

TAXONOMIC REVISION OF *CALAMAGROSTIS FILIFORMIS*, *C. TRIPILIFERA* AND THEIR ALLIES (POACEAE: AGROSTIDINAE)

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Abstract. Nomenclatural notes and typification are provided for three of Hooker's taxa (*Calamagrostis tripilifera*, *C. tripilifera* var. *cumminsii*, *Deyeuxia triaristata*) and one of Grisebach's species, *Calamagrostis filiformis*. The taxonomic position of *C. tripilifera* is reconsidered. A comparison of *C. tripilifera* with Chinese *D. flavens* showed them to be conspecific. *C. tripilifera* var. *cumminsii* and *D. triaristata* are regarded as conspecific with Grisebach's *C. filiformis*, which until now has been considered a member of the separate species complex *C. lahulensis*–*C. scabrescens*. My revision showed that Hooker misapplied Grisebach's *C. filiformis*. The Yunnan record of *Calamagrostis filiformis* sensu Grisebach is the first one I have found from this province and the first one confirmed for China.

Key words: China, *Deyeuxia triaristata*, *D. tripilifera*, *D. flavens*, India, typification, Nepal, new records, new synonyms, nomenclature, taxonomy

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INTRODUCTION

Within the two closely related genera *Calamagrostis* Adans. and *Deyeuxia* Clarion ex P. Beauv. in India (Hooker 1987) and China (Lu *et al.* 2006) is a species complex characterized as follows: a very well developed awn geniculated with a twisted column inserted subbasally or below the middle on the 5-veined lemma; lateral awns or mucros at the lemma tip; palea more than half the lemma length; and a short rachilla prolongation sparsely covered in hair. In NE India this group is represented by three taxa described by Hooker (1897) from the Sikkim Himalayas: *Calamagrostis tripilifera* Hook. f., *C. tripilifera* var. *cumminsii* Hook. f. and *Deyeuxia triaristata* Hook. f. My taxonomic revision of their allies shows that *Calamagrostis filiformis* Griseb. is also related to this species complex. Until now, *C. filiformis* has been regarded as related to *C. lahulensis* G. Singh and *C. scabrescens* Griseb. (Hooker 1897; Bor 1960; Noltie 2000). Table 1 presents the taxonomic treatment and generic status of those taxa according to different authors.

A similar species complex in China (Lu *et al.* 2006) includes *Deyeuxia flavens* Keng, *D. venusta* Keng, *D. filipes* Keng and *Calamagrostis longiflora*

Keng ex Keng f. The first three were described by Keng (1941a, b). The name *C. longiflora* was invalidly published by Keng, so later this species name was validated by Keng f. (1982). In *Flora of China*, Lu *et al.* (2006) accepted *Deyeuxia flavens* with *D. venusta* and *Calamagrostis longiflora* in synonymy. There is a suggestion that *Deyeuxia filipes* may be a hybrid between *D. flavens* and *D. mazzettii* Veldkamp (Lu *et al.* 2006).

I made a detailed taxonomical revision of the species complex in India, and describe the results below.

CALAMAGROSTIS FILIFORMIS AND ALLIES

Grisebach (1868) described *Calamagrostis filiformis* citing specimens from Sikkim (*J. D. Hooker*, 'Deyeuxia 3'). I agree with Noltie (1999) that 'Deyeuxia 3' is not a unique collection number but rather an aggregate 'species number' and that Hooker applied it to several sheets of what he believed to be the same species collected in Sikkim. Seven duplicates representing the type collection of *C. filiformis* were found at seven different herbaria:

Table 1. Taxonomic treatment and generic status of *Calamagrostis filiformis*, *C. tripilifera* and its relatives in selected Asian floras. y = accepted by their author(s), n/a = the taxon was not mentioned in the source.

| Species | Grisebach 1868 | Hooker 1897 | Bor 1960 | Noltie 2000 | Accepted taxa in the present study |
|---|-------------------|---------------------------|----------------------------------|---|---------------------------------------|
| <i>Calamagrostis filiformis</i> | y | as <i>D. filiformis</i> † | syn. <i>D. scabrescens</i> † | y (in synonymy: <i>C. scabrescens</i> var. <i>humilis</i> , <i>D. pulchella</i> var. <i>laxa</i>)† | y |
| <i>Calamagrostis tripilifera</i> | n/a | y | syn. <i>Agrostis triaristata</i> | syn. <i>Agrostis triaristata</i> | y |
| <i>Calamagrostis tripilifera</i> var. <i>cumminsii</i> | n/a | y | n/a | syn. <i>Agrostis triaristata</i> | syn. <i>C. filiformis</i> Griseb. |
| <i>Deyeuxia triaristata</i> | n/a | y | as <i>Agrostis triaristata</i> | as <i>Agrostis triaristata</i> | syn. <i>C. filiformis</i> Griseb. |
| <i>Deyeuxia flavens</i> | n/a | n/a | n/a | n/a | syn. <i>C. tripilifera</i> Hook. f. |

† Hooker (1897), Bor (1960) and Noltie (2000) misapplied Grisebach's *C. filiformis*. *Deyeuxia filiformis* sensu Hooker f. is related to a very variable species complex of *C. lahulensis* and *C. scabrescens*.

BM, CAL, GH, GOET, K, L and W. Revision showed that these seven syntype sheets bear three different taxa: *C. filiformis* sensu Grisebach, *Aniselytron* sp., and *Deyeuxia filiformis* sensu Hooker f. The examined syntypes are as follows:

1. *C. filiformis* m., 'Deyeuxia 3', Sikkim, *J. D. Hooker* (GOET) (Fig. 1) – This syntype is the only one which bears on the herbarium labels the name 'C. filiformis m.' written in Grisebach's hand. The syntype sheet bears three plants. I identify the left-hand and right-hand specimens as *Calamagrostis filiformis* Griseb., and the middle one as *Aniselytron* sp. The right-hand specimen of *C. filiformis* is designated as the lectotype.

2. 'Deyeuxia 3', Sikkim, *J. D. Hooker* (L) = *C. filiformis* Griseb.

