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Author: Ruchisansakun, S.
Title: Balsaminaceae in Southeast Asia: systematics, evolution, and pollination biology
Issue Date: 2018-09-19
CHAPTER 4

Three new species of Impatiens (Balsaminaceae) from Myanmar

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4.1. ABSTRACT

Three new species of *Impatiens* (Balsaminaceae) from Myanmar are here described: *I. decurva* Ruchis. & S.B.Janssens, *I. hartnolliae* Hook.f. ex Ruchis. & Suksathan, and *I. oblongata* Ruchis. & Van der Niet. The 5-lobed short fusiform fruit of all three species suggests that they are members of subgen. *Impatiens* sect. *Uniflorae* Hook.f. & Thomson. For *I. decurva* and *I. oblongata*, subgenus membership was corroborated by phylogenetic analyses of a combined dataset of nuclear ITS and plastid *atpB-rbcL* intergenic spacer DNA sequences. This was not possible for *I. hartnolliae*, which is only known from a single herbarium specimen.

4.2. INTRODUCTION

*Impatiens* L. (Linnaeus, 1753: 937), comprising almost the entire family of Balsaminaceae, is a highly diverse genus with more than 1000 species distributed in tropical and subtropical Africa and Eurasia (Grey-Wilson, 1980). A recent infrageneric classification based on molecular and morphological characters supports a subdivision of the genus into two subgenera: subgen. *Clavicarpa* S.X.Yu ex S.X.Yu & Wei Wang (Yu et al., 2015: 13) and subgen. *Impatiens* L. (Yu et al., 2015: 13). The latter is further divided into seven sections (Yu et al., 2015). Of these, sect. *Uniflorae* Hook.f. & Thomson (1860: 113) is characterized by a 5-locular ovary and a short fusiform capsule (Yu et al., 2015). The known diversity of *Impatiens* is strongly influenced by efforts resulting from taxonomic studies using dried and fresh specimens. Consequently, some geographic regions are better explored than others. Myanmar is the largest country in continental Southeast Asia and recent explorations have revealed a relatively rich biodiversity (Kress et al., 2003). Currently 50 *Impatiens* species are known from the country (Hooker, 1905; Toppin, 1920; Comber, 1934; Grey-Wilson, 1989; Kress et al., 2003; Tanaka et al., 2015; Ruchisansakun et al., 2017; Yang et al., 2017). As part of an ongoing project to revise the Balsaminaceae of Myanmar, a field expedition in the country conducted between July and December 2015 as well as analyses of herbarium specimens and relevant literature was conducted. Based on these studies, we discovered three new species, all of which are described here. We place the species within the infrageneric classification of Yu et al. (2015) by using comparative morphology and molecular phylogenetics.
4.3. METHODS

4.3.1. Comparative morphology

Morphological characters of *Impatiens decurva* and *I. oblongata* were examined from living material in the field. The morphology of *I. hartinolliae* was studied from the single known herbarium specimen (at K). A set of morphologically similar species was selected for comparative analyses. These species were studied from herbarium specimens from AAU, BR, BK, BKF, BM, C, E, K, L, MAND, P, QBG, RAF, and RANG, and from their descriptions in the literature (Wight & Arnott, 1834; Hooker & Thomson, 1860; Hooker, 1875, 1905; Ridley, 1914; Toppin, 1920). Terminology of morphological characters follows that of Grey-Wilson (1980).

