Diversity of Zingiberaceae and traditional uses by three indigenous groups at Lore Lindu National Park, Central Sulawesi, Indonesia

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Abstract. Research on gingers and their traditional uses by three different indigenous ethnic groups at Lore Lindu National Park, Central Sulawesi, Indonesia was carried out from February to June 2018. The objectives of the research was to gain information about the diversity of the family Zingiberaceae and its traditional uses by the Topo Baria, Toi Toro Muma and To Kaili Ledo people. Key informants were traditional healers (sando), traditional leaders (adat), community leaders, village leaders, religion leaders, government officers and crafts-people. The interviews were recorded using audio recorders and notebooks. Samples of plants were collected and photographed while recording the information. Response was obtained by "Snowball technique". A total of 24 species of Zingiberaceae were used of which 19 were determined to species level. Eight species were collected from natural forest, while 14 were recorded from agricultural habitat. Four of the species were endemic to Sulawesi (Alpinia eremochlamys, A. rubricaulis, Etlingera acanthodes and E. flexuosa). Fourteen species were not native to Sulawesi but widely cultivated in the region. The information about the uses by the Topo Baria was not adequate whereas the contrary the Toi Toro Muma and To Kaili Ledo used several species for various daily purposes, such as medicine, spice, cosmetics, ornamentals, or to be eat freshly.

1. Introduction
Central Sulawesi is one of the provinces in Indonesia, located within Wallacea region, a biogeographic region between Sunda and Sahul Shelf that is rich in in endemic floras and faunas. At the same time, the plant richness of this region has been poorly explored [1][2][3]. Research in the recent years
indicated that Sulawesi’s plant diversity holds the potential of many new discoveries [4] such as observed in the number of tree species newly recorded for Sulawesi [5]. Meanwhile, other research findings have indicated high endemcity of palms on this region [6][7] including phytogeographical analyses [8]. In addition, a number of new plant species have been described from this region, e.g. in Begonia (4 species) [9], two (2) species [10] and nine (9) species [11], Elaeocarpus firdausii [12], and Calamus tadulakoensis [13].

The ginger family (Zingiberaceae) is the largest family of the order Zingiberales, containing more than 52 genera and 1600 species. These aromatic herbs with creeping horizontal or tuberous rhizomes are widely distributed throughout tropical Africa, Asia and the Americas [14][15]. The botanists have paid attention to the family since Linnean era because it has play important role for human beings to meet their daily need of spices, medicine, cosmetics and ornamental plant [14][16][17].

The richness of gingers in the Lore Lindu National Park (LLNP), Central Sulawesi and their ethnopharmaceutical studies are scarce, although some species of have been reported but their phytochemical and bioassay studies of bactericide, fungicide and for medicinal application are very limited [4][18][19]

LLNP has many surrounding villages including Sedoa, Toro and Pakuli. This villages are famous for their self governing society regulating all aspect of life and harbouring indigenous knowledge regarding various uses of plants, especially as traditional medicine. That is the reason that the research on diversity of Zingiberaceae and its traditional uses by indigenous ethnics in LLNP is crucially to be investigated in this area.

2. Material and Methods

2.1 Research sites
All study sites situated in the vicinity of LLNP, Central Sulawesi, Indonesia (figure 1). This is one the most important protected areas in Indonesia and was listed as a “Biosphere Reserve” since 1977. It has been identified as biodiversity hotspot in Indonesia covers 220,000 ha. The area has considerable conservation value and provides watershed protection and it occupied by different indigenous people such as the Kaili Ledo, Topo Muma, Topo Baria, To Pekurehua, To Behoa, To Bada and a number of different immigrants who live around the park. The study sites were located in three places at different altitude: (i). montane primary forests on the slopes of Mt. Rorekatimbu near Lake Kalimpaa at 1800 m, at the Sedoa village, (ii) at the south-western part of the edge of submontane forests at Toro village at 900–1100 and (iii) at the lowland forest around Pakuli village at 200–500 m.

2.2. Methodology
The research was carried out from February to June 2018. It was initiated by doing field observations, then interviews were conducted in the community targeting informants with knowledge about the use of plants in their daily life. Respondents or key informants were traditional healers (sando), traditional leaders (adat), community leaders, village leaders, religious leaders, government officers and crafts-people. Audio recorders and notebooks were used for the interviews. Photographs were also taken to record information. Response was obtained by the Snowball technique. Botanical exploration by using transect method was applied in order to understand the diversity of ginger in the studied areas. The observation included vernacular name, scientific name, name of collector, collection number, habitus, geographic position (altitude, latitude and longitude), ecological data and the traditional uses including the plant parts used and the modes of preparation.

