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Typification and taxonomic notes on species of *Muhlenbergia* Schreb. (Poaceae, Muhlenbergiinae) in India

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Abstract

The present paper deals with typification for two names in the genus *Muhlenbergia i.e. M. duthieana* and *M. himalayensis*. Furthermore, taxonomy of all Indian species for the same has been provided along with taxonomic key for correct identification.

Keywords

Chloridoideae; Lectotypification; *Muhlenbergia sylvatica*; taxonomy; Western Himalaya

Introduction

The genus *Muhlenbergia* was proposed by Schreber (1789) in Genera Plantarum and named after G.H.E. Muhlenberg (1756–1817), a pioneer botanist of North American flora. Traditionally, it was placed in the tribe Agrostideae of subfamily Festucoideae (1) or Pooideae (2) or tribe Eragrostideae of subfamily Chloridoideae (3). Whereas, recently on the basis of phylogenetic studies, *Muhlenbergia* is nested in subtribe Muhlenbergiinae of tribe Cynodonteae (Poaceae, Chloridoideae) (4,5). It is a monophyletic genus and divided into five subgenera *viz*. *M*. subg. *Bealia* (Scribn.) P.M. Peterson, *M*. subg. *Clomena* (P.Beauv.) Hack., *M*. subg. *Muhlenbergia*, *M*. subg. *Pseudosporobolus* (Parodi) P.M. Peterson and *M*. subg. *Trichochloa* (P. Beauv.) A. Gray (6–8).

Muhlenbergia comprises of about 176 species, most of the species are perennials and only 29 species are known to be annuals (9), mainly confined to New World (10–12) and only eight species are reported from Southern Asia (13). According to Hitchcock (1935), it is morphologically highly variable, having species of very diverse habit including annuals to perennials, with rhizomatous to stoloniferous root stock. It is characterized by the presence of membranous ligule, spikelet with single floret, lemma firmer and awned with three prominent nerves (2). It is similar to the genus *Sporobolus* R.Br. and *Agrostis* L. in having single flowered spikelets and membranous lemma but differs from former in having awn, 3-nerve in lemma and ligule a line of hairs and from latter in having firmer lemma that are usually longer than the glumes (1–3). However, molecular data do not support this alignment (5). In India, Hooker (1896) recognized three species, *M. sylvatica* Torr., *M. viridissima* Nees ex Steud. and *M. himalayensis* Hack. ex Hook. f. Later, *M. sylvatica* Torr. was corresponded to *M. duthieana* Hack.(14) and *M. viridissima* Nees ex Steud. was synonymized with *M. huegelii* Trin. Bor (1960) included one more species, *M. mexicana* (L.) Trin. and provided a taxonomic key to diagnose all the four species. Recently, one new species *M. rakhchamensis* Arum., G.V.S.Murthy and V.J.Nair has been described from Baspa Valley, Himachal

Pradesh (11–15). These species are distributed from tropical to temperate regions, preferably in the montane region of the western Himalaya, from where all the five species have been reported (13), while only one species, *M. huegelii*, has been reported from Assam and Sikkim in Eastern Himalaya (16). The genus also extends its occurrence to Maharashtra and Uttar Pradesh as well with the reports of *M. himalayensis* and *M. huegelii* (2,13). *M. mexicana* is known to be an introduced species which is at times found as an escape while the other four species are naturally occurring in that area (2,13).

During revisionary studies in the family Poaceae from Western Himalaya, India, we found that two species names under *Muhlenbergia* such as *M. duthieana* and *M. himalayensis,* have not been typified yet. Therefore, this contribution aims to designate the nomenclatural type of these two names. In addition to this, here we also discussed the taxonomy of all species of *Muhlenbergia*, occuring in India.

Lectotypification

Muhlenbergia duthieana Hack. In Oesterr. Bot. Z. 52: 11. 1902.

≡ *Muhlenbergia sylvatica* in Fl. Brit. India, 7 (22); 259. 1896, non *M. sylvatica* Torr. & A. Gray ex Trin.,Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math.,Seconde Pt. Sci. Nat. 6(2, Bot.): 292 (-293). 1841.