4.3.2. Phylogenetic analyses

To determine the phylogenetic relationships of *Impatiens decurva* and *I. oblongata*, DNA sequence data were obtained and analyzed under the Bayesian Inference methodology. A combined dataset, consisting of nuclear ITS and plastid *atpB-rbcL* sequences was analysed. *Impatiens decurva* (*S. Ruchisansakun & Makino BG Exped. 734* (L), ITS: GenBank accession MF979085, *atpB-rbcL*: MF979082), *I. oblongata* (*S. Ruchisansakun & Makino BG Exped. 735* (L), MF979086, *atpB-rbcL*: MF979083), and *I. florulenta* (*S. Ruchisansakun & Makino BG Exped. 736* (L), ITS: MF979087, *atpB-rbcL*: MF979084) were added to the dataset of Ruchisansakun *et al.* (2017). DNA extraction and PCR amplification were conducted as in Janssens *et al.* (2006). Sequences were added to the matrix and manually aligned. Bayesian phylogenetic analyses were conducted in accordance with the protocols provided in Ruchisansakun *et al.* (2017). Bayesian analysis of the combined dataset was run for 10,000,000 generations, starting from different random trees and sampled every 500 generations. The initial 25% of sampled trees were discarded as burn-in. A majority-rule consensus tree was constructed in MrBayes 3.2.2 on XSEDE on the Cipres portal (Ronquist *et al.*, 2001).
4.4. RESULTS AND DISCUSSION

**Taxonomy**

1. *Impatiens decurva* Ruchis. & S.B. Janssens, sp. nov. (Figs. 4.1, 4.2)

*Impatiens decurva* Ruchis. & S.B. Janssens is similar to *I. pendula* B. Heyne ex Wight & Arn. (1834: 136) but differs in having congested leaves towards the stem apex, a pilose midrib on the dorsal petal, pink lateral united petals with a white base, an unequally bilobed apex of the lower lateral united petals, and a strongly decurved pedicel in fruiting stage.

**Type:**—**MYANMAR.** Shan State: Kalaw, 20°39’21.92”N 96°34’55.89”E, 27 Sep. 2015, S. Ruchisansakun & Makino BG Exped.734 (holotype L!, isotypes L!, RAF!, RANG!).

Lithophytic annual herb 6–30 cm tall. Stem erect, 1–3 mm in diam., cylindrical, simple to moderately branched, red, glabrous. Leaves spirally arranged, mostly crowded towards the apex of stem. Petiole absent or to 7 mm long, ca. 1 mm in diam., pale green to green to pink, glabrous. Lamina 10–40 × 5–15 mm, ovate to elliptic to obovate, apex acute to acuminate, base cuneate to attenuate, margin shallowly serrate, adaxial surface green, margin pilose, abaxial surface pale green and glabrous, with 3–5 long red hairs along the margin near the base; lateral veins 3–5 pairs, adaxially pilose. Flowers solitary, axillary, erect, 10–11 × 8–10 mm, 6–8 mm deep, pale pink and white, with two yellow spots at center. Bracts <1 × <1 mm, linear to narrowly lanceolate, the apex acute and mucronate, base cuneate, green with red apex, persistent. Pedicel 10–15 mm long, <1 mm in diam., pale green, pilose. Lateral sepals 2, <1 × 1 mm, free, ovate to lanceolate, apex acute, base obtuse, pale green with red tip, glabrous. Lower sepal 4–5 × 2.5–3 mm, ca. 2 mm deep, navicular, apex acuminate and mucronate, white with red tip, pilose outside, spurless. Dorsal petal 4–5 × 5–5.5 mm, broadly ovate, cucullate, apex round and slightly mucronate, base truncate to shallowly cordate, white, mostly glabrous but pilose on midrib, abaxial midvein simple or with narrow crest, ca. 1 mm wide, green. Lateral united petals 7–9 mm long, free: upper petals 4.5–5 × 2.5–3 mm, ovate, apex round, base cuneate, white to pale pink; the lower petals 6–7 × 3.5–4 mm, free, elliptic to obovate, apex unequally bilobed, pink, each with a yellow spot at base. Stamens 5: filaments ca. 2.5 mm long, white to pale pink; anthers pale pink. Ovary 2 mm long, <1 mm in diam., 5-carpellate, green, pilose. Fruits 8–10 mm long, 2.5–3 mm in diam., short fusiform, 5–lobed, green, pilose;
pedicel strongly decurved in middle during fruiting stage. Seeds ca. 2 mm long, ovoid, 9–11 per fruit, brown.

