

On the correct identity and distribution of *Dactyloctenium scindicum* (Poaceae: Chloridoideae: Cynodonteae: Dactylocteniinae) in the Indo-Gangetic plains and Peninsular India and notes on other species in India

Landge S.N.*, Shinde R.D. & M.K. Mistry

St. Xavier's College (Autonomous), Mumbai, Maharashtra – 400 001, India

*E-mail: schahiedknavaze@gmail.com

Abstract: The identity of *Dactyloctenium scindicum* Boiss. has been a subject of perpetual errors over past decades in two broad regions of India *viz.*, Indo-Gangetic plain (Haryana, Uttar Pradesh and Bihar state) and parts of Peninsular India (Maharashtra and Madhya Pradesh states). Despite its common occurrence in Northwest India (Rajasthan and Gujarat), the boundaries of delimitation of the species have remained vague in many floristic accounts. In the present study, we address and clarify a long trend of misidentifications in species of *Dactyloctenium* Willd. and discuss the correct identity and distribution of *D. scindicum* in India. Lectotypification of the name *D. scindicum* is done to establish the identity. A key is given to identify the species occurring in India. The range of morphological variation within the *D. aegyptium* (L.) Willd. complex and the correct identity and occurrence of *D. australe* Steud. in India is also discussed.

Keywords: *Dactyloctenium scindicum*, Morphological variation, Species delimitation, Taxonomy.

Introduction

Dactyloctenium Willd. has 13 species globally of which four are reported from India, namely, *D. aegyptium* (L.) Willd., *D. aristatum* Link, *D. australe* Steud. and *D. scindicum* Boiss. (Bor, 1960; POWO, 2019; Kellogg *et al.*, 2020). However, delimitation of these taxa has often challenged taxonomists;

especially concerning the seashore forms in East Africa which are ill-defined, often leading to misidentification (Cope, 1982; Clayton & Renvoize, 1989).

The accuracy of determinations of *Dactyloctenium* specimens, in general, is complicated by the intervention of highly variable *D. aegyptium* and a lack of an up-to-date taxonomic treatment that clarifies boundaries between the congeners currently found in India. The best way to distinguish them is to take into consideration the characters of caryopsis, size of the anthers and the lemma. Another parameter is geographical distribution, but this has been complicated for *D. scindicum* for almost 120 years.

In India, according to various authors (Stewart, 1945; Bor, 1960; Cope, 1982; Karthikeyan *et al.*, 1989; Sharma & Purohit, 2013), the distribution of *D. scindicum* is strictly confined to the drier parts of northwestern states, such as northern Gujarat in Rajasthan. However, while studying the genus in India, we found *D. scindicum* to have been reported in the literature from the following Indian states: Maharashtra, Madhya Pradesh, Uttar Pradesh, Bihar and Haryana (Blatter & McCann, 1935; Roy, 1984; Sharma *et al.*, 1996; Kumar, 2001; Singh *et al.*, 2001a, b; Muratkar *et al.* 2012; Potdar *et al.*, 2012; Almeida, 2014; Gaikwad & Garad, 2015; Gore, 2015; Malik, 2015). We discovered that the latter reports differed remarkably from the former in terms of species delimitation in that the identity of *D. scindicum* was

altered in the latter reports. Therefore, it became urgent to discuss this anomaly, the correct identification, taxonomic characters and the distribution of *D. scindicum* in India. We have classified and discussed our findings, with respect to the above mentioned publications, under the two broad phytogeographic regions *viz.*, the Peninsular India (Gujarat, Madhya Pradesh and Maharashtra) and the Indo-Gangetic plains (Rajasthan, Haryana, Uttar Pradesh and Bihar).

Another congener, *Dactyloctenium australe*, a native of South Africa, has also raised the issue of its identification with the cosmopolitan weed *D. aegyptium* in India. These species tend to exhibit a great degree of morphological similarities and most often have been interchangeably identified. The proper identity and occurrence of the former in India will be discussed, as well as the phenotypic plasticity of the latter.

The present paper comprises three main parts, as follows: Firstly, to clarify the identification of *Dactyloctenium scindicum* and its proper distribution in India. Secondly, to understand the phenotypic plasticity of forms of *D. aegyptium* and its delimitation from close species. Thirdly, to clarify the identification of *D. australe* and its occurrence in India.

Materials and Methods

The present investigation is mainly based on the study of *Dactyloctenium* specimens at BLAT, BSI, BSJO, CAL, BAMU, MH and WCAS (herbarium codes according to Thiers, 2020, continuously updated). We have critically examined all the available specimens in the genus from the herbaria mentioned above. Additionally, numerous herbarium specimens of *D. scindicum* were also seen as digital images online at P, K and G. The reports from Madhya Pradesh, Uttar Pradesh, Bihar and Haryana were evaluated after a critical study of the description and notes provided by the authors of

the concerned literature, as mentioned in the introduction. The protologue and the type “*Stocks 637*” at G and K [misquoted by Boissier (1859) as *Griffith 637* (Cope, 1982)] of *D. scindicum* were consulted for establishing the true identity of the species.

All specimens from Africa, the Arabian Peninsula & Pakistan were seen as high resolution images by requesting and accessing them when available online at the virtual herbarium portal of P, K and G. The herbarium specimens from India were critically examined during visits to the herbaria BLAT, BSI, BSJO, BAMU and WCAS). The herbarium specimens from CAL were seen by requesting high resolution images. An image of the type of *Dactyloctenium scindicum* at G (G00799884) is not available at the virtual herbarium portal; we requested and obtained it as a digital image for the present study from G herbarium.

For the past three years (2019–2021), the first author has been critically studying *D. scindicum*, *D. aristatum* and *D. aegyptium* in the grass experimental set-up at St. Xavier’s College (Autonomous), Mumbai. The critical differences, range of variations and growth pattern observed in the species under observation contributed to the present study. The data is being utilized to produce a revision of the genus from India.

The first author personally studied numerous herbarium specimens of *D. aegyptium* at BLAT, BSI, BSJO, BAMU and WCAS and additionally consulted digital specimen images of many international herbaria, such as, K, B, BM, M, NHN, E, P, US, MFU. Data gathered by studying herbarium specimens, living specimens in the field in Madhya Pradesh, Andhra Pradesh, Maharashtra, Assam, Nagaland, Gujarat and Rajasthan states, and specimens in the grass experimental set-up, was used in preparing the comprehensive insight in *D. aegyptium* complex.

Key to the species of *Dactyloctenium* in India:

1. Perennials; anthers 1.2–2 mm long; caryopsis transversely rugose 2
1. Annuals; anthers 0.5–0.8 mm long; caryopsis transversely rugose or finely granular or granular-striate 3
2. Spikes 0.8–2.3 cm long; lemma mucronulate, never gibbous; culms bulbous-thickened at the base *D. scindicum*
2. Spikes (1.5–)2.5–3.5(–5) cm long; lemma acuminate, gibbous; culms not bulbous-thickened at the base *D. australe*
3. Caryopsis finely granular or granular-striate; lemma conspicuously acuminate (tip 1.2–2.3 mm long); spikes 0.6–2(–2.9) cm long
.....*D. aristatum*
3. Caryopsis transversely rugose; lemma mucronate (mucro usually 0.5(–1) mm long); spikes 1.2–6.5 cm long *D. aegyptium*

Taxonomic Treatment

Dactyloctenium scindicum Boiss., Diagn. Sér.2, 4, 131. 1859. *Eleusine scindica* (Boiss.) Duthie, Fodder Grasses North. India. 58. 1888.

D. glaucophyllum Courbon., Ann. Sc. Nat. sér. 4, 18: 133. 1862. *Eleusine glaucophylla* (Courbon) Munro ex Benth. J. Linn. Soc., Bot. 19: 107. 1881. *Type*: ETHIOPIA, Eritrea, Dissei I., Courbon (holo P [P02227114 digital image!]).

