

## ***Hexatheca longipedunculata* (Gesneriaceae), a new species from Sarawak, Borneo**

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**ABSTRACT.** *Hexatheca longipedunculata* S.Julia & Kiew, a new species from Sarawak, is described and illustrated. *Hexatheca* is a genus endemic to the island of Borneo. The description of this new species brings the number of species recognised in the genus to four. A key to the species and subspecies of *Hexatheca* and a distribution map of the newly described species are presented. Its conservation status is assessed.

**Keywords.** Endemic genus, *Hexatheca fulva*, Malaysia

### **Introduction**

The genus *Hexatheca* was established by Clarke (1883) based on a single species, *Hexatheca fulva* C.B.Clarke. *Hexatheca* belongs to subfamily Didymocarpoideae, subtribe Didymocarpinae (Weber et al., 2013, 2020). Currently the phylogenetic status of the genus *Hexatheca* is considered inconclusive (Neo et al., 2020). Morphologically, *Hexatheca* can be differentiated from other genera in Gesneriaceae in having two types of anthers: the anthers of the two lower stamens are ditheous while the anthers of the two upper ones are monothecous. Burt (1971, 1989) provided a detailed account of *Hexatheca*, a genus endemic to Borneo. He recognised three species: *Hexatheca dolichopoda* B.L.Burt, *H. fulva* (subsp. *fulva* and subsp. *beamani* B.L.Butt) and *H. johannis-winkleri* Kraenzl. In 2003, the second author collected a distinct species during an expedition to Sungai Silat in Marudi District organised under the Tree Flora of Sabah and Sarawak Project. Thirteen years later, a second collection of the species was made by the third author from Tama Abu Permanent Forest during the Heart of Borneo Expedition organised by the Forest Department Sarawak. This species is described here as *Hexatheca longipedunculata* S.Julia & Kiew based on these two collections.

### **Materials and methods**

The description and measurements of *Hexatheca longipedunculata* are based on fresh and dried specimens. Further comparison of morphological characters of the new species with all known species was made based on literature and herbarium specimens

at KEP, SAN, SAR as well as images of specimens available in various herbaria accessed through the GBIF website (GBIF, 2021). Morphological characters of the new species are compared in detail with *Hexatheca fulva*. The global conservation categories and criteria follow IUCN Standards and Petitions Committee (2022).

### Taxonomy

A new species of *Hexatheca*, *Hexatheca longipedunculata*, is described and illustrated in this paper. A key, based on Burtt (1989), and expanded here to include all *Hexatheca* species, is also provided.

**1. *Hexatheca dolichopoda*** B.L.Burtt, Notes Roy. Bot. Gard. Edinburgh 46: 54 (1989). – TYPE: Malaysia, Sabah, Lahad Datu District, Ulu Segama, Danum Valley, near Plot 1 west trail, 9 March 1987, *Argent & Jong 261987* (holotype E [E00156830]; isotypes E [E00346509, E00886494], L [L.3794025]).

*Distribution.* Borneo. Endemic to Sabah where the species is known only from Danum Valley, Lahad Datu District.

*Habitat.* Lowland dipterocarp forest at elevations to 200 m where the species grows on boulders in stream beds or gullies in lightly shaded areas.

*Provisional IUCN conservation assessment.* Vulnerable (VU D2). This species has a restricted area of occupancy (AOO) with an AOO suspected to be < 20 km<sup>2</sup> or the number of locations ≤ 5. The species apparently has been collected only from Danum Valley, a protected forest in Sabah. It is likely that most collections are made from the same population that lies on a main visitor trail.

*Specimens examined.* MALAYSIA: **Sabah:** Lahad Datu District, Ulu Segama, Danum Valley, Conservation area stream W5, 9 Jun 1996, *Campbell et al. SAN 111895* (E [E00346512]); Ulu Sungai Segama, Danum Valley, Research Centre, 1 Mar 1985, *Argent et al. SAN 108289* (E [E00346510, E00346511], SAN); ibidem, *Parris 32/85* (K n.v.); ibidem, 19 Feb 1986, *Andrews 727* (K [K000224862]); ibidem, 19 Jul 1970, *Talib SAN 70998* (NL n.v., SAN); ibidem, 16 Sep 1985, *Newman SAN 112158* (SAN); ibidem, 16 Feb 1986, *Wong KMDV 1* (SAN); ibidem, 27 Nov 1985, *Madani SAN 112948* (SAN); ibidem, 19 May 2004, *Gregson et al. 34* (SAN); ibidem, 27 Jul 2014, *Chong et al. SAN 157263* (SAN).