Fig. 4.1. Impatiens decurva. A. Habit; B. Front view of flower; C. Lateral view of flower; D. Fruit; E. Pedicel and ovary; F. Lateral sepals; G. Lower sepal; H. Dorsal petal; I. Lateral united petals. Drawn by Saroj Ruchisansakun.
Fig. 4.2. *Impatiens decurva*. A. Lateral view of flower; B. Front view of flower; C. Habit in situ. Photographs by Saroj Ruchisansakun.
Table 4.1. Comparison of morphological characters of *I. decurva*, *I. muscicola*, and *I. pendula*.

<table>
<thead>
<tr>
<th>Characters</th>
<th><em>I. decurva</em></th>
<th><em>I. pendula</em></th>
<th><em>I. muscicola</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves</td>
<td>congested at stem apex</td>
<td>scattered along the stem for most of its length</td>
<td>congested at stem apex</td>
</tr>
<tr>
<td>Dorsal petal</td>
<td>glabrous, but pilose along the midrib</td>
<td>glabrous</td>
<td>densely pilose</td>
</tr>
<tr>
<td>Lateral united petals</td>
<td>pink with white base</td>
<td>white with red base</td>
<td>white with red base</td>
</tr>
<tr>
<td>Apex of lower lateral united petals</td>
<td>unequally bilobed</td>
<td>round</td>
<td>round to unequally bilobed</td>
</tr>
<tr>
<td>Anther</td>
<td>pink</td>
<td>white</td>
<td>white</td>
</tr>
<tr>
<td>Pedicels at fruiting stage</td>
<td>strongly decurved at the middle in young stage</td>
<td>deflexed at the base, further portion straight</td>
<td>straight to slightly curved</td>
</tr>
</tbody>
</table>

**Phenology:**—Flowering from September to October; fruiting in October.

**Distribution:**—Endemic to Myanmar (Shan State).

**Ecology:**—Growing in limestone soils on a mountain summit in open, fragmented evergreen forest, 1500–1600 m elevation.

**Proposed IUCN conservation assessment:**—Critically Endangered B1ab (i, ii, iii) + 2ab (i, ii, iii). This species is only known from the type locality. The extent of occurrence is estimated as < 5 km, where it occurs as a small population (IUCN, 2012).

**Etymology:**—The specific epithet refers to the decurved pedicel at the early fruiting stage.

**Note:**—*Impatiens decurva* Ruchis. & S.B. Janssens is the only spurless species in Myanmar with solitary flowers and spirally arranged leaves. Although it morphologically resembles *I. pendula*, *I. decurva* possesses a distinct characters: the leaves clustered towards the stem apex, a pilose midrib on the dorsal petal, the apex of the lower lateral united petals unequally bilobed, and a pedicel that is strongly decurved from the middle in the early fruiting stage. *Impatiens decurva* resembles *I. muscicola* Craib (1926: 162) in morphology. *Impatiens muscicola* is a
species endemic to northern Thailand, and differs from \textit{I. decurva} in having lower lateral petals with an unequally bilobed apex and a pedicel that is strongly decurved in the middle during the fruiting stage.

**Phylogenetic analysis:**—Bayesian phylogenetic analyses of the combined ITS and \textit{atpB-rbcL} dataset confirm its position within subgen. \textit{Impatiens} sect. \textit{Uniflorae} Hook.f. & Thomson (1860: 113) (Yu \textit{et al.}, 2015) (Fig. 4.3). Despite the morphological similarity with \textit{I. muscicola} Craib, \textit{I. decurva} appears more closely related to the Myanmar species \textit{I. florulenta} Hook.f. (1905: 25 & 32), a long-spurred species distributed in the same area.

**Pollination ecology:**—We predict that \textit{I. decurva} relies on autonomous self-pollination. This prediction is based on the strong similarity in floral features, including flower size, between \textit{I. decurva} and \textit{I. muscicola}. For the latter species autonomous self-pollination was experimentally confirmed (Ruchisansakun \textit{et al.}, 2016).

