

Syzygium diversity in Gunung Baung, East Java, Indonesia

DEDEN MUDIANA

Purwodadi Botanical Gardens, Indonesian Institute of Sciences. Jl. Raya Surabaya-Malang Km 65, Purwodadi, Pasuruan 67163, East Java, Indonesia.
Tel.: +62-343-615033, Fax.: +62-343-615033, email: dmudiana@yahoo.com

Manuscript received: 15 July 2016. Revision accepted: 5 September 2016.

Abstract. *Mudiana D. 2016. Syzygium diversity in Gunung Baung, East Java, Indonesia. Biodiversitas 17: 733-740. Syzygium* (Myrtaceae) consists of a lot of species which are widely distributed. One of the distribution areas is the Natural Park of Gunung Baung (TWA Gunung Baung) in Pasuruan, East Java. The results of exploration and characterization of known species show that there are six species of *Syzygium* known to grow in this region namely *S. cumini*, *S. littorale*, *S. pycnanthum*, *S. polyanthum*, *S. racemosum*, and *S. samarangense*. *S. pycnanthum* is the most frequently found in Gunung Baung. *S. polyanthum* and *S. samarangense* are the only species that are known to be cultivated. Four other species are wild and have not been explored for their potential utilization.

Keywords: Diversity, East Java, Gunung Baung, Pasuruan, *Syzygium*

INTRODUCTION

Syzygium is widespread in a variety of habitat types. There are approximately 1,200 recorded species of *Syzygium*, which are widely spread in South Asia, Southeast Asia, Australia, and New Caledonia. Some species are also found in Africa, Malagasy and southwestern region of the Pacific Islands, Hawaii and New Zealand. Species spread across Asia are in several areas as follows: the Indo-China (70 species), Thailand (80 sp.), the Malay Peninsula (190 sp.), Java (50 sp.), Borneo (165 sp.), the Philippines (180 sp.), and New Guinea (140 sp.). The Malay Peninsula and Borneo are the two main areas of endemism of this group (Haron et al. 1995). *Syzygium* generally grows in the rain forest, but grows well in nearly all types of vegetation, such as coastal forest, swamp forest, resembled monsoons, bamboo forests, peat swamp, lowland heath forest, savanna, montane forest and shrub vegetation in the sub-alpine region (Parnell et al. 2007). Some species are able to grow in conditions of extreme habitats such as limestone and ultramafic (Partomihardjo and Ismail 2008; Mustain 2009).

The large amount of genus *Syzygium* makes species classification become complicated; therefore many taxonomists have done some studies to classify these species and the most recent study was done by using a phylogenetic approach (Lucas et al. 2005; Craven et al. 2006; Craven and Biffin 2010). Although the number of species is quite high, still very few species of this genus are known by the public. Species that are known by the public at large are species that have been cultivated for their benefits and uses, such as *Syzygium aqueum*, *S. samarangense*, *S. malaccensis*, *S. aromaticum*, and *S. polyanthum*. The main usages of this genus are raw material for medicine, fruit-bearing, ornamental plants as well as a source of lumber and carpentry (Coronel 1992; Panggabean 1992; van Lingen 1992; Haron et al. 1995; Sardjono 1999; Verheij and Snijders 1999).

As for wild species that grow naturally in the forest or

non-cultivated areas, not much is known of the *Syzygium* existence. If information about species diversity and its existence is unknown, it is feared that wild species can be neglected even become scarce before functions and uses can be understood. Flora expedition occasionally reveals important information about floristic diversity of certain area. Shenoy (2015) stated that *S. kanarensis* was re-discovered after 67 years of its last existence's record.

Environmental conditions of habitat and human activity can affect the existence of a plant species. Ultimately this will affect the level of threat and the conservation status in the wild. Raju (2014), suggested that the reproductive capacity of *Syzygium alternifolium* was limited by a variety of environmental conditions. The factors that inhibit them are: low ability to produce fruit from the fertilization process, short viability of seeds, high mortality of seedling due to water stress, the pressure of dry climate in the dry season and fruit utilization by the community.

Some studies suggest that in addition to having the functions and benefits of direct usefulness to humans, *Syzygium* species have ecological functions for the sustainability of an ecosystem. Hasanbahri et al. (1996) suggest that there are at least 33 species of plants that become food for the *Macaca fascicularis* in hardwood forest regions. The most general type is of the genus *Ficus* and *Syzygium*. Alikodra (1997) recorded species of *Syzygium lineatum* and *Syzygium* sp. as species of plants that grow on the banks of the river of Kuala Samboja, which became fodder for proboscis (*Nasalis larvatus*). Besides this, they also used them to perform daily activities, such as exploring, sleeping, and more.

Syzygium plays an important role in the forest ecosystem to maintain the balance of the components inside. This could mean the relationship complementary and mutually beneficial among components in ecosystem. Crome (1985) stated that one form of this relationship is the system of pollination and fertilization of *Syzygium cormiflorum* with bats, birds, and insects as pollinator agents.