**2. *Hexatheca fulva*** C.B.Clarke in De Candolle & De Candolle, Monogr. Phan. 5: 194 (1883); Burtt, Notes Roy. Bot. Gard. Edinburgh 31: 46 (1971); Burtt, Notes Roy. Bot. Gard. Edinburgh 46: 56 (1989). – TYPE: Malaysia, Sarawak, Mt Matang, November 1871, *Beccari 2640* (lectotype FI [FI013102 – 1 specimen over 2 sheets], designated by Burtt (1989); isolectotype K [K000858008]).

## 2.1 *Hexatheca fulva* subsp. *fulva*

*Distribution.* Borneo (Kalimantan, Sabah and Sarawak). In Sabah, the species is recorded from Gunung Trus Madi, while in Sarawak the species is rather widely distributed in Kuching division (Bau, Matang, Padawan, Tebedu), Kapit District (Hose Mountains), Marudi District (Gunung Mulu), Sri Aman District and Serian District.

*Habitat.* On lightly shaded limestone rocks or in lowland forest on sandstone rock faces and crevices, at elevations 60–1200 m.

*Provisional IUCN conservation assessment.* Least Concern (LC). This subspecies is widespread in Sarawak including in the Totally Protected Areas Network (Fairy Cave Nature Reserve, Wind Cave Nature Reserve, Dered Krian National Park (covers most of the limestone outcrops in the Bau District) and Gunung Mulu National Park).

*Specimens examined.* MALAYSIA: *Non-limestone habitats.* **Sabah:** Tambunan District, foothills of Gunung Trus Madi, ridge along trail between Toboban and Kidukarok, 14 Jun 1988, *Wood 865* (E [E00628224]); Tenom District, Tenom, 26 Mar 1999, *Kiew RK 4667* (K [K000224848], SAN); Keningau District, Sungai Pingas Pingas, 17 May 1985, *Sumbing SAN 113979* (SAN). **Sarawak:** Kapit District, Hose Mountains, Bukit Salong, 27 Apr 1976, *Chai S 37263* (SAR); ibidem, 26 Mar 1980, *Burt B 12702* (SAR); Bukit Mabong, 5 Aug 1967, *Burt & Martin B 4791* (SAR); Bukit Nibong, 8 Aug 1967, *Burt & Martin B 4861* (SAR); Ulu Sungai Entulu, Sungai Mengiong, 26 Jul 1987, *Benard S 54763* (KEP, SAR); Gunung Matang, 1929, *Clemens & Clemens 22329* (SAR); ibidem, 21 Sep 1958, *Jacobs 5561* (SAR); ibidem, 27 Jul 2013, *Julia et al. SFC 4205* (SAR); ibidem, 15 June 1895, *Sarawak Museum Collector 469* (SAR); ibidem, 19 Mar 1955, *Brooke 9822* (SAR); Limbang District, Gunung Pagon, 19 Aug 1984, *Dayang Awa & Benard S 47997* (SAR); Marudi District, Gunung Mulu National Park, Pantu ridge, 23 Apr 1978, *Kiew RK 397* (SAR); Lobang Cina, 15 Apr 2012, *Julia et al. SFC 2810* (SAR). *Limestone habitats.* **Sarawak:** Bau District, Bukit Jebong, 6 Jul 1970, *Lehmann S 30134* (SAR); ibidem, 24 Jul 1970, *Lehmann S 29406* (SAR); ibidem, 28 Apr 1967, *Chai & Ilias S 25624* (SAR); ibidem, 5 Mar 2002, *Meekiong et al. SBC 2080* (SAR); Gunung Lanyang, 15 Aug 1978, *Rena S 38299* (SAR); ibidem, 10 Apr 2002, *Julia et al. SBC 2926* (SAR); Siburan, 25 Feb 1960, *Anderson S 12234* (SAR); ibidem, 20 Feb 1960, *Anderson S 14599* (SAR); ibidem, 14 Feb 1960, *Anderson & Ashton S 10090* (SAR); Jambusan, Gunung Batu, 6 Oct 1977, *Martin S 39272* (SAR); Gua Bidi, 1929, *Clemens & Clemens 20678* (SAR); ibidem, 7 Jul 1996, *Mohizah & Yahud S 74401* (KEP); Bukit Boring, 14 Nov 1985, *Yii et al. S 50352* (KEP, SAR); Bukit Bah, Kampung Punau, 27 Nov 1992, *Lesmy et al. S 65178* (SAR); Bukit Doya, 10 Feb 1999, *Julaihi et al. S 82211* (SAR); Bukit Gajah, 9 Feb 1999, *Jemree et al. S 82086* (KEP, SAR); Jambusan, Bukit Batu, 4 Feb 1999, *Jemree et al. S 82043* (SAR); ibidem, 4 Feb 1999, *Jemree et al. S 82042* (SAR); Gunung Meraja, 22 Sep 2001, *Julia et al. SBC 300* (SAR); Gunung Poing, 22 Sep 2001, *Julia et al. SBC 356* (SAR); ibidem, 13 May 2002, *Malcom et al. SBC 1564* (SAR); Gunung Batu Payung, 24 Oct 2001, *Malcom et al. SBC 840* (SAR); Gunung Pambor, 24 Oct 2001, *Julia et al. SBC 1238* (SAR); Gunung Tabai, 12 Mar 2002, *Julia et al. SBC 2500* (SAR); Gunung Aup, 10 Oct 2001, *Julia et al. SBC 581* (SAR); ibidem, 14 May 2002, *Malcom et al. SBC 1584* (SAR); Gunung Stulang, 14 May 2002, *Malcom et al. SBC 3337* (SAR); Gunung Podam, 18 Oct 2001, *Malcom et al. SBC 818* (SAR); Gunung Tai Ton, 18 Oct 2001, *Julia et al. SBC 712* (SAR); Fairy Cave, 21 Feb 2009, *Julia*

