Biosaintifika 9 (2) (2017) 273-281

Biosaintifika
Journal of Biology & Biology Education

http://journal.unnes.ac.id/nju/index.php/biosaintifika

# Diversity and Distribution of Myrmecophytes in Bengkulu Province

**Safniyeti, ✉Sulistijorini, Tatik Chikmawati**

**DOI: 10.15294/biosaintifika.v9i2.8747**

Department of Biology, Faculty of Mathematics and Natural Sciences, Bogor Agricultural University, Indonesia

## History Article

Received 21 March 2017
Approved 29 May 2017
Published 17 August 2017

## Keywords

*H. Formicarum; M. Tuberosa*; light intensity; plant biodiversity; temperature; random distribution

## Abstract

Myrmecophyte is a common medicinal plant used by local people in Indonesia for treating various diseases especially in Papua. Bengkulu province is one of the Myrmecophyte habitats, but there has no report on its identity and distribution. The objectives of this research were to identify the diversity and analyze the Myrmecophytes distribution as well as factor affecting its presence. This study used purposive sampling method by exploring the area where Myrmecophytes commonly found. The Myrmecophyte distribution based on host tree was analyzed using *Morishita index* and the autecological analysis of abiotic factors was performed using *Principal Component Analysis* (PCA) generated from Minitab 16. The results of this research showed that there were two species of Myrmecophytes in Bengkulu province, namely *Hydnophytum formicarum* and *Myrmecodia tuberosa*, as well as two variants of *M. tuberosa* i.e. *M. tuberosa* 'armata' and *M. tuberosa* 'siberutensis'. The distribution of Myrmecophytes based on host tree was mostly randomly scattered in Central Bengkulu regency, Seluma, North Bengkulu, South Bengkulu, and Kaur. Their distributions were affected by light intensity and temperature. The data of this research can be used as basic information for carried out conservation efforts in Bengkulu province. The abundance of Myrmecophytes is also used as a source of additional income for local people in Bengkulu province.

## How to Cite

Safniyeti, Sulistijorini & Chikmawati, T. (2017). Diversity and Distribution of Myrmecophytes in Bengkulu Province. *Biosaintifika: Journal of Biology & Biology Education*, 9(2), 273-281.

© 2017 Universitas Negeri Semarang

✉ Correspondence Author:
Darmaga Kampus, 16680 Bogor, Indonesia
E-mail: sulistijorini@gmail.com

p-ISSN 2085-191X
e-ISSN 2338-7610

## INTRODUCTION

Traditional treatment plant-based materials have been widely used by Indonesian people. Various studies on certain parts of tribe to examine the utilization of plants such as the Sakai tribe in Duri (Irawan et al., 2013) and Anak Dalam tribe in Jambi (Mairida et al., 2016). Root, tuber, stem, bark, leaves, and fruit are part of plants used for medicine. One of herbs with the potential to be developed is a Myrmecophyte.

Myrmecophyte is an epiphyte plant. It is called Myrmecophyte because the inner part of its tuber is inhabited by ants and serves as their nest. Each Myrmecophyte is inhabited only by one species of ant (Soekmanto et al., 2010). Myrmecophyte is a member of *Rubiaceae* family. Only five genera have tuber i.e. *Anthorrhiza, Myrmecodia, Hydnophytum, Myrmephytum,* and *Squamellaria* (Huxley & Jebb, 1991). The tuber, its caudex, comes from the swollen hypocotyl formed a network of death tissues among the tubers cavities caused by phellogen (tissue cork) that developed between parenchyma cells (Huxley & Jebb, 1991). Many Indonesian people used the tuber for medicine. Myrmecophytes used as medicine belong to *Hydnophytum* and *Myrmecodia* genera. Phytochemical analysis showed that Myrmecophyte tubers contain of flavonoids and tannins which have the properties of antiproliferative (Senawong et al., 2013), anticancer (Abdullah et al., 2010), antimicrobe (Ahmad et al., 2010), antioxidant (Dirgantara et al., 2013), antiinflammation, antiparasite, antimalarial, and antifungal (Musman et al., 2015).

Myrmecophytes are known with various local names which is differred in each region. This plant is called *Periok hantu, Peruntak,* and *Sembuku* in Malaysia; *By ki nan, Ki nam gai*, and *Ki nam kin* in Vietnam; *Nongon, Lokon,* and *Suhendep* in Papua New Guinea; *Angkis* in Kalimantan; *Urek-urek* and *Ulek-ulek polo* in Java; *Kepala beruk* and *Rumah semut* in Sumatra (Soekmanto et al., 2010). It is called *Simbagh utak* in Bengkulu.

Myrmecophytes grow in mangrove forests on the edge of the beach up to an elevation of 2400 mdpl. They are distributed in the tropical forests of the eastern part, and the highest diversity located in Papua New Guinea. *Hydnophytum* spreads wider than *Myrmecodia* (Huxley & Jebb, 1991). *Myrmecodia tuberosa* found in Kalimantan, Ambon, West Sumatra, and North Sulawesi (Gunawan et al., 2009). *Hydnophytum* believed to grow in South Bengkulu, but its identity has not been known (Ernis 2013).

Previous studies conducted in the province of Bengkulu reveal many benefits of Myrmecophyte, such as decreasing cholesterol level, blood sugar, healing malaria, and uric acid (Ernis 2013). People use it as medicine for curing headache, stomachache, tumor, and cancer. Distribution pattern of plant species is a characteristic of one that lives in a certain habitat. Distribution of a plant closely related to biological and environmental factors of a species (Sofiah et al., 2013). Unfortunately, Myrmecophyte located in the Province of Bengkulu has never been recorded its species diversity, distribution, and environmental factors that influence it.

