Diversity of jewel orchids (Goodyerinae, Orchidaceae) in Mount Rinjani National Park, Lombok

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Abstract. Orchids are one of the largest families of flowering plants, and one of the taxons is Goodyerinae or jewel orchids. The diversity of jewel orchids on Lombok Island is very little known so it needs to be studied and described. Therefore, this study was conducted to identify and describe species, habitat and distribution of jewel orchids (Goodyerinae) in Mount Rinjani National Park. Sampling and data collection were carried out using the cruising method along the tourist routes and hiking trails on the southern slope of Mount Rinjani. Nine species of five genera of jewel orchids (Goodyerinae) were found in Mount Rinjani National Park, namely *Anoectochilus setaceus*, *Myrmechis* sp., *Goodyera colorata*, *Goodyera reticulata*, *Goodyera velutina*, *Goodyera* sp., *Vrydagzynea nuda*, *Vrydagzynea viridiflora* and *Macodes petola*. Goodyera is a genus of jewel orchids with the largest number of species found. Most of the species are distributed in the montane zone. Joben Resort is the Mount Rinjani National Park subarea with the highest number of jewel orchid species. The results of this study add new orchid species records in the Mount Rinjani National Park flora database and checklist flora of Lombok Island.

1 Introduction

Orchids are one of the largest flowering plant families, with more species than any other flowering plant. Worldwide orchids include 28,000 species in 736 genera [1]. The orchid floras of Sumatra and Java have been comprehensively studied, while several small islands in the Nusa Tenggara archipelago still need to be studied and described. This includes orchid diversity on the island of Lombok. Information on orchid groups is important not only from a scientific point of view but also enables improved conservation strategies and plans [2]. One of the orchid taxons that is part of the biodiversity of the island of Lombok, especially

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the Mount Rinjani National Park, is Goodyerinae. Members of this taxon are widely known as jewel orchids.

Jewel orchid belongs to the subtribe Goodyerinae, one of the subtribes of terrestrial orchids which is cosmopolitan and widespread with the centre of diversity in Asia [1,4,22]. The Asian region has 29 genera and about 500 species [5]. Goodyerinae are terrestrial and sometimes lithophytes or epiphytes characterised by their creeping rhizomes [3]. They are usually recognised by their distinctive leaf shape and can be found in undisturbed natural habitats [6]. Many species of Goodyerinae are small and inconspicuous, so they do not attract the attention of researchers. They are often missed by orchid researchers in the field, so more intensive studies are still needed. One of the tropical forest areas covered by orchids, including the Goodyerinae, is Mount Rinjani National Park (TNGR).

Mount Rinjani National Park is one of the mountain rainforest which consists of various types of ecosystems and vegetation. The potential of the Mount Rinjani National Park (TNGR) area is very rich in flora and fauna diversity, including the diversity of various orchid species [7]. Besides being a conservation area with high biodiversity potential, Mount Rinjani National Park has suitable ecosystem conditions as a habitat for jewel orchids. Therefore, this study was conducted to identify and describe species diversity, habitat and distribution of jewel orchids (Goodyerinae) in Mount Rinjani National Park. The results of this study are expected to provide basic data for jewel orchid conservation, preserve biodiversity, and serve as a reference in orchid studies.

2 Materials and methods

Jewel orchid sampling and field data were collected from four hiking and tourist trails on the southern slopes of Mount Rinjani using the cruising method. Orchid samples were collected, identified and documented. Jewel orchid collection was done by taking complete organ parts. The number of individuals was recorded at each point where the jewel orchid was found. Physical data of the orchid growing environment recorded in the field were latitude, longitude, altitude, habitat type, air humidity, temperature, soil acidity and light intensity. To describe each species, morphological observations of orchids in natural habitats and herbarium specimens were made. Terms related to morphology refer to [8]. Voucher specimens have been deposited at the herbarium Mataram University Lombok (MUL).

Species identification was carried out using the orchid identification guide according to [9-12], and some related scientific publications. Valid names and synonyms were based on names accepted by World Flora Online (WFO) and Global Biodiversity Information Facility (GBIF). Morphological analysis was carried out descriptively by comparing the characteristics of each species to compile an identification key for jewel orchids in Mount Rinjani National Park. Orchid distribution maps were created using ArcGIS based on the coordinates points where each species was found.

3 Results and discussions

Based on the exploration and species identification results, nine species from five genera of jewel orchids were found in Mount Rinjani National Park. The genus Goodyera consists of five species, namely *Goodyera reticulata* Blume, *Goodyera colorata* Blume, *Goodyera reticulata* Blume, *Goodyera velutina* Maxim ex Regel, *Goodyera* sp. Then the genus Vrydagzynea consists of two species, namely *Vrydagzynea nuda* Blume and *Vrydagzynea viridiflora* Hook.f. While the genus *Anoectochilus*, *Myrmechis* and *Macodes* found only one species, namely *Anoectochilus setaceus* Blume, *Myrmechis* sp., and *Macodes petola* (Bl) Lindl. *Goodyera* is the genus with the most species found, with five species, then

Vrydagzynea with two species and the other genera with only one species. The identification key, morphological description, and habitat of each species are as follows.

