

Neotypification of *Zeuxine agyokuana* (Goodyerinae, Orchidoideae, Orchidaceae) with a new synonym

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Based on examination of protologues and herbarium material, combined with field observations, we suggest that *Zeuxine bidupensis* Averyanov should be considered a heterotypic synonym of *Z. agyokuana* Fukuyama. Thus, the known distribution of *Z. agyokuana* includes China, India, Japan, Thailand and Vietnam. A neotype is designated for *Z. agyokuana*, since all original material underlying Fukuyama's description seems to be lost. An improved morphological description, based on all available herbarium material from the entire geographic range of the species, is provided together with illustrations.

The orchid genus *Zeuxine*, belonging to the subtribe Goodyerinae of tribe Cranichideae, consists of ca. 80 species distributed from tropical and southern Africa across the Indian Ocean to tropical and subtropical Asia, New Guinea, north-eastern Australia, and the southwestern Pacific islands (Chen *et al.* 2009), and with a few probably anthropochorous occurrences elsewhere. During one of the routine surveys of the orchids in Wuzhishan National Nature Reserve, Hainan, a species of *Zeuxine* was found and identified as *Z. agyokuana* Fukuyama. This species was first described by Noriaki Fukuyama based on

a single collection (*N. Fukuyama* 4127) collected from Taiwan in August 1933 (Fukuyama 1934) and was previously known to occur only in Taiwan and Japan (Chen *et al.* 2009, Tian *et al.* 2012).

During our study we also came across another two species of *Zeuxine*, viz. *Z. bidupensis* Averyanov and *Z. pantlingii* Avishek Bhattacharjee & H.J. Chowdhery, which looked very similar to *Z. agyokuana* (as already noted by Pedersen & Suksathan 2009). *Zeuxine bidupensis* was first described by Averyanov and Efimov (2006) based on plants collected in October 2005 from

Lac Duong District, Lam Dong Province, Vietnam. *Zeuxine pantlingii* was described later in the same year by Bhattacharjee and Chowdhery (2006), based on plants collected in August 2005 from Darjeeling District, West Bengal, India. However, Bhattacharjee and Chowdhery (2009) found the two taxa to be conspecific and treated *Z. pantlingii* as a synonym of *Z. bidupensis* due to the priority of the latter name over the former. In the same year, Pedersen and Suksathan (2009) reported *Z. bidupensis* from Thailand. Bhattacharjee and Singh (2011) suggested that treatment of *Z. bidupensis* as a synonym of *Z. goodyeroides* Lindley was taxonomically incorrect (Averyanov 2008), and Averyanov (2011) consequently removed *Z. bidupensis* from the synonymy of *Z. goodyeroides*, recognizing it as a distinct species.

Based on examination of the protologues and several authentic specimens of *Z. bidupensis* and *Z. agyokuana*, we here propose that *Z. bidupensis* should be reduced to a synonym of *Z. agyokuana*. This implies that the geographic range of the latter is wider than previously recognized, comprising occurrences in China, India, Japan, Thailand and Vietnam.

In the protologue of *Z. agyokuana* a single collection (*N. Fukuyama 4127*) was cited and there was no indication whether it was described based on one or more specimens with the same collection number. According to the protologue, the type(s) of *Z. agyokuana* were deposited in the personal herbarium of Noriaki Fukuyama in Taiwan (“Herb. Orch. Fuk.”). It has been generally believed that most of Fukuyama’s herbarium specimens, including the types, were lost amid the upheaval in Japan following the close of World War II. However, remnants of Fukuyama’s type material of orchids were rediscovered in the course of sifting through the botanical collection of Dr. Genkei Masamune (teacher of Fukuyama), which Masamune had bequeathed to the herbarium of the Kanagawa Prefectural Museum of Natural History (KPM) upon his death in 1993. Dorr and Nicolson (2009) mentioned that the types of the orchid taxa described by Fukuyama are kept at KPM and TAI. However, Dr. Teruo Katsuyama, Executive Curator of KPM, informed us that KPM does not possess a type specimen of