Lectotype (designated here):––INDIA. West Shimla [Himachal Pradesh, Shimla], 7000-8000 ft. [2133.6-2438.4 m], August 1889, *JF Duthie* 10129 (lecto. W: W19160027700, digital image! isolecto. K: K000245166, digital image! US: US00345052, 3rd cited, digital image!).

Other original materials:––PAKISTAN. Forest above Sambalpat [Shangla, Khyber Pakhtunkhwa], 7000-8000 ft [2133.6-2438.4 m], 5 October 1888, JF Duthie 7610 (W: W19160027702, digital image! E: E00393590, digital image! K: K000245163, digital image! K: K000245162, digital image! K: K000496594, digital image! US: US00345052, 2nd cited, digital image!) Rocks facing Indus Valley at Punj Galli [Mardan distr., Peshawar division], 6900 ft [2103 m], 11 October 1888, *JF Duthie* 7611 (W: W19160027701, digital image! K: K000245165, digital image! K: K000245164, digital image! K: K000496593, digital image! US: US00345052, 1st cited, digital image! US: US00611094, digital image!).

Notes:–– The name "*Muhlenbergia duthieana* first came into existence by Hackel from J. F. Duthie's gatherings. Later, in 1896, during the comprehensive account for Poaceae, Hooker cited *M. duthieana* Hack. as a synonym under the name *Muhlenbergia sylvatica* Torre. by referring Duthie's Herbarium. Thereafter, Hackel (1902) examined those gatherings, and recognized them as distinct species together with the valid publication of the name *M. duthieana* over *M. sylvatica* in Hook. f., Fl. Brit. India" (non Torr. &A.Gray ex Trin.). When Hackel validly published, he cited three localities "Indus Valley [Mardan distr., Peshawar, Pakistan]"; "Sambalpat [Shangla, Khyber Pakhtunkhwa, Pakistan]" and "Simla [Shimla distr., Himachal Pradesh, India]" from where the specimens were collected by Duthie, but he did not designate any one of them as holotype. Even though, both Hooker (1896) and Hackel (1902) did not cite the herbarium where Duthie's collections were housed however, according to Stafleu & Cowan (1979: 2), Duthie's materials, used by Hackel, are deposited in Natural History Museum, Vienna (Naturhistorisches Museum Wien) [W] and duplicates in The Natural History Museum [BM], University of Gothenburg Herbarium [GB] and Royal Botanic Gardens Herbarium [K]. We have traced original materials deposited in K, W and Smithsonian Institution United States National Herbarium [US] which were made from different times and places thus, belonging to three different gatherings viz. #10129 (W19160027700, K000245166, US00345052), #7610 (W19160027702, E00393590, K000245163, K000245162, K000496594, US00345052), and #7611 (W19160027701, K000245165, K000245164, K000496593, US00345052, US00611094). At US, US00345052 contains fragments of all three gatherings on single sheet. A total of 15 original materials have been traced which were examined by Hackel, should be treated as syntypes by following Art. 9.6 of ICN (Turland *et al.* 2018). Since the specimens L0281373, BM000797929 and W0029176, deposited at National Herbarium Nederland, Leiden University branch [L], BM and W, respectively, collected by J.D. Hooker and J.J. Thomson from India (without precise locality) have not seen and used by Hackel, therefore, these specimens could not be part of original materials. Bor (1960) designated Duthie's #7610 (K) as isotype of *M. duthieana*, that confirmed its originality. However, L. Pignotti and P.M. Peterson confirmed the identity of specimens, housed in W and US, respectively. Along with these, E00393590 has also been verified by P.M. Peterson. The identity of specimens K000245163, K000245164, K000245165, K000245166, K000496593 and K000496594 are confirmed by having narrow leaf blades (1.0–2.5 mm width) and spaced panicle branches in rachis with congested spikelet and also agreed with the description of collection date and location, enumerated in the protologue. Furthermore, the illustration slips of spikelet and floret on K000245166 and K000245162, probably illustrated by Hackel, are exact matching with the circumscriptions mentioned in the protologue. Since, according to the Art. 9.3 of ICN (18), lectotypification of the name *M. duthieana*is warranted for the stability of name. Therefore, the specimen W19160027700 is designated here as lectotype, because of its good preservation, complete plant with roots, culms, leaf blades and inflorescences which agrees with the protologue, and its duplicates K000245166 and US00345052 (left-hand side) as isolectotypes.

