Plant Ecology and Evolution 151 (3): 442–448, 2018
https://doi.org/10.5091/plecevo.2018.1523

SHORT COMMUNICATION

Ixora kalehensis, a new Rubiaceae species from the Democratic Republic of the Congo

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Background – The rain forest genus *Ixora* currently comprises 37 species in Continental Africa. Within the framework of a treatment of the genus for the *Flore d'Afrique centrale*, a new species is described from D.R. Congo, despite its being known from only two specimens.
Methods – Standard methods of herbarium taxonomy are followed.
Key results – *Ixora kalehensis* De Block, a new species from the Central Forest District in D.R. Congo, is described and illustrated. *Ixora kalehensis* remains under-collected and relatively poorly known but can nevertheless easily be distinguished from other *Ixora* species. The most distinctive character is the colour of the dried leaves: blackish on the upper surface and vivid brown on the lower surface. Other important characters are the small-sized, compact and sessile inflorescences and the large tree habit. The species is only known from two specimens collected in the 1950s and its preliminary IUCN status is Endangered (EN B2ab(iii)). The lack of more recent herbarium material highlights that the collecting effort in D.R. Congo remains substandard. It is hoped that the formal description of *Ixora kalehensis* will draw attention of international and local collectors and will result in more material and greater knowledge of the species. The description of this species brings the number of *Ixora* species to thirteen for central Africa (D.R. Congo, Rwanda and Burundi) and to twelve for D.R. Congo. An identification key to the species of D.R. Congo is provided.

Key words – Central Forest District, D.R. Congo, *Ixora*, *Ixora kalehensis*, preliminary IUCN assessment.

INTRODUCTION

Ixora L. is the only genus in the tribe Ixoreae (supertribe Ixoridinae, subfamily Cinchonoideae, family Rubiaceae). Previously, this tribe also contained a number of small satellite genera, notably *Captaincookia* N.Hallé from New Caledonia, *Doricera* Verdc. and *Myonima* Comm. ex Juss. from the Mascarenes and *Versteegia* Valeton from New Guinea and the Solomon Islands. After phylogenetic studies by Mouly et al. (2009a) these small genera were placed into synonymy with *Ixora*.

Ixora is a large rain forest genus of shrubs and small trees and has a pantropical distribution. A majority of its c. 530 species (Davis et al. 2009) occur in Asia and Oceania, but *Ixora* is also represented in South and Central America and in Africa. More than 85 species of *Ixora* occur in Africa, c. half of those in Madagascar (De Block 2007, 2008, 2014a, 2014b), 37 in continental Africa (De Block 1998) and six species in the Mascarenes and the Seychelles (Mouly et al. 2009b). In continental Africa, *Ixora* is easily recognized by the following characters: petioles articulate; inflorescences terminal, with branching trichotomous, articulate and bracteolate; flowers narrowly tubular, 4-merous; aestivation contorted; stigma bilobed; ovary bilocular with a single ovule per locule; fruits drupaceous, containing two seeds; seeds hemispherical or hemi-ovoid with a large adaxial excavation (De Block 1998). The representatives from the Indian Ocean Islands usually have the same characters but a few species differ by lacking the articulate branching in the inflorescence (e.g. *I. pudica* Baker from Mauritius) or by being 3–7-locular with the stigma 3–7-lobed, and the seeds 3–7 per fruit and not hemispherical or hemi-ovoid in shape (e.g. *I. quadriloculari*s De Block from Madagascar and *I. borboniae* Mouly & B.Bremer, formerly known as *Myonima obovata* Lam., from Mauritius and Reunion) (Verdcourt 1983, De Block 2014a).

In the most recent revision of the genus in continental Africa, 37 *Ixora* species were recognized and two further taxa were mentioned as possibly new: *Ixora* sp. "Kalehe" from D.R. Congo and *Ixora* sp. "Waka" from Gabon (De Block 1998). *Ixora* sp. "Kalehe" was only known from one specimen collected by Troupin in 1957 west of Lake Kivu.

