



## Rediscovery of *Parahyparrhenia bellariensis* (Poaceae: Andropogoneae): A presumed extinct grass from Andhra Pradesh, India

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### Abstract

*Parahyparrhenia bellariensis*, an extremely rare and highly narrow endemic grass, has been rediscovered after almost 184 years from Cuddapah [Kadapa] district, Andhra Pradesh. The first description of its complete habit, basal portion and other features of the spikelets are provided along with new locality of its occurrence. In addition, photographs of the habitats, live plants, and a key to distinguish two Indian endemic species, distribution map and illustration are provided. As per the IUCN Red List Criteria this species is assessed here as Critically Endangered (CR). In order to facilitate the prospective conservation of this grass, we have discussed about the peculiarity of its habitat.

**Keywords:** Eastern Ghats, Endemic, Gandikota Fort Hill, Gooty fort hill, Peninsular India, Robert Wight

### Introduction

*Parahyparrhenia* A. Camus (1950: 404) is a fairly small, Afro-Eurasian genus, belonging to the tribe Andropogoneae Dumortier (1824: 84). It comprises seven species distributed in Africa and Tropical Asia, of which two species, namely, *P. bellariensis* (Hackel 1885: 123) Clayton (1972: 448) and recently described *P. khannae* Tiwari & Chorghé (2020: 55) found in India (Clayton 1966, Veldkamp 2003, Soreng *et al.* 2017, Tiwari *et al.* 2020).

During the exploration of the grasses of Andhra Pradesh in December 2019, the first author described and collected an interesting species of *Parahyparrhenia* from Gandikota Fort Hill, Cuddapah district and Gooty Fort Hill, Anantapur district of Andhra Pradesh (In December 2020 the first author observed this population disappeared). On critical study of the collected specimens at BLAT, relevant literature and the type material housed at E (E00393922! and E00393923!), G (G00165918!), K (K000245932! and K000245933!) and US (US00156584!) (Herbaria acronyms following Thiers, 2020 continuously updated), the grass has been identified as *P. bellariensis*. Formerly, this species was presumed as 'extinct' because it was not collected after Wight. Thus, the present gatherings are very significant which form a rediscovery of the species after 184 years from its original collection. Fischer (1934) cited a reference of Campbell along with Wight, who possibly had collected this grass from the same locality as Wight on Gooty Fort Hill. Since, there was no specimen indicated by Fischer collected through Campbell and there is none in any herbaria consulted, thus it is not reliable.

*Parahyparrhenia bellariensis* (Hack.) Clayton is an endemic and critically endangered species of the Eastern Ghats. The species was collected by Wight from Gooty Fort Hill ["Ghooty Fort Hill" in protologue], Andhra Pradesh [formerly the part of Madras Presidency in Bellary region, Karnataka state "Mysore Province"]. The date of the collection is difficult to guess, for the specimens were tagged later (Basak 1981). Robert Wight returned to India in 1834 and was posted in Bellary, where he did intensive collections before proceeding to extreme south of peninsular India in 1838 (Basak 1981). Therefore, it is most likely that Wight collected *Parahyparrhenia bellariensis* during the years 1834–1837. After 50 years, it was described by Hackel (1885) as *Andropogon bellariensis* Hackel (1885: 123). Subsequently, Fischer (1934) transferred it into *Heteropogon* Persoon (1807: 533) as *H. bellariensis* (Hack.) Fischer (1934: 1744), which was followed until Clayton (1972), who then gave justifications for delimiting *Heteropogon* and *Parahyparrhenia*; thereby, making a new combination in the latter as *P. bellariensis*.

