

A TAXONOMIC REVISION OF *AXONOPUS* P. BEAUV. (POACEAE: PANICOIDEAE) IN INDIA

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Abstract

The status of the genus *Axonopus* P.Beauv. in India has been varying depicted by different workers so far. After comprehensive study, two species, namely *A. compressus* (Sw.) P. Beauv. and *A. fissifolius* (Raddi) Kuhl., are justified for the country. The distributional incongruity of both species in India is unravelled here. The present record of *A. fissifolius* in Sikkim confirms its extended distribution to the Indian Eastern Himalaya. Additionally, this species is also reported for the first time from Meghalaya. Detailed descriptions of both species are appended here. Illustrations and photoplates, along with notes on habitat, phenology, and distribution, are also presented. A key to the Indian species of *Axonopus* is incorporated for correct identification and easy recognition.

Introduction

The American genus *Axonopus* P.Beauv. of grass tribe Paspaleae (subfamily Panicoideae, family Poaceae) (Kellogg, 2015; Soreng *et al.*, 2015, 2017) includes approximately 78 species globally (POWO 2024). The members of the genus are mainly found in Tropical Africa, Central U.S.A. to Tropical and Subtropical America and Easter Island, with some species seemingly introduced in the Old World (Chen and Phillips, 2006; Giraldo-Cañas, 2008; Mabberlay, 2017; POWO, 2024; WFO, 2024). The genus has great economic importance as fodder (*viz.*, *A. fissifolius* (Raddi) Kuhl., *A. obtusifolius* (Raddi) Chase, *A. purpusii* (Mez) Chase, *A. scoparius* (Flüggé) Kuhl., *A. suffultus* (Mikan ex Trin.) Parodi) as well as ornamentals (*viz.*, *A. aureus* P. Beauv., *A. brasiliensis* (Spreng.) Kuhl., *A. compressus* (Sw.) P. Beauv.) (Black, 1963; Nicora and Rúgolo de Agrasar, 1987; Giuliotti *et al.*, 1988). Apparently though the genus looks like *Digitaria* Haller or *Paspalum* L. due to almost similar appearance of synflorescence, however, the following combination of characters: 2–many mostly sub-digitately arranged slender racemes, sometimes spread along a short central axis, solitary, adaxial, sessile, unawned spikelets alternately arranged in 2 rows in each raceme, total absence of lower glume and lower palea and crustaceous upper floret, immediately make the genus distinct from these two allied genera as well as from other related genera of the tribe (Noltie, 2000).

The monophyly of *Axonopus* is strongly recommended by López and Morrone (2012) and Delfini *et al.* (2020). They advocated inclusion of *Centrochloa* Swallen and *Ophiochloa* Filg.,

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Davidse & Zuloaga within the generic circumscription of *Axonopus*, supported by both morphological and molecular evidences. Gledhill (1964) discussed the origin and taxonomy of the West African representatives of *Axonopus*. The genus in Europe was first revised by Diego Giraldo-Cañas (2008) and five new synonyms were proposed for *Axonopus compressus* (Sw.) P. Beauv. and *A. scoparius* (Flüggé) Kuhl. Cytogenetic and evolutionary relationships in the genus *Axonopus* were illustrated by Hickenbick (1975). The suitability of *Axonopus compressus* for the removal of petroleum hydrocarbons from contaminated soil was assessed by Bordoloi *et al.* (2012). Ibeh and Ezeaja (2011) studied the antidiabetic activity of methanolic leaf extract of *Axonopus compressus* in alloxan-induced diabetic rats.

The genus is variously interpreted by different researchers in terms of number of species in India resulting in confusion. Besides, regional distribution in the country (state wise) differs substantially in different literature.

While surveying the grass flora of North Sikkim, few notable specimens of *Axonopus* were collected from Chungthang and Lachen. After critical examination of the collected materials and perusal of relevant literature (Noltie, 2000; Chen and Phillips, 2006), these were identified as *A. fissifolius* (Raddi) Kuhl. This discovery constitutes the first instance of this species in the Indian Eastern Himalaya.

In addition, during the present investigation two specimens of the genus collected from Shillong, Meghalaya were located at CAL (*Deka* 18394; identified as *A. compressus*) and ASSAM (*Rup Chand* 8195; identified as *A. fissifolius*). Both the specimens were reexamined and meticulous observation revealed that *Rup Chand* 8195 was rightly identified as *A. fissifolius*, while *Deka* 18394 also appears to be *A. fissifolius*. This finding validates the species' wider distributional range, extending to Meghalaya, the second state in Northeast India after Assam.

Besides, though several workers (Naithani and Raizada, 1977; Naithani, 1990; Shukla, 1996; Kellogg *et al.*, 2020) claimed this species for Uttar Pradesh, however, it is now excluded from the flora of the state with evidence. On the contrary, report of this species from Uttarakhand is accepted with justification.

In this communication, a revision of *Axonopus* in India is presented based on field observation as well as study of the herbarium specimens. In addition, we illustrate the current distribution of both species in the country. The new distributional records of *A. fissifolius* are elucidated with evidence. The elaborate morphological descriptions of both members, along with detailed citations and type information, are incorporated herewith for better taxonomic understanding. Hand drawings and photo plates are also included for easy recognition and correct identification. Habitat information, phenological data, exsiccate and key to the Indian species of the genus are also provided.

Materials and Methods

Rigorous field surveys have been conducted during 2021-2024 in different parts of India and a considerable number of specimens of *Axonopus* were collected. During collection, all relevant field data have been recorded to understand the morphological attributes of the members of the genus and also to observe the variation and variability of morphological features between the populations and even within the population, if any. The characters which are widely used in segregating species as discussed earlier have been critically encountered in the field itself. Digital photographs have been captured. Specimens were collected at least in triplicates from each population. To ascertain the taxonomy and distribution of both the members of the genus in India, collections of *Axonopus* housed at ARUN, ASSAM, BSA, BSD, BSID, BSHC, CUH, CAL, DD, MH, PBL and TBGT were rigorously studied. Relevant literature were also consulted. The

identity of both the species was confirmed after having an eye to the protologues and matching with the type specimens or digital images of the types as well as with other authentic specimens available at JSTOR and other online herbarium databases. Voucher specimens are deposited at CUH for future reference.

Results and Discussion

Taxonomic Treatment

Axonopus P. Beauv., Ess. Agrostogr. 12.1812; Hooker, J. D. in Hooker, J. D., Fl. Brit. India 7:63.1896; Prain, Bengal Pl. 2:1173.1903 (Rep. 1963); Bor, Fl. Assam 5:268.1940 et Grass. Burma Ceylon India Pakistan 277.1960; Shukla, Grass. North-Eastern India 308.1996; Noltie, Fl. Bhutan 3(2): 716.2000; Bhat and Nagendran, Sedge. Garss. 182.2001; Chen and Phillips in Wu *et al.*, Fl. China 22:530.2006; Kabeer and Nair, Fl. Tamil Nadu Grass. 213.2009; Potdar *et al.*, Grass. Maharashtra 301.2012; Sur and Roy Choudhury, Grass. Fl. West Bengal, India 92.2015; Sinha *et al.*, Pl. Indian Himal. Reg. Annot. Checkl. Pict. Guid. 2:786.2019; Veldkamp *et al.* in Middleton *et al.*, Fl. Singapore 7:262.2019; Prasanna *et al.* in Mao and Dash, Flower. Pl. India Annot. Checkl. Monocot. 3:326.2020; Kellogg *et al.*, Checkl. Grass. India 207.2020; Siddabathula and Prasanna, Grass. Telengana 170.2023.