D. glaucophyllum Courbon var. *elongatior* Courbon, Ann. Sc. Nat. sér. 4, 18: 134. 1862. *Type*: ETHIOPIA, Eritrea, near Massaua, Ennecoullou, Courbon (holo P [P02227115 digital image!]).

D. glaucophyllum Courbon var. *robustior* Courbon, Ann. Sc. Nat. sér. 4, 18: 134. 1862. *Type*: ETHIOPIA, Eritrea, Dumeira I., Courbon (holo P [P02227112 digital image!]).

Figs. 1-3

Perennial herbs, 10–60 cm high, glaucous, slender, densely tufted mat-forming, with distinct thickets

interconnected by network of woody stolons. Culms long, slender, stiff, geniculate ascending with bulbous thickened/swollen bases (thickening velvety-tomentose), clothed with blade-less or reduced-bladed. Leaf sheath glaucous, striated, shorter than the internodes, papillose long-hispid with bulbous based trichomes, loose near the base, quite disintegrating in appearance in mature plants in the lower parts of culm. Blades 3–16 × 0.18–0.2 cm, linear-lanceolate, acuminate, glaucous, scattered papillose-hispid especially along the margins, with bulbous-based trichomes 0.5–2 mm long, sparsely dispersed, deciduous with age; older blades studded with remnants of trichome bases. Ligule *c.* 0.8 mm long, membranous, truncate, lacerated, and slightly ciliolate. Inflorescence a terminal, a digitately radiating fascicle consisting 3–4(–7) spikes, each spike 0.5–2.3 cm long, falcately curved or sub-patently projecting. Rachis stout, scabrid, minutely ciliolate on the angles, pilose in the junction, somewhat triangular in cross section, excurrent into a pungent mucro of 0.3–3(–5) mm in length, dis-articulating with a transverse constriction or articulation at the base. Spikelets 4–8(–10) mm long, of variable sizes, those occupying the middle of the rachis being longer than those towards the ends, solitary, biserially secund on the inner concavity of the stout rachis, laterally compressed, ovate, sessile, disarticulating above the glume not between the florets, 3–7(12)-flowered (terminal 1–2 florets reduced to lemma, vestigial or staminate, 0.8–1.2 mm long). Lower glume 1.8–2.5 × 1 mm, ovate, 1-nerved, strongly carinate, midrib rigid, sides membranous, sub-hyaline, glabrous, scabrous. Upper glume up to 1.5–2.3 mm long (excluding awn), elliptic or somewhat oblong, 1-nerved, strong midrib extended into a sub-apical awn *c.* 1.2 mm long, long, sides sub-rigid with hyaline margin, glabrous, scaberulous. Lowest pair of florets in the spikelet equal or sub-equal. Lemmas 3–3.8 × 1.8 mm, narrowly ovate-elliptic, lanceolate, never gibbous, 3-nerved (midrib rigid, quite smooth, lateral nerves sub-marginal, gradually evanescent), thick, coriaceous, glabrous, smooth, tip obtuse to mucronulate (mucro *c.* 0.8 mm long).

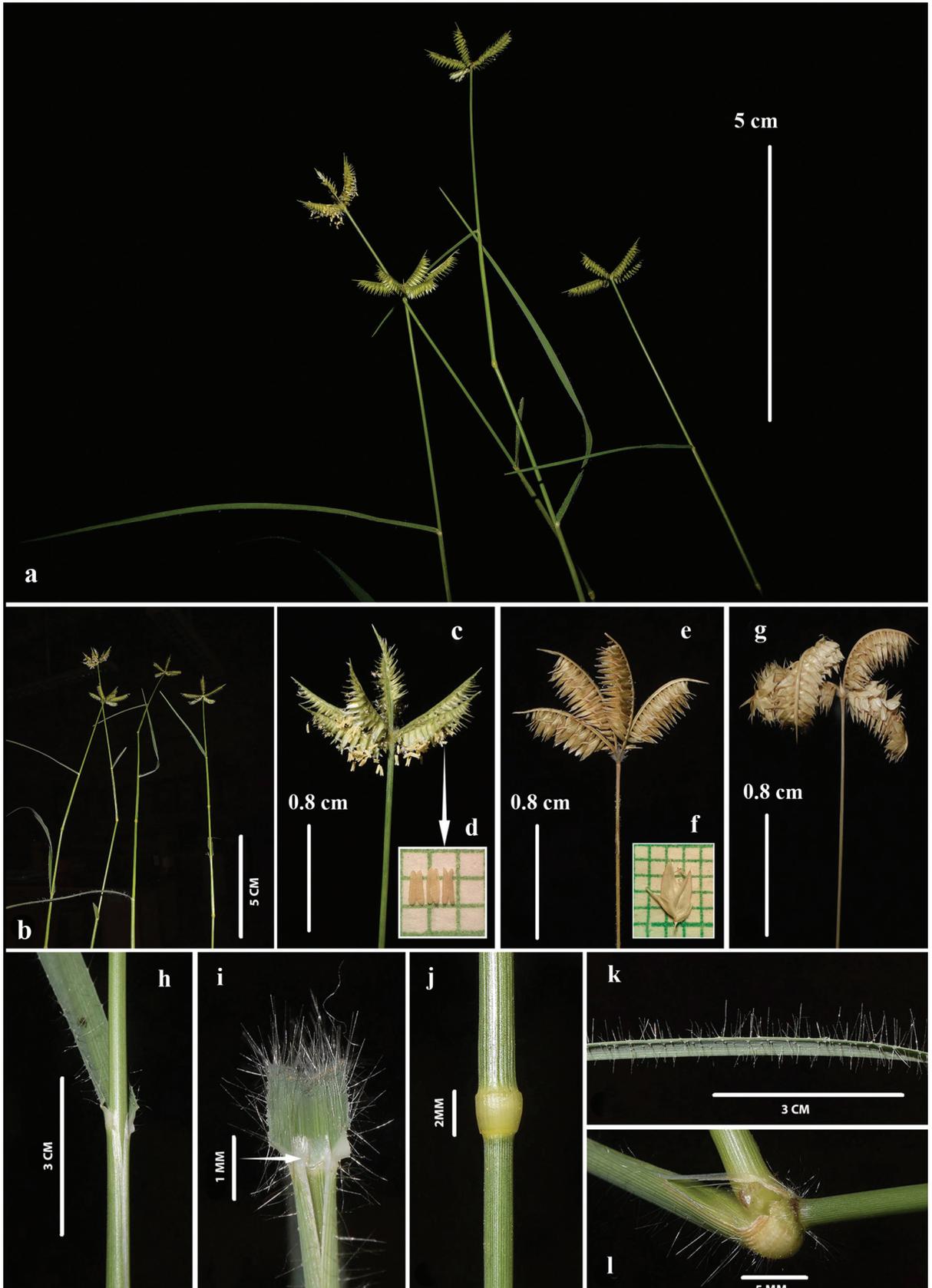


Fig. 1. *Dactyloctenium scindicum* Boiss.: **a.** & **b.** Habit; **c.** Spikes during anthesis; **d.** Anthers; **e.** Mature spikes; **f.** Spikelet; **g.** Disarticulating spikes; **h.** Leaf sheath; **i.** Ligule; **j.** Swollen glabrous node; **k.** Side view of leaf blade; **l.** Bulbous-thickened culm base and stolon (photos by Shahid Nawaz).