3. 'Deyeuxia 3', Sikkim, *J. D. Hooker* (W) – The syntype sheet bears four plants. I identify the three left-hand specimens as members of *Aniselytron* sp.; the right-hand specimen is *Calamagrostis filiformis* Griseb.

4. 'Deyeuxia 3', Sikkim, *J. D. Hooker* (CAL) = *C. filiformis* Griseb.

5. 'Deyeuxia 3', Sikkim, *J. D. Hooker* (GH) = *C. filiformis* Griseb.

6. 'Deyeuxia 3', Sikkim, *J. D. Hooker* (BM) = *C. filiformis* Griseb.

7. 'Deyeuxia 3', Sikkim, Tungee to Samdong, 29 July 1849, *J. D. Hooker* (K) – This syntype sheet is a compilation of two different sheets bearing two morphologically similar specimens and two field labels which indicate that both specimens were collected in the same locality. The specimens on the herbarium sheet closely resemble species representing the complex comprising *Calamagrostis lahulensis* and *C. scabrescens*, which needs further taxonomic study. I identified these specimens as *Deyeuxia filiformis* sensu Hooker f.

8. 'Deyeuxia 3', Sikkim, *J. D. Hooker* (LE) – The syntype sheet bears three plants. I identified the left-hand and right-hand specimens as members of *Calamagrostis filiformis* Griseb., whilst the middle specimen as *Aniselytron* sp.

Seven of the eight syntype sheets of 'Deyeuxia 3' (the exception is the one at K) bear elements of *Calamagrostis filiformis* sensu Grisebach, but unfortunately three of them, one at GOET annotated

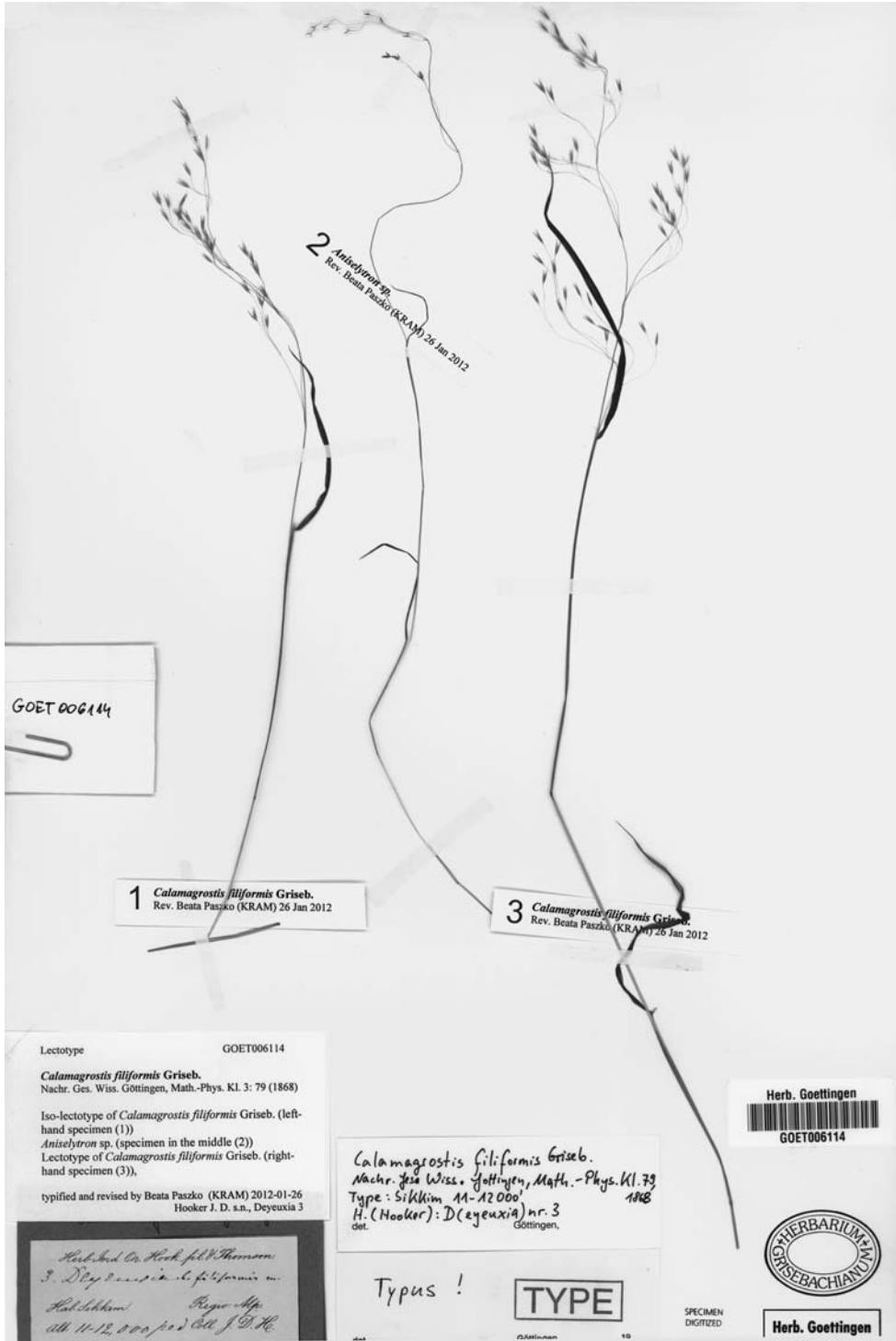


Fig. 1. Lectotype of *Calamagrostis filiformis* Griseb.

with the name in Grisebach's hand (Fig. 1), one at LE and another one at W, bear elements of two different taxa: *Calamagrostis filiformis* sensu Grisebach and *Aniselytron* sp. Grisebach's description of *Calamagrostis filiformis* includes only one element and the name can be applied unambiguously to one taxon, *C. filiformis* sensu Grisebach, which is characterized by two lateral awns *ca* 1.5 mm long at the lemma tip.