In addition, some species of *Syzygium* have an important role in the stabilization of the region along the banks of the river. This is mainly due to the nature and character of roots that can withstand the river flow, as well as hold up or slows down the rate of river flow. Root systems join strong pedestal stems, making it an excellent plant to prevent erosion of the banks of the river (Wiriadinata and Setyowati 2003). Riswan et al (2004), revealed that along the banks of the Ciliwung and Cisadane rivers, there are five species of *Syzygium*, namely: *S. aqueum*, *S. aromaticum*, *S. malaccensis*, *S. polycephalum*, and *S. pycnanthum*. Only *S. pycnanthum* was intended to grow naturally, while the other four species were intentionally grown for various purposes. This species has the potential of plants as barriers to erosion by the river flow. In another study, Waryono (2001), states that *S. polyanthum* is quite often found in the Jakarta area. This species has a considerable number of individuals encountered, both at tree level and seedling, along the banks of the river. One of its roles in the riparian ecosystem is as a source of food for various species of birds that live in that area.

In general, the region of Natural Recreation Park of Gunung Baug (TWA Gunung Baug) has the ecosystem characteristics of a lowland monsoon forest. Flora species that are quite often found in these areas include: *Ficus benjamina*, *F. variegata*, *Sterculia foetida*, *Artocarpus elastica* and bamboo (Bambusoideae). Some parts of the region are dominated by bamboo forest. Chess (2008) mentions as many as 9 species from 4 genera of bamboo grow in the area of TWA Gunung Baug, namely:

Bambusa arundinacea, *B. blumeana*, *B. spinosa*, *B. vulgaris*, *Dendrocalamus asper*, *D. blumei*, *Gigantochloa lear*, *G. atter*, and *Schizostachyum blumei*. Mudiana (2009) argues that there are four *Syzygium* species that found growing along the Welang river in this area, namely: *S. samarangense* (fruit greenish white), *S. javanicum*, *S. pycnanthum*, and *Syzygium* sp. This study aims to determine *Syzygium* species diversity, field character and distribution in the area of TWA Gunung Baug, East Java, Indonesia.

MATERIALS AND METHODS

Study area

Natural Recreation Park of Gunung Baug (TWA Gunung Baug) was established by decree of Minister of Agriculture 657/Kpts/Um/12/1981, dated January 1, 1981, covering an area of 195.50 hectares. TWA Gunung Baug regional government is administratively located in the Village of Cowek, Purwosari, Pasuruan District, East Java, Indonesia. Located about 68 km from the city of Surabaya towards Malang city. Geographically, TWA Gunung Baug is located at $07^{\circ} 46' 09'' - 07^{\circ} 47' 23''$ South and $112^{\circ} 16' 23'' - 112^{\circ} 17' 17''$ East. This region has the following boundaries: North side is adjacent to the Kertosari Village, Purwosari District, bordering the East is Lebakrejo Village, Purwodadi District, southern border is Cowek Village, Purwosari District, and western border is Purwodadi Botanical Gardens (Figure 1) (BBKSDA 2008).

