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Review

Study of Indonesian *Rhododendron*: Classification, Conservation, and Pharmacology Activity

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Abstract. *Rhododendrons* are representatives of ornamental plants with a wide range of pharmacological activities. Indonesia is the second richest country in *Rhododendron* plants with 233 species. Unfortunately, more than 85 species are severely lacking in data, 21 species are vulnerable, and more than 30 others are endangered or even no longer found. The purpose of this study is to review the species that have been found in Indonesia, and find the factors that affect conservation efforts to prevent the extinction of this plant. The results of the study succeeded in recording 221 species that had been found in Indonesia with 4 of them not having sufficient data so that named *Rhododendron sp1, R. sp2, R. sp3* and *R. sp4* by local residents. Four species were confirmed to be extinct, and most of the ex-situ conservation efforts unsuccessful. The results of this study show that there is need for cooperation between the government and residents around the *Rhododendron* growing location in an effort to preserve this plant. Researchers are also expected to pay more attention to this plant considering it has bioactive compounds with very high pharmacological properties.

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1. Introduction

Indonesia is an archipelagic country with a unique biodiversity of 30.466 native vascular plant species with 317 families [1]. Indonesia have a land area with a large number of volcanoes, spectacular geological formations, water sources, soil, altitude, climate, topography, and ongoing geological processes, have led to the formation of diverse ecosystems. Therefore, Indonesia is one of the world's biodiversity centers with 24.362 types of flowering plants. This number is equivalent to 9.5% of the total number of inflorescence species in the world [2]. One of the most abundant vascular and flowering plant genera is *Rhododendron*. Indonesia ranks second with the most *Rhododendron* genus after China [3]. In 2022, there are 231 species of *Rhododendron* spread throughout Indonesia, both endemic and breeding results [1]. Recently, researchers found again 2 new *Rhododendrons* endemic Indonesia from Papua [4].

Rhododendrons growing in the form of woody plants, evergreens, and shrubs. This plant is also known as "Malesian *Rhododendron*" [1]. *Rhododendrons* live wild in forests, swamps, rivers, and mountains. It has a high potential as an ornamental plant because of its flowers of different colors for each species. This is affected by the temperature, soil, and the intensity of the light absorbed by the plant [5]. *Rhododendron* has also been used as a herbal plant for generations as a medicine for skin, itching, and stamina enhancers. In addition, some species such as *Rhododendron renschianum* is known to have seeds that can be consumed [6]. The content of metabolite compounds such as flavonoids, saponins, and tannins allows *Rhododendron* can acting as a Herbal Plant. This plant is also known to have activities as antioxidant, antibacterial, anti-inflammatory, and anticancer [7-10].

Unfortunately, until now there are only 9 species of Indonesian *Rhododendron* that have been identified as containing secondary metabolite compounds. This is because the growing location is difficult to reach, as well as limited data on *Rhododendron* species outside Java makes the advantages of this plant not exposed to the maximum. Not only that, but some species are also endangered as a result of natural disasters, illegal logging, hunting, burning, land conversion, encroachment, and also a lack of attention to the development of these plants [11]. Therefore, it is necessary to conduct a reassessment of Indonesian *Rhododendron* species, considering that a lot of information about *Rhododendrons* in Indonesia still refers to the 1960s when they were first discovered. The review of Indonesian *Rhododendron* can be a reference in the rediscovery of species that have been discovered because this study is equipped with data on *the Rhododendron* growing location. In addition, this study is a booster for conservation efforts considering that this plant has very high pharmacological potential.

2. Experimental Section

Data collection employs the literature review method by Fadhilah., 2024 with several changes [12]. Articles indexed by Scopus and Sinta of the Indonesian Ministry of Education and Culture with the keywords, Indonesian *Rhododendron*, conservation, and pharmacological activities are collected. Articles with the last 10 years are good articles to be used as references, but considering that the focus of the study is *Rhododendrons* that grow and have grown in Indonesia, so the author cannot ignore articles with older years considering that information on Indonesian *Rhododendron* species is very limited or even lacking. Exclusive criteria for this article include *Rhododendron* endemic species of Indonesia, where they grow, conservation of *Rhododendrons* from and in Indonesia, and pharmacological activities of endemic *Rhododendrons* in Indonesia. The research flow chart is shown in **figure 1**. Data synthesis using meta-analysis using 10 selected research articles that describe or compare the flow of discovery of Indonesian *Rhododendron*.

