

The diversity of *Smilax* (Smilacaceae) in Besiq-Bermai and Bontang Forests, East Kalimantan, Indonesia

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Abstract. Sofia S, Sulistyaningsih LD. 2019. The diversity of *Smilax* (Smilacaceae) in Besiq-Bermai and Bontang Forests, East Kalimantan, Indonesia. *Biodiversitas* 20: 379-387. The genus *Smilax* has taxonomic complexity problems and spacious distribution. Taxonomic study to reveal the diversity of *Smilax* species had been done in some regions, such as America, China, Japan, Thailand, and Indonesia. However, there is lack of information of *Smilax* species diversity in Kalimantan especially in East Kalimantan which lies in Sundaland biogeographic. This study was carried out to explore and record the diversity of *Smilax* species including the ecological and environmental data in Besiq-Bermai and Bontang forests in East Kalimantan, Indonesia. This research conducted on February and August in 2012 and July-August 2015 using exploration methods. Purposive random sampling was used to do the botanical sampling. The principal component analysis (PCA) was performed to determine the relationships between environmental components and *Smilax* species occurrences. There were five species of *Smilax* which were housed in those forests in East Kalimantan, namely, *Smilax leucophylla* Blume, *Smilax gigantea* Merr., *Smilax odoratissima* Blume, *Smilax zeylanica* L., and *Smilax modesta* A.DC. *Smilax leucophylla* and *Smilax zeylanica* are the most widely used by the local people for medicine. The taxonomic description, distribution, use, and vernacular name were given. The environmental factors that contribute significantly to *Smilax*'s growing environment are temperature and light intensity.

Keywords: Diversity, East Kalimantan, physical environment, *Smilax*, soils

INTRODUCTION

The genus *Smilax* firstly described by Linnaeus (1753) and belong for a long time to the family Liliaceae (Engler 1964). Today, they were excluded from the family Liliaceae based on the differences that lie in habit, tendril, anther, and pistil, and then included in the family Smilacaceae and followed by many botanists (Hutchinson 1973; Cronquist 1981, 1988; Takhtajan 1987, 1997; APG II 2003; APG III 2009; APG IV 2016). Smilacaceae is a small monocots family in the order Liliales with its complexities and its controversial taxonomic status since their species determination is extremely difficult. Smilacaceae is dioecious plants, flower infrequently made many herbarium specimens lack flower, show considerable phenotypic variation within populations and even among leaves of the same individual plant. Traditionally, Smilacaceae consist of two genera, *Smilax* and *Heterosmilax* which were differing by its connate tepals and the variable number of stamens (3, 6, 9-12) with connate filaments. However, molecular phylogenetic examination showed that the genus *Heterosmilax* is nested within the genus *Smilax* making Smilacaceae as a monogeneric taxon (Cameron and Fu 2006). The genus *Smilax* comprising ca. 350 species with widespread distribution, mostly in tropical and subtropical regions. It was characterized by woody climber or vine up to 20 m long; rhizome tuberous or elongated, often thickened; stem

terete, quadrangular or angular, usually with prickles; leave with paired tendrils raise from petiole at apex of sheath, these sometimes reduce and non-functional; petioles with a variably placed pulvinus (articulation) at junction of blade and petiole or above tendrils, or this absent; blade simple, oblong-ovate to ovate or linear-lanceolate, shiny to waxy, membranaceous to very coriaceous, deciduous to persistent, margin entire, symmetric or asymmetric, main veins prominent, 3-7 venation distinctly reticulate; inflorescence axillary or terminal panicles, simple or compound racemes, spikes or umbels; flower erect, actinomorphic, unisexual, trimerous, hypogynous; fruit black, purple or red berry; seed single to several, globose to ovoid-angular, pale yellow to dark brown (Cameron and Fu 2006). Koyama (1960) divided *Smilax* into eight sections based on differences in morphological characters such as flower, inflorescence and habit, i.e. (1) section *China* Koyama, (2) section *Coilanthus* A.DC, (3) section *Nemexia* Raf., (4) section *Macranthae* Kunth, (5) section *Nervomarginatae* Koyama, (6) section *Pleiosmilax* (Seem) A.DC, (7) section *Smilax* L. Koyama, (8) section *Vaginatae* Koyama.

Sarsaparilla is the popular name of *Smilax* species. They have been used in folk medicine as tonic against rheumatism and anti-syphilitic since the sixteenth century. They also play a role in the remedy of gonorrhea, syphilis, rheumatism, abscesses and also in the manufacture of steroidal hormones, even as candied fruit (Tobias 2007).

Smilax produces rhizomes that are used in folk medicine and beer brewing, while the stems are used in crafts. The roots were exported widely from the Neotropics for use in the treatment of syphilis. It was not clear which species of *Smilax* contain the active components since the phenotypic plasticity of the species in the Neotropics (Ferrufino-Acosta 2010). The ability of *Smilax* species that can provide shelter and food for wildlife and also provide humans with medicine, food, and dye making *Smilax* spp. as an important species.