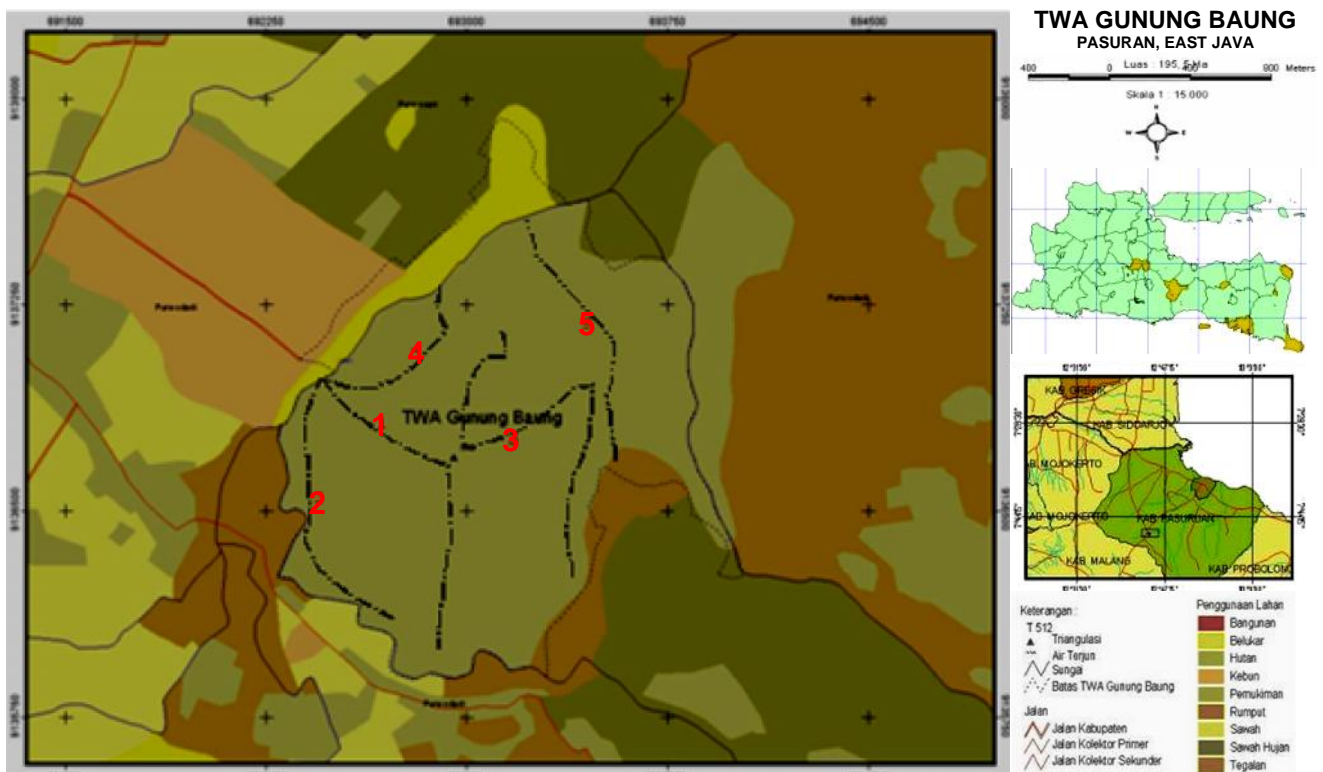


Figure 1. Regions of Gunung Baug Nature Park in Pasuruan, East Java. No. 1-5 indicate five explorative route to encounter *Syzygium*

The topography is generally undulating with steep slopes. Few have flat topography. The highest peak is around 501 m above sea level. The soil is made up of yellow and red mediterranean component of latosols quarter rocks formed from old metamorphic sediments. Climatic conditions of the area including the TWA Gunung Baung belong into type D, with a value of $Q = 76.47\%$. There is an average rainfall of 2571.5 mm with the annual number of rainy days per year of 144.20. Daily temperatures range from 20°C to 23°C. The rainy season with rainfall 100 mm/month, generally occurs between November to April, while the dry season (with rainfall 60 mm/month) occurs between May and October.

Procedures

The method used in this study was a survey method, which explores the research areas, and records the encountered *Syzygium*. Explorative exploration was done wherever possible to examine most of the area. A total of five trails were conducted in this research (Figure 1).

Data collection was mainly carried out in the core of TWA Gunung Baung region. Data collected includes: morphological characters of *Syzygium*, location coordinates, general vegetation conditions, altitude, temperature and humidity. Voucher of herbarium specimens were collected for identification and determination of species. Identification of herbarium specimens was done in the Herbarium Bogoriense (BO) and the Hortus Botanicus Purwodadiensis Herbarium. The data were analyzed descriptively by an identifier of *Syzygium* morphological characters that can be easily recognized in the field and that can be made using a simple identification key. The characters include: habit, bark, leaves, flowers and fruits.

Then, based on the data obtained by morphological characters, we made dendrogram to figure out the close relationship between species *Syzygium* in Gunung Baung. Present method is absent on some morphological characters which is used for species grouping. Data analysis was performed using the method of cluster analysis using Minitab 14 software.

RESULTS AND DISCUSSION

As many as 347 individuals of *Syzygium* from six species are recorded in this study. These six species are: *Syzygium cumini* (duwet), *S. littorale* (kopo laut), *S. polyanthum* (salam), *S. pycnanthum* (klampok, jambu hutan), *S. racemosum* (kopo mangut), and *S. samarangense* (jambu semarang). *S. pycnanthum* is the species mostly found in the area of TWA Gunung Baung followed by *S. racemosum* (Mudiana 2012) (Figure 2).

Of the six species of *Syzygium* encountered, *S. samarangense* and *S. polyanthum* are species that have been commonly recognized and cultivated/planted by the community. Although *S. cumini* has been known by the public, it is not commonly grown as a cultivated plant. *S. littorale*, *S. pycnanthum*, and *S. racemosum* are *Syzygium* species that still grow wild and are not cultivated by the community yet.

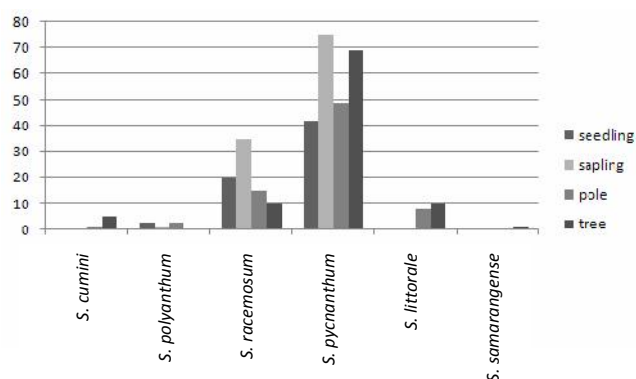


Figure 2. The number of individuals of *Syzygium* in TWA Gunung Baung, East Java

Syzygium cumini (L.) Skeels.

Syn.: *Calypttranthes capitellata* Buch.-Ham. ex Wall, *Calypttranthes caryophyllifolia* Willd, *Calypttranthes cumini* (L.) Pers, *Calypttranthes cuminodora* Stokes, *Calypttranthes jambolana* (Lam.) Willd, *Calypttranthes jambolifera* Stokes, *Calypttranthes oneillii* Lundell, *Caryophyllus corticosus* Stokes, *Caryophyllus jambos* Stokes, *Eugenia calyptrata* Roxb. ex Wight & Arn, *Eugenia caryophyllifolia* Lam, *Eugenia cumini* (L.) Druce, *Eugenia jambolana* Lam, *Eugenia jambolifera* Roxb. ex Wight & Arn, *Eugenia obovata* Poir, *Eugenia obtusifolia* Roxb, *Eugenia tsoi* Merr. & Chun, *Jambolifera chinensis* Spreng, *Jambolifera coromandelica* Houtt, *Jambolifera pedunculata* Houtt, *Myrtus corticosa* Spreng, *Myrtus cumini* L, *Myrtus obovata* (Poir.) Spreng, *Syzygium caryophyllifolium* (Lam.) DC, *Syzygium jambolanum* (Lam.) DC, *Syzygium obovatum* (Poir.) DC, *Syzygium obtusifolium* (Roxb.) Kostel.

