



RESEARCH ARTICLE

Extended distribution of two wild bananas for the flora of Nagaland

Punatemjen Tiatemsu^{1*}, Chitta Ranjan Deb² & Asosii Paul²

¹Department of Botany, Fazl Ali College, Mokokchung-798 601, Nagaland, India

²Department of Botany, Nagaland University, Lumami-798 627, India

*Email: tiamolier@fac.ac.in



ARTICLE HISTORY

Received: 14 January 2023

Accepted: 09 March 2023

Available online

Version 1.0 : 20 April 2023



Additional information

Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

Reprints & permissions information is available at https://horizonepublishing.com/journals/index.php/PST/open_access_policy

Publisher's Note: Horizon e-Publishing Group remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Indexing: Plant Science Today, published by Horizon e-Publishing Group, is covered by Scopus, Web of Science, BIOSIS Previews, Clarivate Analytics, NAAS, UGC Care, etc See https://horizonepublishing.com/journals/index.php/PST/indexing_abstracting

Copyright: © The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited (<https://creativecommons.org/licenses/by/4.0/>)

CITE THIS ARTICLE

Tiatemsu P, Deb C R, Asosii Paul A. Extended distribution of two wild bananas for the flora of Nagaland. Plant Science Today (Early Access). <https://doi.org/10.14719/pst.2328>

Abstract

Musa manii H.Wendl. ex Baker categorized as a critically endangered wild banana species (IUCN red list, 2019) and *M. markkui* Gogoi & Borah, so far reported only from Arunachal Pradesh, India is being reported in this paper as new additions to the flora of Nagaland.

Keywords

Critically endangered, Diversity, Endemic, *Musa*

Introduction

Bananas fall under the family Musaceae Juss., comprising three genera, *Ensete* Bruce ex Horan., *Musa* L. and *Musella* (Franch.) C.Y.Wu & H.W. Li. The family comprises about 132 taxa, out of which 34 wild taxa in 2 genera, *Ensete* and *Musa*, are mainly distributed in the northeastern states of India, bordering China, Myanmar, followed by the Western Ghats, the Eastern Ghats and the Andaman and Nicobar Islands (1). In Northeast India, out of 29 taxa, 20 are endemic to the region, of which 15 are restricted to the northeastern states of India (2).

M. manii H.Wendl. ex Baker was listed among the 'Imperfectly known allied to *M. sanguinea* Hook.f.', along with *M. assamica* W. Bull, *M. aurantiaca* Baker, *M. dasycarpa* Kurz, *M. uranoscopos* Colla and *M. velutina* H.Wendl & Drude (3). His brief description of *M. manii* included only 2 morphological variations compared to *M. sanguinea* which are its longer leaves and shorter stem. The same author gave a more elaborative description of the species later (4) based on a flowering plant in the Royal Botanic Gardens, Kew. The plant was received from Dr. Wendland of the Herrenhausen Botanical Gardens, Hanover in 1885 (5), which was originally collected from Assam in India by Gustav Mann after whom the specific epithet '*mannii*' was given (5). *Musa manii* was thereafter considered as extinct from the wild (9), till its rediscovery in Arunachal Pradesh (6). Subsequently, reports are on an infraspecific variety, *M. manii* var. *namdangensis* Gogoi & Borah from the same state (7). The species has been classified as Critically Endangered under criteria B1ab (iii) +2ab (iii). by the International Union for Conservation of Nature (IUCN) red list of threatened species with restricted distribution in the Namdang area of Changlang district in Arunachal Pradesh of India (8).

Musa markkui Gogoi and Borah has been described recently from Arunachal Pradesh, India (10). This species is categorised under least concern but with limited distribution to the state of Arunachal Pradesh in India by IUCN (11). Reports are on the collection in Minkong forest of Mokokchung

District but that could not locate the species in the location and its adjoining areas mentioned in the protologue, which could possibly be due to its removal from the wild (12). Therefore, except for the state of Arunachal Pradesh, it can be considered as no other occurrence of the species in the wild (11). Despite the reports of a rich diversity of wild banana from Northeast India, in the Checklist of Flora of Nagaland (13), Musaceae is represented by only 3 species, namely *M. nagalandiana* S. Dey & Gogoi, *M. velutina* and *M. nagensium* Prain. Hence, with the scope of morphological description and distribution of wild bananas in Nagaland, surveys were conducted from 2017-2022. During the survey, the authors located *M. mannii* and *M. markkui* in various locations in the state which form new records for Nagaland.

