Taxonomy of the Asian Gymnema latifolium (Apocynaceae, Asclepiadoideae, Marsdenieae), including lectotypification of the synonymous G. khandalense

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Abstract

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The Indian endemics *Gymnema khandalense* and *G. kollimalayanum* are proposed as new synonyms of *G. latifolium*, and lectotypification for *G. khandalense* is provided. The description of *G. latifolium*, which is of wide distribution in Bangladesh, S China, India, Myanmar, Thailand and Vietnam, is emended with regard to coronal structures. A chromosome number is also provided for the first time. A (reduced) gynostegial corona for *G. latifolium* could be confirmed, putting the utility of corona characters for the separation between the genera *Gymnema* and *Marsdenia* into question. As a consequence of the reconsidered status of *G. latifolium*, this species and its synonyms need to be removed from the Indian Red Data List.

Additional key words: *Bidaria*, chromosome number, *Gymnema kollimalayanum*, India, *Marsdenia*, morphology, taxonomy, typification

Introduction

A considerable number of publications have dealt with the Indian endemic taxa *Gymnema khandalense* Santapau and *G. kollimalayanum* A. Ramachandran & M. B. Viswan, be it in floristic works or in the context of their biological and pharmaceutical activities (Kothari in Nayar & Sastry 1990; Sasidharan & Swarupanandan 1994; Sasidharan & Sivarajan 1996; Jagtap & Singh 1999; Prabhakaran & al. 2004; Udayan & al. 2004; Ramachandran & Natarajan 2010; Natarajan 2011). Jagtap & Singh (1990, 1999) treated *G. khandalense* under *Bidaria*, a subgroup of *Gymnema* that is no longer accepted as a separate taxon (cf. Omlor 1997, and see Results and Discussion). Evaluation of the taxonomic status of these two *Gymnema* taxa brought us to realize (1) that they cannot be distinguished from each other, and (2) that they cannot be distinguished from *G. latifolium*, a species of wide distribution in southern Asia. The increasing attention and public interest in *Gymnema* species, especially in India, deserves critical examination of available information about this species, including morphology, cytology, taxonomy and typification, which are here provided.

Results and Discussion

After comparing living and herbarium material, descriptions and illustrations published for *Gymnema khandalense*, *G. kollimalayanum* and *G. latifolium*, we

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determined that not a single morphological character distinguishes the three taxa from each other. Comparison of the protologues might lead one to think that formation of cork on older stems "with distinct warty outgrowths … arranged irregularly and in rows, variable in structure, pustule-like, conical or rectangular" is diagnostic for *G. kollimalayanum* (cf. Ramachandran & Viswananthan 2009) against *G. khandalense* and *G. latifolium*. But this morphological feature for a plant identified as *G. khandalense* from Kerala is depicted in Sasidharan & Swarupanandan (1994: 634, fig. 2), and described in the Flora of Maharashtra (Almeida 2001). But what about the "original" *G. latifolium*? Cork is not present in the type material nor mentioned in the protologue. However, bark that forms cork (cork platelets or pustules) has been observed as well. Omlor (1997: 51) described this trait for *G. latifolium*, and so did Li & al. (1995) for Chinese material. Thus, this character cannot be used to distinguish between the three taxa, and we conclude that *G. kollimalayanum* and *G. khandalense* are synonyms of *G. latifolium*.

In their differential diagnosis, Ramachandran & Viswanathan (2009) compared their new species, *Gymnema kollimalayanum*, with *G. hirsutum* Wight & Arn., but that species possesses glabrous corolla lobes and an inconspicuous style-head. Santapau (1949) compared his new species, *G. khandalense*, with *G. sylvestre*, but correctly emphasized the massive plant growth, and the pubescent corolla lobes and follicles as being different. However, the authors of these two taxa did not compare their new species with *G. latifolium*, although especially the large, broadly ovate, pubescent and discorolous leaves are highly significant for species recognition (Fig. 1A). Important features present in all *G. latifolium* specimens examined are the dense pubescence at least of the stems and petioles, the peduncled, multi-flowered, sciadioidal, often paired inflorescences (Fig. 1A, B), the campanulate corolla, and the corolline corona that forms decurrent hirsute ridges below the corolla lobe sinuses but does not project beyond them (Fig. 1D). The impressive column-shaped gynostegium topped by an exposed egg-shaped style-head (Fig. 1D) are characters found in many other species of *Gymnema* as well. However, guide-rail and pollinarium structures are equally important for possible gynostegium-based species delimitation. *G. sylvestre*, for example, has much more pronounced guide-rails that run along the whole length of gynostegium. If fresh material is available, the copious latex can be tested for its bright yellow, opaque colour as well. However, this character is shared with many other *Gymnema* species.

