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The checklist of *Impatiens* Riv. ex L. (Balsaminaceae) in Nilgiri and Palani Hills of southern Western Ghats (India)

Introduction

The genus *Impatiens* Riv. ex L. consists of more than 1050 species, distributed across the Old World tropics and subtropics, as well as in the north and central America (Ruchisansakun et al., 2018; Arigela et al., 2019a; Singh et al., 2021; Borah et al., 2022). Most of the *Impatiens* species occur in five centres of diversity of the Old World, namely Madagascar, tropical Africa, Sino-Himalayan region, Western Ghats region of India and Southeast Asia. In India, there are about 242 species of *Impatiens* recorded so far, of which 152 species are endemic, and the highest diversity occurs in two regions, the Eastern Himalayas and the Western Ghats (Singh, 2016a, 2016b; Singh, Garg, 2016; Singh, 2017; Arigela, 2019a; Singh et al., 2021). Western Ghats holds about 116 endemic species of *Impatiens* (Bhaskar, 2012; Arigela et al., 2019a). The species of *Impatiens* are generally known as balsam or jewel weed, and several species have ornamental potential.

In Western Ghats, the floristic studies and inventories of the genus *Impatiens* were early reported in floras by Gamble (1915), Fyson (1932) and Matthew (1983, 1999). Recently, Bhaskar (2012) provided a comprehensive account of 106 species from Western Ghats, and Dessai and Janarthanam (2011) reported 26 species and 2 varieties from the

northern and central Western Ghats. Singh (2016) typified thirty six names of thirty five recognised taxa of *Impatiens*, which are endemic to the Western Ghats. In Nilgiri and Palani, the genus is widespread in Montane wet temperate (Shola) forests and high altitude grassland to semi-evergreen forests. To effectively protect the endemic vascular plants, a comprehensive document of endemic plants of these ecosystems is prerequisite.

The present study on the genus *Impatiens* brought out an updated checklist of Balsams in the Nilgiri and Palani Hills of Western Ghats, India (Fig. 1 – Appendix 1).

Study area

The Nilgiri Hills of Tamil Nadu is located between 11°10'–11°43' N and 76°14'–77°00' E, in Nilgiris District with an area of 2452.50 km². The Nilgiri is one of the high mountain ranges of the Western Ghats, at an elevation of 900 to 2636 m a. s. l. and it is surrounded by the plains of Coimbatore in the southeast, Bhavani in the northeast, Moyar valley in the north and Gudalur plateau in the northwest (Fig. 1C – Appendix 1). In the Nilgiri, underlying rocks are crystalline and mostly gneisses in the entire plateau. Moist evergreen forests at 900–1300 m and montane wet temperate (Shola) forests combined with high altitude grasslands at 1300–2600 m are the major vegetation types. The entire district soil is classified under 'humic-ferritic soil' on account of topsoil, as per profile characteristics. The Nilgiris District lies in the tropical zone with subtropical to temperate climate. The western regions of the plateau receive about 3000 mm of rainfall which exceeds 5000 mm in certain sites. The temperature ranged from a minimum of 2°C and a maximum of 25°C, with a layer of mist and fog covering the south eastern slopes.

The Palani (Palni) Hills lie between 10°07'–10°25' N and 77°15'–77°43' E in Dindigul and Theni Districts of Tamil Nadu. The Palani Hills are situated in south central Tamil Nadu, an east-west spur of the Western Ghats, extending roughly from the Kerala border near Munnar, past the town of Kodaikanal as far as Dindigul in the east (Fig. 1B – Appendix 1). The maximum length is 65 km and width is 40 km, with an area of about 2000 km². These hills in turn are divided into the upper Palani (west) and the lower Palani (east). The upper Palani have an average elevation of 2200 m and the lower Palani have elevation less than 1700 m. The upper Palani (1700–2100 m) are predominantly grasslands interspersed with tropical montane Shola forests which tend to cluster along the streams and rivers. Below this, from 1300 to 1700 m is dry evergreen forest. From 800 to 1300 m is dry deciduous forest, from 300 to 800 m is savannah interspersed with dry deciduous trees and from the plains to approximately 300 m elevation is scrub forest (Matthew, 1999, Arigela et al., 2019b). The upper Palani Hills have a quasi-temperate climate with temperature ranges from 2°C to 17°C in the winter and 12°C to 21°C in the summer. The average year round temperature is 16°C. The lower hills become

progressively warmer and temperature ranges from 25°C to 40°C. The average annual rainfall of Kodaikanal is approximately 1700 mm.

Materials and methods

Based on literature and phenology, the specimens were sampled in different sites of Nilgiri and Palani from 2012 to 2020 in different seasons. Exploration sites include Shola forests, grasslands and transitional zones between different vegetation types for ecotype variants. Photographs of habitat, habit, inflorescence and close up of flowers of each species were taken to prepare the digital data base and for identification. Height, inflorescence size and colour, wildlife signs and threat factors were recorded for all plant species. GPS coordinates with altitude were collected for geo-tagging and for further studies. The species were identified with the help of literature (Roxburgh, 1824; Wight, Arnott, 1834; Wight, 1837, 1838–1853, 1839; Hooker, 1875; Gamble, 1924; Matthew, 1983, 1999; Dessai, Janarthanam, 2011; Bhaskar, 2012; Singh et al., 2015; Singh, 2016a, 2016b, 2017) and specimens available with Central National Herbarium (CAL), Howrah, Fischer Herbarium (FRC), IFGTB, Coimbatore and Madras Herbarium (MH), BSI, Coimbatore. The plant specimens of present study have been deposited at MH and FRC for future reference.