Phytochemistry study to reveal bioactive components of *Smilax* species have been conducted almost in China (Xu et al. 2005) and America (Rugna et al. 1999), while the systematic study had been undertaken to investigate the phylogenetic relationship among East Asian species and American species which belonged to section *Nemexia* (Fu et al. 2005). Taxonomic study to reveal diversity and to solve complexity of Smilacaceae have been conducted in America and the Caribbean Islands (Ferrufino-Acosta 2010; Denk et al. 2015), Brazil (Martins et al. 2013), China (Chen and Koyama 2000; Qi et al. 2013a, b), Thailand (Moore et al. 2010), Java (Backer and Bakhuizen v.d. Brink 1968; Ungson and Sastrapradja 1976), Borneo (Merrill 1921). Merrill (1921) reported there were five *Smilax* found in Borneo (*S. borneensis* A.DC, *S. helferi* A.DC, *S. korthalsii* A.DC, *S. laevis* Wall.Cat., *S. leucophylla* Blume) and two species of *Heterosmilax* (*H. borneensis* A.DC and *H. indica* A.DC).

Borneo is the third largest island of the world. It is most diverse part of the Sundaland hotspot, one of the world's 25 biodiversity hotspots (Myers et al. 2000). Borneo lost 30.2% of its forest cover, where only 17.4% of forest remain intact and 36.4% of the land is degraded (Gaveau et al. 2014). The Province of East Kalimantan, Indonesia lies in the Sundaland biogeographic province which possesses extraordinary biodiversity, with some 15,000 endemic plants (Myers et al. 2000). Elevation in East Kalimantan ranges from sea level to over 2,500 m in the interior and tends to vary inversely with total species richness, although endemism in some taxa (e.g. birds) increases with elevation (Sujatnika et al. 1995). The forests are dominated by trees in the family Dipterocarpaceae and Borneo is the center of diversity for this particular group (Ashton 2004). The dominance of genus *Shorea* in the regions closely associated with the island of Borneo as a center of diversity of the genus. Soil chemical content that most influence on the species of the genus *Shorea* is soil organic matter which is quite varied with range 1.12%-3.18% (low to moderate). In this forest, plant species are commonly found, namely *Dillenia excelsa*, *Syzygium* spp. and *Shorea parvifolia*. Saplings habitus (D<30 cm) dominated by *Macaranga triloba*. Herbs in this forest area are dominated by *Phrynium jagorianum*. Several endemic orchid of Borneo were riching the forest, namely *Grammatophyllum speciosum*, *Phalaenopsis modesta*, and *Coelogyne forstermannii* (Sofiah 2018).

The research site was coal mining targeted area for reforestation and restoration after mining. The lowland area of East Kalimantan was almost completely covered by

tropical rainforest before the 1970s (Eichhorn 2006). However, there are a lack of up to date information on *Smilax* diversity and ecological factors in Borneo. The diversity and distribution of many plant species are influenced by ecological factors including edaphic factors (Vleminckx 2015). The soil typical of Kalimantan are much dominated by red yellow podzolic soils, such as in Besiq Bermai (Sofiah 2018) and Bontang Forest. From observations in the field, there is a high value of alkaline saturation and Fe content. Based on previous research, especially besiq bermai village, forest areas are dominated by Dipterocarpaceae (Sofiah 2018). *Smilax* research conducted at the coal-mining site is one of a series of studies in the effort to conserve plants on pre-mining area.

The aims of this study was to explore and record the diversity of *Smilax* species including the ecological and environmental data in Besiq-Bermai Village and Bontang forests of East Kalimantan, Indonesia. Borneo *Smilax* research and its ecological character are the basic for understanding conservation efforts, especially ex situ conservation in botanic gardens.

MATERIALS AND METHODS

Study area

The field study was done in two secondary forests in East Kalimantan, Indonesia, i.e. (i) Besiq Village and Bermai Village, Damai Sub-District, East Kutai District in N 9905934.554001633 E 326615.6294839026; (ii) Protected forest in Bontang, East Kutai in N 0009.52.4 E 117.21.55.1. Both of locations are lowland rainforest. In research sites, the daily climate's average ranged between 21.6°C-31.8°C for temperature, 34-58 % for humidity and 41-1526 Lux for light intensity. Forest area in Besiq-Bermai and Bontang Protected Forest have altitude in 114-139 m asl., belongs to the category of flat.

Data collections

Field research to collect new specimens were carried out by using exploration method. The sampling method used was purposive random sampling (Rugayah et al. 2004), in which sampling localities were randomly selected by considering factors that influence the existence of Smilacaceae species. Data or information recorded from the field include location; altitude, longitude, and latitude; vernacular name; plant general habit and characters which are not visible when it has become herbarium specimens. Specimen were preserved in the form of mounted herbarium specimens as per standard field and herbarium techniques (Djarwaningsih et al. 2002). Distribution survey was conducted to provide information on diversity and distribution of *Smilax* species. Whereas environmental factors survey which consists of temperature, humidity, light intensity, soil physical and chemical properties were conducted to provide the relationship between *Smilax* species and their environment. Those environmental factors



Figure 1. Location of Besiq-Bermai (West Kutai District) and Bontang forests in East Kalimantan, Indonesia. Besiq-Bermai in N 9905934.554001633, E 326615.6294839026, and Bontang forest in N 0009.52.4, E 117.21.55

recorded with purposive random sampling, in which the data recorded is determined based on the presence of *Smilax* species. Field research was conducted on February and August 2012, and July-August 2015 in Besiq-Bermai and Bontang forest area, East Kalimantan. Identification of *Smilax* is done in Purwodadi Botanic Garden, Pasuruan, Indonesia and Herbarium Bogoriense (BO), Research Center for Biology, Indonesian Institute of Sciences (LIPI), Bogor, Indonesia.

