diameter across fruiting heads 2.0-2.5 cm, fruitlets 0.8-1.0 cm long, crowned by calyx remnants.

Distribution in Peninsular Malaysia: Widespread.

Habitat: Lowland to lower montane forest, often rheophytic, commonly along streams but also in forest understory and on limestone.

Uses: Unknown.

Local names: Mengkal batu

Specimens examined: Ulu Sat, Tanjung Petir, T.C. Whitmore, FRI 15259, 12 July 1970, (KEP), Sungai Tahan, Lata Berkoh, Whitmore, FRI 20175, 13 June 1971, (KEP); Sungai Tahan, E. Soepadmo, ES 868, 31 August 1970, (KEP).

Notes: Locally common in Ulu Sat.

3.1.9 Syzygium claviflorum (Roxb.) Wall. ex A.M. Cowan & Cowan var. riparium (M.R. Hend.) I.M. Turner.
I.M. Turner, Journal of the Singapore National Academy of Science 22 & 23 (1996): 18, M.R. Henderson, Eugenia claviflora var. riparia M.R. Hend., Gdn’s Bull. Sing. 12 (1949): 257, Tree Fl. Malaya 3 (1978): 187.

Taxon description: Shrub or treelet to 2 m tall. Twigs rounded or slightly angled. Leaves narrow linear lanceolate, thick 3.4-13.2 cm x 0.6-2.0 cm, stalk usually 0.8-1.0 cm long, apex shortly pointed, or blunt, base cuneate, both surfaces drying pale brown, pale greenish brown to brown, secondary nerves 12-25 pairs, rather faint above, finely to prominently distinct below, intramarginal nerve 1 mm from margin, margin recurved, tertiary nerves and reticulations faint. Flowers in condensed corymbs from twigs below
leaves, axillary or terminal; calyx trumpet-shaped after anthesis. Fruit globose to oblong globose, 0.8 cm diameter.

**Distribution in Peninsular Malaysia:** Pahang, Terengganu and Kelantan; endemic to Peninsular Malaysia.

**Habitat:** Riverbank.

**Uses:** Not known

**Local names:** There is no specific local name but called ‘kelat’ as applied for the most members of Syzygium.

**Specimen examined:** Pahang: Gunung Tahan, Y.K. Wong & J. Wyatt-Smith, W33, February 1961, (KEP).

**Notes:** Kochummen [25] mentioned that this taxon is rare and only known in Sungai Tahan (Pahang). Additional localities have mentioned by van Steenis [8] whereby this taxon was also recorded at Sg Kerbat and Sg. Terengganu in Terengganu.

3.1.10 *Syzygium foxworthianum* (Ridl.) Merr. & L.M. Perry.

Merrill, E.D. & Perry, L.M., Memoirs of the American Academy of Arts and Sciences 18 (1939): 168, Chantaranothai, P. & Parnell, J. Thai For. Bull. 21 (1994): 63, Ridley, *Eugenia densiflora* (Blume) Miq. var. *angustifolia* Ridl., Fl. Malay Penins. 1 (1922): 729, M.R. Henderson, Gdn’s Bull. Sing. 12 (1949): 79, Tree Fl. Malaya 3 (1978): 189.

**Taxon description:** Bushy small tree to 10 m tall. Twigs stout. Leaves narrow, stalk 0.6-1.3 cm, blade leathery, elliptic oblong to oblong, 4.2-18.0 cm x 2.0-4.5 cm, apex pointed, sometimes blunt, base cuneate, upper surface drying brown or reddish brown, lower pale brown, with pustular gland dots, secondary nerves 6-12 pairs, 0.5-1.0 cm apart, raised and distinct on both surfaces, intramarginal vein distinct, looped, 0.2-0.4 cm from margin, the tertiary nervation less prominent above. Flowers lax inflorescences with long pedicelled flowers, in dense terminal panicles, lobes 4, unequal. Fruit globose with rough surface, 1-2 cm diameter.