Muhlenbergia himalayensis Hack. ex Hook.f. in Hook.f., Fl. Brit. India. 7(22): 259. 1897.

Lectotype (designated here):––INDIA. Simla [Himachal Pradesh, Shimla], 7000-8000 ft. [2133.6-2438.4 m], 22 August 1889, *JF Duthie* 10128 (lecto. W: W19160027736, digital image! isolecto. W19160027737, digital image! K: K000245169, digital image! US: US00345055, digital image! US: US00611093, digital image!).

Notes:––Hackel gave the name *Muhlenbergia himalayensis* for #10128, collected from Simla [Shimla, Himachal Pradesh, India] by *J.F. Duthie*. Later it was ascribed by

Hooker (1896) but did not cite the herbarium where the specimens were preserved. Thorough investigation of herbaria revealed that five specimens of collection #10128 were housed in K, US, and W, which belongs to a single gathering. However, according to Stafleu & Cowan (1979), Duthie's materials, used by Hackel, are deposited in W and duplicates in BM, GB and K. At W, W19160027736 and W19960027737 have been verified as "SYNTYPUS" of *M. himalayensis* by L. Pignotti. While at US, US00611093 and US00345055 have been determined by P.M. Peterson and subsequently verified as isotype fragment of *M. himalayensis*. At K, K000245169 contains illustration of spikelet, probably made by Hackel himself, exactly matches with the description in the protologue. Since, none of the specimens have been designated as nomenclatural type, therefore, all should be considered as syntypes in accordance with Arts. 9.6 of ICN (18). Considering the above, here we designate the specimens with barcode-W19160027736 as lectotype for the name *M. himalayensis*, as the specimens is well preserved with complete plant including root, culms and inflorescence, and agrees with the description in the protologue and its duplicates W19160027737, K000245169, US00345055 and US00611093, as isolectotype.

Taxonomic notes and similarity: *Muhlenbergia duthieana* is recognized by having 4–12 cm long interrupted panicle with congested spikelet in panicle branch, spikelets 2.5–3.4 mm long, glumes almost equal to length of lemma with subulate apex and awn 5–10 mm long. Hackel (1902) segregated *M. duthieana* from *M. sylvatica* on the basis of rhizome and subterranean runners with scales that are absent in the former species. According to Hackel (1902), in *M. sylvatica* glumes are usually longer than lemma with subulate apex, which passes directly from the point into the awn while in *M. duthieana*, glumes are almost equal to lemma with tapering apex. But we found that glumes in *M. duthieana* are slightly shorter to longer than length of the lemma with almost subulate apex, which are similar to that of *M. sylvatica*. Although, *M. duthieana* has narrower leaf blades, 1.0–2.5 mm wide, that distinguished it from the latter species. Besides this, *M. duthieana* shares similar habit with *M. himalayensis* and *M. huegelii* but differs from them by having congested spikelet in panicle branches, glumes almost subulate and awn 5–10 mm long (Fig. 1). In *M. himalayensis* however, spikelets are spaced in panicle branches, glumes slightly shorter to almost equal to the length of the lemma and awn 8–18 mm long (Figure 1). *M. huegelii* is easily distinguishable from rest of the species by having glumes almost half of the length of lemma (ratio of glumes to lemma 0.44–0.65) and filiform awn, which is generally 8–22 mm long (Fig. 1). The recently described species, *M. rakhchamensis* differs from other four species by having more contracted, shorter and spiciform panicle with 1.5–4.0 cm long and awn very short with 0.5-3.5 mm long. *M. mexicana* differs from rest of the species by having awnless lemma or rarely with shorter awn (0.5–1.5 mm long).