Materials and Methods

Study area

Nagaland is a mountainous North-eastern state of India located between 25°10' and 27°40' North latitude and 93°20' and 95°15' East longitude, with an area of

16,579 km². It borders Arunachal Pradesh in the North, Assam in the West, Manipur in the South, and Myanmar in the East. The state's topography has variable geographical landscapes with altitudes ranging from approximately 100 m to as high as 3,840 m (Mount Saramati).

Collection

Collections were made with multiple visits to the sites based on the phenological cycle of the species. Collection sites of each specimen were recorded with Garmin GPS 72H. The GPS data of the collection sites were recorded and mapped using ArcGIS 10.7 (Esri, USA) by the Remote Sensing Division of Nagaland Science and Technology Council, Department of Science and Technology Government of Nagaland. Maps were made to scale (Fig. 1).

Documentation of morphological characters

The morphological characters of each species collected were characterized and recorded in the field using the Descriptors for Banana (*Musa* spp.) (14). Colours were also determined using the Taxonomy Advisory Group (TAG) colour chart. Field photographs were taken with Nikon DSLR 3200 and 5200 cameras. The plant parts were

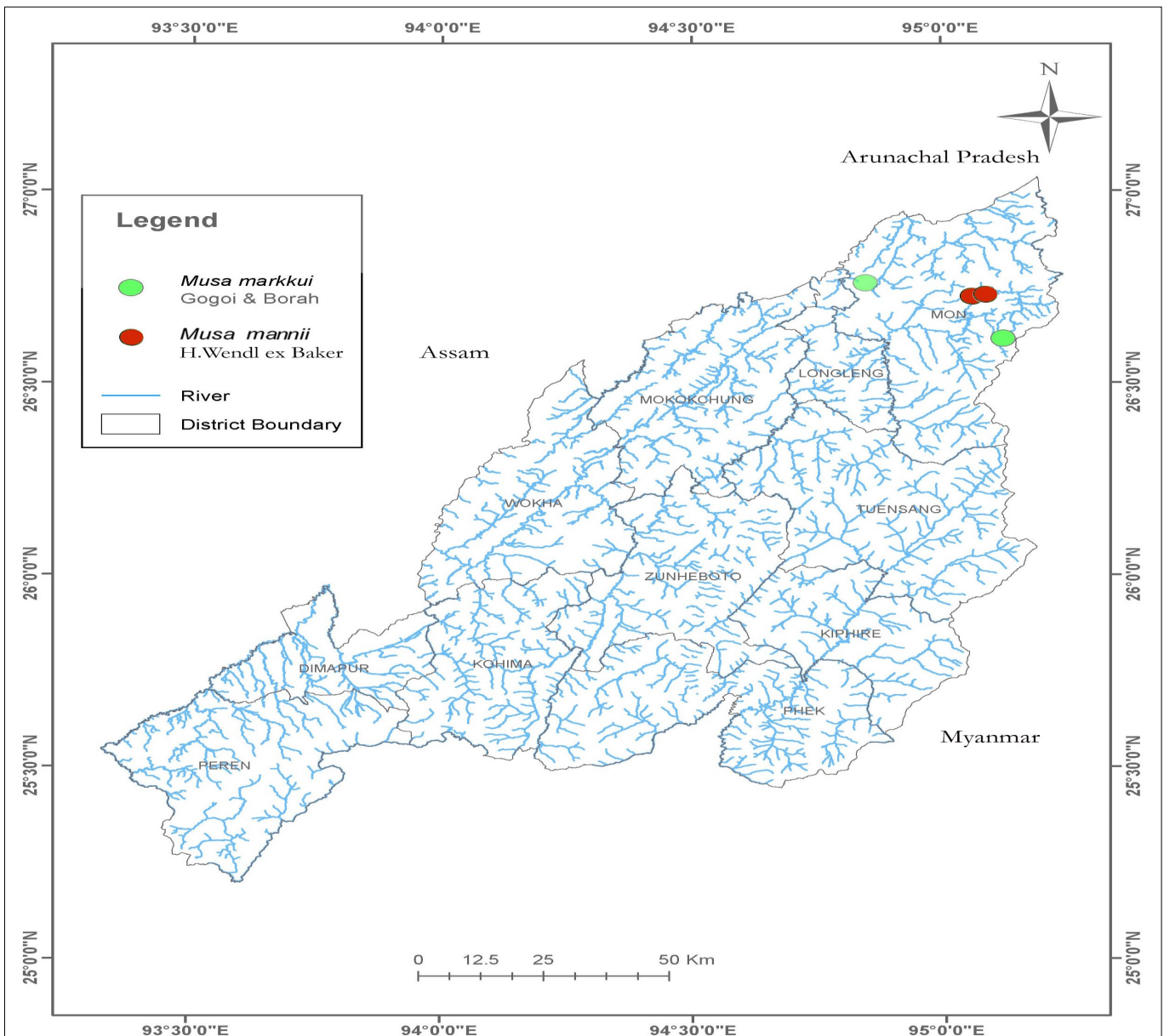


Fig. 1. Map of Nagaland showing the new distribution record of *M. mannii* H. Wendl. ex Drude and *M. markkui* Gogoi & Borah.