Deshpande *et al.* (1978) reported *Parahyparrhenia bellariensis* based on the two specimens of “*Bharkava 50*” collected on October 10, 1977 from dried habitat in Rajkot, Gujarat. The specimens employed to write a description were depauperate. Yet, can be easily compared with *P. khannae* than *P. bellariensis* in overall very slender annual habit and shorter leaves. There floral characters are somewhat difficult to retrieve. Recently, Tiwari *et al.* (2016) reported *P. bellariensis* from grassland slopes in Sailana Bird Sanctuary, Western Madhya Pradesh. They also acknowledged a previous report of the same taxon by Samvatsar (1996) from Jhabua district as misidentification for *Heteropogon contortus* (Linnaeus 1753: 1045) Beauvois ex Roemer & Schultes (1817: 836). However, the description and illustration in Tiwari *et al.* (2016) apparently did not agree with *P. bellariensis*, particularly in smaller anthers (0.5–0.8 mm long) and membranous ligule. The same grass was later described as a new species *P. khannae* by Tiwari & Chorghé (2020). We question the interpretation of “Tamil Nadu”, “Mysore”, “South Asia” and “Peninsula Ind. orientis” on the type specimens at K, E, G and US. We believe, all of them more likely refer to the erstwhile Madras Presidency, which covered a fairly greater Southern proportion of Peninsular India—Andhra Pradesh, Karnataka, Kerala (partly) and Tamil Nadu. In a sense, if we may call proper, hitherto, the distribution of *P. bellariensis* is strictly but only confined to the state of Andhra Pradesh in India.

## Materials and methods

All collections of *Parahyparrhenia bellariensis* were processed by the standard method of herbarium preparation (Forman & Bridson 1991) and later mounted on the sheets for future reference and record. Specimens from both of the discrete populations (from the two collection sites) were critically studied under a stereomicroscope at BLAT and phenotypic data was recorded. The specimens identified referring to the relevant literature (Hooker 1897, Fischer 1934, Bor 1960, Prasad 2006, Clayton *et al.* 2006) and confirmed using the protologue. The type collections were examined as the high resolution digital images at (K, US, E, & G) herbaria by digital access through online portals.

## Taxonomic Treatment

*Parahyparrhenia bellariensis* (Hackel) Clayton (1934: 1744) (Figs 3–4)

≡ *Andropogon bellariensis* Hackel (1885: 123).

≡ *Heteropogon bellariensis* (Hack.) Fischer (1934: 1744).

**Type:**—INDIA. Andhra Pradesh, Ghooty fort hill, *Robert Wight*, [1834–37] 2321 (lectotype [K000245933!]) designated by Tiwari 2017).

Perennial, 50–65 cm high, densely tufted, simple or sparingly branched, slender, glabrous, glaucous herb. Culms terete, geniculately ascending; nodes glabrous. Leaf blade (5.0–) 10–45 × 0.1–0.4 cm, linear, long, extremely narrow (filiform and convolute) to considerably broader—old basal leaves prominently striated, with very acuminate apices, glabrous, glaucous, later turning reddish, flaccid, convolute, drooping and curling; basal sheaths prominently striated (almost ribbed), bulged and villous (with shiny appressed hairs) or bearded, upper sheaths shorter than or as long as (sometimes slightly longer than) the internodes, terete, tightly clasping, slightly keeled in upper part, glabrous, glaucous, striated, spathaceous in the upper parts of the plant; ligule biserially ciliate, inner shorter and outer longer, 0.5 mm and 1.2 mm long respectively. Inflorescence composed of a yellowish raceme, subtended by a linear, spathaceous sheath; spathaceous sheath, glabrous, membranous, 6.0–7.2 cm long; raceme terminal, solitary (if axillary then in fascicles of 5–8, issuing intravaginally on long, slender peduncles), 4.5–5.0 cm long, obliquely inserted on the peduncle, joint (annulus) bearded, 2 homogamous lower pairs of spikelets strictly staminate; rachis internodes, ca. 3.0 mm long, linear, laterally compressed, ciliate on both the margins with white hairs, confluent with pedicel into the pungent callus, tip oblique. Sessile spikelet, hermaphrodite, 5.5–8.0 × 1.2–1.3 mm (including the callus), linear-elliptic; callus long, rigid, obliquely-pungent, somewhat protruded, up to 1.5 mm long, densely bearded with white hairs; lower glume 5.0–6.5 × 1.2–1.5 mm, elliptic, sub-oblong, sub-coriaceous, herbaceous, usually 6 or 7 nerved (but sometimes also 12 nerved), with a prominent longitudinal groove on the dorsal side, glabrous, margin inflexed (compressed and sharp in upper portion, lower broader and open), eciliate or ciliolate, tip acute, hyaline (sometimes due to rupturing membrane, tip appears bi-dentate), membranous; upper glume 5.5–6.8 × 1.2 mm, somewhat oblong-elliptic, sub-