Results

In the present study, 38 species of *Impatiens* from Nilgiri and Palani Hills are documented. Among Balsams, 36 species were recorded from Nilgiri (Figs. 2–4 – Appendix 1), 13 species were recorded from Palani (Fig. 5 – Appendix 1), 11 species occur in both Nilgiri and Palani Hills. Out of 38 taxa, 32 are endemic to India (6 species are endemic to Western Ghats and 26 species are endemic to southern part of Western Ghats) and 6 taxa have wider distribution. Photo plates of the *Impatiens* species from both the localities are presented separately to show the flower colour variations. Few species like *Impatiens fasciculata* (Fig. 3C and 5C – Appendix 1) or *I. tomentosa* (Fig. 4H and 5K – Appendix 1) produce both white and pink colour flowers. The habitat, occurrence in the study areas and distribution of these 38 *Impatiens* species are given in table (1) – Appendix 2.

Short discussion

Presently, Madagascar has the highest *Impatiens* species richness with about 260 species (Rahelivololona et al., 2018) and India is at the second position with about 242 species. India nurtures a wide range of *Impatiens* species due to its diverse topography, vege-

tation and forest types. The diversity of climate types and habitats of Indian Himalaya and Western Ghats is also associated with *Impatiens* species diversity and richness. Phylogenetic studies of the genus *Impatiens* show the centre of origin in South China (Janssens et al., 2006), but Bhaskar (2012) claimed that it lied in the Western Ghats, as the primitive species of *Impatiens* with lowest chromosome numbers ($n=3$ in *Impatiens latifolia* – Fig. 2B and *I. leschenaultii* – Fig. 2A–5G – Appendix 1) and the largest ($n=20$ and 25 in *I. grandis* – Fig. 3K) were recorded from the Western Ghats. Detailed ecological study of *Impatiens* species in different habitats of Nilgiri and Palani Hills showed that some species show variation in the vegetative morphological traits (*I. inconspicua* and *I. minor* – Fig. 3F), some in the reproductive (floral or fruiting or both) traits (*I. fasciculata*, *I. goughii*, *I. tomentosa* and *I. scapiflora*), and some in both vegetative and reproductive traits (*I. acaulis*, *I. balsamina*, *I. chinensis*, *I. diversifolia*, *I. oppositifolia* and *I. scabriuscula* – Figs. 2–5 – Appendix 1). It is observed that abiotic ecological factors (climatic, edaphic and physiographic) play a major role in the morphological variation of some taxa, while biotic factors play a minor role.

Impatiens balsamina (Figs. 4I and 5A – Appendix 1) is native to south India and Sri Lanka, but widely cultivated as garden ornamental plant throughout India and many parts of globe (Bhaskar, 2012). During the present study we found that 10 endemic species of balsam (*Impatiens clavicornu*, *I. campanulata*, *I. dasysperma*, *I. gardneriana*, *I. grandis*, *I. henslowiana*, *I. latifolia*, *I. leschenaultii*, *I. maculata* and *I. minor*) and 8 threatened species (*I. fruticosa*, *I. elegans*, *I. parasitica*, *I. phoenicea*, *I. tangachee*, *I. tanyae*, *I. viscida* and *I. viscosa*) – Tab. 1 – Appendix 2 – have great horticultural potential. The promising potentials of utilisation of wild genes during breeding experiments and cultivar development cannot be ruled out of all these beautiful balsam. These endemic and threatened species of balsam have beautiful foliage and flower (often of different colours within the same species), and can be introduced as garden ornamental plants, especially in south and central India. Multiplication through culture techniques and regeneration of individuals in similar habitats to their natural habitat is the most probable method to increase population number. By this way, we can conserve (*ex-situ*) these endemic and threatened species of balsam.

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Conflict of interest

The authors declare no conflict of interest related to this article.

