

Rediscovery in Singapore of *Plocoglottis lowii* Rchb.f. (Orchidaceae)Matti A. Niissalo^{1*}, Craig E. Williams², Hubert Kurzweil² and Daniel C. Thomas²¹Department of Biological Sciences, National University of Singapore, 14 Science Drive 4, Singapore, 117543, Republic of Singapore; Email: matti.niissalo@iki.fi (* corresponding author)²Singapore Botanic Gardens, 1 Cluny Road, Singapore 259569, Republic of Singapore

Abstract. We discovered a population of *Plocoglottis lowii* Rchb.f., last collected in 1909 and previously listed as Presumed Nationally Extinct, growing in a wet primary forest in Singapore. The historic distribution of the species is reported here, and the national conservation status of the species is assessed. We also provide notes on the genus in Singapore and the pollination biology of *Plocoglottis lowii* involving a remarkable trapping mechanism.

Key words. *Plocoglottis lowii*, critically endangered, rediscovery, pollination

INTRODUCTION

The total documented native orchid flora of Singapore comprises 225 species, of which 61 species, including several recent rediscoveries (Ang et al., 2010, 2011a, 2012; Lok et al., 2010, 2011a, b, 2012; Ibrahim et al., 2011; Chong et al., 2012; Lim et al., 2014), have been reported to survive (Chong et al., 2009; Chong et al., 2012). The recent loss of a *Cratogeomys* tree in Nee Soon Swamp Forest, a well-documented individual hosting several rare orchids (e.g., Lok et al., 2011a), may have contributed to further losses in Singapore. While the number of nationally extinct orchids is disconcerting, the current discovery, along with other recent orchid discoveries as well as several newly discovered species in other families (Yao, 2013; Leong-Škorničková et al., 2014; Niissalo et al., 2014; Sugumaran & Wong, 2014; Leong-Škorničková & Boyce, 2015), give hope that other Presumed Nationally Extinct species may still survive in Singapore and that even more new species discoveries or rediscoveries can still be made.

Plocoglottis Blume is an Asian orchid genus with some 40 species, distributed in the Andaman Islands, southern Indochina, and across Malesia from Peninsular Malaysia to Papua New Guinea's eastern islands (Pridgeon et al., 2005). Four species have been reported from Peninsular Malaysia, three of which have also been collected in Singapore. *Plocoglottis javanica* Blume and *Plocoglottis gigantea* (Hook.f.) J.J.Sm. are considered Critically Endangered in Singapore, while *Plocoglottis lowii* was Presumed Nationally Extinct (Tan et al., 2008; Chong et al., 2009).

Plocoglottis lowii has previously been collected from Kranji, Tuas, North Seletar, and Pasir Panjang (Table 1, see also Ridley [1900]; Keng et al. [1998]). The most recent collection was from 1909, from Pasir Panjang, and until now it has been collected in Seletar only once, in 1890. There is an unconfirmed sighting of the species by National Parks Board

Table 1. Voucher specimens of *Plocoglottis lowii* Rchb.f. and *Plocoglottis gigantea* (Hook.f.) J.J.Sm. collected from Singapore. SING = Singapore Botanic Gardens' Herbarium, SINU = Herbarium, Lee Kong Chian Natural History Museum, National University of Singapore. Vouchers of *Plocoglottis javanica* Blume were recently listed in Ang et al. (2011b).

S/No.	Species	Collector and Collection Number	Year	Locality	Herbarium
1.	<i>Plocoglottis gigantea</i>	H. N. Ridley s.n.	1892	Bukit Timah	SING
2.	<i>Plocoglottis gigantea</i>	H. N. Ridley s.n.	1898	Bukit Timah	SING
3.	<i>Plocoglottis gigantea</i>	G. C. H. Tan, D. P. Y. Lim & Marinah Marzuki NRS 1002	1992	Nee Soon Swamp Forest	SINU
4.	<i>Plocoglottis gigantea</i>	I. M. Turner, J. T. W. M. Gan & Y. W. K. Khng NRS 122	1992	Nee Soon Swamp Forest	SINU
5.	<i>Plocoglottis gigantea</i>	I. M. Turner, J. T. W. M. Gan & Y. W. K. Khng NRS 125	1992	Nee Soon Swamp Forest	SINU
6.	<i>Plocoglottis gigantea</i>	Ali Ibrahim 265	1996	Nee Soon	SING
7.	<i>Plocoglottis gigantea</i>	SING 2009-151	2009	Nee Soon	SING
8.	<i>Plocoglottis lowii</i>	J. S. Goodenough s.n.	1889	Kranji	SING
9.	<i>Plocoglottis lowii</i>	H. N. Ridley s.n.	1890	North Seletar	SING
10.	<i>Plocoglottis lowii</i>	H. N. Ridley s.n.	1892	Tuas	SING
11.	<i>Plocoglottis lowii</i>	H. N. Ridley s.n.	1894	Kranji	SING
12.	<i>Plocoglottis lowii</i>	H. N. Ridley 14102	1909	Pasir Panjang	SING
13.	<i>Plocoglottis lowii</i>	D. C. Thomas 1006	2015	Upper Seletar	SING