Considering the important role of Myrmecophytes as one of the potential medicinal plants to be developed in health sector, the research topic on the species diversity, distribution, and factors affecting the availability of Myrmecophyte in the Province of Bengkulu had been carried out. The objectives of this research were to identify the species identity, diversity, distribution, and factors affecting the presence of Myrmecophytes. The information can be used as basic information for carried out conservation efforts as well as further research. The abundance of Myrmecophytes is also used as a source of additional income for local people in Bengkulu province.

## METHODS

This research was carried out in July 2015 until May 2016. Samples were collected from six districts, Bengkulu Province, the Central Bengkulu regency (village Tabalagan), Bengkulu city (village Dusun Besar, Lingkar Timur), Seluma (village Tangga Batu, Kembang Tanjung), North Bengkulu (village Kemumu, Batu Roto, Pagar Banyu), South Bengkulu (village Suka Jaya, Sukarami, Suka Negeri, Nanjungan), and Kaur (Tanjung Betung Village). The samples were identified in Laboratory of Ecology and Plant Resources, Department of Biology, Faculty of Mathematic and Natural Sciences, IPB.

Plant materials studied consisted of 233 individuals of Myrmecophytes, and 51 host trees found in the study site.

Data were retrieved using purposive sampling method by exploring the area where Myrmecophytes are easily found (Sutomo & Mukaromah, 2010). The collected samples were all individuals of Myrmecophytes found.

On a location where Myrmecophyte found is made 51 observation plots of (10x10) $m^2$. The data recorded on each plot were the number of individual Myrmecophytes found on a host, the Myrmecophyte morphology, and the number

and the identity of host tree. Several supporting data were also recorded. They consisted of four microclimate conditions, light intensity, relative humidity, temperature, and wind speed that were recorded using a *digital 4-in-1*. The elevation level and the geographical position of each location were determined using a *Garmin GPS* 60 at 9:00 am to 1:00 pm.

Myrmecophyte identity was defined using five literatures, *The ant-plant Myrmecodia and Hydnophytum (Rubiaceae), and the relationships between their morphology, ant occupants, physiology and ecology* (Huxley, 1978), *Taxonomy and tuber morphology of the Rubiaceae ant-plant* (Jebb, 1985a), *Taxonomy and tuber morphology of the Rubiaceae ant-plants Volume 2 figures and illustration* (Jebb, 1985b), *The tuberous epiphytes of the Rubiacea 1: a new subtribe - the Hydnophytinae* (Huxley & Jebb, 1991), and *The tuberous epiphytes of the Rubiacea 5: a revision of Myrmecodia* (Huxley & Jebb, 1993). The identity of host trees was determined using *Flora of Java* (Backer & Bakhuizen van den Brink, 1965).

The distribution pattern of Myrmecophytes was analyzed using *Morishita* index (Morishita, 1959). The influence of abiotic factors on Myrmecophyte distribution was analyzed using *Principal Component Analysis* (PCA) that were performed using *Minitab* 16.

## RESULTS AND DISCUSSION

Myrmecophytes were only found in 8 villages of 13 visited villages. They were found at 13 sampling points among 51 observed host trees. As many as 233 Myrmecophytes were found in all sampling locations (Table 1). The species found were *Hydnophytum formicarum* and *Myrmecodia tuberosa* . The species of *M. tuberosa* are consisted of two variants i.e. *M. tuberosa* 'armata' and *M. tuberosa* 'siberutensis'.

Number of Myrmecophytes growing on a host tree ranged from 1 to 22 individuals. There was a tree hosted 10 individuals of Myrmecophytes grown in a rubber plantation owned by local residents in Pagar Banyu Village. In contrast to that village, there was only one Myrmecophyte individual found in a tree in Tanjung Betung Village. In Pagar Banyu Village, there were found as many as 92 individuals of Myrmecophytes living on 22 host trees in a rubber plantation, but there was only found 3 individuals of Myrmecophytes on 3 host trees in Tanjung Betung Village.

**Table 1**. Myrmecophyte species collected at each sampling point

| Locations (Villages) | Point Coordinates Number on the Location | Species Name | Σ Ind/ Host | Σ Host | Σ Total of Myrmecophyte | | Habitat of Myrmecophyte |
|---|---|---|---|---|---|---|---|
| | | | | | Large | Small | |
| Tanjung Betung | 1 | *Hydnophytum formicarum* | 1 | 3 | 3 | 0 | Rubber plantation |
| Suka Jaya | 2<br>3<br>4<br>5 | *Myrmecodia tuberosa*.<br>*Myrmecodia tuberosa*<br>*Myrmecodia tuberosa*<br>*Myrmecodia tuberosa* | 2-12 | 9 | 43 | 13 | *Durio* plantation |
| Kemumu | 6<br>7 | *Hydnophytum formicarum*<br>*Myrmecodia tuberosa* 'armata'<br>*Hydnophytum formicarum* | 1-22 | 6 | 47 | 0 | natural tourism Forest (waterfall) |
| Sukarami | 8 | *Myrmecodia tuberosa* | 5-7 | 2 | 8 | 4 | natural tourism Forest (waterfall) |
| Suka Negeri | 9 | *Myrmecodia tuberosa*<br>*Myrmecodia tuberosa* 'siberutensis' | 1-3 | 4 | 7 | 2 | *Durio* plantation |
| Tangga Batu | 10 | *Hydnophytum formicarum* | 1-10 | 3 | 13 | 0 | *Durio* and Cempedak plantation |
| Tabalagan | 11 | *Hydnophytum formicarum* | 2 | 2 | 3 | 1 | Rubber plantation |
| Pagar Banyu | 12<br>13 | *Hydnophytum formicarum*<br>*Hydnophytum formicarum*<br>*Hydnophytum formicarum*<br>*Hydnophytum formicarum* | 1-10 | 22 | 42 | 50 | Rubber plantation |
| 8 | 13 | 16 | 1-22 | 51 | 233 | | |