*S 99385* (SAR); Bukit Batu Kapor, 22 Mar 1999, *Patsipun & Jugah S 79975* (KEP); ibidem, 15 Dec 1994, *Rantai et al. S 70043* (KEP); Kpg Segong, Sungai Adis, 18 Jul 2014, *Julia et al. SFC 4249* (SAR); Bau, 29 Apr 1955, *Brooke 9930* (L [L.2824233]); Kuching District, Jalan Penrissen, 21 Apr 1962, *Anderson S 15280* (SAR); Bukit Serapat, 25 Jul 1967, *Burt & Martin 4744* (SAR); Jalan Padawan, Teng Bukap, 16 Jan 1973, *Mamit S 32690* (SAR); Gunung Mentawa, 10 May 1975, *Burt 8110* (SAR); Padawan, Temurang, 24 Sep 2009, *Julia et al. S 105067* (SAR); ibidem, 29 Sep 2009, *Julia et al. S 105579* (SAR); ibidem, 3 Sep 2005, *Kiew & Julia S 95678* (SAR); Gunung Sebengkam, 14 Jan 1997, *Jemree et al. S 75806* (KEP); Gunung Braang, 8 Dec 2000, *Jemree S 84035* (SAR); Penrissen, Gunung Bar, 22 Feb 1993, *Rantai et al. S 66024* (SAR); ibidem, 8 Aug 1966, *Ashton & Hou 606* (L [L.2824230]); Serian District, Tiang Bekap, Gunung Mentawa, 11 Mar 1967, *Chew CWL 1294* (SAR); Lobang Mawang, Bukit Selebor, 26 Sep 1968, *Ilias S 28042* (SAR); Mongkos, Gunung Selebur, 20 Apr 1999, *Jemree et al. S 82242* (SAR).