Lectotype: *Axonopus compressus* (Sw.) P. Beauv. (\equiv *Milium compressum* Sw.). LT designated by Hitchcock in Contr. U.S. Natl. Herb. 12: 142. 1908; Chase, Proc. Biol. Soc. Wash. 24: 129. 1911.

Stoloniferous perennials (rarely annuals); stolons spreading, compressed. *Culms* short, erect, single-noded. *Leaves* sub-basal; leaf blades flat or involute, oblong, blunt or obtuse; ligule short, membranous, truncate, ciliolate; leaf sheaths compressed, keeled. *Synflorescence* of 2–many slender racemes, mostly sub-digitate, sometimes along a short central axis; racemes linear, spikelets borne singly, alternate on opposite sides of the triquetrous rachis. *Spikelets* sessile or subsessile, lanceolate to oblong, flatly biconvex, adaxial, compressed, unawned, muticous, falling entire. *Glume* solitary; lower glume absent; upper glume facing away from rachis, back flat, 2–7-veined with 1–3 marginal veins on either side, midvein faint or absent, membranous. *Florets* 2; lower floret sterile, epaleate; lower lemma similar to and about equaling upper glume; upper floret bisexual, compressed; upper lemma crustaceous to coriaceous, back flat, punctate, margins opaque and incurved, tightly enclosing the palea; upper palea flat-backed, crustaceous. *Lodicules* 2. *Stamens* 3. *Pistil* 1; style 2, free; stigmas plumose, exerted laterally. *Caryopsis* elliptic, dorsally compressed, totally enclosed by indurate upper palea and lemma.

Distribution: The native range of this genus is Tropical Africa, Central U.S.A. to Tropical & Subtropical America and Easter Island, with some species seemingly introduced in Africa, Asia-Temperate, Asia-Tropical, Australasia, Europe, Northern America and Pacific (Chen and Phillips, 2006; Giraldo-Cañas, 2008; Mabberlay, 2017; POWO, 2024; WFO, 2024).

Axonopus compressus (Sw.) P. Beauv., Ess. Agrost. 12, 154, 167.1812; Bor, Fl. Assam 5:269.1940 et Grass. Burma Ceylon India Pakistan 278.1960; Hara, Fl. Eastern Himal. 352.1966; Shukla, Grass. North-Eastern India 310.1996; Noltie, Fl. Bhutan 3(2):717.2000; Bhat and Nagendran, Sedge. Garss. 182.2001; Chen and Phillips in Wu *et al.*, Fl. China 22:531.2006; Kabeer and Nair, Fl. Tamil Nadu Grass. 213.2009; Potdar *et al.*, Grass. Maharashtra 301.2012; Sur and Roy Choudhury, Grass. Fl. West Bengal, India 92.2015; Sinha *et al.*, Pl. Indian Himal. Reg. Annot. Checkl. Pict. Guid. 2:786. 2019; Veldkamp *et al.* in Middleton *et al.*, Fl. Singapore 7:262.2019; Prasanna *et al.* in Mao and Dash, Fl. Pl. India Annot. Checkl. Monocot. 3:326.2020;

Kellogg *et al.*, Checkl. Grass. India 208.2020; Siddabathula and Prasanna, Grass. Telengana 170.2023.

Milium compressum Sw., Prodr. 24. 1788. **Lectotype**: Jamaica, *R. Shakespear s.n.* (BM [BM000578790, digital image seen], designated by Pohl & Davidse, Fl. Mesoamer. 6: 357.1991). *Paspalum compressum* (Sw.) Raspail (1825), *nom. illeg.*; *P. tristachyon* Lam. (1791) {Type: “Ex America merid. Communic. D. Richard.” South America; L.C.M. Richard s.n. (P-LAM, not seen; BAA, BAA00002565, digital image seen; US, US00140865, digital image seen)}; *P. platycaulon* Poir. (1804) [as “platycaule” in IPNI]; *Digitaria platycaulis* (Poir) Desv. (1831); *Panicum platycaulon* (Poir.) Kuntze (1898) (as “Platycaulon”); *Anastrophus platycaulis* (Poir.) Nash (1903) {Type: “Cette espece a été recueillie a Porto Ricco, par le citoyen Ledru.” Puerto Rico; A.P. Ledrú s.n. (P-LAM, not seen; US, US00140744 & US00140745, digital images seen)}; *Paspalum platyculmum* Thouars ex Nees (1829) {Type: “Habitat in insula S. Mauritií.”(not seen)}; *P. depressum* Steud. (1853) {Type: USA: Louisiana; F.X.von Hartmann 51 (P, P00753081, digital image seen)}; *P. filostachyum* A. Rich. ex Steud. (1853) {Type: West Indies; F.W. Sieber 365 (P, not seen; US, US00140655, digital image seen)}; *P. guadaloupense* Steud. (1853) {Type: Guadeloupe; Duchassaing *s.n.* (P, not seen)}; *P. raunkiaerii* Mez. (1917) {Type: Antillarum insula St. Jan; Raunkiaer 1313 (US, US00140795, digital image seen; C, C10016782, digital image seen)}; *P. laticulmum* Spreng. (1824; “1825”), *nom. superfl. & illeg.* for *P. tristachyon*; *Agrostis compressa* (Sw.) Poir. (1810), non *Axonopus compressa* Willd.1790; *Digitaria domingensis* Desv. ex Kunth.1833, non Roem. & Schult. (1817); *Anastrophus compressus sensu* Schltr. ex Döll. (1877), non Schltdl. (1850). **(Figs 2 & 3)**