measured on at least five individuals per taxa. The species were identified using standard Floras, Monographs, published papers (2-7, 9, 10-13) and confirmed with the type specimens deposited in various herbaria like ASSAM and CAL. Voucher specimens were made and deposited in the herbarium of ASSAM and Herbarium, Department of Botany, Nagaland University (NU) for further reference.

Results

Taxonomic treatment

Musa mannii

H. Wendl. ex Baker, in Hook.f., Fl. Brit. India 6: 263. 1892 & Ann. Bot. 7: 222. 1893; Hook. f., Bot. Mag. 119: t.7311. 1893; Hore *et al.*, J. Econ. Taxon. Bot. 16(2): 452. 1992; Hakkinen & Vare, Kew Bull. 64: 560. 2009; Hakkinen, Taxon 62(4): 810. 2013; Joe *et al.*, Webbia 69(1): 117. 2014; Gogoi & Borah, Taiwania 59(2): 93. 2014; A. Joe & M. Sabu, South Indian J. Biol. Sci. 21(1): 216. 2016; M. Sabu & A. Joe, Revision of Indian Musaceae, 176. 2019 (Fig. 2).

Type

Icon in Hook. f., Curtis's Bot. Mag. 119: t. 7311. 1893 (neotype, designated by Hakkinen & Vare 64: 559. 2009).

Musa mannii var. *namdangensis* Gogoi & Borah, Taiwania 59(2): 94. 2014. *syn. nov.*

Type

India. Arunachal Pradesh: Namdang, just crossing the check gate towards Changlang, Changlang District, 27°14.58'N; 95°42.21'E, 02 June 2013, R. Gogoi & S. Borah (holotype CAL0000025253 digital image!; isotype ASSAM0000000165!).