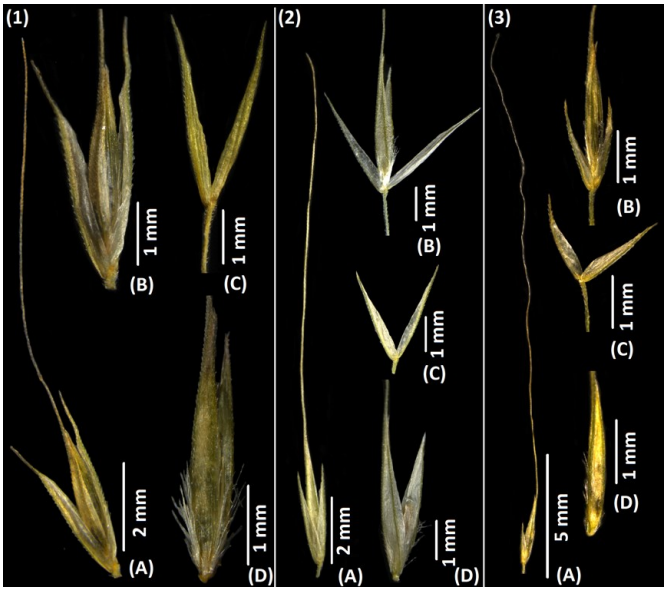

Fig. 1.*Muhlenbergia duthieana* (1), from D. Prasad *et al*. 45666, *M. himalayensis* (2), from S. Tiwari et al. 311665, and *M. huegelii* (3), from S. Tripathi *et al.* 315976. **A.** Spikelet (including awn), **B.**Spikelets (excluding awn), **C.** Glumes, lateral view, **D.** Florets, lateral view.

Key to Indian species of *Muhlenbergia*

1a.Rhizomes short, curved; panicle with congested branches of unawned spikelet……..*M. mexicana*

1b. Rhizomes absent; panicle with very loose to almost congested branches of awned spikelet……2

2a.Panicle spiciform, branches congested……..
……*M. rakhchamensis*

2b.Panicle lax, sometimes very loose or branches with congested spikelet, branches spaced.....…….….3

3a. Glumes half of the lemma, awn filiform, 8-22mm long……..*M. huegelii*

3b. Glumes almost equal or slightly shorter to longer than lemma, awn 5-18 mm long ……. 4

4a. Glumes shorter to almost equal to lemma, lemma 3.2–5.0 mm long; awn 8–18 mm long……. *M. himalayensis*

4b. Glumes longer than lemma, lemma 2.0–3.2 mm long; awn 5–10 mm long……*M. duthieana*

Specimens examined:

Muhlenbergia duthieana : INDIA. **Himachal Pradesh**: Kullu, Solang Valley, 32.17277N, 77.190833E, 1860 m, 08 September 2018, S. Tripathi & P Agnihotri, 314513 (LWG-111119); Kullu, On the way to Naggar, 32.112072N, 77.160864E, 1822 m, 09 September 2018, S. Tripathi & P Agnihotri, 314533 (LWG-111112); Kullu, On the way to Naggar, 32.112072N, 77.160864E, 1822 m, 09 September 2018, S. Tripathi & P Agnihotri, 314529 (LWG-111120); Kullu, On the way to Naggar, 31.984518N, 77.130153E, 1226m, 03 August 2019, D. Prasad, R. Yadav & P. Rajput, 316100, (LWG -111115); Kullu, Solang Valley, Manali, 32.309457N,77.147183E, 2633m, 04 August 2019, D. Prasad, R. Yadav & P. Rajput, 316212 (LWG-111118); Kullu, Marhi, Manali, 32.341507N, 77.216715E, 3260m, 05 August 2019, D. Prasad, R. Yadav & P. Rajput, 316300 (LWG-111116); Kullu, GulabaCheckpost, On the way to Marhi, 32.319782N,