A short-truncate tree that can reach 20 m high and has no buttresses. Branching is grey or yellowish brown. It has single leaves arranged opposite, oval to oval, green-dark green, and has flat leaf edges. Size of leaves is about 7-15 cm x 5-9 cm and has a long petiole 1 to 3.5 cm. Flowers are small (4-7 mm diameter) and are arranged in a single inflorescence. It has white to yellowish flowers, arranged in inflorescences that appear in axillary panicles at the ends of twigs and branches. Berry fruit of the seed is oval-shaped, dark red and purple when ripe, with a sweet taste of kelat (Figure 3.A, B, C). According to Backer and Bakhuizen van den Brink (1963), in Java, in teak forests, this species grows at altitude of below 500 m asl. and is widely cultivated for its fruit. This species is found in open places; a location with no bamboo and with relatively flat topography. A total of 6 individual observations are recorded in plots consisting of individual levels of pole 1 and 5 individual tree levels.

Syzygium littorale (Bl.) Amshoff

Syn.: *Eugenia littoralis* (Bl.) Meijer Drees; *Eugenia subglauca* Koord. & Valetton; *Jambosa littoralis* Bl.

Tall stature of trees can reach 10-20 m. Single leaves are arranged opposite and are lanceolate-oblong-shaped

with a pointed tip. Leaf length is three times the size of its width. The inflorescence terminal appears on the petiole twigs as the former falls. Some flowers are arranged in a single inflorescence. There are white flowers with a size of about 1.5 to 2 cm (Figure 3.D, E, F). Fruit is round, campanulate (bell-shaped), green and yellow with a diameter of about 2.5-3.5 cm. Backer and Bakhuizen van den Brink (1963) states that this species is a native species in Java. They grow in forests, especially along the river bank.

In the area of TWA Gunung Baung, they are found growing in places where there is no bamboo, in bush areas with trees that are not too tight. There were a total of 18 individuals recorded in the observation plots, consisting of 8 individual poles and 10 individual trees.

***Syzygium polyanthum* (Wight.) Walp.**

Syn.: *Eugenia atropunctata* C.B.Rob., *Eugenia holmanii* Elmer, *Eugenia junghuhniana* Miq., *Eugenia lambii* Elmer, *Eugenia lucidula* Miq., *Eugenia microbotrya* Miq., *Eugenia nitida* Duthie, *Eugenia pamatensis* Miq., *Eugenia polyantha* Wight, *Eugenia resinosa* Gagnep., *Myrtus cymosa* Bl., *Syzygium cymosum* Korth., *Syzygium micranthum* Bl. ex Miq., *Syzygium microbotryum* (Miq.) Masam., *Syzygium pamatense* (Miq.) Masam.

A tree with a single trunk and clear, dense canopy shape, and can reach 25 meters high. It has dark brown, rough grooved bark. Single leaves are arranged opposite elliptic-round shaped or obovate (obovate) with a pointed tip. Leaf size is 5-15 x 3.5 to 6.5 cm with petiole length between 5-12 mm. Meeting at the end of the inflorescence branches or armpit. Compact white flowers are fragrant and reddish. Sweet fruit is round with a diameter of 8-9 mm and red to dark red (Figure 3.G, H, I). Its natural habitat is the forest area at an altitude of 5-1000 m asl. This species is often planted in home gardens for the leaves and fruit (Backer and Bakhuizen van den Brink 1963).

Seven individuals are recorded in the observation plots consisting of: 3 individual seedlings, saplings and 1 individual, 3 pole individual levels. They grow in places that are not dominated by bamboo and not too dense thickets of trees, in hillside areas.

***Syzygium pycnanthum* Merr. & L.M. Perry**

Syn.: *Eugenia corymbosa* Roxb., *Eugenia densiflora* (Bl.) DC., *Eugenia densiflora* (Bl.) Duthie, E. Axillary Auct. Non Willd., *Jambosa densiflora* (Bl.) DC., *Myrtus densiflora* Bl.

Syzygium pycnanthum is a small tree, up to 15 m high. Trunk diameter can reach 30 cm with no buttresses. Single leaves are oppositely arranged, dark green on the upper surface and pale green on the lower surface. Leaf shape is ovate-oblong-lanceolate (elongate-ovate-oblong), average leaf edge, acute-acuminate leaf tip (pointy-tapered). Leaf size ranges from 12.5 to 37 cm x 3-10 cm, has an intramarginal vein at a distance of 8-10 mm from the edge of the leaf. Inflorescence appears at the end of twigs. Compact flowers with short flower stalks 3-4 mm, crown-purplish white flowers, white-colored greenish-purple petals, have many stamens. The fruit is berry which is

round, light green, dark purplish red or reddish-green with a diameter of 2.5-3.5 cm (Figure 3.J, K, L).

Two variants of *S. pycnanthum* are found in Gunung Baung TWA, which have purplish-red and green fruit. Stature and other characteristics are relatively the same, the only difference is the color of the fruit. Comparison of the amount between the two is unknown. This is because the time of the study does not coincide with the time of flowering or bearing fruit.