coriaceous, 5 nerved, glabrous, margin inflexed, ciliate, tip acute (median nerve rigid; with disintegrating membrane along with lateral nerves it imparts a tridentate shape to the tip), slightly longer than the lower glume, exaristate; lower lemma epaleate, barren,  $4.0 \times 0.8\text{--}1.0$  mm, oblong-lanceolate, hyaline, membranous, nerveless, margin inflexed, ciliate above the middle, tip obtuse; upper lemma rigid base of a geniculate awn, 4.0–5.0 mm long, linear-oblong, 3 nerved, bifid with thin, appressed, filiform lobes (caducous); upper palea hyaline-membranous, up to 1.3 mm long, oblong, nerveless, eciliate, tip various from obtuse to dentate or lacerated; awn issuing from the sinus of bifid lemma, ca. 32 mm long, hirtellus with long hairs on spirals of the corkscrewed column, limb (bristle) scabrid, pale. Stamens three; anthers 2.8–3.1 mm long; lodicules two, ca. 0.8 mm long, membranous, pale brown, somewhat obconical or oblong with broad truncate or tridentate tip. Stigma very densely plumose 2.3–3.0 mm long, pale orangish when dried; style short, flattened not terete, hyaline-membranous. Caryopsis brown, linear, somewhat elliptic-oblong, 2.8–3.3 mm long. Pedicel 3.0 mm long, similar to the rhachis internode, sub-equal, laterally compressed, tip oblique, ciliate on both the margins with dense white hairs. Pedicelled spikelet, staminate or barren, ex-aristate, 6.5–8.0 mm long (including the callus), elliptic, brownish, glabrous; callus sparsely bearded, up to 0.5 mm long, somewhat squarish, obliquely placed on the pedicel; lower glume 5.0–8.0  $\times$  2.0 mm (unopened), elliptic, sub-coriaceous somewhat translucent, 7–11 nerved, glabrous, acute, margins sharply inflexed, one side curved and minutely winged most of the length and other not curved but winged in upper portion only, ciliate in lower 2/3, tip acute to sub-acuminate, dorsally convex (sometimes with a slight, linear depression base upwards); upper glume 5.0–7.0  $\times$  1.0–1.2 mm, narrow elliptic, sub-hyaline, membranous, 5 nerved (nerves evanescent below the middle, green), glabrous, margin inflexed, densely ciliate, tip acute; lower lemma, epaleate, barren 5.0  $\times$  1.2 mm, oblong-elliptic, hyaline-membranous, nerveless, margin narrowly inflexed, ciliate throughout, tip acute to sub-acute; upper lemma, staminate, 4.0–4.2  $\times$  1.0 mm, oblong-elliptic, hyaline, membranous, 1 nerved, glabrous, margin not inflexed, tip acute to somewhat erose or lacerated; upper palea reduced 0.5 mm or little longer, hyaline-membranous, nerveless, tip various entire to lacerated, or even absent. Stamens three, anthers 3.2–3.5 mm long. Lodicules two, up to 0.9 mm long, fleshy, clavate, somewhat excavated in front, apex tridentate, cupuliform, glabrous.

**Flowering and fruiting:**—December.

**Habitat & associated species:**—Dry open rocky upland in the crevices of quartzite rocks in negligible soil. A typical dry habitat of *Parahyparrhenia bellariensis*, where little of the interest would grow, the giant tussocks of *Cymbopogon nardus* var. *confertiflorus* (Steudel 1854: 385) Bor (1953: 905) constitute the most conspicuous element of the wilderness. The other infrequent grasses are *Eragrostiella bifaria* var. *walkeri* (Stapf 1900: 298) Lazarides (1976: 7), *Heteropogon contortus*, *Chrysopogon fulvus* (Sprengel 1815: 10) Chiovenda (1929: 327), *Aristida adscensionis* Linnaeus (1753: 82), *Aristida funiculata* Trinius & Ruprecht (1842: 159) and *Digitaria tomentosa* (Koenig ex Rottler 1803: 220) Henrard (1934: 100).