Perennial. *Culms* creeping or stoloniferous, sometimes mat forming, erect while flowering, 15–32 cm tall, terete; nodes bearded, brownish, lower ones rooting. *Leaf blades* broadly linear or lanceolate, 5–20 × 0.6–1.2 cm, apex obtuse, margin ciliate, otherwise glabrous or adaxial surface pilose; *ligule* 0.8–1 mm long, membranous, truncate, apex finely fimbriate, base narrowed; *leaf sheaths* 2.5–8 cm long, margins usually sparsely tuberculate hairy. *Spikelets* arranged in terminal racemes; *racemes* 3, digitate or sub-digitate, 5.5–9 cm long; peduncles ca. 6 cm long, short, enclosed by sheath; rachis triquetrous, ca. 0.5 mm wide, margin winged, serrulate; *spikelets* sessile, in 2-rows, alternate, linear-oblong, 2–3 × 0.65–1 mm, acute or acuminate, shaggy hairy; pedicels 0.4–1.5 mm, flat. *Glume* 1; lower glume absent; upper glume elliptic, oblong or oblong-lanceolate, 2–2.5 × 0.4–1 mm, acute to acuminate and never overtopped by hairs, chartaceous, flat, appressed hairs forming a line on both sides of mid-vein, 5-veined, appressed-hairy on veins, margins incurved with long, woolly hairs below. *Florets* 2, lower sterile and upper bisexual; lower lemma elliptic or oblong-lanceolate, 1.7–3 × 0.5–0.9 mm, acuminate to apiculate, flat, appressed hairs forming a line on both sides of mid-vein, 5-veined, appressed-hairy on veins, margins incurved; lower palea absent; upper lemma elliptic-lanceolate, 1.3–2.5 × 0.4–1 mm, apex blunt to acute with tuft of cilia, margin tightly enclosing palea, sub-coriaceous to crustaceous, faintly 3-veined, pale green; upper palea oblong or elliptic, 1.4–2.5 × 0.5–0.8 mm, acute or obtuse, margin inrolled, sub-coriaceous to crustaceous, faintly 2-veined, pale green. *Lodicules* 2, 0.2–0.4 × 0.2–0.3 mm, membranous, hyaline. *Stamens* 3; filaments 0.3–0.5 mm long; anthers 0.6–1.2 × ca. 0.2 mm, yellowish to purplish. *Pistil* 1: ovary oblongoid-ellipsoid, 0.3–1 mm long; styles 2, straight, 0.5–1.3 mm; stigmas 2, 0.8–1.5 mm, plumose, yellowish to brownish. *Caryopsis* oblongoid, 1–2 × ca. 0.6 mm, flat, greenish.

Flowering and fruiting: Almost throughout the year

Habitat: Prefer to grow in open forest margins, as weed along roadsides, in waste ground, neglected garden and orchards in association with *Digitaria ciliaris* (Retz.) Koeler (Poaceae), *Paspalum conjugatum* Bergius (Poaceae), etc.

Distribution: INDIA: Andaman & Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Odisha, Sikkim, Tamil Nadu, Telengana, Uttarakhand, Uttar Pradesh, West Bengal. Native to Tropical and Subtropical America; introduced and naturalized in Africa, Asia-Temperate, Asia-Tropical, Australasia, Europe, Northern America, Pacific (POWO, 2024; WFO, 2024). [up to 2300 m amsl]

Specimens examined: **Andaman & Nicobar Islands**, Rangat, 46 m, 15.10.59, *Thampi H.C. 5* (CAL); Little Andaman, Hut Bay, sea level, 20.11.1977, *Bhargava 6523*; Great Nicobar, 35 Km North & South Road to Galasthea river, 23 m, 25.05.2012, *Prabhu & Sathiyaseelan 0753* (all at PBL). **Andhra Pradesh**, towards Chinthim from Maredumilli, ±550 m, 16-10-94, *M. Mohanan 102514* (MH). **Assam**, Lakhimpur, Tinsukia, July-1937, *N.L.Bor s.n.* (DD); Digboi Forest Bunglow Compound, 10.07.1959, *Panigrahi 18950 & 18951* (CAL); Bokajan, 25.01.74, *Neogi 56914*; Kamrup, G.U. Campus, 1132 m, 09.05.74, *Neogi 57022*; Manas, Mathnguri, 07.06.74, *Neogi 57072*; Borail, WLS, near Kalainchurra, 27.08.2012, *Barbhuiya 930*; Bhutto Bagan, 50 m, 29.08.2013, *Deori & Tahakdu 115421*(all at ASSAM); Duhalia R.F., 20.04.2014, *Moonmee Devi 12379* (ASSAM, CAL). **Chhattisgarh**, Korba, CG, 10.09.2009, *Tiwari 99612* (BSA, two specimens, not seen). **Karnataka**, Bhadravathi, *s.d.*, *A.N.Sindhe 204* (CAL); Subramanya, South Kanara, 500', 9.2.1952, *H Sunanda Kamath 94244* (MH). **Kerala**, Peermede, Travancore, 3200', 2.12.1941, without collector's name, 20223 (MH); Peaty Soils, 3.11.56, *B.D.Patil 783*; Vazhoor, 04.11.56, *B.D.Patil 802*; Chandanathode, ±825 m, 24.02.1979, *V.S.Ramachandran 61351*; Nedumpoyil, ±500 m, 12.12.1979, *V.S.Ramachandran 64072*; Panathur, 250 m, 29.6.1980, *R.Ansari 67905*; Kurumathur, 250 m, 23.09.1982, *R.Ansari 73963*; Kumarakom, below 5 m, 28-12-1983 *V.T.Antony 14* (all at CAL); Garden site, 25.10.84, *K.C.Koshy 487*; Chemingi, Agasthyamala, 18.3.93, *N.Moharan 11343*; Sultan Battery, Nilgiri Biosphere Reserve, 23.07.2012, *Remya. J & Prasanna. R 73707*; JNTBGRI, 27.02.2013, *K.C.Koshy 70542*; VSSC Thuma, 5.2.14, *Teema Joseph 85149* (all at TBGT). **Madras (Chennai)**, Ghat, R.F. Coonoor, 1666 m, 27-7-1957, *K.M.Sebastine 4054*; Arankattumalai, Kakachi, 1733 m, 7-5-1958, *K.M.Sebastine 5807*; near Kumili, 850 m, 22.06.1959, *Subramanyam 8147*; Near Periyar Dam, 980 m, 19.10.1959, *Subramanyam 9449* (all at CAL). **Manipur**, Nambol, Bishnupur District, 776 m, 26.10.2013, *Dui 11289*; Bamonkampu, Imphal East District, 783 m, 02.11.2013, *Dui 12012* (all at ASSAM). **Meghalaya**, Shillong, area in front of Nirala Bunglow, 23.11.1956, *Panigrahi 3791* (ASSAM, CAL). **Telengana**, Rangareddy District, Hyderabad, Lacones *SNR s.n.* (BSID). **Tamil Nadu**, Kotagiri, *s.d.*, *Sindhe 216*; Shembaganur, 6000 ft, Oct 1955, without collector's name, 47 (all at CAL); Nadugani sholar, Gudalur, ±600-700 m, 21.7.2003, *K. Althof Ahamed Kabeer 116248* (MH). **Uttarakhand**, Bangapani, Gori valley Pithoragarh, 20.09.03, *Kandwal 155*; Hudki village, Pithoragarh, 26.07.04, *Kandwal 3348* (all at BSD). **West Bengal**, Ballygunj, Calcutta, 13.11.1919, *Nuskriji 2*; AJC Bose Indian Botanic Garden, near the Big Banyan tree, 14/12/20, *P.M.Debbarman s.n.*; near Oreodoxa Avenue, 15/12/20, *P.M.Debbarman s.n.*; near Palm Avenue, 15/12/20, *P.M.Debbarman s.n.*; near the Herbarium, 15/12/20, *P.M.Debbarman s.n.* Buxa, Santrabari, 700', 23.5.49, *V.Narayanaswami & Party 2940*; IBG, 20th Div., 2.11.1966, *Sharma V.S. S-590*; Botanic Garden, Howrah, student garden's sides, 4-12-1967, *D.K.Banerjee 4882*; West Dinajpur, Ranigunj, 01.11.1983, *R.N.Banerjee & M.C.Biswas 16108*; West Dinajpur, Islampur, 22.4.1984, *R.N.Banerjee & Party 17554*; West Dinajpur, Ranigunj, 20.8.1984, *R.N.Banerjee & Party 17569* (all at CAL); Howrah, Bokultala, near AJC Bose Indian Botanic

Garden gate, 15 m, 19.11.2018, Saha 16622; Kalimpong, Samsing, Suntalekhola, 99 m, 26.04.2023, Maity, Roy and Halder 21 (all at CUH).