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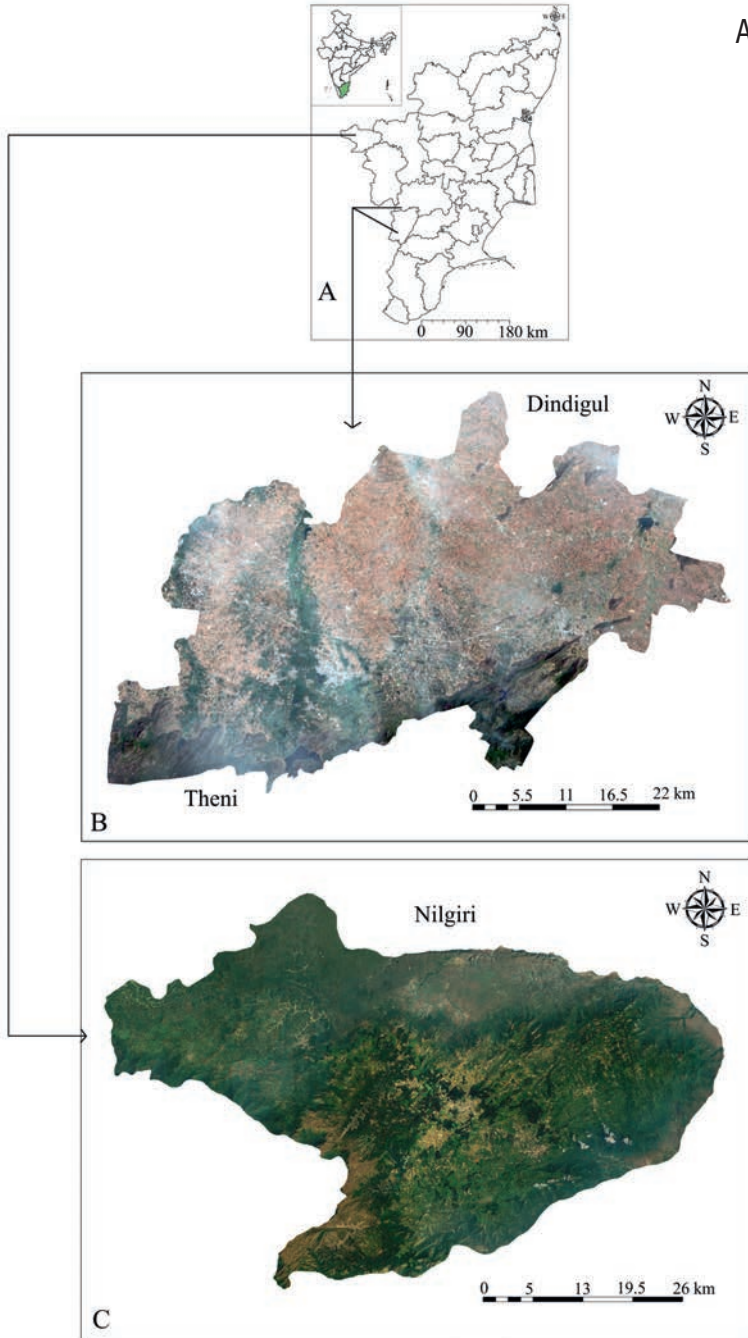


Fig. 1. Study area: India with Tamil Nadu Districts – A, Palani Hills – B, Nilgiri Hills – C