Description

Plants slender, erect leaf habit, 2-4 suckers close to the mother plant. Mature pseudostem up to 2.8 m high, to 30 cm in circumference at base, pseudostem red with black-purple pigmentation, underlying pseudostem light green with brown pigmentation, milky sap. Leaf oblong, shiny, laminae up to 240 × 55 cm, adaxially dark green, abaxially medium green, with purple veins stripes, midrib dorsally red, ventrally green. Leaf base acutely pointed, leaf apex obliquely truncated, cigar leaf with purple stripes. Petiole slender, up to 130 cm long, petiole canal width to 2 cm in diameter, open with brown-black scarious margins, petiole base with dry black scarious wings and clasping the pseudostem. Inflorescences horizontal or vertical, peduncle pink, to 30 × 5 cm, slightly pubescent. First bract leafy, second bract pink, to 50 cm long, sterile, and deciduous. Female bud lanceolate, to 30 cm long, convolute, bract externally pink with yellow stripes, internally pink, moderately grooved; basal flower bisexual, 5-8 bracts with bisexual flowers, each bract with 5-7 flowers in single rows. Compound tepal orange, to 4 cm long, lobe 5-teethed, deflexed, with the 2 external lobes keel-like extended; free tepal translucent yellow, equal or slightly shorter than compound tepal, oblong, obtuse apex. Stamens 5, to 4 cm long, filament light green, to 2 cm long, anthers white, to 2 cm long; Pistil to 10 cm long; ovary straight, to 6 cm long, 3-locular with two rows of ovules in

each locule; style straight, yellow, to 4 cm long, same level, stigma white. Male bud lanceolate, convolute to 10 cm long, aborting before maturity of fruits, external bract red-pink, internal bract pink, 2 bracts lifting at a time, non-revolute, strongly grooved, without wax. Male flower to 5 cm in length, 1 flower per bract, falling before the bract. Compound tepal yellow, to 3.5 cm long, 5-teethed orange lobe; Free tepal translucent white, to 2.5 cm long, oblong, apicular apex, smooth with no folding below the apex; anther 5, exerted, to 4.5 cm long; filament to 2 cm long, white; anthers to 2.5 long, cream coloured. rudimentary ovary white, to 0.5 cm long, style white, to 4 cm long, straight, stigma light green. Fruit bunch horizontal or vertical, 4-5 hands in a bunch, 6-8 fruits per hand; fruit slightly curved to 9-10 cm long, slightly. Fruit pedicel to 1 × 1 cm, glabrous, without fusion. Fruit 3- or 4-ridged, board and blunt apex, without floral relic, immature fruit peel green with purple pigmentation, turning yellow on maturity. Fruit peeling on maturity, deciduous, pulp soft and sweet, Seeds oblate, black, warty, irregularly contorted, depressed hylar rim, acumen on chalazal end, average of 45 seeds per fruit.

Flowering

March-June

Fruiting

April-September

Distribution and habitat

Musa mannii has been collected from a few locations along the tributaries of Tapi river in Mon district. About 5 populations of segregated clumps with less than 10 plants, were found in locations dispersed in an area covering about 10 km² during our survey. We could make only two survey trips to this location and survey along the rivulets was difficult by the monsoon rain. There is possibility of more populations in wild in the adjoining areas. The plant grows in moist, shaded area and restricted to below 500 m. Populations of *M. aurantiaca* G. Mann ex Baker and *M. markkuana* Hareesh, A. Joe & M. Sabu were also observed in the higher altitude of the location vicinity.

Specimen examined

India: Nagaland, Tapi river bank, Tangnyu, Mon district, 481m, 26°43.386'N, 95°05.240'E, 18 September 2018, P. Tiatemsu & A. Paul MM01 (ASSAM); Tangnyu, Mon district, 491m, 26°43.387'N, 95°05.203'E, 13 June 2022, P. Tiatemsu MM02 (NU).

Musa markkui

Gogoi & Borah, Gard. Bull. Singapore 65(1): 20. 2013; A. Joe & M. Sabu, South Indian J. Biol. Sci.21(1):217. 2016; M. Sabu & A. Joe, Revision of Indian Musaceae, 187. 2019, (Fig. 3).

Type

India, Arunachal Pradesh: Lohit District, 7 km before Sallengam towards Tidding, 27°56'25.33"N96°22'38.76"E, 1302 m, 13 September 2012, Gogoi & Borah (holotype CAL0000025271 digital image!; isotype ASSAM0000000154!).