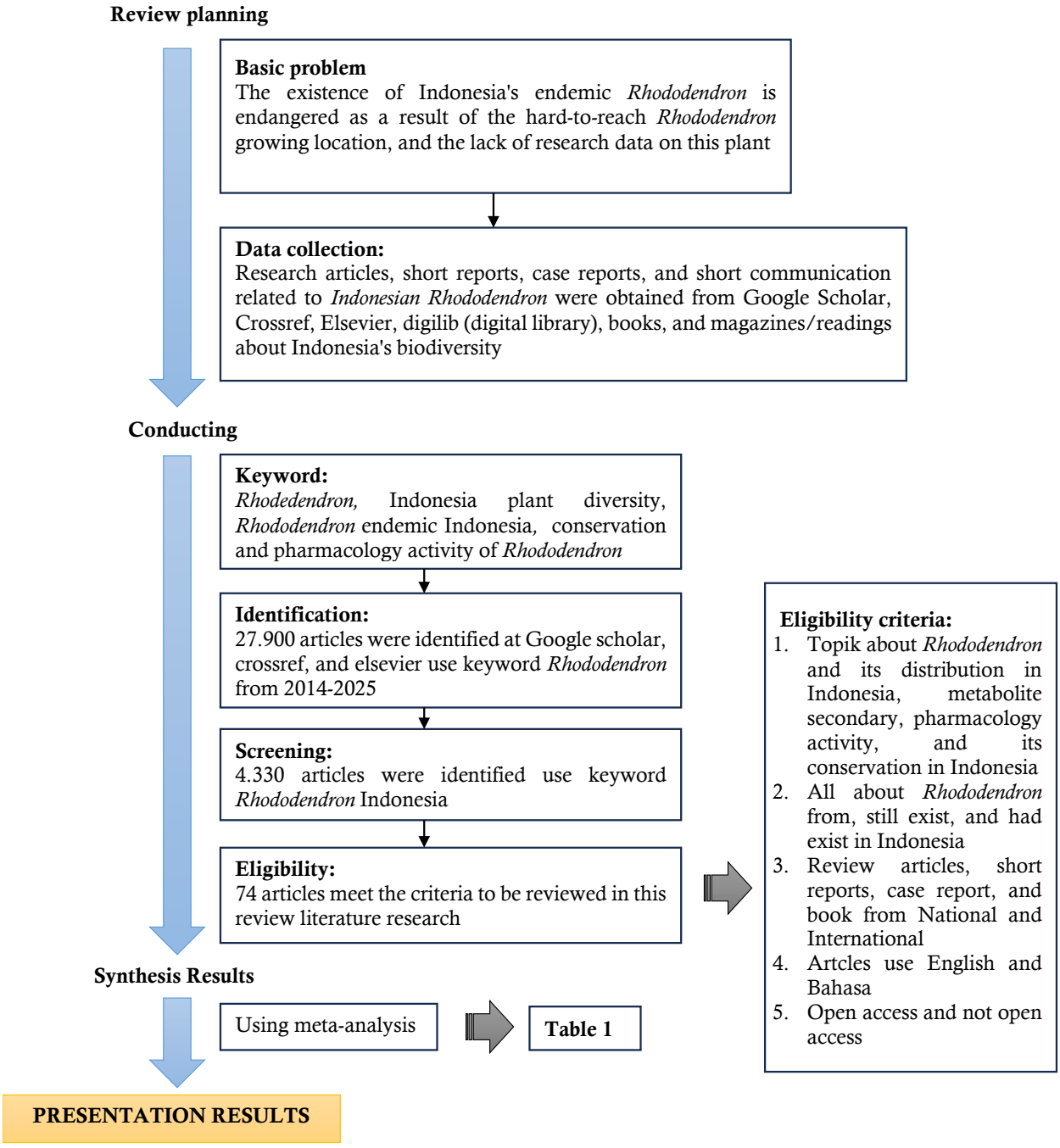

Figure 1. Literature review research flow

Table 1. Comparative studies literature review

No	Tittle	Year	Result
1	Vireya taxonomy in field and laboratory [13]	1988	a. The *Rhododendron* search espedition on Borneo island found 2 new species b. The research is based on the result of The International Conference of *Rhododendton* in May 1982 which claimed that Borneo island has a wealth of biodiversity plant c. The discovery of *Rhododendron* in Indonesia has been started since 1966
2	The *Rhododendron* Handbook [14]	1998	Founded 18 new endemic species found in Indonesia
3	Lack of Data, Taxonomic Status and Natural Hybrid in Conservation of Rhododendron spp. in Indonesia [15]	2008	a. 187 species of *Rhododendron* have been found in Indonesia. Some species are the result of the natural crosses that produce new species b. *Rhododendron* Indoensia is include in Red List IUCN (International Unit Conservation Nature) as an endagered plant group c. 31 species of *Rhododendrons* located outside Java are species with a high extinction rare due to lack of data
4	Plant Formations in the Mascarenean BioProvince [16]	2010	Founded 9 new species discovered on Sumatra island
5	A Plant Collecting Expedition to Papua, Indonesian New [17]	2010	Founded 5 new species discovered in Papua
6	The Red List of *Rhododendrons* [18]	2011	a. Five species have a near threatered category b. Eleven endangered species c. Twenty one species with vulnerable status d. Fifty eight species lack of reseacrh data e. Eighty five spesies at least concern status
7	Current Biodiversity of the Habbema Lake Area in Papua, Indonesia [11]	2018	Four species of *Rhododendrons* that once grew around Habbema Lake Papua, their existence was no longer found in 2018
8	Diversity of *Rhododendron* Species in Lake Habbema, Papua [19]	2020	Founded 31 new species found again in Papua
9	Two new species of *Rhododendron* of subgenus Vireya (Ericaceae) from Sulawesi, Indonesia [1]	2022	Total 231 spesies *Rhododendron* were found in Indonesia
10	Two new species of *Vireya Rhododendron* (Ericaceae), from Tambrauw, Papua, Indonesia [4]	2024	Two species of *Rhododendron* were rediscovered in Indonesia

3. Results and Discussion

3.1. Classification

Rhododendrons have a variety of flower colors, and live in swamps, forests, lakes, and mountains. Indonesian *Rhododendrons* are spread from Sumatra, Java, Kalimantan, Sulawesi, Maluku, Bali, and Nusa Tenggara, to Papua. *Rhododendron* distribution by region when it was first discovered can be seen in **Table 2.**

Tabel 2. Indonesia *Rhododendron*

No	Spesies	Location	Endemic	Reference
1	*R. ardii*			[1]
2	*R. alternans*			[18]
3	*R. tjiasmantoi*			[1]
4	*R. widjajae*			[1], [20]
5	*R. lagenculicarpum*			[18]
6	*R. leptobrachion*			[1], [21], [22]
7	*R. sojolense*			[1], [21]
8	*R. celebicum*			[1]
9	*R. poromense*			[1]
10	*R. brachyantherum*	Sulawesi	√	[18]
11	*R. eymae*			[15], [22]
12	*R. nanophyton var. nanophyton*			[15], [22]
13	*R. nanophyton var petrophilum*			[18]
14	*R. lagunculicarpum*			[15], [22]
15	*R. pseudobuxifolium*			[15], [22]
16	*R. arenicolum Sleumer*			[22]
17	*R. bloembergenii Sleumer*			[22], [23]
18	*R. celebicum (Blume) DC*			[22]
19	*R. impositum J J.Sm*			[22], [24]
20	*R. malayanum Jack*	Sulawesi		[22], [23]
		Sumatra		[25], [26]
21	*R. nanophyton Sleumer var. petrophilum Slemur*			[22]
22	*R. psilanthum*			[22], [23]
23	*R. leptomorphum*			[18]
24	*R. lindaueanum var bantaengense*	Sulawesi	√	[18]
25	*R. pudorium*			[22]
26	*R. quadrasianum Vidal var. selebicum J.J.Sm*			[22]
27	*R. radians J.J.Sm. var. radians*			[15], [22], [24]
28	*R. rhodopus*			[22]
29	*R. scarlatinum*			[22]
30	*R. vanvuurenii*	Sulawesi	√	[22], [24]
		Java (Jawa)		
31	*R. zollingeri*	Sulawesi; Java (Jawa); Bali		[22], [24], [27]
32	*R. bloembergenii*	Sulawesi	√	[22]
33	*R. radians var pubitubum*			[22], [28]

34	*R. radians var minahasae*			[28]
35	*R. rhodopus*			[22]
36	*R. javanicum subsp. schadenbergii*			[18], [24]
37	*R. lompohense J.J.Sm*			[21]
38	*R. pudorinum, R arenicolum*			[29]
39	*R. seranicum*	Sulawesi; Maluku		[29]
40	*R. javanicum (Blume) Benn.*	Sumatra, Bali, Java (Jawa) Kalimantan		[18], [26], [27]
41	*R. javanicum subsp. javanicum*	Sumatra, Java (Jawa), Bali, Kalimantan		[18], [26], [27], [30]
42	*R. vanderbiltianum*	Sumatra	√	[18]
43	*R. retusum blume benn*	Sumatra; Bali; Java (Jawa)		[16], [27], [31]–[33]
44	*R. lampongum*	Sumatra		[18]
45	*R. frey-wysslingii*			[16]
46	*R. atjehense*			[16], [34]
47	*R. pibigermen*			[16]
48	*R. ridleyi*			[16]
49	*R. aequabile*			[14], [16]
50	*R. adinophyllum*		√	[16], [35]
51	*R. banghamiorum*			[18]
52	*R. cernuum*			[15]
53	*R. pyrrhophorum*			[15]
54	*R. perplexum*			[15], [18]
55	*R. pubigermen*			[18]
56	*R. korthalsii*			[15]
57	*R. beccarii*			[18]
58	*R. ripleyi var ripleyi*			[18]
59	*R. trysmanni*			[36]
60	*R. aequabite*			[16]
61	*R. multicolor*		√	[14]
62	*R. rarilepidotum j.j.Sm*			[14]
63	*R. sumatranum*			[16], [35]
64	*R. longiflorum var. bancanum*	Sumatra; Kalimantan	√	[14]
65	*R. vinicolor*	Sumatra	√	[26], [37]
66	*R. jasminiflorum Hook. Spp. Heusseri (J.J.Sm.)*			[35], [37]
67	*R. sessilifolium J.J.Sm*		√	[37]
68	*R. zoelleri*	Papua Maluku	√	[38]
69	*R. ciliilobum*	Papua	√	[15]
70	*R. taxoides*			[15]
71	*R. cyrtophyllum*			[15]