Axonopus fissifolius (Raddi) Kuhl., *Relat. Commiss. Linhas Telegr. Estratég. Matto Grosso Amazonas* 5(11):87.1922; Chen and Phillips, in Wu *et al.*, *Fl. China* 22:531.2006; Veldkamp *et al.* in Middleton *et al.*, *Fl. Singapore* 7:264.2019; Prasanna *et al.* in Mao and Dash, *Fl. Pl. India Annot. Checkl. Monocot.* 3:326.2020; Kellogg *et al.*, *Checkl. Grass. India* 209.2020.

Paspalum fissifolium Raddi, *Agrostogr. Bras.* 26.1823. **Lectotype:** *Raddi s.n.* (PI [PI041257, digital image seen], designated by Judziewicz, *Fl. Guianas, ser. A, Phanerogams* 8: 98.1990); isolectotypes (BAA [BAA00001538, digital image seen], BM [BM000578791, not seen], FI [FI004592, digital image seen], G [not seen], K [K000643281, digital image seen], US [US00140658, digital image seen], W [W19040012152, digital image seen]). *Axonopus affinis* Chase (1938); *A. compressus* var. *affinis* (Chase) Hend. (1954) {Type: USA: Mississippi: Waynesboro, in low moist ground, 2 Oct. 1896, T.H. Kearney 175 (holotype US [US00139602, digital image seen]; isotypes GH [GH00023151, digital image seen], MO [MO-016675, digital image seen], US [US00139603, digital image seen])}; *Paspalum xizangense* B.S.Sun & H.Sun (2001) {Type: Medog, Beibeng, 950m, 24 Sep 1992, Sum Hang *et al.* 0042 (holotype KUN [not seen]; isotype YUNU [not seen])}. **(Figs 1, 4 & 5)**

Stoloniferous perennials, often mat-forming. *Culms* compressed, 2.5–50 cm tall, nodes glabrous, green to purplish red. *Leaf blades* broadly linear, folded, 2–20 × 0.2–0.6 cm, obtuse, margin pilose near the base only, otherwise glabrous; upper one (just below the racemes, often known as ‘flag leaf’) always distinctly smaller; *ligule* membranous, 0.2–0.3 mm, truncate, densely ciliate at apex and back; leaf sheaths compressed, 1.7–7 cm long, strongly keeled, glabrous. *Spikelets* arranged in racemes; *racemes* 2–4, 2-paired, any others spaced slightly below, 3–6 cm long, slightly diverging; rachis glabrous; peduncle long exerted from upper leaf sheath; *spikelets* oblong-elliptic or ovate-elliptic, 1.5–2.5 × 0.6–0.8 mm, subacute, apex and margins pilose. *Glumes* 1; lower glume absent; upper glume oblong or ovate, 1.8–2.5 × 0.6–1 mm, blunt to subacute and always overtopped by hairs, flat, margins incurved, 4-veined laterally, mid-vein absent, membranous, appressed-hairy, with long, woolly hairs abaxially and along margins. *Floret* 2; lower sterile, upper bisexual; lower lemma oblong-lanceolate or elliptic, 1.8–2 × 0.6–0.9 mm, acuminate to apiculate, 2-veined laterally, midvein absent, flat, margins incurved, membranous, appressed-hairy near apex; lower palea absent; upper lemma oblong-elliptic or oblong-ovate, compressed, 1.4–1.7 × 0.7–1 mm, obtuse to blunt, with short apical tuft of cilia, crustaceous, margin membranous, pale; upper palea elliptic, 1.3–1.6 × 0.6–0.8 mm, similar to lemma but glabrous. *Lodicules* 2, oblong-obovate, 0.2–0.3 × ca. 0.2 mm, membranous. *Stamens* 3; anthers 0.7–0.8 × 0.2–0.3 mm, yellow, becoming purple at maturity; filaments 0.3–0.4 mm long, hyaline. *Pistil* 1; ovary 1, oblongoid, 0.3–0.4 × 0.2–0.3 mm; styles 2, 0.4–0.5 mm long; stigmas 2, 0.5–1 mm long, plumose, yellow, becoming purple at maturity. *Caryopsis* ellipsoid or oblongoid-ellipsoid, 1–1.1 × 0.5–0.6 mm, obtuse, glabrous; hilum obovoid ca. 0.3 mm long.

Flowering and fruiting: March–October

Habitat: Prefer to grow along the roadside green patches in association with *Ageratina adenophora* (Spreng.) R.M.King & H.Rob. (Asteraceae), *Artemisia vulgaris* L. (Asteraceae), *Cuphea carthagenensis* (Jacq.) J.F.Macbr. (Lythraceae), *Galinsoga parviflora* Cav. (Asteraceae), *Paspalum distichum* L. (Poaceae), *Thysanolaena latifolia* (Roxb. ex Hornem.) Honda (Poaceae), etc.



Fig. 1. *Axonopus fissifolius* (Raddi) Kuhl.: A. Habit; B. Synflorescence; C. A single raceme.