Data analysis

Principal Component Analysis (PCA) used to analyze the relationship between *Smilax* and their natural habitat. Principal Component Analysis is used to simultaneously see the overall relationship between the variables observed for interpretation and relationship analysis.

RESULTS AND DISCUSSION

A total five *Smilax* species, namely *Smilax leucophylla* Blume, *Smilax gigantea* Merr., *Smilax odoratissima* Blume, *Smilax zeylanica* L., and *Smilax modesta* A.DC. were found in the Besiq-Bermai and Bontang Forests, East Kalimantan. In Besiq-Bermai forest, there are found four species of *Smilax*, namely *Smilax gigantea*, *Smilax odoratissima*, *Smilax leucophylla*, and *Smilax zeylanica*. *Smilax* in Bontang forest found four species, namely *Smilax modesta*, *Smilax zeylanica*, *Smilax gigantea*, and *Smilax leucophylla*. In this forest, *Smilax* is widely grown on the banks of the former forest land aperture. In general, they were found in the forest mostly and covered shady trees.

Identification key

Identification key of *Smilax* in the Besiq-Bermai and Bontang forests

1. a. Leaves coriaceous and not glaucous below 2
b. Leaves chartaceous and glaucous below...*S. leucophylla*
2. a. Branches not rough, but often spiked 3
b. Branches are very rough due to numerous warts *S. odoratissima*
3. a. Leaves base narrowed, costas usually 3 or 5 4
b. Leaves base broadly rounded and deeply cordate, costas usually 7-9 *S. gigantea*
4. a. Inflorescences are borne on distal part of branches, bearing 1 to 5 umbels *S. modesta*
b. Inflorescences are borne terminal or axillary, bearing 1-or 2-3 umbels *S. zeylanica*

Taxonomic description

Smilax gigantea Merr. (Figure 2.A-D)

Smilax gigantea. J. Straits Branch Roy. Asiat. Soc. (1922) 85: 161 (—Type: Ramos M sn., 1850 (K))

Description: A large, coarse, woody vine, the inflorescence-bearing branches terete, brown, striate, 8 to 10 mm in diameter, armed with scattered, very stout, narrowly pyramidal spines about 2 mm in length. *Leaves* broadly ovate, chartaceous to subcoriaceous, about 35 cm long and wide, apex very shortly and abruptly acuminate, base broadly rounded and deeply cordate, upper surface smooth, glabrous, shining, brownish-olivaceous, lower surface brownish, rather softly and densely pubescent, the indumentum short, not at all stellate; petioles stout, about 7 cm, long, the sheathing basal portion; domatia broadly clasping nodes, ovate to acute, brown to black in colour; nerves about 9, all basal, prominent, the reticulations rather lax. *Infructescences* about 30 cm long,

the umbels racemosely disposed, from 3 to 6 in the axil of each brat, their peduncles 7 to 10 cm long, the rachis usually about 20 cm in length, 4 to 6 mm wide, strongly flattened, the umbels up to 25 in each infructescence. *Fruits* globose, shining when dry, about 1 cm in diameter, 12 to 25 cm in each umbel, their pedicels slender, 1.5 to 1.8 cm in length (Merrill 1921).

Distribution. It is native to Borneo (WCSP 2018).

Habitat. Dipterocarp forest. *Smilax gigantea* is commonly found in the open area, such as edge forest.

Uses. The root is used as medicine for treating hernia By Dayak tribe (Tomery; Dayak tribe, 2018, pers. comm)

Vernacular name. Canar (Indonesian), Bomooy (Dayak tribe-Kalimantan).

Notes. This species develops domatia that are very similar to those of *S. borneensis* both in form and size. *Smilax borneensis* and *S. gigantea* have ovate to acute domatia which encloses the stem from all sides. Mature domatia are hard-walled that reach a length of up to 5.5 cm (Heckroth et al. 2004). *S. gigantea* is more commonly found in the edge of an open forest area, especially in sloping land areas. Higher light intensity causes *S. gigantea* to develop faster, and appears to be like a ground cover crops. From the results of observations in the field, *S. gigantea* develops more quickly in the wet months, especially in September-November. Further ecological studies of *S. gigantea* needs to do to assign the species conservation status in the wild.