72	*R. carstensense*		[15]
73	*R. culminicolum*		[19], [32]
74	*R. herzogii*		[11]
75	*R. macgregoriae (Yellow)*		[11], [39]
76	*R. brassii*		[11], [19]
77	*R. flavoviride*		[11], [19]
78	*R. opulentum*		[18]
79	*R. oreadum*		[18]
80	*R. oreites var. chlorops*		[11], [19]
81	*R. orietes var. orietes*		[19]
82	*R. phaeochristum*		[18]
83	*R. anagalliflorum*		[14]
84	*R. pleianthum*		[18]
85	*R. papuanum*		[18]
86	*R. rhodochroum*		[11], [19]
87	*R. rosendahlii*		[18]
88	*R. pusillum*		[18]
89	*R. subcrenulatum*		[11], [19]
90	*R. asperum*		[18]
91	*R. bryophilum*		[14]
92	*R. multinervium*		[18]
93	*R. christi*		[14]
94	*R. agathodaemonis*		[11], [19]
95	*R. beyerinckianum*		[11], [19]
96	*R. gaultheriifolium*		[11], [19]
97	*R. spondylophyllum*		[11]
98	*R. kogo*		[11]
99	*R. saxifragoides*		[11], [19]
100	*R. microphyllum*	√	[11], [19]
101	*R. phaeops*		[11]
102	*R. tuberculiferum*		[11]
103	*R. glabriflorum*		[19], [35]
104	*R. versteegii*		[19]
105	*R. correoides*		[19]
106	*R. pulleanum var. maiusculum*		[19]
107	*R. cravenii*		[19], [40]
108	*R. angulatum*		[14], [18]
109	*R. asperrimum*		[18]
110	*R. haematophthalmum*		[19], [39]
111	*R. revolutum*		[19]
112	*R. villosulum*		[19]
113	*R. caespitosum*		[19], [39]
114	*R. coelorum*		[19]
115	*R. disterigmoides*		[19]
116	*R. schizostigma*		[19]
117	*R. helodes*		[19]
118	*R. syringoideum*		[18]
119	*R. cinchoniflorum*		[18]

120	*R. dianthosmum*			[14]
121	*R. hooglandii*			[14]
122	*R. laetum*			[14]
123	*R. leucogigas*			[14]
124	*R. rubineiflorum*			[14]
125	*R. incospicum*			[19]
126	*R. nubicola*			[19]
127	*R. porphyranthes*			[19]
128	*R. rubrobracteatum*			[19]
129	*R. subuliferum*		√	[15], [19]
130	*R. xenium*			[15]
131	*R. hameliiflorum*			[15]
132	*R. ultimum*			[15]
133	*R. ciliilobum*			[15]
134	*R. habbemae*			[15]
135	*R. maius*			[19], [39]
136	*R. roseiflorum*		√	[19]
137	*R. meagaii*			[19], [41]
138	*R. gumineese Craven*			[3]
139	*R. superbum*			[42]
140	*R. inudatum*			[39]
141	*R. vitis-idaea*			[39]
142	*R. gardenia*			[39]
143	*R. wrightianum*			[39]
144	*R. konori Becc*	Papua		[17]
145	*R. brachypodarium*			[18]
146	*R. cililobum Sleumer*			[17]
147	*R. arfakianum*			[17]
148	*R. englerianum*			[18]
149	*R. extrorsum*			[18]
150	*R. evelyneae*			[18]
151	*R. rappardii*		√	[17]
152	*R. dutartrei*			[18]
153	*R. cuspidellum*			[17]
154	*R. curviflorum*			[35]
155	*R. delicatulum var lanceolatoides*			[18]
156	*R. hatamense*			[18]
157	*R. hirtolepidotum*			[18]
158	*R. delicatulum var delicatulum*			[18]
159	*R. milleri*			[21]
160	*R. cornu-bovis*			[18]
161	*R. cinerascens*			[18]
162	*R. protandrum*			[15]
163	*R. thaumasianthum*			[15]
164	*R. calosanthes*			[18]
165	*R. kawir*			[15]
166	*R. tintinnabellum*	Papua	√	[18]
167	*R. proliferum*			[15], [18]
168	*R. parvulum*			[15], [18]

169	*R. oxycoccoides*			[18]
170	*R. rhodosalpinx*			[18]
171	*R. psammogenes*			
172	*R. myrsinites*			[15], [18]
173	*R. mollianum*			[18]
174	*R. subulosumR*			[15]
175	*R. wentianum*			[18]
176	*R. sp4*			[5]
177	*R. sp5*			[5]
178	*R. purpureiflorum*			[18]
179	*R. vinkii*			[18]
180	*R. incommodum*			[18]
181	*R. pachystigma*			[15]
182	*R. lamii*			[18]
183	*R. muscicola*			[18]
184	*R. pachycarpon*			[43]
185	*R. gracilentum*			[44]
186	*R.. mulyanie*			[4]
187	*R.. engelbertii*			[4]
188	*R. blackii*			[44]
189	*R. aurigeranum*			[44]
190	*R. mogeanum*			[19]
191	*R. fortunans*			[19]
192	*R. alborugosum*			[13]
193	*R. bagobonum*			[14]
194	*R. brookeanum*			[14]
195	*R. crassifolium*			[14]
196	*R. himantodes*			[14]
197	*R. durionifolium*			[18]
198	*R. intranervatum*			[14]
199	*R. lanceolatum*		√	[14]
200	*R. javanicum sub. brookeanum*	Kalimantan		[18]
201	*R. javanicum subsp. cladotrichum*			[18]
202	*R. javanicum subsp. kinabaluense*			[18]
203	*R. stapfianum*			[14]
204	*R. edanoi subsp. pneumonanthum*			[18]
205	*R. kemulense*			[18]
206	*R. commutatum*			[18]
207	*R. lanceolatum*			[13]
208	*R. ruttenii*			[35]
209	*R. impressopunctatum*			[15]
210	*R. malayanum var pubens*	Maluku	√	[18]
211	*R. toxopei*			[18]
212	*R. stresemannii*			[15]

213	*R. buruense*			[18]
214	*R. meliphagidum*			[35]
215	*R. renschianum*	East Nusa Tenggara (Nusa Tenggara Timur)	√	[35]
216	*Rhododendron sp*	West Nusa Tenggara (Nusa Tenggara Barat)		[45]
217	*R. citrinum*	Bali	√	[27]
218	*R. wilhelminae*	Java (Jawa)	√	[15], [46]
219	*R. album*			[15]
220	*R. loerzinggi*			[15]
221	*R. zippelli*			[27]

3.2. Sulawesi

Sulawesi is an island of extraordinary complexity in geological history and biodiversity [21]. In 2019, Sulawesi has 29 species of *Rhododendron* [20], and in 2022 it will drop to 22 species [1]. However, **Table 2** shows that the number of *Rhododendron* species in Sulawesi is 39 with 4 species also found in Sumatra, Java, Bali, Kalimantan and Maluku. This difference is because the data collected is data since *Rhododendrons* began to be found in Indonesia until now. Meanwhile, the expedition by Argent was carried out in 2019, which means that 17 species are no longer found in their natural habitat. Sulawesi *Rhododendrons* are distributed in the South, Central, North, and Southeast areas with habitats around Lake Poso and the mountains of Sulawesi.

