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TWO NEW SPECIES OF *BEGONIA* (*BEGONIACEAE*) FROM CENTRAL SULAWESI, INDONESIA

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Two new species of *Begonia* (*Begoniaceae*), *Begonia ozotothrix* and *Begonia hekensis*, are described from the Indonesian island of Sulawesi. Both species belong to *Begonia* section *Petermannia*. *Begonia ozotothrix* is unusual amongst Asian *Begonia* in having branched trichomes on the stems, petioles and the abaxial lamina surfaces, and it is unusual amongst species of *Begonia* section *Petermannia* in having extremely compressed cymose-subumbellate male partial inflorescences.

Keywords. *Begonia* section *Petermannia*, inflorescence, new species, Sulawesi, trichome.

Introduction

Thirty-two indigenous species of *Begonia* L. have been reported from the Indonesian island of Sulawesi (Table 1; Hughes, 2008; Thomas & Hughes, 2008). A revision of two difficult species complexes containing some widespread taxa, the *Begonia longifolia* Blume complex and the *Begonia rieckei* Warb. complex (Table 1), may result in a reduction of the number of currently accepted names in the Sulawesi *Begonia* flora through synonymy, reduction to infraspecific rank and correction of misidentifications (see discussions on synonymy and species boundaries in these two complexes in Tebbitt, 1997, 2003; Tebbitt & Dickson, 2000; Hughes, 2008). However, most species from Sulawesi are local endemics and morphologically very distinct, and a close examination of all available *Begonia* specimens from Sulawesi from A, B, BM, BO, CEB, E, K, L and SING indicates that there are numerous endemic species awaiting description. The majority of *Begonia* species from Sulawesi are classified in *Begonia* section *Petermannia* (Klotzsch) A.DC. (Doorenbos *et al.*, 1998; Hughes, 2008) (28 species, including the four closely related or conspecific taxa in the *B. rieckei* complex). Four species have been classified in *Begonia* section *Sphenanthera* (Hassk.) Warb. (including the three closely related or conspecific taxa in the *B. longifolia*

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TABLE 1. Indigenous *Begonia* species of Sulawesi

Section	Species/species complex
Petermannia	*Begonia bonthainensis* Hemsl.
	Begonia capituliformis Irmsch.
	Begonia carnosa (Teijsm. & Binn.) Teijsm. & Binn.
	Begonia celebica Irmsch.
	Begonia chiasmogyna M.Hughes
	Begonia cuneatifolia Irmsch.
	Begonia flacca Irmsch.
	Begonia gemella Warb. ex L.B.Sm. & Wassh.
	Begonia grandipetala Irmsch.
	Begonia hekensis D.C.Thomas
	Begonia heteroclinis Miq. ex Koord.
	Begonia hispidissima Zipp. ex Koord.
	Begonia humilicaulis Irmsch.
	Begonia imperfecta Irmsch.
	Begonia insularum Irmsch.
	Begonia macintyreana M.Hughes
	Begonia masarangensis Irmsch.
	Begonia mendumiae M.Hughes
	Begonia ozotothrix D.C.Thomas
	Begonia rachmatii Tebbitt
	'*Begonia rieckei* Warb. complex'
	Begonia koordersii Warb. ex L.B.Sm. & Wassh.
	Begonia pseudolateralis Warb.
	Begonia rieckei Warb.
	Begonia strictipetiolaris Irmsch.
	Begonia sarasinorum Irmsch.
	Begonia siccacaudata J.Door.
	Begonia sphenocarpa Irmsch.
	Begonia stevei M.Hughes
	Begonia strachwitzii Warb. ex Irmsch.
	Begonia varipeltata D.C.Thomas
Sphenanthera	'*Begonia longifolia* Blume complex'
	Begonia aptera Blume
	Begonia longifolia Blume
	Begonia renifolia Irmsch.
	Begonia robusta Blume

complex, and *B. robusta* Blume), which was shown to be paraphyletic with respect to *Begonia* section *Platycentrum* (Klotzsch) A.DC. (Tebbitt *et al.*, 2006).