Z. agyokuana. Furthermore, Mrs. Zheng Shu Fen, Assistant Curator of TAI, confirmed (pers. comm.) that no type material of *Z. agyokuana* had been retrieved from TAI either. In TAIF, we found a folder (“Herbarium no. 117043”) labelled ‘*Z. agyokuana*’ (misspelled ‘*agyohuana*’ in the database) and with the collection date Feb. 25 1933, i.e. the year before *Z. agyokuana* was formally described. It was collected by Kokichi Segawa from “Lilongchiting” (written in Chinese). Unfortunately, the specimen (fruiting) inside the folder did not possess any label and there was no definite indication that Fukuyama examined this TAIF specimen before describing *Z. agyokuana*. Therefore, the specimen in the folder “Herbarium no. 117043” is not tenable as original material of *Z. agyokuana* (cf. McNeill et al. 2012: Art. 9.3). Finally, we also searched in vain for type material of *Z. agyokuana* in TI, KANA and KYO, although those herbaria are known to accommodate other collections related to Masamune’s work (Staffeu & Cowan 1981). Therefore, on unavailability of any ‘original material’ of *Z. agyokuana* the specimen ‘*T. C. Hsu 3124*’ (Fig. 1E) deposited at TAIF is designated here as neotype of *Z. agyokuana* according to McNeill et al. (2012: Art. 9.7). The neotype is a complete flowering specimen, and it matches the description in the protologue.

***Zeuxine agyokuana* Fukuy. (Fig. 1)**

Bot. Mag. (Tokyo) 48(571): 433. 1934. — TYPE: China. Taiwan, Taoyuan County, Mt. Nachieh, 1000–1500 m a.s.l., 28 August 2010 *T. C. Hsu 3124* (neotype, designated here: TAIF!).

Zeuxine bidupensis Aver., Rheedeia 16(1): December 2006, *syn. nov.* — TYPE: Vietnam. Lam Dong Prov., Lac Duong Distr., Da Chais Municipality, territory of Bi Doup Nui Ba National Park, around point 12°08'17" N and 108°40'47" E, at about 1600 m a.s.l., 19 October 2005 *T. T. Trang, T. V. Thao, N. T. Vinh HLF 5319* (holotype HN, photo!; isotype LE, photo!).

Zeuxine pantlingii Av. Bhattacharjee & H.J. Chowdhery, Sida 22(2): 935. 2006. — TYPE: India. West Bengal, Darjeeling District, near Mongpoo, ca. 900 m, a.s.l. 28 August 2005 *A. Bhattacharjee 34807* (holotype CAL!). — Synonymized by Bhattacharjee and Chowdhery (2009).

Terrestrial herbs, with ascending stem. Plagiotropic part of stem 5–15 cm long, dull brownish-green, rooting at nodes, ascending leafy part



Fig. 1. *Zeuxine agyokuana* Fukuy. — **A–D:** Entire plants. — **E–H:** Inflorescences. (**A** and **E:** specimen from Hainan; photo by Huai-Zhen Tian; **B** and **F:** specimen from Taiwan; photo by Tian-Chuan Hsu; **C** and **G:** Thai specimen; photo by Henrik Æ. Pedersen; **D** and **H:** Indian specimen; photo by Avishek Bhattacharjee). — **K:** Neotype [*T. C. Hsu 3124* (TAIF; reproduced with permission of Herbarium of Taiwan Forestry Research Institute)]. — **I:** Labellum. — **J:** Column (*A. Bhattacharjee 34846*, CAL, spirit; photo by Avishek Bhattacharjee).

5–7 cm tall, purple-green to brownish-green, glabrous, with 5–7 leaves. Leaves scattered to clustered at top, petiolate to sessile; petiole 0.5–1.7 cm long, sheathing at base, sheath membranous, clasping, purple-red; blade narrow-ovate to ovate-lanceolate, sometimes oblique, 2–7 × 1–3 cm, blackish velvety-green to dark purplish-green adaxially, pale greenish-purple to reddish-grey abaxially, without any distinct white median stripe or band, subacute to shortly acuminate at apex. Inflorescence a terminal spike, with 2–14 lax flowers, sparsely hairy; peduncle 5–10 cm

long, with 1–3 sheaths; sheaths 0.6–1.9 cm long ovate, acuminate at apex, reddish-brown, cuspidate, clasping, membranous, glabrous; rachis 1.8–8 cm long. Floral bracts triangular to ovate, abruptly acuminate at apex, 5–11 × 2–5 mm, as long as or a little shorter than ovary, dull reddish-brown to purplish green, erose-ciliate, otherwise glabrous; ovary deep purplish-green, 7.5–11.7 × 1–1.8 mm, cylindrical, glabrous, slightly twisted. Flowers odorless, resupinate; sepals narrowly ovate, 4.5–6 × 1.3–4.2 mm, glabrous, 1-veined or weakly 3-veined; dorsal sepal forming hood