All fertile specimen of Zingiberaceae were collected in sets of at least three duplicates. Plant collecting was according to the “Schweinfurth method” [20]. Processing and identification of the specimens was conducted at the Laboratory of Biodiversity (Herbarium Celebense), Faculty of Mathematics and Natural Science, Tadulako University, Palu. Wisnu Ardi (Bogor Botanic Garden, Indonesia) helped in the initial identification. Voucher specimens are kept in Herbarium Celebense (CEB). The data was explored by using a descriptive approach.
3. Results and Discussion

3.1. Diversity of Zingiberaceae

The results revealed 24 species of the family of Zingiberaceae, consisting of the genera Alpinia, Curcuma, Etlingera, Hedychium, Meistera, Plagiostachys, and Zingiber (table 1). Some species occurred in the natural forest, especially those collected in the research site I (near by Lake Kalimpa’a) as well as sites II (Toro village) but all species recorded in the research site III (Pakuli village) were only found cultivated in the agriculture habitat or at the home yard.

The seven wild species of Zingiberaceae recorded growing in the Park area were *Etlingera flexuosa* (tikala), *Alpinia eremoclamys*, *Alpinia rubricaulis*, *Etlingera acanthodes* (katimba), *Plagiostachys* sp. (tikala marangkale), *Alpinia* sp. (tikala tete) and *Meistera aculeata* (tikala walehu). The three species that grow in the wild but outside the TNLL were *Hedychium coronarium* (karondo), *Hedychium spicatum* (tumon karondo) and *Hedychium flavescens* (karondo wana). Some species were cultivated by the community in the yard of houses, gardens and in pots namely *Etlingera elatior* (tikala), *Curcuma aeruginosa* (kuni vuri), *Zingiber zerumbet* (lempuya), *Zingiber montanum* (bangle), *Curcuma xanthorriza* (temulawak), *Curcuma mangga* (kai taipa), *Kaempferia galanga* (kencur), *Curcuma longa* (kuni), and *Zingiber officinale* (kula). A list of the Zingiberaceae species found in the studied area are presented in table 1.

Among the 24 species of Zingiberaceae, nineteen (19) species were determined to species level and three only to genus, eight were collected from the natural forest, while 14 species were recorded from agricultural habitats. Based on the distribution of the species of Zingiberaceae, many of the collected species grow in the agricultural areas as well as cultivated in the yard houses. These species were not native to the island of Sulawesi but have been introduced and cultivated by local community for several purposes as spices, medicines and ornamental plants. We were also recorded four endemic species of Zingiberaceae: *Alpinia eremochlamys*, *A. rubricaulis*, *Etlingera acanthodes* and *E. flexuosa*.
Table 1. Diversity of Zingiberaceae and its traditional uses by three different indigenous ethnics at Lore Lindu National Park, Central Sulawesi Indonesia.