All recent expeditions to Sulawesi organised by the Royal Botanic Garden Edinburgh (RBGE) have brought to light some new species of *Begonia* (Hughes, 2006; Thomas & Hughes, 2008). This is not surprising given that, firstly, the mega-diverse genus *Begonia* has a centre of diversity in Southeast Asia; secondly, fewer botanical collections have been made on Sulawesi than on any other major island in Indonesia, and from several large regions of Sulawesi only a very small number of

specimens has been collected (Kessler *et al.*, 2002; Cannon *et al.*, 2007); and thirdly, Sulawesi *Begonia* have never been revised. Two further species collected on a joint expedition of the RBGE and Bogor Botanic Garden are described below. They are classified in *Begonia* section *Petermannia* as they exhibit typical characters of the section: protogynous, two-flowered female inflorescences, three-locular ovaries with axile placentation and bilamellate placentae, fruits with equal or subequal wings, and anthers with unilaterally positioned slits (Figs 1, 2). All available *Begonia* specimens from A, B, BM, BO, CEB, E, K, L and SING have been consulted, and hence it must be assumed, at least until more intensive collecting on Sulawesi may reveal otherwise, that these two species have restricted ranges and are endemic to Central Sulawesi (Sulawesi Tengah) (Fig. 3).

Species Descriptions

Begonia ozotothrix D.C.Thomas, **sp. nov.** Sect. *Petermannia*. **Figs 1**, **3–5.**

Ab aliis speciebus sectionis *Petermanniae* in caule, petiolis et in laminae facie abaxiali pilos ramosos habenti differt. – Type: Indonesia, Sulawesi, Sulawesi Tengah, Tojo Una-una District, close to Watusongo Village, Gunung Katopas, on wet rock wall at riverbank, 01°10′17.9″S, 121°28′40.5″E, 615 m, 7 v 2008, *D.C. Thomas & W.H. Ardi* 08-67 (holo E; iso BO, CEB).

Perennial, monoecious, erect herb, to 75 cm tall, hairy with microscopic, c.0.05–0.2 mm long, simple trichomes on all vegetative parts and heterotrichous on the stems, petioles and the veins of the abaxial lamina surface by the addition of a few interspersed multicellular, multiseriate, branched trichomes, c.0.3–1.8 mm long. *Stems* branched; internodes 2.9–7.9 cm long, hairy. *Leaves* alternate; stipules 20–32 × 6–20 mm, very asymmetric, oblong to narrowly elliptic, cymbiform with abaxially prominent midrib forming a thin, short appendage at the apex, persistent, abaxially densely hairy; petioles 4.1–18.6 cm long, hairy; lamina basifixed, 14.5–24.8 × 7.2–15.3 cm, very asymmetric, elliptic, base cordate with non- or only very slightly overlapping lobes, apex acuminate, margin dentate, the teeth bristle-pointed, adaxial and abaxial surface hairy, adaxial surface mid green and abaxial surface pale green, or adaxial surface dark green and abaxial surface reddish, venation palmate-pinnate. *Inflorescences* protogynous; *female inflorescences* basal to male inflorescences or solitary, 2-flowered, subtending leaves foliose, peduncles 1–5 mm long, bracts (subtending the pedicels of the female flowers) 8–11 × 6–7 mm, ovate to elliptic, abaxially hairy; *male inflorescences* distal to one female inflorescence, composed of 1–5 strongly compressed, cymose-subumbellate partial inflorescences, subtending leaves bracteose, c.8–11 × 7–9 mm, elliptic, abaxially hairy, peduncles 2–25 mm, hairy, bracts of only the most basal dichotomous branching developed, 3–10 × 2–6 mm, elliptic, abaxially hairy, caducous, each partial inflorescence branching once dichotomously at the base, then 1–2 times dichasially and the lateral branches of the most distal dichasia branching (0–)1–4 times monochasially. *Male flowers*: pedicels 2–15 mm, hairy; tepals 2, white or pink,