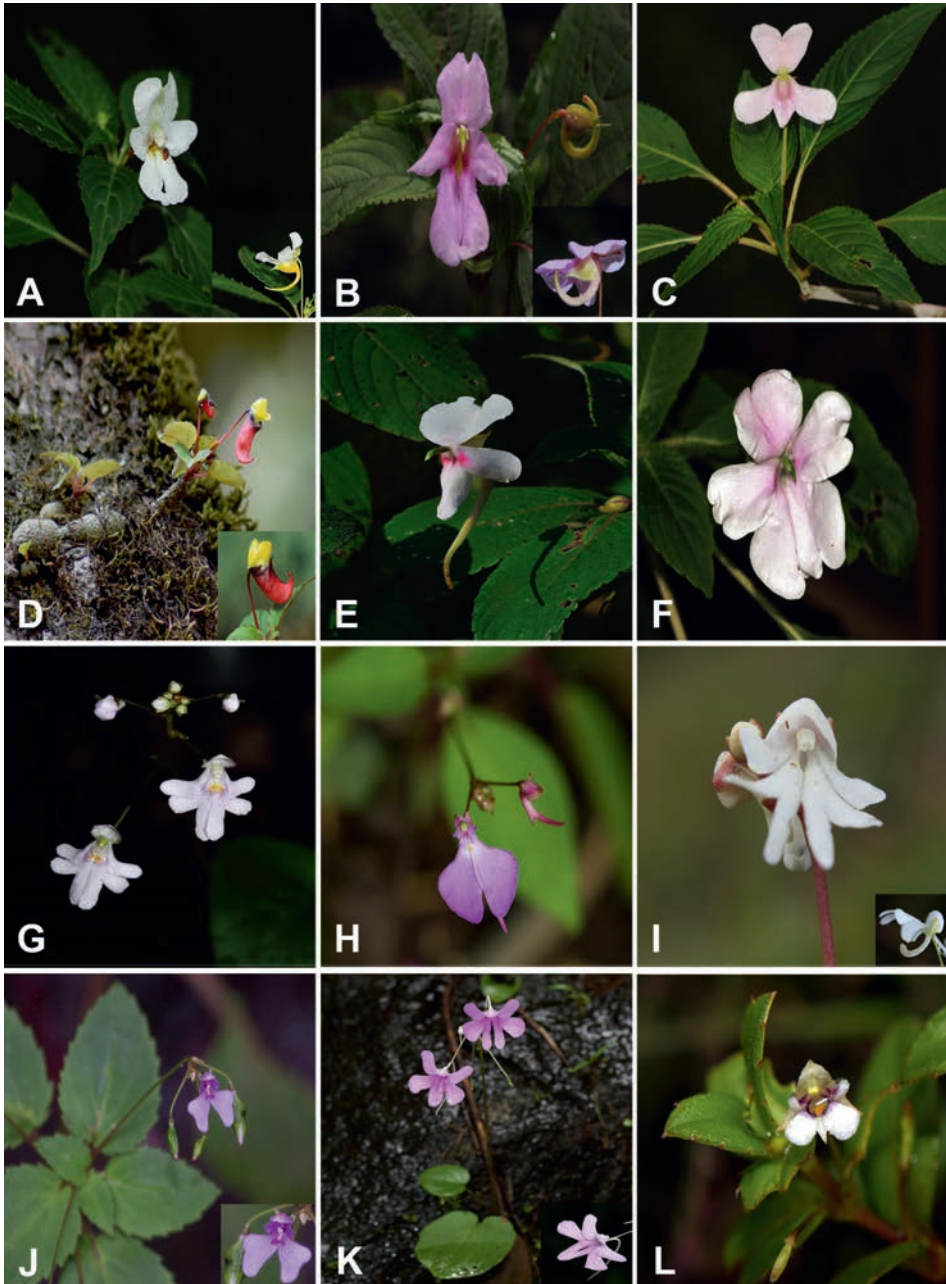


Fig. 2. Species of *Impatiens* from Nilgiri: *Impatiens leschenaultii* (DC.) Wall. ex Wight & Arn. (white flower) – A, *I. latifolia* L. – B, *I. cuspidata* Wight & Arn. – C, *I. parasitica* Bedd. – D, *I. fruticosa* Lesch. ex DC. – E, *I. henslowiana* Arn. (light pink flower) – F, *I. modesta* Wight – G, *I. viscosa* Bedd. – H, *I. clavicornu* Turcz. – I, *I. goughii* Wight (pink flower) – J, *I. scapiflora* B. Heyne ex Wall. – K, *I. inconspicua* – L (Photo: S. Jeevith and C. Rajasekar)