![Fig. 4.3. Majority-rule consensus tree from Bayesian phylogenetic analyses of a combined dataset of nuclear ITS and plastid \textit{atp-BrbcL} DNA sequences. \textit{Impatiens decurva} and \textit{I. oblongata} are highlighted in bold font. Bayesian posterior probabilities are indicated at each node.](image)

2. \textit{Impatiens hartnolliae} Hook.f. ex Ruchis. & Suksathan, sp. nov. (Figs. 4.4, 4.5)

\textit{Impatiens hartnolliae} Hook.f. ex Ruchis. & Suksathan is most similar to \textit{I. allanii} Hook.f. (Ridley, 1914: 325) but can be distinguished by its possession of a large orbicular sepal and large upper lateral petals.

Terrestrial annual herb to 36 cm tall. Stem erect, ca 12 mm in diam., richly branched, glabrous. Leaves spirally arranged. Petiole 6–12 mm long, ca. 1 mm in diam., glabrous. Lamina 110–120 × 45–50 mm, ovate to elliptic, the apex acute to acuminate, base round to obtuse to cuneate, margin crenate to serrate, adaxial surface glabrous to sparsely pilose, abaxial surface glabrous with 2–3 pairs of long hairs along the margin near base; lateral veins 8–9 pairs. Inflorescence subterminal, erect, 6–7-flowered racemes. Peduncle 10–15 mm long, ca. 1 mm in diam., glabrous. Rachis 7–14 mm long, ca. 1 mm in diam. Flowers ca. 18 mm long, ca. 15 mm wide, ca. 23 mm deep. Pedicel 9–10 mm long, ca. 1 mm in diam., glabrous. Bracts 2.5–3.5 × 1.5–2 mm, ovate, apex acute to mucronate, base round, margin entire, glabrous, persistent. Lateral sepals 2, 6.2–6.6 × 7.5–8 mm, free, orbicular to broadly elliptic, apex round to mucronate, base round, glabrous. Lower sepal ca. 10 mm long, ca. 8 mm deep, navicular, apex acuminate to mucronate, glabrous, distal part gradually tapering into a straight or curved spur, 15–17 mm long. Dorsal petal ca. 6.5 × 8 mm, broadly obovate, the apex emarginate, base obtuse, truncate, glabrous, abaxial midvein simple or with a narrow crest. Lateral united petals ca. 15.5 mm long, free: upper petals 9–10 × 5–5.5 mm, obliquely broadly oblong, apex truncate and slightly emarginate, base cuneate; the lower petals 8.5–9 × 3.5–4 mm, free, oblong, apex truncate, without auricle. Stamens 5: filaments 4–5 mm long; anthers obtuse. Ovary ca. 3.5 mm long, ca. 1 mm in diam., glabrous. Fruits short fusiform, glabrous, 5-lobed. Seeds ellipsoid, ca. 1.6–2 mm long, pilose.

Phenology:—Flowering and fruiting in September.

Distribution:—Endemic to Myanmar (Rakhine state).

Ecology:—Growing in limestone soils.

Proposed IUCN conservation assessment:—Critically Endangered B1ab (i, ii, iii) + 2ab (i, ii, iii). This species is known from only one specimen from the type locality (IUCN, 2012).

Etymology:—The specific epithet is derived from the collector name, H.S. Hartnoll.

Notes:—Impatiens hartnolliae was written by J.D. Hooker on a single specimen sheet kept at Kew but was not validly published as according to Art. 30.1 (McNeill et al., 2012). To recognize Hooker’s work on Impatiens, we used the initial name provided by him to name this new species. The species can be easily distinguished from other species in having a racemose inflorescence, truncate lateral united petals, an emarginate dorsal petal, and a fusiform fruit.
Fig. 4.4. *Impatiens hartnolliae*. A. Habit; B. Immature flower; C. Immature fruit; D. Ovary; E. Stamen; F. Lateral sepals; G. Lower sepals; H. Dorsal petal; I. Lateral united petals. Drawn by Saroj Ruchisansakun.
Fig. 4.5. The type specimen of *Impatiens hartnolliae*
http://specimens.kew.org/herbarium/K001097654.
Pollination ecology:—We have not observed living plants of this species. However, based on the possession of a long, broad spur, we predict that this species is pollinated by both bees and butterflies (cf. Ruchisansakun et al., 2016).

