Two New Species of *Impatiens* (Balsaminaceae) from the Eastern Arc Mountains of Tanzania

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Abstract. We describe and illustrate the new species *Impatiens butu* Gavin-Sm. (Balsaminaceae) from the South Pare Mountains and *I. ndovu* Gavin-Sm. from the Nguru Mountains of Tanzania and compare them with morphologically similar and sympatric species of *Impatiens* L. Both localities are within the Eastern Arc Mountains of Kenya and Tanzania, a well-known center of plant species richness and high endemism.

Key words: Balsaminaceae, Eastern Arc Mountains, *Impatiens*, Nguru Mountains, South Pare Mountains, Tanzania.

Impatiens L. (Balsaminaceae) is one of the world's largest plant genera, containing at least 1200 species (Yuan et al., 2004; Janssens, 2009; Fischer et al., 2021). The family Balsaminaceae is characterized by zygomorphic flowers with a modified lower sepal that is typically tapered or constricted into a nectary-tipped spur. The unmodified lateral sepals are usually two, less typically four, and the five petals are differentiated into a single dorsal petal and four lateral petals. The five stamens are connate into a ring surrounding the stigma and fall off in a single piece before the stigma is receptive. *Impatiens* is further distinguished within the family by the explosive fusiform capsules. *Impatiens* species have great diversity in morphology and habit: extensive variation in floral form including lower sepals with poorly defined or no spurs, and species that are terrestrial herbs, epiphytes, or woody shrubs. The genus is mainly distributed in tropical and subtropical Asia, Africa, and Madagascar, with a few species in temperate North America and Eurasia.

About 130 *Impatiens* species occur in tropical Africa (Grey-Wilson, 1980, 1982; Fischer et al., 2021). At least 27 species (including the two species described here and one more yet to be described) are endemic to the Eastern Arc Mountains of Tanzania and Kenya (Burgess et al., 2007; Platts et al., 2011), and more undescribed species of this genus are expected to be found in this species-rich region.

1. Impatiens butu Gavin-Sm., sp. nov. TYPE: Tanzania. Kilimanjaro Region: Same District, Chome Forest Reserve, Gonja Ward, SW of Kanza Village in forest dominated by *Syzygium* and *Ocotea usambarensis* near Heghambu, 04°20′38″S 37°58′38″E, 1850 m, 26 Feb. 2001, *J. A. Mlangwa 1400* (holotype, MO!; isotypes, F!, K!, NHT!, WAG!).

Diagnosis. Haec species quoad staturam, foliorum formam marginesque ac magnitudinem relativam petalorum lateralium superiorum cum inferioribus *Impatienti pseudoviolae* Gilg simillima, sed ab ea foliis angustioribus, pedunculo breviore, bractea longiore, petalo superiore minore atque floribus semper albis (nec violaceo-rosaceis usque purpurascentibus) distinguitur; ab omnibus congeneris Africae continentalis sepalo inferiore calcari omnino carente differt.

Procumbent glabrous herb to 25 cm tall, rooting at nodes. Leaves spirally arranged, becoming congested toward stem apex; petiole 0.7–1.1 cm, without fimbriae or occasionally with 1 or 2 inconspicuous fimbriae near base; blade ovate, 1.5–2.5 × 1–1.2 cm, asymmetrically attenuate into petiole at base, acute and apiculate at apex; lateral veins 3 or 4 pairs; margin crenate, glandular-fimbriate. Inflorescence a 1-flowered reduced raceme (as implied by presence of bract); peduncle 1.2–1.6 cm; bract 5–7 mm, linear-lanceolate; pedicel 9–13 mm, slender. Lateral sepals 1 pair, ca. 6 mm, subulate; lower sepal 6–8 mm, navicular; spur absent; petals white; dorsal petal 7–8 × 6–7 mm, suborbicular with a narrow crest terminating in an acute point; lateral united petals entire, ca. 9 mm with the upper of each pair ca. 8 × 2.5–3 mm, oblong, the lower ca. 9 × 2.5 mm, elliptic; upper and lower petals about equal in size; ovary glabrous. Fruit ca. 12 × 2 mm, narrowly fusiform; seeds unknown. Figure 1.