**2.2 *Hexatheca fulva* subsp. *beamanii*** B.L.Burt, Notes Roy. Bot. Gard. Edinburgh 46: 56 (1989). – TYPE: Malaysia, Sabah, Ranau District, Crocker Range, Bukit Lugas, Kampong Himbaan 8.5 km SE of Tenompok, 7 July 1984, *Beaman 10530* (holotype E [E00155048]; isotypes A [A00056367], K [K000858009], L [L0216353], MICH [MICH1192312], MO [MO-05001693]).

*Distribution.* Borneo. Endemic to Sabah where the species is recorded from Crocker Range in Ranau District.

*Habitat.* In montane forest, on overhanging cliffs of waterfall or bedrock of sandstone and shale at elevations 1000–1300 m.

*Provisional IUCN conservation assessment.* Critically Endangered (CR D). The species is very rare and known only from the type specimen. The population is likely to consist of fewer than 50 mature individuals.

**3. *Hexatheca johannis-winkleri*** Kraenzl., Mitt. Inst. Allg. Bot. Hamburg 7: 93 (1927); Burt, Notes Roy. Bot. Gard. Edinburgh 31: 47 (1971); Burt, Notes Roy. Bot. Gard. Edinburgh 46: 56 (1989). – TYPE: Indonesia, Kalimantan, Bukit Tilung, 9 February 1925, *Winkler 1507* (holotype HBG [HBG517398]; isotypes E [E00155049, E00155050]).

*Distribution.* Sarawak and Kalimantan. In Sarawak, the species is known only from one collection from Kapit District, while in Kalimantan the species is recorded from two localities.

*Habitat.* Primary forest in a small ravine with a heavily shaded stream, on sandstone outcrops and boulders at 457 m elevation.

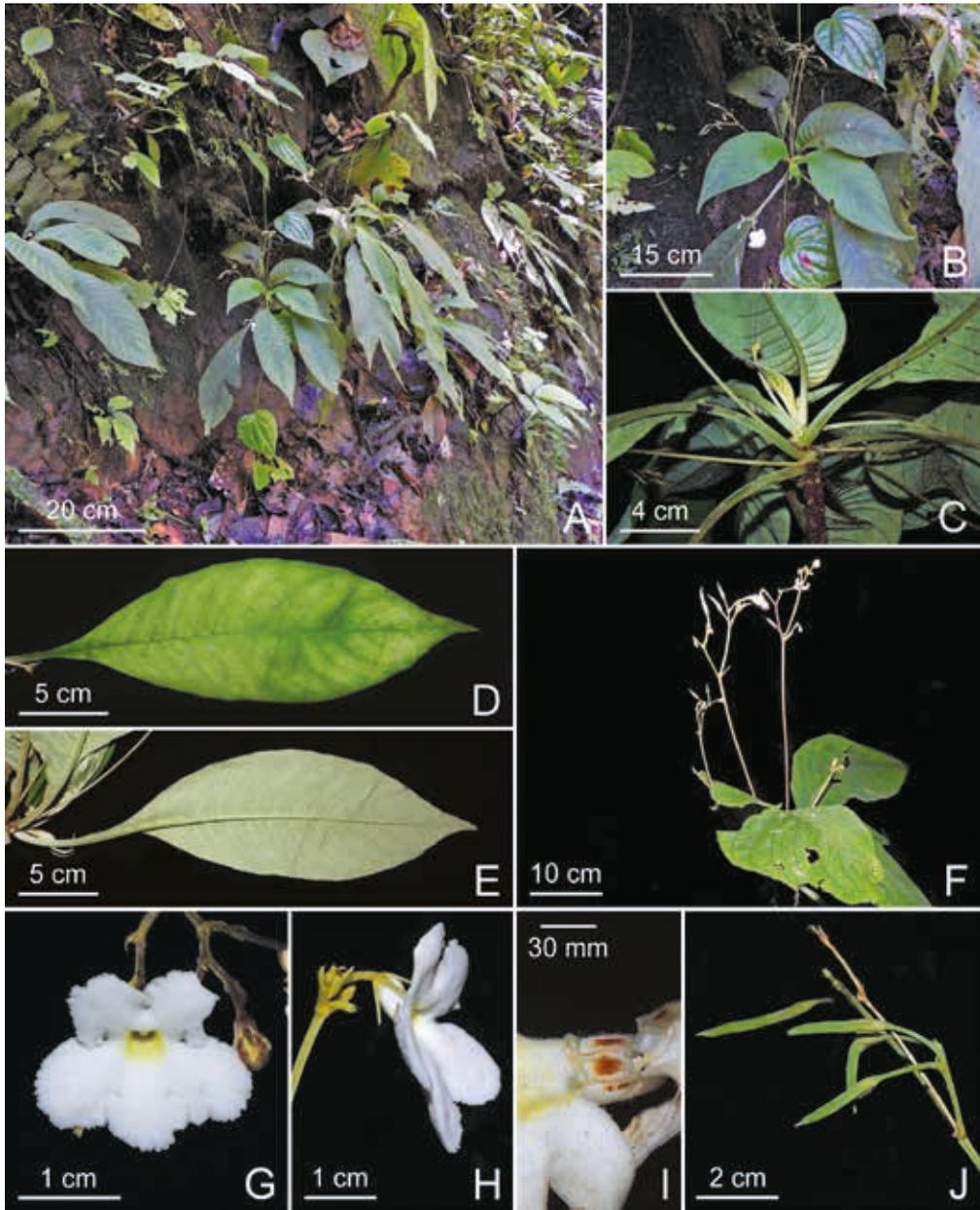
*Provisional IUCN conservation assessment.* Endangered (EN B2ab(i,ii,iii)). This species is known only from three locations in Borneo with an area of occupancy (AOO) of 12 km<sup>2</sup> and an extent of occurrence (EOO) of 19,726 km<sup>2</sup>. In Sarawak, this species occurs outside protected areas, thus the habitat and population are threatened by habitat conversion and deforestation. In Kalimantan the habitats of the species occur within forested areas.