Identification key of jewel orchids (Goodyerinae) in Mount Rinjani National Park:
Description of morphology and habitat of jewel orchids (Goodyerinae) in Mount Rinjani National Park:

1a. Sympodial stem, green or cream green rhizome, asymmetrical leaves, venation is not prominent ……. 2

1b. Monopodial stem, brown or greenish cream rhizome, symmetrical leaves, prominent venation with reticulate or parallel pattern ……. 3

2a. Inflorescence 17 flowers, penducle length 3 cm with one internode, inflorescence length 13 -14 cm, pink-white flowers …… *Vrydagzynea nuda*

2b. Inflorescence 11-14 flowers, peduncle length > 4.5 cm with three internode, inflorescence length 1.7 cm, cream flowers …… *Vrydagzynea viridflora*

3a. Reticulated venation, green leaf color …… 4

3b. Parallel or curved venation, blackish green or brownish green leaf color ……. 5

4a. Lamina ovata, semi-leathery, margin not wavy, tip attenuata, leaf width > 5 cm …… *Macodes petola*

4b. Lamina lanceolate, papery, wavy margin, tip acute, leaf width < 2 cm ……*Goodyera reticulata*

5a. Stems reddish brown; lamina ovata, length > 3 cm, leaf sheat brownish white; spica inflorescences 2-3 flowers …… *Myrmechis* sp.

5b. Stems green, reddish green, or blackish red; lamina lanceolate or oblong, length < 1 cm, leaf sheat reddish cream or reddish green; inflorescence raceme > 9 flowers .. 6

6a. Stem pubescent, light brown rhizome, lamina ovate…….. *Anoectochilus setaceus*

6b. Stem glabrous, cream or greenish cream rhizome, lamina lanceolate or oblong 7

7a. Stem green; lamina ovata-oblong, silvery green, green venation…….. *Goodyera* sp

7b. Stem blackish red or reddish green; lamina lanceolate, brownish red or blackish green, white venation …….. 8

8a. Abaxial reddish brown, adaxial single stripe along midrib…… *Goodyera velutina*

8b. Abaxial blackish green, adaxial three-striped on midrib and venation …….. *Goodyera colorata*

3.1 *Anoectochilus setaceus* Blume; Bijdr. Fl. Ned. Ind: 412 (1825)

Synonyms: *Anoectochilus aureus* K. Koch & Lauche, *Anoectochilus regalis* H. Low ex C. Morren, *Anoectochilus regalis* var. *inornatus* (Hook.) Williams, *Anoectochilus setaceopictus* K. Koch & Lauche, *Anoectochilus setaceus* var. *aureoreticulatus* Hook, *Anoectochilus setaceus* var. *inornatus* Hook, *Orchis picta* Reinw. ex Lindl.

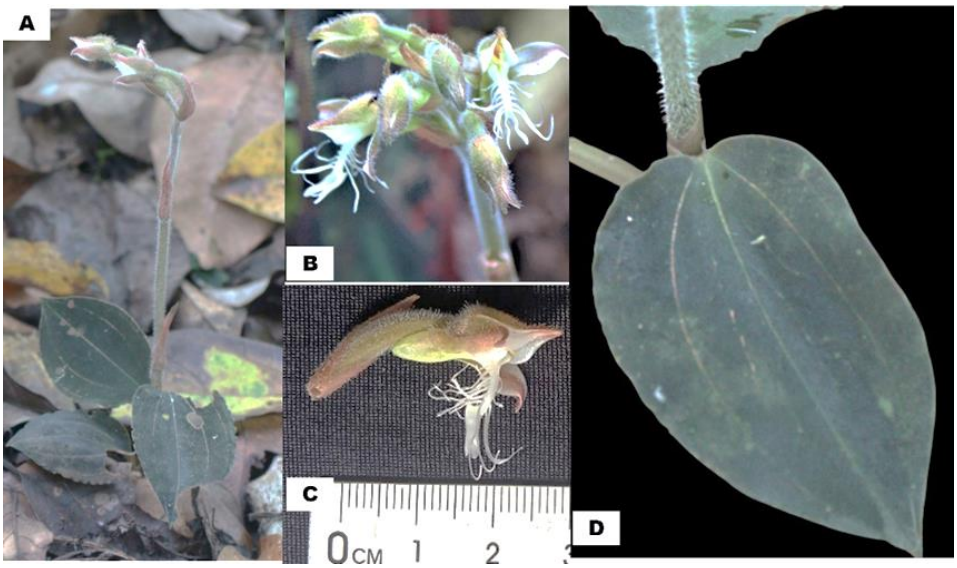

Fig. 1. *Anoectochilus setaceus* Blume: A. plant habit, B. inflorescence, C. flower, D. puberous leaves and stem.

Description: herbaceous shrub, perennial, plant height 5.5 - 20 cm. Roots terete, wire-like, l x d (2-4 x 0.2 cm), creamy. Stem monopodial, terete, green - creamy green; l x d (5.5 - 6 x 0.2 - 0.3 cm), puberolous, soft; rhizoma whitish green, terete, l x d (5 x 0.2 cm). Leaves simple, 3-4 leaves, complete, alternate and very dense; lamina semi coriaceous, ovate, l x w (3-4. 5 x 2-3 cm), basally rounded, tips acute-acuminate, margin entire; adaxial glabrous, blackish-purple-green, abaxial glabrous, whitish-green; venation paralel, one pair, pink or white; petiole bright green-creamy green, adaxially concave, 1 - 1.1 cm long, glabrous; leaf sheats green-brownish green, enclosing base of internode, glabrous. Inflorescence terminal, raceme, 2-6 flowers per inflorescence; penducle dark green, puberolous, terete, l x d (6 -11 x 0.2-0.3) cm; brachtea brown, lanceolate, 1-1.1 cm long, puberolous; pedicel subsessile, 1 mm long. Flowers resupinate; sepals green - brownish green, lanceolate, 0.7 - 1 cm long, puberolous; petals white, lanceolate, 1 cm long; labellum bright white, longer than floral decoration, lacerate type (The lips are divided into 8 pairs of hairs on both sides).
Habitat and distribution: This species grows in littered primary forest with sparse forest floor vegetation, clinging to thick mossy tree bases, near watercourses with elevation 951 - 1562 masl, air humidity 75 - 92%, air temperature 18ºC-26, light intensity 92-5554 lux, soil pH 6.0 - 6.8, soil moisture 36 - 60%. *A. setaceus* was distributed in Tetebatu track, Aik Berik, Aik Mel, and Timbanuh.
Specimen examined: 04/23-05-2024/SK

3.2 *Myrmechis* sp.