ISSN: 2032-3913 (print) – 2032-3921 (online)

In the framework of a flora treatment of *Ixora* for D.R. Congo, Rwanda and Burundi (*Flore d'Afrique centrale*, see Sosef 2016), the continental African material of *Ixora* at the BR herbarium was revisited, inter alia to check if new material was available for several under-collected species, including *I. hartiana* De Block (known from three specimens in D.R. Congo), *I. phellopus* K.Schum. (known from three specimens in D.R. Congo), *I. nana* Robbr. & Lejoly (known from two specimens in D.R. Congo), and *Ixora* sp. "Kalehe". While very few *Ixora* specimens were collected between 1998 and 2018, and no recent material was found for the under-collected species, a second historical collection (*Gutzwiller* 2506, collected in 1958) was located for *Ixora* sp. "Kalehe".

In this paper *Ixora kalehensis* is described as new to science. The species is illustrated and compared with closely related taxa. Furthermore, a key to the *Ixora* species of D.R. Congo is provided.

MATERIAL AND METHODS

Collections of the BR herbarium were studied, with specific attention to specimens collected between 1998 (date of the most recent revision of the genus) and 2018. Herbarium acronyms follow Thiers (continuously updated). Terminology follows Robbrecht (1988), but leaf shape is described according to the terminology of simple symmetrical plane shapes (Anonymous 1962). Standard methods of herbarium taxonomy are used (De Vogel 1987). Flowering and fruiting periods are based on dates given on the labels of herbarium material. Localities are cited as given by the collectors on the specimen labels. Coordinates of localities were determined using a botanical gazetteer of central Africa (Bamps 1982). The distribution map was adapted from De Block (1998). Preliminary conservation status was assessed by applying the IUCN Red List Category criteria (IUCN 2018).

RESULTS

Ixora kalehensis De Block, **sp. nov.**

Resembling *Ixora nana* by the shape and size of the leaves, the sessile, compact inflorescences with relatively few flowers and the corolla tube length; differing from this species by the colour of the dry leaves (blackish above and vivid brown below in *I. kalehensis* vs. greenish on both surfaces in *I. nana*), the texture of the leaf blades (subcoriaceous in *I. kalehensis* vs. papyraceous in *I. nana*), the length of the petiole and shape of the leaf base (petioles 0.4–1.2 cm long and their bases cuneate to attenuate and never crispate in *I. kalehensis* vs. leaves subsessile and long attenuate at the base with the basal margins often crispate in *I. nana*), the presence/absence of pubescence on the young shoots (glabrous in *I. kalehensis* vs. moderately to densely covered with short erect hairs in *I. nana*), the length of the first order axes and pedicels (up to 5 mm and 1.5 mm long, respectively, in *I. kalehensis* vs. first order axes not developed and flowers subsessile in *I. nana*) and the length of the corolla lobes (at least 6 mm long in *I. kalehensis* vs. 4.5–5 mm long in *I. nana*). – Type: D.R. Congo, Province Kivu, Territoire Kalehe, vers km 110 sur route Kavumu-Walikale, Irangi, réserve IRSAC, catena II à 120 m, 01°53′S 28°27′E, alt. 850–900 m, 8 Nov. 1957, fl., *Troupin* 4662 (holo-: BR; see electronic appendix 1).

Ixora sp. "Kalehe" (De Block 1998: 162).

Tree, up to 15 m tall (see remarks); young twigs glabrous, smooth, drying blackish brown; older branches glabrous, smooth, drying brown and somewhat glossy. Leaves with petioles 0.4–1.2 cm long, glabrous; blades elliptic, narrowly elliptic, obovate or narrowly obovate, 9.5–12 × 3–4.5 cm, subcoriaceous, glabrous on both surfaces, drying blackish above and vivid brown below; tip acuminate, with acumen 0.6–2.2 cm long; base cuneate to attenuate; midrib prominently raised below, dark brown; secondary nerves 9–12 on each side of midrib, dark brown or the same colour as the leaf blade and hardly raised below; higher order nerves inconspicuous on both surfaces; domatia absent; margins not revolute when dry. Stipules glabrous, drying blackish; sheaths triangular, 3–4 mm long, keeled; awns 2–4 mm long. Inflorescences sessile, compact, with 15–45 flowers, c. 1 × 1.5 cm (without corollas); axes, pedicels, bracts and bracteoles glabrous, drying reddish brown or blackish; first order axes up to 0.5 cm long; first order bracts with the stipular parts fused to an ovate blade (drying reddish-brown, 0.5–0.8 cm high) with a central awn (c. 3 mm long) and the foliar parts either absent or forming small leaves (up to 1 × 0.2 cm); higher order bracts with stipular parts absent, the foliar parts narrowly triangular and vaulted, up to 2 mm long. Ultimate flower triads with flowers subsessile or shortly pedicellate; pedicels up to 1.5 mm long; bracteoles present on most pedicels, opposite at the base of the ovary, triangular, narrowly triangular or filiform, c. 0.5 mm long, tips acute. Mature flowers unknown; calyx tube c. 0.3 mm long; glabrous outside, glabrous but with a ring of small colleters at the base of the lobes inside; calyx lobes 4(–5), triangular or ovate, c. 0.5 mm long, glabrous outside, basal half moderately covered with appressed hairs inside, tips acute, bases not overlapping; corolla tube at least 15 mm long, glabrous outside, basal half moderately to densely covered with erect hairs inside (except for the very base); lobes at least 6 × 2 mm, glabrous on both surfaces; stamens with filaments c. 1 mm long; anthers at least 4 mm long; ovary 0.8–1.2 mm long, glabrous outside; style glabrous, stigma lobes 1.5–2 mm long above a c. 1 mm long thickened zone. Fruits: unknown. Fig. 1.