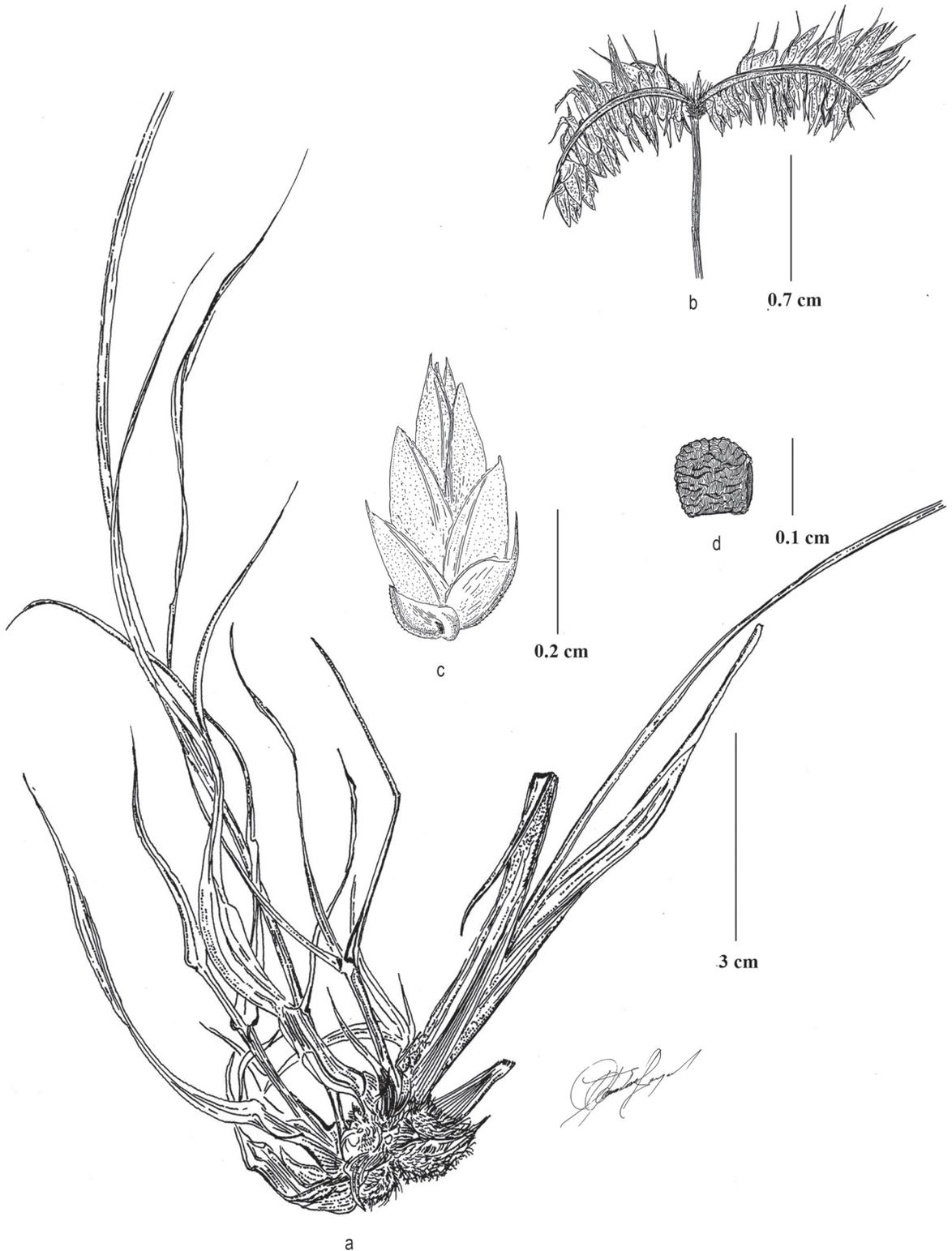


Fig. 2: *Dactyloctenium scindicum* Boiss.: **a.** Habit; **b.** Inflorescence (spike); **c.** Spikelet; **d.** Transverse view of rugose caryopsis (drawn by Shahid Nawaz).

Palea 2.8–3 × 0.8–(–1) mm, elliptic, 2-keeled, membranous, margin inflexed, keels thick, moderately scabrid, wingless, tip acute and undivided. Lodicules 2, *c.* 0.3 mm long, turgid with oblique apices. Stamens 3, filaments long, anthers 1.1–2 mm long. Caryopsis 0.7–1.2 mm long, ovate, never concave at the tip, transversely rugose.

Vernacular names: Sindh: Mandjiro; Punjab: Bhobra (in Hissar), bobriya (in South Punjab); in Rajasthan (formerly Rajputana): Ganthya, gantighas and janglimalicha (in Ajmer), kharomakro or makra (in Jaipur) (Duthie, 1888).

Flowering & fruiting: almost throughout the year.

Habitat: Dry rocky outcrops, sandy soil on hard ground and also on wet ground. It also occurs on highly saline soil tracks in the Kutch district. In its northwestern range of distribution in Rajasthan, it is a common species.

Illustrations: Sultan (1954: 16, fig. 8), Fröman and Persson (1974: 230, plate 90).

Distribution: Northeast tropical Africa, from Egypt to Kenya; Sudan to Arabia. Also Pakistan (Sindh, Balochistan, Punjab and Northwest Frontier Province) penetrating into Northwest India (Bor, 1960, Cope, 1982 Clayton *et al.*, 2006, Kamal *et al.*, 2016).

In India, this taxon is distributed in: Rajasthan state (almost in all districts) and Gujarat state, mostly northern parts such as Kutch district, Banaskantha district and Surendranagar district, and also mentioned to occur in the Ahmedabad district of this state (Woodrow, 1901). According to Blatter and McCann (1935), Sedgwick's collections from Ahmedabad exist but provided no collection number. We have not seen any material by Sedgwick from Ahmedabad. Although according to Duthie (1888) and Blatter and McCann (1935), it occurs in Punjab, but we have not seen any specimen in the consulted herbaria.

Specimens examined: INDIA [Indes Orient?]. Indes Orient, *s.d.*, V. Jacquemont 59 & 75(P). Gujarat, Banaskantha district, Deodhar, 90m, 02.09.2004, S.

L. Meena 20714 (BSJO); Jessore Wildlife Sanctuary., 240 m, 21.08.2003, S. L. Meena 1814 (BSJO); Juigao, 20 m, 02.09.2004, S. L. Meena 20726 (BSJO); Dwarka district, neighborhood of station, 22.08.1952, H. Santapau 14736 (BLAT); Mithapur Talao, Saurashtra, 16.10.1953, H. Santapau 16751 (BLAT); Kutch [Kachchh] Anjar, 18.10.1958, S. K. Jain 46692 (BSI); Chobari Plantation, Parlander, 12.09.1955, M.P. Gula 72 (CAL); Fatehgarh-KDWS, 61 m, 05.10.2004, R.P. Pandey 16020 (BSJO); Guhar Village, 40 m, 13.10.2002, R. P. Pandey 17769 (BSJO); Along Haji Pir, 125 m, 09.10.2002, R. P. Pandey 17626 (BSJO); Khavda, 19.10.1958, S. K. Jain 46863 (BSI); Sugaria village, 275 m, 09.01.2004, R. P. Pandey 20361 (BSJO); reserve forest near Vandhiya village, 28.09.1964, S. R. Rolla 103139 (BSI); Surendranagar district, Falkio dam side, 5 m, 13.01.2002, R. P. Pandey 14868 (BSJO); way to Halwad, 23.10.1999, R. P. Pandey 14396 (BSJO). Rajasthan, *s.loc.*, 07.10.1960, D. M. Varma 2607 (CAL); Alwar, Naldeshwar forest block, 24.10.1983, P. J. Parmar *s.n.* (BSJO); Baran district, 04.10.1960, S. R. Rolla 66851 (BSJO); *Ibid.*, 05.10.1960, *s.coll.*, 66898 (BSI); Barmer district, Hillock, Mataji Temple, 07.11.2019, Sushant More SSM-151 (BLAT); northern side of Rann of Kutch, 15 m, 24.10.1945, B. V. Shetty 2328 (BSJO); Sheogulosa pond side, 21.11.1973, G. L. Tiwari 934 (BSJO); Bikaner district, 23.08.1957, G. S. Puri 21947 (BSI); near K. c. p. Colony along Bichwal rd., 213m, 09.03.1975, G. P. Roy 1652, 1654 (BSJO); Gajner, J. B. Bhagat 23506 (BSI); Churu district, 225m, 26.03.1976, G. P. Roy 2623 (BSJO); Hanumangarh district, Pallu, 175 m, 29.08.1978, G. P. Roy 6458 (BSJO); University Reserved Forest, 465 m, 11.09.1966, S. Sharma S. S. 2153(CAL); Jaisalmer district, 10.08.1958, S. K. Jain 40719 (BSI); Devikot, 390 m, 30.08.1976, B. V. Shetty 3353 (BSJO); Loharki, 450 m, 25.08.1976, B. V. Shetty 3328 (BSJO); Mohangarh, 27.08.1964, B. M. Wadhura 5053 (BSJO & CAL); Near Phalari, 275 m, *s.d.*, R. P. Pandey 7825 (BSJO); Devikot, 10.09.1964, B. M. Wadhwa 5295A (CAL); Pokhran, 25.08.1964, B. M. Wadhura 5027 (BSJO); Sudasri R. F., 250 m, 5.11.1981, R. P. Pandey 7840 (BSJO);