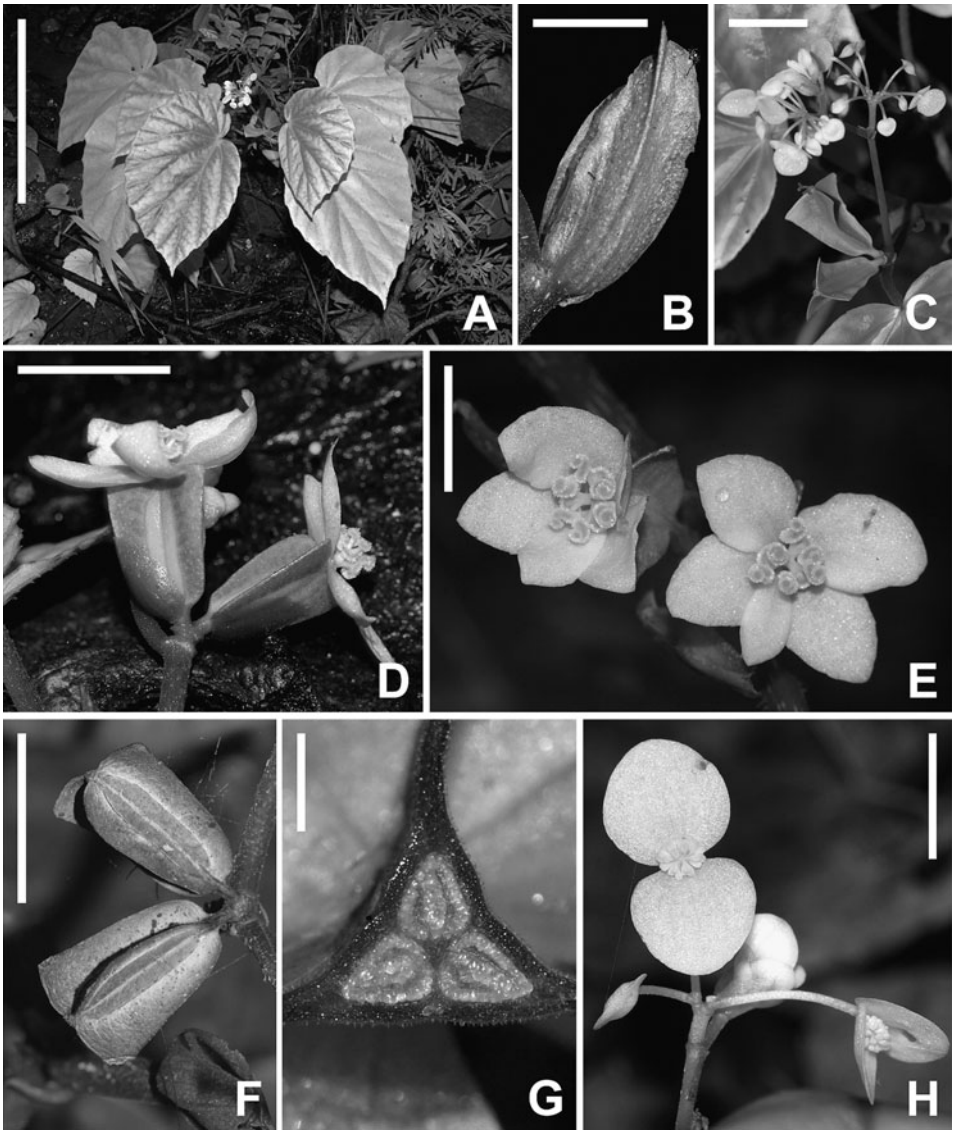

FIG. 1. *Begonia ozotothrix* D.C.Thomas. A, habit (scale bar = 20 cm); B, stipule (scale bar = 12 mm); C, inflorescence (scale bar = 2 cm); D, female inflorescence (scale bar = 2 cm); E, female flowers (scale bar = 12 mm); F, capsules (scale bar = 2 cm); G, ovary, cross-section, three-locular with axillary, bilamellate placentae (scale bar = 2 mm); H, male flowers (scale bar = 10 mm). A, B, C, F, H: *D.C. Thomas & W.H. Ardi* 08-58; D, E, G: *D.C. Thomas & W.H. Ardi* 08-53.

8–11 × 9–12 mm, broadly ovate, base slightly cordate or with convex margins, apex rounded, abaxially sparsely hairy to glabrescent; androecium of c.25–35 stamens, yellow, filaments c.0.4–1.6 mm long, slightly fused at the very base, unequal, longer in the middle of the androecium, anthers c.0.8–1.4 mm long, obovate, dehiscing through