The illustration of *Gymnema latifolium* presented in the *Flora of China* (Li & al. 1995: http://www.efloras.org/object_page.aspx?object_id=86383&flora_id=2 accessed 25 Mar 2013) is a good match for this species – except for the absence of indumentum on the leaves, and for the follicles, which are normally more slender than depicted there. Instead, they are c. 8 cm long and 5–8 mm in diam. It is imaginable, though, that the follicle shown in the Flora of China has been drawn by using the outline of the opened and spread follicle that is part of the syntype specimen in E (Wallich Asclep. no. 144). In all three protologues, including the one of *G. latifolium*, a slender follicle is described, but not an ovoid one as depicted and described in the *Flora of China*. The indumentum, however, represents one of the most variable characters in all *Gymnema* species and is therefore not useful for species delimitation (Forster 1995).

Wight (1834), Santapau (1949) and Ramachandran & Viswanathan (2009) described a "corona" referring to the fleshy corolline corona present in flowers of *Gymnema* and *Bidaria* species. However, the terminal free lobular projection typical for the corollas of *Gymnema* is missing in *Bidaria* (cf. Huber 1983; Omlor 1997; Jagtap & Singh 1999). Thus, because the corona in *G. latifolium* is restricted to five fleshy ridges situated in the corolla tube (each ridge under the sinus of two corolla lobes), this species conforms to the concept of *Bidaria* as proposed for *G. latifolium* by Li (1991), and for the synonymous *G. khandalense* by Jagtap & Singh (1999). *G. latifolium*, however, is missing the bifarious stem indumentum, proposed by Huber (1983) as diagnostic for *Bidaria*. Bifarious stem indumentum is lacking also in species from Australasia (cf. Forster 1995) and the Philippines, e.g. *G. inodorum*. Because of the lack of truly diagnostic characters, the separation of *Bidaria* from *Gymnema* in two genera is hardly accepted anymore (cf. Forster 1995; Li & al. 1995; Omlor 1997) and has been used recently only by Jagtap & Singh (1999) in the Flora of India. *Gymnema* (incl. *Bidaria*) is sometimes even treated as part of *Marsdenia* R. Br. (e.g. Forster 1995) – a proposal made with regard to the several character transitions between the two genera as there are: (1) similar corolline coronas as in *M. rostrata* R. Br. and other Australian species, in particular (cf. Omlor 1997), and (2) the development of a gynostegial corona (see below). Molecular work to reconstruct the phylogeny of *Marsdenieae* and also clarifying the circumscription of *Marsdenia* and *Gymnema* is underway at the Universities of Stockholm, Philadelphia, and Bayreuth.

None of the protologues (Wight 1834; Santapau 1948; Ramachandran & Viswanathan 2009) or flora descriptions, however, mentions a gynostegial corona, although one is present. Shortly beneath each anther, a small scale (c. 0.07 × 0.2 mm) is developed which has to be interpreted as gynostegial corona (Fig. 1E). These scales are difficult to observe with photo-optical tools, especially when dried and shrunk or when covered by nectar or by fixing fluids like alcohol. Instead, the scanning electron microscope allows observation of this highly reduced coronal structure (Fig. 1E). With the observation of a gynostegial corona in *Gymnema*, again, the morphological boundaries between *Gymnema* and *Marsdenia* are blurred, because *Gymnema* has been diagnosed by the lack of a gynostegial corona, whereas *Marsdenia* is