Rhododendron from Sulawesi has a habitat in the form of shrubs with a height of 2-6 meters, scaly stems, and light green leaves when fresh with an elliptical shape extending to ovate. The shape of the flower crown is generally relatively the same in the form of a tube or funnel to a bell. Not all species live in mountainous areas, the *R. eymae* have their habitat in rock cracks with little soil. *Rhododendron pseudobuxifolium* and *R. impositum* live in humid areas with minimal light intensity, and *R celebicum* live in mossy areas. Another species, *R vanvuurenii* lives on the remains of pine forests and is considered a poisonous plant by residents. This species is also found in West Java [1], [15], [20], [21], [24], [26], [32]

Rhododendron ardii

Rhododendron rhodopus

Rhododendron zollingeri

Rhododendron quadrasianum var selebicum

Rhododendron malayanum

Rhododendron lagunculicarpum

Rhododendron nanophyton var nanophyton

Rhododendron eymae


Rhododendron celebicum


Rhododendron widjajae


Rhododendron vanvuurenii


Rhododendron impositum J.J.Sm


Rhododendron bloembergenii


Rhododendron sojolense


Rhododendron radians


Rhododendron leptobrachion


Rhododendron javanicum (Blume)


Rhododendron pubigermen


Rhododendron alternans

Figure 2. *Rhododendron* Sulawesi

3.3. Sumatra

Sumatra has become one of the ecoregions that is a global conservation priority with a critical status, with 38% of Sumatra's tropical rainforests in the endangered and critically endangered category [26], [31]. Sumatra *Rhododendrons* are spread in every region from Aceh to Lampung. There are 28 species found with 3 of them, *R. javanicum, R. retusum* and *R. longiflorum* also found in Bali, Java, and Kalimantan. *Rhododendron retusum* in 2015 is included in the endangered category because it grows in the area of active volcanic peaks. Sumatran *Rhododendrons* are shrubs, epiphytes, and terrestrial with a height of 1.5 to 4 meters. The twigs have brown scales with green leaves like the typical *Rhododendron*. The crown has a variety of colors, but the flowers belonging to *R rarilepidotum* give off a fragrant and sweet aroma [31], [37].


Rhododendron retusum


Rhododendron vinicolor


Rhododendron sessilifolium


Rhododendron aequabile


Rhododendron sumatranum


Rhododendron jasminiflorum


Rhododendron multicolor


Rhododendron rarilepidotum


Rhododendron longiflorum


Rhododendron banghamiorum

Figure 3. Rhododendron Sumatra

3.4. Papua

Papua is an affluent island with endemic plant diversity reaching 55% [47]. The data collected shows that the Papuan *Rhododendron* has reached 121 with 49 species in the Papua High Mountains, and 1 species *of R. zoelleri* also grows in Maluku. The altitude of the place where it grows, the temperature and humidity, as well as the ecological characteristics, make Papua an island with many and varied *Rhododendron* genera. The shortcomings are that the existence of *Rhododendrons* in Papua has not been fully revealed.

The Central Highlands of Papua, the Foja Mountains, and the Memberamo River Valley are believed to be areas with many *Rhododendrons*. Experts claim that Indonesia is likely to become the country with the most *Rhodendrons* if every region of Papua is explored [11]. The discovery of 4 species of *Rhododendrons* that are not clearly classified in Bilai District at an altitude of 1750-1800 is clear evidence that not all Papuan *Rhododendrons* have been explored. These four new species have a variety of flower colors, white, pale yellow to bright yellow, and pink, and are known as *Rhododendron sp1, sp2, sp3,* and *sp4* [47].


Rhododendron zoelleri


Rhododendron kogo


Rhododendron wrightianum


Rhododendron meagaii

Rhododendron inudatum

Rhododendron saxifagoides

Rhododendron versteegii

Rhododendron glabriflorum

Rhododendron incospicuum

Rhododendron rubrobracteatum

Rhododendron roseiflorum

Rhododendron macgregoriae

Rhododendron konori

Rhododendron rappardii

Rhododendron cuspidellum

Rhododendron culmicolum

Rhododendron herzogii

Rhododendron microphyllum

Rhododendron tuberculiferum

Rhododendron correoides

Rhododendron pulleanum

Rhododendron cravenii

Rhododendron haematophthalmum

Rhododendron villosulum

Rhododendron caespitosum

Rhododendron superbum

Rhododendron vitis-idaea

Rhododendron gardenia


Rhododendron arfakianum


Rhododendron curviflorum


Rhododenderon cartensense


Rhododendron pachystigma


Rhododendron anagalliflorum


Rhododendron bryophilum


Rhododendron Christi


Rhododendron dianthosmum


Rhododendron laetum


Rhododendron leucogigas


Rhododendron rubineiflorum


Rhododendron delicatulum


Rhododenderon asperum


Rhododendron multinervium


Rhododendron rubrobracteatum


Rhododendron sp4


Rhododendron sp5


Rhododendron pachycarpon


Rhododendron gracilentum


Rhododendron blackii


Rhododendron aurigeranum

Figure 4. *Rhododendron* Papua [5],[11],[14], [17-19], [21], [39-41]

3.5. Kalimantan

Kalimantan has 18 species of *Rhododendron* with *R. javanicum* having 3 different variants. One of the unique species of Kalimantan is *R. crassifolium*. This plant has a crown with a variety of colors ranging from pink to crimson, as well as white to orange. Unfortunately, very little data on the white-orange species has been recorded. In addition, *R. bogobonum* is found growing in landslide areas, as well as *R. alborugosum* and *R. stapfianum* which have flowers with a fragrant and sweet aroma [35].

Rhododendron alborugosum

Rhododendron mogeanum

Rhododendron fortunans

Rhododendron brookeanum

Rhododendron bagobonum

Rhododendron crassifolium

Rhododendron himantodes

Rhododendron intranervatum

Rhododendron stapfianum

Figure 5. *Rhododendron* Kalimantan [13], [14], [19]

3.6. Maluku

Referring to **Table 2**, Maluku has 7 species of *Rhododendron* with the species recorded including *Rhododendron ruttenii***.** This species has flowers with a long white tubular shape. Other types are *Rhododendron impressopunctatum* and *Rhododendron stresemannii*. Both species have shrub habitats that thrive in tropical mountainous areas**.** Finally, *Rhododendron meliphagidum*, lives to form a habitat in mountain forests and is a species that is easy to cultivate. This plant has long flowers with a pale yellow color [35].