**Distribution in Peninsular Malaysia:** Perak, Kelantan, Terengganu and Pahang.

**Habitat:** Along riverbanks in lowland to montane forests.

**Uses:** Not known

**Local names:** There is no specific local name but called ‘kelat’ as applied for the most members of Syzygium.

**Specimens examined:** Pahang: Taman Negara, Sg Tembeling, Jeram Panjang, Whitmore, T.C., FRI 4914, 1 March 1968, (KEP); Sg Tembeling, Whitmore, T. C., FRI 15399, 22 July 1970, (KEP); Ng, F. S. P., FRI 20882, 24 February 1973, (KEP), B. Everett, FRI 14467, 14 July 1970; Jeram Perahu, Ulu Sungai Sepia, Mohd Shah & Mohd Noor, MS 1987, 18 July 1970, (KEP); Sg Tahan, A. Zainuddin, AZ 1038, 22 September 1983, (UKMB); Mohd. Shah & Ahmad Shukor, MS 2673, 14 August 1972.

**Notes:** Very common bush on the riverbanks of Sungai Tembeling and Ulu Sungai Sepia. In Gunung Padang, Terengganu, the fruit is eaten by fish.

3.1.11 *Syzygium graeme-andersoniae* (Ridl.) I.M. Turner.

I.M. Turner, Journal of the Singapore National Academy of Science 22 & 23 (1996): 19, Ridley, *Eugenia graeme-andersoniae* Ridl., Fl. Malay Penins. 1 (1922): 743, M.R. Henderson, Gdn’s Bull. Sing. 12 (1949): 111, Tree Fl. Malaya 3 (1978): 193.

**Taxon description:** Small trees to c. 10 m tall. Leaves blade narrow, oblong lanceolate, 8.8-15.2 cm x 2.2-3.9 cm, stalk slender 0.6-1.0 cm long apex with long tip, 0.8-2.0 cm long, base narrowed, drying greenish; secondary nerves fine, numerous, close together, intramarginal nerve fine, 1 mm from margin with another fainter loop closer to the margin, nervation faintly visible on both surfaces. Inflorescences 1.9-3.7 cm long. Flowers in terminal and axillary, sessile, stamens many, calyx somewhat ridge, lobes 4, unequal, persistent. Fruit oblong-ovoid, 1.0-1.3 cm x 0.5-0.9 cm, crowned by enlarged calyx lobes, base narrowed.

**Distribution in Peninsular Malaysia:** Kelantan and Pahang; endemic.
**Habitat:** Along riverbanks.

**Uses:** Wood is used for tops.

**Local names:** There is no specific local name but called ‘kelat’ as applied for the most members of *Syzygium*.

**Specimens examined:** Pahang: Taman Negara, Sungai Tembeling, Kuala Belau, Whitmore, T. C., FRI 8590, 7 March 1968, (KEP); Ulu Sungai Tembeling, Mohd. Shah, MS 1616, 7 March 1968; Taman Negara, Sungai Tahan, Chan, Y.C., FRI 23813, 24 April 1975, (KEP); Sungai Sat, A. Latiff, PTD 114, 23 October 1982, (UKMB); Sungai Tahan, A. Latiff & Hamid, S., ALM 393, 24 March 1984, (UKMB); Pengkalan Lata Berkoh, Razali, J., RJ 215, 26 April 1975, (UKMB).

**Notes:** Very common along Sungai Tahan. Kochummen [25] mentioned that this species is very common along the riverbanks forming a complete vegetation strip just above the water, characterized by the drooping leaves and white fruits.

### 3.1.12 *Syzygium salictoides* (Ridl.) I.M. Turner.

I.M. Turner, *Journal of the Singapore National Academy of Science* 22 & 23 (1996): 24; Ridley, *Eugenia salictoides* Ridl., Fl. Malay Penins. 1 (1922): 728; M.R. Henderson, Gdn’s Bull. Sing. 12 (1949): 82; K.M. Kochummen, Tree Fl. Malaya 3 (1978): 215.

**Taxon description:** A shrub to 2 tall with pale grey or pale brown smooth bark. Leaves blade narrow, lanceolate, leathery, 3.4-13.0 cm x 0.5-1.5 cm, stalk 0.5 cm long, apex pointed or blunt, base cuneate, secondary nerves 16-25 pairs, inconspicuous above, 1-3 mm apart, nervation faintly visible below. Flowers in terminal or axillary panicles; calyx with 3-5 mm long pseudostalk, lobes 4. Fruit globose, 0.8-0.9 cm diameter, crowned by the short calyx rim and calyx lobes.