Smilax leucophylla Blume (Figure 2.E-G)

Smilax leucophylla Blume. Enum. Pl. Javae (1827) 18 (—Type: Blume, CL sn. (L))

Description: Woody climber up to 18 m long; branches stout, armed with patent or recurved prickles 2-3.5 mm long, internodes subterete, 11-20 cm long, 3-5 mm thick. *Leaves* leathery; blades broadly ovate to ovate-oblong, leathery, 10-32 cm long, 4-22 cm wide, fresh green above, glaucous below, apex acuminate, cordate at base, costas 5 (rarely 7), leaf margin regular, pruinose beneath, yellowish or greenish when dry; petiole 4-5 cm long, breaking off at bottom between sheath and blade, obtusely trigonous, often weakly incurved, sheathing portion 15-20 mm long, with acute wings 2-4 mm in width; tendrils on branches, attaining 1/3 to 1/2 the length of blade. *Inflorescences* 2-6 umbellate, axis stout, 3-4 cm long, rachis arising at young branch, prophyllate at base, almost wholly enclosed in the subtending petiolar sheath; peduncles of umbels verticillate, 2-to 4-nate at 1 to 3 nodes, 8-10 cm long, divergent, the base with deltoid bracts ca. 7 mm long. *Staminate umbels* densely 15-to 25-flowered, ca. 5 mm across. *Staminate perianth* 0.8-1 cm long, venation uni-nerved; tepals reflexed above, outer ones oblong, 2 mm wide, obtuse at apex, inner ones linear. *Stamens* 6, subequal with the perianth; filaments slender, 0.8-1 mm long; cross section of peduncle compressed; anthers lanceolate, 2 locules, 1.5 mm long. *Pistillate umbels* 10-to 20-flowered; receptacles globose, 6-8 mm across; rays wiry, up to 25 mm long. *Pistillate flowers* unknown. *Fruit* berries, globose, 1 cm across, black at maturity.

Distribution. *Smilax leucophylla* could be found in Peninsular Malaysia, Java, Borneo and the Philippines to New Guinea and northern Australia (van Valkenburg 2002).

Habitat. In Besiq-Bermai Village and Bontang forest, *Smilax leucophylla* usually found in open and covered areas. The field study showed that *S. leucophylla* was more common in the former an open area of land openings and thrives there.

Uses. The roots and leaves were used for treating cancer. The rhizomes are considered blood purifier and used in cases of syphilis, rheumatism, and skin diseases. Subro (2012) reported that *S. leucophylla* has high chlorophyll content that contributes to the environmental services ecosystem through the amount of oxygen produced and absorbed the carbon dioxide. The young shoots and leaves are edible. The local people in Cidahu usually make them as "lalapan". Stem usable as a substitute for rattan to make some craft. However, *S. leucophylla* is one of the ground cover plants that contribute to the reduction of air emissions.

Vernacular name. Ubi danau, marsh yam, akarbanar; canargede, canarbokor, canarminyak, cangkores (Sundanese); sarsaparillangputi, banag, kaguno (Philippines); wanabekira (Papua New Guinea).

Notes. Further ecological studies of *S. leucophylla* needs to do to assign the species conservation status in the wild. In general, *S. leucophylla* is more commonly found in area soil-pH range 4-6.2. In addition, *S. leucophylla* is found in areas with a slope of 80-108°.

Smilax modesta A.DC. (Figure 2.H-I)

Smilax modesta A.DC. Monogr. Phan. 1 (1878): 185(—Type: Zollinger H. 1599 (P))

Description: Climber up to 10 m long; *Stems* terete or more angular, spinous with spreading spines 1-2 mm long or unarmed, rather slender-branched, internodes 2-6 cm long, 1-3 mm thick. *Leaves* mostly small; blade generally oblong to lanceolate, narrowed upwards, 6-8 cm long, 2-5 cm wide, usually rather long acuminate, acute at apex, thinly, herbaceous, bright green above, paler beneath, not glaucous, costas 5 or 7 including a marginal pair, the median 3 more pronounced than the remainder, united at base for 3 to 7 mm, highly raised with sharp edge on lower surface, distinct on upper surface, lateral veinlets obliquely spreading, straightish, forming not very elongate, fine reticulations; petioles 5-20 mm long with narrow basal sheath; wings 0.5-1 mm wide; tendrils vestigial on flowering leaves, up to 12 cm on sterile leaves and stems. *Inflorescences* borne on a distal part of branches, bearing 1 to 5 umbels; main rachis 0.5-4.5 cm long; prophyll broadly ovate, acuminate, 4-6 mm long, peduncles with convex basal scale, sometimes elongated into a leafy branch. *Staminate umbels* densely 10--flowered, 2-3 cm across. *Pistillate umbels* 15-30-flowered, 2-3 cm across. *Staminate perianth* pale-green, 4.5-5 mm long; outer tepals oblong or oblong-oblancoate, rounded at apex, 4-7 mm long, 1-1.2 mm wide, inner ones linear-oblong, obtuse, 0.3-0.5 mm wide, both recurved at anthesis. *Anthers* oblong, 1 mm long; filaments 3-3.5 mm long. *Pistillate perianth* 3 mm long; outer tepals elliptic, subobtuse, 1.5 mm wide, inner

ones elliptic-oblong, 0.75 mm wide, tapering to subobtusate tip, both patent to weakly recurved; ovary ellipsoid, *ca* 2 mm long, 1 mm thick; stigmas downward, nearly 1 mm long; staminodes 3, needle-like, 1.5 mm long. Fruit berries 1-6, 5-6 mm across, becoming dirty gray at maturity, 1-or 2-seeded.