3.7. Bali, East Nusa Tenggara (NTT), and West Nusa Tenggara (NTB)

Bali and Nusa Tenggara, have 1 endemic species each. Bali has *R. citrinum* with a shrub-shaped habitat covered with brown scales. Flowers are clustered in groups of 2 to 5 with a half-hanging position. The flower crown has a length of 12 mm in the shape of a bell with a white to pale yellow color [27]. NTT has *R. renschianum*. This species is epiphytic, living in the area of the eruption of Mount Kelimutu. The plant has a neat growth with orange bell-shaped flowers with a yellow flower crown base [35]. This plant is known to have fruits that can be eaten by locals and monkeys [6]. One species of *Rhododendron* found in the Rinjani mountains, NTB has not been well identified, so there is no data on this species.

3.8. Java

Java has several species of *Rhododendron* that are spread in other areas such as *R. vanvuurenii* (Sulawesi), *R. retusum* (Sumatra and Bali), and *R. citrinum* (Bali). The types of *Rhododendrons* that are known to be endemic to the island of Java are *R. javanicum*, *R. wilhelminae, R. album,* and *R. loerzinggi*. *Rhododendron wilhelminae* had caused controversy because it was considered a hybrid *Rhododendron* of *R. javanicum* and *R. malayanum*. Its status then changed to a natural hybrid, due to a lack of information about Indonesian *Rhododendron*. Despite the existing controversies, this species is included in one of the three endangered species along with two other species; *R. album* and *R. loerzinggi*. These three species have habitats in the form of shrubs and grow in mountainous tropical biomes [15].

3.9. Conservation

In recent decades plant diversity has declined rapidly as a result of climate change, increased rate of deforestation, and indiscriminate exploitation of forests for short-term economic gains [15], [48], [49]. Because of this, Indonesia is almost always classified as an area that has high-value flora and at the same time is threatened with degradation [15]. This is in line with the reality of habitat loss of several species of *Rhododendron* in Papua when the *Rhododendron* expedition is repeated [19]. In-situ and ex-situ conservation are seen as necessary to prevent the extinction of *Rhododendrons*. In addition, *Rhododendron* species propagation techniques also continue to be carried out by paying attention to the characteristics of each species. Not every species is given the same treatment or care. Soil conditions, temperature, humidity, light intensity, and water volume are highly considered in conservation efforts [50]. Several species from abroad have also been tried to be cultivated in several conservation sites such as *R. groenlandicum* from the U.S.A., *R. simsii* from China, and *R. mucronatum* (Blume) G. Don from Japan.

The Intan Jaya Papua area has made several efforts to proliferate *Rhododendrons* by creating a special area for *Rhododendron* plantations in their natural habitat. Propagation is carried out using cuttings, paying attention to light conditions and water sufficiency. This treatment has positive impacts on the increase in the number of *Rhododendron* habitats [47]. *Rhododendron* breeding can also be carried out using crossbreeding techniques. The crossing technique by bark graph method on *R. javanicum* and *R. zooleri* bear positive results with the formation of a joint network and a high percentage of live seedlings [51].

Table 3. Conserved *Rhododendrons*

Location	Species	Status	Reference
CBD	*R. macgregoriae*	**	[49], [51-53]
	R. groenlandicum	* America	
	R. javanicum	**	
	R, simsii	* China	
	R. zoelleri	**	
	R. longiflorum	**	
	R. sessilifolium	**	
	R. multicolor	**	
	R. wilhelminae	**	
	R. album	**	
EKB	*R. seranicum J.J.Sm*	**	[28], [54-57]
	R. rhodopus	**	
	R. javanicum var teysmannii	**	
	R. javanicum Bene	**	
	R. radians J.J.Sm	**	

	R. konori Becc	**	
	R. sp	**	
	R. sp (bunga orange kecil)	**	
	R. zollingeri	**	
	R. mucronatum (blume) G. Don	*Japan	
	R. macgregoriae F. Muell	**	
	R. renschianum	***	
TNLL	*R. malayanum Jack*	**	[58]
	R. quadrasianum var celebicum	**	
	R. zollingeri	**	
	R. celebicum Blume	**	
TNGP	*R. album*	**	[59]
TWA	*R. malayanum Jack*	**	[60]
KRBW	*R. konori*	**	[5]
	R. herzogii	**	
	R. macgregoriae 2 (cream-orange)	*	
	R. macgregoria 3 (White-pink)	*	
	R. sp	*	
	R. mucronatum	**	
	R. nanophyton Slumer	**	
	R. sp2	*	
	R. sp3	*	

Note: CBD= Cibodas Botanic Garden; EKB= Eka Karya Bali; TNLL= Taman Nasional Lore Lindu; TNGP= Taman Nasional Gunung Gede; TWA= Taman Wisata Alam Sicike-cike; KRBW= Kebun Raya Biologi Wamwna; *Only exists in conservation areas; **Growing in other areas of Indonesia, *** Its existence is no longer found

Figure 9. Rhododendron Konservasi [5]

Conservation efforts provide different results for each species. It can be said that ex-situ conservation is not an easy thing. One of the obstacles that need to be taken is different soil and climate conditions. Some species experience a change in crown color such as *R. radians* J.J.Sm from Central Sulawesi which has a pseudo-white crown that is almost pink, becoming white at the conservation site. Other species are monitored to be difficult to carry out conservation because they cannot adapt

to a new environment. This inability to adapt causes the plant to be in a vegetative state and only produces leaf buds without the growth of flower crowns. In addition, several species with the same flower cannot ultimately maintain their existence even though they have been cultivated such as *R macgregoriae* [5], [55]. Species with native habitats in mountainous areas with certain criteria such as *Rhododendron album* and *Rhododendron renschianum* are not successfully conserved. *Rhododendron album* which was conserved in Mt Gede National Park in 2004 has undergone a status change from vulnerable to almost extinct [59], and *Rhododendron renschianum* which grows in lake craters with high sulfur content cannot survive in conservation due to climate differences. *Rhododendron renscianum* has been sought for conservation in the Eka Karya Bali Botanical Garden, but in 2024 its existence will no longer be found [27]. This species still exists in its natural habitat, at Kelimutu National Park Area, East Nusa Tenggara.

Based on the results of the study, conservation of *Rhododendron* is still far from successful. Soil and climate conditions in different conservation areas or even those that have been created to resemble natural habitats are also unable to maintain the survival of *Rhododendrons*. In-situ conservation of *Rhododendron* habitats is the wisest choice in preventing the extinction of *Rhododendron*. For example, *R. eymae* tend to retain ancestral ecological Ncharacteristics (niche conservatism) because they have a specific type of microhabitat [32].

3.10. Pharmacology Activity

Pharmacological activity is certainly inseparable from the content of secondary metabolites. *Rhododendron* is a plant with the highest content of flavonoids and terpenoids [53]. Research on the pharmacological activity of *Rhododendron* must be carried out considering the large number of species of this genus. For example, the endemic American *R. groenlandicum* cultivated in CBD is known to have antidiabetic activity [61]. Indonesian *Rhododendrons* have also been proven to contain secondary metabolites (**Table 4**). One of the factors that supports the existence of bioactive compounds in *Rhododendron* is the presence of endophytic microorganisms. These microorganisms are gram-positive bacteria that significantly contribute to the production of bioactive compounds in medicinal plants [8], [53]. They colonize plant tissues without negatively impacting their hosts but can produce the same metabolite compounds as their hosts [62]. Actinobacteria from several species of *Rhododendron* are claimed to have the potential to be antioxidants, antibacterial, anticancer, and pancreatic lipase inhibitors [63].