| No | Local name | Scientific name | Distribution | Uses |
|----|------------|-----------------|--------------|------|
| 1  | Katimba    | *Etlingera flexuosa* A.D. Poulsen | E            | Fr = cooking, flavour |
| 2  | Tikala     | *Alpinia* sp. 1  | Unknown      | Unknown |
| 3  | Tikala     | *Alpinia eremochlamys* K. Schum. | E            | Lf = wrapping, tonic |
| 4  | Tikala     | *Alpinia rubricaulis* K. Schum. | E            | Unknown |
| 5  | Tikala     | *Etlingera acanthodes* A.D. Poulsen | E            | Fr = edible |
| 6  | Unknown    | *Plagiostachys* sp. | Unknown      | Unknown |
| 7  | Unknown    | *Alpinia* sp. 2   | E            | Unknown |
| 8  | Tumoni Karondo | *Hedychium coronarium* J. Koenig | TA, I        | Rhi. = fever, stomach ache, febrifuge, Schistosomiasis |
| 9  | Karondo    | *Hedychium spicaturn* Sm. | Indochina, I | Rhi. = cosmetics, spice |
| 10 | Tikala Bola| *Etlingera elatior* (Jack) R. M. Sm. | Thai, I      | Inf. = vegetable, Fr = spice |
| 11 | Karondo Wana| *Hedychium flavescens* Carey ex Roscoe | I            | Rhi. = fever, stomach ache, Schistosomiasis |
| 12 | Tikala Walehu | *Meistera aculeata* (Roxb.) Škorníček & M. F. Newman | PM, Jv, WP | Unknown, wild |
| 13 | Tikala tete | *Alpinia* sp. 1   | Unknown      | Unknown, wild |
| 14 | Tikala Marangkaleke | *Plagiostachys* sp. | Unknown      | Unknown, wild |
| 15 | Tikala     | *Alpinia purpurata* (Vieill.) K. Schum. | PNG, Pacific | Lf = stomach complaint, Ornamental |
| 16 | Kuni Vuri  | *Curcuma aeruginosa* Roxb. | Jv, I        | Rhi. = cure of hookworm |
| 17 | Lempuya    | *Zingiber zerumbet* L. | Jv, I        | Rhi. = cosmetics, rheumatics, stomach, neck problem |
| 18 | Bangle     | *Zingiber montanum* (J. Koenig) Link ex. A. Dietr | Serawak, I   | Rhi. = menstrual disorder, stomach ache |
| 19 | Lengkuas/Balintua | *Alpinia galanga* (L.) Wild. | MP, B, Phi | Rhi. = dermatomycosis, spice |
| 20 | Temulawak  | *Curcuma zanthorrhiza* Roxb. | MP, Jv, I    | Rhy = yellow fever, hepatitis |
| 21 | Kuni Taipa | *Curcuma mangga* Valeton | Jv, I        | Rhi. = cure for hook worm, anti inflammatory, anticancer, stabilize menstrual disorder |
| 22 | Kencur     | *Kaempferia galanga* L. | Thai, MP, Phi, I | Rhi. = fever and vertigo |
| 23 | Kuni     | *Curcuma longa* L. | Cult. | Lf = spice, Rhy = HIV treatment, spice, antibacterial, infection disease |
| 24 | Kula      | *Zingiber officinale* Roscoe | Cult. | Rhi. = Diabetes, cough, spice, stomach ache and rheumatics |

Notes: MP = The Malay Peninsula, Phi = Philippines, Thai = Thailand, Jv = Java, Cult= widely cultivated, B = Borneo, PNG = Papua New Guinea, I = Introduce to Sulawesi, WP = West Papua, Indochina = Laos, Cambodia, E = endemic, TA = Tropical America, Fr. = fruit, Lf = leaves, Inf. = Inflorescent, Rhi. = rhizome
3.2. Traditional Uses

There were significant differences among ethnic groups in terms of traditional uses. We recorded that only a few ginger species were used by the Topo Baria, especially for spice, medicine and wrapping food. The fruits of *Etlingera acanthodes* and *E. flexuosa* were used in fish dishes and as flavour enhancer.

The leaves of *Alpinia eremochlamys* were used for wrapping food and the decoction of its rhizome as a tonic. A number species of Zingiberaceae were used by the Toi Toro Muma as food, spice, cosmetics, ornamental and medicine.

*Alpinia purpurea* (red ginger) is introduced and widely planted as an ornamental plant at the study site II (Toro village), while the rhizome of *Hedychium coronarium* and *H. flavescen* were used as medicine for fever, stomach pains and schistosomiasis. The Toi Toro Muma community utilized the inflorescence of *Etlingera elatior* as a vegetable.

We also documented a number ginger species to be used by the Topo Kaili Ledo at site III (Pakuli village) for medicine, spice and cosmetics. They utilized *Curcuma aeruginosa* and *Curcuma zanthorriza* to cure hook worms and this species was also used as medicine against yellow fever, hepatitis, stomach ulcers and as an anti-inflammatory remedy. Four species (*Curcuma zanthorriza*, *Zingiber montanum*, *Z. officinal* and *Z. zerumbet*) were used as a medication for digestive system disorders. Interestingly, we documented that the community used two species of *Curcuma* (*C. longa* and *C. mango*) for HIV and cancer treatment, respectively.