Table 4.2. Comparison of morphological characters of I. hartnolliae and I. allanii.

<table>
<thead>
<tr>
<th>Characters</th>
<th>I. hartnolliae</th>
<th>I. allanii</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf arrangement</td>
<td>spiral</td>
<td>Opposite, decussate</td>
</tr>
<tr>
<td>Lateral sepals</td>
<td>orbicular</td>
<td>elliptic to ovate</td>
</tr>
<tr>
<td>Upper lateral united petals</td>
<td>9–10 × 5–5.5 mm, obliquely broadly oblong</td>
<td>1.5–6.5 × 1–4 mm, falcate to obliquely ovate</td>
</tr>
<tr>
<td>Lower lateral united petals</td>
<td>8.5–9 × 3.5–4 mm, oblong</td>
<td>24–32 × 14–20 mm, ovate to elliptic</td>
</tr>
</tbody>
</table>

3. Impatiens oblongata Ruchis. & Van der Niet, sp. nov. (Figs. 4.6, 4.7)

*Impatiens oblongata* Ruchis. & Van der Niet is most similar to *I. patula* Craib (1926: 164) but can be distinguished by a distinctly shorter spur, broadly oblong upper lateral united petals with a truncate to slightly emarginated apex, and the apex of the lower lateral united petals truncate to slightly bilobed.

Type:—MYANMAR. Shan State: Kalaw, 20°39’24”N, 96°34’96”E, 1569 m elevation, 27 Sep. 2015, S. Ruchisansakun & Makino BG Exped. 735 (holotype L2071128!, isotypes L2071129, L2071130, L2071131!, RAF!, RANG!).

Terrestrial annual herb 30–50 cm tall. Stem erect, 1–4 mm in diam., angular, simple, or moderately to richly branched, red, mostly glabrous except sparsely pilose towards apex. Leaves spirally arranged. Petiole 3–10 mm long, ca. 1 mm in diam., pale green to pink, pilose. Lamina 50–75 × 10–20 mm, lanceolate to narrowly ovate, apex acute, base cuneate to attenuate, margin serrate, adaxial green, abaxial pale green, pilose on both sides, with 3–5 long red hairs along the margin near base; lateral veins 6–7 pairs. Flowers solitary, axillary, erect, 19–20 × 16–18 mm, 14–17 mm deep, pink, with two small dark pink dots and two small yellow dots at center. Bracts ca. 2 mm × <1 mm, linear, apex acute, base cuneate, green with red apex, pilose, persistent. Pedicel 18–20 mm long, less 1 mm in diam., pink, pilose. Lateral sepals 2-4: upper pair ca. 2 × <1 mm, sometimes absent, linear to oblong, apex acute, base cuneate, pale green with red tip, pilose;
lower pair 1.5–2 mm × 1.5–2 mm, ovate, apex acuminate, base obtuse, pink, glabrous. Lower sepal 5–6 × 3–4 mm, 3–4 mm deep, navicular, apex acuminate and mucronate, pale pink with dark pink mark near base, pilose outside, distal part abruptly constricted into a straight or curved spur, 8–12 mm long, pink with dark pink tip. Dorsal petal 5–6 × 6–9 mm, broadly obovate, flat, apex truncate and stipitate, to 2 mm long, base truncate, pink with green stipitate tip, glabrous with pilose midrib and tip, abaxial midvein with an acute appendage, <1 mm tall, pink or green. Lateral united petals 12–14 mm long, free: upper petals 7–8 × 4–5 mm, broadly oblong, apex truncate to slightly emarginate, base cuneate, pink; lower petals 10–11 × 4–5 mm, free, elliptic to obovate, apex truncate to slightly bilobed, pink, each with a yellow dot and dark pink dot at base. Stamens 5: filaments ca. 2.5 mm long, pale pink; anthers pale pink. Ovary ca. 2 mm long, ca. 1 mm in diam., 5–carpellate, green, pilose. Fruits 15–20 mm long, 4–5 mm in diam., short fusiform, 5–lobed, green, pilose. Seeds 6–7, ca. 3 mm long, ovoid, brown.