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Figure 1. *Impatiens butu* Gavin-Sm. —A. Habit of flowering plant with immature fruit. —B. Dorsal petal, posterior view. —C. Lateral sepal. —D. Lower sepal, posterior view. —E. Lateral united petals, one pair. All based on *J. A. Mlangwa 1400* (F, K, MO, NHT, WAG). Drawn by N. Gavin-Smyth.

Distribution and habitat. This new species is known only from the type collection in the South Pare Mountains (Fig. 2), one of the 13 mountain blocs of the Eastern Arc Mountains of Kenya and Tanzania (Platts et al., 2011). The South Pare Mountains are home to 50 of the 552 vascular plant species known to be endemic to the Eastern Arc Mountains (Gereau, unpublished data), and are also home to significant numbers of globally threatened species of birds, amphibians, mammals, and reptiles (Gereau et al., 2016).

In 2001, the type locality was within Chome Forest Reserve, re-gazetted in 2016 as Chome Nature Forest Reserve (NFR) (Doggart et al., 2017). The Reserve covers an elevational range of 1250–2463 m. *Impatiens butu* was collected at 1850 m elevation in wet montane forest dominated by *Ocotea usambarensis* Engl. This vegetation type is characteristic of the middle to upper slopes of Chome NFR between ca. 1800 and 2300 m elevation, and is the habitat of a very high proportion of the 473 total taxa (species, subspecies, and varieties) of vascular plants known from the Reserve (Gereau, unpublished data). Three previously described vascular plant taxa are known to be strictly endemic to Chome NFR: *Chamaepentas hindsioides* var. *parensis* (Verdc.) Kårehed & B. Bremer (Rubiaceae), *Pimpinella silvicola* Hemp (Apiaceae), and *Streptocarpus parensis* B. L. Burtt (Gesneriaceae). However, these all inhabit moss-covered upper montane forest, elfin forest, and rocky open areas at higher elevations (2000–2460 m) than *I. butu*.

Provisional conservation status. *Impatiens butu* is known from a single collection site in a well-managed protected area, and nothing is known of its population size or trend. Thus, only IUCN Red List criterion B (IUCN, 2012) can be applied to assess its conservation status. The extent of occurrence (EOO) cannot be calculated from a single point, and using the required grid cell size of 2 × 2 km (IUCN Standards and Petitions Committee, 2022), the area of occupancy (AOO) is 4 km^2, falling below the threshold value for Critically Endangered under criterion B2. However, there are no known threats to the species in its single locality, and therefore no "location" can be defined, and the species fails to meet the conditions for any threatened category under criterion B. Furthermore, the effective and continued protection provided by the legal status of an NFR (the highest protection status afforded in Tanzania) pre-