The Myrmecophytes in Bengkulu Province are mostly found in a plantation. Previous study in Papua also reported that many Myrmecophytes, 388 individuals/ha, found in a plantation area around Nature Reserve of Wasur, Merauke, Papua (Parinding, 2007). They also found in area of mixed farms (Gunawan et al., 2009). They grow on many trees of *Hevea brasiliensis*, *Artocarpus integer, Myristica fragrans, Mangifera indica, Syzygium aromaticum, Syzygium aqueum, Lansium domesticum*, and *Durio zibethinus* (Parinding, 2007; Susanti, 2016), which are commonly found in plantation areas. As epiphytic plants, the Myrmecophytes grow on a various tree species that serve as their host and rely on the micro-climatic conditions of forest stands. Some Myrmecophytes also coexist with orchids on the same tree. Both epiphytic plants only use the host as a place to attach to, hang on, and support their live (Febriliani et al., 2013). In addition, the epiphytes usually grow on host trees with thick, streaked, stringy, and tough bark (Nawawi et al., 2014). Myrmecophytes found in various positions of trees, on the height of tree ranges from 3 to 16 m and located on the main branches or trunks of host trees. Myrmecophytes also live on dead host tree (Parinding, 2007).

The Myrmecophytes of *Hydnophytum* were found scattered around the village of Kemumu, Pagar Banyu, Tabalagan, Tangga Batu, and Tanjung Betung. While, the genus *Myrmecodia* was found in the village of Kemumu, Sukarami, Suka Jaya, and Suka Negeri (Figure 1). The Myrmecophytes was not found in the region of Bengkulu city, Batu Roto village, Nanjungan, and Kembang Tanjung. Many the Myrmecophyte individuals were located in mixed gardens (*Durio* sp. and *Artocarpus integer*), settlement of citizens, natural tourism waterfalls, *Hevea brasiliensis* plantation, *Durio* plantation. In the Kemumu village, two species of Myrmecophytes found on the same tree, a host of 22 individuals of Myrmecophytes.

Based on Figure 1, most individuals of *H. formicarum* were found in the Pagar Banyu village. People in this village do not know the benefits of Myrmecophytes. They let them to live in their garden, but they do not harvest them. In this village, many individuals of Myrmecophytes were found, but they have smaller tuber sized (< 10 cm) compared to that of the other villages. The Myrmecophytes in this village were suspected newly developed plants that grow spreading in the rubber plantation. *Myrmecodia tuberosa* was found in the village at Suka Jaya. Some people already cultivated it. They put this species on trees that grows in their yard by adding a moist of coconut coir as media at the bottom of the tuber of Myrmecophytes.

*Hydnophytum formicarum* and *M. tuberosa* were found in the Kemumu village. The Myrmecophytes in the village were found in the forest near some natural waterfalls and rivers. Since Myrmecophytes prefer habitats closed to water sources (Parinding, 2007), so it is suspected to be the cause of both species found in the village. Very small quantities of *H. formicarum* were found in the Tabalagan Village due to excessive exploitation. People who know these plants sell them in the traditional markets. They harvest them and it reachs a total of 20 to 25 kg once, so at this time Myrmecophytes in the village is getting hard to be found. People in Bengkulu used Myrmecophytes of *M. tuberosa* and *H. formicarum* as a medicine. Both species had been proven its efficacy as a medicine.

*Myrmecodia tuberosa* has a cylindrical tuber, sometimes grooved, spiny, greenish and black color, with narrow cavity. Its stem is mostly unbranched, thorny, with clear clypeoli, but sometimes unlike clypeoli. This species has simple leaves with oval to oblanceolate in shape, green, 9-21 cm long, margin entire, pinnately veined and white petiole. Its flower has tubular form and white color with 4 petals, 0.8-1.2 cm long, anthers and stigma easily found at the mouth of the tube, style 0.6-1.0 cm long. Its fruit is ovate, green to orange, fleshy, 0.5-1.0 cm long, with 4-5 pyrene and seeds.

*Myrmecodia tuberosa* found had two variants namely *M. tuberosa* ' armata' and *M. tuberosa* 'siberutensis''. Previous studies reported that *M. tuberosa* 'siberutensis' found in Sumatra were

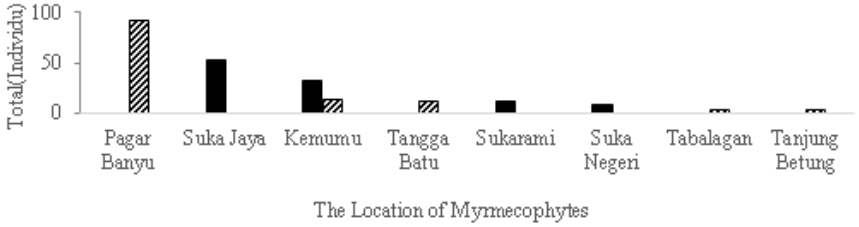


**Figure 1**. Comparison the number of Myrmecophytes of *M. tuberosa* and *H. formicarum* found at each location. ■= *M. tuberosa*; ▨= *H. formicarum*