Synonyms: -

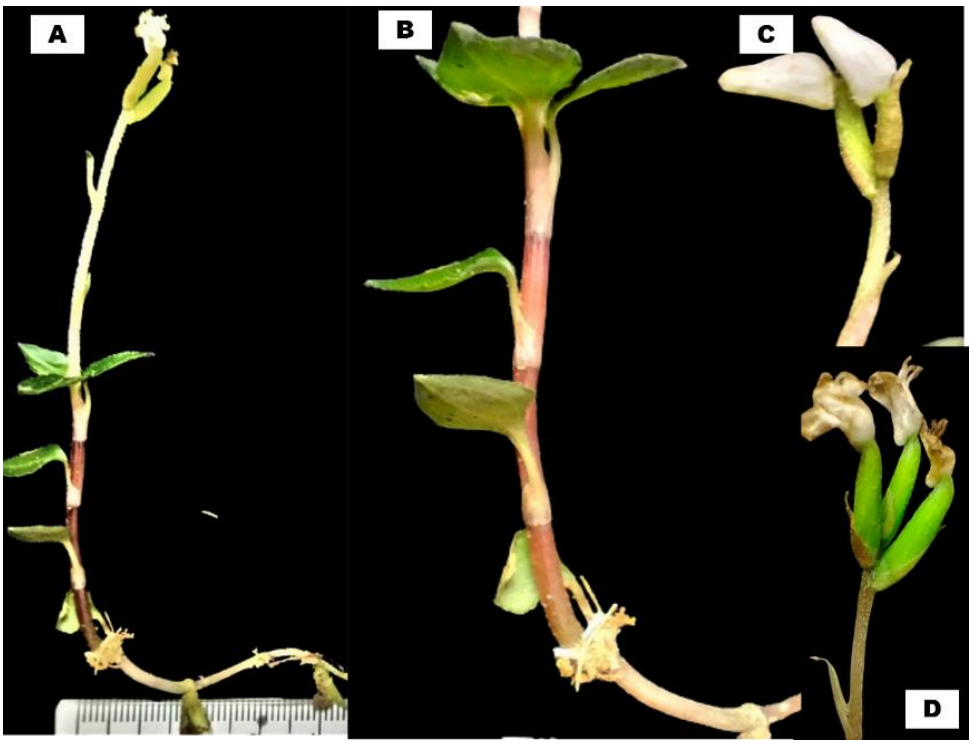

Fig. 2. *Myrmechis* sp. A. habit, B. stem and leaf arrangement, C. inflorescence with flowers still in bud, D. fruit.

Description: Shrub, herbaceous, terrestrial, perennial, height at flowering 12 cm. Thread-like roots, greenish cream, soft. Stems herbaceous, monopodial, terete, l x d (4-6 x 0.1 cm), brown - reddish brown, glabrous. Rhizoma terete, three internodes, white. Leaves simple, complete, alternate, 5-6 leaves; lamina papery, ovate, l x w (0.8 -1.1 x 0.7- 0.8 cm), base rounded, tip acute, margin entire, glabrous, adaxially green, abaxially greyish green; petiole adaxially concave - abaxially convec, 5-4 cm long, glabrous, brownish green - creamy green; leaf sheat enclosing base of internodes, 2 mm long, glabrous, brownish white. Inflorescence terminal, spike, 2-3 flowers per inflorescence, clustered at rachis tip. Pendule terete, 3 internodes and reduced leaves present, 3.5 - 4 cm long, brownish green - bright green, puberulent; bractea lanceolate, 6 mm long, greenish brown, glabrous. Flowers sessile, ovoid in bud, 5 mm in diameter; sepals lanceolate, white, glabrous; petals lanceolate, white, glabrous.
Habitat and distribution: This species grows in the shade among forest floor plants at an elevation of 1386 masl, air humidity 81%, air temperature 20 ºC, light intensity 716 lux, soil pH 6.9, soil moisture 45% and is only found on the Aik Berik.
Specimen examined: 05B/2-05-2024/SK

3.3 *Goodyera colorata* Blume; Coll. Orchid: 37 (1858)

Synonyms: Epipactis colorata (Blume) A.A.Eaton, Neottia colorata Blume, Orchiodes coloratum (Blume) Kuntze, Spiranthes colorata (Blume) Hassk.

Fig. 3. *Goodyera colorata* Blume. A. inflorescence and reduced leaves, B. plant habit, C. inflorescence, D. vegetative phase in its natural habitat.