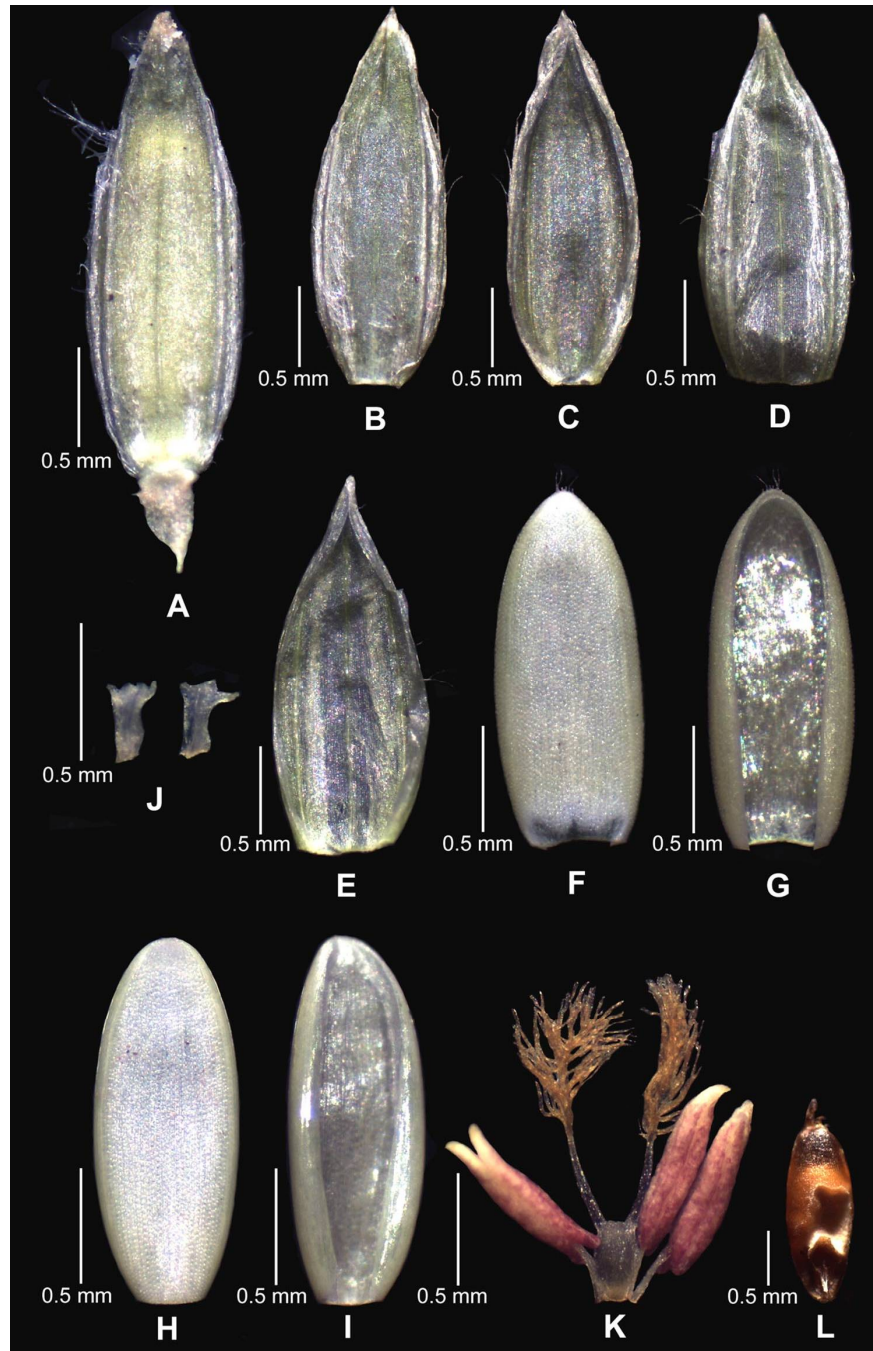


Fig. 2. *Axonopus compressus* (Sw.) P. Beauv.: A. Spikelet; B. Upper glume (abaxial surface); C. Upper glume (adaxial surface); D. Lower lemma (abaxial surface); E. Lower lemma (adaxial surface); F. Upper lemma (abaxial surface); G. Upper lemma (adaxial surface); H. Upper palea (abaxial surface); I. Upper palea (adaxial surface); J. Lodicules; K. Stamens & pistil; L. Caryopsis

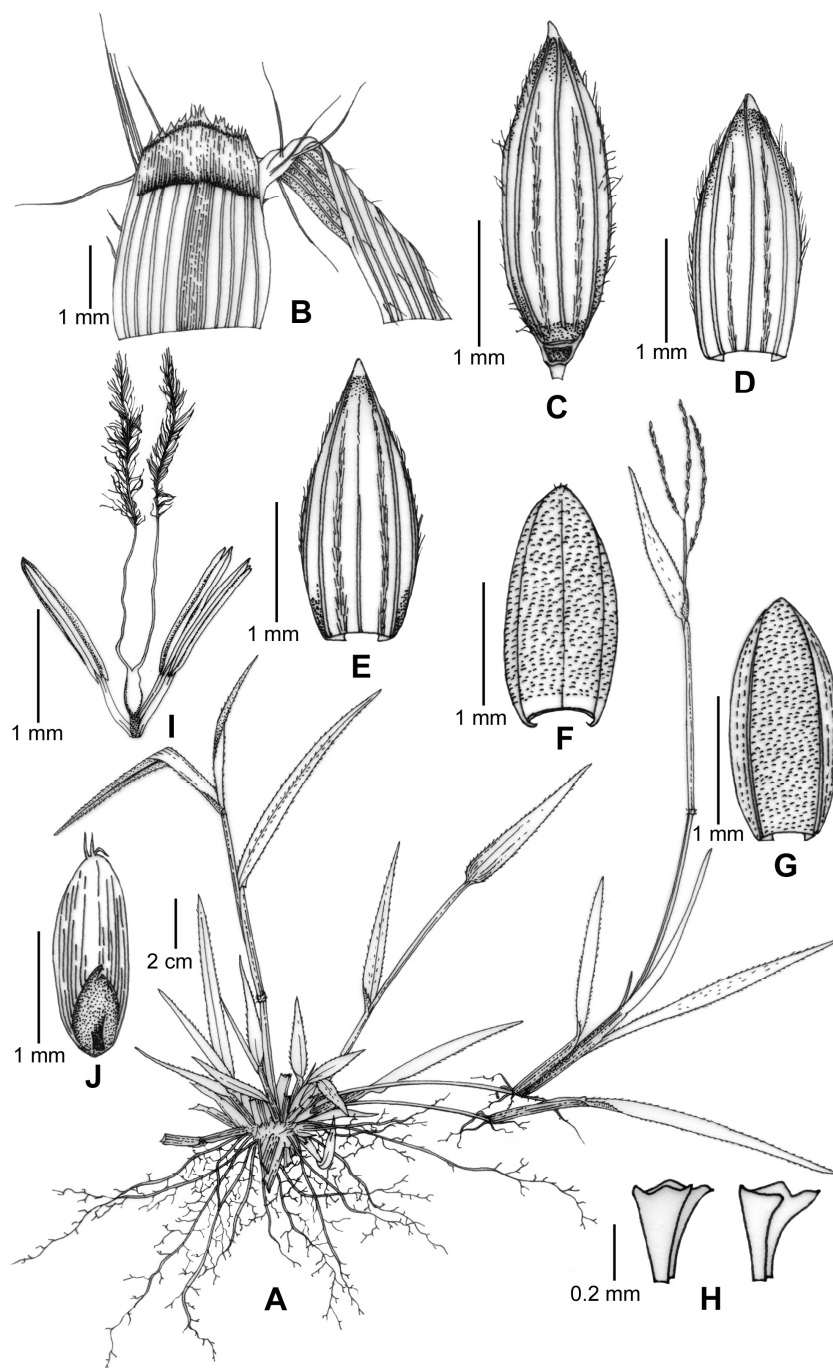


Fig. 3. *Axonopus compressus* (Sw.) P. Beauv.: A. Habit; B. Ligule; C. Spikelet; D. Upper glume; E. Lower lemma; F. Upper lemma; G. Upper palea; H. Lodicules; I. Stamens & pistil; J. Caryopsis. Illustrated by Suparna Saha from Saha 16622 & Maity, Roy and Halder 21.