**Distribution:**—Gandikota fort Hill, Cuddapah [Kadapa] district, Andhra Pradesh, India. Apparently narrow endemic.

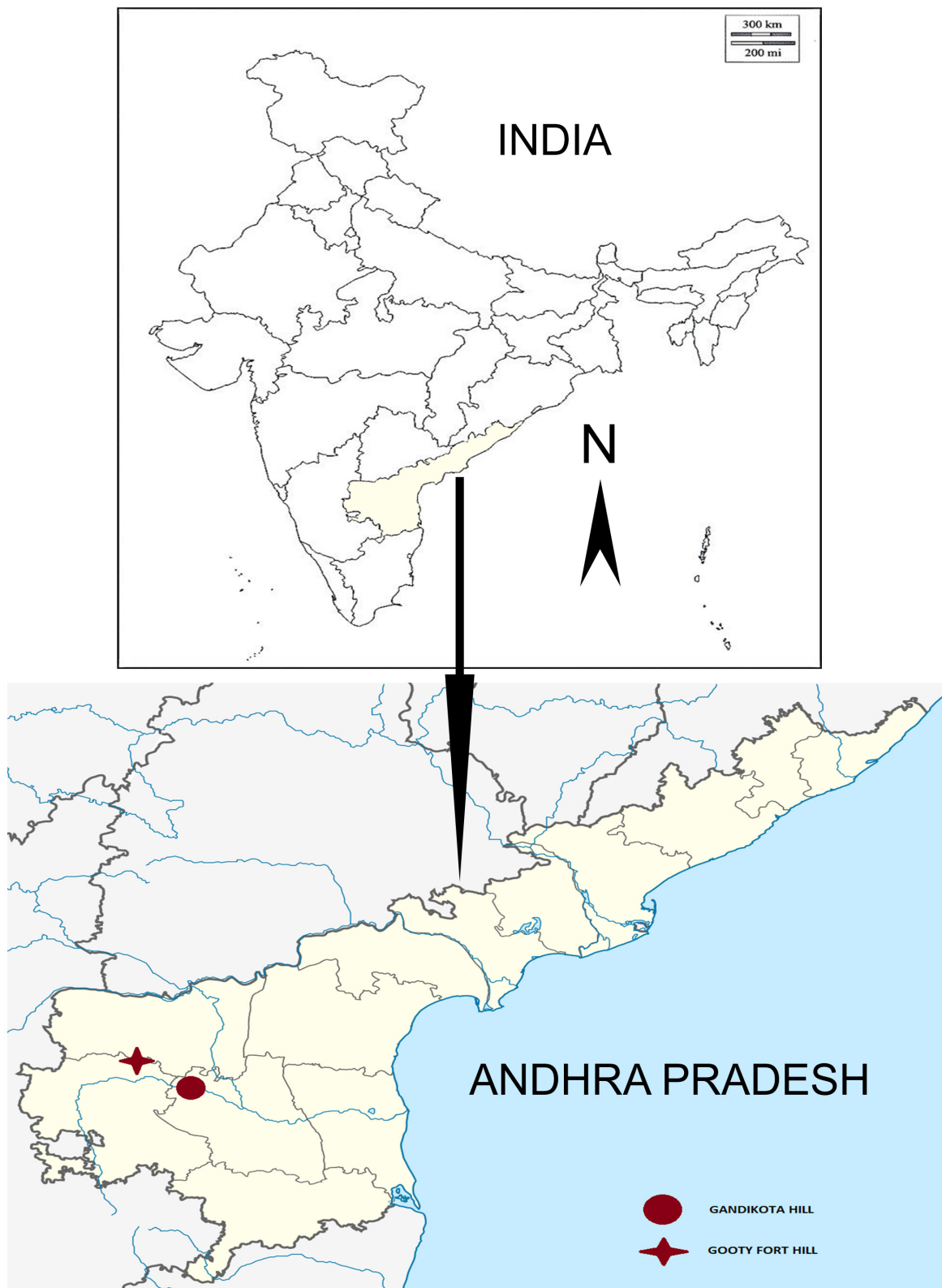
**Conservation status:**—Several decades of extensive explorations executed by various workers to locate *Parahyparrhenia bellariensis* in Andhra Pradesh were consistently futile, based on that Pullaiah *et al.* (2004) tagged it as “presumably extinct”, and suggested its addition to the Red Data Book of Indian plants. Reddy *et al.* (2006) categorized it as “Vulnerable” in the Red Data Book.