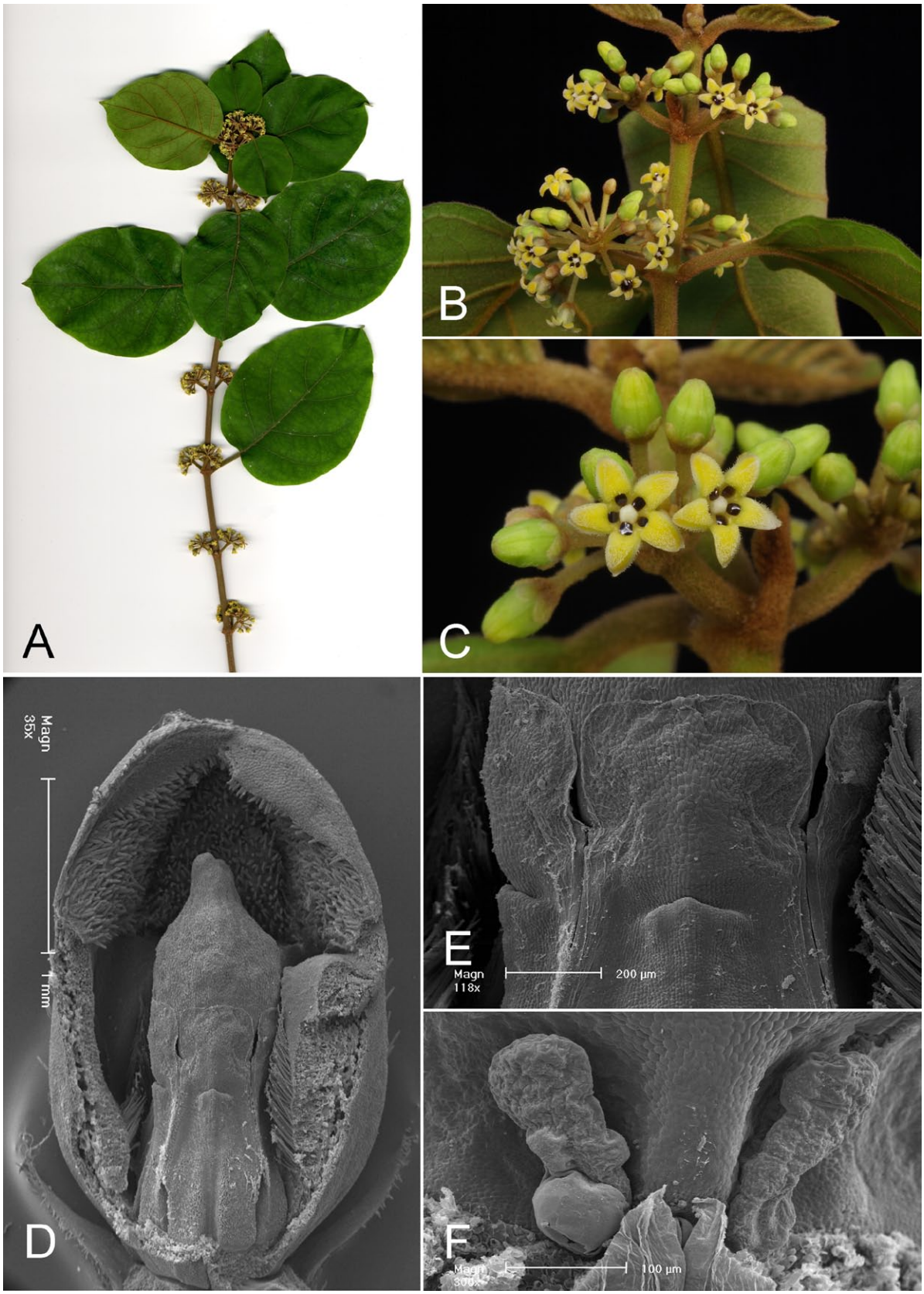

Fig. 1. *Gymnema latifolium* – A–B: flowering stems; C: flowers in top view showing black nectar in the five separated cavities formed by the corolline corolla; D: SEM micrograph of mature flower bud, two sepals removed, exposing gynostegium incl. massive style-head; bearded corolline corona ridge inside corolla tube (right side of flower); E: SEM micrograph of staminal corona scale (central) on back of anther that is terminated by rectangular anther appendage; F: SEM micrograph of pollinarium. – All from *M. Sardesai 705* (UBT).

charactized by its presence. *G. latifolium*, nevertheless, is not the only species of the genus possessing gynostegial corona lobes or scales (cf. also Forster 1995). We did not investigate more than a handful of species in detail, but found similar coronal structures also in *G. pachyglossum* Schltr. and in *G. inodorum* (Lour.) Decne.

Nectar is copiously produced by ten nectaries (nectary patches) at the base of the gynostegium (Fig. 1D; cf. also Li & al. 1995, fig. 231, 5; Ramachandran & Viswanathan 2009: fig. 1, O). The originally translucent nectar becomes blackish with age (Fig. 1C), as can be observed in some Marsdenieae species (e.g. *Gongronema angolense* (N. E. Br.) Bullock) and also in other asclepiads such as *Macroscepis hirsuta* (Vahl) Schltr. (Meve, unpubl. obs.).

The pollinaria of this species are fairly tiny with a comparatively small ovoid corpuscle with broad kidney-shaped to sub-hemispherical caudicles and erect, oblongoid-obovoid pollinia, c. 0.2 mm long (Fig. 1F; cf. also Jagtap & Singh 1999: pl. 16, fig. 3). They are comparable to pollinaria of other *Bidaria*/*Gymnema* species (cf. Jagtap & Singh 1999).