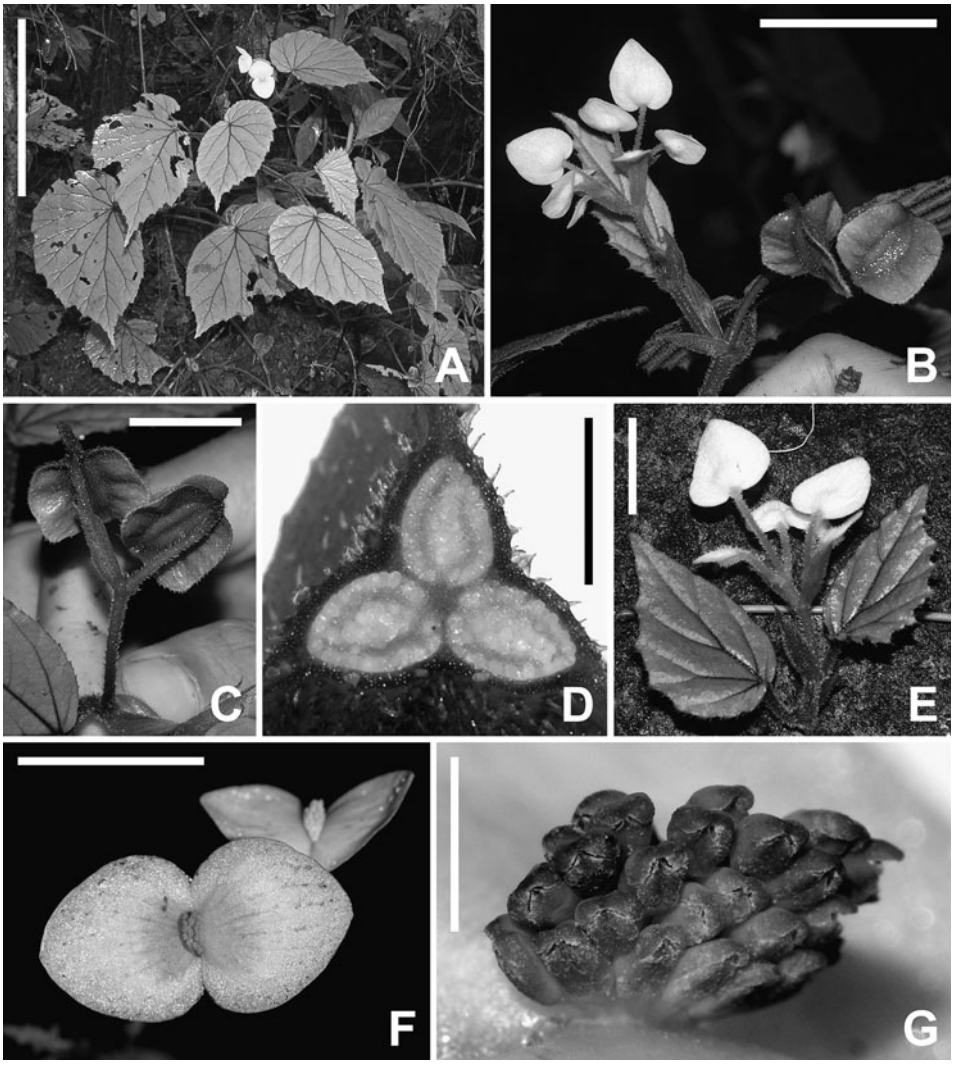

FIG. 2. *Begonia hekensis* D.C.Thomas. A, habit (scale bar = 7 cm); B, male inflorescence and infructescence (scale bar = 3 cm); C, infructescence (scale bar = 1.5 cm); D, ovary, cross-section, three-locular with axillary, bilamellate placentae (scale bar = 3 mm); E, male inflorescence with subtending leaves (scale bar = 1.5 cm); F, male flowers (scale bar = 2 cm); G, androecium, anther dehiscing through short, unilaterally positioned slits (scale bar = 4 mm). A–G: *D.C. Thomas & W.H. Ardi* 08-43.

unilaterally positioned slits c.1/2 as long as the anther, connective not projecting. *Female flowers*: pedicels 1–4 mm, hairy; tepals 5, unequal to subequal, the four larger ones ovate or elliptic, 9–14 × 7–9 mm, the innermost obovate or narrowly elliptic, 8–11 × 3–8 mm, white or pale pink, abaxially hairy; ovary 12–21 × 10–18 mm, locules 3, placentation axile, placentae bilamellate, wings 3, narrowly triangular, rounded at the

