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Cover: Illuminating the cruelty of Pangolin trade in India for the purpose of black magic, for the sanctity of protection. Using an animal's shell, ripping its armor against the world to protect oneself. When does one become the evil they are trying to ward off? — Acrylic on wood. © Maya Santhanakrishnan.

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SHORT COMMUNICATION

Phenology of *Rhododendron wattii* Cowan (Ericales: Ericaceae) - a threatened plant of Nagaland, India

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Abstract: The paper deals with the flowering phenology of *Rhododendron wattii* Cowan (Ericaceae family), a threatened and endemic plant from Nagaland, northeastern India. The study was conducted at Dzukou Valley, Kohima District of Nagaland, on a single tree of *R. wattii* growing at an elevation of 2,600 m with no other tree of the same species in the vicinity. Flowering occurs from the end of February to April, and fruiting is observed from April to December. The flowers present in trusses of 18–25 flowers are pink with darker flecks and purplish basal blotches. They are foraged and pollinated by the Fire-tailed Sunbird *Aethopyga ignicauda* and bumble bees (*Bombus* spp.). The only attractant for the foragers is the nectar secreted in the five nectaries at the base of the corolla tube. Catastrophes like frequent forest fires and anthropogenic activities are responsible for the disappearance of this species.

Keywords: *Aethopyga ignicauda*, *Bombus* spp., Dzukou Valley, endemic, nectaries, northeastern India, Vulnerable.

The genus *Rhododendron*, belonging to the Ericaceae family, is one of the largest, most fascinating genera, with immense horticultural importance for its beautiful flowers and foliage. The genus is popular in Europe, America, Canada, Australia, and New Zealand. It occurs at higher altitudes, having ecological and economic importance in addition to its graceful flowers (Paul et al. 2005). The flowers of Rhododendrons are also considered sacred and offered in temples and monasteries (Mao et al. 2001). They display a wide range of morphological characteristics in their sizes, which range from less than 10 cm high to trees taller than 20 m (Williams et al. 2011).

Rhododendrons play a vital role in ecosystem services as they grow in areas of high rainfall and high humidity on acidic soils, conditions under which few plants would survive. They stabilise slopes in hilly areas and provide the structure of plant communities which support a wealth of biodiversity (Gibbs et al. 2011). According to Mainra et al. (2010), rhododendrons have phenological sensitivity to climate change and play a vital role in the ecological stability of ecosystems and as indicators of forest health. Thus, rhododendrons play important roles in maintaining biodiversity, preserving water & soil, and stabilizing the ecosystem. In the current century, the genetic resources of wild rhododendrons have been damaged severely due to the constant increase in human, social, & economic activities and some species have become highly threatened (Ma et al. 2014). Rhododendrons growing in high altitudes face the impact of disturbances due to various natural and anthropogenic factors (Mao et al. 2010). Natural threats include landslides and forest fires, which affect the rich growth of rhododendrons. Anthropogenic threats include fuel wood collection,

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small-scale extraction of timber, and collection of plants by locals for their graceful and magnificent flowers.

There are over 1,000 species of Rhododendrons worldwide. In India, 132 taxa are recorded, out of which 129 taxa are recorded from northeastern India. Northeastern states support the luxuriant growth of Rhododendrons, including many endemic species (Mao et al. 2017). According to the IUCN Red List, *R. wattii* is 'Vulnerable' due to population fragmentation and area of occupancy less than 500 km^2 (Gibbs et al. 2011).

Rhododendron wattii was first collected by Sir George Watt from Japfu Hill ranges during his survey (1882–1885) of Manipur and Nagaland (Mao et al. 2018). It is endemic to the Indian states of Manipur and Nagaland. It is a small tree attaining a height of 6–7.6 m (20–25 feet). Flowering occurs from March to April, and fruiting from April to December. During a field survey in 2012–2013, a single tree of *R. wattii* was located in Dzukou Valley, Nagaland, reported by Mao & Gogoi (2007) and later the tree was felled by the locals for firewood. Another tree was located in the surrounding hills of Dzukou Valley which is the subject of the present study. No seedlings or saplings were observed in the vicinity during the study period. The quick disappearance of this species from its natural habitat due to anthropogenic activities and natural disasters accompanied by poor regeneration of seedling survivability and recruitment failure could be one of the reasons for population decline and dwindling of *R. wattii*, which made it critically endangered in its natural habitat (Mao et al. 2017). In the present communication, an attempt has been made to highlight flowering phenology to provide valuable information on its conservation.