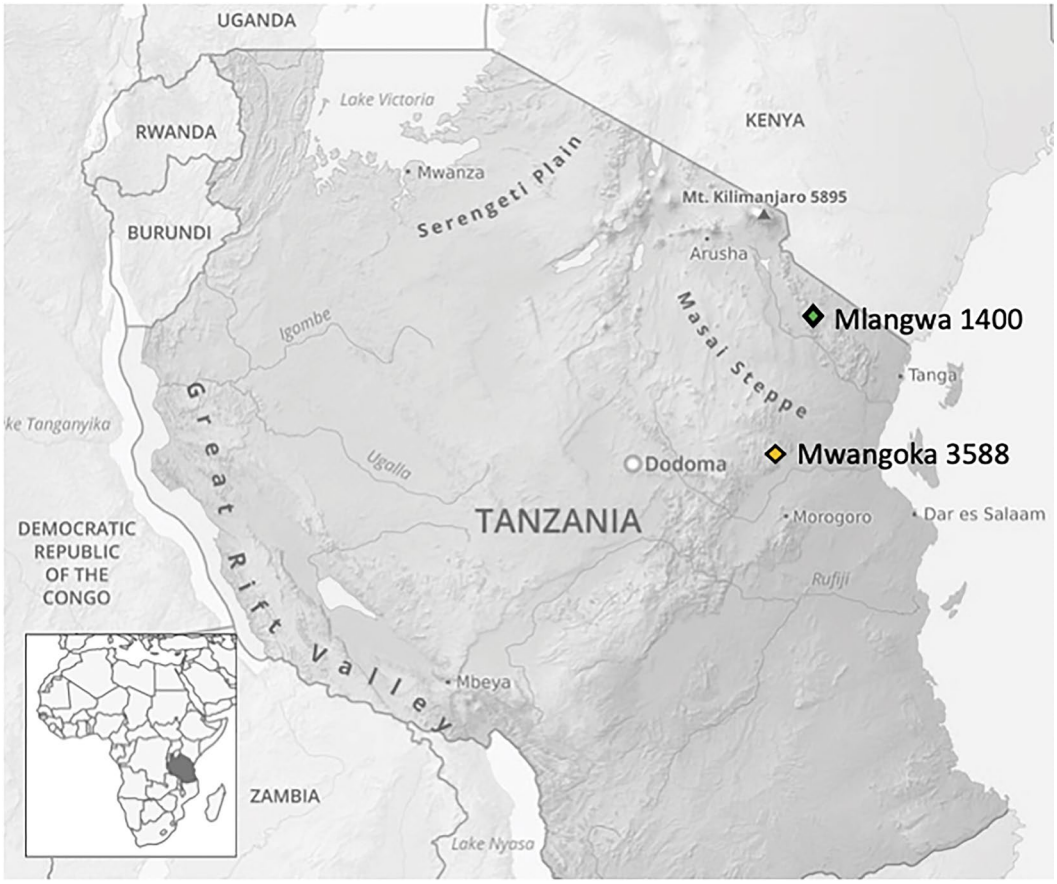

Figure 2. Map of Tanzania (https://www.freeworldmaps.net/africa/tanzania/tanzania-physical-map.jpg). Green diamond = type collection of *Impatiens butu* Gavin-Sm.; orange diamond = type collection of *I. ndovu* Gavin-Sm. © http://www.freeworldmaps.net/

cludes even a plausible threat that could justify an assessment of Vulnerable D2. Therefore, the Red List status of *I. butu* is provisionally assessed as Least Concern (LC), with the proviso that this status is entirely dependent on the continued, effective conservation of Chome NFR.

Etymology. *Impatiens butu* is named for the Swahili word "butu," meaning "blunt," which refers to the complete lack of a spur.

Notes. Other *Impatiens* species lacking the spur that is distinctive of the Balsaminaceae include *I. ecornuta* Gerry Moore, Zika & Rushworth of North America and the large *Impatiens* subg. *Trimorphopetalum* (Baker) Eb. Fisch., endemic to Madagascar and with well-supported monophyly (Rahelivololona et al., 2018); however, none of these spurless species show other strong similarities to *I. butu*. The evolution of this flower type has been linked to a loss in pollinator dependency, with associated characteristics such as decreased nectar production, flower display size, and pollen and ovule number (Abrahamczyk et al., 2021).

In Africa, *Impatiens joachimii* G. M. Schulze, *I. elachistocentra* G. M. Schulze ex Schlieben, *I. rosulata* Grey-Wilson, and *I. quadrisepala* R. Wilczek & G. M. Schulze have extremely reduced spurs; however, their lower sepals are bucciniform, whereas the lower sepal of *I. butu* is navicular. Otherwise, these taxa have few strong similarities.

Rather, *Impatiens butu* shows strongest similarity to *I. pseudoviola* Gilg (see Table 1), and some similarity to *I. humifusa* G. M. Schulze in relative size and shape of the upper and lower lateral petals. However, the flowers and leaves of *I. butu* are both smaller than those of *I. pseudoviola* and *I. humifusa*. *Impatiens butu* and *I. pseudoviola* have similar stature and leaf shape and margins. While the flowers of *I. pseudoviola* are

Table 1. Key morphological traits of *Impatiens pseudoviola* Gilg and *I. butu* Gavin-Sm.