In our study, we have found that the entire population of *Parahyparrhenia bellariensis* occupies an extremely limited area of only 7 m<sup>2</sup> in Gandikota Fort hill. Since, there is a regular movement of tourists; its habitat is very vulnerable. We have observed its decline in the type locality, where it recently became perished. According to IUCN Red List Criteria (2019) the species is assessed as Critically Endangered (CR), based on the criteria A2a, B2ab (i,ii,iii,iv,v), C2a (i) and D.

A little hope has remained to save this grass; hitherto, for which, no conservation measures have been taken. At the moment, the possible conservation strategy is to restrict tourist encroachment in Gandikota Fort Hill—at least in the small magnitude where the population of the grass still exist, to prevent any irreversible decline. There is an urgent need to conjure, in scholarly minds, the idea of its immediate and undeniable conservation, for the population already experiencing a terrifying menace of extinction!

**Note:**—Upper lemma of the sessile spikelet is distinctly bifid with filiform lobes, mostly appressed to the column of its principal awn. The lobes are very delicate and caducous with age. Spikelets that are dissected at the time of fruiting are devoid of lemmatal lobes, it might be therefore well taken by many as the upper lemma entire. Lobes of the bifid lemma can be well observed during anthesis. This phenomenon is seen in both the endemic species of *Parahyparrhenia* from India. The caryopses in both the species are sulcate. In *P. bellariensis* it is almost ridged, showing perpendicular outline in the transverse section (Fig.4). The sulcus is an effect of the impression cast on the

young ovary by raised median longitudinal groove on the under surface of lower glume of sessile spikelet. One of the most peculiar features of this species is its short, flattened, hyaline-membranous (papery) style quite contrary to the usually occurring terete and solid style. This character needs to be checked in other congeners. This is the only species in the genus to have biserially ciliate ligule.



**FIGURE 1.** Distribution map of *Parahyparrhenia bellariensis* in India. (Star represents Gooty Fort Hill [The type locality] where the grass became eventually extinct after an elapse of a year since its rediscovery. Circle represents Gandikota Fort hill, the only known locality in India).