*Specimens examined.* MALAYSIA: **Sarawak:** Kapit District, Batang Baleh, Ulu Sungai Sedampa, 2 Jul 1969, *Anderson S 28292* (E [E00628205], L [L.2824236], SAR). INDONESIA: **West Kalimantan:** G. Bentuang area, 5–10 km north of Masa Village, 28 Jun 1989, *Burley & Turkirin 3023* (E [E00628204]); Bukit Tilung, 8 Feb 1925, *Winkler 1486* (HBG [HBG517395, HBG517396]).

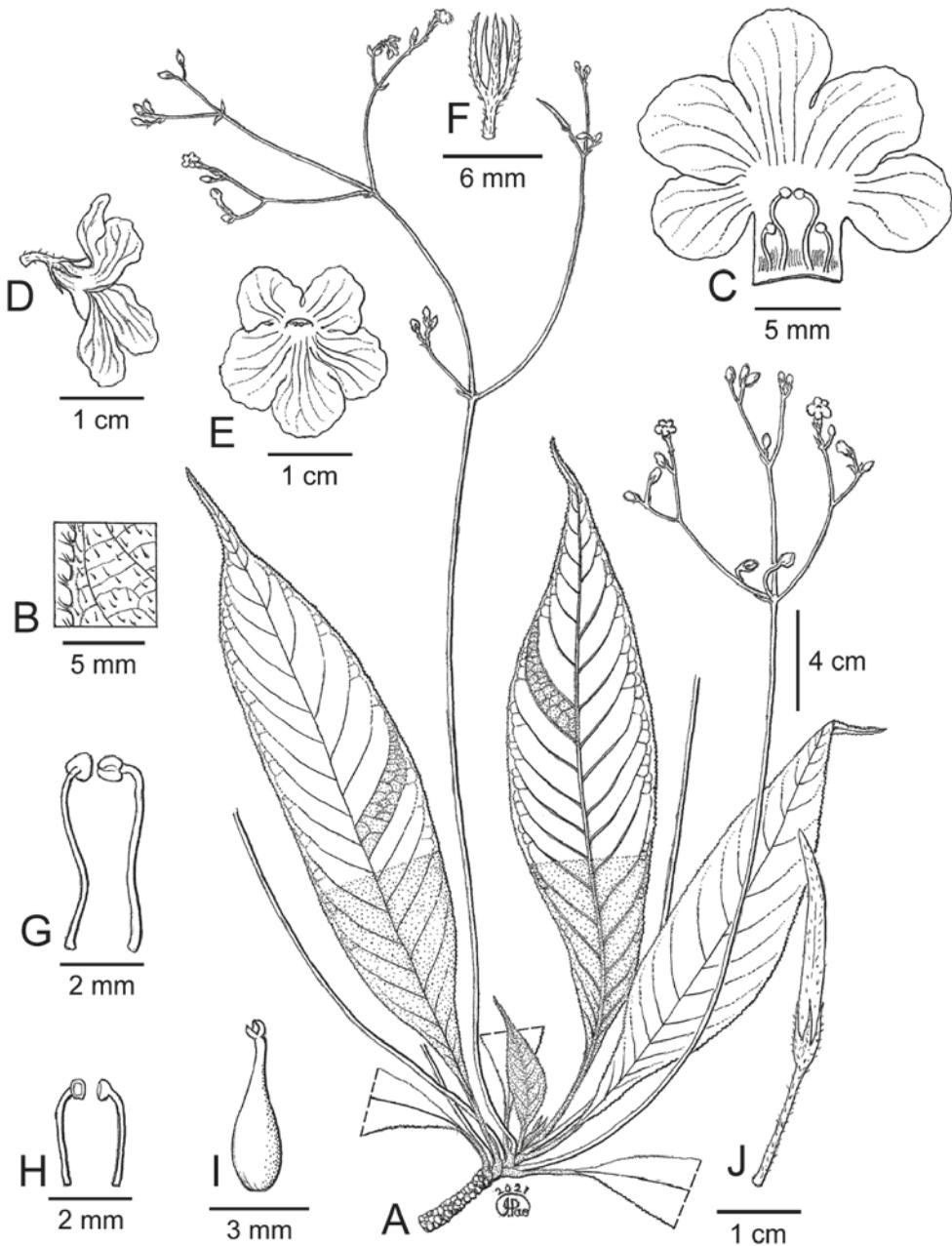
#### 4. *Hexatheca longipedunculata* S. Julia & Kiew, **sp. nov.**