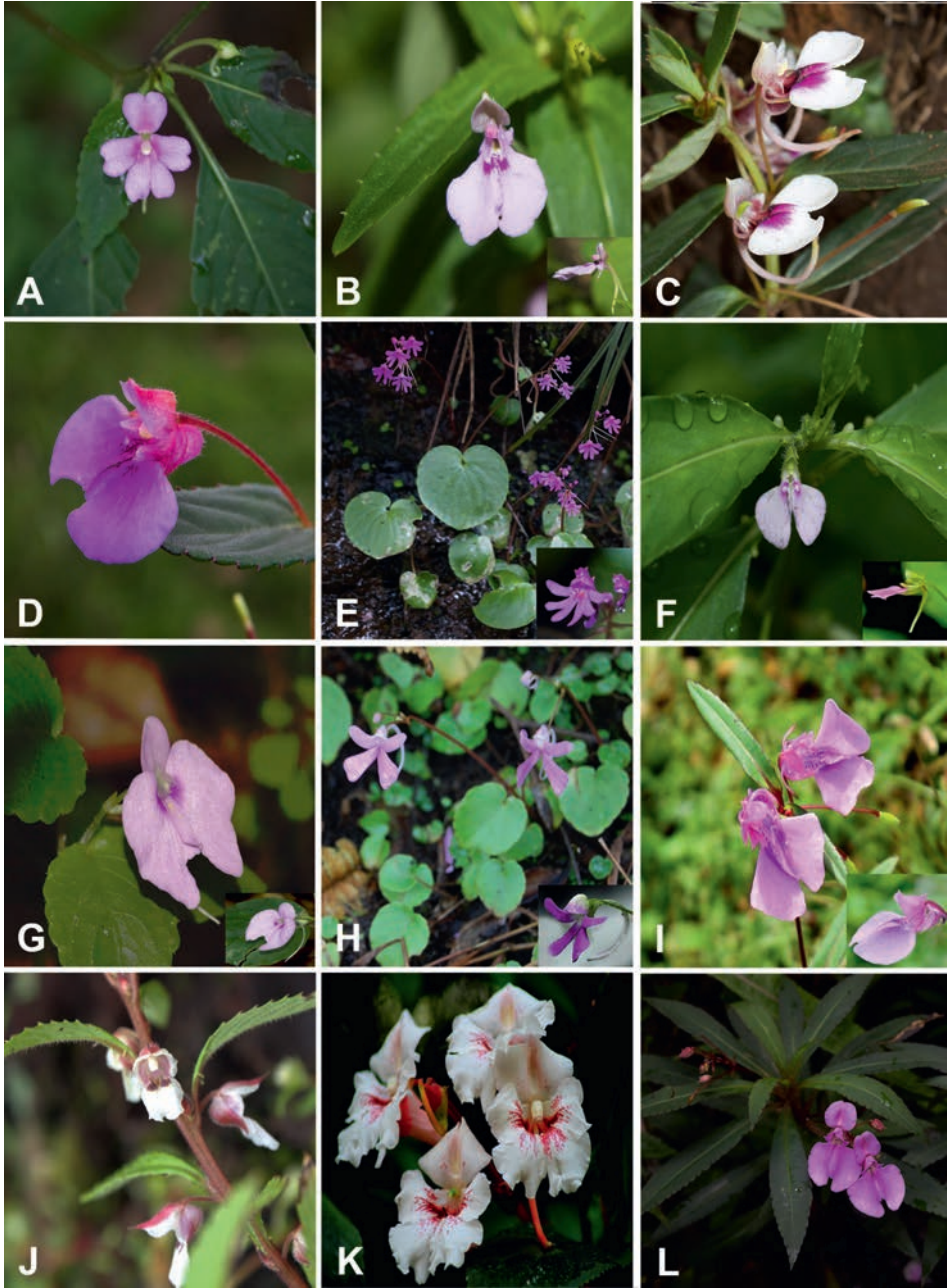


Fig. 3. Species of *Impatiens* from Nilgiri: *Impatiens dasysperma* Wight – A, *I. tenella* B. Heyne ex Wight & Arn. – B, *I. fasciculata* Lam. (white flower) – C, *I. rufescens* Benth. – D, *I. denisonii* Bedd. – E, *I. minor* (DC.) Bennet – F, *I. cordata* Wight – G, *I. acualis* Arn. – H, *I. oppositifolia* L. – I, *I. scabriuscula* B. Heyne ex Wall. – J, *I. grandis* B. Heyne ex Wall. – K, *I. tangachee* Bedd. – L (Photo: S. Jeevith and C. Rajasekar)