This species has a wide range of habitats. It can grow from lowlands to highlands with various types of environmental conditions. According to Backer and Bakhuizen van den Brink (1963), in Java, this species grows naturally in the underbrush, open woods or edges of rivers, at an altitude of 5-1500 m asl. Mustian (2009) found *S. pycnanthum* along with several other *Syzygium* species in a nickel mining region in Sorowako, South Sulawesi, on ultramafic soils. This type is found growing naturally on the banks of the river flow (Mudiana 2009; 2011). Sunarti et al. (2008) recorded this species habitat at an altitude of 750-850 m asl. in the Polara forests of Waworete Mountains, Wawonii Island, Southeast Sulawesi.

This species of *Syzygium* is the most often found species in TWA Gunung Baung. A total of 235 individuals were recorded in the observation plots, consisting of 42 individual seedlings, 75 saplings, 49 individual levels and 69 depressed pole level tree individuals. This species grows in a variety of conditions, such as the location of the dominance of bamboo groves *B. blumeana*, in an open space, where there is dominance of shrubs and trees, or in the hillsides.

***Syzygium racemosum* (Bl.) DC.**

Syn.: *Calyptanthus racemosa* Bl., *Eugenia brunneoramea* Merr., *Eugenia cerasiformis* (Bl.) DC., *Eugenia evansii* Ridl., *Eugenia expansa* Duthie, *Eugenia jamboloides* Koord. & Valetton, *Eugenia robinsoniana* Ridl., *Jambosa cerasiformis* (Bl.) Hassk., *Myrtus cerasiformis* Bl., *Syzygium brunneorameum* (Merr.) Masam., *Syzygium cerasiforme* (Bl.) Merr. & L.M.Perry, *Syzygium costatum* Miq., *Syzygium javanicum* Miq.

Tree's height can reach 3-20 meters, generally in the form of a small tree with dense branching. Bark is light gray-brown. Ellipse-shaped leaf face round with a tapered tip, leaf size is about 8-15 x 3.5-5 cm, petiole 0.5-1.5 cm size. Young leaves are reddish-copper. Inflorescence terminal or axillary panicles appear on the end of the branch. Yellowish-white flowers, with a crown like a small calyptas. Fruit is yellowish green, rounded bell-shaped with a diameter of 2-3 cm (Figure 3.M, N, O).

Backer and Bakhuizen van den Brink (1963) stated that this species is found growing in Java, in a mixed forest and a teak forest at an altitude of 10-1200 m asl. In TWA Gunung Baung, it is often found growing mainly in areas with a predominance of bamboo, *B. blumeana*, on the local hillsides. A total of 77 individuals were recorded in this study, consisting of 20 individual seedlings, 35 individuals, 14 individuals saplings and 8 pole level individual trees level.

***Syzygium samarangense* (Bl.) Merr. & L.M. Perry**

Syn.: *Eugenia javanica* Lam. non *Syzygium javanicum* Miq., *Eugenia samarangensis* (Bl.) O. Berg, *Jambosa javanica* (Lam.) K. Schum. & Lauterb., *Jambosa samarangensis* (Bl.) DC., *Myrtus javanica* (Lam.) Bl., *Myrtus samarangensis* Bl.

Stature of *S. samarangense* is a small tree with a lot of dense branching, height can reach 10 meters. Leaves are arranged opposite and are oval or oblong, bright green young leaves with leaf size of 6 to 11.5cm x 12-24cm and petiole length of 3-5 mm. Inflorescence appears in the former leaves that have fallen. Yellowish-white flowers with a diameter of 3-4 cm (Figure 3.P, Q, R). The fruit is bell-shaped and green and yellow. Its existence has been common and planted by residents in the garden and yard for some uses. Only found in 1 individual tree level recorded in the observation plots. It grows in the open area, in areas of bamboo bush.

Based on the fact that morphological characters are easily recognizable in the field, it is simple to identify. Key for *Syzygium* species in TWA Gunung Baung is as follows:

Identification key**I.A. Habit of a big tree**

I.A.1. elliptic-oblong leaf shape; flowers are small, clustered; perianth white-reddish flowers; sweet, small round, red-colored or dark red fruit *S. polyanthum*

I.A.2. elliptical-obovate leaf shape; flowers are small, clustered; white-yellowish flowers; sweet, oval, purple-dark purple fruit *S. cumini*

I.B. Habit of a small tree

I.B.1. light gray or light brown sunny bark

I.B.1.1. elliptic-ovate leaf shape, thick leaf; purplish white flowers; round green or purplish green fruit *S. pycnanthum*

I.B.1.2. elliptical-oblong leaf shape, leaf thin copper-colored young leaves; small round white flowers *S. racemosum*

I.B.2. dark gray or dark brown bark

I.B.2.1. elliptic-ovate bright green leaf; axillary inflorescence; white flowers; bell shaped fruit *S. samarangense*

I.B.2.2. elliptic-ovate dark green leaf; axillary inflorescences on the top branches; white flowers; round shaped fruit *S. littorale*

Based on the identification key and dendrogram in Figure 4, it can be seen that in general there are three groups of *Syzygium* growing on Gunung Baung. The first group consists of *S. cumini* and *S. polyanthum*, while the second group is *S. littorale*, *S. samarangense* and *S. pycnanthum*, and the third group is *S. racemosum*. Differences among the three are primarily on two morphological characters that are easily seen in the field, namely: flower size and habit. The first group has the small flowers with a large tree habit. The second group has a large flower size with a small tree habit. While the third group has a small flower size and small tree habit. *S. cumini* and *S. polyanthum* have the same character with a small flower size and habit of a large tree (the first group). Despite having a small flower size, *S. racemosum* has a tree with a small size habit (third group). *S. littorale*, *S. samarangense* and *S. pycnanthum* is classified into second group.

