Botanical inventory and rarity of the fern Genus *Pteris* in the karst forests of Bantimurung - Bulusaraung National Park, Sulawesi – Indonesia

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Abstract. The ferns flora of Sulawesi is poorly documented. *Pteris* L. is a large fern genus inhabiting various habitats, mostly forests, which are distributed in tropical and subtropical countries. Floristic study on fern genus *Pteris* in the karst forests of Bantimurung Bulusaraung National Park (BabulNP) was carried out to add our knowledge of the ferns flora of Sulawesi. This study aimed to inventory *Pteris* growing in the karst forest of BabelNP and determine the rarity of each species. Nine species were recorded, namely, *Pteris biaurita* Lam., *P. ensiformis* Burm.f., *P. longipes* Don, *P. pellucida* C. Presl., *P. radicans* Christ., *P. quadriaurita* Retz., *P. spinescens* C. Presl., *P. tripartita* Swartz, and *P. vittata* L.. *P. pellucida* and *P. spinescens* may be new records for Sulawesi. Summary of the most important characters for distinguishing species of *Pteris* in the park is provided. Five species, namely *Pteris longipes*, *P. pellucida*, *P. quadriaurita*, *P. radicans*, and *P. spinescens* are considered as rare species. This study contributes to the knowledge of Malesian biodiversity, especially for fern flora of Sulawesi growing on karst forest. This survey provides baseline data for one of the most dominant elements of the understory cover in the limestone forests of BabulNP.

1. Introduction

Sulawesi, with a surface of 174,600 km2, has been highlighted as one of the most important ecoregions in SE Asia [1,2]. This status is mainly a result of its position at the biogeographic crossroads between East Asia and Australasia [3,4] and complex geology [5]. These processes have resulted in high levels of endemism [6]. However, collection rates on the island are among the lowest in Indonesia and taxonomic study has been limited, with most experts reporting large numbers of undescribed species [7].

The pteridophyte flora of Sulawesi is still poorly documented [8]. There are only a few pteridologists have collected the ferns and fern-allies on the island. Christ [9] published the first account of the fern flora and listing 308 species. Few years later, Christ [10] listed 49 species more and described few numbers of species. Therefore, in total, he listed 357 species [9,10]. Lam [11] added another 23 to the list of pteridophytes in Sulawesi. Botanical inventory of ferns conducted by Hovenkamp & de Joncheere [12] resulted in another 34 species. From this historical collection, it can be estimated that Sulawesi has more than 400 species of pteridophyte flora. Kato [13] estimated that Sulawesi is home of about 500 pteridophyte species. It is clear that the total number of pteridophyte...
species in Sulawesi is still uncertain. Therefore, the floristic studies for clarifying the diversity of ferns and fern-allies in Sulawesi are still needed.

*Pteris* is a large fern genus as it is consisting of about 250 species [14-16]. This genus is easily recognized by the naked eye, because it has marginal sori supported by a collecting vein and protected by an indusium formed by the reflexed lamina margin [14,17]. It is a cosmopolitan fern genus and distributed throughout the tropical, subtropical, and temperate areas of all continents except Antarctica, from Australia, New Zealand and South Africa northward to Japan and North America. [15,18,19]. *Pteris* grows either terrestrially or lithophytically (on rocks) on a diverse ecosystem. Most species occur in primary forest, however it also can be found frequently in secondary forests, on forest gaps or along rocky riverbanks, coastal areas, and xeric niches [18,20].

*Pteris* is an interesting genus as it known to be the model for studying plant evolution and speciation. Species diversity of *Pteris* has resulted, in part, from the hybridization, apogamy, and polyploidy processes [21-24]. Chao et al. [20] summarized that dispersal events followed by allopatic and parapatric speciation contribute to the species diversity of *Pteris*. Some species are used as ornamental plants, e.g. *P. cretica* L., *P. ensiformis* Burm., *P. grevilleana* Wall. ex J.Agardh var. *ornata* Alderw and *P. nipponica* W.C. Shieh [20]. Some species are used for phytoremediation of contaminated soils, such as *P. vittata* L. [25,26]. Many species of *Pteris* are also beneficial for traditional medicine, for example *Pteris ensiformis* Burm., *Pteris multifida* Poir., and *Pteris semipinnata* L. [27].