Distribution. It is native to Borneo, Java, and Sumatra (WCSP 2018).

Habitat. In Dipterocarp forest. *Smilax modesta* is commonly found in shaded area.

Vernacular names. Areuj canar, canar, canar beurit, canar kembang (Sundanese).

Notes. This species has been much confused with *S. zeylanica*, which can be distinguished by its leave shape. *S. modesta* mostly oblong and smaller than *S. zeylanica*. *S. modesta* is only found in Bontang forest in small population. Further ecological studies of *S. modesta* needs to do to assign the species conservation status in the wild, especially because it is rarely found in the forest. There is no information yet about its use by local communities.

Smilax odoratissima Blume (Figure 2.J-K)

Smilax odoratissima Blume. Enum Pl. Javae (1827) 19

Description: Climber up to 20 m height. *Stems* with spines, rough or scabrid; young stems usually purple-colored. *Leaves* alternate with narrow basal sheaths and paired tendrils; blade oblong-lanceolate, margin entire, 6-13 × 4-8 cm, base obtuse-acute, apex sub-acuminate; midrib with 2 lateral veins. Petiole 1-2 cm long. *Inflorescences* terminal or axillary, 1- or 2-3 umbels; peduncle up to 5 cm long. *Flowers* dioecious, erect, actinomorphic, hypogynous; pedicels 4-5 mm long; receptacle sub-globose (in the same branch) or lanceolate (between bracteolate). *Flower* bud oblong or obovate-oblong, 5 mm long. *Tepal* linear-oblong, opened-revolute. *Stamens* 6, in 1-3 whorls; filaments free. *Anthers* basifixed, latrorse, dehiscing longitudinally, tetrasporangiate. *Gynoecium* of 3 united carpels, rarely unicarpellate. *Ovary* 3-locular with basal or axile placentae. *Ovules* anatropous, borne paired in each loculus. *Fruits* a red to purplish blackberry, 5-6 mm in diam. *Seeds* single to several, globose to ovoid-angular, pale yellow to dark brown. Fl. April-October. $2n = 32$.

Distribution. It is native to Bangladesh, Borneo, Java, Lesser Sunda Islands, Myanmar, Thailand (WCSP 2018).

Habitat. Lowland to montane forests, mostly collected from higher altitudes.

Uses. In ethnomedicinal uses, the root of *S. odoratissima* is used as a hemostatic. Root sap is taken to treat dehydration (Faruque 2018).

Vernacular names. Canar bokor, canar kembang, canar wangi (Sundanese).

Notes. *S. odoratissima* is a synonym from of infraspecific taxa of *S. bracteata* subsp. *verruculosa*, with densely verruculose and usually sparingly prickly stem and branches.

Smilax zeylanica L.

Smilax zeylanica L. Species Plantarum (1753) 1029 (Hermann sn (BM)); *Smilax ceylanica* Oken. Allg.

Naturgesch (1841) 3 (1): 616; *Smilax collina* Kunth. Enum. Pl. (1850) 5: 261; *Smilax elliptica* Desv. Ex Ham. Prodr. Pl. Ind. Occid (1825) 58; *Smilax elliptica* R.Br. Prodr. Fl. Nov. Holl. (1810) 293; *Smilax hohenackeri* Kunth. Enum. Pl. (1850) 5: 240; *Smilax indica* Burm.f. Fl. Ind. (1768) 213; *Smilax ovalifolia* var. *nervulosa*. Monogr. Phan (1878) 1: 200; *Smilax villandia* Buch. - Ham. Ex Royle. Ill. Bot. Himal. Mts. (1839) 384; *Smilax zeylanica* var. *penangensis* A.DC. Monogr. Phan. (1878) 1: 191; *Smilax zollingeri* Kunth. Enum. Pl. 5 (1850) 5: 241

Description. Climber up to 12 m long; *Stems* more or less 4-angular, armed, sparingly prickly, prickles 1-2 mm, internodes 3-6 cm long, 1-3 mm thick. *Leaves* moderate; blade generally elliptic to ovate, base narrowed, 6-10 × 3-7 cm, rounded-truncate at base, contracted above to subacute apex, herbaceous to thinly coriaceous, costas 3 or 5, often stained with dark red, the median 3 united for 4 to 7 mm above the base; petioles 9-17 mm long, sheathing for *ca.* 4 mm from base; wings 0.5-1 mm wide; tendrils vestigial on flowering leaves, up to 12 cm on sterile leaves and stems. *Inflorescences* borne on a distal part of branches, bearing (1-)2-3 umbels; main rachis 0.5-3 cm long; prophyll broadly ovate, acuminate, 4-5 mm long, peduncles with convex basal scale, sometimes elongated into a leafy branch. *Staminate umbels* densely 20-40-flowered, 2-3 cm across. *Pistillate umbels* 20-40-flowered, 2-3 cm across. *Staminate perianth* pale-green, 3-4 mm long; outer tepals oblong or oblong-ob lanceolate, rounded at apex, 4-7 × 1-1.2 mm wide, inner ones linear-oblong, obtuse, 0.3-0.5 mm wide, both recurved at anthesis. *Anthers* oblong, 1 mm long; filaments 3-3.5 mm long. *Pistillate perianth* 3 mm long; outer tepals elliptic, subobtusate, 1.5 mm wide, inner ones elliptic-oblong, 0.75 mm wide, tapering to subobtusate tip, both patent to weakly recurved; ovary ellipsoid, *ca.* 2 mm long, 1 mm thick; stigmas downward, nearly 1 mm long; staminodes 3, needle-like, 1.5 mm long. Fruit berries 1-6, 5-10 mm across, bright red to blue-black at maturity, 1-or 2-seeded.