Description: Shrub, herbaceous, terrestrial, perennial, up to 7 cm tall. Stems monopodial, terete, l x d (7 x 0.2 cm), greenish brown or pale green, glabrous. Leaves simple, complete, alternate; lamina papery, lanceolate, l x w (5-5.2 x 1. 5-2 cm), basal obtuse, tips attenuate, margins entire, adaxially brownish green-dark green, abaxially pale green-brownish green, glabrous; venation paralel, one pair, white; adaxial petiole concave, 7-8 mm long, glabrous, pale green-pink; leaf sheat enclose stem, glabrous, pale green-brownish green. Inflorescence terminal, raceme, 10 flowers per inflorescence, rachis 0.9 cm long; penducle terete, consisting of three internodes, there are reduced leaves at each node, reddish brown, puberulent; pedicel terete, 3 - 8 mm long, green, puberulent; bractea lanceolate, l x w (5-10 x 2 mm), reddish brown. Flowers brownish orange with a white pattern; sepals ovoid, 3 - 4 mm in diameter and opening at the flower tip during blooming, petals orange - brownish orange, sepal tips and labellum white, columna triangular and white. Fruit oblong, l x d (7 x 1.5 mm), puberulent, bractea persistent.
Habitat and distribution: This species grows on littered soils, semi-open canopies, around water courses in primary forest at elevation 924-1114 masl, air humidity 95%, air temperature 22-23 ^{o}C, light intensity 338-397 lux, soil pH 6.4-6.5, soil moisture 40-70%. This species is distributed in Tetebatu Trail, Sangkareang hiking trail, and Aik Berik trail.
Specimen examined: 07B/23-04-2024/SK

3.4 *Goodyera reticulata* Blume; Coll. Orchid: 35 (1858)

Synonyms: *Epipactis reticulata* (Blume) A.A.Eaton, *Neottia reticulata* Blume, *Orchiodes reticulatum* (Blume) Kuntze.

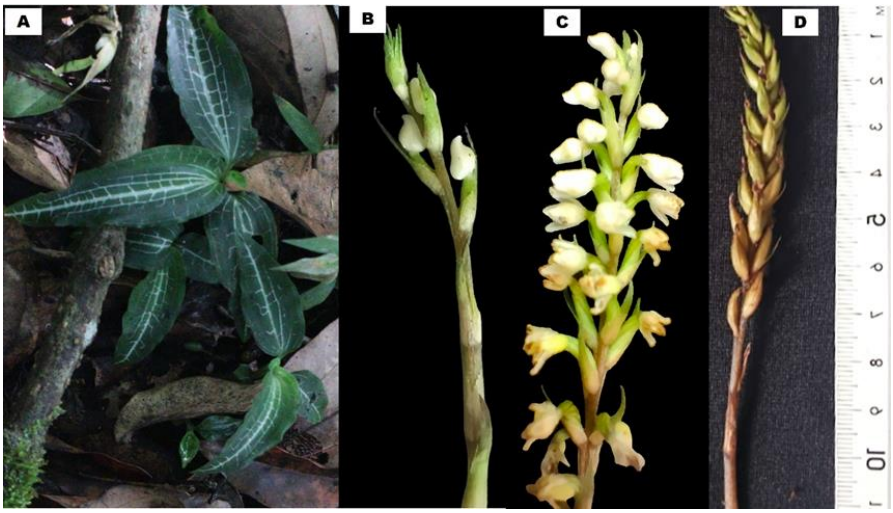

Fig. 4. *Goodyera reticulata* Blume. A. plant habit, B,C. inflorescence, D. fruit

Description: Shrub, herbaceous, terrestrial, perennial, 5 - 8 cm tall. Stems at ground level twisted, horizontal then erect leafy, sympodial, terete, l x d (5 x 0.2 cm), green, covered with leaf sheath. Leaves simple, complete, papery, alternate and very dense; lamina lanceolate, l x w (4 - 4.5 x 1.5 - 2 cm), basal rounded, tips acute, margin entire and wavy, adaxially green - silvery green, glabrous; venation reticulata, white on leaf adaxially; adaxial petiole concave, glabrous, green, 4 - 5 mm long, leaf sheath wrapping around stem, overlapping at stem tip. Inflorescence terminal, raceme, 20 flowers per inflorescence, rachis 4 -5 cm long. Penducle terete, l x d (7.2 x 0.2 cm), longer than rachis, midrib present, brownish green, puberulous. Pedicel terete, green, covered by bractea; bractea green, lanceolate, l x w (7 x 2 mm), glabrous, persistent. Flowers a green-white colour combination, resupinate, l x d (5-7 x 2-4 mm); petals white, lanceolate, 2-4 mm long; sepals white, ovary green. Fruit oblong, l x d (0.8 x 0.3 cm), brown - greenish brown, glabrous.
Habitat and distribution: this species is found in leaf litter and weathered wood, around forest paths, with shaded places at an elevation of 1326 - 1729 masl, air humidity 76-85%, air temperature 17-22 oC, light intensity 88-1252 lux, soil ph 6 - 6.5, soil moisture 15 -72%. Based on the coordinate points, *G. reticulata* is scattered in Aik Berik and Timbanuh.
Specimen examined: 02/23-05-2024/SK

3.5 *Goodyera velutina* Maxim. ex Regel.; Gartenflora 16:38. 1867

Synonyms: -

Fig. 5. *Goodyera velutina* : (A) plant habit, (B) adaxial leaf with white midrib stripe.

Description: Shrub, herbaceous, terrestrial, perennial, 4.5 -6 cm tall. Roots beige, terete, soft, l x d (3 x 0.2 cm). Stem monopodial, terete, l x d (15 x 0.2 cm), blackish red; rhizoma blackish red, terete. Leaves simple, complete, alternate; lamina blackish-green, papery, lanceolate, 3-4 cm × 1-1.5 cm, basal obtuse - rounded rounded, tip acute, margin entire, surface glabrous; venation is not prominent, midrib visible as a longitudinal white line on leaf adaxial; petiole reddish beige, adaxially concave, 0.4 - 0.5 cm long, surface glabrous; leaf sheat reddish beige, ovate, 4 mm long, overlapping at stem tip.
Habitat and distribution: *G. velutina* grows in primary forest, in a shaded place with an elevation of 1232-1467 masl, light intensity is 819-1490 lux, air humidity is 82-91%, and air temperature ranges from 22.1-22.9 ˚C. Scattered only on the Tetebatu trail.
Specimen examined: 01/05-07-2024/SK

3.6 *Vrydagzynea nuda* Blume.; Coll. Orchid: 17 (1858)

Synonyms: *Hetaeria nuda* (Blume) Miq.