Similar to *Hexatheca fulva* in its habit and winged petiole but differs in its conspicuously longer inflorescence ((10–)17–38(–52) cm long in *H. longipedunculata* vs 5–8 cm long in *H. fulva*), longer peduncle (8–20(–31) cm long vs 1.2–3(–6.5) cm long), and the lamina width:length ratio (1:2.8–3 vs 1:3.1–3.8). – TYPE: Malaysia, Sarawak, Marudi, Sungai Silat Basin, 2°48'40"N 115°01'09"E, 29 March 2003, *Kiew & Leong S 91615* (holotype SAR; isotypes KEP, SAN, SAR, SING). (Fig. 1–3)

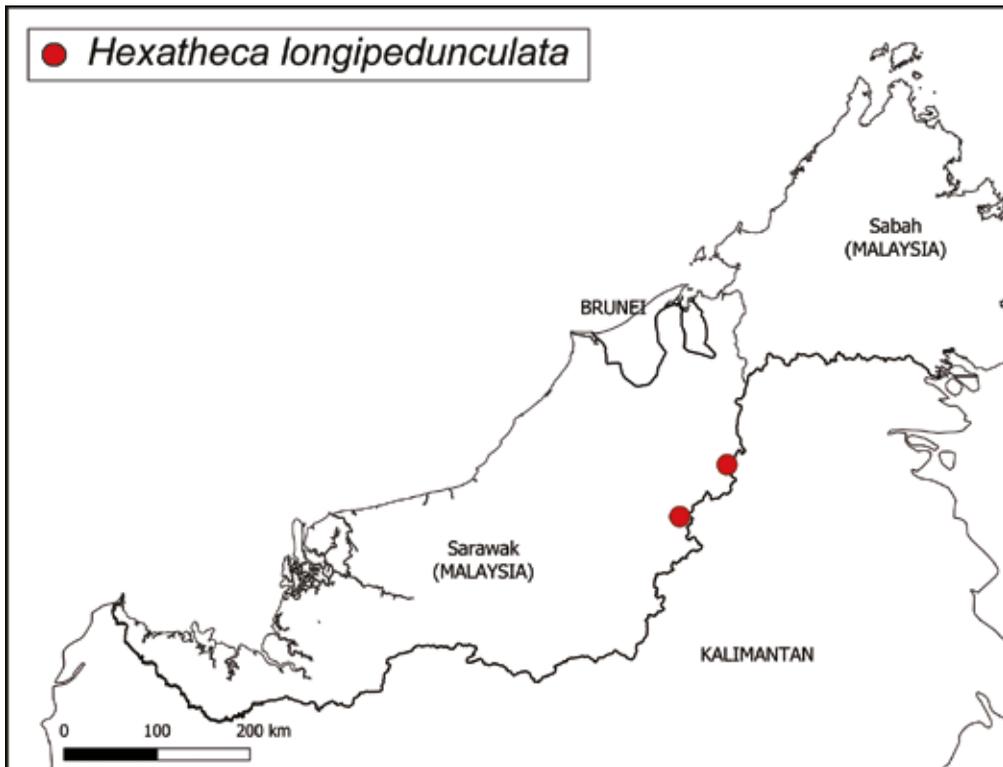
Shrub 12–60 cm tall, growing horizontally on rock face, stem woody, greyish or dark brown, 7–8 mm diam. **Stipules** absent. **Leaves** crowded at the end of the stem, up to 12 leaves per plant; petiole pale green, grooved, woolly, 3–5.5 cm long; lamina elliptic, 20–31 cm long, 6.5–11 cm wide at the widest part, base of lamina conspicuously unequal, gradually narrowed into ill-defined winged base towards the petiole, apex acuminate, pale green or yellow-green above, whitish underneath, woolly underneath, indumentum of bristles above, midrib and lateral veins prominently impressed above, raised below, veins on narrow side 10–12 pairs, veins on broader side 12–15 pairs. **Inflorescences** cymose, 3–8 per plant, (10–)17–38(–52) cm long, only a few flowers open at a time; peduncle purplish at base, green towards the tip, woolly, 8–20(–31) cm long; bract c. 2 mm long, green; bracteoles green, 3–5 mm long, c. 2 mm diam. **Flower** with pedicel 7–9 mm long, sparsely pilose; calyx 5-lobed, lobes narrowly lanceolate, 3–5 × c. 1.5 mm, outer densely pilose, inner sparsely pilose, green or purplish; corolla white with yellowish patches on the throat and brownish patch at the base of