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# Ginger species in Besiq Bermai forest, East Borneo: Inventory and collection FREE

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# Ginger Species in Besiq Bermai Forest, East Borneo: Inventory and Collection

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**Abstract.**This research is aimed to inventory and collect ginger species from Borneo, especially from Besiq Bermai forest, East Borneo forest. This research was conducted by surveys and using a purposive sampling method. The characterization of Borneo gingers also used a guide to ginger of Borneo. The results showed that there are 19 species which have been recorded in this forest. Amomum, Alpinia, Plagiostachys, Globba, Hornstedtia, Plagiostachys, Zingiber, is genus that found in the forest. The life collections are conserved in Purwodadi Botanical Gardens. The species of Zingiberaceae are *Alpinia pubiflora* (Benth.) K. Schum., *Alpinia aquatica* (Retz.) Roscoe, *Alpinia capitellata* Jack, *Alpinia beamanii* R.M.Sm. *Amomum oliganthum* K. Schum, *Etlingera pauciflora* (Ridl.) R.M.Sm, *Elettaria surculosa* (K.Schum) B.L. Burrt&R.M. Sm, *Hornstedtia rumphii* (Sm.) Valeton, *Hornstedtia conica* Ridl, *Hornstedtia reticosa* Valeton, *Globba pumila* Ridl, *Plagiostachys bracteolata* R.M. Sm, *Plagiostachys albiflora* Ridl, *Plagiostachysbreviramosa* Cowley, *Zingiber aromaticum* Noronha, *Zingiber zerumbet* (L.) Roscoe ex Sm, *Zingiber officinale* Roscoe, *Zingiber montanum* ( J.Koenig) Link ex A. Dietr, and *Zingiber leptostachyum* Valeton.

## INTRODUCTION

Borneo Island is known asone of the centersof plant diversity in the world. This island is home to various endemic, rare, and potentially important plant species.[1-2] The study of biodiversity like habitat and taxonomy is very poor. Plant conservation is needed in Borneo to reduce the rate of plant species loss in Borneo.The forest character of Borneo is lowland tropical; it has high humidity, and high rain intensity, so many herbal plants can grow there. One family of herbal plants with high diversity is Zingiberaceae.

The ginger family, Zingiberaceae, consists of more than 1500 species in 53 genera, mostly in tropical forests. Classifications of the family were first proposed in 1889 and refined by others since then to recognize four tribes based on morphological features, i.e.: Globbeae, Hedychieae, Alpinieae, and Zingibereae.[3] Borneo gingers display great diversity and are separated into 19 genera with nearly 250 taxa; Burbidgea, Haplochorema, and Myxochlamys are endemic gingers on this island.[4] Zingiberaceae has much potential. Many species are used by people as medicine, spices, dyes, perfume and aesthetics.[5] It is an important natural resource that provides many useful products. In total, 16-20% of ginger products are edible and can be consumed fresh, cooked, picked, or boiled.[6] Many potions of wild ginger are unidentified with unknown uses. Borneo ginger is a bio-resource that must be saved.

Conservation is important for long-term plant rescue programs. It is a crucial step toward minimizing biodiversity loss, which is caused by human activities, global environmental changes, habitat loss and species extinction.[7] The purpose of conservation is to rescue the plant either *in-situ* or *ex-situ*. This study aimed to record the diversity of wild ginger and collect samples from the forest in East Borneo. This research is used to add information regarding wild ginger in Borneo forest, then conserve Zingiberaceae in the Purwodadi Botanic Garden. This specimen can be used to develop research into genetic resources of wild ginger from Borneo forest.