In total, we documented 24 species of Zingiberaceae from three study sites. The results indicated that the diversity of Zingiberaceae was quite high but there may still be many species unrecorded or not yet described taxonomically. We recommend to continue the botanical exploration in a wider research area, especially to obtain fertile specimens that are easier to identify. A total revision of the Zingiberaceae for Sulawesi is far from complete, and further studies including fieldwork where the best vouchers are secured is fundamental for future elucidation of ecological, ethnobotanical and agricultural aspects.

Based on the available literature, the knowledge of Indonesia’s flora especially the island of Sulawesi is very poor due to lack of collecting activity. For example the amount of botanical collecting in Sumatera is 20 times higher than in Sulawesi [1]. Nevertheless, a number of the checklist and Catalogue of Sulawesi’s flora have been published [1, 19, 21], and several monographs have also been written in the Flora Malesiana series.

A number systematics study on the genera of Sulawesi’s Zingiberaceae such as; *Alpinia*, *Etlingera* and *Curcuma* are still actively conducting by botanists. Forty-eight taxa of *Etlingera* were revised, 36 of which were new species to science [19]. *Zingiber ultralimitale* Ardiyani & A.D.Poulsen, is a recently described and barcoded (*rbcL, trnH-psbA* and ITS) new species occurring on limestone at Bantimurung NP, South Sulawesi, Indonesia [22]. Two new species of *Alpinia* subsection *Cenolophon* (*A. macrocrista* and *A. pusilla*) were recently described by Ardiyani and Ardi from western Sulawesi [23].

Zingiberaceae is a plant family widely used by humans especially as medicine and food. Additionally, it has been utilized as raw material in industry “jamu” and herbal medicine. The family currently contains about 58 genera but with the advances in molecular-based studies, the number will soon increase further. Only a few genera are naturally distributed in Central Sulawesi, namely *Alpinia*, *Etlingera*, *Hedychium*, *Meistera*, *Sulettaria*, and *Wurfbainia* [16] but this will likely increase once the polyphyly of *Alpinia* is addressed.

Apart from the aspect of diversity, the traditional use of gingers in the studied area showed that three ethnic groups have different knowledge systems. The Topo Baria community used a low number of species in their daily life whereas the Toi Toro Muma at the western part of Lore Lindu utilized a much higher number of native species for several purposes. In contrast, the Topo Kaili Ledo used a large number of cultivated species.

There are 19 indigenous tribes in the region of Central Sulawesi. These ethnic groups occupy different areas, and each has their own culture and traditions in utilizing plants including
pharmaceuticals, household appliances, various source of fibre, complimentary materials for traditional ceremonies, clothing, food and construction [4], i.e the Kaili Inde tribe of Central Sulawesi who are settled in the village of Mantikole, Sigi District, Central Sulawesi also utilize various species of plants for food supply, drug ingredients, and various ceremonial culture [24]. Moreover, the simple life of the local community in rural area and location away from urban life, forcing most of the local people is dependent on the natural resource for survival.

The uses of plant as herbal medicine in the studied area have been reported by some researchers. For example: 329 species of medicinal plants from Lore Lindu National Park has described Among of them were Alpinia eremochlamys, Alpinia sp., Curcuma aeruginosa, Curcuma mangga Etlingera elatior, Etlingera sp., and Hedychium coronarium [18]. The uses of various plant species as medicines study by local people in the enclave of Lore Lindu National Park has been done [25], the result showed ninety six (96) species used as medicinal plants, among them Zingiber zerumbet for treatment of Elephantiasis, and Etinglera elatior for Hyperuricemia and food. Fifteen species of plants that used as spice by the “Kaili Tara tribe” in Central Sulawesi including the Curcuma longa (kuni), Alpinia galangal (balintua), Kaempferia galanga (sikuri) and Zingiber officinale (goraka) [26]. These examples documents that there are a lot more to be learn on the important use aspects of gingers in the region.

4. Conclusion
We recorded twenty four species of Zingiberaceae useful to at least one of the three studied ethnic groups. Nineteen species determined to species level, eight were collected from natural forest, while fourteen species were recorded from agricultural habitat, four species were endemic to Sulawesi, and 14 species were not native to Sulawesi but are widely cultivated in the tropic. The information about the uses by the Topo Baria community was not adequate whereas the other two communities were documented to use several species for various purposes. It is likely that further studies in communities in the vicinity of Lore Lindu National Park will lead to several additional species documented to be useful.

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