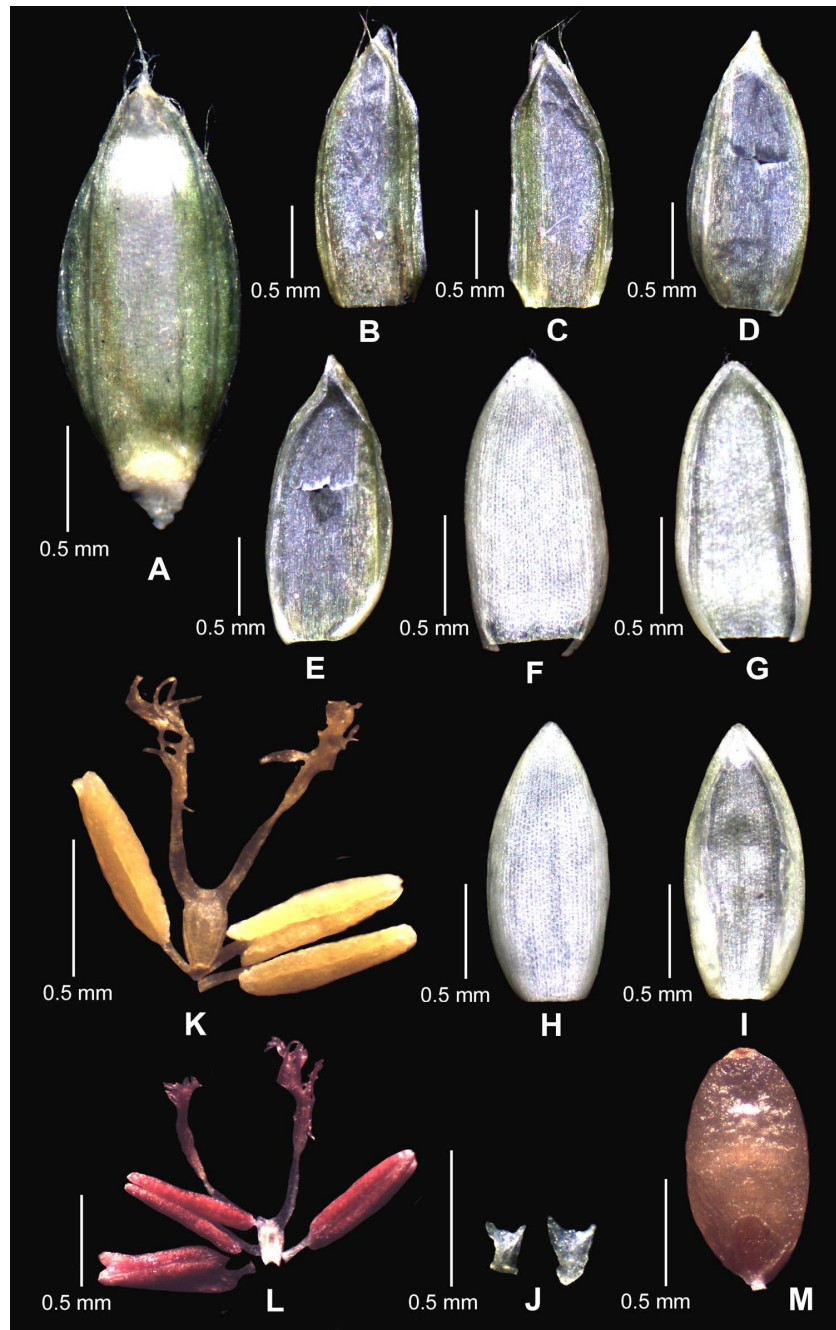


Fig. 4. *Axonopus fissifolius* (Raddi) Kuhl.: A. Spikelet; B. Upper glume (abaxial surface); C. Upper glume (adaxial surface); D. Lower lemma (abaxial surface); E. Lower lemma (adaxial surface); F. Upper lemma (abaxial surface); G. Upper lemma (adaxial surface); H. Upper palea (abaxial surface); I. Upper palea (adaxial surface); J. Lodicules; K. Stamens & pistil; L. Stamens & pistil (at maturity); M. Caryopsis