the inner corolla tube; corolla tube 5–6 mm long, sparsely pilose; upper and lower corolla lips 1.5–2.3 cm wide, covered with adpressed hairs, each upper corolla lobe c. 7 mm wide, each lower corolla lobe c. 10 mm wide; stamens 4, glabrous, attached to the corolla lobe a third of the way from the base; filaments white, 3–4 mm long; anthers yellowish or white, two lower anthers dithecous, two upper ones monothealous; pistil c. 3 mm long, style and stigma white, sparsely pilose, stigma slightly forked, ovary yellowish green. **Fruit** (young) with green or purplish pedicel, pedicel 1–1.8 cm long, calyx green or purplish, capsule pale to dark green, 1.2–2.7 cm long, 2–3 mm diam., woolly; seeds white.



**Fig. 1.** *Hexatheca longipedunculata* S.Julia & Kiew. **A.** Habitat on sandstone rock faces. **B.** Habit. **C.** Close-up of leafy twig showing base of lamina. **D.** Upper surface of lamina. **E.** Lower surface of lamina. **F.** Inflorescences showing long peduncles. **G.** Flower in front view. **H.** Flower in side view. **I.** Stamens. **J.** Fruits. All from *SFC 8140*. (Photos: C.Y. Ling & S. Julia)



**Fig. 2.** *Hexatheca longipedunculata* S.Julia & Kiew. **A.** Habit showing flowering leafy twig, lamina showing indumentum and venation. **B.** Portion of leaf margin. **C.** Dissected corolla. **D.** Side view of flower. **E.** Front view of flower. **F.** Calyx. **G.** Outer stamens. **H.** Inner stamens. **I.** Pistil. **J.** Fruit. A & B from *S* 91615; C–J from *SFC* 8140. Drawn by Joseph Pao.



**Fig. 3.** Distribution of *Hexatheca longipedunculata* S.Julia & Kiew in Sarawak.

*Distribution.* Borneo. Endemic to Sarawak where the species is known only from Marudi District.