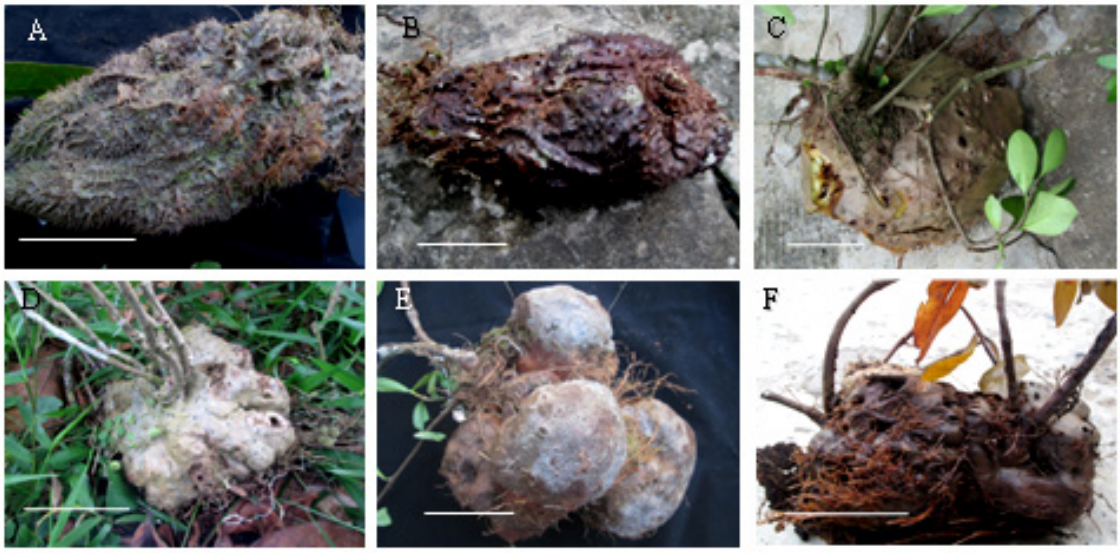


**Figure 2**. Myrmecophytes tuber variations. *M. tuberosa*: A= *M. tuberosa* 'armata'; B= *M. tuberosa* 'siberutensis'. *H. formicarum*: C= ball; D= sprawl; E= ball with 3 grooves; F= cylinder. Bar 10 cm

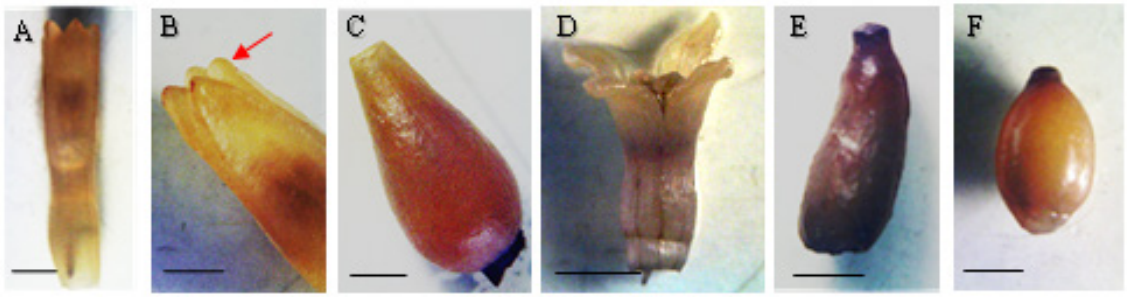


**Figure 3**. The generative organ of Myrmecophyte. *M. tuberosa*; A= flowers; B= end of flowers (arrow); C= fruit. *H. formicarum*: D= flowers; E= oval-formed fruit; F= ovate-formed fruit. Bar 1 mm

located in Mentawai Islands, Batu, and Siberut, whereas *M. tuberosa* 'armata' found in Payakumbuh and Asahan (Huxley & Jebb, 1993). Both variants are differed in shape and color of tuber, as well as the presence of thorns on the stem and tuber (Figure 2 A-B). The flowers and fruits (Figure 3 A-C) of *M. tuberosa* 'armata' are the same as *M. tuberosa* fruit, meanwhile, *M. tuberosa* 'siberutensis' flower could not be observed because there was no fruit and flower found. Huxley & Jebb (1993) reported that variants of *M. tuberosa* were only given informal name, and could not be categorized as subspecies or varieties because they do not have specific morphological and geographical characteristics.

*Hydnophytum formicarum* has a sprawl tuber, ball-like, cylindrical, and sometimes cylinder with irregular grooves, no spiny, greenish and brown color, with wide cavity. Its stem has 2 to 7 branches, no thorny, without clypeoli, but its position is sometimes irregular. It has single leaves with oval and oblanceolate blade shape, green, 3 to 12 cm, margin entire, pinnately veined, and green petiole. It has tubular flowers, white, 0.4 to 0.7 cm long, 4 petals, anthers and stigma at the mouth of the tube, style of 0.3 to 0.6 cm long. Fruit is ovate to oval, green to orange, fleshy, 0.5 to 0.8 cm long, with 1 to 2 pyrene and seeds.

The tuber of *H. formicarum* found in Bengkulu has variation of tuber shape: ball-like, cylinder, and sprawl. They also have distinct color (greenish and brownish) and cavity (Figure 2 C-F),but, the generative organs, flowers and fruits, (Figure 3 D-F) of *H. formicarum* are same.