**Distribution in Peninsular Malaysia:** Pahang and Terengganu; endemic.

**Habitat:** Common along streams.

**Uses:** Not known

**Local names:** There is no specific local name but called ‘kelat’ as applied for the most members of *Syzygium*.

**Specimens examined:** Sungai Teku, Mohd Shah, MS 1334, 20 February 1968; Sungai Tahan, Holttum, R.E., SFN 20546, 22 August 1928; Strugnell, E.J. & Soh, KEP 42944, 27 July 1936; Whitmore, T.C., FRI 15984, 18 April 1971, 13 June 1971; Sungai Tahan, Ng, F.S.P., FRI 20891, 27 February 1973, FRI 27019, 2 March 1977, FRI 27027, 2 March 1977; Chan, Y.C., FRI 23810, 22 April 1975; Lata Berkoh, Razali, J. RJ 212, 26 April 1975, A. Zainuddin, AZ 1026, 22 September 1983; Kuala Tahan, Razali, J., RJ 333, 21 April 1975; Taman Negara, Wong, K. M. & Khairuddin, FRI 32625, 18 August 1982; Willis R. Littke, WL 449, 2 May 1975; Sungai Tembeling, Ng, F.S.P., FRI 20874, 24 February 1973; Kuala Belau, Whitmore, T.C., FRI 8591, 7 March 1968; Kuala Terengganu, Wyatt-Smith, J., KEP 71949, 17 April 1954, KEP 71950, 17 April 1954.

**Notes:** Common in Sungai Teku and Sungai Tahan. In Sungai Tahan, it is a bush leaning over water.

### 3.2 Riparian species

#### 3.2.1 *Dipterocarpus oblongifolius* Blume

Blume. Mus. Bot. Ludg. Bat. 2 (1852): 36; Sloat., Bull. Jard. Bot. Btgg 3 (8) (1927): 338; Fox. Mal. For. Rec. 10 (1932): 86; Ashton. Flora Malesiana 1(9): 317.

**Taxon description:** Large tree to 20 m tall, bole gnarled and twisted, usually leaning over rivers and frequently covered with moss and other epiphytes. Twigs slender, glabrous, drying black. Bud ca. 2.0 by 0.3 cm. linear, compressed, acute. Stipules often longer than 15 x 1.5 cm, very narrow, linear or obtuse, silvery stellate-hairy on the outside, pale green and frequently tinged pink when mature. Leaves oblong-lanceolate, petiole 1.7-3.0 cm long, drying black, lamina 14.0-20.0 cm x 4.0-7.0 cm, apex gradually tapering; acumen to 1 cm long, base cuneate; secondary nerves 15-20 pairs, glabrous. Fruits calyx tube narrow, pointed at the base, hairy with wavy ridges running to the base; wing about 10-12 cm long. Racemes to 18 cm long, terminal and axillary, simple or singly branched, with distichous
flowers; bracts to 2.0 cm x 0.2 cm, linear. Calyx densely cream tomentose. Stamens 15, shorter than style; anther as long as the filament, narrowly oblong, tapering from the base into the glabrous stout appendage; shorter than anther; ovary conical, densely tomentose. tapering into the stylopodium. Fruit pedicel 1-2 mm long. Fruit calyx tube 2.0-3.0 cm x 0.7-0.9 cm, narrowly obovoid or fusiform, thin wings from neck to base; 2 longer lobes 10.0 x 1.5 cm, narrowly spatulate, obtuse, 0.3-0.4 mm wide at base, 1-nerved with 2 small lateral nerves at the base; 3 shorter lobes c. 1.0 cm x 0.3 cm. narrowly deltoid to linear, obtuse, recurved.

Distribution in Peninsular Malaysia: Mostly east of Main Range, rare in the west side of Peninsular Malaysia.

Habitat: Banks of fast-flowing rivers.

Uses: Timber but not prominent due to the poor shape of trees.