Fig. 6. *Vrydagzynea nuda* Blume. A. Habitus, B. Stolon, C. Inflorescence, D. phyllotaxis and terminal inflorescences

Description: Shrub, herbaceous, terrestrial, perennial, up to 10 cm tall. Roots terete, up to 6 cm long, white, root hairs thick, soft. Stems monopodial, terete, l x d (9 -10 x 0.15 mm), internodes 1.5 - 2 cm long, green, glabrous, stolons terete. Leaves simple, complete, alternate; lamina papery, ellipsoid, asymmetric, l x w (2.6 - 4.4 x 1.5 -2 cm), base obtuse - rounded, tip attenuate - acuminate, margin entire, adaxially glabrous, green, venation not obvious; petiole concave, 1.2 - 1.5 cm long, glabrous, green; leaf sheath enclosing internodes, pale green. Inflorescence terminal, in clusters, 17 flowers per inflorescence and very densely clustered on short rachis; pendule terete, l x d (3 cm x 0.2 cm), green, glabrous; pedicel terete, 0.4 cm long, creamy green; bractea lanceolate, green, l x w (1.1 cm x 0.3 cm), tip acute. Flowers 2 mm long; petals oblong, blunt-tipped, colour combinations of green, pink and white; sepals white; labellum resembling an elongated spade, white with a green pattern.
Habitat and distribution: This species is very rare, growing in shaded primary forest at elevation 864-936 masl, with air humidity of 79-83%, air temperature of 25-25.5ºC, and light intensity of 159 lux on the Jeruk Manis trail.
Specimen examined: 03/24-02-2024/SK

3.7 *Vrydagzynea viridiflora* Hook.f.; Fl. Brit. India 6: 96 (1890)

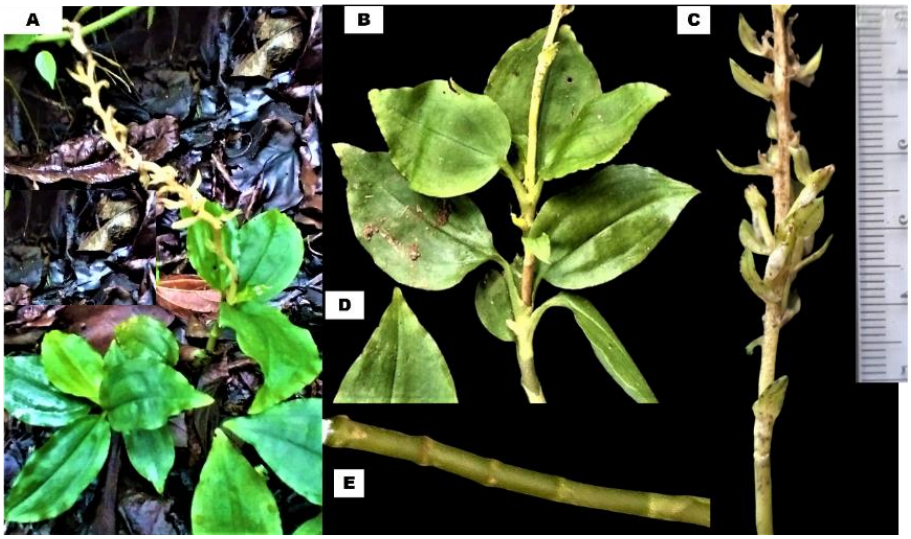

Fig. 7. *Vrydagzynea viridiflora*. A. plant habit, B. leaf arrangement, C. inflorescence, D. leaf tips, E. stem.

Description: Shrub, herbaceous, terrestrial, perennial, up to 22 cm tall when flowering. Roots grey, terete, 2-3 roots per node, l x d (3 x 0.15 cm), dense root hairs. Stems sympodial, base horizontal then grow upright, terete, l x d (10 -14 x 0.2-0.3 cm), internodes 0.5 -2 cm, green, glabrous. Rhizome terete, horizontal, l x d (7 x 0.2-0.3 cm), green. Leaves simple, complete, papery, alternate, elliptic-ovoid, asymmetrical, l x w (4.5 – 5 x 2 – 3 cm), basal obtuse – rounded, tip attenuate, margin entire, surface glabrous, adaxial glossy green, abaxial pale green; pedicel concave-convex, 1 – 1.5 cm long, glabrous; leaf sheath encircling the stem, creamy green, glabrous. Inflorescence terminal, raceme, 13-14 flowers per inflorescence, rachis 11 – 14 cm long; peduncle terete, l x d (4.5 -5 x 0.2 cm), two segments and containing reduced leaves, greenish cream, glabrous. Pedicels terete, semi-sessile, 1 mm long, cream; bracts lanceolate, l x w (5 – 7 x 2 mm), greenish cream, glabrous, persistent. Flowers oval, 7 mm long, cream petals, cream sepals.