The specimens of *Aniselytron* are incomplete. They have very short glumes and no lateral awns at the lemma tip. Only the mixed sheet of 'Deyeuxia 3' at GOET bears a panicle of *Aniselytron* with three complete spikelets (with florets). The genus *Aniselytron* is characterized by glumes conspicuously shorter than the lemma, which is a salient characteristic of *Aniselytron*. Recent morphological and molecular studies have revealed that *Aniselytron* is a member of Poeae subtribe Poinae (in the Poeae-type plastid DNA clade) and not closely related to *Calamagrostis* s.l. (Ma *et al.* 2005; Soreng *et al.* 2007; Gillespie *et al.* 2008). Morphologically the *Aniselytron* specimens mixed with the type collection of *C. filiformis* are not a good match with *Aniselytron treutleri* (Kuntze) Soják, the species currently known from Sikkim (Hooker 1897; Bor 1960). The incomplete collection does not allow for further detailed analysis.

The syntype sheet of 'Deyeuxia 3' housed at Kew bears specimens morphologically differing from *Calamagrostis filiformis* sensu Grisebach found on the other syntype sheets, and do not match its description. The Kew material is what Hooker f. saw, and what he based his misinterpretation of *Deyeuxia filiformis* in *Flora of British India* (Hooker 1897). *Deyeuxia filiformis* sensu Hooker has spikelets with a very well developed rachilla prolongation covered with numerous silky hairs as long as the lemma, which is a salient characteristic of the species complex *C. lahulensis*–*C. scabrescens*. Additionally, their lemmas do not have lateral awns on the top. Bor (1960) in *The grasses of Burma, Ceylon, India and Pakistan*, as well as Noltie (2000) in *Flora of Bhutan*, followed Hooker's concept of *C. filiformis*.

A further complication arises from the fact that Hooker (1897) described *Deyeuxia triaristata*,

which without doubt is conspecific with *Calamagrostis filiformis* sensu Grisebach. There are two sheets in the type cover of *Deyeuxia triaristata* at K labelled 'J. D. Hooker, Sikkim Himalayas, Yeumtong'. In *The grasses of Burma, Ceylon, India and Pakistan*, Bor (1960) transferred *D. triaristata* to *Agrostis* as *A. triaristata* (Hook. f.) Bor. Noltie (2000) in *Flora of Bhutan* as well as Hajra and Verma (1996) in *Flora of Sikkim* followed Bor's (1960) concept and maintained it under *Agrostis*.

Hooker (1897) also described var. *cumminsii* of his *Calamagrostis tripilifera*, citing Cummins' collection from NE Sikkim, which was found at Kew. Revision of the collection showed that it is conspecific with *C. filiformis* Grisebach. On the herbarium label is a note that a rachilla prolongation is absent in this case. Hooker's original description does not indicate the presence of a prolonged rachilla in *C. tripilifera*, nor in var. *cumminsii*. My revision, however, showed that both of them have a short sparsely hairy rachilla prolongation. It seems that Hooker's generic division between *Calamagrostis* and *Deyeuxia* was based on the presence or absence of a rachilla prolongation. During revision of *Agrostis triaristata* at DD I found one spikelet without a rachilla prolongation in the collection of Dr. Bor's collector 503. I maintain that the presence or absence of a rachilla prolongation is without any taxonomic value in this case.

Revision of the available Chinese collections identified previously as *Deyeuxia flavens* revealed that Soreng's collection from Yunnan is in fact *Calamagrostis filiformis* Griseb. This Yunnan record of *C. filiformis* is the first one I have discovered from the province and the first confirmed for China. It is possible that Liou (1994) recorded *C. filiformis* in *Vascular Plants of the Hengduan Mountains* under the name *Deyeuxia tripilifera* (Hook. f.) Keng [erroneously as *D. 'tripilifera'* (Liou 1994: 2238)]. Keng (1941a, b) misunderstood *D. tripilifera* as *Deyeuxia triaristata* (= *Calamagrostis filiformis*) and probably Liou (1994) and Keng f. (1982) followed Keng's concept. I could not trace the voucher specimen of *Deyeuxia tripilifera* cited by Liou (1994), J. W. Zhang 6277 collected

near Chayu (Xizang), so revision is not possible. *Calamagrostis filiformis* is not included in *Flora of China* under *Calamagrostis* (Lu & Phillips 2006b), *Deyeuxia* (Lu *et al.* 2006), or *Agrostis* L. (Lu & Phillips 2006a). In *Flora of China*, Lu *et al.* (2006) characterized *Deyeuxia flavens* as “having lateral and intermediate veins prolonged into 0.5–1.5 mm mucros with the outermost mucros longest”. I suggest that the range of variation of mucro length covers *Deyeuxia flavens* and also *Calamagrostis filiformis*.

The following more detailed synonymy and typification can therefore be made:

Calamagrostis filiformis Griseb.

Nachr. Königl. Ges. Wiss. Georg-Augusts-Univ. **1868**: 79. 1868. ≡ *Deyeuxia filiformis* (Griseb.) Hook. f., Fl. Brit. India **7**(22): 268. 1897. TYPE CITATION: H[imalaya] or [ientalis], Sikkim, 11–12,000 ft, H[ooker]: D[eyeuxia] no. 3. LECTOTYPE (designated here): [India], Sikkim, ‘*Deyeuxia* 3’ [p.p., mixed collection with *Aniselytron* sp., the right-hand specimen of *C. filiformis* is designated as lectotype], *J. D. Hooker* (GOET!); ISOLECTOTYPES: BM!, CAL!, GH!, L!, W!.

= *Deyeuxia triaristata* Hook. f., Fl. Brit. India **7**(22): 266. 1897, **syn. nov.** ≡ *Agrostis triaristata* (Hook. f.) Bor, Grass. Burma, Ceylon, India & Pakistan 391. 1960. TYPE CITATION: Sikkim Himalaya; in woods, Yeumtong, alt. 12,000 ft, *J. D. H[ooker]*. LECTOTYPE (designated here): India, Sikkim, *Deyeuxia* 6, Yeumtong, alt. 12,000 ft, Sept. 1848, *J. D. Hooker* (K!; barcode no. K000032326), ISOLECTOTYPE: (K!; barcode no. K000032327).

= *Calamagrostis tripilifera* var. *cumminsii* Hook. f., Fl. Brit. India **7**(22): 262. 1897, **syn. nov.** TYPE CITATION: N.E. Sikkim, *Cummins*. LECTOTYPE (designated here): India, NE Sikkim, *H. A. Cummins* (K!; barcode no. K000032325).