Habitat – In humid forest, altitude 850–1000 m.

Distribution – Only known from the eastern part of the Central Forest District in D.R. Congo, close to the Great Lakes. Territoire Kalehe is located c. 50 km north of Bukavu in the province of South-Kivu (fig. 2).

Phenology – Flowers: November; young fruits: January.

Vernacular names – Katangondo (dial. Kitembo; *Troupin* 4662); Nsamba (dial. Kirega; *Gutzwiller* 2506).

Etymology – The species is named for the locality in which it occurs, notably Kalehe Territory.

Preliminary conservation assessment – Endangered (EN). The extent of occurrence (EOO) of *Ixora kalehensis* cannot be calculated because the species is only known from two specimens. Its area of occupancy (AOO) was estimated to be 8 km^2 using a grid cell width of 2 km, which falls under

the threshold of Critically Endangered status. Kalehe is located close to Lake Kivu and close to two National Parks, Kahuzi-Biega National Park and Virunga National Park, but no specimens of *Ixora kalehensis* are known from these protected areas. This densely populated region in eastern D.R. Congo is highly perturbed by political instability and the two National Parks are under severe threat of habitat destruction by local people, refugees and armed militias, under the form of land clearing, poaching, tree cutting and artisanal mining (UNESCO 2017a, 2017b). These difficult circumstances could explain the lack of recent herbarium specimens for *I. kalehensis*, but would also suggest that the species is threatened. The two known subpopulations of this species represent two different locations, which falls within the Endangered status, and, despite the lack of recent data, we can assess that the species is threatened by the destruction of its habitat. We therefore assign a preliminary conservation status of EN B2ab(iii).

Remarks – Only two specimens are known for this species. The first, *Troupin* 4662, is flowering and is described as a dominant tree up to 15 m tall. The second, *Gutzwiller* 2506, bears young fruits (as well as young buds) and is described as a suffrutex of 60 cm tall.

The length of the corolla tube in mature flowers is unknown. The flowers of *Troupin* 4662 seem close to maturity but the anthers have not yet released the pollen inside the bud. *Ixora* shows secondary pollen presentation (Puff et al. 1996): the flowers are proterandrous with the anthers opening and depositing the pollen on the outside of the stigmatic lobes (receptaculum pollinis) just before the flower opens.

In both specimens of this species the number of calyx lobes varies between four and five. Flowers with five calyx lobes are quite common.

Additional specimen examined – **D.R. Congo**: Central Forest District, Territoire Kalehe, Turole, Bunyakiri, 02°04′S 28°34′E, alt. 1000 m, 2 Jan. 1958, fr., *Gutzwiller* 2506 (BR).