The animals found in the tubers of *H. formicarum* grown in the village of Tanjung Betung was ant *Crematogaster* sp. which is not found in other species of Myrmecophyte in the province of Bengkulu. In contrast to our result, previous studies reported that *H. formicarum* was not only inhabited by *Crematogaster* ants, but also inhabited by *Camponotus, Technomyrex,* and *Iridomyrmex* (Lok & Tan, 2009), *Anoplolepis, Pedomyrna, Pheidole, Polyrachis, Monomorium, Turneria, Vollenhovia*, and *Ocheletellus* as well (Huxley, 1978). These ants do symbiotic mutualism with nearby plants.

**Table 2**. The distribution pattern of Myrmecophytes based on found host tree at 8 locations in Bengkulu province

| Locations (Village)/District | Myrmecophyte genera | Degrees of *Morishita* dispersion (Ip) | Distribution pattern |
|---|---|---|---|
| Tanjung Betung/Kaur | *Hydnophytum* | 0.0000 | *Random* |
| Suka Jaya/South Bengkulu | *Myrmecodia* | 0.0067 | C*lumped* |
| Kemumu/North Bengkulu | *Myrmecodia* | 0.0000 | R*andom* |
| | *Hydnophytum* | 0.0024 | C*lumped* |
| Sukarami/South Bengkulu | *Myrmecodia* | 0.0000 | *Random* |
| Suka Negeri/South Bengkulu | *Myrmecodia* | 0.0000 | *Random* |
| Tangga Batu/Seluma | *Hydnophytum* | 0.0000 | *Random* |
| Tabalagan/Central Bengkulu | *Hydnophytum* | 0.0000 | *Random* |
| Pagar Banyu/North Bengkulu | *Hydnophytum* | 0.0008 | *Clumped* |

Plants provide food and ants will help pollinate the plants (Harrison, 2014).

**Distribution of Myrmecophytes**

Based on *Morishita* index (Morishita, 1959) both genera of Myrmecophytes found on host tree in this study were mostly randomly (77.8%) scattered in each location, and as much as 22.2% were dispersed in a cluster (Table 2). These results are consistent with that of previous studies that reported Myrmecophytes commonly showed clustered or clumped distribution patterns (Dali, 2014), forming uneven patterns, and irregularly scattered (Gunawan et al., 2009). This pattern is believed to be related to environmental factors (microclimate) of its habitat and reduction of their habitat. Their habitat were turned into settlements and plantations. Myrmecophytes like habitat with slope topography and area near a river. The presence of these plants were also related to a water source as humidity resource (Gunawan et al., 2009). The intensity of exploitation activity can also affect the spread of Myrmecophytes. The overexcess of Myrmecophytes collection may lead to their extinction if some conservation efforts are not performed.

The Myrmecophytes were scattered in five districts in the province of Bengkulu were Kaur, South Bengkulu, Seluma, Bengkulu central, North Bengkulu. The distribution of *H. formicarum* was wider than *M. tuberosa*. *Hydnophytum formicarum* was distributed in Kaur district, Seluma, Bengkulu central, North Bengkulu, and was found at 25 to 629 m altitude. *Myrmecodia tuberosa* was found only in South Bengkulu and North Bengkulu, and grew in an altitude ranged 205 to 351 m altitude (Table 3). *Hydnophytum formicarum* found in locations having cold warm temperatures ranged from 25.0 to 36.0°C and 65.6 to 82% humidity. Compared to *H. formicarum*, *M. tuberosa* prefers hotter (28.4 to 33.8°C temperature) and drier area (54.7 to 78.4% humidity). *Hydnophtyum formicarum* individuals were found in various microclimate conditions, and they are able to adapt to the various environment.

The Myrmecophytes was found in Kemumu village at 377 m altitude with 29.2 to 30.6°C temperature, while in the Tangga Batu village was found at 25 m altitude with temperature ranged 32.1 to 33.3°C. The Myrmecophytes in the Kemumu village were found near a waterfall and a river with cool weather. In contrast to the Kemumu village, in Tangga Batu village, Myrmecophytes were found in rice fields with hot weather and got directly sunlight. Myrmecophytes found in the Kemumu village were *H. formicarum* and *M. tuberosa* 'armata', while in the village of Tangga Batu it was found only *H. formicarum*. Thus, the microclimate of each village affected the diversity of Myrmecophytes found.

Microclimate and ecological conditions of Myrmecophytes habitat in Bengkulu Province were different from South Kalimantan. The Myrmecophytes in South Kalimantan grown at range 23.0 to 26.8°C temperature with relative humidity of 78.0 to 82.0%, and light intensity of 570.0 to 870.0 lux (Gunawan et al., 2009). In South Kalimantan forests, Myrmecophytes grew in the mountains, while in Bengkulu Province they were found in lowlands and plantations. Myrmecophytes were found in Bengkulu Province namely *H. formicarum*, *M. tuberosa*, and two variants of *M. tuberosa* (*M. tuberosa* 'armata' and *M. tuberosa* 'siberutensis'), whereas in South Kalimantan only found a species, *M. tuberosa*. *Myrmecodia tuberosa* is suspected to have capability living in the mountain forests and lowlands. Thus, not only the microclimate of each Myrmecophytes