staff from the Central Catchment Nature Reserve in the 1990s (Chew et al., 1997), but this sighting has not been included in Singapore Red List assessments. We first discovered a population of *Plocoglottis lowii* (Fig. 1) near the Upper Seletar Reservoir while surveying suitable habitats for native Zingiberales in April 2015. Further plants were discovered during fieldwork for pollination biology studies in May and July 2015, when the species was identified.

THE GENUS *PLOCOGLOTTIS* IN SINGAPORE

The three *Plocoglottis* species present in Singapore can be easily distinguished (see identification key in Seidenfaden & Wood [1992]; Figs. 1, 2). They all have plicate, petiolate leaves with small flowers that have sepals and petals that are mostly yellow. *Plocoglottis gigantea* differs from the other two species in having a long vegetative stem (60–100 cm), with c. 10 leaves. It is also the largest-flowered species in Singapore (flowers over 3 cm wide), and the flowers are supported by relatively wide bracts (7 mm). *Plocoglottis javanica* and *Plocoglottis lowii* have a single leaf (rarely two), and a short (3–10 cm) vegetative stem. Sterile specimens can be identified reliably by leaf characters alone: *Plocoglottis javanica* has a much longer petiole (10 cm or longer), a minimum of 0.7× the length of the lamina, while



Fig. 1. *Plocoglottis lowii* in Upper Seletar Reservoir forest (2015). A, plant with purplish green leaves—notice the reddish purple lamina undersides; B, pseudobulbs on a plant that has been uprooted; C, dehiscent, mature capsule; D, leaf base, showing the fused, tubular portion of the petiole (*) directly above the pseudobulb; E, flower before the release mechanism of the lip has been triggered, with the lateral sepal on the right is holding the lip in an open position; F, triggered flower, with lip held against the column; G, inflorescence with three open flowers; H, large clump of mature, flowering plants. Scale bars = 10 cm [A], 2 cm [B–D], 1 cm [E–G] (Photographs by: Matti Niissalo [A, B, G, H] and Craig Williams [C–F]).

Plocoglottis lowii has petioles that are less than 0.4× the lamina length. Both of the single-leaved species can have bright green leaves, but the leaves of *Plocoglottis javanica* are often white-spotted and the leaves of *Plocoglottis lowii* can be purplish green. As Ang et al. (2011b) state, the leaves of the small individuals of *Plocoglottis javanica* and *Plocoglottis lowii* are easily confused with sterile plants of *Peliosanthes teta* Andrews (Asparagaceae), but the latter does not have the tubular, hollow petiole found in all *Plocoglottis* species examined, and which is formed by the edges of the grooved petiole becoming fused (Fig. 1D). Both *Plocoglottis javanica* and *Plocoglottis lowii* have small flowers (1.5–2.5 cm across), which, however, differ dramatically in shape and colour: *Plocoglottis javanica* has flowers with petals and sepals that are yellow spotted with red, with a pale lip without prominent calli (for illustrations, see Holttum, 1964; Seidenfaden & Wood, 1992; Fig. 2), while the flowers of *Plocoglottis lowii* are dull yellow with dark red or purplish blotches on the lateral petals and the lip, which shows multiple pointed calli (Fig. 1, see paragraph on pollination biology below).

Plocoglottis gigantea has been collected in Nee Soon several times from the 1990s to 2009. It still occurs there in very small numbers, and we observed it flowering in 2013. Previously the species was also present in Bukit Timah, but it has not been collected there for over a century (Table 1). The distribution of *Plocoglottis javanica*, collected several times in Nee Soon in the past three decades, has previously been addressed by Ang et al. (2011b). For the distribution of *Plocoglottis lowii* see above.