Materials and Methods

The study was carried out during 2012–2013 on a single tree of *Rhododendron wattii* found growing in its natural habitat at Dzukou Valley, Kohima District, Nagaland situated at 25^{0}33.387 N, 94^{0}04.707 E at an altitude of 2,600 m (Image 1). Regular field trips were conducted during the entire flowering period (February–April) to study the flowering phenology, the timing of the onset and termination of flowering, and the development of the ovary, fruit, and seed. The different floral visitors were observed and recorded during the study period. The foraging behaviour of the floral visitors were observed at different hours of the day. Field photographs and videos were taken using the Canon digital still camera with 8MP resolution. The species *R. wattii* was identified and

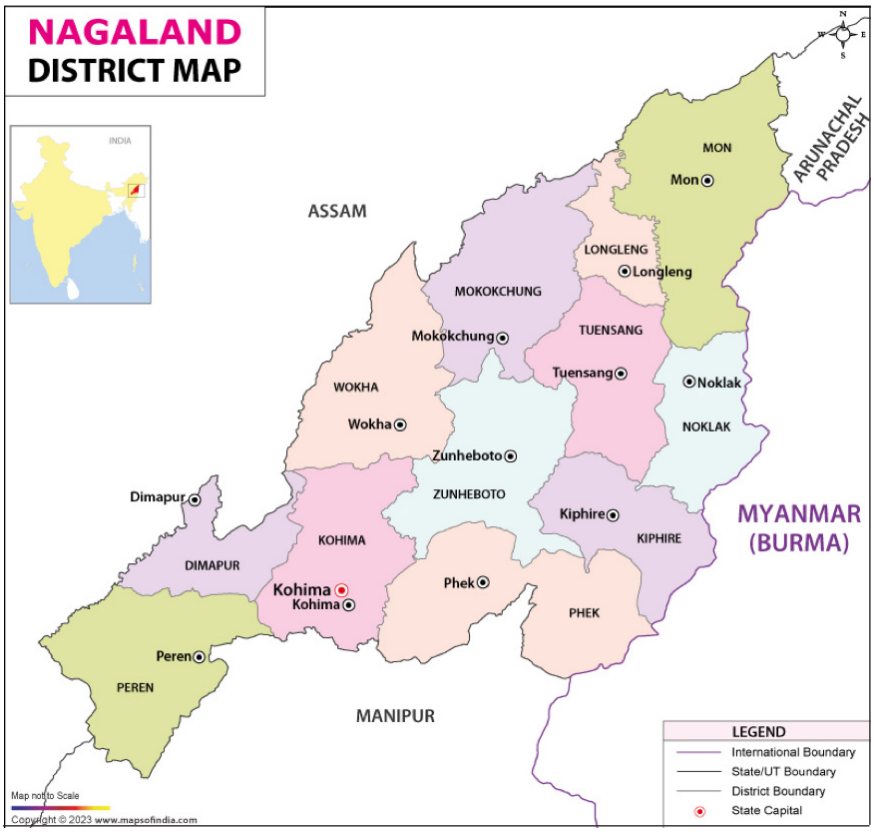

Image 1. The study area in Kohima District, Nagaland.

Image 2. *Rhododendron wattii* Cowan: A—Landscape view of the study site | B—Inflorescence in truss | C—Habit of the plant. © Imtilila Jing.

Table 1. Phenology of *Rhododendron wattii*.

Parameters	Observations (2012–2013)
Leaf fall	Evergreen
Leaf renewal	Throughout the year
Flowering period i. Minimum ii. Maximum iii. Decline	 Last week of February The second week of March The first week of April
Initiation of fruits	April
Fruit maturation	December
Seed dispersal	January
Mode of seed dispersal	Wind

authenticated by consulting the Herbarium, Botanical Survey of India (BSI), ERC, Shillong, Meghalaya.