In addition, the character of the surface of the bark can also be a distinguishing character between *Syzygium* species in the field. *S. pycnanthum* and *S. racemosum* is very easily recognizable in the field because of the bright color of the bark (brown-light gray) with a relatively smooth surface. Other species have a dark color of bark with a rough surface.

Potential and utilization *Syzygium*

Syzygium cumini, *S. polyanthum*, and *S. samarangense* are *Syzygium* species that had been commonly recognized and utilized by the local community. It is traditionally and mainly used for fruit consumption, as a seasoning, as traditional medicine or timber used for household furniture and buildings.

As a producer of fruit, *S. samarangense* is one that is undergoing a process of "most advanced" cultivation techniques compared to other species. Today, many cultivars of this species have been produced. Even, sometimes, it leads to new species as a result of human intervention. Widodo (2007) stated that the activity of hybridization to produce new varieties is one speciation process that occurred in the genus *Syzygium*. There are at least 9 *Syzygium samarangense* cultivars that have been recognized and developed by the community (Cahyono 2010).

Traditionally, the potential use of *S. cumini* includes fruit for jam making or as material consumption of fruit; the wood is used as raw material for home furnishings and building materials, as well as leaves and seeds for traditional medicine. Intensive studies on the potential of the active substance content in this species suggest that there are many medical benefits provided by this species. One is as a producer of raw materials of diabetes mellitus drug. The content of oleanolic acid in this plant (the stem bark, leaves, and especially in the seeds) is an efficacious material for lowering blood glucose levels (hypoglycemic) and acts as an anti-diabetic (Tjitrosoepomo 1994; Dalimartha 2003; Mas'udah et al. 2010). Lestario (2003) suggested that a *S. cumini* fruit is a source of antioxidants which is beneficial to health. These substances are needed by the body to prevent degenerative diseases. In fact, the leaf extract of *S. cumini* contains a substance (i.e. methanol) that potentially developed as growth inhibitor of bacteria or anti bacteria (Gowri and Vasantha 2010).

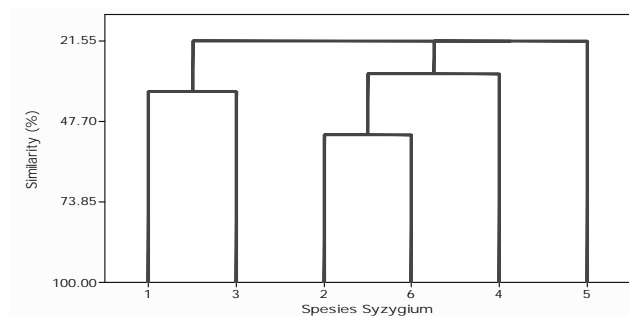


Figure 4. Dendrogram of *Syzygium* in Gunung Baung based on morphological character practically recognized in the field. Note: 1. *S. cumini*, 2. *S. littorale*, 3. *S. polyanthum*, 4. *S. pycnanthum*, 5. *S. racemosum*, 6. *S. samarangense*





Figure 3. Flowers (A), fruit (B), and tree physique of *Syzygium cumini* (C); Flowers (D), flower buds and leaves (E), and tree physique of *Syzygium littorale* (F); Flower (G), leaf (H), and tree physique of *Syzygium polyanthum* (I); Variant of young purplish red fruit (J), green fruit variant (K), and tree physique of *Syzygium pycnanthum* (L); Flowers (M), leaf (N), and tree physique of *Syzygium racemosum* (O); Flower buds (P), leaf (Q), and tree physique of *Syzygium samarangense* (R)

Several studies on the chemical content owned by *S. polyanthum* suggest that this species has the potential as a producer of tannins, flavonoids and essential oils (at 0.05%). Citric acid and eugenol are also produced by this species (Sumarno and Agustin 2008). Bay leaves (*S. polyanthum*) contain chemicals that could potentially be used as anti-diarrheal drugs as proposed by Wiryawan et al (200). His research notes that the chemicals in the leaves can suppress populations of the bacterium *Escherichia coli* that cause diarrhea in chickens. Chemical substances contained in the leaves include: essential oils, triterpenoids, saponins, tannins and flavonoids.

The three species, *S. littorale*, *S. pycnanthum* and *S. racemosum* are not widely known and neither has been utilized their potential for specific uses. All three of these species are wild and not cultivated. Traditionally, people use their wood as firewood. Not many studies have been done to explore the potential of these species. One was done by Wahidi (2001), which suggests that *S. pycnanthum* contains 15 essential oil components. From the results of these studies, it can be concluded that this species could be a source of -farnesen and eugenol. Mudiana (2008)

suggested that *S. pycnanthum* has the potential to be developed as an ornamental out door plant because it has characters of small-boned medium tree, leafy canopy forms, attractive colors and shapes of flowers and also attractive fruit.