– *Deyeuxia tripilifera* auct. non Hook. f.: Keng, *Sunyatsenia* **6**: 68. 1941; Keng, *Sunyatsenia* **6**: 94. 1941; Keng f., *Acta Bot. Yunnan.* **4**(4): 350. 1982; Liou in Wang, *Vasc. Pl. Hengduan Mount.* **2**: 2238. 1994.

SPECIMENS SEEN. CHINA. YUNNAN: Fugong (N 1/2 Bijiang) Co., W slope of Bilou Mts, E side of Nu Jiang (Salween Rv.), above Bijiang ca 10 km. by rd., ca 45 km S of Fugong, 2900–3200 m, 26°30'N, 100°00'E, 8 Sept. 1997, *R. J. Soreng et al.* 5233 (PE, US). INDIA. SIKKIM: without precise locality, above 6000 ft, Nov–Dec 1943, *N. L. Bor's coll.* 308, *N. L. Bor's coll.* 319, *N. L. Bor's coll.* 320, *N. L. Bor's coll.* 332, *N. L. Bor's coll.* 335

(DD); Kopuh, 13,000 ft, 5 Sept. 1945, *N. L. Bor's coll.* 460, *N. L. Bor's coll.* 886 (DD); Kopuh, 13,000 ft, 31 Aug. 1945, *N. L. Bor's coll.* 636, *N. L. Bor's coll.* 865 (DD); Tsomgo, 12,000 ft, 17 Sept. 1945, *N. L. Bor's coll.* 477, *N. L. Bor's coll.* 496 (DD); Tsomgo, 13,000 ft, 8 Aug. 1945, *N. L. Bor's coll.* 782 (DD); Chumunko, 14,000 ft, 18 Sept. 1945, *N. L. Bor's coll.* 498, *N. L. Bor's coll.* 503 (DD); Namnam, 12,000 ft, 19 Sept. 1945, *N. L. Bor's coll.* 526; Changu, 12,000 ft, 27 Sept. 1913, *R. E. Cooper* 963 (BM). NEPAL. Tudam, 12,000 ft, 1 Nov. 1971, *L. W. Beer* 10667 (BM); Bhararate Himal: Barun Valley, Yangle pasture, 3700 m, 2 Oct. 1972, *T. Wraber* 350 (BM, LE); Koshi Zone, Sankhuwasabha distr., Chyakesha (3850 m) – Kibuk (3640 m) – Jaggu Danda (4210 m) – Sando Birke (3990 m) – Lachembu (3930 m) – Dogor Phuk (3755 m), 3760 m, 27 Aug. 1997, *S. Noshiro et al.* 9770335 (BM, E); Near Mandanda, 28 Sept. 1964, *Dr. Baneryee, Shreshta & Upadhyay* 2940 (US); Langtang, Schiabru N Slank, 4160 m, 24 Oct. 1986, *G. & S. Mieche* 14787 (K).

RECONSIDERATION OF THE SPECIFIC STATUS OF *CALAMAGROSTIS TRIPILIFERA*

Calamagrostis tripilifera was described by Hooker (1897), who cited three syntypes (*J. D. Hooker, Clarke, Dr. King's collector*) collected in Sikkim. These have been found at K; the first was collected from Tungu (Fig. 2), the second from Jongri, and the third from Bijan. All of them are annotated with the name in Hooker's hand, but unfortunately they comprise two different species, only one of which I propose to call *Calamagrostis tripilifera*; the other two are *Calamagrostis filiformis* Grisebach. The examined syntypes are listed below:

1. Sikkim, Himalaya, Tungu, 1848, *J. D. Hooker s.n.* (K000098593) (Fig. 2) = *Calamagrostis tripilifera* Hook. f.
2. Sikkim, Jongri, alt. 13,000 ft, 15 Oct 1875, *C. B. Clarke* 26196 (K000098591) = *Calamagrostis filiformis* Griseb.
3. Sikkim, Bijan, 1889, *Dr. King's collector s.n.* (K000098592) = *Calamagrostis filiformis* Griseb.

The first syntype, Hooker's collection from Tungu, represents, I suggest, material in full accordance with the original description of *Calamagrostis tripilifera* as provided by Hooker (1897), which is characterized by two short (ca 0.7 mm