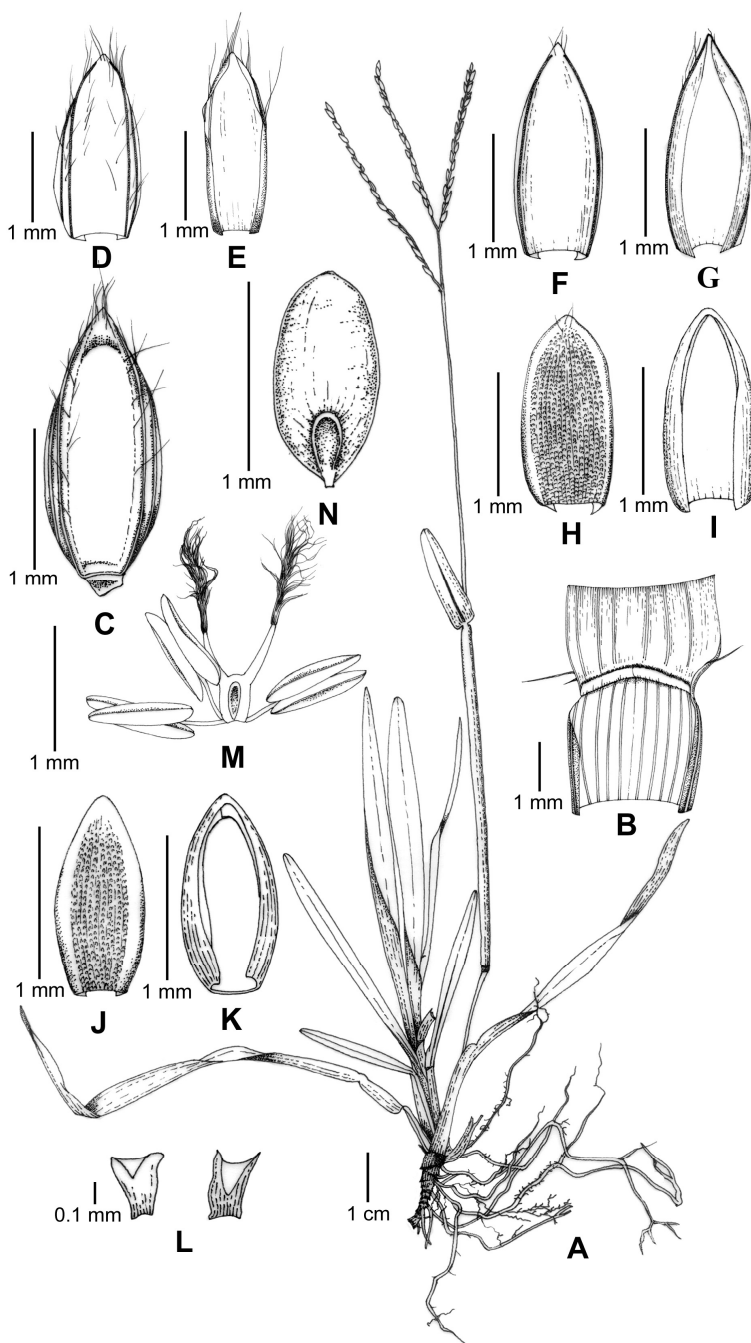


Fig. 5. *Axonopus fissifolius* (Raddi) Kuhl.: A. Habit; B. Ligule; C. Spikelet; D. Upper glume (abaxial surface); E. Upper glume (adaxial surface); F. Lower lemma (abaxial surface); G. Lower lemma (adaxial surface); H. Upper lemma (abaxial surface); I. Upper lemma (adaxial surface); J. Upper palea (abaxial surface); K. Upper palea (adaxial surface); L. Lodicules; M. Stamens & pistil; N. Caryopsis. Illustrated by Suparna Saha from Maity, Mandal, Ghosh, Miday, Saha and Halder 24810.

Distribution: INDIA: Andaman & Nicobar Islands (doubtful), Assam, Meghalaya (present report), Sikkim (present report), Uttarakhand; China, Bhutan, Myanmar, Singapore, Taiwan (Noltie, 2000; Chen and Phillips, 2006; Veldkamp *et al.*, 2019). [1000-2300 m amsl]

Specimens examined: **Meghalaya**, Khasi Hills, 1524 m, *s.d.*, *Rupchand* 8195 (ASSAM); Shillong, Khasi & Jaintia Hills, 28.8.1959, *G.K.Deka* 18394 (2 herbarium sheets at CAL). **Sikkim**, towards Lachen, 2250 m, 12.06.2022, *Maity, Mandal, Ghosh, Middy, Saha and Halder* 24810; Chungthang to Lachung, 19.08.2023, *Maity, Mandal, Ghosh, Saha and Halder* 26805; near Munsithang, 19.08.2023, *Maity, Mandal, Ghosh, Saha and Halder* 26820; Chungthang, 1618 m, 20.08.2023, *Maity, Mandal, Ghosh, Saha and Halder* 26842; Phodong, 1656 m, 20.08.2023, *Maity, Mandal, Ghosh, Saha and Halder* 26846 (all at CUH).

Key to the Indian species of *Axonopus*

1. Culm nodes bearded; leaf blades 0.6-1.2 cm across, margin long-ciliate; longest raceme spicate to base; glume apex acute, never overtopped by hairs; upper floret shorter than spikelet **A. compressus**
- Culm nodes glabrous; leaf blades 0.2-0.6 cm across, margin eciliate, pilose near base only; longest raceme espicate at base; glume apex blunt, overtopped by hairs; upper floret equaling spikelet **A. fissifolius**

Note: Many workers claimed only *A. compressus* (Sw.) P. Beauv. in India (Kabeer and Nair, 2009; Potdar *et al.*, 2012; Sur and Roy Choudhary, 2015), though in the past, Shukla (1996) reported *A. fissifolius* (Raddi) Kuhl. from the then Uttar Pradesh and Assam in addition to the former while studying the grasses of North-Eastern India. Recently, Prasanna *et al.* (2020), Kellogg *et al.* (2020), and Siddabathula and Prasanna (2023) also listed both species for the country. Likewise, the regional distribution within the nation (state-by-state) also varies significantly. Prasanna *et al.* (2020) reported *A. compressus* in 14 states of India, including Jharkhand, Odisha, and Sikkim. On the other hand, Kellogg *et al.* (2020), though recorded the same species also in these 14 states of India but did not include Jharkhand, Odisha, and Sikkim. On the contrary, they reported the species in Arunachal Pradesh, Himachal Pradesh, and Uttar Pradesh, which are not mentioned by Prasanna *et al.* (2020). Notably, Tiwari and Ansari (2014) and Bawistale (2016) recorded *A. compressus* in Chhattisgarh and Madhya Pradesh, respectively, however, both Prasanna *et al.* (2020) and Kellogg *et al.* (2020) did not recognize the species for these two states. Recently, Siddabathula and Prasanna (2023) recorded this species in Telengana.

In the case of *A. fissifolius*, the same contradiction prevails. According to Naithani and Raizada (1977), *A. fissifolius* was first recorded by R.B. Majumdar, as evident from his note on the herbarium sheet *Naithani* 1868 (CAL), where he stated that "I have also reported it from Assam, where it is also naturalized. But my report has not yet been published". However, Naithani and Raizada (1977) published the first evidence on its occurrence in India from Dehra Dun. Later on, Naithani (1990) stated its distribution in Uttar Pradesh. Subsequently, referring to Naithani and Raizada (1977), its distribution in Uttar Pradesh was also reported by Shukla (1996), though no specimen was scrutinized by him. Notably, Uniyal *et al.* (2007) did not include the genus *Axonopus* in the checklist of flowering plants in Uttarakhand. On the other hand, while updating the grass flora of Uttarakhand, Kandwal and Gupta (2009) reported only *A. compressus* for the state. Furthermore, under the present investigation, one specimen collected from Gori Valley region of Uttarakhand and identified as *A. affinis* (\equiv *A. fissifolius*) has been traced at BSD. Though

it apparently looks like *A. fissifolius*, in-depth character assessment confirms its identity as *A. compressus*.

Recently, Kellogg *et al.* (2020) documented this species in Uttar Pradesh based on Naithani (1990). But we failed to trace any representative specimen in any herbaria collected from present day Uttar Pradesh. Notably, Naithani and Raizada (1977) recorded this species in Dehra Dun, the capital of Uttarakhand, and thus the distributional data by Kellogg *et al.* (2020) is corrected here for this state. Therefore, Uttar Pradesh is excluded from the distributional range of this species, which also corroborates Agnihotri *et al.* (2023), where the genus *Axonopus* is not considered under the recent floristic checklist of the state. Prasanna *et al.* (2020) claimed the distribution of *A. fissifolius* in Andaman & Nicobar Islands and Assam. But specimens from neither of the states have been traced during this study, hence, the existence of the species in these two states is doubtful.