Reduction of *Gymnema khandalense* to a synonym of *G. latifolium* means that this species should no longer be considered as endangered in India (cf. Nayar & Sastry 1990). Possibly, *G. latifolium* is even more common than currently known. When not in flower, it can easily be overlooked in the field. It seems to flower rarely and only at a very mature state (pers. obs. Vazhachal, cited in Prabhakaran & al. 2004). In greenhouse cultivation in Bayreuth, Germany, where we have been cultivating the species since 2002 (raised from seeds), the first flowers were produced in 2010 (Fig. 1A–C). Finally, *G. latifolium* is a strongly growing liana that can reach 25 m in height, where the flowers are hard to spot and collect.

Taxonomy and Nomenclature

Gymnema latifolium Wall. ex Wight, Contr. Bot. India: 45. 1834 ≡ *Bidaria latifolia* (Wall. ex Wight) P. T. Li in J. S. China Agric. Univ. 12(3): 39. 1991. – Lectotype (designated by Rahman & Wilcock 1993: 10): Bangladesh, Silhet, mixed woods, 500–1000 m, *N. Wallich Asclep No. 68b* (E; isolectotype: K). – Syntypes: Bangladesh, Silhet, mixed woods, 500–1000 m, *N. Wallich Asclep No. 68a* (E, K); Myanmar, Tavoy, mixed woods, 500–1000 m, *N. Wallich Asclep. no. 144* (E!); Myanmar, Saluen, mixed woods, 500–1000 m, *Wallich Cat. no. 1532* (K).
= *Gymnema khandalense* Santapau in Kew Bull. 1948: 486. 1949, **syn. nov.** ≡ *Bidaria khandalensis* (Santapau) A. P. Jagtap & N. P. Singh in Biovigyanam 16: 62. 1990, "*khandalense*". – **Lectotype (designated here):** India, Maharashtra, Khandala, lower slopes of c. 550 m alt. sub Duke's Nose ravine, 1 Nov 1944, *H. Santapau 5434* (BLAT; isolectotypes: A (sub *H. Santapau 5437*), K (sub *H. Santapau 5435*), BLAT (sub *H. Santapau 5436* & *5437*)). – Syntypes: St Xavier ravine, 20 Jan 1945, *H. Santapau 5797* (BLAT, K; isosyntypes: A (sub *H. Santapau 5795*), BLAT (sub *H. Santapau 5796* & *5798*)).
= *Gymnema kollimalayanum* A. Ramachandran & M. B. Viswan in Adansonia, sér. 3, 31: 408. 2009, **syn. nov.** – Holotype: India, Tamil Nadu, Namakkal Distr., Kollihills, Sethukadai, c. 850 m alt., 13 Aug 2005, *A. Ramachandran 912* (MH; isotype: Herbarium of Dept. of Plant Science, Bharathidasan Univ.).

Description — *Lianas*, up to 15(–25) m high, often many-branched; *latex* light yellowish. *Shoots* 1–3 cm diam., woody, lenticellate, basally corky with platelets and/or pustules, young shoots densely (rusty) tomentose. *Leaves* petiolate, petioles 2–4 × 0.3 cm, subterete, rusty tomentose; *leaf* blades herbaceous, discolorous (upper side dark green, lower side bright green), elliptic to broadly ovate (to suborbicular), 5–16 × 2–11 cm, rusty pubescent to tomentose all over, basally subtruncate to subcordate, apically acuminate; *nerves* in 3 or 4 pairs, obtruding on abaxial surface of leaves, more densely tomentose. *Inflorescences* extra-axillary, paired, multi-flowered, sciadioidal; *peduncles* 1–2 × 1–1.8 mm, rusty tomentose. *Pedicels* c. 5–8 × 1 mm, rusty tomentose. *Flowers* ovoid in bud, corolla lobes contorted. *Sepals* ovate, c. 2 × 1.5 mm, abaxially rusty pubescent to tomentose. *Corolla* (bright) yellow, campanulate, 3.5–5 mm long, scattered pilose on outer side, corolla tube 1–2 × 1–2 mm, adaxially glabrous; *corolla* lobes triangular-ovate, 1.2–1.8 × c. 1.2 mm, spreading, adaxially densely pubescent, bluntly acute at apex. *Corolline* corona present, consisting of five longitudinal ridges inside corolla tube below corolla lobe sinuses, creamish or bright yellowish, ridges fleshy, c. 1.5 mm long, conical, adaxially with two decurrent hirsute ridges, apically broadened, flattened. *Gynostegial* corona reduced to inconspicuous scales shortly below back of anthers, scales broadly deltoid, erect, c. 0.04 × 0.2 mm. *Gynostegium* concealed in corolla, column-shaped, nearly 2.5 mm long (incl. style-head), bright yellowish-green; *anther* wings extending along ⅔ of gynostegium length; *base* of gynostegium slightly swollen, laterally with ten oval nectary patches. *Connective* appendages membranous, broadly ovate to rectangular, c. 0.25 × 0.4–0.5 mm, vertically appressed to lateral faces of style-head; *style-head* much exserted above anthers (and corolla tube), upper part c. 1.5 mm long, ovoid, whitish, pointed, apically bifurcate. *Pollinaria*: pollinia erect, c. 0.2 × 0.075 mm, oblongoid-obovoid, yellow, with slightly inwardly curved outline, (sub)basally attached to the caudicles; *caudicles* ascending, c. 0.05 mm long, slightly bent, sublaminar; *corpusculum* broadly ovoid, c. 0.8 mm long. *Mericarps* usually one per flower, spreading to pendulous, fusiform, terete, shortly beaked, 6.5–12 × 0.5–1(–1.5?) cm, rusty pubescent (at least when immature). *Seeds* many, oblong-lanceolate, winged, 10–14 × 3–4.5 mm, dark brown, wing light brown, 0.5–1 mm wide; *coma* 3–4 cm long, white.