A

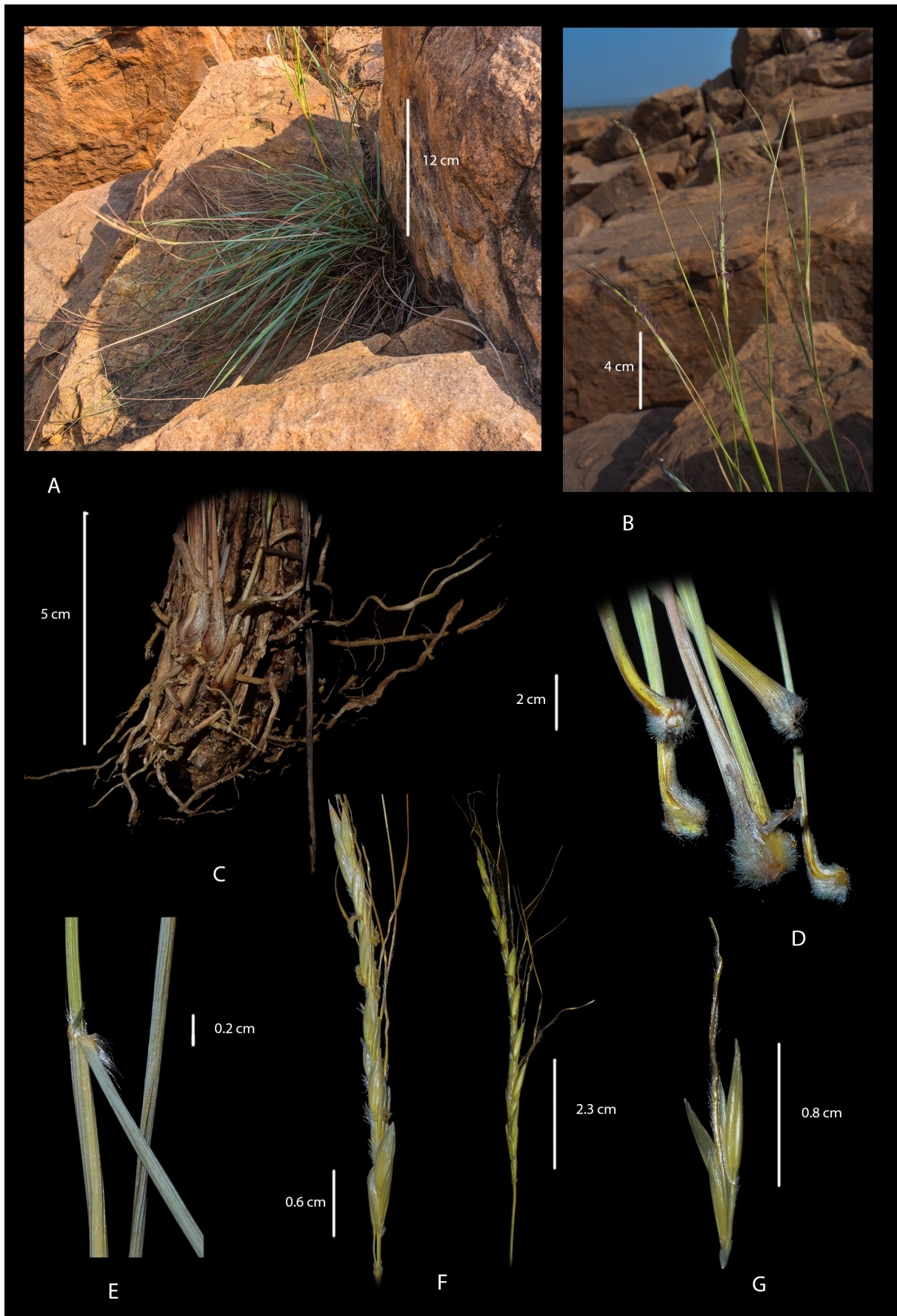


B

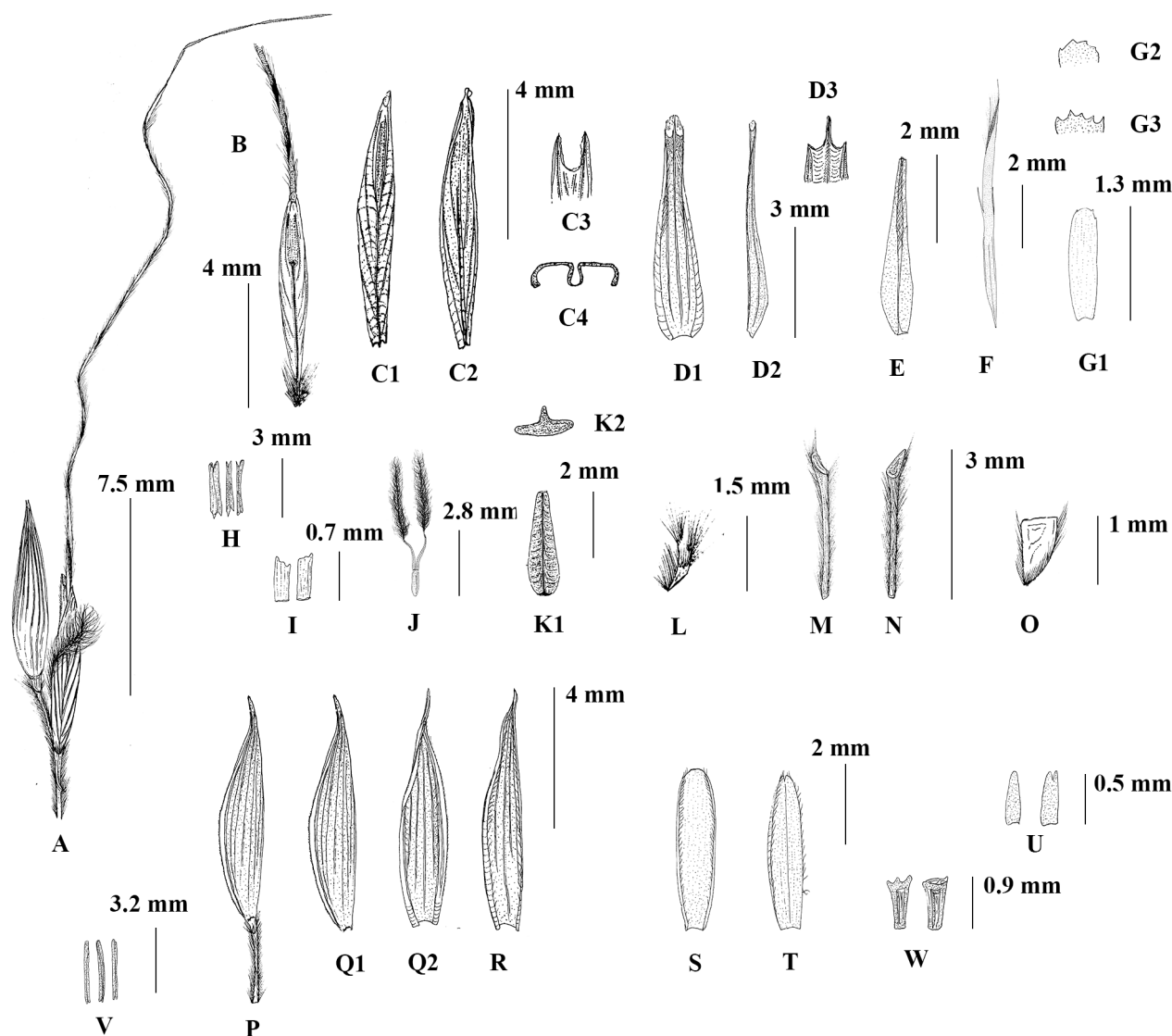


C

**FIGURE 2.** Habitats of *Parahyparrhenia bellariensis*. A & B: Gandikota Fort Hill. C. Gooty Fort Hill. (Photography by: Mr. Mohammad Yusuf Mujawar & Shahid Nawaz)



**FIGURE 3.** *Parahyparrhenia bellariensis* in Gandikota Fort Hill. A. Habit. B. Inflorescence. C. Basal portion. D. Magnified lowest bulged sheath. E. Ligule. F. Raceme. G. Heterogamous spikelets. (Photography by: Shahid Nawaz)



**FIGURE 4.** Illustration of the spikelets of *Parahyparrhenia bellariensis*. A. Portion of spiciform-raceme. B–L: Sessile spikelet and its parts. B. Sessile spikelet. C1. Lower glume (dorsal). C2. Lower glume (ventral). C3. Apex of lower glume. C4. T.S. of lower glume. D1. Upper glume (ventral). D2. Upper glume (lateral). D3. Apex of upper glume. E. Lower lemma. F. Upper lemma. G1. Upper palea. G2. Apex of upper palea. G3. Apex of upper palea. H. Anthers. I. Lodicules. J. Pistil. K1. Caryopsis. K2. T.S. of