Rarity is often defined in terms of abundance of individuals or range size [28]. Rarity include species that have limited distribution due to human activities, habitat destruction and degradation [29]. Understanding the natural history of rare plants is important for their conservation [30]. Understanding the ecology of rare species can inform aspects of conservation strategies as well as population status and future growth trajectories [31]. Comparisons between rare species and their more common congeners would provide valuable information for conservation [32].

One of the most important karst ecosystems in Indonesia is Maros Pangkep Karst Forest (MPKF). It is located in South Sulawesi Province and has 43,750 ha. About 19,337 ha of the area of MPKF is part of Bantimurung-Bulusaraung National Park (BabulNP) [33]. This national park was established in 2004 (Ministry of Forestry Decree No. 398/Menhut/II/2004) to protect regional biodiversity and karst ecosystems. Floristic study on fern genus *Pteris* in the karst forests of BabulNP was carried out to add our knowledge of the fern’s flora of Sulawesi. This study aimed to conduct an inventory of *Pteris* growing in the karst forest of BabulNP and determine the rarity of each species.

2. Materials and Methods

2.1. Study Sites

BabulNP is a national park located in the Maros and Pangkep Regency, South Sulawesi Province, about 50 km north of Makasar, or abot 20 km from Sultan Hasanuddin International Airport. The park covers an area of approximately 43,750 Ha and located between latitudes 04°43’10” S to 05°07’12” S and longitudes 119°34’11” E to 119°55’13” E.

This study was carried out on September 26th to October 15th 2017. Ten sites located in Tompo Bulu Village, Balocci Subdistrict, Pangkep Regency, were explored, namey: (1) Nangkaah, (2) Tompo Leang, (3) Saliaro, (4) Inru Inru, (5) Acce, (6) Tosempo, (7) Paranglakbuah, (8) Kampaung, (9) Pattung Pattung dan (10) Lamporo (Table 1.). All sites are include in the BabulNP (Figure 1.).

2.2. Study Taxon

*Pteris* has diagnostic characters as follows: sporangia borne continuously along most of the length of the pinnae from commissural veins and pinnae are entire or pectinately divided into segments (with these sometimes asymmetrical) [15]. This genus is described by character combinations as follow: lamina catadromus, or the anadromous at base and becoming catadromous upward; rarely lamina
simple; leaves simply pinnate; veins reticulate; sori on a short to long submarginal commisure uniting at few to many vein, or even all veins of a segment, often absent from its apex and or the sinus; indusia always present and evident, elongate or linear formed by modified, reflexed leaf margin, occasionally slightly intramarginal [34].

2.3. Specimens Collection and Species Determination.
Specimens were made according to the standard method for making herbarium specimens in ferns. Photographs were taken for every species observed. Voucher specimens are deposited at the Herbarium of Bogor Botanic Gardens (BOHB). Species determinations were performed by consulting Copeland [35], Holttum [14], Zhang [36], and Zhang et al. [16]. The taxonomic classification system followed the Pteridophyte Phylogeny Group (PPG I) [37].

Table 1. Survey Localities for Pteris at the Karst Forest in Balocci Resort, BabulNP, South Sulawesi

| Location     | Elevations (m) | Forest Type         | Explored Area and Notes                           |
|--------------|----------------|---------------------|--------------------------------------------------|
| Acce         | 821 – 888      | Secondary Forest    | 119°46'14.2"-119°46'31.3" E; 04°55'55.1"-04°55'59" S |
| Inru Inru    | 800 – 813      | Secondary Forest    | -                                                 |
| Kampuang     | 493 – 587      | Production Forest   | 119°44'3.3"-119°44'7.9" E; 04°54'42"-04°55'4 S   |
| Lamporo      | 612 – 653      | Production Forest   | 119°44'25-119°44'58.6"; 04°54'37.5"-04°54'45.4" S |
| Nangkaah     | 830 – 860      | Secondary Forest    | 119°46'20.4"-119°46'33" E; 04°55'58.2"-04°55'56.9" S |
| Paranglakbua| 864 – 929      | Production Forest   | 119°46'18.3"-119°46'9" E; 04°55'55.9"-04°56'0.5" S |
| Pattung Pattung | 580 – 701 | Production Forest   | 119°44'10"-119°44'22.7" E; 04°54'40.8"-04°54'41.7" S |
| Saliaro      | 804 – 899      | Secondary Forest    | 119°46'21.8"-119°46'31.8"; 04°55'55.4"-04°55'58.6" S |
| Tompo Leang  | 820 – 860      | Secondary Forest    | -                                                 |
| Tosempo      | 900 – 905      | Production Forest   | -                                                 |