Somatic chromosome number — 2*n* = 22. Voucher: India, Maharashtra, Kolhapur, Panhala, 10 Oct 2001, *M. Sardesai 705* (UBT). First count for this species.

Distribution — Andaman and Nicobar Islands, Bangladesh, China (Guangdong, Guangxi, S Yunnan), India (Arunachal Pradesh, Assam, Kerala, Maharashtra, Tamil Nadu), Myanmar, Thailand, Vietnam.

Note on the lectotypification of *Gymnema khandalense*

In their 1990 paper, Jagthap & Singh did not mention the type of *Bidaria khandalensis*, and in their flora of 1999, the specimen *H. Santapau 5434* in BLAT is cited as holotype. However, the two type collections made and cited in the protologue are represented by (1) a flowering specimen (*H. Santapau 5434*, collected at Duke's Nose ravine on 1 Nov 1944), and (2) a fruiting specimen (*H. Santapau 5797*, collected at St Xavier ravine on 20 Jan 1945). Thus, the "type" is represented by two independent and different specimens (gatherings) – a case that is not in accordance with the International Code of Nomenclature for algae, fungi, and plants (ICN; McNeill & al. 2012: Art. 8.1, 8.2; http://www.iapt-taxon.org/nomen/main.php) because a holotype or lectotype, when not an illustration, must be a single specimen. Therefore, one of the two gatherings of Santapau, cited by him as "*typus florum*" (= *H. Santapau 5434*) and *"typus fructuum"* (= *H. Santapau 5797*), has to be chosen as the lectotype. Since flowers are most distinctive in *Gymnema*, the specimen *H. Santapau 5434* (BLAT) is selected here to serve as lectotype. BLAT (Kale, pers. comm.) reported on the existence of two further specimens of the gathering from 1 Nov 1944, stored under the numbers *H. Santapau 5436* and *H. Santapau 5437*, and also of the gathering from 20 Jan 1945, stored under *H. Santapau 5796* and *H. Santapau 5798*. Although provided with four different numbers, these specimens clearly belong to only two gatherings, so that nos. *5436* and *5437* should be regarded as duplicates of one gathering, and nos. *5796* and *5798* as duplicates of the other.

Additional *Gymnema* material investigated

Gymnema latifolium – India (Maharashtra): Khandala, lower slopes at c. 550 m alt., St Xavier ravine, 20 Jan 1945, *H. Santapau 5797* (K); Kolhapur, Panhala, 10 Oct 2001, *M. Sardesai 705* (SUK, UBT).

Gymnema inodorum – Philippines (Luzon): Irosin: San Benon; San Mateo Hot and Cold Springs Ressort, *J. Schneidt 96-100*, 5 Jun 1996 (B, UBT).

Gymnema pachyglossum – Philippines (Palawan): c. 40 km S Puerto Princesa, *S. Liede & U. Meve 3609*, 11 Oct 2006 (UBT).

Gymnema sylvestre – Cameroon: 20 km E Mokolo, 11 Mar 1995, *U. Meve 919* (B, UBT); Indonesia (Bali): E of Singaraja, 2005, *M. Boppré 05-1069* (UBT).

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