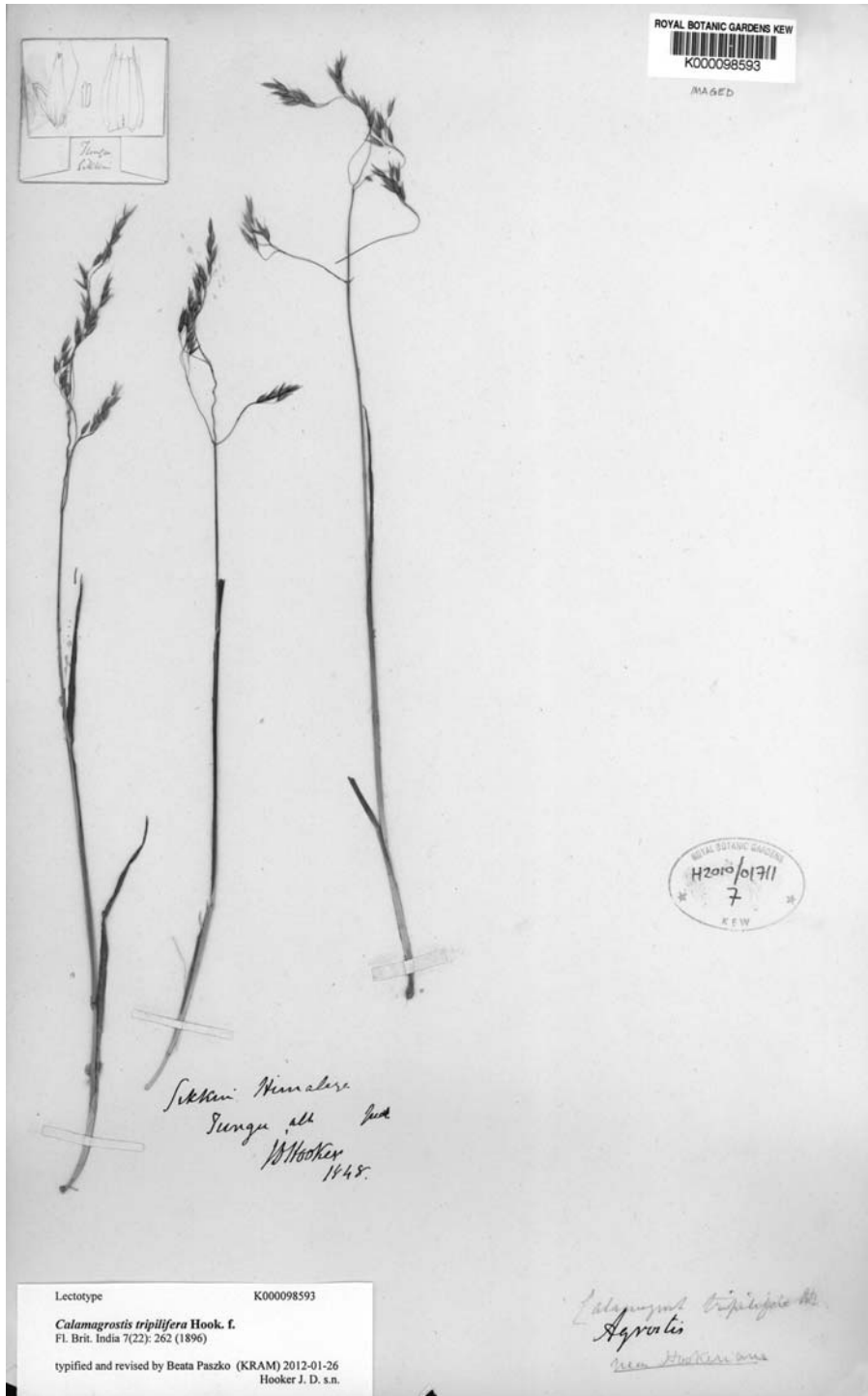


Fig. 2. Lectotype of *Calamagrostis tripilifera* Hook. f.

long) lateral awns at the lemma tip. The other two syntypes of *Calamagrostis tripilifera*: Clarke 26196 and Dr. King's collector s.n., are conspecific with the original collections of Grisebach's *Calamagrostis filiformis*, which is characterized by long (ca 1.5 mm long) lateral awns at the lemma tip.

Hooker (1897) described *Deyeuxia triaristata* in addition to *Calamagrostis tripilifera*. Currently these species are not accepted as distinct. Bor (1960) transferred the former to *Agrostis* as *Agrostis triaristata* (Hook. f.) Bor with *C. tripilifera* in synonymy. For clarification of the differing criteria regarding the taxonomic status and the identification of these two species, I had to go back to the protologues and the original material. Both the protologue and an examination of the lectotype of *Calamagrostis tripilifera* show that Hooker (1897) intended to describe a species with two short lateral awns at the lemma tip as *C. tripilifera*, and a species with two longer lateral awns at the lemma tip as *Deyeuxia triaristata*. Once again I can confirm the diagnostic value of the length of the two lateral awns for identification of these two species. In my opinion, the original description of *Calamagrostis tripilifera* does not indicate similarity between *C. tripilifera* and *Deyeuxia triaristata*. Hooker's (1897) description of *Calamagrostis tripilifera* matches the three specimens from Hooker collection (barcode no. K000098593), which he obtained at Tungu in the Sikkim Himalayas, India. Hooker's collection of *C. tripilifera* is the only one I found from India. In this revision I transfer *Deyeuxia triaristata* to synonymy with *C. filiformis* Griseb. (see above).

The Chinese *Deyeuxia flavens* and Indian *Calamagrostis tripilifera* Hook. f. share a noticeable morphological similarity. Keng (1941a) considered the closeness of *Deyeuxia flavens* to *D. tripilifera* (Hook. f.) Keng, but he misapplied the name *Deyeuxia tripilifera* to Hooker's *Deyeuxia triaristata* (= *Calamagrostis filiformis* Griseb.), which is characterized by lateral awns 1.5 mm long. On the PCA plot (Fig. 3) there is a gap between the clusters of *C. filiformis* and *C. tripilifera*. The lectotype of *C. tripilifera* fell within the group of *Deyeuxia flavens* from China,

whereas the lectotypes of *C. filiformis*, *C. tripilifera* var. *cumminsii* and *Deyeuxia triaristata*, as well as specimens identified as *Agrostis triaristata*, cluster together forming a separate group of specimens. There is undoubtedly a close morphological similarity between Keng's *D. flavens* and Hooker's *C. tripilifera* collected at Tungu in Sikkim, and they are considered conspecific here. However, further detailed taxonomic revision of the species complex comprising *Deyeuxia flavens*, *D. venusta*, *D. filipes*, and *Calamagrostis longiflora*, with particular reference to China, is necessary.

The following synonymy and distribution can be given:

***Calamagrostis tripilifera* Hook. f. Fig. 2**

Fl. Brit. India 7(22): 262. 1897. ≡ *Deyeuxia tripilifera* (Hook. f.) Keng, Sunyatsenia 6(1): 68. 1941. TYPE CITATION: Sikkim Himalaya, in the drier interior, alt. 10–13,000 ft, *J. D. H., Clarke, King's Collector*. LECTOTYPE (designated here): [India], Sikkim, Himalaya, Tungu, 1848, *J. D. Hooker s.n.* (K!).

= *Deyeuxia flavens* Keng, Sunyatsenia 6: 67. 1941, **syn. nov.** TYPE CITATION: Type in the Herbarium of the Biological Laboratory, the Science Society of China, no. 57974 (in part), collected on steppe, Labrang, Kansu prov., 8 October 1934, by *C. W. Yao* (no. 515 in part, mixed with *Poa sphondylodes* Trin. var. *macerima* Keng). HOLOTYPE: China, Kansu [Gansu] prov., Labrang, collected on steppe, 8 Oct. 1934, *C. W. Yao* 515 (p.p., mixed with *Poa sphondylodes* Trin. var. *macerima* Keng) (IBSC, n.v.).