Habitat and distribution: this species grows under littered trees, shaded in primary forests overgrown with lianas and ferns, elevation 950 - 1383 masl, air humidity 80-95%, air temperature 21 - 28oC, light intensity 111 - 2774 lux, soil pH 6.8 and soil humidity 80%. This species is distributed in the Aik Berik, Joben, and Jeruk Manis.
Specimen examined: 03/02-04-2023/SK, 03/30-04-2024/SK, 05/22-04-2023/SK

3.8 *Goodyera* sp.; *Goodyera* R.Br. in: W.T.Aiton, Hortus Kew. 5: 197 (1813)

Fig. 8. *Goodyera* sp. A. habitus, B. stem and root, C. inflorescence.

Description: Shrub, herbaceous, 15 cm high when flowering. Roots white, wire-like, terete, l x d (7 x 1 mm). Stem monopodial, terete, l x d (9-9.5 x 0.3-0.4 cm), green, glabrous, soft. Rhizome terete, cream, creeping. Leaves simple, entire, alternate; lamina papery, ovate-lanceolate, l x l (5-8 x 3-4 cm), base rounded, acuminate tip, margin entire, surface glabrous, adaxial silvery green, abaxial pale green; petiole concave-convex, 1.5-2 cm long, glabrous, silvery green; leaf sheaths ring-shaped around the stem. Inflorescence terminal; penducle terete, two segments, p x d (6 x 0.1 cm), green, puberous; bracts lanceolate, acuminate tips, 1 cm long, brown, puberous.
Habitat and distribution: This species is only found in Jeruk Manis at coordinates S 08º30'53".74" T 116º25'20.78" at an elevation of 864 masl, temperature 26.6ºc humidity 78%, and light intensity 137 lux
Specimen examined: 16/24-02-2024/SK

3.9 *Macodes petola* (Blume) Lindl.; Gen. Sp. Orchids. Pl.: 497 (1840)

Synonyms: *Anoectochilus petola* (Blume) Hereman., *Anoectochilus petola* (Blume) Linden., *Anoectochilus veitchianus* Blume., *Anoectochilus veitchii* B.S.Williams., *Anoectochilus veitchii* T.Moore, *Argyrorchis javanica* Blume., *Haemaria argyroneura* Miq., *Macodes argyroneura* (Miq.) Rolfe., *Macodes javanica* (Blume) Hook.f., *Macodes petola* var. *cuprea* Rob., *Macodes petola* var. *superba* Rob., *Macodes petola* var. *velutina* Rob., *Macodes robusta* J.J.Sm., *Macodes veitchii* Boxall., *Macodes veitchii* Boxall ex Náves., *Macodes xanthophyllus* Boxall., *Macodes xanthophyllus* Boxall ex Náves, *Neottia petola* Blume., *Rhomboda confusa* Ormerod., *Spiranthes petola (*Blume) Hassk.

Fig. 9. *Macodes petola* (Bl) Lindl. A, B Habitus, C. leaves with reticulate venation.

Description: Shrub, herbaceous, 6 cm tall. Roots are wire-like, greenish cream, soft, up to 18 cm long. Stems monopodial, terete, bright green, glabrous. Leaves simple, complete, alternate, 5-7 leaves. Lamina semi succulent, ovate, p x l (6.5 x 4 cm), base rounded, tip acuminate, margin entire, glabrous, adaxial dark green, abaxial pale green- whitish green, reticulate venation with white stripes; petiole concave-convex, 1.5 cm long, bald, whitish green; leaf sheaths do not cover the stem, bald, whitish green.
Habitat and distribution: This species grows on littered soil around the base of trees at an elevation of 1380 masl, air humidity 92%, air temperature 18-22 oc, light intensity 2146 lux, soil pH 6.0, on the Sangkareang hiking trail.
Specimen examined: 12/08-06-2023/SK

3.10 Discussion

The morphological characteristics of the organs observed in this study were roots, stems, leaves, flowers and fruits. Some species could not be observed in full morphological characteristics because they were not in the flowering or fruiting period. All species showed the same characteristics in the nature of herbaceous stems, terete, rhizomes, complete leaves with concave-convex grooved petioles, reduced leaves on the penducle, and persistent bracts. According to [13], the genus Goodyerinae is distinguished based on flower characteristics, including flower resupination, presence or absence of spurs, ornaments on the labellum, and columna characteristics. These characteristics are not always easy to identify if the material used is a dry specimen or a sample from the field that is not in the flowering phase. Therefore, more detailed vegetative organ characteristics are very helpful in species identification, and these characteristics are the main basis for compiling identification keys in this paper.

The stem characteristics of the species observed show differences in colour and surface properties. *A. setaceus* is the only species of jewel orchid observed to have puberous stems and inflorescences. Other species show glabrous stems, except for *Myrmechis* sp., which shows puberulent characteristics on the penducle. The colour of the stem surface is also

important as a characteristic because some species show distinctive stem colours, for example, *Myrmechis* sp. and *G. velutina* have a reddish brown stem, while G. colorata has a greenish brown stem, and Vrydagzynea has green stems.

In the leaf organ, there are several species characteristics, namely shape, color pattern, presence of trichomes and venation patterns. For example, *G. reticulata* has dark green leaves with white patterns formed by a netting venation, while *G. colorata* has brownish green leaves with a striking pattern of three white lines on the leaf veins. Leaf shape can also be a distinguishing feature. *M. petola* and *A. setaceus* have oval leaves, while leaves in species of Goodyera are oblong-lanceolate. In addition to being a taxonomic characteristic, the leaf color pattern determined by pigmentation and venation patterns produces a combination of colors that attract members of Goodyerinae for cultivation. Some members of this orchid genus are often referred to as 'jewel orchids' because of their beautiful reticular, spotted or striped leaves [14]. There are species that have striking and netted leaf veins, namely *A. setaceus, G. reticulata, G. colorata* and *M. petola*. According to [15], leaf vein patterns and colors are related to interactions between species. Reticulated or spider web-like patterns may deter pest insects and mammals, confuse herbivores, or may represent aposematic colouration.