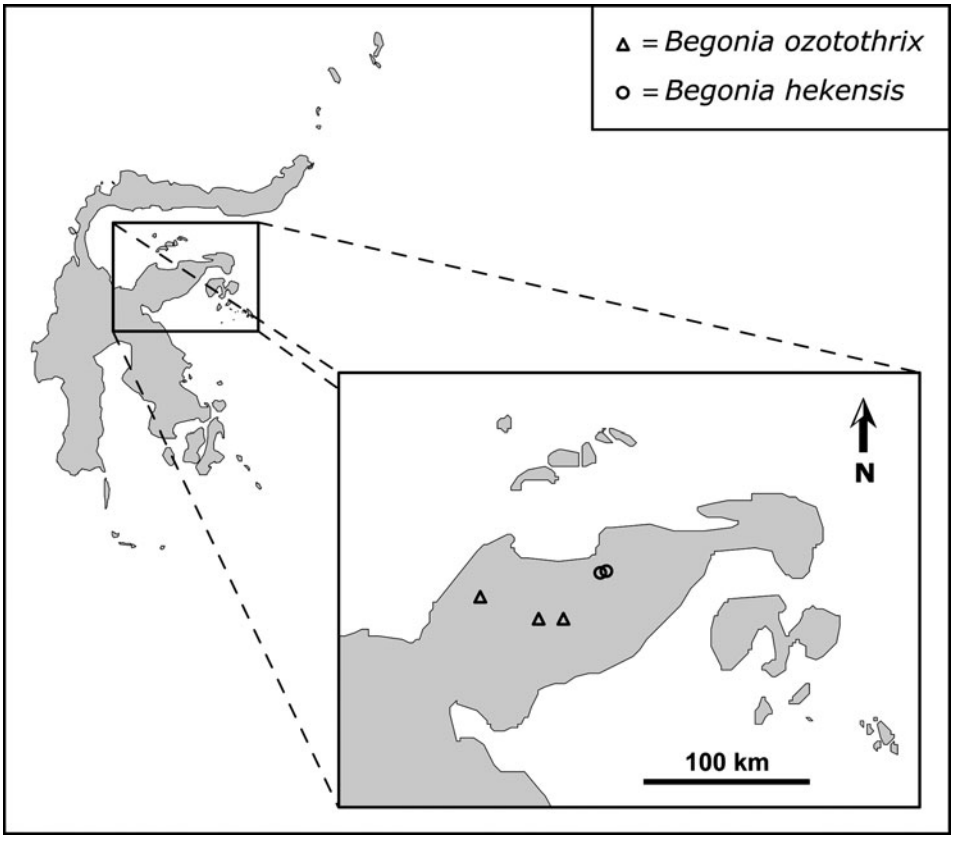

FIG. 3. Distribution of *Begonia ozotothrix* and *Begonia hekensis* in eastern Central Sulawesi (Tengah), Indonesia.

base, widest at the apex, hairy, style fused only in the most basal part, 3-branched, each stylodium bifurcate in the stigmatic region, stigmatic surface a spirally twisted papillose band, the style and stylodia pale yellow, the stigma bands orange. *Fruits*: capsules cylindric, 19–22 × 4–6 mm (without wings), on stout, erect, 1–4 mm long, hairy pedicels, dehiscent, splitting along the wing attachment, drying pale brown, hairy to glabrescent, wing shape as for ovary, wings 5–10 mm wide at the widest point (at the apex), hairy to glabrescent. *Seeds* ellipsoidal, c.0.3 mm long, collar cells c.1/2–3/4 of the length of the seed.

Distribution. Indonesia, Sulawesi, Central Sulawesi (Sulawesi Tengah), Gunung Katopas, and the lowland rainforest area between the villages of Bulan Jaya and Uwetangko, and the upland rainforest north of Uwetangko (Fig. 3).

Habitat. This species grows in the herb layer or on wet rock walls in lowland and upland primary rainforest, often at the sides of rivers or small streams, between c.300 and 800 m.

Proposed IUCN conservation category. LC. This species is locally common and more than 20 populations were observed along a c.40 km walking trail between the villages of Bulan Jaya and Uwetangko, and the upland rainforest north of Uwetangko. Additionally, several populations were observed on Gunung Katopas. While the lowland rainforest area of this species is fragmented by plantations (cacao and others), most of the upland populations were found in areas which are very difficult to access and show no or only slight signs of anthropogenic disturbance by rattan collecting.

Additional specimens examined. SULAWESI. **Tengah**: Tojo Una-una District, close to Bulan Jaya village, side of track through primary lowland rainforest, at forest margin close to river, 01°17′32.4″S, 121°57′11.6″E, 369 m, 21 iv 2008, *D.C. Thomas & W.H. Ardi* 08-52 (BO, CEB, E); close to Bulan Jaya village, disturbed lowland rainforest, margin of *Theobroma* plantation, 01°17′30.7″S, 121°57′02.6″E, 370 m, 21 iv 2008, *D.C. Thomas & W.H. Ardi* 08-53 (BO, CEB, E); between the villages of Bulan Jaya and Linkasa, on wet rock wall next to small stream, 01°17′24.4″S, 121°56′10.3″E, 364 m, 21 iv 2008, *D.C. Thomas & W.H. Ardi* 08-56 (BO, CEB, E); close to Uwetangko village, primary lowland rainforest, next to small waterfall, 01°17′09.6″S, 121°48′67.0″E, 322 m, 22 iv 2008, *D.C. Thomas & W.H. Ardi* 08-58 (BO, CEB, E); Watusongo Village, Gunung Katopas, on wet rock, primary rainforest margin at river side, 01°10′29.3″S, 121°28′36.3″E, 750 m, 11 v 2008, *D.C. Thomas & W.H. Ardi* 08-72 (BO, CEB, E); Watusongo Village, Gunung Katopas, on vertical, wet rock at the side of a small stream, primary rainforest, 01°10′14.9″S, 121°28′49.3″E, 625 m, 11 v 2008, *D.C. Thomas & W.H. Ardi* 08-74 (BO, CEB, E).