Phenology:—Flowering from September to October; fruiting from September to October.

Distribution:—Endemic to northeastern Myanmar (Shan State), where it is known only from the type locality.

Ecology:—Growing in shady areas on a mountain summit in open fragmented evergreen forest, 1500–1600 m elevation.

Proposed IUCN conservation assessment:—Critically Endangered B1ab (i, ii, iii). This species is only known from a small population from a single locality. The extent of occurrence is estimated to be < 5 km (IUCN, 2012).

Etymology:—The specific epithet is derived from its broadly oblong upper lateral petals.

Note:—This species usually has four lateral sepals, rarely two, in contrast to other similar species which have only two sepals, e.g., I. patula, I. violiflora Hook.f. (Hooker, 1875: 457), I. curvipes Hook.f. (Hooker, 1905: 25 & 32), and I. florulenta.

Phylogenetic analysis:—The results suggest that this species is part of Impatiens subgen. Impatiens sect. Uniflorae (Yu et al., 2015) (Fig. 4.7) and closely related to the Burmese species I. florulenta and I. decurva rather than to the species it resembles most closely in morphological characters, i.e., I. patula from Thailand.

Pollination ecology:—We did not observe any animals visiting the flowers of the species. However, based on the possession of a long, broad spur, we predict that
Fig. 4.6. *Impatiens oblongata*. A. Habit; B. Front view of flower; C. Lateral view of flower; D, E. Fruit; F. Pedicel and Stamens; G. Upper lateral sepals; H. Lower lateral sepals; I. Lower sepal; J. Dorsal petal; K. Lateral united petals. Drawn by Saroj Ruchisansakun.
this species is pollinated by both bees and butterflies (cf. Ruchisansakun et al., 2016).

Fig. 4.7. *Impatiens oblongata*. A. Lateral view of flower; B. Front view of flower; C. Habit in situ. Photographs by Saroj Ruchisansakun.
Table 4.3. Comparison of morphological characters of *I. oblongata* and *I. patula*.

<table>
<thead>
<tr>
<th>Characters</th>
<th><em>I. oblongata</em></th>
<th><em>I. patula</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral sepals</td>
<td>(2) 4</td>
<td>2</td>
</tr>
<tr>
<td>Spur length</td>
<td>8–12 mm</td>
<td>20–30 mm</td>
</tr>
<tr>
<td>Upper lateral united petals</td>
<td>broadly oblong with truncate to</td>
<td>falcate with obtuse apex</td>
</tr>
<tr>
<td></td>
<td>slightly emarginate apex</td>
<td></td>
</tr>
<tr>
<td>Lower lateral united petals</td>
<td>truncate to slightly bilobed apex</td>
<td>distinctly asymmetric bilobed apex</td>
</tr>
</tbody>
</table>

ACKNOWLEDGEMENTS

This work was supported by Naturalis Biodiversity Center, the Alberta Mennega Foundation and the Treub-Maatschappij. We thank the curators and staff of the following herbaria: AAU, BK, BKF, BM, BR, C, E, K, L, MAND, P, QBG, RAF, and RANG. We thank Dr. Kazumi Fujikawa and the Makino Botanic Garden expedition team, the Ministry of Natural Resources and Environmental Conservation (MONREC) of the Republic of the Union of Myanmar, Dr. Thet Yu Nwe and Myanmar Floriculturist Association for their assistance during our field trip. Wim Baert and Arne Mertens are acknowledged for their help in the molecular laboratory of Botanic Garden Meise.