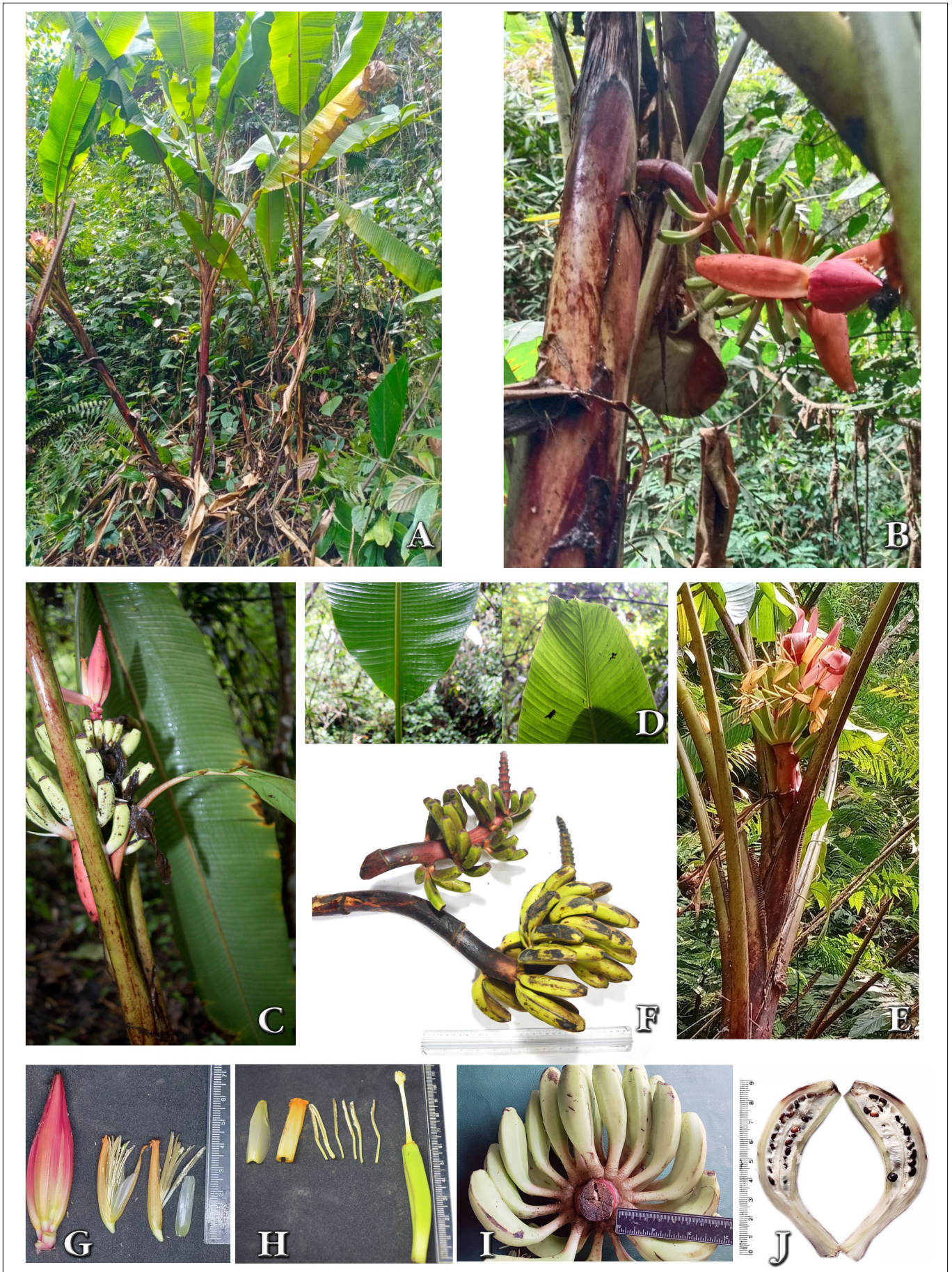


Fig. 2. *Musa mannii* H.Wendl ex Baker **A.** habit of the plant. **B.** horizontal fruiting body; **C.** Early fruiting stage with erect inflorescence; **D.** leaf base and leaf apex; **E.** female inflorescence; **F.** Fruiting body; **G.** Male bud and male flowers; **H.** female floral parts **I.** Fruits; **J.** Fruit with seeds. Photograph of P Tiatemsu.