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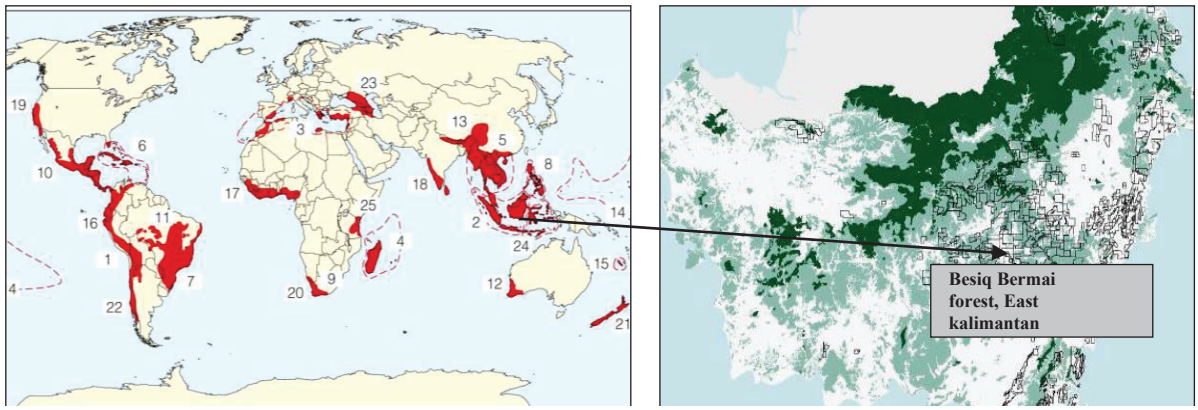
## MATERIALS AND METHODS

The research was conducted in 2015, at Besiq Bermai forest, Kutai Barat, East Borneo by surveys using a purposive sampling method. Ten plots with a size of 100x20m were made to inventory Zingiberaceae in the forest. The data and specimens were collected for *ex-situ* conservation. We also recorded environmental factors of the Zingiberaceae habitat, including altitude, humidity, temperature, soil pH and light intensity. The *ex-situ* conservation was done by planting flora specimens in Purwodadi Botanic Garden. Herbarium in order to identify the plant species. This herbarium was identified in Purwodadi Botanic Garden and Bogoriense Herbarium Indonesian Institute of Sciences. The characterization of Borneo gingers also used a guide to gingers of Borneo.[4]

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Source: final report study biodiversity in Bharinto Ekatama forest concession

**FIGURE 1.** Map of Inventory of Zingibraceae in East Borneo

## RESULT AND DISCUSSION

The results showed that there are 19 species of wild ginger collected from the forest (Table 1). These included 4 species of *Alpinia*, 1 species of *Amomum*, 1 species of *Etlingera*, 1 species of *Elettaria*, 3 species of *Hornstedtia*, 1 species of *Globba*, 3 species of *Plagiostachys*, and 5 species of *Zingiber*. All of these species comprise a new collection for Purwodadi Botanic Garden. Regarding habitat, Zingiberaceae are found in lowland and streams, with low light intensity, and high humidity.