2.4. Measuring Rarity of Species
Schoener [38] distinguished two measures of rarity of species, namely occurrence rarity and abundance rarity. Occurrence rarity is when a species occurs in few localities and abundance rarity is when the absolute population size in these localities is small. It is very difficult to obtain data on the abundance rarity of plants at a regional or even at a local level. Therefore, occurrence rarity was applied to define the rare fern species assemblage of Pteris in the karst forest of BabulNP. The rarity assessment of species was determined by following Schoener [38] and Sanchez et al. [39], the species was categorized as rare species if it was encountered in less than 10 sites and/or the population was less than 20 plants.
3. Results and Discussion

3.1. Botanical Inventory and Diversity of Pteris in BabulNP

The list of species of the genus *Pteris* of Sulawesi is presented in Table 2. The diversity of *Pteris* from the Resort Balocci, BabulNP, is presented on Table 3. Nine species of *Pteris* were recorded from ten sites, namely *Pteris biaurita*, *P. ensiformis* Burm.f., *P. longipes* D. Don, *P. pellucida* C. Presl, *P. radicans* Christ., *P. quadriaurita* Retz., *P. spinescens* C. Presl., *P. tripartita* Swartz, and *P. vittata* L. Hidayat [40] reported eight species of *Pteris* of South East Sulawesi, including four species that are common in BabulNP, *P. biaurita*, *P. ensiformis*, *P. tripartita*, and *P. vittata*. Hovenkamp and Cicuzza [41] listed 33 species of *Pteris* of Sulawesi, including *P. biaurita*, *P. ensiformis*, *P. longipes*, *P. radicans*, *P. quadriaurita*, *P. tripartita*, and *P. vittata*. *Pteris pellucida* and *P. spinescens* have never been reported from Sulawesi. Further in-depth taxonomic studies are needed to confirm the status of the two species. The species total number of *Pteris* of BabulNP is only represented by 23% of the total species of *Pteris* reported for Sulawesi until 2011 (Table 2.). The exact number of *Pteris* species in many geographical areas, including Sulawesi, has not known yet due to the overestimation and synonyms of several species. For example, there are more than 20 synonyms for *P. quadriaurita* Retz. Therefore, in-depth taxonomic studies for species delimitation and revision of *Pteris* throughout the phytogeographical distribution are needed.
Tabel 2. The list of species of the genus *Pteris* in Sulawesi.