SPECIMENS SEEN. CHINA. GANSU: Luqu, ca 30–40 km N of Gansu-Sichuan border on rd. from Chengdu to Lanzhou, ca 20 km S of Waxu and 10 km E of Gahai, ca 230 km SSW Lanzhou, 3440 m, 18 Sept. 1997, *R. J. Soreng* 5385 (with company of *P. Peterson & H. Sun*) (US). QINGHAI: Yushu Xian, just E of Jiangxi Forest Station on E side of the Zi Qu, SE of Mozhong, 3540 m, 27 Aug. 1996, *T. N. Ho, B. Bartholomew, M. Watson & M. Gilbert* 2454 (PE, GH, BM); Keduo Xiang, Henan Xian, 3400 m, 19 Sept. 1970, *S. W. Liu* 1890 (CAS); Duofudun Xiang, Zeku Xian, 3400 m, 22 Aug. 1970, *S. W. Liu* 1564 (CAS); S of Xining, S slope of Laji Shan Mts, 36°18'04"N, 101°37'44"E, 1 Aug. 2010, *B. Paszko s.n.* (KRAM). SICHUAN: Tsipula, 3600 m, 2 Aug. 1922, *H. Smith* 4152 (PE); Huang-chien-kuan, ca 3300 m, 29 Aug. 1922, *H. Smith* 4059 (PE). INDIA. SIKKIM: Tungu, 1848, *J. D. Hooker s.n.* (K).

NUMERICAL ANALYSIS OF *CALAMAGROSTIS*
FILIFORMIS AND *C. TRIPILIFERA*

To further characterize variation between *C. filiformis* and *C. tripilifera*, I made a principal components analysis (PCA) of their morphological characteristics, analyzing 41 individual specimens for 13 quantitative morphological characters using Statistica software (StatSoft, Inc. Tulsa, U.S.A.). Included in the PCA were specimens identified as *Deyeuxia flavens* (10 individuals) and *Agrostis triaristata* (21 individuals), and type collections of *C. filiformis* (5 syntypes), *C. tripilifera* (3 syntypes), *C. tripilifera* var. *cumminsii* (1 syntype) and *D. triaristata* (1 syntype) (Fig. 3). The first principal component (PC1) had relatively high (positive or negative) loadings for mucro length at the lemma tip (ML), lower and upper glume width (LGW, UGW), callus hair length (CHL), lemma length (LL), length of awn column (CoL), distance from the base of the lemma to the point of awn insertion on the lemma back (AI), and three ratios: upper glume to lower glume length (UGL/

LGL), lower glume width to lower glume length (LGW/LGL), and relative awn insertion on the lemma back (AI/LL). PC2 had relatively high loadings for lower and upper glume length (LGL, UGL) and awn length (AL) (Fig. 4). On the PCA plot, the individuals form two distinct groups corresponding to two species, *C. filiformis* and *C. tripilifera*. The *C. tripilifera* cluster includes individuals previously identified as *Deyeuxia flavens*, and the lectotype of *C. tripilifera*. The second cluster includes individuals previously identified as *Agrostis triaristata*, syntypes of *C. filiformis*, *C. tripilifera* var. *cumminsii*, *Deyeuxia triaristata*, two syntypes of *C. tripilifera* recognized here as *C. filiformis*, and one collection from China (*Soreng 5233*) recognized here as *C. filiformis*.

Analysis of the morphological characters shows that *Calamagrostis filiformis* Griseb. is morphologically similar to *C. tripilifera* Hook. f. However, the former differs from the latter by having narrower lower glumes (0.9–1.5 versus 1.4–2.2 mm), an awn inserted at the lower 1/3 of lemma back

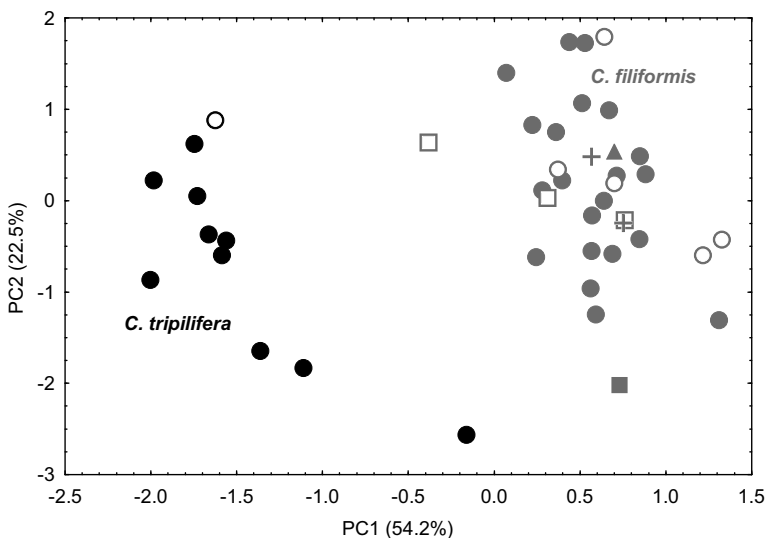


Fig. 3. Plot of principal components (PC) 1 (54.2% of total variation) and 2 (22.5% of total variation) for *Calamagrostis filiformis* (grey symbols) and *C. tripilifera* (black symbols) using 13 morphological characters (see Fig. 4). Taxa are indicated as follows: *Agrostis triaristata* (grey solid circle); syntypes of *Calamagrostis filiformis* (grey open circle); *C. tripilifera* var. *cumminsii* (grey solid square); lectotype of *Deyeuxia triaristata* (grey solid triangle); *Calamagrostis filiformis*, from Yunnan (grey open square); two syntypes of *C. tripilifera* I identified as *C. filiformis* (grey cross); *Deyeuxia flavens* (black solid circle); lectotype of *Calamagrostis tripilifera* (black open circle).