77.20379E, 2944 m, 07 August 2019, D. Prasad, R. Yadav & P. Rajput, 326849 (LWG-111111); Kullu, Manali, On the way to Rohtang, 32.335697N, 77.203631E, 2566 m, 30 August 2021, S. Tiwari, R. Yadav, P. Rajput & S. Sharma, 311652 (LWG-111110); Lahaul and Spiti, Keylong to Sissu, Towards Atal Tunnel, 32.480270N, 77.123571E, 2938 m, 29 August 2021, S. Tiwari, R. Yadav, P.Rajput& S. Sharma, 316574 (LWG-111114); **Uttarakhand**: Chamoli, Auli, Garhwal, 30.94910 N, 77.74760, 3010 m, 30 september 2018, S. Tripathi & P Agnihotri, 315891 (LWG-111123); Chamoli, Auli, Garhwal, 30.95980 N, 77.74830, 3018 m, 30 september 2018, S. Tripathi & P Agnihotri, 315892 (LWG-111117); Rudraprayag, On Way to Kedarnath, 30.716003N, 79.072278E, 3412 m, 13 October 2019 , R. Yadav & D. Hussain, 328465 (LWG-111121); Bageshwar, On way to Dwali, 30.143384N, 79.964834E, 2387 m, 06 July 2021, S. Tiwari, S. Sharma, P. Rajput & R. Kumar, 337269 (LWG-111122); **Jammu & Kashmir**: Baramullah, On the way to Gulmarg, 34.049505N, 74.40233E, 2532 m, 22 july 2019, S. Tripathi, S. Jaiswal & R. Yadav, 316844 (LWG-111113).

Muhlenbergia himalayensis: INDIA. **Himachal Pradesh**: Kullu, Hidimba Temple, Manali, 32.248294N, 77.180823E, 2088 m, 31 August 2021, S. Tiwari, R. Yadav, P. Rajput & S. Sharma, 311665 (LWG-111109); Lahaul and Spiti, Keylong to Sissu, Towards Atal Tunnel, 32.480270N, 77.123571E, 2938 m, 29 August 2021, S. Tiwari, R. Yadav, P.Rajput& S. Sharma, 316562 (LWG-111108); Kullu, Near Hidimba Temple, 32.24694N, 77.18361E, 1926 m, 11 September 2018, S. Tripathi & P Agnihotri, 314590 (LWG-111107); **Uttarakhand**: Almora, On way to DSB campus, Nainital, 29.3855N, 79.4564E, 2020 m, 30 July 2018, S. Tripathi & P. Agnihotri, 315919 (LWG-111106); Chamoli, Valley of Flower, 30.711077 N, 79.596004 E, 3385m, 23 August 2019, D. Prasad, R. Yadav & P. Rajput, 326797, (LWG-111105); Bageshwar, On way to Khati, 30.112273 N, 79.939570E, 2252 m, 06 July 2021, S. Tiwari, S. Sharma, P. Rajput & R. Kumar, 337268 (LWG-111103); Bageshwar, on way to Dwali, 30.181556 N, 80.003107E, 2613 m, 06 July 2021, S. Tiwari, S. Sharma, P. Rajput & R. Kumar, 337270 (LWG-111104);

Muhlenbergia huegelii : INDIA. **Uttarakhand**: Almora, Kilbury, 29.4114N, 79.4473E, 2290 m, 31 July 2018, S. Tripathi & P. Agnihotri, 315976 (LWG-111124).

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Authors contributions

ST first identified the problem, conducted the necessary research and prepared the first draft of the manuscript. DP, SJ, RY, and SS provided important suggestions to improve the manuscript. SPT reviewed the final draft of the-manuscript.PA supervised the whole work and sent the manuscript for publication.

Compliance with ethical standards

Conflict of interest: The authors have no conflicts of interest.

Ethical issues: None.

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