| No. | Species                             | References                   |
|-----|-------------------------------------|------------------------------|
| 1   | *Pteris aquilina* L.                | [9] [41]                     |
| 2   | *P. asperula* J. Sm.                | [9]                          |
| 3   | *P. biaurita* Linn                  | [40] [41], Present study     |
| 4   | *P. blumeana* C. Agardh             | [41]                         |
| 5   | *P. cretica* L.                     | [9] [41]                     |
| 6   | *P. dactylina* Hook.                | [41]                         |
| 7   | *P. decussata* J.Sm.                | [41]                         |
| 8   | *P. digitata* Wall. ex C.Hope       | [41]                         |
| 9   | *P. ensiformis* Burm.f.             | [9] [40] [41], Present study |
| 10  | *P. excelsa* Gaud.                  | [40] [41]                    |
| 11  | *P. heteromorpha* Fée               | [9] [41]                     |
| 12  | *P. hollummi* C.Chr.                | [12] [41]                    |
| 13  | *P. incisa* Thunbg.                 | [9] [41]                     |
| 14  | *P. ligulata* Gaudich.              | [41]                         |
| 15  | *P. longifolia* L.                  | [41]                         |
| 16  | *P. longipes* D. Don                | [41], Present study          |
| 17  | *P. longifolia* L.                  | [9]                          |
| 18  | *P. longipinnula* Wall              | [40] [41]                    |
| 19  | *P. melanocaulon* Fée               | [41]                         |
| 20  | *P. mertensioides* Willd.           | [41]                         |
| 21  | *P. marginata* Bory                 | [9]                          |
| 22  | *P. moluccana* Blume                | [9]                          |
| 23  | *Pteris pediformis* M.Kato & K.U.Kramer | [9] [41]                  |
| 24  | *P. opaca* Smith                    | [9] [41]                     |
| 25  | *P. oppositipinnata* Fée            | [41]                         |
| 26  | *Pteris osmundae* K.U.Kramer        | [41]                         |
| 27  | *P. pacifica* Hieron.               | [41]                         |
| 28  | *P. patens* Hook                    | [9]                          |
| 29  | *P. pellucida* C. Presl             | Present study                |
| 30  | *P. radicans* Christ                | [9] [41], Present study      |
| 31  | *P. quadriaurita* Retz.             | [9] [41], Present study      |
| 32  | *P. schlechteri* Brause             | [41]                         |
| 33  | *P. semipinnata* L.                 | [9] [40] [41]                |
| 34  | *Pteris spinescens* C. Presl        | Present study                |
| 35  | *P. tripartita* Swartz              | [40] [41], Present study     |
| 36  | *P. venulosba* Bl.                  | [40]                         |
| 37  | *P. vittata* L.                     | [41], Present study          |
| 38  | *P. wallichiana* Agardh             | [9] [40] [41]                |

Based on their leaf incision, *Pteris* found in the karst forest of the Resort Balocci of BabulNP could be classified into three group, namely: pinnate group, bipinnatifid group, and tripininate group. *Pteris pellucida* and *P. vittata* are pinnate group. Bipinnatifid consist of four species, namely *P. ensiformis*, *P. biaurita*, *P. quadriaurita*, and *P. spinescens*. The tripininate group includes three species, namely *P. radicans*, *P. tripartita* dan *P. longipes* D.Don. Morphological comparison among species of *Pteris* found in BabulNP is provided in the Figure 2. and Table 3. Zang et al. [16] classified *Pteris* into three sections, namely *Pteris* sect. *Campteria*, sect. *Pteris*, and sect. *Quadriauricula*. The three sections are mainly differentiated by typical of veins, segment margin characteristics, existence of the spines on the costa, and the incision of pinnae/pinnules.

*Pteris* sect. *Pteris* are characterized by morphological combination as follow: Venation free; fronds often dimorphic or subdimorphic; pinnae/pinnules entire, margin with cartilaginous margins, basal
pair(s); sometimes forked near base, but never pectinately divided; sterile margins acutely serrate, rarely entire; costae without spines, grooves not erose [16]. *Pteris ensiformis*, *P. longipes*, *P. pellucida*, *P. radicans*, and *P. vittata* are included in this group.

*Pteris* sect. *Campteria* have characteristics as follows: Fronds monomorphic, division patterns and lobe shape same as for *Pteris* sect. *Quadriauricula* but often divided and 3-divaricate (lateral pinnae usually again divided into 2 forks); lobes without cartilaginous margin, serrate; costae spiny along both sides of groove on adaxial side; venation anastomosing to form a series of narrow areoles along costae, veinlets free beyond areoles and extending to margins. Sori linear, extending continuously along lobe margins, often sterile at apex; indusia brown or light brown, linear, membranous, entire, persistent [16]. *Pteris biaurita* and *P. tripartita* are the member of *Pteris* sect. *Campteria*. The presence of costal areoles and a fairly wide sines between fertile lobus are two constant characters that distinguished *P. biaurita* from others. Meanwhile, *P. tripartita* can be well recognized due its tripartite large fornds with basal pinnae as large as the rest of the frond and the presence of costal and costular areoles [14].