Table 4. Metabolite Secondary of *Rhododendron* from Indonesia

Species	a	b	c	d	e	References
R. jasminiflorum	++	+	-	-	-	
R. retusum	+	+	-	-	-	
R. konori	+	+	-	-	-	[64]
R. seranicum	-	+	-	-	-	
R. malayum	+	+	-	-	-	
R. javanicum	+	+	+	+	+	[64]
R. macgregoriae	+	-	-	-	-	[55]
R. zoelleri	-	-	+	-	-	[62]
R. sessillifolium	+	-	+	-	+	[62]

Note: a. Flavonoid; b. Anthocyanin; c. Alkaloid; d. Saponin; e. Terpenoid

3.11. Antioxidant and Antibacterial

Rhododendrons from Indonesia that have been known to have antioxidant activity are *R. retusum* and *R. konori.* However, the plant parts tested have quite obvious differences. Twigs *R. retusum* extract has high antioxidant activity, while *R. konori* is found in leaf extracts [64]. In another study, it was found

that the types of flavonoids contained in *R. retusum* are epicatechins and kaempferol which have cytotoxic activity against P388 leukemia cells [65]. Indonesian *Rhododendron* species that are also known to have antibacterial activity are *R. konori*, *R. macgregoriae*, *R. javanicum, Rhododendron sp* hybrid West Java, and *R. zoelleri* [55], [66]. *Rhododendron sp* hybrid West Java and *R. zoelleri* have the potential as an antibacterial that can inhibit the growth of *B. pumilus*. The test was carried out by observing the decrease and elongation of bacterial cells by endophytic actinobacteria of *Rhododendron* [8].

Research on the antioxidant and antibacterial activity of *Rhododendrons* in several countries such as China, Japan, Nepal, and India continue until 2025. *Rhododendron* species that have antibacterial and antioxidant activity include: *R. arboreum, R. simsii, R. spinuliferum, R. tomentosum, R. formosanum,* and *R. inaequale.* The species that has been most frequently researched is *Rhododendron arboreum*. This species, which is also known as the national flower of Nepal, has a rich bioactive content so that it is able to inhibit the growth of *Aeromonas hydrophila, Eschericia coli,* and *Staphylococcus aureus bacteria* [67].

3.12. Anticancer and Anti inflamatorry

So far, there has been no research on the anti-inflammatory and anticancer activity of *Indonesian Rhododendron*, but several species of endemic *Rhododendron* in other countries are known to have pharmacological activity in inhibiting the growth of cancer cells such as *R. molle, R. luteum, R. dauricum, R. arboreum,* and *R. subsect. Ledum*. These species are claimed to inhibit the growth of cervical cancer cells, Human Colorectal Cancer Cells, AGS gastric adenocarcinoma cell line, as well as anti-inflammatory [10], [68-69] .

Until now, there has been no research on the main compounds in *Rhododendron* that play an active role in every pharmacological activity. In the future, further research related to the isolation of potential compounds is highly expected for the advancement of science, and facilitates the further development of drugs

4. Conclusion

Indonesia *Rhododendrons* are currently claimed to have 233 species. Based on the study in this review article, it was found that 221 species of *Rhododendrons* were successfully recorded again even though the existence of several species is no longer found like *R. agathodaemonis, R. flavoviride, R. rhodochronum,* and *R. spondylophyllum*, while 8 other species are found in conservation locations. Differences in the number of species successfully recorded in the data and those reported in previous studies are caused by several factors, such as: there are some species with different variants, so not all of them are recorded; some species were not rediscovered during repeated expeditions; and the lack of data on each species can lead to errors in recording the number of species in Indonesia. Reflecting on some of the shortcomings, a review of *Rhododendron* species in the Indonesian area needs to be carried out again, considering that there are still several species that have not been properly identified. The assumption is that if the forest areas of Kalimantan and Papua are reviewed, the *Rhododendron* species obtained will be much more abundant than what has been recorded previously. In addition, the review will update the *Rhododendron* species data, considering that some *Rhododendron* species still use old data from the 1900s.

Conservation is important considering the potential of *Rhododendron* as an ornamental plant that can be an attraction for tourists and also has promising pharmacological activities [64]. Developed countries such as China have conducted many treatment trials using *Rhododendron* against several cancer compounds. The author sees that it is not impossible if the *Rhododendron* species from Indonesia also have equally good pharmacological activity compared to those in other countries. This plant, along with other native species, plays a significant role in sustaining local ecosystems and supporting food resources for various species in and around the park. Any type of support and sponsorships from the government are urgently needed in this regard, considering that Indonesia's forest area is

mountainous with difficult topography to pass, so identifying species takes a long time at a considerable cost.

In the future, research is expected to focus on the identification and isolation of Indonesian *Rhododendron* bioactive compounds that have the potential to have pharmacological activity. This further research will be very helpful in the medical world and also for the development of science. In addition, with further research, attention to the growth and development of this plant will become more prioritized.

References

[1] P. W. . Hutabarat, W. A. Mustaqim, and Y. M. Mambrasar. (2020). Two new species of Rhododendron of subgenus Vireya (Ericaceae) from Sulawesi, Indonesia. *Taiwania*, vol. 67, no. 1, pp. 119–128.

[2] A. Retnowati, Rugayah, J. S. Rahajoe, and D. Arifiani. (2019). *Status of Indonesia's Biodiversity: The Wealth of Indonesia Plant Species*.

[3] Y. M. Mambrasar. (2018). Rhododendron Gumineense Craven (Ericaceae, Subgenus Vireya), a New Record for Indonesia. *Floribunda*, vol. 6, no. 1.

[4] Y. M. Mambrasar, A. C. Elliott, and K. M. Cameron. (2024). Two new species of Vireya Rhododendron (Ericaceae), from Tambrauw, Papua, Indonesia. *Nord. J. Bot.*, vol. 12, no. 1.

[5] A. H. Wawo, R. A. Hidayat, N. Setyowati, and P. Lestari. (2022). Diversity of Rhododendron Collection and Response of Its Flowers to Sorrounding Air Temperature and Constraints in Enriching Its Species at Wamena Biological Botanical Garden, *Biota J. Ilm. Ilmu-Ilmu Hayati*, vol. 6, no. September, pp. 203–215.

[6] G. Smith and A. Jellyman. (2021). Pukeiti Highlights Displaying the Vireya Collection. *Pukeiti Newsl.*, vol. 68, no. 1, pp. 1–4.

[7] A. Maqsoudlou, H. Mohebodini, and S. M. Jafari. (2020). *Antioxidant activity analysis of nanoencapsulated food ingredients*. Elsevier Inc.

[8] R. Fitriandini, S. Budiarti, and Y. Lestari. (2017). Endophytic Actinobacteria from Rhododendron spp. as an Antibacterial Agent. *Biosaintifika J. Biol. Biol. Educ.*, vol. 9, no. 3, p. 600.