Results and Discussion

The observed *Rhododendron wattii* is a small tree of about 6–7.6 m in height (Image 2). The inflorescence is a terminal truss (Image 2); hypogynous and nectar pouches are present at the base of the corolla tube. The corolla has blotches or spots of darker colour, which is a typical feature of rhododendron flowers, and acts as a nectar guide. Leaves are obovate to oblong, apex rounded, apiculate, base rounded, glabrous above, with a sparse whitish felted indumentum beneath. The inflorescence bears 18–25 flowers per truss. The flowers are tubular-campanulate, corolla 6-lobed, pink with darker flecks and purplish basal patches. The stamens are 12 in number and unequal, anther lobes brown and dorsifixed and dehisce by apical pores. The ovary is densely pilose with brownish indumentum. The pollen grains remain in permanent clusters of four to form tetrads, which are

Image 3. *Rhododendron wattii* Cowan: A–D Floral visitors: A— Fire-tailed Sunbird *Aethopyga ignicauda* (male) | B—*Aethopyga ignicauda* (female) | C&D—Bumble bees (*Bombus* spp.) with pollens on their body | E&F—Young fruits | G&H—Old dehisced fruit capsules. © Imtilila Jing.

held together by viscin threads. The viscin threads play an important role in pollen removal from the anthers and its adhesion to pollinators for accurate pollen delivery to the stigma, increasing pollination efficiency (Hesse et al. 2000). The fruit is a capsule that is oblong, grooved, and dehisce from the top by longitudinal slits (Image 3). The seeds are fusiform and winged, which retain viability for about one year when stored at normal temperature and humidity (Williams et al. 2011). No seedlings were observed in its natural habitat.

Rhododendron wattii is an evergreen plant, and leaf renewal occurs throughout the year (Table 1). It was observed that the same branch did not bear flowers consecutively for two years. The fruits dehisce when still attached to the branch (Image 3). The plant grows on rocky hill slopes with other *Rhododendron* species *R. macabeanum*, and dwarf bamboo, mosses, and ferns. The flowers bloom in the last week of February, while peak flowering is observed in the second week of March and declines by the first week of April. Fruit initiation begins in April and matures by the month of December (Table 1). Fruit is a capsule dehiscing laterally, producing

Table 2. Visitor census in *Rhododendron wattii*.

Order	Family	Scientific name	Common name	Forage type		Duration of foraging per flower (in seconds)	Visiting hours
				Nectar	Pollen		
Passeriformes	Nectariniidae	*Aethopyga ignicauda*	Fire-tailed Sunbird	+	–	1–2	0900–1600 h
Hymenoptera	Apidae	*Bombus* spp.	Bumble bees	+	–	1–7	1200–1600 h

numerous seeds that are dispersed by wind. The onset of nectar secretion was observed already at the opening bud stage. The same observation has been made by Chwil & Chmielewska (2009).

The most dominant visitors to *R. wattii* were the passerine Fire-tailed Sunbird *Aethopyga ignicauda* (Image 3) followed by bumble bees *Bombus* spp. (Images 3). The duration of foraging by the Sunbird lasted for 1–2 seconds per flower and 1–7 seconds per flower in the case of bumble bees. Nectar and pollen grains are the main attractants for the floral visitors (Table 2). The nectars are secreted by the nectaries present at the base of the corolla tube. The pollen grains were found attached on the ventral surface of birds' necks during the foraging, whereas in *Bombus* spp. they were found on both the dorsal and ventral surfaces of the body. The pollen tetrads are present in lumps and bound with viscin threads to increase pollination efficiency, which is the characteristic feature of the family Ericaceae.

Conclusion

The main pollinators of *R. wattii* are Fire-tailed Sunbirds *Aethopyga ignicauda* and bumble bees (*Bombus* spp.), which forage for nectar and carry pollen. Natural regeneration of the plant species was found to be very low though the plants produce numerous seeds. Pornon & Doche (1995) have also reported that seedling recruitment is poor in many rhododendrons. For successful seedling establishment, the seeds require favourable microsites (Cross 1981; Plocher & Carvell 1987; Kohyama & Grubb 1994). Poor seedling survivability and recruitment failure may be another reason why the population of *R. wattii* is dwindling, making it highly threatened in its natural habitat, besides natural calamities and anthropogenic factors (Mao & Gogoi 2012; Mao et al. 2018). Thus, there is an urgent need to conserve this species by protecting its natural habitat.

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