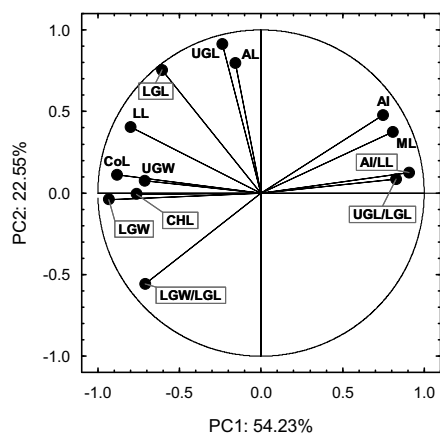


Fig. 4. Projection of the variables on the factor plane (PC1 versus PC2) scored for *Calamagrostis filiformis* and *C. tripilifera*. PC1 explains 54.23% and PC2 22.5% of the total variation. Character abbreviations: AI – distance from base of lemma to the point of awn insertion at the lemma back; AL – length of dorsal awn at lemma; CHL – length of callus hairs; CoL – length of awn column; LGL, UGL – length of lower and upper glume; LGW, UGW – width of lower and upper glume; LL – length of lemma; ML – length of lateral mucros at the lemma tip.

(0.20–0.36 versus 0.13–0.21), a shorter awn column (1.75–2.85 versus 2.0–3.5 mm), longer mucros at the lemma tip (0.90–1.75 versus 0.30–0.85 mm) and a longer upper glume in relation to the lower glume (equal or subequal versus slightly shorter) (Table 2). *Calamagrostis filiformis* (= *Deyeuxia triaristata*) and *C. tripilifera* (= *Deyeuxia flavens*) can be distinguished due to a combination of two characters: width of the lower glume and length of the mucro at the lemma tip (Fig. 5).

DEYEUZIA FILIFORMIS SENSU HOOK. F.

In *Flora of British India*, Hooker (1897) misunderstood Grisebach's *C. filiformis*. Hooker's description of *Deyeuxia filiformis* does not correspond to the description of *Calamagrostis filiformis* (Grisebach 1868). Hooker (1897) probably relied on the duplicate of 'Deyeuxia 3' (1 of 7 different syntypes) housed at K, which turns out to be something quite different from what Grisebach described. As a reference, Hooker (1897) cited his own collection from the Lachen Valley in the Sikkim Himalayas. My revision shows that the duplicate of 'Deyeuxia 3' at Kew as well as Hooker's collection from the Lachen Valley housed at CAL are members of a very variable species complex, *Calamagrostis lahulensis* and *C. scabrescens*. *Calamagrostis filiformis* Griseb. is characterized by two lateral awns ca 1.5 mm long at the lemma tip, whereas *Deyeuxia filiformis* sensu Hooker has no such awns. Additionally, *D. filiformis* sensu Hooker has a very well developed rachilla prolongation covered with long silky hairs, as long as the lemma, which is a diagnostic characteristic for the *C. lahulensis*–*C. scabrescens* complex and their allies. Bor (1960) in *The grasses of Burma, Ceylon, India and Pakistan* as well as Noltie (2000) in *Flora of Bhutan* followed Hooker's concept of *Deyeuxia filiformis*.

The taxonomic status of *Deyeuxia filiformis* sensu Hooker is uncertain and can be explained in the context of a very variable and morphologically overlapping species complex of *Calamagrostis*

Table 2. Salient characteristics of *Calamagrostis filiformis* and *C. tripilifera*.

| Character | <i>C. filiformis</i> | <i>C. tripilifera</i> |
|--|----------------------|-----------------------|
| Lower glume width (mm) | 0.9–1.5 (1.2) | 1.4–2.2 (1.9) |
| Ratio: lower glume width / lower glume length | 0.19–0.32 (0.25) | 0.32–0.43 (0.36) |
| Ratio: distance from lemma base to point of awn insertion on lemma back / lemma length | 0.19–0.36 (0.28) | 0.13–0.21 (0.15) |
| Length of the awn column (measured from the base to the point of bend) | 1.75–2.85 (2.10) | 2.0–3.5 (2.9) |
| Length of lateral mucros at lemma tip (mm) | 0.90–1.75 (1.24) | 0.30–0.85 (0.50) |
| Ratio: upper / lower glume length | 0.9–1.0 (0.96) | 0.8–0.9 (0.86) |
| Awn column length | 1.75–2.85 (2.1) | 2.0–3.5 (2.9) |

lahulensis-*C. scabrescens* and their Chinese allies, which needs further studies.

SPECIMENS SEEN. INDIA. Sikkim: Lachen Valley, 29 July 1849, *J. D. Hooker* (CAL); Tungee to Samdong, 29 July 1849, *J. D. Hooker* (K, 1 of 7 syntypes of *Calamagrostis filiformis* sensu Griseb.).

THE PROBLEM OF GENERIC POSITION

The generic positions of *Calamagrostis filiformis* and *C. tripilifera* are anomalous. Both species were described under *Calamagrostis* (Grisebach 1868; Hooker, 1897) and both of them have their own combinations under *Deyeuxia* (Hooker 1897; Keng 1941a). Bor (1960) merged the former species with *Agrostis*, as *A. triaristata* (Hook. f.) Bor (= *Calamagrostis filiformis* Griseb.). In *Flora of Bhutan*, Noltie (2000) followed Bor's concept in this case (Table 1).

Agrostis, *Calamagrostis* and *Deyeuxia* are three of the most complex and difficult grass genera within the subtribe Agrostidineae of tribe Poeae in the subfamily Pooideae (Soreng *et al.* 2007). The species concepts within these three genera

are very inconsistent between the different floras. They have been variously combined and separated during their history. I agree with Noltie (1999) that there is a lack of clear-cut characters to distinguish these genera unambiguously. The characters traditionally used include induration of the lemma, relative lengths of glumes and lemma, spikelet length, presence/length of callus hairs, and rachilla presence/absence (see key in Phillips and Chen 2003). According to Noltie (1999) and from what I have learned about the closely related species complexes within *Calamagrostis* s.l. (Howard *et al.* 2009; Paszko & Nobis 2010; Paszko 2011; Paszko & Ma 2011), all these characters are variable and occur in various combinations.