[9] T. Warseno and D. M. Siswoyo Putri. (2019). Shoot Multiplication and Root Induction on In Vitro Propagation of Rhododendron radians J.J.Sm (Ericaceae). *J. Hortik.*, vol. 28, no. 1, p. 51.

[10] I. Turan, S. Demir, S. O. Yaman, D. Canbolat, A. Mentese, and Y. Aliyazicioglu. (2022). An Investigation of the Antiproliferative Effect of Rhododendron luteum Extract on Cervical Cancer (HeLa) Cells via Nrf2 Signaling Pathway. *Nutr. Cancer*, vol. 74, no. 5, pp. 1882–1893.

[11] A. P. Kiem, K. Kartawinata, and O. Effendy. (2018). *Current Biodiversity of the Habbema Lake Area in Papua, Indonesia*.

[12] D. Fadhilah, P. Santoso, and R. Maliza. (2024). Utilisation of Snails for Wound Healing : A Review. vol. 09, no. 03, pp. 1–12.

[13] G. C. G. Argent, Vireya taxonomy in field and laboratory. (1988). *Proc. Fourth Int. Rhododendron Conf.*, no. October, pp. 119–132. [Online]. Available: http://www.vireya.net/archive/ArgentPro88.pdf

[14] G. Argent, J. Bond, D. Chamberlain, P. Cox, and A. Hardy. (1998). *The Rhododendron Handbook*.

[15] W. Rahman. (2008). Lack of Data, Taxonomic Status and Natural Hybrid in Conservation of Rhododendron spp. in Indonesia. *Bul. Kebun Raya Indones.*, vol. 11, no. 2, pp. 5–14.

[16] P. M. Rhind. (2010). Plant Formations in the Mascarenean BioProvince. *East*.

[17] G. Argent, L. Galloway, S. Barber, and A. Ensoll. (2010). A Plant Collecting Expedition to Papua , Indonesian New. *Virginia Tech Sch. Commun. Univ. Libr.*, pp. 1–11.

[18] D. Gibbs, D. Chamberlain, G. Argent, B. O. G. Ardens, and C. O. (2011). International,

Rhododendrons.
[19] Y. M. Mambrasar and D. Arifiani. (2020). Diversity of Rhododendron Species in Lake Habbema, Papua. *The Rhododendron*, vol. 60, pp. 20–34.
[20] G. Argent and Y. M. Mambrasar. (2019). Rhododendron Widjajae (Ericaceae, Section Schistanthe) a New Species From Sulawesi, *Reinwardtia*, vol. 18, no. 1, pp. 27–30.
[21] G. Argent. (2009). Rhododendron sojolense Argent (Ericaceae), A New Species of Rhododendron Subgenus Vireya from Sulawesi , Indonesia. vol. 61, no. 1, pp. 1–6.
[22] A. Kartonegoro. (2014). Ericaceae of Latimojong Range, South Sulawesi, *Floribunda*, vol. 4, no. 8.
[23] B. J. Farbarik and H. R. H. Helm. (1997). A Rhododendron Expedition to Sulawesi, Indonesia May 1997 By John Farbarik and Henry R. (Hank) Helm.
[24] D. Binney. (2002). Rhododendron Collecting in Sulawesi, Indonesia David Binney.
[25] N. Suluh. (2015). Eksplorasi flora di kawasan hutan lindung Gunung Talamau, Sumatera Barat dan hutan lindung Gunung Sibuatan, Sumatera Utara untuk pengayaan koleksi Kebun Raya Cibodas, *pros sem Nas Masy Biodiv Indon*, vol. 1, pp. 501–508.
[26] M. Muhaimin. (2016). Plant Exploration and Vegetation Composition Study in The Hill Zone of Mount Patah, Bengkulu. *pros sem Nas Masy Biodiv Indon*, vol. 2, pp. 132–137.
[27] Y. M. Mambrasar, T. Warseno, F. Kuswantoro, and D. Arifiani. (2024). Notes on Rhododendron (Ericaceae) From Bali, Indonesia, and a New Subspecies of Rhododendron Javanicum. *Edinburgh J. Bot.*, vol. 81, pp. 1–11.
[28] D. M. Putri. (2016). Phenology of Rhododendron spp. (Subgenus Vireya) at 'Eka Karya' Bali Botanical Garden Collection. *J. Hortik.*, vol. 21, no. 3, p. 232.
[29] H. Brentel. (2020). Looking for Rhododendron in Sulawesi.*Floribunda*, vol. 4, no. 9.
[30] L. Kuswanto. (2022). Identification-and-documentation-of-wild-plant-species-with-ornamental-potentials-at-Mount-Prau-Central-Java-Indonesia_2022_Brazilian-Society-of-Floriculture-and-Ornamental-Plants.pdf. vol. 0, pp. 110–119.
[31] T. Nasution. (2015). Potential Flora Doversity and Vegetation Composition on Mount Marapi, West Sumatra. *pros sem Nas Masy Biodiv Indon*, vol. 1, no. September, pp. 1334–1340.
[32] W. Rahman and A. H. Rozak. (2016). Population Size Of Two Endangered Vireya Rhododendron Species And Their Surrounding Vegetation On The Top Of The Mt . Rantemario , Sulawesi Ukuran Populasi Dua Jenis Vireya Rhododendron Berkategori Genting. *Bul. Kebun Raya*, vol. 19, no. 1, pp. 57–66.
[33] A. Sadili, K. Kartawinata, A. Kartonegoro, H. Soedjito, and A. Sumadijaya. (2009). Floristic Composition and Structure of Subalpine Summit Habitats on Mt. Gede-Pangrango Complex, Cibodas Biosphere Reserve, West Java, Indonesia. *Reinwardtia*, vol. 12, no. 5, pp. 391–404.
[34] M. Black. (1969). Historical Survey of Rhododendron Collecting, with emphasis on its close associations with horticulture., *Ars J.*, vol. 23, no. 4.
[35] G. Argent. (2008). Some recent Vireya species introduced into cultivation, *Scottish Rhododendron Soc. Yearb.*, no. 10.
[36] E. Indian. (1855). Greenhouse Rhododendrons, *East Indian*, vol. iii.
[37] Y. M. Mambrasar, I. P. G. P. Damayanto, and T. D. Atikah. (2019). Rediscovery Sumatran endemic flora: Towards the establishment of data of biodiversity loss. *IOP Conf. Ser. Earth Environ. Sci.*, vol. 308, no. 1.
[38] B. Clancy. (2000). Rhododendron zoelleri. *J. Aust. rhododendron Soc.*, vol. 33.
[39] H. B. Brentel. (2001). A trip to the Rhododendrons of Irian Jaya. *J. Am. Rhododendron Soc.*, vol. 55, no. 1, pp. 42–44.
[40] F. Danet. (2015). The genus Rhododendron L. (Ericaceae) in New Guinea: a new neotype for R. gardenia Schltr. and a new species, Rhododendron cravenii Danet, sp. nov, *Rhododendron, J. Aust. Rhod. Soc.*, vol. 55, no. March, pp. 12–26.