caryopsis. L. Callus of sessile spikelet. M. Rhachis internode. N. Pedicel. O–W: Pedicelled spikelet and its parts. O. Callus. P. Pedicelled spikelet. Q1. Lower glume (dorsal). Q2. Lower glume (ventral). R. Upper glume. S. Lower lemma. T. Upper lemma. U. Upper palea. V. Anthers. W. Lodicules. (Illustrated by Shahid Nawaz from “*Shahid Nawaz GK-302*”)

**Specimens Examined:**—INDIA. Andhra Pradesh, Cuddapah district, Gandikota Fort Hill, 320m, 21 December 2019, 14°49'5.10"N 78°17'8.90"E, *Shahid Nawaz* GK-300, GK-301, GK-302, GK-303, GK-304, GK-305, GK-306 (BLAT); Anantapur district, Gooty Fort Hill [Bellary region], 23 Dec 2019, *Shahid Nawaz* GF-310 (BLAT). INDIA. Tamilnadu, Madras [Andhra Pradesh], Gooty Fort Hill, *s.d.*, *Wight* 2321 (K!) 2 preparations; Inde [Peninsula Ind. orientis], *s.d.*, *Wight* 2321 (G!) 1 preparation; Mysore, Deccan, prope Bellari [Bellary region], *s.d.*, *Wight* 2321 (US!) 1 preparation; South Asia [India], *s.d.*, *Wight* 2321 (E!) 2 preparations. (Type collections).