	I. pseudoviola	*I. butu*
Leaf blade	1.2–5.3(–7) × 1.4–3.5(–4) cm	1.5–2.5 × 1–1.2 cm
Peduncle	1.8–2.2(–4) cm	1.2–1.6 cm
Bract	2–4 mm	5–7 mm
Flower color	violet, pink, purplish, rarely white; lower lateral petals with dark pink stripe	white
Lateral sepals	2.5–3.5 mm	6 mm, subulate
Dorsal petal	8–11 × 10–12 mm	7–8 × 6–7 mm
Upper lateral petal	8–11 × 4–7 mm	8 × 2.5–3 mm
Lower lateral petal	7–10 × 2.5–5 mm	9 × 2.5 mm
Spur	1.2–3.6 cm	without spur

typically violet-pink to purplish, rarely white morphs have been observed (e.g., *Agnew & Coe 8771*, MO; "flowers white or palest pink"). Although *I. butu* and *I. pseudoviola* are clearly morphologically similar in the characters noted above and sympatric at the type locality of *I. butu*, the complete lack of a spur in *I. butu* quickly distinguishes them as distinct species.

2. Impatiens ndovu Gavin-Sm., sp. nov. TYPE: Tanzania. Morogoro Region: Mvomero Distr., Nguru South Forest Reserve, grassland in permanent swamp area surrounded by *Osyris lanceolata*, *Rubus*, *Morella salicifolia*, and *Olinia rochetiana*, 06°03′58″S 37°29′52″E, 2006 m, 1 Nov. 2004, *M. A. Mwangoka 3588* (holotype, MO!; isotypes, F!, K!, NHT!, WAG!).

Diagnosis. Haec species quoad folia late ovata spiraliter disposita, sepala lateralia in pari unico ac ovarium glabrum *Impatienti gesneroideae* Gilg simillima, sed ab ea planta praeter bracteas sepalaque mox glabrescente, petiolo longiore, pedicello breviore, sepali inferioris calcari ad apicem 2- vel 3-lobo atque petalis lateralibus unitis brevioribus pari inferiore suborbiculari distinguitur.

Succulent herb ca. 150 cm tall. Leaves spirally arranged; petiole (2.2–)5–6 cm, pubescent when young, glabrescent with age; blade ovate, 4.5–7 × 2.5–4 cm, asymmetrically attenuate into petiole at base, acuminate and acute at apex; lateral veins 5 to 7 pairs with fine pubescence below on midrib and veins when young; margin crenulate-serrate with few basal fimbriae. Inflorescence a 2- to 4-flowered subumbellate raceme; peduncle 2–4 cm; bracts 4–5 mm, pubescent, narrowly lanceolate; pedicels 15–17 mm. Flowers red; lateral sepals 1 pair, ca. 4 mm, with sparse trichomes, ovate-lanceolate, attenuate; lower sepal 5–9 mm, narrowly bucciniform with few sparse trichomes around upper margin, tapering into a 1.7–2.2 cm spur, slightly incurved, ending in widened tip with 2 or 3 pouch-like lobes ca. 2 mm; dorsal petal ca. 5 × 7 mm, shallowly cucullate with a narrow and sparsely pubescent crest terminating in an acute point ca. 1 mm; lateral united petals entire, ca. 7.5 mm, not extending beyond upper margin of lower sepal, with upper petal of each pair 4.5–5.5 × 3–3.5 mm, lower ca. 3 × 3–3.5 mm; ovary glabrous. Fruit 8–10 × 1.5–3.5 mm, fusiform, glabrous. Figure 3.

Distribution and habitat. This new species is known only from the type collection from the Nguru Mountains (Fig. 2), one of the 13 mountain blocs of the Eastern Arc Mountains of Kenya and Tanzania (Platts et al., 2011). The Nguru Mountains are home to 131 of the 552 vascular plant species known to be endemic to the Eastern Arc Mountains (Gereau, unpublished data), and are also home to significant numbers of globally threatened species of amphibians, birds, insects, mammals, and reptiles (Gereau et al., 2016). In 2004, the type locality was within Nguru South Forest Reserve, which was combined with the former Mkindo Forest Reserve and re-gazetted in 2016 as Mkingu Nature Forest Reserve (Doggart et al., 2017). The Reserve covers an elevational range of 300–2400 m, with seven vegetation types, varying from lowland wet forest at 300–900 m in valleys of the eastern slopes to montane heath on the upper ridges above 2000 m. The type locality is at 2006 m elevation in grassland in a permanent swamp area, surrounded by the drier montane forest type of the western slopes above Maskati Mission. Of the 257 total taxa (species, subspecies, and varieties) of previously described vascular plants known from the Reserve (Gereau, unpublished data), eight taxa are known to be strictly endemic to the Reserve. *Impatiens nguruensis* Pócs (Balsaminaceae) has been collected quite near to the type locality of *I. ndovu* and at generally similar elevations (1900–2260 m), but in "mossy montane rainforest" and tall montane forest rather than in grassland or swamp. The seven other endemic taxa occur at elevations of 1400–2000 m in mostly forested habitats. Thus, the north-central and western parts of Mkingu NFR have already yielded a