DESCRIPTION, POLLINATION BIOLOGY AND NATIONAL CONSERVATION STATUS ASSESSMENT OF *PLOCOGLOTTIS LOWII*

***Plocoglottis lowii* Rchb.f., Gard. Chron. 434 (1865). = *Plocoglottis porphyrophylla* Ridl., Transactions of the Linnean Society of London: Botany, 3: 368 (1893).** A terrestrial forest floor herb that forms small clumps from a creeping, subterranean rhizome. Aerial stems emerging from the rhizome form short (5–10 cm) and thin (1–2 cm) pseudobulbs with one or two terminal leaves. The stem is sheathed by a papery bract. The lamina is ovate, plicate, green or dark purplish green, 20–35 × 6.0–8.5 cm. The leaf base folds to form a short (3–8 cm), tubular petiole. In dried specimens it is difficult to distinguish the petioles from the pseudobulbs; together they are 0.2–0.4× the length of the lamina. The inflorescence is up to 160 cm long, thin (3–5 mm), with a few sheathing tubular bracts (10–20 mm long). The flowers are numerous (up to 100), one to three opening at one time, small (c. 25–30 mm in width), and have dull yellow sepals and petals. The lip and lateral sepals have dark purple, glossy markings. It is distributed in Thailand, Malaysia, Indonesia, and Papua New Guinea.

Pollination biology. The flowers of *Plocoglottis lowii* are treated in detail by both Ridley (1896) and Burkill (1913). The pollinator, however, has not been observed and remains a subject of speculation. Ridley expected the pollinator to belong to the Diptera, although this assumption appears to have been based on the pollination of the foul-smelling, sapromyophilous *Plocoglottis foetida* by flies. *Plocoglottis lowii* was noted by Burkill to have no detectable scent, which is consistent with our observations in the field. Ridley also drew attention to the ‘pair of shining, deep purple horns, which resemble drops of nectar’, characteristics that could indicate deceitful myophily. Burkill (1919) suggested that the pollinator may be a carpenter bee, *Xylocopa*, but Schneckenburger (1990) considered that this is unlikely owing to the small size of the flowers and the lack of nectar, and suggested the flower colouration is more likely to attract flies, as per Ridley’s observations reported in Pijl & Dodson (1966). Pridgeon et al. (2005) referred to the ‘insect-like flowers’ and we consider there is a possibility that pollination involves pseudocopulation.

The pollination process involves one of the more violent evolutionary tricks served up by the Orchidaceae. The flower of *Plocoglottis lowii* is a remarkable booby trap. The most prominent feature of the flower is the two thickened and curved lateral sepals, largely dark red to purple with an apparently enamelled finish. The flower’s unusual and marked asymmetry results from the position of the right lateral sepal, the top of which rests on the lip, holding it in place against the considerable spring tension produced at the base of the lip (Fig. 1E). Pressure from an alighting insect releases the lip from the grip of the sepal, catapulting the visitor upwards and bringing it into intimate contact with the column (Fig. 1F). We have filmed the release mechanism in action (<https://www.youtube.com/watch?v=FD8yBpIitrA>). The lip remains in its elevated position, forcing the insect to struggle to free itself from the flower’s pinch and resulting in the removal or deposition of the pollen masses.

The stress induced by initial entrapment may be advantageous, as it may frighten the pollinator and therefore reduce the chance that the pollinator proceeds to visit the immediately adjacent flowers, thus reducing the possibility of geitonogamy. This behaviour has been observed in pollinators of *Epidendrum tridactylum*, which also has flowers with a trapping mechanism (Pansarin & Pansarin, 2014).

National conservation status assessment. The known range of *Plocoglottis lowii* is a small fraction of its previous range in Singapore, which once covered several parts of the island. It occurs in a very small area of primary swamp forest, close to a stream, and the distance between the most widely separated known individuals is barely 300 m. Within this area, the species is relatively abundant, and appears to set seed regularly (1–2% of flowers form fruits). We found



Fig. 2. The two other *Plocoglottis* species in Singapore (Nee Soon Swamp Forest, 2013–2015). *Plocoglottis gigantea*: A, flowers and buds at the tip of the raceme. B, habit. *Plocoglottis javanica*: C, flower; D, Habit of an individual with blotched laminas. Scale bars = 1 cm. (Photographs by: Matti Niissalo [A, B, D] and Craig Williams [C]).

50 individuals, and estimate the entire populations to be no more than 100 mature individuals. While the habitat is protected and relatively undisturbed, the species should be considered nationally Critically Endangered (CR), as its range is very limited, and the very fragmented habitat is likely to degrade over time (Davison, 2008; IUCN, 2012). The main threat to this population comes from stochastic events such as catastrophic tree fall, which could make the habitat unsuitable for the species. However, this is unlikely to eradicate the entire population in the immediate future. The species is occasionally present in the horticultural trade in small numbers for its interesting flowers and colourful leaves, and illegal collection may be a threat to the population. We also saw evidence of plants having been dug up and eaten, presumably by the Eurasian wild boar (*Sus scrofa*) that are abundant in the area.

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