**Key to the species of *Parahyparrhenia* in India.**

Annual up to 30 cm high; ligule eciliate, membranous; leaves granulate, 2.5–6.0 × 0.1–0.15 cm; basal sheaths dorsally not villous or bearded; anthers 0.5–0.8 mm long ..... *P. khannae*  
 Perennial up to 65 cm high; ligule biserially ciliate; leaves not granulate, 5.0–45 × 0.1–0.4 cm; basal sheaths dorsally villous or bearded; anthers 2.8–3.0 mm long ..... *P. bellariensis*

## Discussion

In our specimens of *Parahyparrhenia bellariensis*, number of nerves on both the lower glumes of sessile and pedicelled spikelets are apparently variable from 6–12 in number. They are usually 6 or 7 but sometimes also 12 in number. The protologue only mentioned 6 and 7 nerves on the lower glumes of sessile and pedicelled spikelets respectively. The size of the leaves in the protologue is up to 20 cm which is less than half as long as 45 cm in our specimens. The characters, such as, the habit (“lower parts lacking” (translated in English) *fide* Hackel in the protologue), bulged villous or bearded basal sheaths and the glaucous leaves were not described by Hackel in the protologue. We presume that such quantitative and qualitative anomalies might have existed owing to the dearth and incompleteness of the specimens at Hackel’s disposal, while this species was being described. The distinctness of this grass was realized, after 50 years of its type collection, by Hackel who found it as an admixture to *Heteropogon contortus* on the herbarium sheet. Therefore, its intended or deliberate collection by Wight is refutable. Rather, it seems logical to believe that it was inadvertently collected along with *H. contortus*, with which it shares the most disguising and superficial resemblance at a random glance in its habitat. Since, it resembles *H. contortus* in utmost deceptive degree and also occupies the similar habitats; there is a fair possibility for it might have eluded the eyes of observers for decades, perhaps also of Wight! It is clear from its accidental discovery through Hackel.

**Occurrence of *Parahyparrhenia bellariensis* and notes on its habitat and the population:**—*Parahyparrhenia bellariensis* is an extremely rare and highly narrow endemic grass known only from a single locality in India and in the world. It is absolutely incredible, that, how the presence of it in Gandikota Fort Hill had been beyond the scope of frequent botanical explorations in that region after Wight. Although, it is one of the major tourist attraction sites in Erramala mountain ranges! It is very likely to have been misidentified or overlooked for *Heteropogon contortus* or *Sehima* Forsskål (1775: 178) with which it shares a remarkably deceptive superficial resemblance. The status of existence and extinction of a species, is much often, inferred through prejudice and with reference to meagre sources. There may be some possibilities behind its seclusion from the science since 1834, such as, misidentification for other grasses, extreme rarity, difficulties in reaching obscure habitats and loss of habitats because of tourism encroachment. The cause for its extreme rarity, at this instance, cannot be satisfactorily reasoned, for it might require a futuristic study to primarily answer the questions on its seed production, efficacy of their germination with respect to suitable substrata, and impact of biotic and abiotic stresses on the growth.

Gandikota Fort Hill (Fig. 2)—a new collection locality, situated 130 km to the East by road of the type locality, has remarkably unique geological formation in India which is crucial to undertake while conceiving *in vivo* conservation in future. Its terrestrial features mostly consist of magnificent sandstone and quartzite rocks (quartz arenite). Quartzite does not contribute well in the soil formation owing to its high durability and nature of mineral composition. It does not wither any further than quartz debris even under strong erosive forces; hence the soil formation is unlikely (Saha & Tripathy 2012). The scarce soil in such habitats is mostly brought about by the agency of wind. A search for similar habitats across the Erramala mountain ranges, Eastern Ghats might be of some benefits in unveiling the recondite population(s)—if exist, before an impending terror of extinction strikes. It is essential to consider habitats as equally significant as the plant.

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