The epithet '*ozotothrix*' (from Greek *ozotos* – branched, and *thrix* – hair) refers to the very unusual branched, multicellular, multiseriate trichomes found on the stem, the petioles and the abaxial lamina surfaces of *Begonia ozotothrix* (Fig. 4). Begonias with branched trichomes are rare outside of Africa and have not previously been reported for *Begonia* section *Petermannia*. Stellate hairs have been described in only two Asian sections, *Begonia* section *Parvibegonia* A.DC. (*B. sinuata* Wall. ex Meisn.) and *Begonia* section *Diploclinium* (Lindl.) A.DC. (*B. cladotricha* M.Hughes). *Begonia picta* Sm. (*Begonia* section *Diploclinium*) has branched, flattened scale-like hairs on the capsules. *Begonia calcicola* Merr. and *B. oxysperma* A.DC. (both in *Begonia* section *Diploclinium*, although the latter is usually classified in the monotypic *Begonia* section *Baryandra* A.DC.) have hairs with a broad and flat stalk divided at the apex into few to several thinner branches on the vegetative parts (Doorenbos *et al.*, 1998; Hughes, 2007). The morphology of the male inflorescences of *Begonia ozotothrix* is noteworthy as they exhibit a strong reduction syndrome. The male inflorescence morphology predominantly found in *Begonia* section *Petermannia* is characterised by cymose-dichasial branching with only very few or no monochasial branchings in the most distal part, clearly developed axes, and small bracts usually subtending the lateral branches in the cymose inflorescence (Irmscher, 1914; Doorenbos *et al.*, 1998). However, Irmscher (1914) has already indicated that there are several variations of this typical syndrome in the huge section *Petermannia*. In *Begonia ozotothrix* the axes are strongly compressed resulting in a subumbellate appearance of the cymose inflorescences, only the bracts subtending the peduncles and the bracts subtending the lateral branches of the basal dichotomous branchings of the male partial inflorescences are developed, and

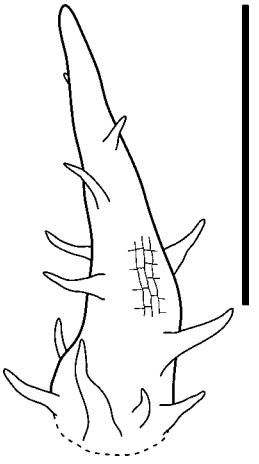

FIG. 4. Branched, multicellular trichome from the petiole of *Begonia ozotothrix* (scale bar = 500 μm) (*D.C. Thomas & W.H. Ardi* 08-58).

there are only one or sometimes two basal dichasial branchings and up to four distal monochasial branchings (Figs 1C, 5). Similar compressed subumbellate syndromes have been described for the Sulawesi endemics *Begonia siccacaudata* J.Door., which shows male partial inflorescences with only one basal dichasial branching and the end flower flanked by two monochasia (Doorenbos, 2000), and *Begonia mendumiae* M.Hughes, which shows male inflorescences with compressed monochasial partial inflorescences (Hughes, 2006). An analysis of herbarium material from Sulawesi (A, B, BM, BO, CEB, E, K, L and SING) shows that similar subumbellate male inflorescences are characteristic for several undescribed species from Sulawesi, and this reduction syndrome might represent a synapomorphy for several species derived from an endemic radiation on Sulawesi. However, phylogenetic analyses of morphological and/or molecular data are needed to test this hypothesis.

Begonia hekensis D.C.Thomas, **sp. nov.** Sect. *Petermannia*. **Figs 2, 3.**

Begoniae hispidissimae Zipp. ex Koord. similis a qua pedunculis inflorescentiarum feminearum longioribus, pedicellis capsularum valde deflexis differt. – Type: Indonesia, Sulawesi, Sulawesi Tengah, Luwuk District, Bunta Subdistrict, Sumber Agung, Gunung Hek, riverbank near small waterfall, 01°01′72.2″S, 122°11′54.7″E, 1009 m, 12 iv 2008, *D.C. Thomas & W.H. Ardi* 08-43 (holo E; iso BO, CEB).