**Table 3**. Some microclimate parameters around the Myrmecophytes

| Village/ District | Location | Microclimate | | | | |
|---|---|---|---|---|---|---|
| | | Altitude (m dpl) | Humidity (RH%) | Temperature (°C) | Light Intensity (Lux) | Wind Speed (Km/h) |
| TB/KAUR | 1 | 629 | 82.6 | 25.0 | 5170.0 | 1.2 |
| SJ/BS | 2 | 219 | 63.6-78.4 | 28.8-31.8 | 1157.0-1234.0 | 0.0-1.0 |
| SJ/BS | 3 | 249 | 57.4 | 36.1 | 1192.0 | 2.0 |
| SJ/BS | 4 | 290 | 63.8-64.7 | 30.5-32.0 | 1463.0-1977.0 | 2.2-3.4 |
| SJ/BS | 5 | 270 | 63.0-76.5 | 29.3-33.8 | 1353.0-1643.0 | 0.0-2.4 |
| KM/BU | 6 | 351 | 74.4-77.0 | 30.0-30.3 | 4690.0-6020.0 | 0.0-1.1 |
| KM/BU | 7 | 377 | 76.1-76.3 | 29.2-30.6 | 3870.0-5260.0 | 0.0-0.9 |
| SKR/BS | 8 | 211 | 75.1 | 28.4 | 4650.0 | 0.8 |
| SKN/BS | 9 | 205 | 71.5-77.3 | 32.2-32.6 | 1763.0-3410.0 | 0.0-1.7 |
| TB/SELUMA | 10 | 25 | 71.9-73.6 | 32.1-33.3 | 5070-5810.0 | 2.6-2.7 |
| TBL/BT | 11 | 54 | 76.0-76.9 | 33.6-34.3 | 4020.0-5090.0 | 0.0-0.7 |
| PB/BU | 12 | 133 | 66.8 | 35.4 | 6670.0 | 1.2 |
| PB/BU | 13 | 132 | 65.6 | 36.3 | 3490.0 | 1.4 |

Note : TB= Tanjung Betung; SJ= Suka Jaya; KM= Kemumu; SKR= Sukarami; SKN= Suka Negeri; TB= Tangga Batu; TBL= Tabalagan; PB= Pagar Banyu; BS= Bengkulu Selatan; BT= Bengkulu Tengah; BU= Bengkulu Utara

location, but also the ecological conditions of Myrmecophytes habitat affected the diversity of Myrmecophytes.

*Myrmecodia tuberosa* was found in the seashore near Jurong and Bukit Timah at Singapore, but they were disappeared in the early 1990s, and *H. formicarum* was categorized into endangered species. *Hydnophytum formicarum* was found in lowland, mangrove forests along the northern coastline of Pulau Tekong and Pawai (Lok & Tan, 2009). In addition, both species were found in lowlands, plantations, beaches, mangrove forests, swamps, and savanna in Papua (Parinding, 2007; Susanti, 2016). *Hydnophytum formicarum* and *M. tuberosa* were allegedly able to adapt to various microclimate conditions. Both species have wide distribution from Sumatra, Kalimantan, North Sulawesi and Papua, and Singapore. The highest diversity and abundance of Myrmecophyte is in Papua.

The diversity of Myrmecophytes found in Bengkulu province was relatively low when compared to that in Papua province and North Sulawesi. The Myrmecophytes found in the Nature Reserve of Wasur Merauke Papua, were 4 species of *Hydnophytum* and 14 species of *Myrmecodia* (Parinding, 2007), whereas in Fakfak, West Papua discovered 7 species of *Hydnophytum* and 2 species of *Myrmecodia* were found (Susanti, 2016). Three species, *Hydnophytum formicarum*, *M. pendans*, and *M. tuberosa* also found in the nature reserve of Gunung Ambang sub region East Mongondow Bolaang, North Sulawesi (Dali, 2014). The light intensity and temperature measured were also different in both locations. The nature reserve of Gunung Ambang sub region East Mongondow Bolaang, North Sulawesi had light intensity of 600 to 870 lux and temperature of 23 to 28°C where Myrmecophytes found (Dali, 2014). The light intensity in Fakfak is 1010 to 1764 lux and temperature ranged 27.5 to 31.9°C (Susanti, 2016). So it is suspected that the diversity of Myrmecophytes affected by environmental conditions where the plant grows.

Based on *Principal Component Analysis* (PCA), it was known that light intensity and temperature factors were contributed to the population size of Myrmecophytes (Figure 4). Some locations where *M. tuberosa* and two variants of *M. tuberosa* 'siberutensis', *M. tuberosa* 'armata' and *H. formicarum* found in Bengkulu had the same microclimates.

The first major component is temperature. It contributed of 54.8% to the presence of Myrmecophytes. The 2nd major component is light intensity of which contributed of 21.9%. The total of major components is 76.7%. Myrmecophytes in Bengkulu Province grew at above 1000 lux light intensity and the temperature reached 36.3°C, while in the mountainous regions of South Kalimantan and Nature Reserve Gunung Ambang Bolaang Mongondow Eastern