- Jalore district, Agwari along Jalotfalna rd., 250 m, 20.09.1978, *B. V. Shetty* 6647 (BSJO); Runn side near Aakodia, 20 m, 29.09.1978, *B. V. Shetty* 6762 (BSJO); Jhalawar district, Khanpur village, 360 m, 19.03.1976, *G. P. Roy* 2505 (BSJO); Jhunjhunu district, Khetri F. B., 13.09.1992, *P. J. Parmar* 11070 (BSJO); Jodhpur, BSJO compound, 22.01.2020, *Shahid Nawaz* JP80, JP81, JP82 (BLAT); on the way to Sardar Samand from Jodhpur, 06.11.2019, *Sushant More* SSM-152 (BLAT); Beriganga station area, compt.-I, 21.09.1972, *B. V. Shetty* 113 (BSJO & CAL); Bithri Pohorimachia, 305 m, *s.d.*, 15.09.1998, *R. P. Pandey* & *P. M. Padhye* 14207 (BSJO); Chaba, 400 m, 08.10.1976, *A. N. Singh* 3142 (BSJO & CAL); Dechu village, 21.08.1959, *G. S. Puri* 23167 (BSI); Kailana-Compt. II, *s.d.*, 31.07.1972, *S. Moorthy* 30 (BSJO); Pal village 8 km from Jodhpur, 06.05.1975, *R. P. Pandey* 1763 (BSJO & CAL); Phalodi, 11.08.1958, *S. K. Jain* 40753 (BSI); 47 miles from Jodhpur, 19.08.1959, *G. S. Puri* 22974 (BSI); *s.loc.*, 30.09.1958, *S. K. Jain* 40033 (BSI); 17 miles from Jodhpur Bikaner rd., 22.08.1957, *G. S. Puri* 21931 (BSI); Marwar region [Marwad], 1868, *G. King*, *s.n.* (CAL); Sikar district, Baleshwar F. B., 427 m, 10.10.1994, *P. J. Parmar* 12214 (BSJO); Ramgarh, 13.10.1960, *G. S. Puri* 67141 (BSI); Sri Ganganagar district, Anupgarh, canal, 19.09.1980, *S. K. Malhotra* 7439 (BSJO); Gharsana, 200 m, 20.11.1976, *G. P. Roy* 3816 (CAL); *s.loc.*, 300 m, 10.11.1976, *G. P. Roy* 3816 (BSJO). PAKISTAN [Formerly part of India]. Scinde [Sindh], *J. E. Stocks* 637 (3K & 1G images!). Scinde, western India, 26.02.1857, *s.coll.*, *s.n.* (P). DJIBOUTI, Gorges de ban, 26.10.1986, *J. Audru* 8506 (P); Yager, 16.04.1986, *J. Cesar* 2391 & 2449 (P); *Ibid.*, 15.10.1986, *J. Cesar* 3202 (P); *Ibid.*, 17.10.1986, *J. Cesar* 3184 (P). ETHIOPIA (Abyssine, Abyssinia), 10.02.1973, *G. Boudet* 8279 (P); Mt. Filtu, 12.11.1972, *G. Rippstein* 599 & 818 (P); 84 km N. W. de Godde, 30.11.1972, *G. Rippstein* 1219 (P); 25 km E de Wacille, 05.01.1973, *G. Rippstein* 1834 (P); Harar Province, 05.02.1966, *J. O. Kokwaro* 671 (P); *s.loc.*, 31.05.1960, *Mr. Russels* (P); *s.loc.*, 1859–1860, *Mr. Russel*, *s.n.* (P); *s.loc.*, *s.d.* [1964], *Dr. Vet R. Blane* 37 (P); Gobelli river valley West of Dalletti, 12.06.1963, *William Burger* 2960 (P); North of Eve-Gota near Idoma, 31.08.63 [1963], *William Burger* 3213 (P); Degh Medo, 14.06.1972, *Zandie Telahun* 4 (P); Docoa, 16.06.1970, *Zandie Telahun* 6 (P); Fibi Plain, 15.06.1972, *Zandie Telahun* 13 (P); Togmane, *s.d.* [06.1972], *Zandie Telahun* 3–9 (P); Togmane, *s.d.* [06.1972], *Zandie Telahun* 8 bis & 10 (P); Togmane, 14.06.1972, *Zandie Telahun* 12 (P). KENYA, *s.loc.*, 850 feet alt., *s.d.*, *P. J. Greenway* & *Kanuri* 157 (P). NUBIA [NUBISCHE KÜSTE], *s.loc.*, 28.06.1864, *G. Schweinfurth* 1538 (P); *s.loc.*, 28.06.1865, *G. Schweinfurth* 1538 (P). SOMALIA, *s.loc.*, 09.1912, *Deniss.* (P); *s.loc.*, 15.07.1986, *D. Rousuool* 127 (P); *s.loc.*, 05.1953, *E. Chedeville* 805 (P); *s.loc.*, 08.1953, *E. Chedeville* 806 (P); Bordo du lac SnlAcdra?, desert [Somalia], 06.09.04, *Neuvilles.* (P); *s.loc.*, 14.02.1938, *s.coll.*, *s.n.* (P). SOMALILAND, *s.loc. s.d.* [1897], *E. Yort Phillipssn.* (P); Hargeisa, 1310 m, 21.11.1932, *J. B. Gillett* 3903 (P). ARABIA [Arab, Arabie or Saudi Arab], *s.loc.*, 26.03.1890, *Bilad Fodhli* 455 (Aurige) & 468 (in Wadiarab?) (P); *s.loc.,s.d.* [1825], *C. G. Ehrenberg* 229 (P); Arabie-safjir, 20.01.1982, *D. Dulieu* 1588 (P); Arabie-Taifa, 1838, *M. Bottas.* (P); Asirsudjeddah, 29.11.1966, *M. Mosnier* 3016 (P); *s.loc.*, 06.04.1967 [more than 10 florets in the spikelets], *M. Mosnier* 3353 (P); Wasga, 27.02.68, *M. Mosnier* 3685 (P); Arabia, *s.loc.*, *S. Fischer* 206 (K); Arabie-Djedda, *s.d.* [1838], *s.coll.,s.d.* (P); Arabia, *s.loc.,s.d.*, *s.coll.*, *s.n.* (P 02624660). MUSCAT, [Mascate?] *s.loc.,s.d.*, *Aucher Eloy* 5468 & *s.n.* (P). YEMEN. Aden., *s.d.* [05.1842], *s.coll.*, *s.n.* (P); *s.loc.*, 08.03.1885, *s.coll.*, *s.n.* (P); 09.04.1890, *s.coll.*, 521 & 671 (P); *s.loc.*, *s.d.*, *s.coll.*, *s.n.* (BLAT Acc.no. 83330); *s.loc.*, *s.d.* [1842], *M. Bottra*, *s.n.* (P); *s.loc.*, *s.d.* [1837], *M. Bottas.* (P); *s.loc.*, 28.12.1977, *M. Monod* 166821 (P). YEMEN DU SUD [South Yemen], *s.loc.*, *s.d.* [09.1880], *J. E. T. Aitchison* 525 & 75 (P); *s.loc.*, 20.12.1977, *M. Monod* 16402 (P); *s.loc.*, 22.12.1977, *M. Monod* 1644964 (P); *s.loc.*, 09.01.1978, *M. Monod* 17050 (P); *s.loc.*, 18.07.1978, *M. Monod* 17287 (P).

