

Distribution pattern and population characteristics of *Impatiens johnii* E. Barnes, a stenotopic endemic and endangered Balsam in the mountain landscape of Munnar, Kerala, India

G. Prasad^{1,2}, P. Rajan^{1,*}, V. T. Antony³ and P. K. Shaji⁴

¹Munnar Wildlife Division, Kerala Forest Department, Munnar 685 612, India

²Bharathiar University, Coimbatore 641 046, India

³KE College, Mannanam, Kottayam 686 561, India

⁴Environmental Resources Research Centre, Thiruvananthapuram 695 005, India

***Impatiens johnii* has high conservation concern due to its rarity and geographical narrow range. This species is a stenotopic endemic in the Munnar landscape and rediscovered after 67 years. This plant was found as part of epilithic along the streams and high canopy areas in high humidity locations at an elevation of 1600–1800 m amsl. *I. johnii* is distributed in less than 5 km² area near Eravikulam National Park and therefore this area needs to be protected for the conservation of *I. johnii*.**

Keywords: Distribution, endemism, habitat, *Impatiens johnii*, threats.

THE genus *Impatiens* (Balsaminaceae) is represented by over 1000 species, distributed in the tropical and north temperate regions of the world, particularly in India, China and Africa, with a few representatives in America and Europe¹. Its distribution in India, with 210 species, is mainly concentrated in two ‘world hotspots of Balsam diversity’, viz. the Himalayas and the Western Ghats². Among them, 106 species and 13 varieties are reported from South India, of which 103 species and 13 varieties are from the Western Ghats³. Altogether 88 taxa of *Impatiens* are reported from the Kerala part of the Western Ghats, of which 73 are endemic to this region^{4,5}.

The present study on *Impatiens johnii* E. Barnes, a stenotopic endemic balsam of the Munnar mountain landscape, has given thrust on its spatial distribution, population characteristics and threats in its type locality. Barnes⁶ published a detailed account of his floristic exploration of Geraniaceae in the mountain landscape, including description of a new species. He described the species, *Impatiens johnii* E. Barnes from Kallar valley near the present Eravikulam National Park in 1931; thereafter the species remained unavailable to botanical explorers. After a lapse of 67 years, Biju and Kumar⁷ rediscovered the species from the type locality. The

earlier efforts for rediscovery of the species were not successful and it was considered to be extinct. The rediscovery of the species from this biotope represents an extreme case of narrow endemism with evolutionary and phyto-geographical interests. The species was earlier categorized as extinct⁸, rare or threatened⁹, and presently classified as endangered^{3,10,11}.

Impatiens johnii E. Barnes, an erect shrub, up to 1 m high; stems branch at base and are swollen at nodes; leaves are opposite, ovate with scattered stiff white hairs on the upper surface and midrib and nerves on the lower surface; flowers are solitary, pink-purplish, spur up to 4 cm long with wing petals lobed to near base, distal lobe ovate, deeply notched at apex and basal lobe is small linear; pollen is yellow, spinulate; capsule has white stiff hairs; capsules are obovate, c. 2 cm long and beaked; seeds are brown and tubercled.

Phenology: Flowering and fruiting during September to December.

Habitat: Shola forests¹². An epilithic balsam found in the humus and sand-filled depressions of dripping/moist rock surfaces associated with mosses and lithophytic orchids and along the sandy fringe areas of streams.

IUCN threat status: This taxon has not yet been assessed for the IUCN Red List.

Pettymudy (10°10'14.2"N and 76°59'50.4"E), the area representing distribution of *I. johnii* is located in the high ranges of the Munnar landscape, adjacent to the south-west boundary of Eravikulam National Park (Figure 1). This area is protected under the Munnar Territorial Forest Division of Kerala Forest Department. The slope of this cup-shaped valley faces west and the elevation of the valley varies from 1400 m to 1900 m amsl. This area subtends a wet evergreen forest with few small perennial streams flowing west towards the Edamalar Dam. The south-west monsoon dominates the annual weather cycle and temperature varies from 10°C to 24°C. The average humidity during winter season is above 80%. The soil is sandy/sandy loamy and remains wet during monsoon.

Systematic field trips were conducted in Pettymudy and adjoining the Eravikulam National Park during the pre-monsoon, monsoon and post-monsoon seasons of 2014–2016. The area was explored thoroughly to locate *I. johnii* in its distinctive habitats of moist rock surfaces and sandy stream banks. Location (geo-coordinates), size (number of individuals) of clusters and associated species were also recorded. Permanent plots (quadrates of 10 m × 10 m size) were marked in the area covering representative populations/clusters for periodic/continuous monitoring. Quadrat-based data on the number of plants, number of flowers per plant, number of mature fruits developed per plant, number of seeds per fruit and number of seedlings that emerged in the succeeding season were recorded during the study.