Jacobs (2001) used a study of lemma epidermal features to try to settle the confusion surrounding the generic limits between *Agrostis*, *Calamagrostis*, *Deyeuxia* and *Lachnagrostis*. My study of the lemma epidermis of *Calamagrostis filiformis* and *C. tripilifera* shows that the two have a similar lemma epidermal pattern: long cells with raised wavy margins, long cells interspersed with short cells, and these always bearing short prickles

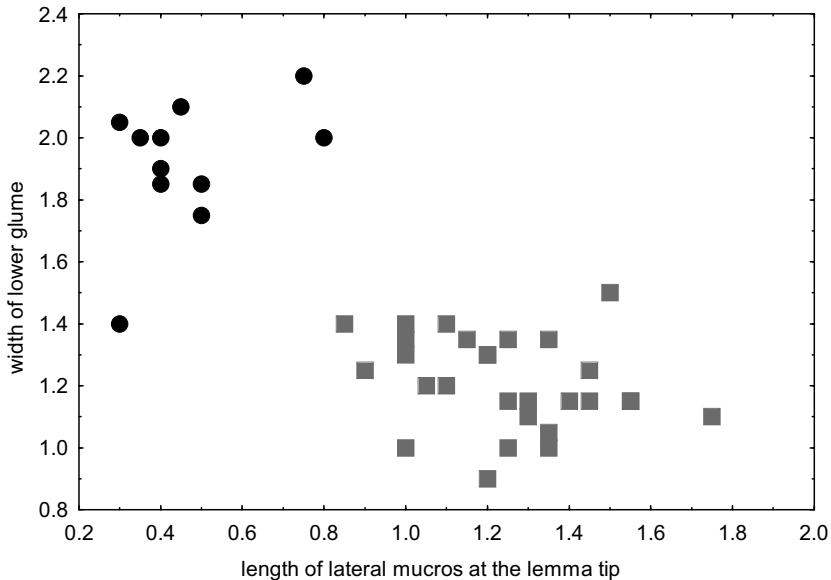


Fig. 5. Scatterplot of lateral mucro length at lemma tip against width of lower glume for *Calamagrostis filiformis* (grey solid square) and *C. tripilifera* (black solid circle).

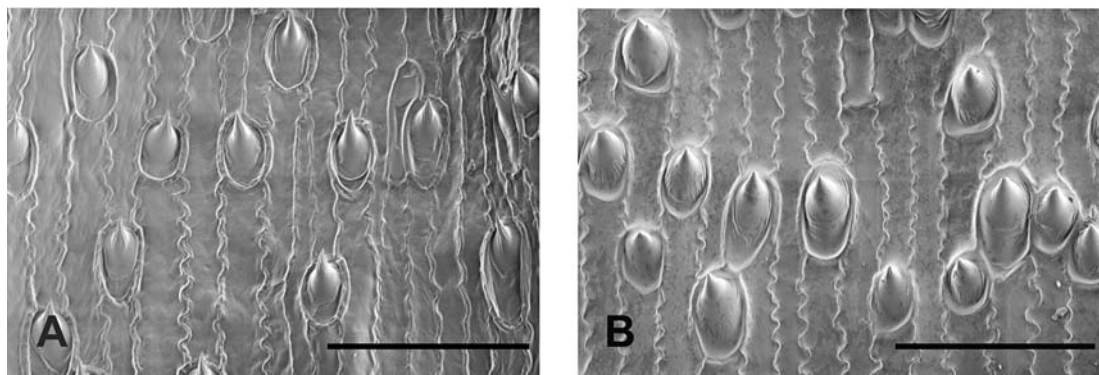


Fig. 6. Lemma epidermis with long-cell walls with raised and wavy margins and long cells interspersed with short cells and these always bearing prickles; A – *Calamagrostis filiformis* (Soreng *et al.* 5385, US); B – *Calamagrostis tripilifera* (Ho *et al.* 2454, BM). Scale bar = 40 µm.

(Fig. 6). According to Jacobs (2001) this kind of lemma epidermal pattern can be found within both *Calamagrostis* and *Deyeuxia*.

Recent studies of the *Calamagrostis epigeios* complex in Southeast Asia (Paszko & Ma 2011) reveal that a great deal of work remains to be done, and in particular, comparative studies of the closely related species complexes from Bhutan, China, India, Nepal, Russia and the former Soviet republics. Study of the relationships between *Agrostis*, *Calamagrostis* and *Deyeuxia* based on morphology, and also studies including molecular data, are needed before a final decision can be made about their generic relationship. At this stage it seems best to concentrate on species definition, description and study of the morphological variation of some extremely difficult species complexes within *Agrostis*, *Calamagrostis*, and *Deyeuxia*. That work would provide a basis for reassessing these species, necessary before any attempt is made to separate or combine the genera. Based on what we know about the morphology of the closely related species complexes collected to date, I think it best to recognize *Calamagrostis filiformis* and *C. tripilifera* under *Calamagrostis* s.l.

CONCLUSIONS

Study of Central and Southeast Asian representatives of *Calamagrostis filiformis*, *C. tripilifera* and their allies, and examination of the corresponding

type specimens, led to these findings: (i) Hooker (1897) described two distinct species under the names *Calamagrostis tripilifera* Hook. f. and *Deyeuxia triaristata* Hook. f.; (ii) *Calamagrostis tripilifera* is conspecific with the Chinese *Deyeuxia flavens* Keng; (iii) in *Flora of British India*, Hooker (1897) misunderstood Grisebach's *Calamagrostis filiformis*; (iv) *Deyeuxia filiformis* sensu Hook. f. is related to another group of species, the highly variable species complex of *C. lahulensis* and *C. scabrescens*; (v) Hooker's *Deyeuxia triaristata* and *Calamagrostis tripilifera* var. *cumminsii* are conspecific with Grisebach's *C. filiformis*, which has priority over both of them; (vi) Keng (1941a, b) misapplied the name *Deyeuxia tripilifera* to *Deyeuxia triaristata* (= *C. filiformis*); (vii) the Yunnan record of *Calamagrostis filiformis* Griseb. is the first one I discovered from the province and the first record confirmed for China.

This study also showed that most of the taxa of *Agrostis*, *Calamagrostis* and *Deyeuxia* that Grisebach (1868) and Hooker (1897) described need detailed revision and lectotypification. In most cases there are several syntypes spread around different herbaria: BM, CAL, DD, E, GH, GOET, K, L, M, US, and W (herbarium abbreviations follow Holmgren *et al.* 1990). Frequently we find a mixed collection of different taxa on the same herbarium sheet, and collections of the same taxon from different localities can be fixed on the same herbarium sheet.

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