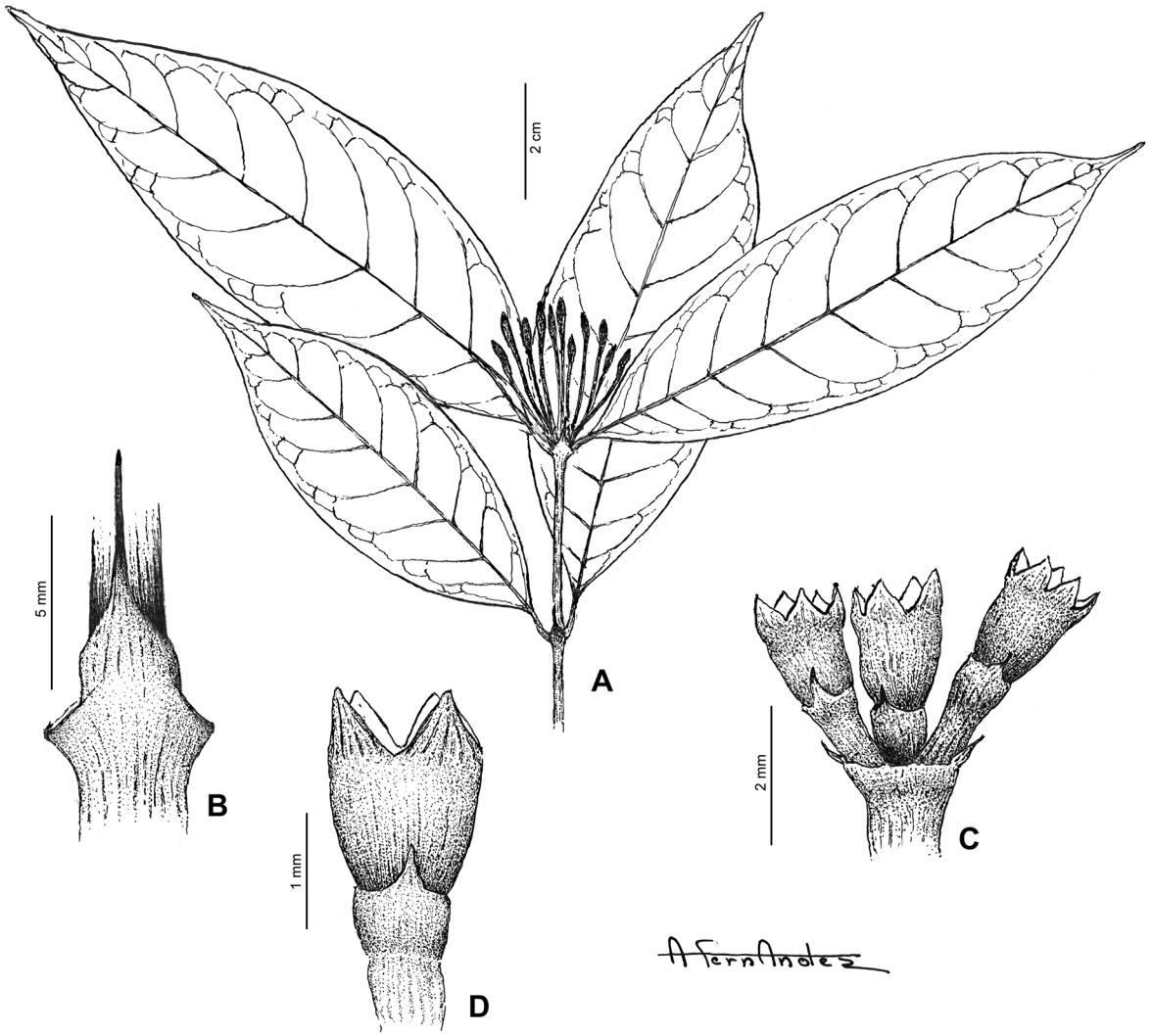

Figure 1 – *Ixora kalehensis*: A, flowering branch; B, stipule; C, triad (corollas removed); D, bracteole, ovary and calyx. From *Troupin* 4662 (BR). Drawn by A. Fernandez.

DISCUSSION

Ixora kalehensis is only known from two specimens collected in 1957 and 1958. No recent material of the species is available for study. This could be explained in part by the fact that the species is a large tree up to 15 m tall (according to the label on *Troupin* 4662), reducing the chances to observe flowering/fruiting and to collect it. However, the lack of recent specimens also highlights the fact that D.R. Congo remains severely under-collected (Hepper 1979, Campbell & Hammond 1989, Taplin & Lovett 2003, Küper et al. 2006, Stropp et al. 2016: figs. 3–5, Sosef et al. 2017: 8). The recent, large-scale collecting expedition ("Boyekoli Ebale Congo 2010") undertaken along the Congo River in 2010 by joint Belgian scientific institutions considerably increased collections for some organisms (e.g. De Haan 2014, Cocquyt & Taylor 2015), but was less fruitful for vascular plants. Collecting plant material in eastern D.R. Congo, where *Ixora kalehensis* occurs, is difficult owing to political instability and the presence of armed militia in the forests.