**TABLE 1.** Wild Ginger Collection in Besiq Bermai, East Kalimantan

| Species of Wild Ginger | Habitat in Forest |
|---|---|
| *Alpinia pubiflora* (Benth.) K. Schum. | Altitude 110 MSAL, temperature 31,5° C, humidity 74 %, soil pH 6,2, light intensity 2785 Lux |
| *Alpinia aquatica* (Retz.) Roscoe | Altitude 135 MSAL, temperature 30° C, humidity 78 %, soil pH 6,2, light intensity 2386 Lux |
| *Alpinia capitellata* Jack | Altitude 154 MSAL, temperature 30,4° C, humidity 80 %, soil pH 6,2, light intensity 2766 Lux |
| *Alpinia beamanii* R.M.Sm. | Altitude 120 MSAL, temperature 29,8° C, humidity 83 %, soil pH 6,4, light intensity 4400 Lux |
| *Zingiber aromaticum* Noronha | Altitude 95 MSAL, temperature 30,4° C, humidity 92 %, soil pH 6,1, light intensity 5110 Lux |
| *Zingiber zerumbet* (L.) Roscoe ex Sm | Altitude 95 MSAL, temperature 30,4° C, humidity 92 %, soil pH 6,1, light intensity 5110 Lux |
| *Zingiber officinale* Roscoe | Altitude 120 MSAL, temperature 29,8° C, humidity 83 %, soil pH 6,4, light intensity 4400 Lux |
| *Zingiber montanum* (J.Koenig) Link ex A. Dietr | Ketinggian 154 MSAL, temperature 30,4° C, humidity 80 %, soil pH 6,2, light intensity 2766 Lux |
| *Zingiber leptostachyum* Valeton | Altitude 154 MSAL, temperature 30,4° C, humidity 80 %, soil pH 6,2, light intensity 2766 Lux |
| *Amomum oliganthum* K. Schum | Altitude 120 mdpl, temperature 29,8° C, humidity 83 %, soil pH 6,4, light intensity 4400 Lux |
| *Etlingera pauciflora* (Ridl.) R.M.Sm | Altitude 154 mdpl, temperature 30,4° C, humidity 80 %, soil pH 6,2, light intensity 2766 Lux |
| *Elettariasurculosa* (K.Schum) B.L. Burrt & R.M. Sm | Altitude 169 mdpl, temperature 28,2° C, humidity 79 %, soil pH 6, light intensity 2766 Lux |
| *Plagiostachys bracteolata* R.M.Sm | Altitude 120 mdpl, temperature 29,8° C, humidity 83 %, soil pH 6,4, light intensity 4400 Lux |
| *Plagiostachysalbiflora*Ridl | Altitude 123 MSAL, temperature 31,3° C, humidity 82 %, soil pH 5,9, 5266 Lux |
| *Plagiostachys breviramosa* Cowley | Altitude 135 mdpl, temperature 30° C, humidity 78 %, soil pH 6,2, light intensity 2386 lux |
| *Hornstedtia rumphii* (Sm.) Valeton | Altitude 135 MSAL, temperature 30° C, humidity 78 %, soil pH 6,2, light intensity 2386 Lux |
| *Hornstedtia conica* Ridl | Altitude 123 MSAL, temperature 31° C, humidity 82 %, soil pH 5,9, light intensity 5266 Lux |
| *Hornstedtia reticosa* Valeton | Altitude 135 MSAL, temperature 30° C, humidity 78 %, soil pH 6,2, light intensity 2386 Lux |
| *Globba pumila* Ridl | Altitude 123 MSAL, temperature 31° C, humidity 82 %, soil pH 5,9, light intensity 5266 Lux |

The Besiq Bermai forest is a rainforest, with only a small percentage of light penetrating the canopy, so understory vegetation is generally shade-tolerant. In logged forest, several species have been found, such as Etlingera and Hornstedtia. A number of species are browning when found in increased sunlight and lower humidity. The differences in the mean radiance of each coupe may relate to changes in the proportion of climax tree canopy relative to a cover of either pioneer trees or ginger.[8] The utilization of wild ginger by local people is so limited. Some ginger species that are used and cultivated include *Curcuma domestica* and *Zingiber officinale*. Dayak People in Benggeris village Eas Kalimantan used *C. domestica* to treat asthma, and gynecological and intestinal problems.[9]