Plants flower in May and June with white/green clustered flowers. If pollination occurs, the plant will produce a bright red to blue-black spherical berry fruit about 5-10 mm in diameter that matures in the fall (Jena 2011). *S. zeylanica* also often founded in temperature zone, tropics and subtropics worldwide (Babu 2017).

Distribution. It is native to Assam, Bangladesh, East Himalaya, India, Java, Myanmar, Nepal, Solomon Islands, Sri Lanka (Hossain et al. 2013) and Borneo (Trimanto and Sofiah 2018).

Habitat. In Dipterocarp forest. *S. zeylanica* is more commonly found in the open area.

Uses. The root is used as medicine to treat rheumatism and together with rhizomes and leaf are used in epilepsy (Madhavan 2008), fever, venereal, and skin diseases, sores, swelling and abscesses as they have large amounts of tannin, saponin, 31-norcycloartenol, parilin, phenolic acid and potassium nitrate (Sharma 2018). By Dayak tribe, *S. zeylanica* is used to treating rheumatism and dysentery. The part used for medicine is the root. The part used for medicine is the root which it is boiled with some water, then the boiled water is drunk.

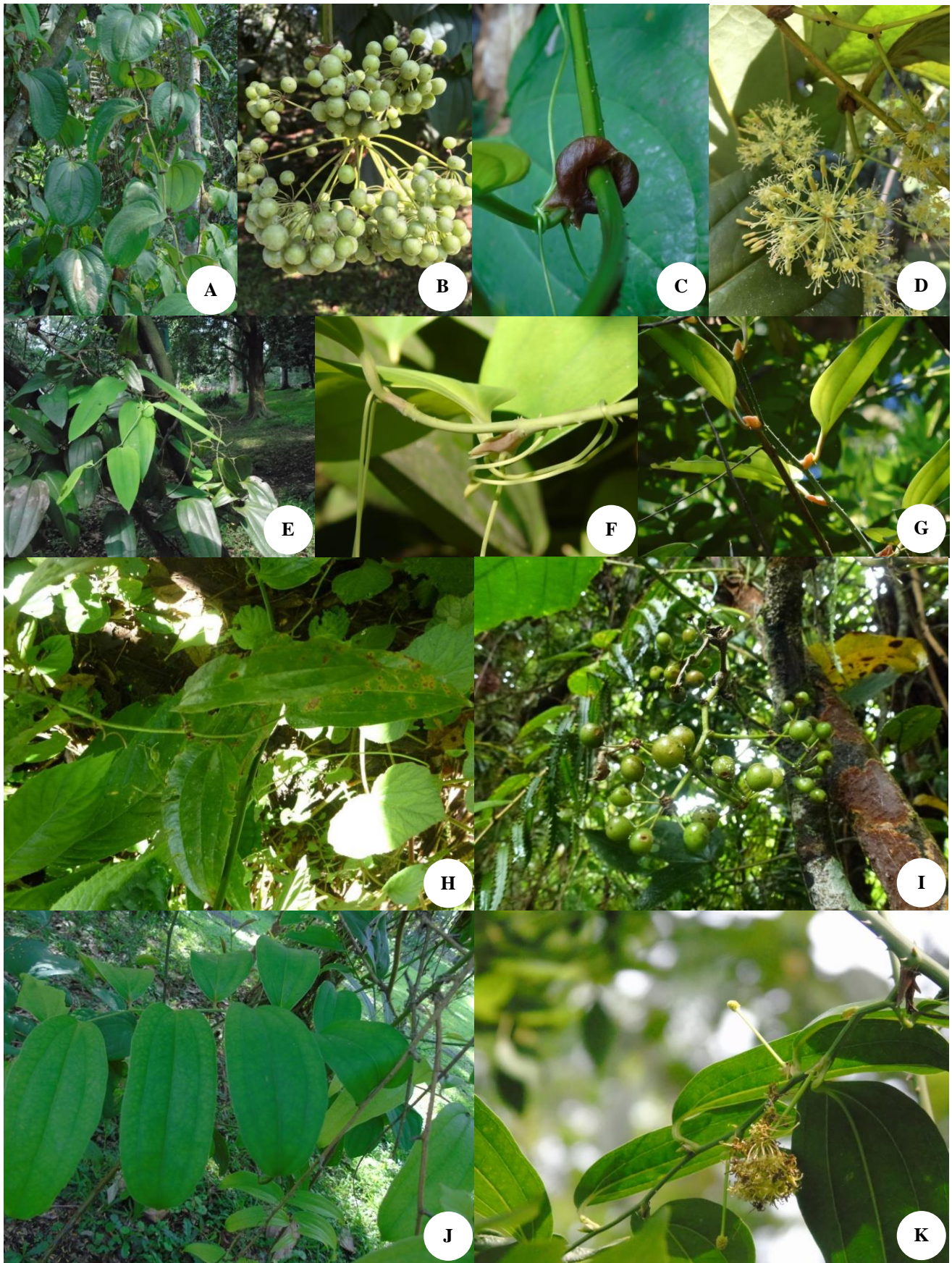


Figure 2. *Smilax gigantea*. A. Habitus, B. Infructescence, C. Domatia, D. Inflorescence; *Smilax leucophylla*. E. Habitus, F. Young tendrils, G. Stem articulation; *Smilax modesta*. H. Habitus, I. Infructescence; *Smilax zeylanica*. J. Leaves, K. Inflorescence (All photographs by SS, except for H-I by LDS)

Vernacular names. Canar, canarbeurit, canarbokor, canarlotik, canarlembut (Sundanese), gadung cina, kayu cina utan.

Habitat of *Smilax* and Its Interaction with abiotic factors

The most merely interpretable sign of biological is species richness which highlights with different environmental characters (Khan et al.2016). Abiotic variation is a well-known characteristic both in space and time which effect plant communities and population. The soil is an environmental factor that also determines plant growth which is