Despite the lack of recent observations/collections, the preliminary conservation status of *Ixora kalehensis* is assessed as Endangered, since it is probable that the species is under severe threat from anthropogenic actions. The two localities in which the species was collected, (km 110 on Kavumu-Walikale road and Bunyakiri) are close to the eastern part of Kahuzi-Biega National Park. This more mountainous region of the park is part of the Albertine Rift in the Great Rift Valley and runs parallel to Lake Kivu; in contrast, the much larger western region of the park is dominated by lowlands and lower mountain ranges (Doumenge 1990). It is possible that *I. kalehensis* occurs within the borders of Kahuzi-Biega National Park, at least in its mountainous eastern part. Another protected area, Virunga National Park, is situated north of Lake Kivu and also forms part of the Albertine Rift Valley. Although this park is located further away from the two collecting localities of *Ixora kalehensis*, the species may also occur there. Because of their outstanding natural richness, both parks are listed as UNESCO natural world heritage sites. However, the two parks are under severe threat and are now designated as UNESCO natural world heritage sites in danger (https://whc.unesco.org/en/danger/). They are located in a densely populated region (for Kahuzi-Biega this is true for the eastern highland sector), with most people depending on agriculture for their livelihood.

The forests in both parks are being cleared for wood production, charcoal production for neighbouring cities, as well as for agriculture and grazing of livestock (Aveling 2010). Anthropogenic pressure has increased strongly since the 1994 Rwandan Civil War when the parks were overrun by refugees and armed militias, resulting in large-scale destruction of primary habitat (UNESCO 2017a, 2017b). Furthermore, Kahuzi-Biega National Park is subject to traditional mining for gold, diamonds, coltan and tin whereas Virunga National Park is potentially threatened because of the presence of large natural oil and gas reserves (Aveling 2010). Logistical problems include understaffing and insufficient funding to guarantee efficient protection of the remaining natural vegetation. This creates dangerous working conditions for the staff of both parks: e.g. to date, 175 Virunga park rangers have been killed in the line of duty (Norton 2018).

Ixora kalehensis resembles *I. nana* (Robbrecht & Lejoly 1982, De Block 1998), another species from eastern D.R. Congo, by the shape and size of the leaves, the sessile, compact inflorescences with relatively few flowers and the relatively short corollas. Both species occur in the Central Forest District in humid rain forest. *Ixora nana* (electronic appendix 2) is only known from Maiko National Park north of the known localities of *I. kalehensis*. *Ixora nana* may occur at lower altitudes (500 m vs. 850–1000 m for *I. kalehensis*), but comprehensive data is lacking since both species are only known from two specimens. The two species can easily be distinguished in dried condition by the colour of the leaves: blackish above and vivid brown below in *I. kalehensis* vs. greenish on both surfaces in *I. nana*. Furthermore, *I. nana* is a monocaulous dwarf (one-stemmed) or dwarf shrub (few-stemmed) of 0.2–0.3 m tall, whereas *I. kalehensis* is a dominant tree up to 15 m tall, at least according to the label