*Pteris quadriaurita* and *P. spinescens* are include in the *Pteris* sect. *Quadriauricula*. The morphological characteristics of *Pteris* sect. *Quadriauricula* stated by previous study [16] as follows: fronds monomorphic; pinnae/pinnules pectinately divided or lobed on at least one side, basal pair(s) of pinna often with 1–3 (or 4) pinnules near base on basiscopic side; segments lanceolate or ± oblong-falcate, often obtuse or acute, without cartilaginous margins, entire or rarely serrate; adaxial grooves of costae with spines or erose margins.

### 3.2. Ecology and Rarity of *Pteris*

The inventorying of rare species is very important. Distribution data of rare species are essential for assessing the extinction risk under the IUCN Red List. The data are used to calculate the Extent of Occurrence (EOO) and the Area of Occupancy (AOO) [42].

A description of a species’ rarity should include three components, viz: habitat range, geographic range, and population size [43,44]. Habitat is defined as all include the specific resources and conditions in an area that produce occupancy [45]. The definition of “habitat” which is broad enough to account for species needs is the area or type of site where a species naturally occurs or depends on directly or indirectly to carry out its life processes, or where a species formerly occurred or has the potential to occur and carry out its life processes in the foreseeable future [46]. Species rarity can be categorized into seven, viz.: (1) Large geographic range, wide habitat specificity, small population size; (2) Large geographic range, narrow habitat specificity, large population size; 3. Large geographic range, narrow habitat specificity, small population size; 4. Small geographic range, wide habitat specificity, large population size; (5) Small geographic range, wide habitat specificity, small population size; (6) Small geographic range, narrow habitat specificity, large population size; 7. Small geographic range, narrow habitat specificity, small population size. A species’ geographical range is a basic unit of comparative biology, biogeography and macroecology [47].
Figure 2. Selected morphologies of *Pteris* to represent three sections in *Pteris* group. A-D. *Pteris* section *Pteris*. A-B. *Pteris pellucida*; C-D. *Pteris radicans*. E-H. *Pteris* section *Quadriauricula*. E-F. *Pteris spinescens*; G-H. *Pteris quadriaurita*. 
Figure 2. Continued.  I – L. *Pteris* sect. *Campteria*. I – J. *Pteris biaurita*; K – L. *Pteris tripartita*. 
The ecology and distribution of *Pteris* recorded from BabulNP are presented on Table 4. The common and frequent species of *Pteris* in the BabulNP are recorded. Two species of *Pteris* which are the most widely distributed in world are *P. ensiformis* and *P. vittata*. These species are very common in the BabulNP and found mainly in the forests margin. *Pteris ensiformis* is distributed throughout Malesia and widely from India to Pacific Islands. It usually grows in damp places, shaded places such as earth banks, road cuttings, crevices of rocks [48,49]. Plants growing in damp and deeply shaded places are usually have a dark, glossy-green fronds, but others from more exposed places can be quite stunted with grey-green in colour. The Chinese ladder brake, *P. vittata*, is also common fern widely distributed in the world. In BabulNP this species is growing at the forests margin of opened areas among the gravels. It is a terrestrial and epilithic sun-loving fern that can be found growing on earth banks of road cuttings and in light shade of scrub along streams, usually among rocks, in rock crevice, or crevice in bricks or stone walls, growing in moist or seasonally moist conditions [49,50], from sea level to 1600 m altitude, in warm countries of the Old World [35], throughout the tropical and sub-tropical areas of Africa, Asia, and Australian [48]. This species can grow in a wide range of soil concentrations ([As]) [51,52], therefore it is known as a hyperaccumulator of arsenic. The common species are usually more frequently found both in the production forest and secondary forest, in fully opened area to fairly shady places.

Two species of *Pteris* which are frequently found in BabulNP are the thin leaf brake, *P. biaurita*, and *P. tripartita*. They are often growing in fairly shady places beneath trees of forests margin. The thilf leaf brake is a pantropical species, distributed in China, S Taiwan, Xizang, Yunnan, Bhutan, India, Indonesia, Laos, Malaysia, Nepal, Philippines, Sri Lanka, and Thailand. *Pteris tripartita* is occurred in tropical regions of the world, occurring in the continents of Africa, Australia, America, and Asia. In Asia this species is distributed in China, India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand, and Vietnam.