Goodyera is a genus of the Goodyerinae subtribe whose species are most commonly found in Mount Rinjani National Park (TNGR). This genus is represented by four species, namely *G. reticulata, G. colorata, G. velutina* and *Goodyera* sp. The large species diversity of the genus *Goodyera* allows representatives of the species found to be many, as stated by [5] that Goodyerinae consists of 37 genera, around 630 species with the largest genus being *Goodyera*. The genus *Goodyera* in the world includes around 40 species [21], in Southeast Asia, it is known that there are 25 species, and in Java, there are 12 species recorded [9]. The TNGR orchid database only records two species, namely *G. procera* and *G. bifida*. Meanwhile, the checklist flora of Lombok Island only records the presence of G. reticulata. Data from this study adds to the TNGR orchid species diversity database and the Lombok Island flora checklist data, especially the *Goodyera* genus. The *Goodyera* is distributed in Africa, Madagascar, Europe, Asia, Australia, the Southwest Pacific, and North America [14].

Overall, the total number of *Goodyera* species recorded so far in Lombok is six species, lower than the diversity of Goodyera species in Java and only 15% of all species of this genus recorded by [21]. G. colorata, one of the species found in TNGR, is a cosmopolitan species with a distribution area in Sumatra, Java, Lombok, and Peninsular Malaysia. While G. reticulata is spread in Java, Sumatra and Lombok.

The genus Vrydagzynea found in Mount Rinjani National Park consists of two species, namely *V. viridiflora* and *V. nuda*. These two species are distinguished by the structure of the inflorescence, while the vegetative organs are very similar so that they are difficult to distinguish without flower organs. The existence of *V. viridiflora* and *V. nuda* has been reported by [9] in Java, while in Lesser Sunda there has been no record of the existence of this species by orchid researchers or a list of species in the Rinjani orchid database [7] or the Lombok flora checklist [16]. Vrydagzynea is usually a terrestrial orchid with drooping rhizomes and root nodes. The stem on the ground surface is horizontal, then turns upright and leafy, the stalk is soft and fleshy with a few green and white striped leaves in the middle. Terminal inflorescence, the flowers are small, upright, and have short and dense inflorescences [6, 9, 13].

Jewel orchid from the genus *Anoectochilus* only *A. setaceus* was found. Anoectochilus includes about 20 species and only three species in Java [9]. This genus is a terrestrial herb and can be recognised by its green leaves with silvery or red veins, white or pink flowers, dark green leaves, gold or pink veins, and reddish purple undersides [6]. In *Anoectochilus*, most of the diagnostic characters are found in the morphology of the labellum [13]. Anoectochilus setaceus is found in China, India, Bangladesh, Nepal, the Himalayas, Sri

Lanka, Myanmar, Thailand, Vietnam, and Indonesia. This species grows in several types of vegetation that have high levels of shade [17]. Therefore, the ecological conditions for A. setaceus are quite broad, but the most important is vegetation cover.

The known species of jewel orchids from the genus *Macodes* are seven species, in Java Island, three species were recorded [9], and only one species was found in Lombok in this study. The geographical distribution of jewel orchids from the genus *Macodes* ranges through the Malay archipelago to New Guinea and South West Pacific Island. *M. petola* found on Mount Rinjani has a wide distribution in SE Asia, including the Philippines, Peninsular Malaysia and Indonesia [9].

Jewel orchid species (Goodyerinae) found at the study site grow in primary forests and are part of the forest floor vegetation. These orchids generally occupy shaded forest floors with dense-semi-open canopies, relatively sparse understory layers, and littered soil surfaces. These orchids are also found around footpaths around watercourses and are associated with lianas and ferns. Canopy cover and litter can reduce evaporation and maintain soil moisture around orchid roots. Decomposed and decayed litter is a source of nutrients for the growth of jewel orchids in Mount Rinjani Forest. Jewel orchids are usually found in undisturbed natural habitats [6], cosmopolitan [3, 4], terrestrial and sometimes live as lithophytes or epiphytes [3]. All the jewel orchids found are terrestrial, except *M. petola* which can grow on the base of thick mossy trees. In general, jewel orchids in Mount Rinjani grow in an environment with an air temperature of 17 - 27°C, air humidity of 75 - 95%, pH 6.0 - 6.9 and light intensity of 92 - 5554 lux. The major environmental factors affecting the patterns of the terrestrial orchid distribution are elevation, latitude, longitude, area size, climatic factors, geological substrates, soil characteristics, vegetation types, and effects of disturbance [18]. In addition, optimal growth conditions for orchid species are specifically limited by the edaphic environment and their relationship with mycorrhizal fungi and pollinators [19]. The local distribution of jewel orchids in Mount Rinjani National Park can be seen in the following map (Fig. 10)