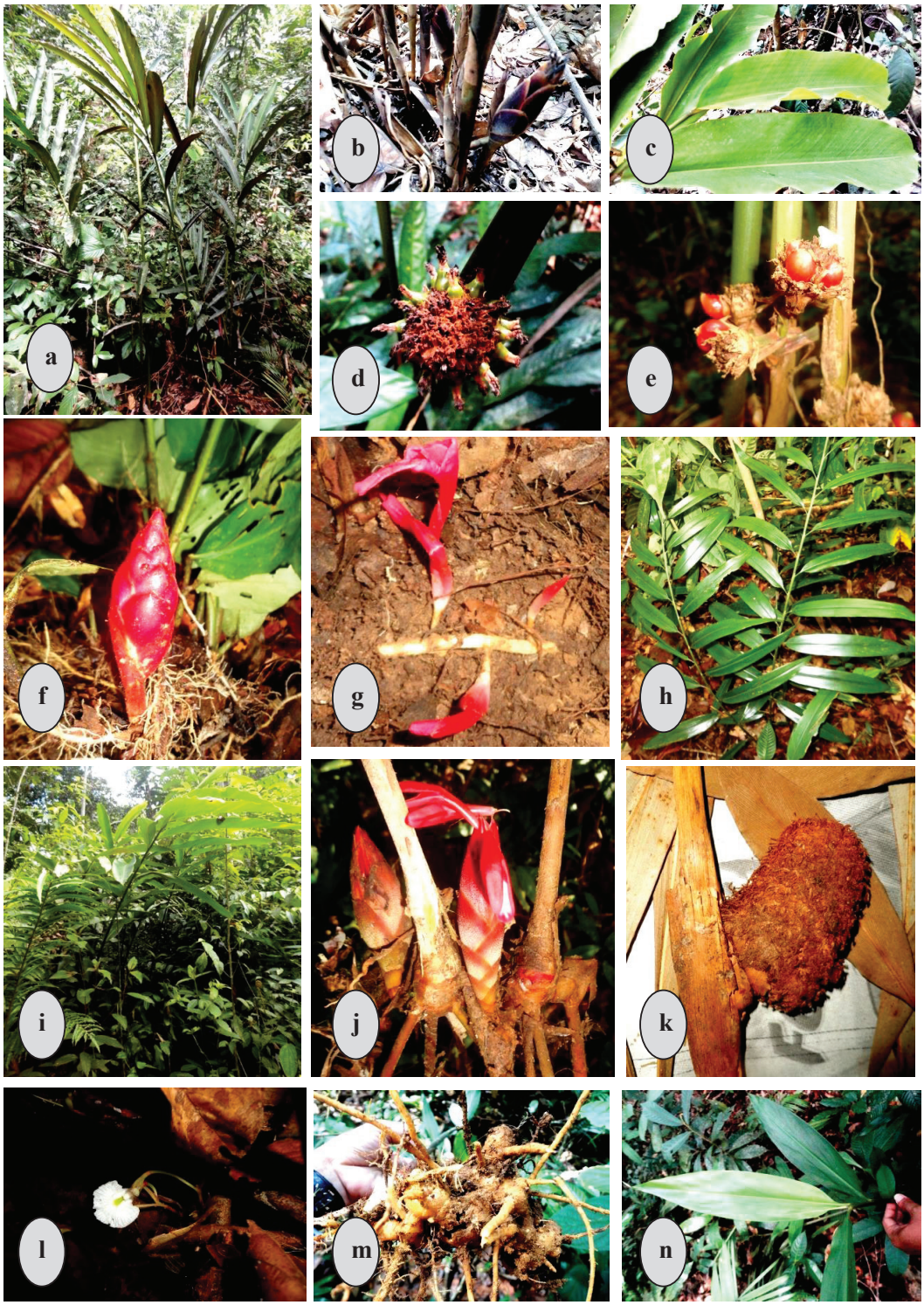


**FIGURE 2.** Diversity Zingiberaceae Spesies in Besiq Bermai East Borneo Forest*: a)* Alpinia beamanii*, b) & c)* Hornstedtia rumphii*, d)* Plagiostachys breviramosa*, e)* Plagiostachys bracteolata*, f)* Zingiber aromaticum*, g)*

Etlingera pauciflora*, h)* Zingiber officinale*, i)* Hornstedtia conica*, j) Flower* Hornstedtia conica*, k)* Plagiostachys albiflora*, l)*Elettaria surculosa*, m) & n)* Zingiber leptostachyum .

## *Alpinia*

*Alpinia* is an herb lacking true stems, which grows from thick rhizomes, and has terminal inflorescences. It is one of the largest genera in Sabah. Many species of *Alpinia* have edible fruits. There are 4 species of *Alpinia* in the forest. Most *Alpinia*is plants of the forest understory. First, *Alpinia beamanii* was distributed in Sabah,[10] and Endemic in Borneo. This species forms large clumps with broad leaves of over 2 m. The inflorescences consists of many tiny flowers in the terminal. The color of the fruit is green, which changes to black if the fruit ripens. The fruit can be eaten. Second is *A. capitellata*, which is most common in Sarawak and is widespread. This species is also found in East Kalimantan, and forms clumps of about 2-4 m tall. The leaves are glabrous, and have terminal inflorescence. These fruits are round with a yellow color. *A. aquatica* is found in the forest understory habitat and lowland. This species forms clumps of pseudostems of over 2 m. The inflorescence is terminal and a white dark pink color. The leaf margins have short bristles. This fruit is round and the color is purple-black. *A. pubiflora* is distributed in the Philippines, Moluccas and West Papua. This species has leafy shoots of about 2.5 m long, with lamina lanceolate, dark green and glabrous, and with a base that is acute apex acuminate. Inflorescences are branched and terminal with a length of 20 cm. Fruit us round, 5 x 5 mm, with a green color and glabrous.[11] The species of *Alpinia* are known to be a medicine. *A. galanga* is believed to have antimicrobial and antifungal properties,[12-13] *A. katsumadai* has antioxidant activity,[14] and *A. speciosa* produces phenolic compounds[15] Many species of wild *Alpinia* have not been reported, so it is important to save wild *Alpinia* diversity in Borneo.