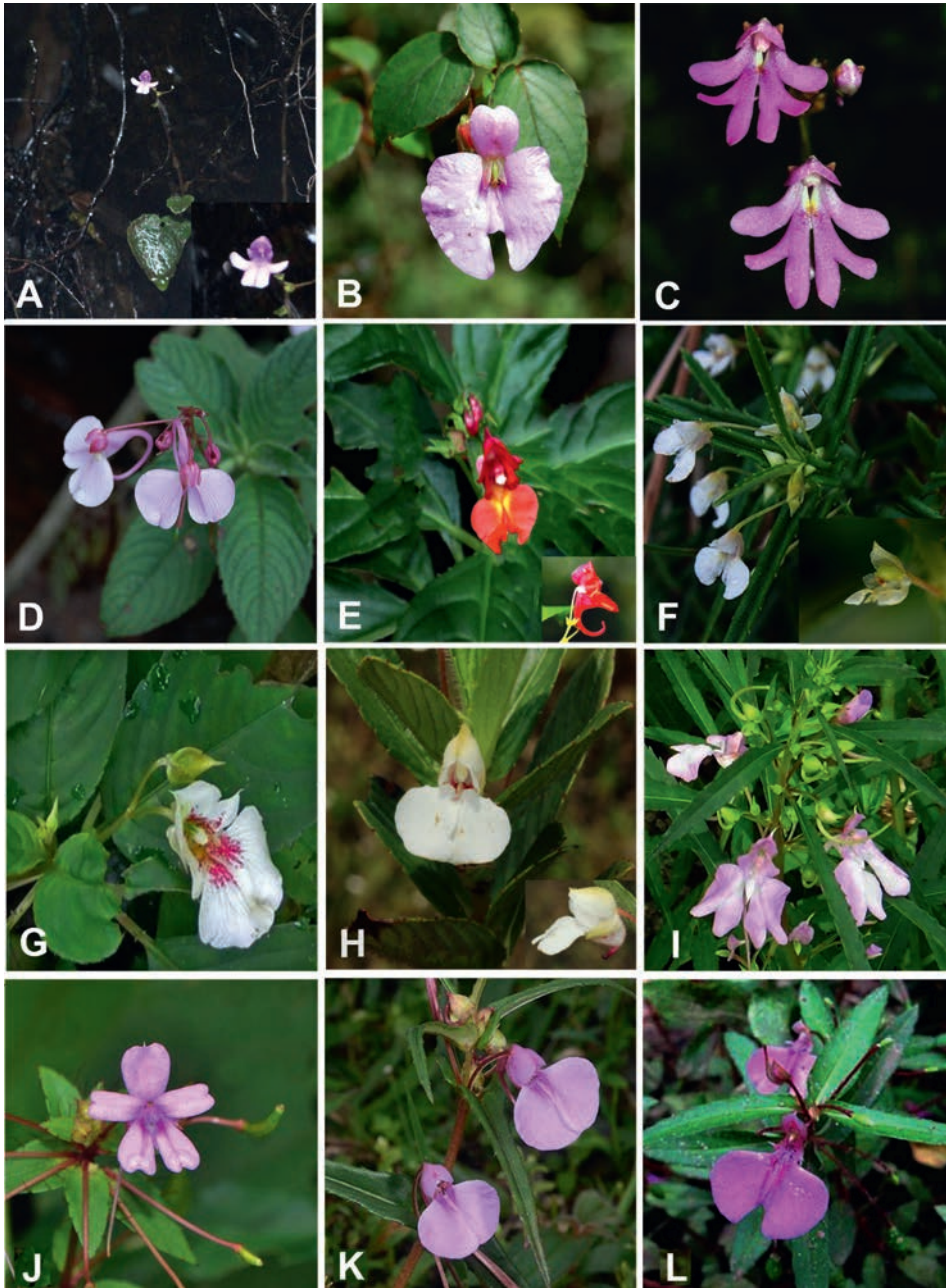


Fig. 4. Species of *Impatiens* from Nilgiri: *Impatiens nilgirica* C.E.C. Fisch. – A, *I. elegans* Bedd. – B, *I. levingei* Gamble ex Hook.f. – C, *I. maculata* Wight – D, *I. phoenicea* Bedd. – E, *I. herbicola* Hook.f. – F, *I. campanulata* Wight – G, *I. tomentosa* B. Heyne ex Wight & Arn. (white flower) – H, *I. balsamina* L. – I, *I. gardneriana* Wight – J, *I. chinensis* L. – K, *I. diversifolia* Wall. ex Wight & Arn. – L (Photo: S. Jeevith and C. Rajasekar)

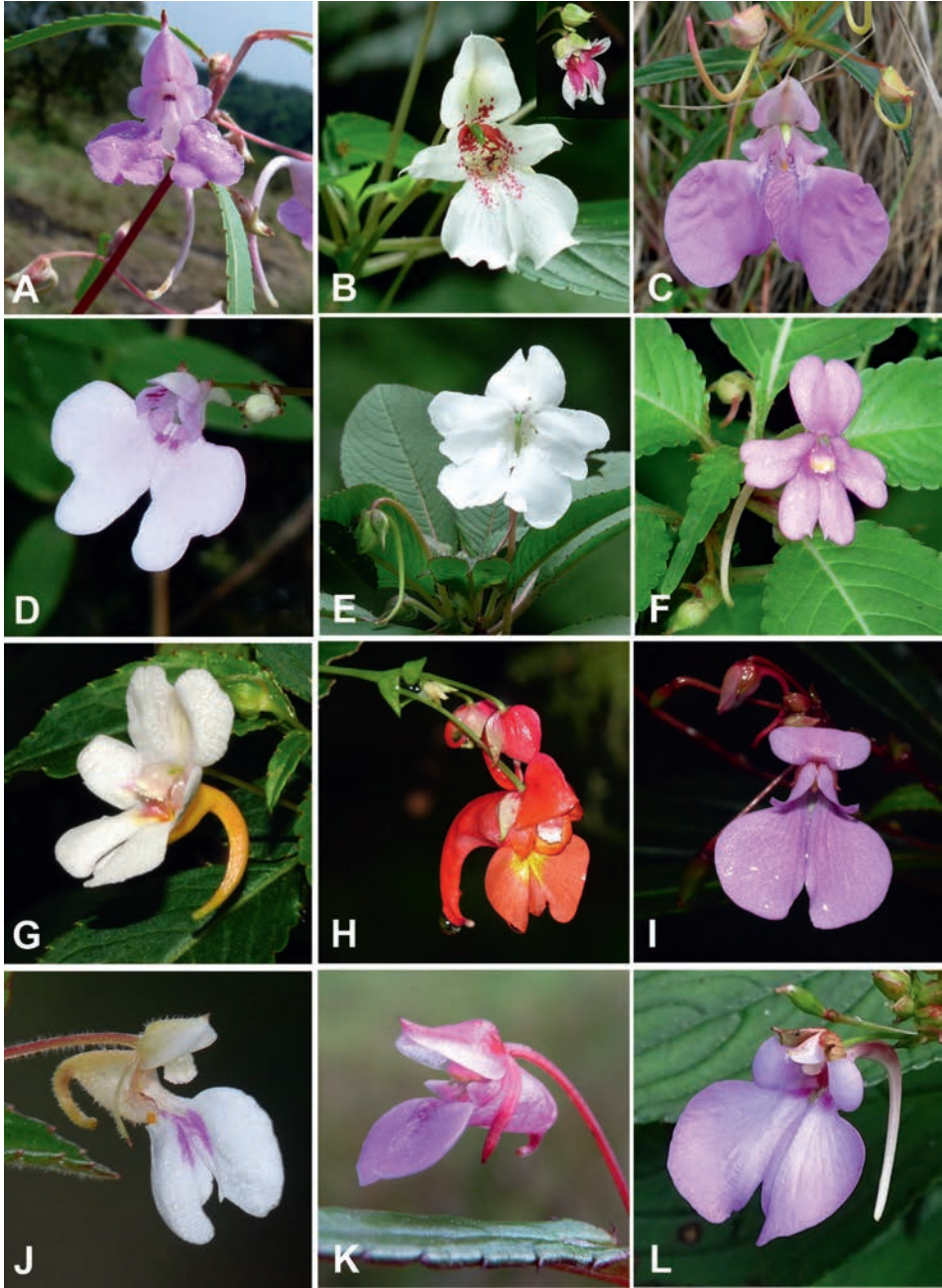


Fig. 5. Species of *Impatiens* from Palani: *Impatiens balsamina* L. (pink flower) – A, *I. campanulata* Wight – B, *I. fasciculata* Lam. (pink flower) – C, *I. goughii* Wight (red flower) – D, *I. henslowiana* Arn. (white flower) – E, *I. dasysperma* Wight – F, *I. leschenaultii* (DC.) Wall. ex Wight & Arn. (light orange flower) – G, *I. phoenicea* Bedd. – H, *I. tangachee* Bedd. – I, *I. tanyae* R. Kr. Singh, Arigela & Kabeer – J, *I. tomentosa* B. Heyne ex Wight & Arn. (pink flower) – K, *I. viscida* Wight – L (Photo: Ravi Kiran Arigela)