Description

Plant slender, erect habit, suckers 10-18 growing close to the mother plant, vertical; pseudostem yellow-green with

red pigmentation, covered with dead sheath, shiny to 200 cm tall, base diameter to 10 cm; Leaf blade oblong to 170 × 35 cm, leaf base symmetrically rounded, apex

obliquely truncated, laminae ventrally dark green, dorsally green to light green, mid-rib adaxially pink or green; Petiole slender, to 100 cm long, not clasping the pseudostem; petiole canal margin erect or overlapping. Inflorescence

erect or with a horizontal curve, sterile bract elongated, light pink, deciduous; peduncle yellow-green, which turns dark green to purple on maturity, to 20 × 8 cm, slightly pubescent, with 1 empty node. Female bud lanceolate,



Fig. 3 *Musa markkui* Gogoi & Borah. **A.** Habit of the plant; **B.** Plant with fruiting body; **C.** female (left) and male (right) inflorescence; **D.** Male floral parts; **E.** Female floral parts; **F.** T.S. of trilobular ovary showing two rows of ovules in each locule; **G.** seeds. Photograph of P Tiatesmu.

to 40 × 10 cm, both outer and inner bracts pink, shiny, convolute, revolute at the bract apex, 2 bracts opening at a time. Basal flowers hermaphrodite or female, arranged in single tier, flower to 8 cm long; compound tepal 3.5 × 1.5 cm, orange coloured, 5-toothed orange apex; free tepal to 3 × 2 cm ovate, translucent yellow, extremely short or no acumen with a simple fold under the apex; stamens 5, staminodes in female basal flowers or in bisexual basal flowers, filaments to 1.8 cm long, white anther lobes to 2 cm long, turning rusty brown after maturity, pollen white, style and stamen of equal height; ovary green, triangular, to 4 cm long, straight or slightly curved; style to 3 cm long, white with yellow tinge, stigma capitate, white, 3-locular with 2 rows of ovules in each locule; Male bud lanceolate, to 20 × 10 cm; bracts dorsally pink, ventrally light pink or yellow, revolute and deciduous. Male flowers 5-8 in a single row per bract, compound tepal to 5 cm long, yellow, compound tepal apex 5-toothed; free tepal to 3 cm long, ovate, translucent white, ovate, short acumen; stamens 5, white filaments, anther lobes creamy or light brown, anther and style at the same level; ovary straight, white, style light yellow, stigma white. Fruit bunch compact, with 4-7 fruits in single rows per hand, 7-10 hands, slightly curved or bent towards the pedicel, pedicel to 4 cm long; individual fruit to 12 × 3 cm, fruit apex blunt-tipped, without floral remains, fruit peel colour light greenish or with purple pigmentation when young, yellow when ripe, immature fruit pulp white, becoming creamy and soft at maturity. Seeds black, irregularly ovoid, surface warty, hilar rim prominent, chalazal region with an acumen, tuberculate, to 40 seeds per fruit, to 4 × 6 mm in size.

Flowering

March-July

Fruiting

April- September

Distribution

The species was found growing in small clumps at two separate Shinghawamsa and Kongon villages under Mon district.

Habitat

The plants were found growing in damp soil near perennial water sources. The area of distribution for both locations is restricted as it was found in forests reserved as water catchment areas and has not been disturbed by the locals, unlike the surrounding areas have been used for farming purposes. *M. nagensium* Prain, *M. aurantiaca* G. Mann ex Baker and *M. cheesmanii* was found growing sympatrically in the surveyed area.

Specimens examined

INDIA

Nagaland, Kongan, Mon district, 714m, 26°45.451'N, 94°50.647'E, 27 January 2019, *P. Tiatemsu* 94928 (ASSAM); Shinghawamsa, Mon district, 1360m, 26°36.9597'N, 95°07.1672'E, 14 June 2022, *P. Tiatemsu* MM02 (NU).