To conclude, a total of six species of *Syzygium* are found growing in the area of TWA Gunung Baung. These six species are *S. cumini*, *S. littorale*, *S. polyanthum*, *S. pycnanthum*, *S. racemosum*, and *S. samarangense*. Based on morphological characters that are easily recognizable in the field in Gunung Baung, *Syzygium* species can be classified into 3 groups. The first group consists of *S. cumini* and *S. polyanthum*. The second group consists of *S. littorale*, *S. samarangense* and *S. pycnanthum*. The third group is *S. racemosum*. Flower size, habit, and the surface of the stem are character identifiers that are easily recognizable in distinguishing species of *Syzygium* in Mt. Baung. Of the six species of *Syzygium*, only *S. polyanthum* and *S. samarangense* have been commonly recognized and cultivated by people, while four other species grow wild in nature.

ACKNOWLEDGEMENTS

The author would like to thank Prof. Dr. Elizabeth A. Widjaja, who has provided advice and input in the utilization of data and information on the preparation of this manuscript. The authors also thank to Samantha Tesoriero, who have helped enhance manuscript writing.

REFERENCES

- Alokodra HS. 1997. Population and behavior proboscis monkey (*Nasalis larvatus*) in Kuala Samboja, East Kalimantan. *Media Konservasi* 5 (2): 67-72. [Indonesian]
- Backer CA, Bakhuizen van den Brink RC. 1963. *Flora of Java* Vol. I. N.V.P. Noordhoff, Groningen, The Netherlands.
- BBKSDA [Center for Conservation of Natural Resources of East Java]. 2008. Natural Park of Gunung Baung. www.ditjenphka.go.id/kawasan_file/TWA.%20Gunung%20Baung-a.pdf. [September 22, 2008]. [Indonesian]
- Cahyono B. 2010. Raising Successful Jambu Air in the Courtyard and Plantation. Lily Publisher, Yogyakarta. [Indonesian]
- Chess IRW. 2008. Diversity and Utilization of Bamboo in The Natural Park of Gunung Baung, Purwodadi, Pasuruan. [Final report]. Intertide Ecological Community-Laboratorium of Ecology. Department of Biology, Institut Teknologi Sepuluh Nopember. Surabaya. [Indonesian]
- Coronel RE. 1992. *Syzygium cumini* (L.) Skeels. In: Verheij EWM, Coronel RE (ed). *Plant Resources of South-East Asia 2: Edible Fruits and Nuts*. Prosea, Bogor.
- Craven LA, Biffin E. 2010. An infrageneric classification of *Syzygium* (Myrtaceae). *Blumea* 55: 94-99.
- Craven LA, Biffin E, Ashton PE. 2006. *Acmena*, *Acmenosperma*, *Cleistocalyx*, *Ptilocalyx* and *Waterhouse* formally transferred to *Syzygium* (Myrtaceae). *Blumea* 51: 131-142.
- Crome FHJ. 1985. Two Bob Each Way: The pollination and breeding system of the Australian rain forest tree *Syzygium corniflorum* (Myrtaceae). *Biotropica* 18(2): 115-125.
- Dalimartha S. 2003. *Atlas of Medicinal Plants Indonesia*, Volume 3. Puspa Swara, Jakarta. [Indonesian]
- Gowri SS, Vasantha K. 2010. Phytochemical screening and antibacterial activity of *Syzygium cumini* (L.) (Myrtaceae) leaves extracts. *Intl J PharmTech Res* 2 (2): 1569-1573.
- Haron NW, Laming PB, Fundter JM, Lemmens RHMJ. 1995. *Syzygium Gaertner*. In: Lemmens, RHMJ, I. Soerianegara, and Wong WC (Eds.) *Plant Resources of South-East Asia 5 (2): Timber Trees: Minor Commercial Timbers*. Prosea, Bogor.
- Hasanbahri S, Djuwantoko, Ngariana IN. 1996. Composition of plants feed long tailed macaques (*Macaca fascicularis*) in jati forest habitat. *Biota* 1 (2): 1-8. [Indonesian]
- Lestario LN. 2003. Duwet fruit sources of antioxidants. *Kompas*, 23 October 2003. <http://kompas.com/kompas-cetak/0310/23/inspirasi/640919.htm>. [August 13, 2007]. [Indonesian]
- Lucas EJ, Belsham SR, NicLughadha EM, Orlovich DA, Sakuragui CM, Chase MW, Wilson PG. 2005. Phylogenetic patterns in the fleshy-fruited Myrtaceae-preliminary molecular evidence. *Plant Syst Evol* 251: 35-51.
- Mas'udah KW, Istiqomah, F. 2010. Seed of juwet (*Syzygium cumini* (Linn.) Skeels.) as an alternative medicine for diabetes mellitus. Malang State University, Malang. [Indonesian]
- Mudiana D. 2008. Potential *Syzygium pycnanthum* Merr. & L.M. Perry as house plants: Collection of Purwodadi Botanical Garden. *Warta Kebun Raya* 8 (1): 17-22. [Indonesian]