Tab. 1. Species list of *Impatiens* in Nilgiri and Palani Hills (Southern India)

| No. | Species | Distribution | Habitat | Occurrence in the study area |
|-----|---|--|--|------------------------------|
| 1. | <i>Impatiens acaulis</i> Arn. | Southern India and Sri Lanka | Wet rocky slopes and moist soil walls of evergreen forests | Nilgiri |
| 2. | <i>Impatiens balsamina</i> L. | Native to India and Sri Lanka. Introduced in new world countries | On open dry, wet rocky slopes and plains from foothills to 2500 m elevation | Nilgiri and Palani |
| 3. | <i>Impatiens clavicornu</i> Turcz. | Endemic to southern Western Ghats (Karnataka, Kerala and Tamil Nadu) | Montane (Shola) grasslands and wet rock slopes | Nilgiri |
| 4. | <i>Impatiens campanulata</i> Wight | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Dripping rocky slopes and on tree trunks in shola forests and shola forest borders | Nilgiri and Palani |
| 5. | <i>Impatiens chinensis</i> L. | Native to Asia and introduced in Africa | On open dry, wet rocky slopes, swamps, marshes and plains from foothills to 2500 m elevation | Nilgiri and Palani |
| 6. | <i>Impatiens cordata</i> Wight | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Evergreen forests along the streams and shola grasslands | Nilgiri |
| 7. | <i>Impatiens cuspidata</i> Wight & Arn. | Endemic to southern Western Ghats (Karnataka, Kerala and Tamil Nadu) | Fringes of shola forests | Nilgiri |
| 8. | <i>Impatiens dasysperma</i> Wight | Endemic to southern Western Ghats (Karnataka, Kerala and Tamil Nadu) | Dripping rocky slopes in shola forests and wet evergreen forests borders | Nilgiri and Palani |
| 9. | <i>Impatiens denisonii</i> Bedd. | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Wet rocks and moist grasslands slopes in evergreen and shola forests | Nilgiri |
| 10. | <i>Impatiens diversifolia</i> Wall. ex Wight & Arn. | Endemic to southern Western Ghats (Karnataka, Kerala and Tamil Nadu) | Evergreen forests and moist grasslands, also found along the streams from 700–1200 m elevation | Nilgiri |
| 11. | <i>Impatiens elegans</i> Bedd. | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Moist evergreen and shady places, also prefers dripping rocks in sholas and shola grasslands | Nilgiri |
| 12. | <i>Impatiens fasciculata</i> Lam. | Endemic to southern Western Ghats (Karnataka, Kerala and Tamil Nadu) | Dripping rocky slopes in shola forests, wet evergreen forests borders and swamps in grasslands | Nilgiri and Palani |

| | | | |
|---|---|---|--------------------|
| 13. <i>Impatiens fruticosa</i> Lesch. ex DC. | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Near streams of shola forests | Nilgiri |
| 14. <i>Impatiens gardneriana</i> Wight | Endemic to southern Western Ghats (Karnataka, Kerala and Tamil Nadu) | Wet evergreen forests and found along the margins of shola forests | Nilgiri |
| 15. <i>Impatiens goughii</i> Wight | Endemic to southern Western Ghats (Karnataka, Kerala and Tamil Nadu) | Dripping rocky slopes at shola forest borders and shola grasslands from 1800–2500 m elevation | Nilgiri and Palani |
| 16. <i>Impatiens grandis</i> B. Heyne ex Wall. | Karnataka, Kerala, Tamil Nadu and Sri Lanka | Moist shady places in shola forests | Nilgiri |
| 17. <i>Impatiens henslowiana</i> Arn. | Karnataka, Kerala, Tamil Nadu and Sri Lanka | Dripping rocky slopes in shola forests and wet evergreen forests borders | Nilgiri and Palani |
| 18. <i>Impatiens herbicola</i> Hook.f. | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Moist grasslands, swampy areas and wet rocky slopes from 1700–2200 m elevation | Nilgiri |
| 19. <i>Impatiens inconspicua</i> Benth. ex Wight & Arn. | Endemic to Western Ghats (Goa, Karnataka, Kerala, Maharashtra and Tamil Nadu) | Dripping rocky slopes of shola forest borders and shola grasslands from 1800–2500 m elevation | Nilgiri |
| 20. <i>Impatiens latifolia</i> L. | Endemic to Western Ghats (Karnataka, Kerala, Maharashtra and Tamil Nadu) | Fringes of shola forests | Nilgiri |
| 21. <i>Impatiens leschenaultii</i> (DC.) Wall. ex Wight & Arn. | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Rocky slopes of shola forest borders from 1800–2500 m elevation | Nilgiri and Palani |
| 22. <i>Impatiens levingei</i> Gamble ex Hook.f. | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Wet rocky slopes of shola forests and shola grasslands | Nilgiri |
| 23. <i>Impatiens maculata</i> Wight | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Moist evergreen and shola forests along the streams | Nilgiri |
| 24. <i>Impatiens minor</i> (DC.) Bennet | Endemic to Western Ghats (Goa, Karnataka, Kerala, Maharashtra and Tamil Nadu) | Semi-evergreen forests and wet evergreen forests from 1600–2000 m elevation | Nilgiri |
| 25. <i>Impatiens modesta</i> Wight | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Grasslands and rocky slopes of moist evergreen forests | Nilgiri |
| 26. <i>Impatiens nilgirica</i> C.E.C. Fisch. | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Dripping rocks of shola grasslands | Nilgiri |

