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A new location for *Hubbardia heptaneuron* (Poaceae)

Presumed to have become extinct, the pendulous annual grass, *Hubbardia heptaneuron* Bor (Nayar & Sastry 1987), became the subject of immense botanical interest due to its unusual habitat preference. *Hubbardia* Bor with a single species, *H. heptaneuron*, was described by N.L. Bor (1951) on the basis of two specimens sent to him through Rev. Father Hermenegild Santapau (1903–1970). These specimens were actually collected in 1919 by Leonard John Sedgwick (1883–1925) from Jog Falls, then known as Gersoppa Falls. Initially placed under tribe Isachneae Benth. by Bor, the extremely habitat and morphological characters of the new genus entirely differentiated this remarkable species from all other grasses of the world. This led to the establishment of a monogeneric tribe, Hubbardieae C.E. Hubb. (Hubbard 1960). *Hubbardia heptaneuron* was thought to have been rediscovered in 2002 on the basis of a 2000 S.R. Yadav collections from Tillari Ghat, Kolhapur District in Maharashtra (Mishra & Singh 2001; Potdar *et al*. 2002). As a result it was plants from this newly found location that were introduced in 16 different Ghat regions at 108 locations of Maharashtra and Karnataka (Yadav *et al*. 2009), but all failed to survive. Subsequent collections were made in 2010 from another site at Chapoli-Jamboti in the Belgaum District of Karnataka, and again all attempts of reintroduction of the grass proved futile. More importantly, all of these recent gatherings ultimately proved to represent a new species, *H. diandra* Chandore *et al.* (2012). Finally, after a lapse of about nine decades, true *H. heptaneuron* was recollected by S.R. Yadav *et al*. from the type locality at Jog Falls in 2010.

During an assessment of endemic and threatened grass taxa of Western Ghats in Goa, Karnataka and Maharashtra from 2007 to 2012, an intensive search was made to locate *Hubbardia heptaneuron* in the entire area. During this exploration, the species was confirmed to be extant at its type locality in 2011 and the same species was discovered from another location – Arsenagundi Falls, Mookambika Wildlife Sanctuary, Udupi District, Karnataka, in 2012 where some 70 individuals were found. Hence, *H. heptaneuron* is endemic to Karnataka at Jog Falls and Arsenagundi Falls, while *H. diandra* is endemic to Maharashtra in Tillari Ghat and Karnataka in Chapoli-Jamboti. As per the Indian Red Data Book, *H. heptaneuron* was categorised 'extinct' and was listed as such in the IUCN report of 1998. Later the status got upgraded to 'Vulnerable' due to its rediscovery from Tillari Ghat and the reintroduction into 16 Ghat regions of two states Maharashtra and Karnataka. However, due to survival failure of the reintroduced plantlets, coupled with the establishment of *H. diandra*, the status of *H. heptaneuron* was re-confined to its two small pockets, the type locality and the new site at Arsenagundi Falls. At present *H. heptaneuron* is restricted to less than 2 sq. km while that of *H. diandra* is known only from an area of less than 5 sq. km area (Chandore *et al*. 2012). Thus the two species of *Hubbardia* should now be categorised as 'critically endangered' as per the IUCN categories.

Hubbardia heptaneuron is found mainly in steep, upright, rocky gorges which are concealed behind the veil formed by falling water in a specialized niche surcharged perpetually with water sprays. This delicately branched annual grass grows in saturated soil with moss clusters in an atmosphere of heavy mist. Interestingly, similar niche conditions are prevalent in the Arsenagundi Falls region which is almost an exact replica of the type locality. Similarly, the two sites of *H. diandra*, the Tillari Ghat and Chapoli-Jamboti, also imitate each other in terms of habitat conditions as these occur on hanging, dripping rocky surfaces which are shady, sheltered and occur in close proximity to seasonal waterfalls. This realization means that

any reintroduction procedures must selected similar sites to ensure each species' long-term survival. It may be for these reasons that the earlier efforts of reintroduction and rehabilitation failed.