- Mudiana D. 2009. *Syzygium* (Myrtaceae) along Welang River Natural Recreation Park of Gunung Baung Purwodadi. *Biosfera* 26 (1): 35-42. [Indonesian]
- Mudiana D. 2011. Some kind of *Syzygium* that grow on the banks of rivers or streams in the District of Malang. In: Widyatmoko D, Puspitaningtyas DM, Hendrian R, Irawati, Fijridiyanto IA, Witono JR, Rosniati R, Ariati SR, Rahayu S, Praptosuwiryo TNg. (eds.) *Proceeding of National Seminar on Tropical Plant Conservation: Current Condition and Future Challenge*. Cibodas Botanical Garden-LIPI, Cianjur April 7, 2011. [Indonesian]
- Mudiana D. 2012. Diversity, Population Structure and Distribution Pattern *Syzygium* In Gunung Baung. [Thesis]. Graduate School of Institut Pertanian Bogor, Bogor. [Indonesian]
- Mustian. 2009. Biodiversity of Plants on Land Concession Area Ultramafic at PT. INCO Tbk. Prior Mining South Sulawesi Province. Faculty of Forestry, Institut Pertanian Bogor, Bogor. [Indonesian]
- Parnell JAN, Craven LA, Biffin E. 2007. Matters of scale: Dealing with one of the largest genera of Angiosperms. In: Hodkinson TR, Parnell JAN. (eds.) *Reconstructing the Tree of Life, Taxonomy and Syztematics of Species Rich Taxa*. CRC Press, Boca Raton.
- Panggabean G. 1992. *Syzygium aqueum* (Burm.f) Alston, *Syzygium malaccense* (L.) Merr.& Perry, *Syzygium samarangense* (Blume) Merr. & Perry. In: Verheij EWM, Coronel RE (ed.). *Plant Resources of South-East Asia 2: Edible Fruits and Nuts*. Prosea, Bogor.
- Partomihardo T, Ismail. 2008. Diversity flora in the Nature Reserve of Nusa Barung, Jember, East Java. *Berita Biologi* 9 (1): 67-80. [Indonesian]
- Raju AJS, JR Krishna, PH Chandra. 2014. Reproductive ecology of *Syzygium alternifolium* (Myrtaceae), an endemic and endangered tropical tree species in the southern Eastern Ghats of India. *J Threaten Taxa* 6 (9): 6153-6171.
- Riswan S, Rachman I, Waluyo EB. 2004. The types of plants in the borders and the River Plate, Ciliwung and Cisadane. In: Maryanto I, Ubaidilah R (eds.) *Management Bioregional Jabodetabek: Profile and Strategy Management of Rivers and Streams Water*. Puslitbang Biologi-LIPI, Bogor. [Indonesian]
- Shenoy HS, Krishnakumar G, Marati R. 2015. Rediscovery of *Syzygium kanarensis* (Talbot) Raizada (Myrtaceae)-an endemic species of the Western Ghats, India. *J Threaten Taxa* 7 (1): 6833-6835.
- Sumarno A, Agustin WSD. 2008. The use of bay leaf (*Eugenia polyantha* Wight) in dentistry. *Majalah Kedokteran Gigi* 44 (3):147-150.
- Sunarti S, Hidayat A, Rugayah. 2008. Diversity of plants at Forest Mountains Waworete, District East Wawonii, Wawonii Island, Southeast Sulawesi. *Biodiversitas* 9 (3): 194-198. [Indonesian]
- Tjitrosoepomo G. 1994. *Taxonomy of Medicinal Plants*. Yogyakarta: Gadjah Mada University Press, Yogyakarta. [Indonesian]
- van Lingen TG. 1992. *Syzygium jambos* (L.) Alston. In: Verheij EWM, Coronel RE (ed.). *Plant Resources of South-East Asia 2: Edible Fruits and Nuts*. Prosea, Bogor.
- Verheij EWM, Sniijders CHA. 1999. *Syzygium aromaticum* (L.) Merrill & Perry. In: de Guzman CC, Siemonsma JS (ed.). *Plant Resources of South-East Asia 13: Spices*. Prosea, Bogor
- Wahidi. 2001. Essential Oil of Bayleaf (*Syzygium polyanthum* (Wight.) Walp., Klampok (*Syzygium pycnanthum*), and Clove (*Syzygium aromaticum*). Department of Chemistry, Institut Teknologi Sepuluh November, Surabaya. [Indonesian]
- Waryono T. 2001. The role and functions of services of bio-ecohydrological communities along the river. *Proceeding of National Seminar on Integrated Watershed Management Java-Bali*. Department of Forestry, Jakarta, June 2001. [Indonesian]
- Widodo P. 2007. Review: Speciation in *Syzygium* (Myrtaceae): Model fast and slow. *Biodiversitas* 8 (1): 79-82. [Indonesian]
- Wiriadinata H, Setyowati FM. 2003. Plant riparian for the Situ, Rawa and Lake in Jabodetabek. In: Rosichon U, Maryanto I (eds.) *Management Bioregional Jabodetabek: Profile and Management Strategy Situ, Swamp and Lake*. Puslitbang Biologi-LIPI, Bogor. [Indonesian]
- Wiryanawan KG, Luvianti S, Hermana B, Suharti S. 2007. Improved performance of broiler chickens with supplementation leaf bay (*Syzygium polyanthum* (Wight) Walp) as antibacterial *Escherichia coli*. *Media Peternakan* 30 (1): 55-62. [Indonesian]