Conservation status: *Dactyloctenium scindicum* is a fairly common species in Northwest India in two

states *viz.* Rajasthan and northern parts of Gujarat. Hitherto, there is no sign of any considerable decline or threat. It manages to survive in human settlements and on the fringes of cultivated fields, roads, and lanes in towns. Based on this information, according to IUCN Red List Categories and Criteria (2019), we assess this species as Least Concern (LC).

Typification: Boissier (1859) wrote “Hab. in ditione Scinde cl. Griffith N° 637”. According to Cope (1982) Boissier misquoted Griffith as the collector of the type specimens of *Dactyloctenium scindicum*. However, the type specimens were originally collected by J.E. Stocks from Sindh [Scinde] present day Pakistan. Boissier cited only a gathering as “Griffith 637” and did not indicate the particular herbarium. We located four type specimens corresponding to the information in the protologue at G (G00799884) & K (K000245134, K000245135 & K000245136). Boissier did not indicate which one of these four specimens were a holotype. Later, Clayton *et al.* (1974) indicated holotype at G and isotypes at K. According to Art. 9.6 of International Code of Nomenclature (Turland *et al.*, 2018), there is no holotype of this name in absence of any indication by Boissier; these specimens are rather syntypes. The action of Clayton *et al.* (1974) resulted in an inadvertent lectotypification by calling specimen at G a holotype. A second step, according to Turland *et al.* (2018), is required to establish the identity of the name *D. scindicum* with the particular specimen. Thus, we designate the herbarium specimen at G (G00799884) (Fig. 1) as a lectotype of the name because it was originated from Boissier’s herbarium and has annotations “637 *Dactyloctenium* sp. nov. Scinde” corresponding to the protologue and the specimen agrees well with the description given in the protologue. The other three duplicates at K (K000245134, K000245135 & K000245136) are considered isolectotype.

Notes: In *D. scindicum* the spikes are arranged in a compact head, variable in appearance, sub-patently projecting when young (much similar in appearance to that of *D. aristatum*) and falcately

decurved when dried and mature, dis-articulating at the base as a single unit (Fig. 2). The lemma of *D. scindicum* is non-gibbous, obtuse to mucronulate or acute but never aristate or acuminate, and the keels are quite smooth (Fig. 3). These features are unique to this species and equally helpful for distinguishing it from *D. aegyptium*, *D. australe*, and *D. aristatum*. In some cases [Shahid Nawaz JP80 (BLAT), Rajasthan & M. Mosnier 3353 (P), from the Arabian Peninsula], the number of florets in the spikelet is approximately 10–12, giving a very peculiar appearance to the overall spikes, yet no peculiar differences in length of the anthers, size of the lemmas, shape and ornamentation of the caryopsis and size of the glumes were observed. Such forms have been encountered infrequently in the drier regions of Rajasthan, Northern Gujarat and the Arabian Peninsula. The leaves are of variable length, longer and finely pubescent in wet damp areas and shorter, linear, rigid, sometimes conduplicate, and papillose-hispid in drier areas.

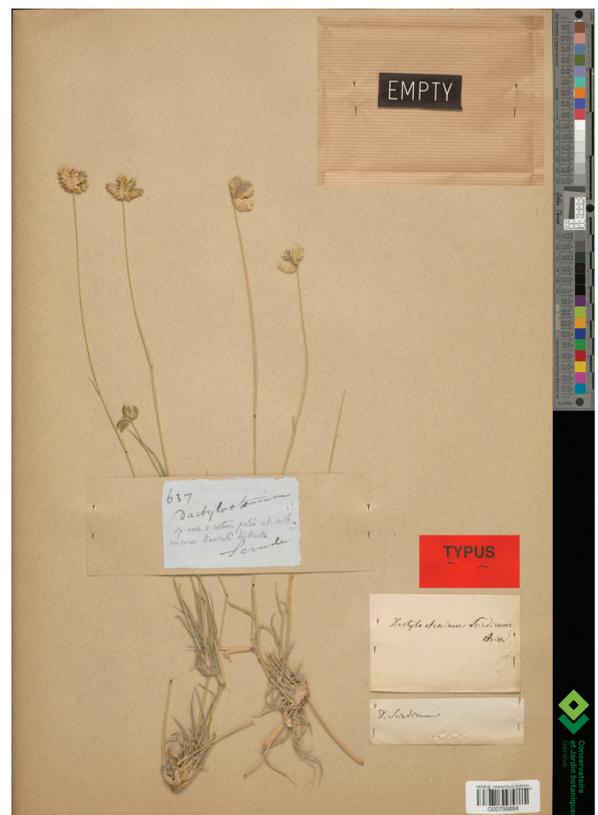


Fig. 3. Lectotype of *Dactyloctenium scindicum* Boiss., J.E. Stocks 637 (G00799884). ©The Board of Trustees of Genève Herbarium (G).

The basal portion of the culms is bulged, with distinct thickenings being interconnected by slender stolons; this feature can be utilized to establish its identity even in the vegetative state. The caryopsis is transversely rugose (Fig. 3), but not as coarsely rugose as that of *D. aegyptium*.

Discussion

Distribution of *Dactyloctenium scindicum* in India

Bor (1960) gave distribution for the species as “hotter parts of the Middle East and penetrating in Northwest India” chiefly referring to Rajasthan and parts of Gujarat. In Maharashtra, the report of *D. scindicum* first appeared in Cooke (1908) in reference to Woodrow (1901) from Konkan: Ratnagiri “Rutnagiri”. However, Woodrow (1901) did not cite any specimen in his paper to trace and study. Therefore, the report does not justify the basis of occurrence. Later, the species appeared in numerous floristic accounts (e.g. Blatter & McCann, 1935; Sharma *et al.*, 1996; Muratkar *et al.*, 2012; Potdar *et al.*, 2012; Almeida, 2014; Gaikwad & Garad, 2015; Gore, 2015). After a scrupulous study of the cited specimens, and the description provided in the above mentioned literature held at BSI, BLAT and WCAS, the characteristics such as annual habit, non-gibbous culm bases, caryopsis transversely rugose or finely granular and anthers c. 0.8 mm long were revealed. Based on these it is quite evident that their specimens belonged to two different species *viz.* *D. aristatum* (with granular caryopsis and strictly coastal distribution) and *D. aegyptium* (with transversely rugose caryopsis and coastal as well as inland distribution). We have not found a single true *D. scindicum* specimen from Maharashtra during the herbarium study and fieldwork.