Hubbardia heptaneuron may be distinguished by its partly trailing and then pendulous habit, 5–15 cm long, extremely delicate, slender culms, rooting at nodes, with many panicles at each node, awnless spikelets, and three stamens. *Hubbardia diandra* differs by having tubercle-based hairs on glumes and two stamens in fertile florets. Field observations and population analysis reveals that the most plausible cause of rarity of these two species is their extreme habitat requirements as each grows on water-laden vertical rock surfaces which are shaded from direct sunlight by mist. It is also imperative that the normally anemophilous pollen, when shed, likely gets trapped in the mist and fails to be blown about by wind currents so that successful pollination is extremely limited. Hence any pollination which occurs is probably through selfing among individuals within small populations. Similarly the seeds reared from the hanging panicles usually drop into moving water and are removed to remote places where they do not find a suitable substratum and specific niche for successful germination. However, the few seeds, some 3–5%, which happen to fall on the same substratum within the same niche establish themselves and therefore maintain the species perpetuation. Under these environmentally specialised conditions the possibility of conservation is not only difficult but practically unachievable. Any conservation measures therefore are possible only through culture techniques, as conventional methods of seed propagation were also found to be unsuccessful. Since the tissue culture techniques generally require less plant material to produce many individuals, this method of propagation is expected to be most suitable without causing any detrimental impact to the extant populations. The juvenile plantlets after acclimatization can be reintroduced in their natural niche and then monitored for successful establishment in wild. Until then the possibility of reintroduction and rehabilitation of *H. diandra* and *H. heptaneuron* remains remote.

Hubbardia heptaneuron Bor
Kew Bulletin 1950: 385. 6 Feb 1951.
(Fig. 1)

Type: India, Karnataka, Shimoga District, Gersoppa Falls [now Jog Falls], Oct 1919, *L.J. Sedgwick 7089* (holotype: K-000245469!; isotype: BLAT!).

Plants annual herbs. **Culms** 5–15 cm long, trailing, pendulous, slender, rooting at nodes; nodes glabrous. **Leaf sheaths** 1.5–4.5 mm long, terete, hairy, eligulate. **Leaf blades** 0.6–3 × 0.2–0.7 cm, elliptic-oblong, thin, acute, membranous, delicate, translucent, with tuberculate hairs on both surfaces and scabridous along margins, 8–15 nerved. **Inflorescences** axillary panicles. **Rachis** terete, glabrous, swollen at joint. **Panicles** slender, numerous from nodes. **Spikelets** 2-flowered, 2–3 × 0.3–0.5 mm, elliptic-lanceolate, terete, awnless. **Upper glumes** 2–2.5 × 0.2–0.3 mm, oblong-lanceolate, acute, membranous, scabrid, 5–7-nerved, 2-keeled. **Lower glumes** 2–2.5 × 0.2–0.3 mm, oblong-lanceolate, acute, membranous, scabrid, 5–7-nerved, 2-keeled. **Upper lemma** 2–2.5 × 0.3–0.4 mm, oblong-lanceolate, acute, hyaline, glabrous, 5–7-nerved, epaleate. **Lower lemma** 2–2.5 × 0.3–0.4 mm, oblong-lanceolate, acute, hyaline, glabrous, 5–7-nerved, epaleate. **Stamens** 3; anthers 0.4–0.5 mm long; filaments 2–2.5 mm long. **Ovary** 0.4–0.6 mm long; styles 2, 0.5–0.6 mm long; stigma 1.5–2 mm long, plumose. **Lodicules** 2. **Caryopsis** 1–1.3 × 0.3–0.4 mm, spindle shaped, brownish; hilum 0.2–0.3 mm long, linear.

Flowering and Fruiting: September–November.

Illustration: Bor, *Kew Bulletin* 1950: 386, f. 1–9 & t. 4. 6 Feb 1951; Bor, *The Grasses of Burma, Ceylon, India and Pakistan* 573, f. 60. 1960.

Distribution: Endemic to Jog Falls, Sharavathi Wildlife Sanctuary, Shimoga District, and to Arsenagundi Falls, Mookambika Wildlife Sanctuary, Udupi District, Karnataka, India

Specimens examined: Arsenagundi Falls, Mookambika Wildlife Sanctuary, Udupi district, Karnataka, 24 Sep 2012, *R. Kr. Singh 69501* (BSA).

IUCN threat status: Based on assessment and field observations from 2007 to 2012, *Hubbardia heptaneuron* is Critically Endangered [B2b(ii,iii,v) c(ii,iv); C2b].

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PLATE 12

Figure 1: *Hubbardia heptaneuron* Bor (**A**) habit; (**B**) close up of habit, at Arsenagundi Falls, Mookambika Wildlife Sanctuary, Udupi district, Karnataka, India