*Habitat.* Mossy sandstone boulders near the banks of a small stream and on a rock wall above the stream at elevation 725–744 m.

*Etymology.* Latin, *longus* = long, *pedunculatus* = peduncled; referring to the long-stalked inflorescence.

*Provisional IUCN conservation assessment.* *Hexatheca longipedunculata* is assessed as Endangered (EN B1ab(ii,iii), B2ab(ii,iii)). The populations occur outside any Totally Protected Area. Both populations are threatened by the impact of logging activities on its habitat. The species has only been collected twice from two locations with the extent of occurrence (EOO) estimated at not more than 5000 km<sup>2</sup> and the area of occupancy (AOO) is estimated at less than 500 km<sup>2</sup>.

*Additional specimen examined.* MALAYSIA: **Sarawak:** Marudi District, Tama Abu Permanent Forest, Sungai Baleh, 3°18'33"N 115°28'35"E, 22 Aug 2017, *Sirukit & Ling SFC 8140* (SAR).

*Notes.* This species seems to be very rare where it occurs. Populations of the species were found only once during 2–3 weeks of exploration of the areas by a large team during expeditions. It occupies a specific microhabitat on semi-shaded sandstone boulders near small streams and nowhere else. The subpopulation at Tama Abu Permanent Forest consisted of individual plants at various life stages from seedlings to mature individuals. Both localities of *Hexatheca longipedunculata* occur within the Heart of Borneo area in Sarawak.

### Key to species of *Hexatheca*

- 1a. Petiole as long as or longer than the lamina ..... *H. dolichopoda*
- 1b. Petiole shorter than the lamina ..... 2
- 2a. Lamina width:length ratio of 1:2, base of lamina rather abruptly narrowed into slender petiole ..... *H. johannis-winkleri*
- 2b. Lamina width:length ratio of 1:2.8–3.8, base of lamina gradually narrowed into winged petiolar region ..... 3
- 3a. Inflorescence as long as or longer than the lamina; peduncle conspicuously longer than lamina, 8–20(–31) cm long ..... *H. longipedunculata*
- 3b. Inflorescence much shorter than the lamina; peduncle shorter than the lamina, 2–6 cm long ..... 4
- 4a. Leaf with dense indumentum; peduncle 2–4 cm long, rarely to 5 cm long .....  
..... *H. fulva* subsp. *fulva*
- 4b. Leaf with looser indumentum; peduncle longer, to 6 cm long .....  
..... *H. fulva* subsp. *beamanii*

### Discussion

Compared with many other genera of Gesneriaceae in Borneo such as *Cyrtandra* J.R.Forst. & G.Forst., the genus *Hexatheca* is generally considered rare and is not commonly encountered in Borneo's forests. Based on our current knowledge of this genus, the majority of *Hexatheca* species are rather rare and uncommonly seen where the species occur. Among the four known species, *Hexatheca fulva* has the widest distribution range, being recorded from Sabah, Sarawak and Kalimantan where the species is widespread and common where it occurs. *Hexatheca fulva* subsp. *beamanii* on the other hand is endemic in Sabah where the species is only recorded from Lahad Datu. *Hexatheca johannis-winkleri* is only recorded from Kalimantan and Sarawak. *Hexatheca dolichopoda* is endemic in Sabah where it is also only recorded from Lahad Datu. So far, no species of *Hexatheca* has been recorded from Brunei.

ACKNOWLEDGEMENTS. We are grateful for the financial and logistic support for expeditions to remote areas by the Sarawak Forestry Corporation, the Forest Research Institute Malaysia through the Tree Flora of Sabah and Sarawak Project, and the Forest Department Sarawak through the Heart of Borneo Expedition. We thank the Curators of KEP, SAN and SAR for the permission to study the specimens in their care. Special thanks to Dr Joan T. Pereira and Andi Maryani A. Mustapeng for their assistance in checking the specimens in SAN and to Sirukit Dubod of the Sarawak Forestry Corporation, the collector of the specimen from Tama Abu PF. We thank Joseph Pao for his elegant illustration and Tan Jiew Hoe for additional funding.

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