## *Plagiostachys*

*Plagiostachys* is distinguished from other genera of Zingiberaceae by the apparently lateral, extremely congested inflorescence, which is, in fact, terminal on short sterns from leafy shoots that usually break through the leaf sheaths just above ground level or occasionally from the middle of the plant.[16] The genus *Plagiostacdys*, (Zingiberaceae) is rather small in the family, comprising about 20 species[17] and is distributed from Indochina to Malaysia with the center of diversity in Borneo. *P. albiflora* is found widespread in Besik Forest, where this species dominated. This forms a clump, with leafy shoots to 1.5 m. Inflorescence appears with a yellow lip and the fruit is shaped like a capsule; the color is green. The other species are *P. breviracemosa,* with non-mucilaginous inflorescence, papery calyx, and bracteoles, which sometimes disintegrate before anthesis. *P. bracteolata* has non-mucilaginous inflorescence, bracteoles open to the base, and distinct apiculates, 3-5 mm long. *Plagiostachys* are known to be medicinal plants. *P. albiflora* is used by people in Sumatra as a medicinal plant.[18] Many wild species of *Plagiostachys* in Borneo are potential medicines.

## *Amomum*

*Amomum* is the second largest genus after Alpiniawithin Zingiberaceae, with about 150-180 species, widely distributed in Southeast Asia.[19] One species is *Amomum oliganthum*. This species is endemic to Borneo, and is also found in East Kalimantan forest. The habitus is clumps of generally up to 1.5 m tall. The inflorescence is short peduncule with a compact inflorescence, large brown barcts, and 1-4 pale orange tubular flowers. Fruits are red and spiny when young and green when mature. *Amomum* is known to be a medicine. Chemical compounds of some species were identified. *A. subulatum* was known as an anti-ulcerogenic,[20], antimalarial peroxide from *A. krervanh.*[21] It is possible to observe chemical compounds of *A. oliganthum.* Because this medical report is unknown, it is known to be an ornamental plant found in rails to hot springs, near the second river, on the riverbank.[22]

## *Hornstedtia*

*Hornstedtia* is a genus with medium to tall gingers. The flowers mostly open one at a time from the top of the inflorescence. The species is distributed in Thailand, the Malay Peninsula, Java, Sumatra, and Borneo. Several species have stilt roots. *H. rumphii* is a robust perennial plant producing a cluster of unbranched, leafy stems up to 5 meters tall. The stems grow from a woody, branched rhizome. *H. conica* is widely distributed in Thailand, the Malay Peninsula, Singapore, Sumatra, Java, and Borneo. This species forms a clump of 3 m tall. The inflorescence is

produced on the rhizome, and bracts are bright red, with most it covered in silvery, strongly appressed hairs. Flowers consist of 1 with red corolla lobes and pink lips with a white center. The other species is *H. reticosa.* Some species of *Hornstedtia* are successfully identified by their chemical compounds, like *H. leonurus,* which contains essential oils of the rhizome, leaf, and stem,[23] which has antibacterial activity similar to *H. pininga*.[24] Many species of wild *Hornstedtia* from Borneo also have potential as medicine. Conservation is needed to save the species and observe these bioresources.

## *Globba*

*Globba* is distributed in the Tropical Asia monsoon forest. *Globba* species are distributed throughout tropical (and parts of subtropical) Asia, ranging from India to southern China.[25] The species are found in the Malay Peninsula, from Borneo to New Guinea. Thirteen taxa have been recorded for Borneo. Many species have very short branches of flowers and cincinni. Globba is a slender herb with leafy shoots up to 50 cm in length. All species have bilobed ligules. *G. pumila* is an endemic species from Borneo, known from Sarawak and West Kalimantan; this species also found in East Kalimantan. This species is less than 20 cm tall, with leaves less than 7 cm, which are dark green, with a white inflorescence. It is used as an ornamental plant.