| | | | |
|--|---|---|--------------------|
| 27. <i>Impatiens oppositifolia</i> L. | India, Myanmar, Sri Lanka and Thailand | Dripping rocky slopes of shola forest borders and shola grasslands from 1800–2500 m elevation | Nilgiri |
| 28. <i>Impatiens parasitica</i> Bedd. | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Mostly epiphytic on shola trees, also found on wet rocks | Nilgiri |
| 29. <i>Impatiens phoenicea</i> Bedd. | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Along the stream of shola forests and fringes of moist evergreen forests | Nilgiri and Palani |
| 30. <i>Impatiens rufescens</i> Benth. | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Mostly in swampy areas and shola grasslands at 2100–2300 m elevation | Nilgiri |
| 31. <i>Impatiens scabriuscula</i> B. Heyne ex Wall. | Endemic to Western Ghats (Karnataka, Kerala, Maharashtra and Tamil Nadu) | Wet slopes and dripping rocks of shola forest and grasslands | Nilgiri |
| 32. <i>Impatiens scapiflora</i> B. Heyne ex Wall. | Endemic to southern Western Ghats (Karnataka, Kerala and Tamil Nadu) | Dripping rocky slopes of evergreen forests and grasslands | Nilgiri |
| 33. <i>Impatiens tangachee</i> Bedd. | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Dripping rocky slopes in shola forests | Nilgiri and Palani |
| 34. <i>Impatiens tanyae</i> R. Kr. Singh, Arigela & Kabeer | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Swampy areas and along the streams of shola grasslands | Palani |
| 35. <i>Impatiens tenella</i> B. Heyne ex Wight & Arn. | Endemic to Western Ghats (Karnataka, Kerala, Maharashtra and Tamil Nadu) | Shola forests and shola grasslands | Nilgiri |
| 36. <i>Impatiens tomentosa</i> B. Heyne ex Wight & Arn. | Endemic to Western Ghats (Goa, Karnataka, Kerala, Maharashtra and Tamil Nadu) | Dripping rocky slopes of shola forest borders and shola grasslands from 1800–2500 m elevation | Nilgiri and Palani |
| 37. <i>Impatiens viscida</i> Wight | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Dripping rocky slopes of shola forests and shola forest borders | Palani |
| 38. <i>Impatiens viscosa</i> Bedd. | Endemic to southern Western Ghats (Kerala and Tamil Nadu) | Dripping rocky slopes of shola forest borders and shola grasslands 1800–2500 m elevation | Nilgiri |

Abstract

A comprehensive checklist of the genus *Impatiens* Riv. ex L. (Balsaminaceae) in Nilgiri and Palani of southern Western Ghats, India is presented. After thorough field explorations in these areas from 2012 to 2020 in different seasons, 38 species of *Impatiens* are recorded, in which 6 species are endemic to Western Ghats and 26 species are endemic to southern Western Ghats of India. Horticultural potential of 18 endemic species of balsam is also discussed.

Key words: Balsams endemic, grasslands, Shola forests, Western Ghats

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Wykaz gatunków z rodzaju *Impatiens* Riv. ex L. (Balsaminaceae) z Nilgiri i Wzgórz Palani, w południowej części Ghatów Zachodnich (Indie)

W artykule zamieszczono listę gatunków z rodzaju *Impatiens* Riv. ex L. (Balsaminaceae), odnotowanych w Nilgiri i na Wzgórzach Palani (południowa część Ghatów Zachodnich w Indiach). Po dokładnych badaniach terenowych, przeprowadzonych w różnych porach roku w latach 2012–2020, zarejestrowano na analizowanym obszarze 38 gatunków niecierpka, w tym 6 gatunków endemicznych dla całych Ghatów Zachodnich i 26 gatunków dla południowej części Ghatów Zachodnich. Krótko omówiono również potencjał ogrodniczy 18 endemicznych gatunków niecierpków.

Słowa kluczowe: niecierpki endemiczne, lasy Shola, łąki, Ghaty Zachodnie

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