Local names: Keruing neram, Nerang

Specimens examined: Sungai Sat, Ulu Tembeling, M.R. Henderson, SFN 22087, 17 July 1929, (KEP); Lata Berkoh, L.E. Teo & G. Pachiappan, KL 3359, 6 June 1982, (SING); Ulu Sungai Sat, Mohd. Shah & Mohd. Noor, MS 1815, 11 July 1929, (KEP); Lata Berkoh, van Balgooy, 2516, 23 April 1975, (BO); Sungai Tahan, F.S.P. Ng, FRI 1430, 13 August 1966, (KEP); Kuala Sungai Teku, Sow, KEP 41034, 22 July 1936, (KEP); Sungai Teku, Md. Hamid & Md. Nur, SFN 8032, 22 June 1922, (KEP); Sow, KEP 41029, 21 July 1936, (KEP);

Notes: Leaves of seedlings are linear-lanceolate [26]. This species is so characteristic of swift-running streams in Borneo and Malaya, that Corner [27][23] gave the name Neram rivers to this type. Symington [6] stated that this species is well represented in Taman Negara. Common along riverside of Sungai Sat.

3.2.2 Ficus obpyramidata King

King. Ann. R. Bot. Gard. Cal. 1 (1888): 116, Ridl., Fl. Malay Penins. 3 (1924): 343, Corner, J. Malay. Br. Roy. As. Soc. 11 (1933): 40, Corner, Wayside Trees (1940): 685, Kochummen, Tree Fl. Malaya 3 (1978): 152.

Taxon description: Small tree to 9 m tall. Leaves; stalk 1.5-7.5 cm long, hairy; lamina obovate or nearly rhombic, 7.5-30.0 cm x 3.5-17.0 cm long, apex pointed, base cuneate and almost heart-shaped; secondary nerves 5-8 pairs, prominent below as the tertiary nerves and reticulations, margin wavy to sparsely toothed, both surfaces sparsely hairy along the midrib and nerves. Figs on the trunk and main branches, stalked, pear-shaped, 3.0-5.0 cm wide, depressed above, ripening yellow to dingy brownish ochre.

Distribution in Peninsular Malaysia: Throughout.

Habitat: Very common by rivers from lowlands to lower montane forests.

Specimens examined: Ulu Tembeling, M.R. Henderson, SFN 22046, 21 July 1929, (KEP); Ulu Sungai Sat, Mohd. Shah & Mohd. Noor, MS 1816, 11 July 1970, (KEP); Sungai Tembeling, B. Everett, FRI 14472, 14 July 1970, (KEP); Sungai Tahan, Lata Berkoh, B. C. Stone, BCS 11569, 16 August 1973, (KLU); Ulu Sungai Tembeling, Bukit Belar, Mohd. Shah, MS 1631, 7 March 1968, (KEP).
Figure 2. Herbarium collections of rheophyte from Taman Negara. A. Aglaia yzermannii. B. Calophyllum rupicola.
Figure 3. Herbarium collections of rheophyte from Taman Negara. A. *Dysoxylum angustifolium*. B. *Ficus iscnopoda*. C. *Glycosmis perakensis*. D. *Hedyotis rivalis*. 
Figure 4. Herbarium collections of rheophyte from Taman Negara. A. Homonoia riparia. B. Neonauclea pallida ssp. malaccensis. C. Syzygium claviflorum var. riparium. D. Syzygium graeme-andersoniae.
Figure 5. *Syzygium* spp around the riverbanks of Taman Negara. A. *Syzygium foxworthianum* bear flowers, a common species in Sungai Tahan. B. *Syzygium salictoides* usually growed on the rocky bed on the riverbanks, C. *Syzygium foxworthianum* from Ulu Sungai Sepia, Pahang (MS 1987); and D: *Syzygium salictoides* from Sg. Tahan, Taman Negara, Pahang (FRI 27027).
Figure 6. Riparian species around Taman Negara. A. The stand of *Dipterocarpus oblongifolius* in the riverbanks. B. The fertile herbarium specimens of *D. oblongifolius*. C. The seedling specimens of *D. oblongifolius* with stenophyll leaves. D. *Ficus obpyramidata*. 
4. Conclusion
The riparian habitat around the riverbanks of Taman Negara is inhabited by the species of rheophytes and riparian. Further studies would be needed to expand the list of the species and determine the stand structure as well as the phenology and ecological studies.

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