### Table 3. Frond-morphology comparisons among species of *Pteris* from Karst Forest of Balocci Resort, BabulNP.

| Species Character | *Pteris biaurita* | *Pteris ensiformis* | *Pteris longipes* | *Pteris pellucida* | *Pteris radicans* | *Pteris quadriaurita* | *Pteris spinescens* | *Pteris tripartita* | *Pteris vittata* |
|------------------|------------------|--------------------|------------------|------------------|------------------|----------------------|--------------------|------------------|------------------|
| Frond architecture | Single-axis fronds | Single-axis fronds | Tripartite | Single-axis fronds | Tripartite | Single-axis fronds | Single-axis fronds | Tripartite | Single-axis fronds |
| Lamina dissection | Bipinnatifid | Bipinnatifid | Bipinnatifid | Pinnate | Bipinnatifid | Bipinnatifid | Bipinnatifid | Simple pinnate |
| Lowest pinnae bearing basiscopid secondary pinnae | No | No | NA | No | NA | Yes | Yes | NA |
| Number of lateral pinnae | 5-9 pairs | 3-4 pairs | NA | 3-4 pairs | NA | 5-6 pairs | 12-14 pairs | NA |
| Costal areolas | Present | Absent | Absent | Absent | Absent | Absent | Absent | Present | Absent |
| Costula areoles | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Present | Absent |
The natural distribution of perennial ferns genus *Pteris* which are rare and usually grow on shady or fairly shady places in the kars forest of BabulNP are reported. *Pteris longipes*, *P. pellucida*, *P. quadriaurita*, *P. radicans*, and *P. spinescens* are considered as rare species. List of these species, distribution in Sulawesi, the wider distribution, habitat, last record, and occurrences or plant encountered in the BabulNP are provided.

Table 4. *Pteris* (Pteridaceae) of Karst Forest of Balocci Resort, BabulNP.

| No. | Species                      | Habitat                                      | Frequency | Representative Voucher Herbaria | Location             |
|-----|------------------------------|----------------------------------------------|-----------|---------------------------------|----------------------|
| 1   | *Pteris biaurita* Linn       | Forest margin, secondary forest, opened places, 560-850m dpl. | Frequent  | TNgP 3754                       | Saliaro, Kampuang    |
| 2   | *Pteris ensiformis* Burm.f. | Forest margin, fairly shady,                 | Common    | No voucher                      | Tompo Bulu           |
| 3   | *Pteris longipes* Don        | Karst forest, secondary forest, shadowed place, 580-600m dpl. | Rare      | TNgP 3950                       | Pattung-pattung      |
| 4   | *Pteris pellucida* C. Presl  | Karst forest margin, secondary forest, lightly shady, 430-450m dpl. | Rare      | TNgP 3915                       | Kampuang             |
| 5   | *Pteris radicans* Christ     | Forest margin, opened place, 829-927m dpl.   | Rare      | TNgP 3750                       | Nangkaah Tosempo     |
| 6   | *Pteris quadriaurita* Retz.  | Karst margin forest, production forest, fairly shady, 515-830m dpl. | Rare      | TNgP 3752                       | Saliaro Lamporo      |
| 7   | *Pteris spinescens* C. Presl.| Karst forest margin, fairly shady, 640-700m dpl. | Rare      | TNgP 3965                       | Saliaro Lamporo      |
| 8   | *Pteris tripartita* Swartz   | Karst forest margin, production forest, fairly shady, 450-600m dpl. | Frequent  | TNgP 3918                       | Kampuang             |
| 9   | *Pteris vittata* L.          | Karst forest margin, production forest, opened places, 430-600m dpl. | Common    | TNgP 3918                       | Kampuang             |