In Madhya Pradesh, *D. scindicum* had been reported by Roy (1984) and Singh *et al.* (2001b). The characters provided by them in the description, such as transversely rugose caryopsis and the anthers c. 0.8 mm long, are taxonomically significant in

delimiting species. Thus, we conclude that the specimens are certainly *D. aegyptium*. We have not seen a single true specimen of *D. scindicum* from Madhya Pradesh in the herbaria visited.

We have examined many specimens of true *D. scindicum* from Gujarat at BSI, BSJO and BLAT. These specimens are mostly from northern districts (Kutch, Banaskantha, and Surendranagar).

Indo-Gangetic plains (Rajasthan, Haryana, Uttar Pradesh, and Bihar states)

Kumar (2001) reported *D. scindicum* in the Flora of Haryana. However, there is no description and details of the collected specimens given. Therefore, the identification cannot be justified.

Malik (2015), while preparing a checklist of grasses (Poaceae) for the Saharanpur forest division, Uttar Pradesh, reported *D. scindicum*. The identification cannot be confirmed as he added “Identification of grasses is chiefly based on personal observation in the field and undoubtedly, there are errors in identification of grasses”. Moreover, he provided no description or cited any voucher specimens.

Singh *et al.* (2001a) reported *D. scindicum* from Bihar but did not provide a key to identify species and there is no citation of voucher specimens.

We have not found any specimen of true *D. scindicum* from Haryana, Uttar Pradesh, Madhya Pradesh and Bihar at (BSI, BSJO, BLAT, WCAS, BAMU).

We have examined numerous specimens of true *D. scindicum* from Rajasthan, the state in India representing the highest population number of this species. There, it is widely distributed and regionally one of the most abundant grasses.

The most commonly misidentified species for *D. scindicum* in India is *D. aristatum*. The latter has a strict distribution, confined to the west coast of Peninsular India and a fairly wide distribution in Rajasthan and Gujarat. The best way to segregate these two species is based on surface characters of their caryopses, which is transversely rugose and

finely granular in the former and latter respectively. Liu *et al.* (2005) also emphasized the importance of characters of the Caryopsis in segregating genera and even species in the sub-family Chloridoideae.

In India, distribution of proper *D. scindicum* is strictly confined to the drier northwestern states such as the northern Gujarat (Kutch, Banaskantha, and Surendranagar districts) and Rajasthan (Stewart, 1945; Bor, 1960; Cope, 1982; Karthikeyan *et al.*, 1989; Sharma & Purohit, 2013). However, the species seem to have also been reported from Punjab (Stewart, 1945; Cope, 1982), but we have not seen any specimen in herbaria. Sedgwick's collection (as indicated in Blatter & McCann, 1935) from the open dry hills in the Ahmadabad district and Pandey's collection (*R. P. Pandey* 14868 at BSJO) from the Surendranagar district, Gujarat, appear to be the southernmost distribution points of *D. scindicum* in India. Beyond this most southerly distribution, there is no true distributional report of this species in India. More fieldwork in the southern districts of Gujarat state is still needed, to assess the range limits of *D. scindicum*.

Range of morphological variation within the *Dactyloctenium aegyptium* complex

Dactyloctenium aegyptium, a pantropical weed, is highly polymorphic and is the most widely distributed species in the genus in India and in the world. It is commonly misidentified as *D. scindicum*, *D. australe*, *D. aristatum* and *D. radulans* (R.Br.) P. Beauv. in regions where these species share habitats. According to Peterson *et al.* (2016) the considerable morphological variation within *D. aegyptium* is reflected among the 11 individuals included in their study, where support for the monophyly of this species is weak (BS=62, PP=0.54). Numerous characters have been noted to be highly variable and with a little taxonomic significance in delimiting species, such as:

- Habit varies from unusually ephemeral (in thin layer of soil on rocky outcrops and lateritic plateau in the Western Ghats and Deccan

traps), usually annual to rarely perennial (on the sea shore).

- The number of spikes variable, range varies from one to 10, and sometimes, although infrequently, double whorls of spikes are also seen; this phenomenon was studied by Ajibade and Ebukanson (2000) in Africa.
- The habit is also highly variable, the plants being varying 5–18 cm tall, with slender culms, weakly tufted, non-stoloniferous (sometimes rooting on the lower nodes), with shortly projecting spikes of 0.5–1.5 cm long (*Shahid Nawaz* M1, M2, M3, M4 at BLAT) to robust, strongly tufted, elaborately stoloniferous, mostly annual but sometimes perennial on the seashore, with longer, slightly recurved spikes.
- The size of the leaves and associated indumentums is also inconsistent and extremely variable (especially in the drier habitats including sandy seashores).
- The ligule morphology varies between well-developed and entire or ciliate, reduced, or completely lacking.
- The curvature of the spikes (it is clearly seen in the specimen L. 1237987 at L) (downward or upward) and the dis-articulation of the spikelets is also taxonomically insignificant.
- The mucro (extension of rachis) at the distal end of a spike is also of variable length, 1–7 mm long (in the specimen *S. Karthikeyan* 160130 at BSI, the mucro is up to 5 mm long) (Gould & Moran, 1981). Although the character of shorter mucro (*c.* 1 mm) was used (Bor, 1960; Potdar *et al.*, 2012; Almeida, 2014; Gaikwad & Garad, 2015; Gore, 2015) to separate *D. aegyptium* from *D. aristatum*. According to these authors, *D. aristatum* has a longer mucro of *c.* 4 mm. In our study this character is taxonomically insignificant and apparently variable hence cannot be employed to warrant any distinction between *D. aegyptium* and *D. aristatum*.

- The shape of the spikes varies from linear to oblong.
- The lower glume can be muticous or mucronate.
- The upper glume is long-awned, and varies in size from twice as long to half as long as the lower glume.
- The lemma shape varies between broadly-ovate to lanceolate, its tip varying from mucronulate to mucronate and 0.5–1 mm long.
- The keels of the palea vary from wingless or narrowly to broadly winged, with the tip varying between divided or entire.

The characters found to have taxonomic significance in distinguishing *D. aegyptium* from other closely related congeners include: the shape and sculpturing of the caryopsis (globose or ovoid, with distinct transverse ridges on the surface, rugose and truncate tip, rarely concave) and size of the anther (0.4–0.8 mm long). The characteristics are constant, and readily assessable, unlike most of the variable features as discussed above. It has been observed that based on vegetative features alone *D. aegyptium* and *D. aristatum* are challenging to separate. Anatomical studies could be of some merit in this area.

Certain specimens were encountered which exhibited a set of consistent characteristics that differed notably from the general characteristics of *D. aegyptium*. These are as follows:

- Forms with low stature (6–18 cm high), erect, tufted, and are infrequently distributed on the coast (Madh Island, Juhu beach, Mumbai). These forms have compact inflorescence like that of *D. aristatum* and a few spikes usually 1–2 (–3). Such forms are also found to occur in open grassland (Sangli, Arurangabad, Kolhapur, Karnataka); river, pond side (Mumbai); on the road side sandy tracks (Rajasthan); on the eroded rocky grounds (Sangli, Karnataka and Andhra Pradesh); and sometimes also in public places such as the pavements and on the walls (in Mumbai). Such

distinct forms mostly exhibit densely pubescent leaf blades and sheaths but at times also glabrous. They often have light-coloured (greyish or somewhat reddish-brown) transversely rugose caryopses and a very shallow fibrous root system such that the plants can be uprooted with ease. The rachis extension (mucro) is variable between 1–7 mm long. Though such forms are readily distinguishable in nature, a series of intermediates are not uncommon in the field and they represent quite a visible chain of gradation. However, in India, these slender forms have been most commonly misidentified as *D. aristatum*.