[41] Y. M. Mambrasar and P. W. K. Hutabarat. (2018). Rhododendron Meagaii, A New Species of Rhododendron Subgenus Vireya From Papua, Indonesia. *Reinwardtia*, vol. 17, no. 2, pp. 97–100.
[42] H. Brentel. (2001). A Trip to the Rhododendrons of Irian Jaya, *J. Am. Rhododendron Soc.*, vol. 55, no. 1.
[43] S. Hootman. (2000). RSF Plans New Vireya Conservatory. *J. Am. Rhododendron Soc.*, no. 59.
[44] E. T. Nilsen and S. E. Scheckler. (2003). A unique 'Giant Cell' type in leaves of vireyas. *J. Am. Rhododendron Soc.*, no. Winter, pp. 6–11.
[45] T. Rianto, A. Asnawi, A. Basit, Suparmo, D. Megawati, and F. M. MY. (2016). *Database Keanekaragaman Hayati Taman Nasional Gunung Rinjani*.
[46] I. Robiansyah and S. U. Rakhmawati. (2018). An urgent conservation call from endemic plants of Mount Salak, West Java, Indonesia. [Online]. Available: https://www.rufford.org/files/25567-1 Detailed Final Report.pdf
[47] M. Beljai, Y. Y. Runtuboi, D. Manuhua, M. S. Worabai, and D. M. H. Renwarin. (2016). Ecotourism Aspects of Rhododendron: Review of its Potential and Development Strategi in Intan Jaya Area. *J. Kehutan. Papuasia*, vol. 2, no. 1, pp. 24–33.
[48] K. Kartawinata. (2024). Biodiversity Conservation in Relation To Plants Used for Medicines and Other Products in Indonesia, *Journal of Tropical Ethnobiology*, no. Vol. 1 No. 2: July 2004. pp. 1–11.
[49] R. Cahyaningsih. (2021). Genetic Conservation and Sustainable Use of Ondonesia Medicinal Plants.
[50] D. M. S. Putri and T. Warseno. (2020). Variation of Water Status in Rhododendron javanicum Benn. *J. Penelit. Hutan dan Konserv. Alam*, vol. 17, no. 2, pp. 143–153.
[51] L. Juairiah and W. Rahman. (2014). Anatomy Evaluation Graft Area at Three Grafting Technique on Successfull Interspecific Grafting at Vireya Rhododendron. *J. Biol. Indones.*, vol. 10, no. 1, pp. 145–148.
[52] W. Rahman. (2015). Criteria for Determining The Priority Species of Threatened Rhododendron. *Bul. Kebun Raya*, vol. 18, no. 1, pp. 31–40.
[53] Y. Lestari, L. A. Murdini, and D. D. Solihin. (2018). The existence of endophytic actinobacteria from Rhododendron zoelleri revealed by culture-dependent and culture-independent approaches. *Hayati J. Biosci.*, vol. 25, no. 2, pp. 54–62. doi: 10.4308/hjb.25.2.54.
[54] D. M.S. Putri. (2017). Effect of Rootone-F Concentration and Length of Cutting on the Growth of Rhododendron mucronatum G. Don. var. phoeniceum. *J. Biol. Udayana*, vol. 21, no. 1, p. 35..
[55] D. M. S. Putri. (2018). Rhododendron Collection Ad One of the Thematic Gardens in Bali's 'Eka Karya' Botanical Garden, *Bul. Udayana Mengabdi*, vol. 17, no. 1, p. 1.
[56] Y. M. Mambrasar, F. Kuswantoro, and T. Warseno. (2019). Rhododendron Subgenus Vireya in the Lesser Sunda Islands Based on the Herbarium Bogoriense Collection and Its Conservation in the 'Eka Karya' Bali Botanical Garden, in *Prosiding Seminar Nasional Konservasi dan pemanfaatan tumbuhan dan Satwa Liar "Riset Sebagai Pondasi Konservasi dan Pemanfaatan Tumbuhan dan Satwa Liar".* no. September, pp. 49–56.
[57] T. Warseno. (2015). Ex situ In Vitro Conservation of Rare and Critical Plant Species at the 'Eka Karya' Bali Botanical Garden. vol. 1, no. Fay 1994, pp. 1075–1082.
[58] Masnawati, R. Pitopang, and S. Suleman. (2017). Inventory of Rhododendron (Ericaceae) Types in The Mountains Forest of Lore Lindu National Park (TNLL) Central Sulawesi. vol. 12, no. 2, pp. 66–75.
[59] W. Wihermanto. (1970). Dispersion pattern interspecific association and population status of threatened plants on submontane and montane zones of Mount Gede-Pangrango National Park. *Biodiversitas J. Biol. Divers.*, vol. 5, no. 1, pp. 17–22.

[60] M. K. Huda, N. Pasaribu, Syamsuardi, and E. S. Siregar. (2020). Vegetation Structure and Composition in Taman Wisata Alam (TWA) Sicike-cike as Ritual Site for Local Community. *J. Phys. Conf. Ser.*, vol. 1462, no. 1. doi: 10.1088/1742-6596/1462/1/012050.

[61] L. H. Nugroho and Y. S. Hartini. (2023). *Ethnomedicinal Antidiabetic Medicinal Plants, Herbs, and Mechanisms of Action*.

[62] W. Winanda, I. Batubara, and Y. Lestari. (2021). Pancreatic Lipase Inhibitory Activity of Endophytic Actinobacteria from Rhododendron spp., *Biosaintifika J. Biol. Biol. Educ.*, vol. 13, no. 2, pp. 178–184.

[63] Y. Lestari, I. Batubara, and W. Winanda. (2019). Characterization and In Vitro Activity of Pacreatic Lipase Inhibitor from Actinobacteria Endofit Rhododendron spp. IPB. [Online]. Available: http://repository.ipb.ac.id/handle/123456789/97754

[64] M. Rafi *et al.* (2018). Total Phenolics , Flavonoids , and Anthocyanin Contents of Six Vireya Rhododendron from Indonesia and Evaluation of their Antioxidant Activities. vol. 8, no. 09, pp. 49–54.

[65] V. R. Aldilla and L. D. Juliawaty. (2018). Flavonoid Derivatives from Rhododendron retusum Leaves (Ericaceae), Institut Teknologi Bandung. [Online]. Available: https://digilib.itb.ac.id/index.php/gdl/view/32208

[66] R. Fitriandini, Y. Lestari, and S. Budiarti. (2017). Endophytic Actinobacteria of Rhododendron spp. which are Effective as Antibacterials [Online]. Available: http://repository.ipb.ac.id/handle/123456789/91000

[67] A. K. Jha, M. A. Khalid, and S. N. Labh. (2024). In Vitro Antioxidant and Antibacterial Activities of Medicinal Flower Laligurans Rhododendron arboreum Collected from Kathmandu Valley, Nepal. *Int. J. Food Sci.*

[68] L. Zong *et al.* (2021). Rhododendron molle g. Don extract induces apoptosis and inhibits migration in human colorectal cancer cells and potential anticancer components analysis, *Molecules*, vol. 26, no. 10.

[69] A. Durmaz *et al.* (2025). In Vitro, Anti-Colon Cancer Activity of Green Dumbbell-Shaped Rhododendron luteum-Based Carbon Dots, *ChemistryOpen*.