Perennial, monoecious, erect herb, to c.100 cm tall, hairy with up to c.1.2 mm long, multicellular, multiseriate, simple trichomes and microscopic, glandular trichomes on all vegetative parts. *Stems* branched; internodes 2.2–8.3 cm long, densely hairy. *Leaves* alternate; stipules 8–28 × 2–10 mm, narrowly ovate, cymbiform with abaxially

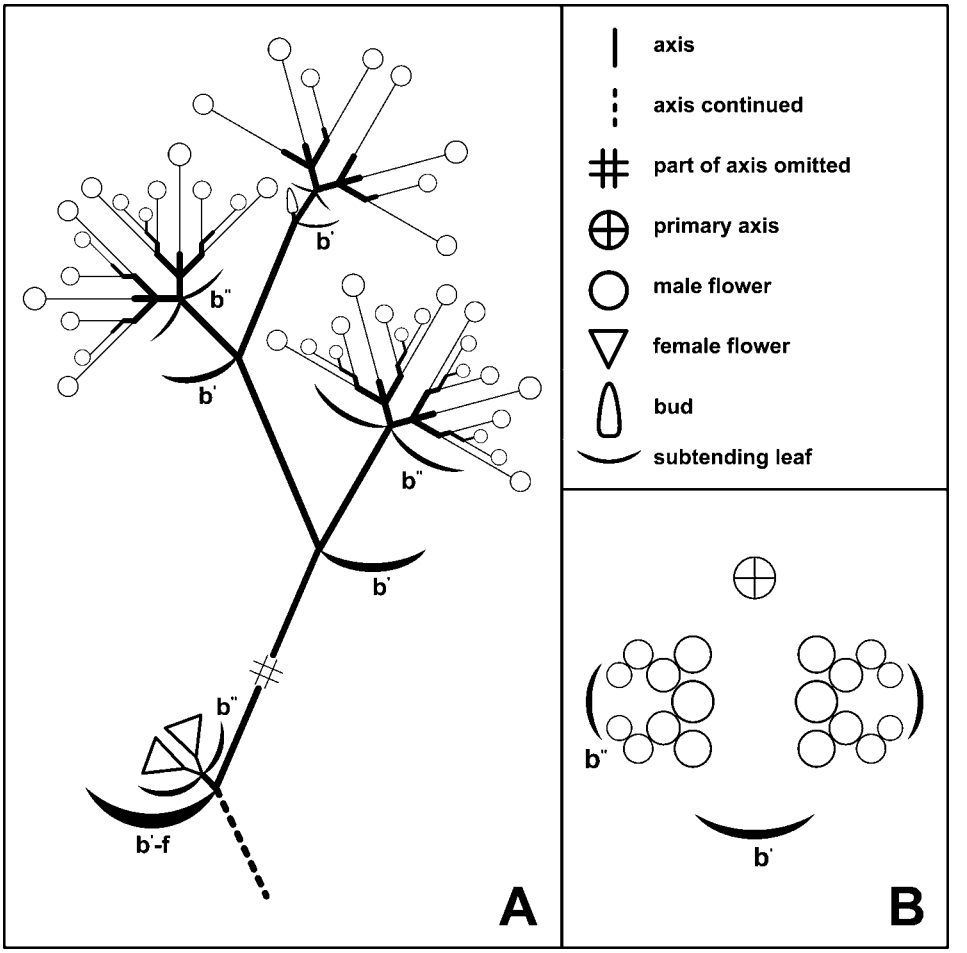

FIG. 5. Schematic inflorescence branching pattern of *Begonia ozotothrix*. A. Schematic branching of the inflorescence. The axes of the branches of the cymose-subumbellate male partial inflorescences are elongated in relation to the original in order to illustrate the branching pattern. The sequence of anthesis in the male partial inflorescences is indicated by circle size: the larger the size, the earlier the anthesis. B. Diagram of a male partial inflorescence. b′, bracteose leaf subtending the male partial inflorescence; b′-f, foliose leaf subtending the female inflorescence; b″, bracteose leaf subtending the branches of the male partial inflorescence, or subtending the pedicels of the female flowers.

prominent midrib forming a thin, short appendage at the apex, persistent, abaxially densely hairy; petioles 0.7–11.2 cm long, densely hairy; lamina basifixed, 2.5–15.2 × 1.1–8.2 cm, very asymmetric, ovate or elliptic, base cordate with non- or only very slightly overlapping lobes, apex acuminate, margin dentate to serrate, teeth bristle-pointed, abaxial surface hairy, adaxial surface sparsely hairy, adaxial surface mid green and abaxial surface pale green, venation palmate-pinnate. *Inflorescences* protogynous;