- We have also seen some morphologically unusual specimens at P (P02609872 and P02313947 from Yemen and Ethiopia respectively) with long linear spikes, appearing like *D. aegyptium* but with spikelets much like that of *D. scindicum* i.e. long with a non-gibbous lemma. Such forms are part of the highly flexible morphology and may probably represent hybrids between the two species.

Dactyloctenium radulans an Australian endemic species can also be sometimes mistaken for *D. aegyptium*, although it bears more similarities to *D. aristatum* in terms of habit and with short projecting spikes in a compact head, but differs from *D. aristatum* by its transversely rugose caryopsis. However, such a type of caryopsis is also found in *D. aegyptium*. The former differs from the latter in the combination of characters such as: a much more compact, globular inflorescence, with short spikes 0.5–1.5 cm long, spikelets 4–5 mm long and an ephemeral life cycle (Lazarides, 1970; Simon & Alfonso, 2011).

The taxonomic identity of *Dactyloctenium australe* in India

Dactyloctenium australe is an obligatory perennial native of South Africa (introduced to Australia and elsewhere) and has characteristically long anthers, 1.3–1.7 mm long (Simon & Alfonso, 2011; Fish *et al.*, 2015). It differs from *D. scindicum* with its rather

long spikes (1.5–5 cm long *vs.* 0.5–2.3 cm long); lemma (gibbous and acuminate *vs.* non-gibbous and obtuse to mucronate); culms (not bulbous-based *vs.* bulbous-based) and stolons (non-woody, not coming from distinct thickets *vs.* woody, coming from distinct thickets). *Dactyloctenium australe* may easily be confused with the perennial forms of *D. aegyptium*, yet the latter can be distinguished in shorter anthers *c.* 0.8 mm long *vs.* 1.3–1.7 mm long in the former.

Until Bor (1960), *Dactyloctenium australe* was never reported from India. According to him, it was introduced in India as a lawn grass. The specimens G. A. Gammie 15395 (barcode: BLAT83342) and H. Santapau 211.3 (barcode: BLAT83344) were sent to K from BLAT by H. Santapau under the authority of Bor for identification (according to personal letters of Santapau to Bor archived at BLAT). Bor (1960) identified these two specimens as *D. australe* and it is very likely that his identification was taken up by subsequent workers from India to further identify this species. The first author has critically examined three specimens (G. A. Gammie 15395, P. Divakar PD2744 (barcode: BLAT83343) H. Santapau 211.3 from Maharashtra state) previously identified as *D. australe* at BLAT and found that the anthers are only 0.4–0.5 mm in length, which implies that the specimens are of *D. aegyptium*. Bor (1960) used the character of perennial habit to separate *D. australe* from *D. aegyptium*, the latter of which according to him is an obligatory annual. However, it could be sometimes perennial in certain habitats, such as on the seashore, and drier places. In these cases, it is very difficult to separate either one by following the key provided in Bor (1960), and the probabilities for their misidentification are much higher. Such a case is seen in the recent report from Telangana state by Nagaraju *et al.* (2021); according to them their grass is *D. australe* and is an addition to the flora of Telangana state. The reported species is perennial and showing anthers *c.* 0.4 mm long, which implies that it is a misidentification of the perennial form of *D. aegyptium* away from the coast

where it is infrequently seen. Nagaraju *et al.* (2021), followed identification key given in Bor (1960), which is misleading, as discussed above. We followed Clayton *et al.* (2006) and Fish *et al.* (2015) for the identification of *D. australe*. Hitherto, we have not found *D. australe* in our survey or in any herbaria (BSI, BLAT, WCAS, BSJO and BAMU) so far visited in India. There is no evidence of the presence of this species in India. Therefore, we eliminate *D. australe* from Indian grasses.

Dactyloctenium aegyptium specimens examined (previously identified as *D. scindicum*):

INDIA, **Gujarat**, Kuchchh district [Kutch], Narayan Sarovar, Lakhpattaluka, 25.09.2000, V. Singh 15817 (BSJO). **Maharashtra**, Buldhana district, Dhagenala near Varvat, 20.06.1982, P. G. Divakar 162835 (BSI); Latur district, Dhanora (Nilanga), 18.09.2010, R. D. Gore RDG-238 (WCAS); Nashik district, Karayal (Umerthan), 12.08.1983, P. L. Narsimhan 165248 (BSI); Raigad district, Uran [Navi Mumbai], 15.01.1963, P. Divakar PD5795 & Danda PD5796 (BLAT); Satara district, Bowdhan [Bavdhan], 10.10.1956, S. K. Jain 7551 (BSI); Solapur district, Pangri Camp, *s.d.*, S. R. Rothe 6876 (BAMU); *Ibid.*, Pangri-Barshi, 18.09.2010, *s.coll.*, KUG-904 (WCAS). **Rajasthan**, Sabarkantha district, Raigarh F.B., 21.09.2005, P. J. Parwar 19388 (BSJO).

Dactyloctenium aristatum specimens examined (previously identified as *D. scindicum*):

INDIA, **Gujarat**, Dwarka district, Okha sea shore, 14.10.1953, H. Santapau 16731 (BLAT); Mehsana district, Charul Gochar, Kadi, 05.07.2002, P. J. Parwar 12754 & 12753 (BSJO). **Maharashtra**, Mumbai district, Madh Island, 14.07.1951, H. Santapau 12969 (BLAT); *Ibid.*, 23.09.1956, H. Santapau 21269 & 21270 (BLAT); *Ibid.*, 26.08.1956, G. L. Shah 7400 & 7399 (BLAT); *Ibid.*, 02.09.1956, G. L. Shah 7606 (BLAT); Versova (Andheri), 29.09.1956, R. R. Fernandez R2104 (BLAT). **Rajasthan**, Jaipur district, 440 m, 09.08.1966, S. Sharma 1599 (CAL); Jaipur-Ajmer road,

19.08.1964, B. M. Wadhwa 4837 (BSJO); Jodhpur district, Dians village, 31.10.1972, B. V. Shetty 251 (BSJO); Kota district, Shahbad, 15.09.1968, R. B. Majumdar 10499 (BSJO); Pali district, new Padara village on the way to Gum Pratapsingh hill, 262 m, 07.11.1974, B. V. Shetty 1380 (BSJO).

Dactyloctenium aegyptium specimens examined (previously identified as *D. australe*):

INDIA, Maharashtra, Mumbai district, Versova, 31.07.1941, H. Santapau, 211.3 [83344] (BLAT); Raigad district, Mora Uran [from compound of the sanatorium], 31.10.1961, P. Divakar, PD2744 [Acc. No. 83343] (BLAT); Pune [Poona] district, Khandala, 20.09.1902, G. A. Gammie, 15395 [Acc. No. 83342] (BLAT).

Dactyloctenium aristatum specimens examined (previously identified as *D. aegyptium*):

INDIA, Gujarat, Saurashtra region, Junagadh-sasur, 04.10.1953, H. Santapau 16288 (BLAT).

Dactyloctenium aegyptium specimens examined (previously identified as *D. aristatum*):

INDIA, Uttar Pradesh, Aligarh near Cherat Usar reserve, 26.08.1888, J. E. Duthie 7699 (K).

Acknowledgements

The first author is beholden to his family for providing funding to accomplish the present work. The authors thank the authorities of St. Xavier's College (Autonomous), Mumbai for the support and providing laboratory facilities and library services. We also thank directors of K, BM, G, BR, BLAT, BSI, WCAS, BAMU, MH, G, P, BR, WC, MPU, BSJO, CAL, MH, NHN, E, LE, L, M, CAL & B herbaria for their valuable help.