Figure 3. *Impatiens ndovu* Gavin-Sm. —A. Habit of flowering plant with mature fruit. —B. Lower sepal and spur, lateral view. —C. Leaf margin. —D. Dorsal petal, lateral view. —E. Lateral united petals, one pair. —F. Lateral sepal. All based on *M. A. Mwangoka 3588* (F, K, MO, NHT, WAG). Drawn by N. Gavin-Smyth.

substantial number of narrowly endemic taxa, including *I. ndovu*. This would seem to warrant a good deal of further botanical inventory, especially given the relatively large size of the Reserve (264 km^2) and its only moderate level of past collecting.

Provisional conservation status. *Impatiens ndovu* is known from a single collection site in a well-managed protected area, and nothing is known of its population size or trend. Thus, only IUCN Red List criterion B (IUCN, 2012) can be applied to assess its conservation status. The EOO cannot be calculated from a single point, and using the required grid cell size of 2 × 2 km (IUCN Standards and Petitions Committee, 2022), the AOO is 4 km^2, falling below the threshold value for Critically Endangered under criterion B2. However, there are no known threats to the species in its single locality, and therefore no "location" can be defined, and the species fails to meet the conditions for any threatened category under criterion B. Furthermore, the effective and continued protection provided by the legal status of an NFR (the highest protection status afforded in Tanzania) precludes even a plausible threat that could justify an assessment of Vulnerable D2. Therefore, the Red List status of *I. ndovu* is provisionally assessed as Least Concern (LC), with the proviso that this status is entirely dependent on the continued, effective conservation of Mkingu NFR.

Etymology. *Impatiens ndovu* is named for a Swahili word meaning "elephant." *Ndovu* refers to its broad spur with sac-like lobes developing on either side of the tip, resembling an elephant's trunk.

Notes. Few other African *Impatiens* species have the unusual character of a bilobed spur: the spur tip of *I. digitata* Warb. divides into four to six lobes, that of *I. tricaudata* G. M. Schulze divides digitately into three lobes, while some specimens of *I. polhillii* Grey-Wilson can have widened or bulging spur tips. This interesting new species from the Nguru Mountains in Tanzania has two or three shallow saccate lobes, but otherwise shows few similarities to the other African species with digitately lobed spurs. Rather, the characters of spiral leaf arrangement and pedunculate inflorescences ally *I. ndovu* with *I. fischeri* Warb., *I. gesneroidea* Gilg, and *I. superglabra* (Grey-Wilson) Eb. Fisch., Abrah., Holstein & S. B. Janssens. However, *I. ndovu* has markedly shorter peduncles than the Kenyan endemic *I. fischeri*, and has lower lateral petals that do not extend beyond the upper margin of the lower sepal. Importantly, *I. ndovu* has only one pair of lateral sepals, while *I. fischeri* has two pairs, a trait that distinguishes the Tuberosae clade of *Impatiens* (Yu et al., 2016) from the rest of African *Impatiens*, indicating that these species are not likely to be close relatives. The lateral united petals of *I. ndovu* are similar to those of *I. gesneroidea* and *I. superglabra* in size and shape. However, in contrast to *I. ndovu*, *I. gesneroidea* is pubescent on most parts; in *I. superglabra* the ovary is pubescent and the pedicels, peduncle, and petioles are comparatively short. *Impaties ndovu* shows similarities to *I. ulugurensis* Warb. and *I. kilimanjari* Oliv. in that they occupy upland grasslands and have bucciniform red flowers with lateral united petals that do not extend far beyond the upper margin of the lower lateral sepal. However, these species have opposite or verticillate leaf arrangement in contrast to the spiral leaf arrangement of *I. ndovu.*

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