The population of *I. johnii* is distributed in less than 5 sq. km area in the Pettymudy area. The species was

*For correspondence. (e-mail: rajandudu@gmail.com)

distributed in random clusters of varying size, with the number of plants in each cluster varying significantly. A total of 15 such clusters of *I. johnii* were recorded from the Pettymudy area during the study, with an average of 124 individuals per cluster (Table 1). Of the 15 clusters, 10 were found to be located very close to each other, at a distance of 15–50 m apart.

A maximum of 400 individuals of *I. johnii* was recorded in one cluster, while the highest number of individuals (200–400) was recorded in the high altitude (~1800 m amsl) areas of the segment where the streams originate; whereas less population was observed towards the lower altitude areas. The possibility of dehisced pods shattering their seeds down to the streams was explored both at the upstream and downstream end of the segment. It has been inferred that the plant cannot be found in the upper crests of the adjoining Eravikulam National Park. The population seems to be extending downwards to the south-west part of the segment where it ends at a lower elevation below 1400 m amsl. This study observed that the distribution of *I. johnii* was restricted only to a small part of the study area. The majority of clusters is found associated with one stream, except for two clusters which recorded about 50 m of lower elevation from the main stream. The distribution of clusters along the stream side could be due to the possibility of seed dispersal by flowing water. It is also inferred that the species abundance would fluctuate drastically depending on weather conditions.

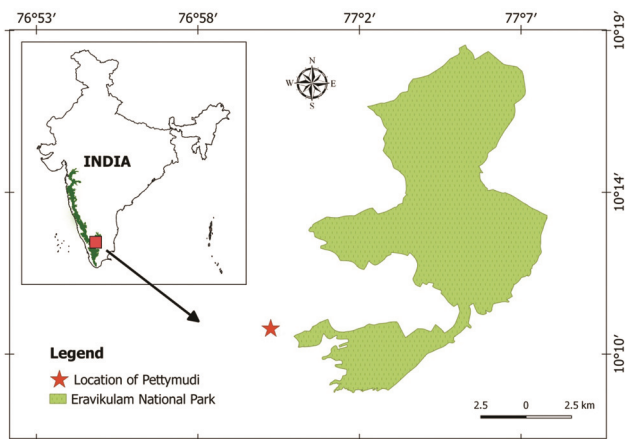


Figure 1. Location of Pettymudi: the area representing distribution of *Impatiens johnii*.

Table 1. Profile of *Impatiens johnii* population in Pettymudy area

	N	Minimum	Maximum	Mean	SE	SD
No. of plants	15	8	400	123.93	32.95	127.64
Plants with flower	15	0	50	11.00	3.62	14.01

N, total number; SE, standard error; SD, standard deviation.

The flowering and fruiting season of the species extends from September to December. However, the peak season of flowering was observed during the first week of October and it extends only for a short duration. Presence of rains resulted in an extended flowering season in the locality. The positive correlation between the number of plants and the number of flowers ($r = 0.715$, $P < 0.005$) shows that the number of flowers is directly dependent on the number of plants in the area. The species is found exclusively in the humus and sand-filled depressions of moist rock surfaces associated with mosses, lithophytic orchids (*Disperis neigherrensis* Wight) and aroids (*Ariopsis peltata* Nimmo), and in the riverine soil (black in colour with high humus content) (Figure 2) typically associated with *Impatiens gardneriana* Wight and *Plectranthus malabaricus* (Benth.) Willemsse. Considering the narrow distribution of *I. johnii* in the biotope (Munnar landscape), the species could be categorized as exclusively endemic to the political region of Kerala, and represents an instance of stenotopic endemism (habitat specialist confined to a single biotope). The species, therefore, assumes highest conservation significance.

Conversely, there are also threat factors affecting the highly restricted population of this endangered species^{3,11}. Unpredictable weather change during the flowering season is one of the major threats to *I. johnii*. The year 2016 noticed a dip in the rainfall than the previous years. The flowering had been evidently stopped by early December 2016; whereas in 2015 it extended up to the first week of January. Wind velocity has not been seen affecting the seed dispersal, since the turbulence of the wind at such a low height from the ground is negligible. The wind velocity is high in the top regions of the study area, i.e. in the Eravikulam National Park. Human-induced habitat degradation is another threat to the species in the locality. Human interference is evident as a paved road passes through the area to Edamalakkudy with a cluster of tribal colonies representing the first tribal Grama Panchayath in Kerala. The road was made jeep-worthy in 2013–14 disturbing the pristine habitat of *I. johnii*. Even though the area forms a part of a buffer zone to the well-known Eravikulam National Park, no such protection is afforded to the locality. Unscientific mining (of rock) and road construction have been done in the area.

Studies show that the current species extinction rate is very high globally due to habitat degradation and climate change^{13,14}. Threats to ecosystems lead to species extinction. The most common threats are connected with resource use, construction, exotic alien species and the resultant alteration of habitat dynamics. Pollution, heavy rainfall and extreme weather also lead to species extinction¹⁵. In the case of *I. mysorensis* Roth ex Wall, known only from the Chitradurga district of Karnataka, excessive grazing by goats and quarrying operations in the locality have been projected as major threats to the



Figure 2. Typical habitat of *I. johnii*.

species¹⁶. Similarly, many potential sites of occurrence of *I. johnii* have been destroyed by unscientific construction of road and associated quarrying.