Literature Cited

- AJIBADE G.A. & G.J. EBUKANSON 2000. Inflorescence diversity, distribution and productivity in *Dactyloctenium aegyptium* (L.) P.Beauv. *West African Journal of Biological Sciences* 11: 71–77.
- ALMEIDA M.R. 2014. *Dactyloctenium*. In: ALMEIDA M.R. (ed.), *Flora of Maharashtra: Volume 6A. Poaceae*. Satyan Enterprises, Mumbai. pp. 92–95.
- BLATTER E. & C. McCANN 1935. *The Bombay Grasses*. Scientific Monograph 5, Imperial Council of Agricultural Research, Dehra Dun.
- BOISSIER P.E. 1859. *Diagnoses plantarum orientalium Novarum*, B. Hermann, Lipsiae.
- BOR N.L. 1960. *The grasses of Burma, Ceylon, India & Pakistan (Excluding Bambuseae)*. Pergamon Press, London.
- CLAYTON W.D., PHILLIPS S.M. & S.A. RENVOIZE 1974. *Flora of Tropical Africa*, Part 2. Crown Agents for Oversea Governments and Administrations, London.
- CLAYTON W.D. & S.A. RENVOIZE 1986. *Genera Graminum: Grasses of the world*. Kew Bulletin Additional Series 13. Royal Botanical Garden, Kew. p. 389.
- CLAYTON W.D., VORONTSOVA M.S., HARMAN K.T. & H. WILLIAMSON 2006. *GrassBase - the online world grass flora*. Available at: <http://www.kew.org/data/grasses-db.html> (Accessed on 12.07.2019).
- COOKE T. 1908. *The flora of the Presidency of Bombay*. Taylor & Francis, London.
- COPE T.A. 1982. Poaceae In: NASIR E. & S.A. ALI (eds.), *Flora of Pakistan*. Volume 143. Pakistan Agricultural Research Council and University of Karachi, Pakistan. pp. 105–109.
- DUTHIE J.F. 1888. *The fodder grasses of northern India*. Thomason College Press, Roorkee.
- FISH L., MASHAU A.C., MOEAHA M.J. & M.J. NEMBUDANI 2015. *Identification guide to southern African grasses. An identification manual with keys, description and distributions*. *Strelitzia* 36, South African National Biodiversity Institute, Pretoria.
- FRMAN B. & S. PERSSON 1974. *An illustrated guide to the grasses of Ethiopia*. Chilalo Agricultural Development Unit (CADU), Asella.
- GAIKWAD S.P. & K.U. GARAD 2015. *Flora of Solapur District*. Laxmi Book Publisher, Solapur.
- GORE R.D. 2015. *Flora of Balaghat Ranges of Maharashtra, India*. Ph.D. Thesis (unpublished), Solapur University, Solapur.
- GOULD F.W. & R. MORAN 1981. *The grasses of Baja California, Mexico*. San Diego Society of Natural History 12, San Diego.
- IUCN 2019. *Guidelines for using the IUCN Red List Categories and Criteria*. Version 14. Prepared by the Standards and Petitions. IUCN, Gland and Cambridge. Available at <https://www.iucnredlist.org/resources/redlistguidelines>. (Accessed on 28.11.2021).
- KAMAL M.I., HASNAA A.H., & P.M. PETERSON 2016. *Grasses of Egypt*. Smithsonian Institution Scholarly Press, Washington, D.C.

- KARTHIKEYAN S., JAIN S.K., NAYAR M.P. & M. SANJAPPA 1989. *Flora Indicae Enumeratio: Monocotyledonae*. Botanical Survey of India, Kolkata.
- KELLOGG E.A., ABBOTT J.R., BAWA K.S., GANDHI K.N., KAILASH B.R., GANESHAIHAH K.N., SHRESTHA U.B. & P. RAVEN 2020. Checklist of the grasses of India. *PhytoKeys* 163: 1–560. <https://doi.org/10.3897/phytokeys.163.38393>
- KUMAR S. 2001. *Flora of Haryana: Materials*. Bishen Singh Mahendra Pal Singh, Dehra Dun.
- LAZARIDES M. 1970. *The grasses of central Australia*. Australian National University Press, Canberra.
- LIU Q., ZHAO N.X., HAO G., HU X.Y. & Y.X. LIU 2005. Caryopsis morphology of the Chloridoideae (Gramineae) and its systematic implications. *Botanical Journal of the Linnean Society* 148: 57–72. <https://doi.org/10.1111/j.1095-8339.2005.00385.x>
- MALIK V. 2015. A checklist of grasses (Poaceae) of Saharanpur forest division. *Indian Journal of Fundamental and Applied Life Sciences* 5(2): 74–80.
- MURATKAR G.D., CHERIAN C.J. & D.M. MATE 2012. Fodder grasses of Melghat forest of Amravati district of Vidharba region, Maharashtra. *Multilogic in Science - an International Refereed & Indexed Quarterly Journal* 2(2): 73–83.
- NAGARAJU S., PARAMESH L. & ARIGELA R.K. (2021). Durban grass *Dactyloctenium australe* Steud. (Poaceae), an addition to the flora of Telangana state, India. *Species* 22(70): 293–295.
- PETERSON P.M., ROMASCHENKO K. & A.Y. HERRERA 2016. A molecular phylogeny and classification of the Cynodonteae (Poaceae: Chloridoideae) with four new genera: *Orthacanthus*, *Triplasiella*, *Tripogonella*, and *Zaqqiqah*; three new subtribes: Dactylocteniinae, Orininae, and Zaqqiqahinae; and a subgeneric classification of *Distichlis*. *Taxon* 65(6): 1263–1287. <https://doi.org/10.12705/656.4>
- POTDAR G.G., SALUNKHE C.B. & S.R. YADAV 2012. *Grasses of Maharashtra*. Shivaji University, Kolhapur.
- POWO 2019. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Available at: <http://www.plantsoftheworldonline.org/> (Accessed on 12.07.2019).
- ROY G.P. 1984. *Grasses of Madhya Pradesh*, Series 4. Botanical Survey of India, Kolkata.
- SHARMA B.D., KARTHIKEYAN S. & N.P. SINGH 1996. *Flora of Maharashtra State Monocotyledones*. Botanical Survey of India, Kolkata.
- SHARMA S.C. & C.S. PUROHIT 2013. *Grasses of Northwest Rajasthan*. Madhu Publications, Jodhpur.
- SIMON B.K. & Y. ALFONSO 2011. AusGrass2. Available at: <http://ausgrass2.myspecies.info/> (Accessed on 12.12.2020)
- SINGH N.P., MUDGAL V., KHANNA K.K. & S.C. SRIVASTAVA 2001a. *Flora of Bihar*. Botanical Survey of India, Kolkata.
- SINGH N.P., KHANNA K.K., MUDGUL V. & R.D. DIXIT 2001b. *Flora of Madhya Pradesh*, Volume 14. Botanical Survey of India, Kolkata.
- STEWART R.R. 1945. The grasses of Northwest India. *Brittonia* 5(4): 404–468. <https://doi.org/10.2307/2804891>
- SULTAN A. 1954. *Grasses & sedges of Lahore District*. Punjab University Press, Punjab.
- THIERS B. 2020. [continuously updated] Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical garden's Virtual Herbarium. Available at: <http://sweetgum.nybg.org/ih/> (Accessed on 02.02.2020).
- TURLAND N.J., WIERSEMA J.H., BARRIE F.R., GREUTER W., HAWKSWORTH D.L., HERENDEEN P.S., KNAPP S., KUSBER W.H., LI D.Z., MARHOLD K., MAY T.W., MCNEILL J., MONRO A.M., PRADO J., PRICE M.J. & SMITH G.F. (Eds.) 2018. *International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code)*. Regnum Vegetabile 159. Koeltz Botanical Books, Glashütten. <https://doi.org/10.12705/Code.2018>
- WOODROW G.M. 1901. The flora of western India. *Journal of Bombay Natural History Society* 13: 440.