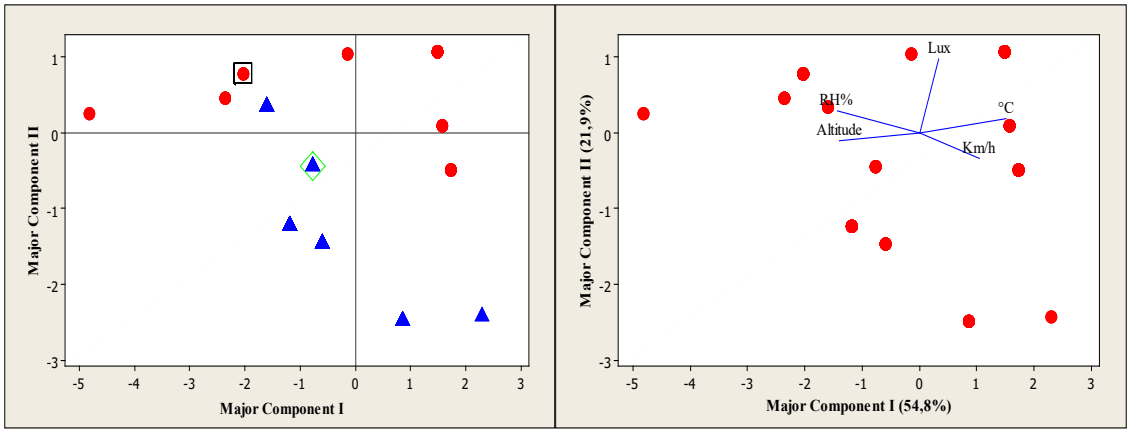


**Figure 4**. The major components analysis of environmental factors: A. the distribution of Myrmecophytes spesies; B. Environmental factor correlation contributed to the distribution of Myrmecophytes; Altitude= the altitude of the place; %RH= humidity; C°= temperature; Lux= light intensity; Km/h= wind speed; ▪ = *H. formicarum*; ⌐ = *M. tuberosa* 'armata'; ◇ = *M. tuberosa* 'siberutensis'; ▲ = *M. tuberosa*

(North Sulawesi) they grew in an area that had low light intensities, below 1000 lux (Dali, 2014) and are not able to grow at above 27°C temperatures (Gunawan et al., 2009). Myrmecophytes require high light intensity. One individual tree can be a host of 22 individuals of Myrmecophytes that tend to attach on branches, at canopy, and in the main stem of trees to meet their needs to light. Light is the energy source used by plants to perform photosynthesis, stomata conductance and resistance, and the chlorophyll synthesis (Buntoro et al., 2014).

Myrmecophytes found in Bengkulu Province were *H. formicarum*, *M. tuberosa* and two variants of *M. tuberosa* namely *M. tuberosa* 'armata' and *M. tuberosa* 'siberutensis'. Both species had been proven its efficacy as a medicine and used to people in Bengkulu for medicinal plant. The benefit of this research is to can be used as basic information for carried out conservation efforts (in situ and ex situ) in the area of Bengkulu province to prevent the extinction of this species. The abundance of Myrmecophytes in Bengkulu province is also used as a source of additional income for local people.

## CONCLUSIONS

Myrmecophytes found in Bengkulu Province were *H. formicarum*, *M. tuberosa* and two variants of *M. tuberosa* namely *M. tuberosa* 'armata' and *M. tuberosa* 'siberutensis'. Myrmecophytes were distributed in North Bengkulu, Central Bengkulu, Seluma, South Bengkulu, and Kaur. Based on found host tree, most Myrmecophytes (77.8%) were scattered in random distribution pattern and the highest variations of their distribution is in South Bengkulu district. Myrmecophytes in Bengkulu Province was found in altitude of 25 to 629 m altitude, wind speed of 0.0-3.4 km/h, relative air humidity of 57.4 to 82.6%, light intensity of 1157.0 to 6670.0 lux, and temperature 25.0 to 36.3°C.

## ACKNOWLEDGEMENT

Acknowledgements are presented to friends from the University of Bengkulu (Jeri Stia Nanda, M. Rifqi Hariri, Yetti Rahmadani, Wika Putriana, Meliyawati, Silisti, Metalia Soneta, Ria Restu Hardianti, Fitri Rahmadany, Level Loyen, Deki, Nike Rismawati, Mia Wulandari, Noli Krisnanto, Tri Wijayanto) who assisted and lent their hand during exploration and data collection. Thank to Ministry of Research, Technology and Higher Education of the Republic of Indonesia for awarding the Fresh Graduate Scholarship 2014-2016.

## REFERENCES

Abdullah, H., Pihie, A. H. L., Hohmann, J., & Molnar, J. (2010). Anatural compound from *Hydnophytum formicarium* induces apoptosis of MCF-7 cells via up-regulation of Bax. *Cancer cell international,* 10(1), 14.

Ahmad, R., Mahbob, E. N. M., Noor, Z. M., Ismail, N. H., Lajis, N. H., & Shaari, K. (2010). Evaluation of antioxidant potential of medicinal plants from Malaysian *Rubiaceae* (subfamily *Rubioideae*). *African Journal of Biotechnology*, 9(46), 7948-7954.

Backer, C. A. & Bakhuizen van den Brink, R. C. (1965). *Flora of Java* (*Spermathopyte only*). Groningen: NVP Noordhoft.

Buntoro, B., H., Rogomulyo, R., Trisnowati, S. (2014).

Pengaruh takaran pupuk kandang dan intensitas cahaya terhadap pertumbuhan dan hasil temu putih (*Curcuma zedoaria* L.). *Vegetalika*, 3(4), 29-39.

Dali, R. (2014). Keanekaragaman dan pola penyebaran tumbuhan sarang semut di kawasan Cagar Alam Gunung Ambang sub kawasan Kabupaten Bolaang Mongondow Timur. *Skripsi*. Gorontalo: Universitas Negeri Gorontalo.

Dirgantara, S., Nawawi, A., & Insanu, M. (2013). Uji aktivitas antioksidan tiga spesies tanaman sarang semut (Famili: *Rubiaceae*) asal Kabupaten Merauke, Papua. *Jurnal Biologi Papua,* 5(1), 10-16.