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References

- Agnihotri, P., Yadav, R., Jaiswal, S., Prasad, R., Prabhukumar, K.M., Wagh, V.V. and Rana, T.S. 2023. A checklist of Angiosperms in Uttar Pradesh, India. *In*: Rana, T.S., Agnihotri, P. and Prabhukumar, K.M. (Eds.), Plant Resources of Uttar Pradesh- A Checklist. Army Printing Press, Lucknow, pp. 205–418.
- Bawistale, O. 2016. *Axonopus compressus* (Sw.) P.Beauv. (Poaceae) New Record for Satpura Region, Madhya Pradesh, India. *Flora and Fauna* **22**(1):26–28.
- Black G.A. 1963. Grasses of the genus *Axonopus* (a taxonomic treatment). *Advancing Frontiers of Plant Science* **5**:1–186. Bor, N.L. 1960. The Grasses of Burma, Ceylon, India and Pakistan. Pergamon, Oxford, pp. 277–278.
- Bordoloi, S., Basumatary, B., Saikia, R. and Das, H.C. 2012. *Axonopus compressus* (Sw.) P. Beauv. A native grass species for phytoremediation of hydrocarbon-contaminated soil in Assam, India. *J Chem Technol Biotechnol.* **87**: 1335–1341.
- Chen, S. and Phillips, S.M. 2006. *Axonopus*. *In*: Wu, Z.Y., Raven, P.H. and Hong, D.Y. (Eds.), *Flora of China*. Vol. **22** (Poaceae). Science Press, Beijing and Missouri Botanical Garden Press, St Louis, pp. 530–531.
- Delfini, C., Acosta, J.M., Souza, V.C. and Zuloaga, F.O. 2020. Molecular phylogeny of *Axonopus* (Poaceae, Panicoideae, Paspaleae). *Ann. Missouri Bot. Gard.* **105**(4): 459–480.
- Giraldo-Cañas, D. 2008. Revision of the genus *Axonopus* (Poaceae: Paniceae): First record of the genus for Europe and taxonomic novelties. *Caldasia* **30**(2): 301–314.

- Giulietti N., Giulietti A.M., Pirani J.R. and Menezes N.L. 1988. Estudos em sempre-vivas: importância econômica do extrativismo em Minas Gerais, Brasil. *Acta Botanica Brasilica* **1**: 179–193.
- Gledhill, D. 1964. Experimental studies on the grass *Axonopus compressus* (Sw.) Beauv and related species, Durham theses, Durham University. Available at Durham E-Theses Online: <http://etheses.dur.ac.uk/9190/>
- Hickenbick, M. Clara M., Valls, J.F.M., Salzano, F.M. Fernandes, M. and Irene B. de Moraes. 1975. *Cytologia* **40**: 185–204.
- Ibeh, B.O. and Ezeaja M.I. 2011. Preliminary study of antidiabetic activity of the methanolic leaf extract of *Axonopus compressus* (P. Beauv) in alloxan-induced diabetic rats. *J. Ethnopharmacol.* **138(3)**: 713–716.
- Kabeer, K.A. and Nair, V.J. 2009. Flora of Tamil Nadu-Grasses. Botanical Survey of India, Kolkata, pp. 213–214.
- Kandwal, M.K. and Gupta, B.K. 2009. An update on grass flora of Uttarakhand. *Indian J. For.* **32(4)**:657–668.
- Kellogg, E.A. 2015. Poaceae. *In*: Kubitzki, K. (Ed.), Families and Genera of Vascular plants. Springer, pp. 1–416.
- Kellogg, E.A., Abbott, J.R., Bawa, K.S., Gandhi, K.N., Kailash, B.R., Ganeshaiyah, K.N., Shrestha, U.B. and Raven, P. 2020. Checklist of the grasses of India. *PhytoKeys* **163**: 1–560.
- López, A. and Morrone, O. 2012. Phylogenetic Studies in *Axonopus* (Poaceae, Panicoideae, Paniceae) and Related Genera: Morphology and Molecular (Nuclear and Plastid) Combined Analyses. *Syst. Bot.* **37(3)**: 671–676.
- Mabberley, D.J. 2017. *Mabberley's Plant-book: a Portable Dictionary of Plants, their Classification and uses*. 4th edition. Cambridge University Press, Cambridge.
- Naithani, H.B. and Raizada, M.B. 1977. Notes on the Distribution Records on Grasses. *Indian For.* **103(8)**: 513–524.
- Naithani, H.B. 1990. Flowering Plants of India, Nepal and Bhutan (not recorded in Sir J.D. Hooker's Flora of British India). Surya Publications, Dehra Dun, 479 pp.
- Nicora, E.G. and Rúgolo de Agrasar, Z.E. 1987. Los géneros de gramíneas de América Austral. Argentina, Chile, Uruguay y áreas limítrofes de Bolivia, Paraguay y Brasil. Hemisferio Sur, Buenos Aires, 611 pp.
- Noltie, H.J. 2000. Flora of Bhutan. Vol. **3(2)**. Royal Botanic Garden Edinburgh, Edinburgh. pp. 716–717.
- Potdar, G.G., Salunkhe, C.B. and Yadav S.R. 2012. Grasses of Maharashtra. Shivaji University, Kolhapur, 301 pp.
- POWO 2024. Plants of the World Online. <<http://www.plantsoftheworldonline.org/>> . Royal Botanic Gardens, Kew. Retrieved on 14 June 2024.
- Prasanna, P.V., Chowdhury, S.D., Arumugam, S., Vivek, C.P., Chorgha, A., Kar, S. and Prasad, K. 2020. Poaceae (Gramineae) (except Bambusoideae). *In*: Mao, A.A. and Dash, S.S. (Eds.), Flowering Plants of India: An Annotated Checklist (Monocotyledons). Botanical Survey of India, Kolkata.
- Shukla, U. 1996. Grasses of North-Eastern India. Scientific Publishers, Jodhpur, India. pp. 308–310.
- Siddabathula, N. and Prasanna, P.V. 2023. Grasses of Telangana. Botanical Survey of India, Kolkata. pp. 170–172.
- Soreng, R.J., Peterson, P.M., Romaschenko, K., Davidse, G., Zuloaga, F.O., Judziewicz, E.J., Filgueiras, T.S., Davis, J.I. and Morrone, O. 2015. A worldwide phylogenetic classification of the Poaceae (Gramineae). *J. Syst. Evol.* **53**:117–137.
- Soreng, R.J., Peterson, P.M., Romaschenko, K., Davidse, G., Teisher, J.K., Clark, L.G., Barbera, P., Gillespie L.J. and Zuloaga F.O. 2017. A worldwide phylogenetic classification of the Poaceae (Gramineae) II: An update and a comparison of two 2015 classifications. *J. Syst. Evol.* **55**:259–290.
- Sur, P.R. and Roy Choudhury P. 2015. The Grasses Flora of West Bengal, India. Best Books, Kolkata, 92 pp.
- Tiwari, A.P. and Ansari, A.A. 2014. New Record of Angiospermic Taxa for Chhattisgarh. *Indian J. For.* **37(1)**:97–102.

- Uniyal, B.P., Sharma, JR., Choudhery, U. and Singh, D.K 2007. Flowering Plants of Uttarakhand (A Checklist). Bishen Singh Mahendra Pal Singh, Dehra Dun.
- Veldkamp, J.F., Duistermaat, H., Wong, K.M. and Middleton, D.J. 2019. Poaceae (Gramineae). *In*: Middleton, D.J., Leong-Škorničková, J. and Lindsay, S. (Eds.), Flora of Singapore. Vol.7. National Parks Board, Singapore Botanic Gardens, Singapore. pp. 219–501.
- WFO 2024. World Flora Online. Published on the Internet; <http://www.worldfloraonline.org>. Accessed on 14 June 2024.

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