influenced by the organism, climate, topography, time and parent material (Hoveizch 1997). There are many soil factors (variables) that influence the diversity and distribution of plant species, such as organic matter, exchangeable cation, soil types and other soil factors Tanveer et al. (2013) suggest that the *Celosia arvensis* tends to grow better in neutral and slightly acidic soil as compared to alkaline soil environments.

The topography of Besiq-Bermai and Bontang forests are relatively flat. The soil type in this area is dominated byred-yellow podzolic, that it makes interactions with climate and rainfall typical lowland rain forest, and bean optimal growing environment for the types of Dipterocarp. Soil acidity(pH) of Besiq-Bermai and Bontang forests are ranged from 3.5 to 4.7, including very acid criteria. Soil organic matter content varies 1.9-5.5%, which belong to the criteria of low to middle. Available phosphorus soil content ranged between 10.6-42.8 ppm, which are included in the high category. Some forests in East Kalimantan have sufficient cover tightly. The lack of sunlight that enters the surface of the ground floor, then causing micro humidity is quite high (80.4-87.3%). However, daytime temperatures up to reach 32°C, so the conditions were fairly high humidity and temperatures are high enough during the day, will speed up the process of weathering of existing litter on the forest floor surface. The results of previous research show that edaphic factors that had the highest influence on the occurrence and establishment of flora in Besiq-Bermai forest were total N and C/N ratio (Sofiah 2018).

Table 1. Eigenvalue of *Smilax* habitat

PC	Eigenvalue	% variance
1	2.70119	54.024
2	1.81475	36.295
3	0.417662	8.3532
4	0.0663989	1.328

	PC 1	PC 2	PC 3	PC 4
Elevation	-0.5286	-0.10424	0.73445	-0.0607
Temperature	0.53803	0.28578	0.28948	-0.72467
Humidity	-0.31315	0.59609	-0.46409	-0.071633
Light intencity	0.36153	0.55432	0.38479	0.64326
Soil-pH	0.44983	-0.49484	-0.11552	0.22857