Ernis, G. (2013). Pengaruh ekstrak umbi "*Simbagh utak*" (*Hydnophytum* sp.) terhadap kadar asam urat *Mus musculus* jantan dan karakterisasi hasil isolasi menggunakan FTIR. *Skripsi*. Bengkulu: Universitas Bengkulu.

Febriliani, Mallombasang, S. N., & Muslimin. (2013). Analisis vegetasi habitat Anggrek di sekitar Danau Tambing kawasan Taman Nasional Lore Lindu. *Warta Rimba*, 1(1), 1-9.

Gunawan, Suyanto, Hafizianor, & Hamidah, S. (2009). Inventarisasi komposisi jenis dan potensi tumbuhan sarang semut *(Myrmecodia* sp.) berdasarkan karakteristik ekologis habitatnya di kawasan hutan pegunungan Meratus Kalimantan Selatan. *Jurnal Hutan Tropis Borneo*, 25, 71-85.

Harrison, R. D. (2014). Ecology of a fig ant plant. *Acta Oecologica*, 57, 88-96.

Huxley, C. R. (1978). The ant-plants *Myrmecodia* and *Hydnophytum* (Rubiaceae), and the relationships between their morphology, ant occupants, physiology and ecology. *New Phytologist*, 80(1), 231-268.

Huxley, C. R., & Jebb, M. H. P. (1991). The tuberous epiphytes of the *Rubiaceae* 1: A new subtribe – The *Hydnophytinae*. *Blumea*, 36(1), 1-20.

Huxley, C. R., & Jebb, M. H. P. (1993). The tuberous epiphytes of the *Rubiaceae* 5: a revision of *Myrmecodia*. *Blumea*, 37(2), 271-334.

Irawan, Y. R., Fitmawati, Herman. (2013). Pengetahuan Tumbuhan Obat Dukun Sakai Desa Sebangar Duri Tiga Belas dan Desa Kesumbo Ampai Duri Kabupaten Bengkalis. *Biosaintifika: Journal of Biology & Biology Education,*, 5(1), 30-35.

Jebb, M. H. P. (1985a). Taxonomy and tuber morphology of the Rubiaceae ant-plant. *Thesis*. Oxford: Postgraduate, University of Oxford.

Jebb, M. H. P. (1985b). Taxonomy and tuber morphology of the Rubiaceae ant-plant. *Thesis*. volume 2 figures and illustration. Oxford: Postgraduate, University of Oxford.

Lok, A. F. S. L., & Tan, H. T. W. (2009). Tuberous, epiphytic, rubiaceous *Myrmecophytes* of Singapore. *Nature in Singapore*, 2, 231-236.

Mairida, D., Muhadiono, M., & Hilwan, I. (2016). Ethnobotanical Study of Rattans on Suku *Anak Dalam* Community in *Bukit Duabelas* Nasional Park. *Biosaintifika: Journal of Biology & Biology Education*, 8(1), 64-72.

Morishita, M. (1959). *Measuring of the Dispersion on Individual and Analysis of the Distributial patterns*. Jepang: Kyushu University.

Musman, M., Karina, S., Defira, C. N., Fadhillah, N., Kayana, A., Hasballah, N., Faunanda, A. R., & Putra, R. (2015). Phytofungitoxic Agent from wild plants. *International Journal of Sciences: Basic and Applied Research*, 21(1), 78-85.

Nawawi, G. R. N., Indriyanto, Duryat. (2014). Identifikasi jenis epifit dan tumbuhan yang menjadi penopangnya di blok perlindungan dalam kawasan Taman Hutan Raya Wan Abdul Rachman. *Jurnal Sylva Lestari*, 2(3), 39-48.

Parinding, Z. (2007). Potensi dan karakteristik bioekologis tumbuhan sarang semut di Taman Nasional Wasur Merauke Papua. *Tesis*. Bogor: Sekolah Pascasarjana, Institut Pertanian Bogor.

Senawong, T., Misuna, S., Khaopha, S., Nuchadomrong, S., Sawatsitang, P., Phaosiri, C., Surapaitoon, A., & Sripa, B. (2013). Histone deacetylase (HDAC) inhibitory and antiproliferative activities of phenolic-rich extracts derived from the rhizome of *Hydnophytum formicarum* Jack.: sinapinic acid acts as HDAC inhibitor. *BMC Complementary and Alternative Medicine*, 13(1), 232.

Soekmanto, A., Subroto, M. A., Wijaya, H., & Simanjuntak P. (2010). Anticancer activity test for extracts of Sarang semut plant (*Myrmecodia pendens*) to HeLa and MCM-B2 cells. *Pakistan Journal of Biological Sciences,* 13(3), 148-151.

Sofiah, S., Setiadi, D., & Widyatmoko, D. (2013). Pola penyebaran, kelimpahan, dan asosiasi bambu pada komunitas tumbuhan di Taman Wisata Alam Gunung Baung Jawa Timur. *Berita Biologi*, 12(2), 239-247.

Susanti, E. (2016). Inventarisasi tumbuhan sarang semut di Kabupaten Fakfak Papua Barat. *Skripsi*. Bogor: Institut Pertanian Bogor.

Sutomo, & Mukaromah, L. (2010). Autekologi Purnawijaya (*Euchresta horsfieldii* (Lesch.) Benn. (Fabaceae) di sebagian kawasan Hutan Bukit Tapak Cagar Alam Batukahu Bali. *Jurnal Biologi*, 14(1), 24-28.