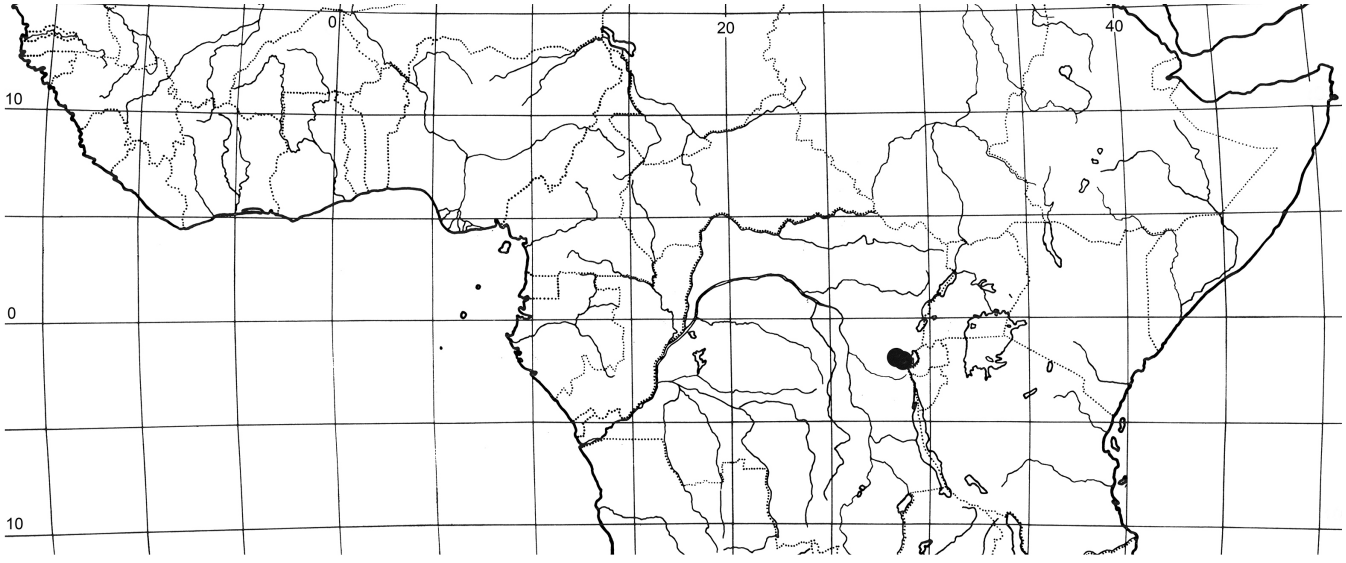

Figure 2 – Distribution map of *Ixora kalehensis* (adapted from De Block 1998).

Key to the species of *Ixora* of D.R. Congo

1. Inflorescences distinctly pedunculate, 0.8–26 cm long 2
1'. Inflorescences (sub)sessile 6

2. Inflorescences compact, often consisting of three compact clusters; peduncle and axes densely covered with short hairs; pedicels 0–3 mm long (rarely up to 5 mm long in case of reduction) 3
2'. Inflorescences lax; peduncle and axes usually glabrous; pedicels 0–18 mm long 4

3. Inflorescences erect; peduncles 1–10 cm long; corolla tubes (3.3–)4.9–7.2 cm long; ovary, calyx and corolla tube glabrous or densely covered with short hairs outside; corolla lobes glabrous inside ..... ***I. brachypoda***
3'. Inflorescences pendulous; peduncles (4–)10–26 cm long; corolla tubes (1.4–)1.8–2.5 cm long; ovary, calyx and corolla tube glabrous outside; corolla lobes with a few hairs near the throat inside ..... ***I. longipedunculata***

4. Inflorescences drooping or pendulous; peduncle 11.5–21.5 cm long; corolla lobes 12–15 mm long; filaments 4–10 mm long; anthers 8–10 mm long ..... ***I. aneimenodesma*** subsp. ***kizuensis***
4'. Inflorescences erect; peduncle 0.8–5(–6.5) cm long; corolla lobes up to 10 mm long; filaments 1–2.5 mm long; anthers 3.5–6.5 mm long 5

5. Leaf blades 12–26.5 × 4.5–8 cm, usually densely pubescent below; inflorescences 8–12 × 13–17 cm (without corollas) ..... ***I. phellopus***
5'. Leaf blades 6–12.5 × 2.5–4.5 cm, glabrous below; inflorescences 4.5–7.5 × 6–12.5 cm (without corollas) ..... ***I. hartiana***

6. Inflorescences without corollas up to 1.5 × 1.5 cm 7
6'. Inflorescences without corollas at least 2 × 2 cm, but usually much larger 8

7. Dwarf shrub, one- or rarely few-stemmed, 0.2–0.3 m tall; young twigs pubescent; leaves narrowly obovate, subsessile, drying greenish, base long attenuate, basal margins often crispate; flowers subsessile ..... ***I. nana***
7'. Large tree (see remarks); young twigs glabrous; leaves elliptic, narrowly elliptic, obovate or narrowly obovate, shortly petiolate (petiole 0.4–1.2 cm long), drying blackish above and vivid brown below, base cuneate to attenuate, basal margins not crispate; flowers with pedicels up to 1.5 mm long ..... ***I. kalehensis***

8. Leaf blades narrowly elliptic, 0.5–1.7 cm wide; small shrub, ± 1 m tall, branching fastigiate ..... ***I. fastigiata***
8'. Leaf blades any shape, at least 2.5 cm wide; shrub or tree, branching not fastigiate 9

9. Inflorescence axes and pedicels glabrous 10
9'. Inflorescence axes and pedicels pubescent (sometimes only sparsely) at least in the upper part of the inflorescence 12