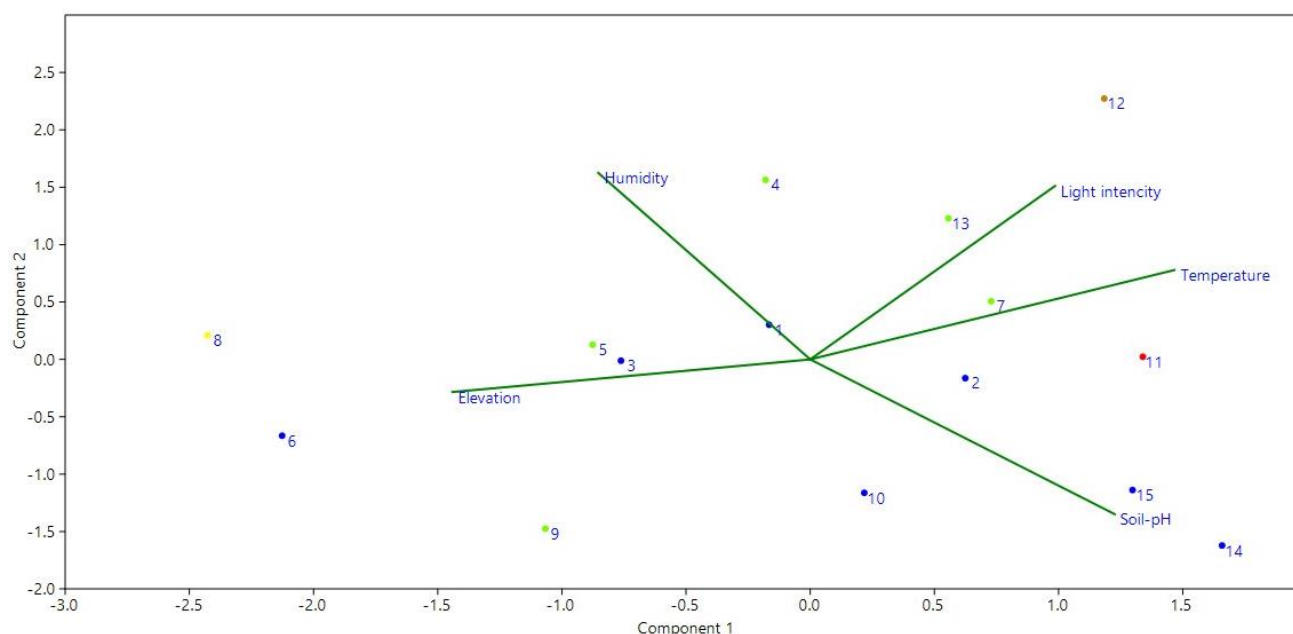


Figure 3. The results of the main components of environmental factors in the presence of *Smilax* in their habitat. The environmental factors recorded are elevation, humidity, light intensity, temperature, and Soil-pH. *Smilax leucophylla* (1,2,3,6,10,14,15); *Smilax gigantea* (4,5,7,9,13); *Smilax odoratissima* (8); *Smilax modesta* (11); *Smilax zeylanica* (12).

Table 2. Environmental variable of *Smilax*

Species	Elevation (m asl.)	Temperature (°C)	Humidity (%)	Light intensity (Lux)	Soil-pH
<i>Smilax leucophylla</i>	100.29	28.78	79.76	2835.94	5.06
<i>Smilax gigantea</i>	78	28	84.81	2749.44	4.4
<i>Smilax odoratissima</i>	139	27.05	85	2245	3.5
<i>Smilax modesta</i>	83	31.5	80	3220	5.1
<i>Smilax zeylanica</i>	84	32	85.1	5330	4

Analysis of principal component using PCA (Principal Component Analysis) towards environmental factors consists of five variables, namely elevation, temperature, humidity, light intensity, and soil-pH. Two principal components can explain 90.31% of all environmental component measured. The first component can explain 54.02%, when the second component can explain 36.29% of all variable environmental measured. The first component provided more information than the second component (Table 1). This results indicate that between the two component factors, PC 1 provides relatively larger information to describe *Smilax* habitat conditions. The component of temperature variable is a physical environment variable which is quite influential on the first component factor (PC1), followed by elevation and soil-pH. The component of the humidity variable and light intensity is a physical environment variable that affects the second component factor (PC2). The model of the habitat of *Smilax* in each forest of East Kalimantan with its environmental factors can be formulated based on Table 1. $PC1 = -0.529 \text{ elevation} + 0.538 \text{ temperature} - 0.313 \text{ humidity} + 0.361 \text{ light intensity} + 0.449 \text{ soil-pH}$; $PC2 = -0.104 \text{ elevation} + 0.286 \text{ temperature} + 0.596 \text{ humidity} + 0.554 \text{ light intensity} - 0.495 \text{ soil-pH}$.

Smilax's existence does not correlate closely with one physical factor where it grows, but is spread over various places of growth. However, there are several locations where *Smilax* is located which correlates very closely with the temperature and light intensity factors (Figure 3). It can be seen from temperature and light intensity line which form a slightly pointed angle. *Smilax* is commonly found in shady forest areas. However, certain species of *Smilax* are also often found on the edge areas of forest openings, namely is *S. gigantea*. An edge area is an interface between two different types of environments or ecosystems, arising between two different landscape forms or habitats (Vinter 2013). Most of the exploration and research areas are coal mining areas. Along the boundary of opening forest areas, many found *Smilax gigantea*. *Smilax* breeds with tubers, and includes the type of vines and easily spreads and grows into new individuals.

Smilax often found in areas with high humidity in range 80-85%, with low lux intensity, and acid soil-pH (Table 2). *Smilax* species in Kalimantan forest area are commonly found in humid and shady habitats. This plant propagates and easily reproduce itself through the tubers. Ecologically, this plant functions as a ground cover. *Smilax* species such as *S. leucophylla* has wide leaves which is useful in

absorbing the spectrum of sunlight, so that it has enough chlorophyll content (54 SPAD units) (Subro 2012).. In some places, *Smilax* fruit also used as sweets or consumed directly. *Smilax* in Kalimantan forest area is also found in acid soils, with soil-pH ranges from 3.5-5, some of them are found in a karst hill. The physical environment of the karst ecosystem is dry, especially during the dry season, and has a low fertility rate. Therefore, only certain plant and animal species are able to adapt to these environmental conditions.

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