female inflorescences basal to male inflorescences or solitary, 2-flowered, subtending leaves foliose, peduncles 2.6–3 cm long (in fruit), bracts (subtending the pedicels of the female flowers) c.16 × 6 mm, narrowly elliptic, abaxially hairy; *male inflorescences* distal to one female inflorescence or solitary, subtending leaves frondose-bracteose (lamina strongly reduced in size), peduncle 9–12 mm long, bracts (subtending the lateral branches) 4–12 × 1–6 mm, oblong, the basal ones abaxially hairy, the distal ones glabrous, a once-branched dichasium or with one dichotomous branching at the base, and each of the two resulting branches branching once dichasially, sometimes the lateral branches of the dichasia branching once monochasially. *Male flowers*: pedicels 4–23 mm, hairy; tepals 2, white, 11–18 × 10–18 mm, broadly ovate to subcircular, base cordate or tepal margin convex at base, apex rounded, abaxially sparsely hairy; androecium of c.24–38 stamens, yellow, filaments c.0.4–2 mm long, slightly fused at the very base, unequal, longer in the middle of the androecium, anthers c.1–2 mm long, obovate or oblong, dehiscing through unilateral positioned slits < 1/2 as long as the anther, connective not projecting. *Female flowers*: unknown. *Fruits*: capsules ellipsoid, 14–17 × 5–8 mm (without wings), on apically strongly deflexed, 18–24 mm long, hairy pedicels, dehiscent, splitting along the wing attachment, drying brown, hairy, locules 3, placentation axile, placentae bilamellate, wings 3, sublunate, base rounded, widest in the middle to subapical part, subequal, one slightly larger than the other two, 7–8 mm wide in the widest part, the smaller two 6–7 mm in the widest part, hairy. *Seeds* ellipsoidal, c.0.3–0.4 mm long, collar cells c.1/3–1/2 of the length of the seed.

Distribution. Indonesia, Sulawesi, Central Sulawesi (Sulawesi Tengah), Gunung Hek (Fig. 3).

Habitat. This is an upland species which grows in the herb layer of primary rainforests, often along the sides of small streams, at c.850–1200 m.

Proposed IUCN conservation category. VU D2. This species is known only from Gunung Hek and has a very restricted range in an area which has no legal protection as a national park or nature reserve. Although the forest is in good condition in this area at around 1000 m, there are clear signs of anthropogenic disturbance, especially selective timber harvesting and rattan collection, at slightly lower altitudes. Therefore, the populations are 'prone to the effects of human activities or stochastic events within a very short time period in an uncertain future' (IUCN, 2001).

Additional specimens examined. SULAWESI. **Tengah**: Luwuk District, Bunta Subdistrict, Sumber Agung, Gunung Hek, Sungai Hek, between Cabang Tiga and Agathis Camp, 01°01′10″S, 122°10′30″E, 980 m, 1 iii 2004, *Hendrian, M. Newman, S. Scott, M. Nazre Saleh & D. Supriadi* 1015 (E); Sumber Agung, Gunung Hek, side of steep track, 01°01′58.2″S, 122°10′90.9″E, 870 m, 10 iv 2008, *D.C. Thomas & W.H. Ardi* 08-30 (BO, CEB, E); Sumber Agung, Gunung Hek, small isle in Sungai Hek, 01°01′81.2″S, 122°11′35.0″E, 1080 m, 11 iv 2008, *D.C. Thomas & W.H. Ardi* 08-33 (BO, CEB, E); Sumber Agung, Gunung Hek, side of small tributary of Sungai Hek, 01°01′76.0″S, 122°11′42.4″E, 993 m, 12 iv 2008, *D.C. Thomas & W.H. Ardi* 08-41 (BO, CEB, E).

The epithet '*hekensis*' is composed of 'Hek', a reference to Gunung Hek where the type material was collected, and '*-ensis*' (Latin – originating from).

Begonia hekensis is morphologically similar to *Begonia hispidissima* and *Begonia masarangensis* Irmsch. These three species exhibit a character combination which differentiates them from most other Sulawesian *Begonia* section *Petermannia* species: densely hairy stems and petioles, few-flowered male inflorescences, male flowers with abaxially hairy tepals, and short, hairy ovaries and capsules. However, *Begonia hekensis* can be easily differentiated from *Begonia masarangensis* by its ovate to elliptic leaves with a dentate to serrate margin and the compressed, purely, or at least partially, dichasially branching male inflorescences (versus oblong to narrowly elliptic leaves with double serrate margin and purely monochasially branching male inflorescences). *Begonia hekensis* differs from *B. hispidissima* by the apically strongly deflexed pedicels of the fruits (Figs 2B–C) and the peduncles of the female inflorescences which may be up to 3 cm long (versus not or only slightly deflexed pedicels and peduncles up to c.1.5 cm long in *B. hispidissima*).

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