with petals, obtuse at apex, forward directed, pinkish-red; lateral sepals subacute, reflexed at right angle, deep pinkish-green at base, pinkish-red at apex; petals obliquely oblong-falcate, acute to rounded at apex, white with olive-brown base, $4.5\text{--}5.5 \times 1.2\text{--}1.5$ mm, glabrous, 1- or 2-veined; lip $4\text{--}5 \times 2\text{--}3$ mm (at widest part), distinctly divided into hypochile and epichile; hypochile pale yellowish, saccate, with 2 oblong to hooked glands/appendages inside (one on either side), $2\text{--}3 \times 2\text{--}3$ mm, margins incurved, fleshy, with 2 round flaps near junction with epichile, flaps minutely papillose inside; epichile entire, $1\text{--}1.5 \times 1\text{--}1.5$ mm, flat, finely papillose, margin entire to slightly crenulate; column $1\text{--}3.4$ mm tall, with 2 incurved obliquely triangular frontal wings, rostellum $1.7\text{--}2.5$ mm long; stigma 2-lobed, lateral; anther narrowly-ovate, acuminate, $2.2\text{--}3.5 \times 0.8\text{--}1.2$ mm; pollinia 2, $1\text{--}1.5$ mm long, oblong-ovate to obclavate, setose, dull yellowish; caudicles ca. 0.2 mm long; viscidium ca. 1 mm long, oblong to lanceolate. Flowering August–November.

DISTRIBUTION AND HABITAT: China (Hainan, Taiwan), India (West Bengal, Meghalaya), Japan (Ryukyu Islands), Thailand (Phitsanulok, Loei) and Vietnam (Lam Dong Prov., Lac Duong Distr., Lao Cai Prov.), under the forest cover between 800–2200 m a.s.l.

CONSERVATION STATUS: In spite of its wide geographic distribution, *Z. agyokuana* appears to be a very rare species with predominantly small, fragmented populations. Using the GPS locations of all the sites, Area of Occupancy was calculated to be 1024.5 km². and Extent of Occurrence was estimated to be 419 895 km². Judging from the number and size of the known populations, *Z. agyokuana* seems to be decreasing and hence the species can be classified as Vulnerable (VU, B2abc, C2a) based on the IUCN Red List Categories and Criteria (IUCN 2012).

ADDITIONAL SPECIMENS EXAMINED: **China.** Hainan: Wuzhishan National Nature Reserve, $18^{\circ}53'49''\text{N}$, $109^{\circ}41'37''\text{E}$, 1300 m, *H. Z. Tian & Q. Y. Dong 654A* (HSNU); Guangxi: Longlin, Yacha, 1420 m, *S. Q. Tang et al. 231* (IBK); Jinxiu, Shengtangshan, 1200–1600 m, *T. C. Hsu 6443* (TAIF); Taiwan: Chiayi, Taihe, 1500 m, *T. C. Hsu 628* (TAIF); Hsinchu, Jianshih Township, Mt. Neiniaotsuei, 1200 m, *T. C. Hsu 587* (TAIF); Miaoli, Chialishan, 15 January 1916, *S. Sasaki s. n.* (TAI); Taipei, Pataoerhshan, 900 m,

T. P. Lin 162 (TAIF); Pingtung, Mt. Jitangchen, 1500 m, *S. W. Chung 8192* (TAIF); Taipei, Wulai Hsiang, Pataoerhshan, 800 m, *H. J. Su, T. Y. Chen & N. G. Chung 8605* (HAST); Taipei, Wulai Hsiang, Pataoerhshan, *H. J. Su & T. Y. Chen 7406* (HAST); Taipei, Mt. Tatung, 800 m, *T. C. Hsu 331* (TAIF); Taitung, Donghe Township Mt. Tulan, 900 m, *T. C. Hsu 391* (TAIF); Taitung, Lilongchiting, 25 February 1933, *K. Segawa s.n.* (TAIF); Taitung, Donghe Township, Mt. Tulan, 1000 m, *T. C. Hsu 1164* (TAIF); Taoyuan, Fuhsing Hsiang, Nachiehshan, ca. 1100 m, *T. Y. Chen, M. S. Chen & H. J. Su 8540* (HAST); Taoyuan, Mt. Fuhsinchian, 1200 m, *T. C. Hsu 2343* (TAIF). **India.** West Bengal, Darjeeling District, near Mongpoo, ca. 950 m, *A. Bhattacharjee 34846* (CAL). **Thailand.** Phitsanulok: Phu Soi Dao, *Suksathan 4617* (QBG); Loei: Phu Luang Wildlife Sanctuary, Kok Nok Kraba ranger substation, trail to KoK Phrom Chan, *Suddee et al. 3952* (BKF); Phu Luang Wildlife Sanctuary, Pah Yueng, *Suddee et al. 3958* (BKF). **Vietnam.** Lao Cai Prov., Sa Pa Distr., 1900–2200 m, *T. C. Hsu 3450* (HN); Lao Cai Prov., Sa Pa Distr., 2000 m, *T. C. Hsu 4360* (TAIF).

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