10. Leaf blades drying pale greyish or fawnish green; ovaries and calyces drying fawnish; calyx lobes truncate with central acumen; pedicel of the central flower in a triad usually distinctly shorter than the pedicels of the lateral flowers; dyads often present ..... ***I. mildbraedii***
10'. Leaf blades usually drying (dark) brown; ovaries and calyces drying brown; calyx lobes widely triangular to ovate with rounded to acute tips; pedicel of the central flower in a triad not distinctly shorter than the pedicels of the lateral flowers; dyads absent 11

11. Leaves drying bronze brown above; pedicels (0–)2–10 mm long; bracteoles filiform ..... ***I. praetermissa***
11'. Leaves drying dark brown above; pedicels 0–2 mm long; bracteoles broadly ovate at the base with long filiform tips ..... ***I. laurentii*** (atypical glabrous variant)

12. Leaves drying pale greyish of fawnish green; pedicels of the lateral flowers in a triad 6–10 mm long, pedicel of the central flower usually distinctly shorter; dyads often present; anthers 6–8 mm long ....***I. mildbraedii*** (atypical pubescent variant)

12'. Leaves drying (dark) brown; pedicels of the lateral flowers in a triad 0–4 mm long, that of the central flower not markedly shorter; dyads absent; anthers 3–6 mm long 13

13. Leaf blades drying dark to blackish brown above, paler brown underneath; stipular sheaths 1.5–2.5 mm long; bracteoles broadly ovate at the base with long filiform tips; calyces turbinate, lobes broadly ovate with rounded to obtuse tips, their bases not overlapping; style glabrous; pedicels 0–2(–5) mm long .....***I. laurentii***

13'. Leaf blades drying brownish; stipular sheaths 3–7 mm long; bracteoles narrowly triangular to filiform; calyces tubular, lobes truncate with central acumen or irregularly truncate, their bases often overlapping; style pubescent especially in its lower half; pedicels 0–4(–6) mm long .....***I. seretii***

information on *Troupin* 4662. As mentioned above, the habit data on the label of *Gutzwiller* 2506 reads "suffrutex, 60 cm tall". Further differences between the two species are given in the diagnosis above.

With the description of *Ixora kalehensis*, the number of *Ixora* species in D.R. Congo increases to twelve. *Ixora brachypoda* DC. is widespread in tropical Africa and widely collected from D.R. Congo. *Ixora longipedunculata* De Wild., *I. nana* and *I. seretii* De Wild. are endemic to D.R. Congo, their distribution centered in the Central Forest District. *Ixora laurentii* De Wild. and *I. mildbraedii* K.Krause are mostly known from D.R. Congo with a few specimens collected from surrounding countries such as the Central African Republic, Republic of the Congo or Uganda. The other *Ixora* species occurring in D.R. Congo are *I. aneimenodesma* K.Schum. subsp. *kizuensis* De Block, *I. fastigiata* (R.D.Good) Bremek., *I. hartiana*, *I. phellopus* and *I. praetermissa* De Block. All are known from very few specimens from D.R. Congo. Except for *I. praetermissa*, which is common in Gabon, these species have only rarely been collected (even outside the *Flore d'Afrique centrale* area), which results in taxonomic uncertainty. In Rwanda and Burundi, a single *Ixora* species occurs: *I. burundiensis* Bridson, an Afromontane species occurring in the region of the Great Lakes. Besides these native species, two Asian *Ixora* species, *I. coccinea* L. and *I. chinensis* Lam., are cultivated in central Africa.

SUPPLEMENTARY DATA

Supplementary data are available in pdf at *Plant Ecology and Evolution*, Supplementary Data Site (https://www.ingentaconnect.com/content/botbel/plecevo/supp-data) and consist of the following: (1) scanned holotype of *Ixora kalehensis* (BR); and (2) scanned holotype of *Ixora nana* (BR).

ACKNOWLEDGMENTS

Antonio Fernandez (BR) is acknowledged for making the line drawing of *Ixora kalehensis*. Nuno Veríssimo Pereira (BR) is thanked for extracting *Ixora* information from BG-Base. I thank two anonymous reviewers, as well as Natacha Beau and Elmar Robbrecht, for their helpful remarks on a previous version of this paper.

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Manuscript received 21 Jun. 2018; accepted in revised version 8 Oct. 2018.

Communicating Editor: Elmar Robbrecht.