Zang and Ma¹⁷ provided insights for prioritizing biodiversity conservation as well as processing the mechanism of distribution patterns of threatened species. Various attributes such as bio-geographical range, habitat specificity and population size are used to identify the threatened species and it can be used for conservation of the species¹⁸. The stenotopic (habitat specialist) endemic and endangered species *I. johnii*, therefore assumes high conservation importance to restore the population and to protect its habitat. The area needs to be declared as part of Eravikulam National Park and legal protection to this type locality must be given at the earliest.

- Mabberley, D. J., *The Plant-Book: A Portable Dictionary of the Vascular Plants*, Cambridge University Press, New York, 2005, 2nd edn.
- Pusalkar, P. K. and Singh, D. K., Three new species of *Impatiens* (Balsaminaceae) from Western Himalaya, India. *Taiwania*, 2010, **55**, 13–23.
- Bhaskar, V., *Taxonomic Monograph on Impatiens L. (Balsaminaceae) of Western Ghats, South India: The Key Genus for Endemism*, Centre for Plant Taxonomic Studies, Bangalore, 2012.
- Sasidharan, N., *Flowering plants of Kerala: ver 2.0*, Kerala Forest Research Institute, Peechi [CD-ROM], 2013.
- Hareesh, V. S., Sreekumar, V. B., Dandus, K. J. and Sujanalal, P., *Impatiens sahyadrica* sp. nov. (Balsaminaceae) – a new species from southern Western Ghats, India. *Phytotaxa*, 2015, **207**(3), 291–296.
- Barnes, E., The species of geranials occurring on the Travancore high range including the description of the new balsam. *J. Indian Bot. Soc.*, 1939, **18**, 95–105.
- Biju, S. D. and Kumar, V. M., Rediscovery of *Impatiens johnii* E. Barnes (Balsaminaceae), a balsam endemic to Eravikulam National Park, Kerala, India. *Indian J. Forestry*, 1999, **22**(2), 174–176.
- Shetty, B. V. and Vivekananthan, K., The endemic and endangered plants of the High Range, Idukki district, Kerala. In *Proc. Symp. Rare Endangered and Endemic plants of Western Ghats* (eds Karunakaran, C. K. et al.), Kerala Forest Dept., Thiruvananthapuram, 1991, pp. 135–154.

- Vajravelu, E. and Daniel, P., *Enumeration of Threatened Plants of Peninsular India. Materials for a Catalogue of Threatened Plants of India*, Botanical Survey of India, Calcutta, 1983.
- Nayar, M. P. and Sastry, A. R. K., *Red Data Book of Indian Plants*, Botanical Survey of India, Kolkatta, vol. 1 (1987), vol. 2 (1988), vol. 3 (1990).
- Rao, C. K., Geetha, B. L. and Suresh, G., *Red List of Threatened Vascular Plant Species in India*, Botanical Survey of India, 2003.
- Sharma, B. D., *Flora of India: Malpighiaceae-Dichapetalaceae*, Botanical Survey of India, 1997.
- Panda, S., Notes on conservation of RET species in India. *Curr. Sci.*, 2004, **106**(7), 916.
- Rawat, G. S., *Special Habitats and Threatened Plants of India*, ENVIS Bulletin: Wildlife and Protected Areas, Wildlife Institute of India, Dehradun, India, 2008, vol. 11(1).
- Lawler, J. J., Cambell, S. P., Guerry, A. D., Kolozsvary, M., O'Connor, R. J. and Seward, L. C. N., The scope and treatment of threats in endangered species in recovery plans. *Ecol. Appl.*, 2002, **12**(3), 663–667.
- Ganesh Babu, N. M., Dessai, J. R. N., Ravikumar, K. and Rao, N. R., *Impatiens mysorensis* Heyne ex Roth (Balsaminaceae), a little known endemic from Karnataka. *Phytotaxonomy*, 2007, **7**, 83–88.
- Zang, Y. B. and Ma, K. P., Geographical distribution patterns and status assessment of threatened plants in China. *Biodivers. Conserv.*, 2008, **17**, 1783.
- Kumari, P., Joshi, G. C. and Tewari, L. M., Biodiversity status, distribution and use pattern of some ethno-medicinal plants. *Int. J. Conserv. Sci.*, 2012, **3**(4), 309–318.

ACKNOWLEDGEMENTS. We thank the Forest Department of Kerala for providing the necessary facilities. We also thank the staff and Eco Development Committee (EDC) watchers of Eravikulam National Park for support throughout the study. We thank Bhavadas for providing the relevant literature. We are grateful to the staff and watchers of Munnar Territorial Division for their help during the field work. We also thank Dr Shaju for helping us improve the article.

Received 17 February 2017; revised accepted 8 August 2018

doi: 10.18520/cs/v115/i10/1960-1962