## *Elettaria*

*Elettaria* has inflorescences from the rhizome and on the surface of the soil. *E. surculosa* have small patches of leafy shoots from the spreading rhizome. Inflorescences growing out from the soil surface are often too long, with long corolla tubes and broad white lips with a yellow center. This species is found in small populations in East Kalimantan. It is an endemic species to Borneo. This species is found in high humidity and low light intensity. Several species of *Elettaria* has a pungent smell when the leaf is crushed, which indicates that this species contains chemical compounds used for medicine. Many *Elettaria* has unknown potency.

## *Etlingera*

*Etlingera* species are recognized by the presence of an involucre of large, sterile bracts, with elongated and tubular bracteoles.[26] *Etlingera* is a tall leafy shoot. The form is 1 to 8 m. There is a variation on peduncule and the lip also a very lot. In Borneo, it has large species. Many of this species have flowers pollinated by birds and insects. *E. pauciflora*is found separately. They are found in high humidity and low light intensity, with flowers growing on the soil surface. The color of the flowers is pink–red. Many species of *Etlingera* from the Malay Peninsular have potential. Some species have phenolic content, antioxidant activity, and antibacterial activity.[27] Wild *Etlingera* species have the potential for medicine.

## *Zingiber*

*Zingiber* is known as a major spice species in ginger. Most species have inflorescence at the base and separate from the leafy shoot. The flower has three lobed lips, with anthers that are is long like horn structure. There are 5 species of *Zingiber* collected from Besiq Bermai forest: *Z. aromaticum, Z. zerumbet*, *Z officinale*, *Z. montanum*, and *Z. leptostachyum*. Many species of *Zingiber* are used in traditional herbal medicine in villages like *Z. zerumbet* and *Z. officinale*. *Zingiber* is also known to be a medicine. Dayak people also cultivate several *Zingiber* species in their gardens.

*Z. aromaticum* is found in wet and moist areas. This species can grow to 150 cm high. The morphology is fibrous rhizome, lateral and red inflorescence if mature, very aromatic rhizome, bitter taste, and very spicy. The current research showed that it contains zerumbone, an HIV-inhibitory and cytotoxic Sesquiterpene,[28] with anticancer properties and antitumor activity.[29] *Z. zerumber* has anti-nociceptive,[30] anti-inflammatory,[31] and nephroprotective activities.[32] *Z. montanum* is known as Cassumunar ginger, is probably native to India and is now widely cultivated in tropical Asia. The rhizomes are used for food flavoring and are used medicinally like carminative, a stimulant for the stomach, and against diarrhea and colic. In the current research, this species contains essential oils with antioxidant activity.[33]

*Zingiber zerumbet* is locally known as *Lempoyang* is a perennial herb found in many tropical countries. The leaves and inflorescences of the pinecone ginger crop up from a thick knobbly rhizome or the underground stem that grows just under the surface of the soil. It can grow up to 120 cm, with blade-shaped leaves, flowers that are initially green and develop a brighter red color when matured. *Z. zerumbet*, particularly, has been regularly used as a food flavoring and appetizer. *Z. zerumbet* is also a very useful medicinal plant. They have antimicrobial activity[34], Antipyretic and analgesic activity.[35] The active pharmacological component of the most widely studied *Z. zerumbet* rhizomes is zerumbone.[36] *Z. officinale* found in the open has been used as a spice. This can grow up to 75 cm, with lateral inflorescences and 2-2.5 cm long flowers, and dark green leaves that are narrowly oblong. They have antioxidant,[37] antithrombotic, anti-inflammatory,[38] and anti-diabetic activity.[39]

## SUMMARY

Nineteen species of wild ginger have been collected from Besiq Bermai forest, East Kalimantan. They are *Alpinia pubiflora, Alpinia aquatica*, *Alpinia capitellata, Alpinia beamanii*, *Amomum oliganthum, Etlingera pauciflora, Elettaria surculosa*, *Hornstedtiarumphii, H. conica*, *H. reticosa, Globba pumila, Plagiostachys bracteolata*, *P. albiflora*, *P. breviramosa*, *Z. aromaticum*, *Z. zerumbet*, *Z. officinale*, *Z. montanum*, and *Z. leptostachyum.* Regarding habitat, they are found in lowland and streams, with low light intensity, and high humidity. Many species of Zingiberaceae are potention as medicine, but but few are utilized by locally people. Conservation is needed to save wild ginger from Borneo because there are many species with unknown potency.

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