*Pteris longipes* D. Don.
Distribution in Sulawesi. South Sulawesi.
Wider distribution. This species is widespread in N India, S China, Vietnam, and Taiwan, southwards to the Philippines [53].
Habitat. It usually grows on mountain slopes usually in dense thickets in dry evergreen or lower montane forests at 700–1600 m alt [53]. In BabulNP, this species grows in the shady place of karst forest, at 580–600 m alt.
Last record in BabulNP. TNgP 3950 (4 October 2017)
Occurrences/Plant encountered in BabulNP. One individual plant in one site. It was only found in Pattung-pattung, in the karst forest margin.
Pteris pellucida C. Presl.
Distribution in Sulawesi. South Sulawesi (may be new record for Sulawesi)
Wider distribution. This species is widespread in India, Myanmar, Malay Islands, Bangladesh, Philippines and Guinea Coast.
Habitat. In BabulNP, this species was found at secondary forest, lightly shady, at 430-450 m asl.
Last record in BabulNP TNgP 3915 (3 October 2020).
Occurrences/Plant encountered in BabulNP. One individual plant in one site. This species was only recorded from K安抚ong karst forest.
Notes: This species may closely relate to P. cretica [34]. It is distinguished from P. cretica by its larger size and more numerous pinnae, the basal pinnae undivided, the sterile margin entire, the pinnae of fertile fronds narrowly linear.

Pteris quadriaurita Retz.
Distribution in Sulawesi. North and South Sulawesi.
Wider distribution. Tropic and subtropics of the world; its native range is in South West of India and Sri Lanka.
Habitat. This species can be found at 900-2700 m asl.
Last record in BabulNP. TNgP 3752, 3755 (28 September 2017); TNgP 3904, 3905 (2 October 2017)
Occurrences/Plant encountered. Five individual plants from two sites.
Notes: This species was first recorded by Christ from North Sulawesi, exactly at Limboto, Gorontalo [9].

Pteris radicans Christ.
Distribution in Sulawesi. South Sulawesi.
Wider distribution. Ceylon, Borneo, Sulawesi, Philippine.
Habitat. In BabulNP this species is growing on karst forest margin at opened place, 829 m asl.
Last record in BabulNP. TNgP 3750 (28 September 2017)
Occurrences/Plant encountered. Six individuals in two sites. This species is only found in Nangkaah and Tosempo forest margin.
Notes: This species was first reported by Christ [9] in Lompobattang, Bantaeng Regency, South Sulawesi at 1200 m asl.

Pteris spinescens C. Presl.
Distribution in Sulawesi. South Sulawesi (may be new record for Sulawesi)
Wider distribution. Its native range is Himalaya to Taiwan and Philippines, Japan (Kyushu).
Habitat. In BabulNP, it is growing in karst forest margin, fairly shady, 640-700 m asl.
Last record in BabulNP. TNgP 3965 (4 October 2017)
Occurrences/Plant encountered. One individual plant in one site. This species was only recorded from Lamporo forest.

All species of Pteris are terrestrial ferns and they are growing everywhere, most species occur in primary forest, but others can be found in secondary forest, clearings, or along rocky stream banks [54]. Pteris can grow on the forest over limestone or karst forest. Barcelona et al. [55] found 10 species of Pteris that inhabiting the karst forests of Bohol Island, Philippines, four species of them were also growing in the karst forests of BabulNP, namely P. ensiformis, P. pellucida, P. tripartita, and P. vittata.

4. Conclusions
A total of known nine species of Pteris were recorded from ten sites of BabulNP, namely Pteris biaurita, P. ensiformis Burm.f., P. longipes D. Don, P. pellucida C. Presl, P. radicans Christ., P. quadriaurita Retz., P. spinescens C. Presl., P. tripartita Swartz, and P. vittata L. Pteris pellucida and
P. spinescens may be new records for Sulawesi. Further study for clarifying their status is needed. The natural distribution of perennial ferns genus Pteris which are rare and usually grow on shady or fairly shady places in the karst forest of BabulNP are reported. Pteris longipes, P. pellucida, P. quadriaurita, P. radicans, and P. spinescens are considered as rare species. This survey provides baseline data for one of the most dominant elements of the understory cover in the limestone forests of BabulNP. Botanical inventory and study on the rarity of the fern genus Pteris in the karst forests of BabelNP contribute the knowledge of Malesian biodiversity, particularly Sulawesi biodiversity. The list of ferns flora from karst forest is also increased. Indepth taxonomic study for understanding the species diversity of Pteris of Sulawesi is needed.

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