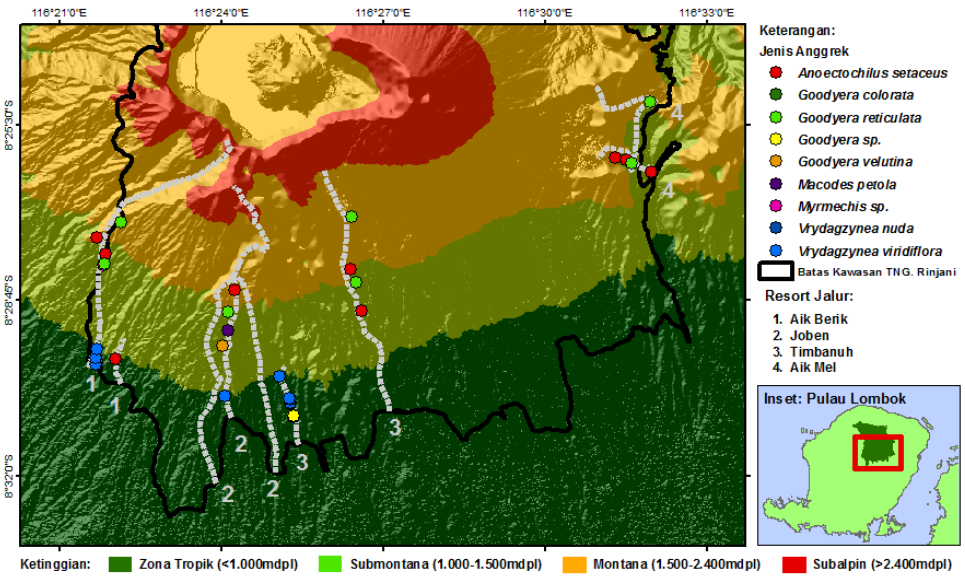

Fig. 10. Map of distribution of jewel orchids (Goodyerinae) in Mount Rinjani National Park.

In general, Goodyerinae in Mount Rinjani Forest is found in the elevation range of 864 - 1729 masl. The distribution map of jewel orchids based on the elevation zonation of mountain

flora [20] shows that the submontane zone has the most diversity of jewel orchid species, followed by the tropical zone and the montane zone. Some species are spread in one particular zone, while others are spread in all three elevation zones. *V. viridiflora* is spread only in the tropical zone of Joben and Timbanuh resorts. *M. petola* and *G. colorata* are only found in the submontane zone, while *G. reticulata* is spread in the submontane and montane zones. Only *A. setaceus* is spread in three elevation zones. The distribution of species abundance in each sub area of Mount Rinjani National Park is shown in the following table.

Table 1. Distribution of the number of orchid individuals found in each sub area of TNGR

Species	Sub area			
	Joben	Aik berik	Timbanuh	Aik Mel
Anoectochilus setaceus	6	3	4	17
Myrmechis sp.	-	2	-	-
Goodyera colorata	2	3	-	2
Goodyera reticulata	8	5	3	50
Goodyera velutina	5	-	-	-
Vrydagzynea nuda	-	-	2	1
Vrydagzynea viridiflora	28	10	31	-
Goodyera sp.	-	-	1	-
Macodes petola	2	-	-	-

The total number of individual of jewel orchids recorded was 193 individuals. *G. reticulata* and *V. viridiflora* were the two most commonly found species, with 76 and 69 individuals, respectively. Meanwhile, the least found species and spread only in one resort was *Goodyera* sp., only one individual, *Myrmechis* sp. and *M. petola*, with two individuals recorded each. Joben Resort is the Mount Rinjani National Park sub area with the most jewel orchid species, namely six species, followed by Aik Berik and Timbanuh with five species and the least in Aik Mel with four species. The ecological conditions of the tropical forest of Joben Resort support the growth of various types of jewel orchids. Joben Resort has a forest area with high - medium density, medium-high rainfall, and has a lowland to subalpine forest vegetation zone.

Jewel orchids exhibit unique morphological characteristics because they have velvety leaves, various leaf colors and are patterned with reticulate or parallel venation. This orchid has significant horticultural value because of its beautiful leaves and flowers so that it can be planted as an ornamental plant. Therefore, jewel orchids face the threat of illegal harvesting for horticultural purposes. In addition, jewel orchids require specific microhabitat conditions in primary forests with dense canopy cover, moist, loose soil with litter. So that changes in land cover can threaten their sustainability. Therefore, it is necessary to protect the natural habitat to maintain the tree vegetation that creates a microhabitat that remains suitable for the growth of jewel orchids. Orchids are posed by intricate life histories involving many obligate or facultative biotic interactions, so in situ conservation provides symbiotic interactions that orchids depend upon [23]. Increasing community awareness around the area is very important for the conservation of wild orchids in their place of origin by motivating and involving local communities in conservation.

Ex-situ conservation can be done through the collection of living specimens in local botanical gardens such as the Lombok Botanical Garden. For example, by building an orchidarium or thematic orchid garden enriched with species of jewel orchid. This is important not only for conserving jewel orchids but also for educational purposes. The collection of living specimens can be a source of learning for the education of orchid biodiversity on Lombok Island. In addition, orchid propagation can be done using both conventional and tissue culture techniques. Then, they are replanted into their natural habitat, especially jewel orchids that are very rarely found. This study is limited to subtribe

Goodyerinae, it is expected that there will be more new scientific contributions on various biological aspects of orchids through a series of research projects conducted by universities and national research institutions to produce monographs, guidebooks, local orchid flora, checklists and more comprehensive basic data on orchid ecology.

4 Conclusion

The tropical forest area of Mount Rinjani National Park is a suitable place for various types of jewel orchids (Goodyerinae) to grow, with nine species from six genera found, namely *Anoectochilus setaceus, Myrmechis* sp*., Goodyera colorata, Goodyera reticulata, Goodyera velutina, Goodyera* sp*., Vrydagzynea nuda, Vrydagzynea viridiflora,* and *Macodes petola*. Goodyera is a genus of jewel orchids with the largest number of species found. Most species are spread in the montane zone. Goodyerinae species are spread across five sub-areas on the southern slopes of Mount Rinjani. Joben Resort is a sub-area of Mount Rinjani National Park with the largest number of jewel orchid species. The results of this study add new records of orchid species to the Mount Rinjani National Park flora database and the Lombok Island flora checklist.

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