Discussion

In our survey, the distribution of *M. mannii* and *M. markkui* have been observed in the wild only in Mon district, which also harbours the maximum number of wild banana species in the state as per our collections (unpublished data). Mon district lies conjoint to Arunachal Pradesh on the North, Assam on the west and Myanmar on the east. State-wise, the maximum *Musa* L. diversity in India has been described from Arunachal Pradesh in India with 16 species (2); the holotypes of many wild bananas were described from Assam and Myanmar (then Burma) (5, 15-20). Therefore, these areas including the studied area may be considered as an important region in regard to the origin of Musaceae.

Conclusion

Jhum cultivation and deforestation for various anthropogenic activities were observed in the study area. In Kongon area under Mon district, coal-mining activities were being carried out with no proper mechanism for management of overburden and acid mine drainage, thus posing a great threat to the biodiversity of the area. Additionally, *M. mannii* and *M. markkui* are small wild plants with smaller leaves and inflorescence which under previous treatment would have been placed under Cheesman's Sect. *Rhodochlamys*. These species do not have any ethnobotanical usage; it is therefore removed in the wild by the locals. However, the regeneration of the species might be difficult owing to the species preference for wet or damp and shaded areas, its production of lesser seed quantity and smaller fruits as compared to the other larger species which require urgent redressal and mitigation initiatives for its conservation.

Acknowledgements

The authors would like to thank the National Mission on Himalayan Studies for funding of this research work under the project on 'Inventory of Wild *Musa* of Nagaland, Nutritional Assessment and Production of Clonal Planting Materials of Few Commercially Viable Species' (Project ID: NMHS/2017-18/MG36/20). We are also thankful to the officers of the Department of the Forest, Environment and Climate Change, Government of Nagaland for granting permission and providing necessary help for the field study in the forest. The author would like to thank Mr. Wangsa Ashak for his support during the collection of the specimens.

Authors contributions

PT, AP carried out the field work, PT drafted the manuscript. CRD, PT and AP conceived the study and participated in its design and coordination. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: : Authors do not have any conflict of interests to declare.

Ethical issues: None

References

- Hareesh VS, Sabu M. Significance of seed morphology and anatomy in the systematics of Musaceae. *Botanical Journal of the Linnean Society*. 2022; 201(1):1-35. <https://doi.org/10.1093/botlinnean/boac017>
- Joe A, Sabu M. Revision of Indian Musaceae. Kerala: Indian Association for Angiosperm Taxonomy; 2019. Chapter 8, Distribution and Endemism; p. 277.
- Baker JG. Scitamineae, In: Hooker JD. *Flora of the British India*. 1892;6:225-64.
- Baker JG. A synopsis of the genera and species of Museae. *Annals of Botany*. 1893; 7(26):189-222. <https://doi.org/10.1093/aob/os-7.2.189>
- Hooker JD. *Musa mannii*. *Curtis's Botanical Magazine*. 1893;119.
- Joe A, Sreejith PE, Sabu M. Notes on the rediscovery, taxonomic history and conservation of *Musa mannii* H. Wendl. ex Baker (Musaceae). *Webbia*. 2014;69(1):117-22. <https://doi.org/10.1080/00837792.2014.893603>
- Gogoi R, Borah S. *Musamannii* var. *namdangensis* (Musaceae) from Arunachal Pradesh, India. *Taiwania*. 2014;59(2):93-97. <https://doi.org/10.6165/tai.2014.59.93>
- Plummer J, Kallow S. *Musa mannii*. The IUCN Red List of Threatened Species 2022: e.T158541345A158544353. <https://dx.doi.org/10.2305/IUCN.UK.2022-2.RLTS.T158541345A158544353.en>. Accessed on 23 December 2022.
- Häkkinen M, Väre H. Typification of *Musa mannii*, *M. sanguinea* and *M. x kewensis* (Musaceae). *Kew Bulletin*. 2009;64(3):559-64. <https://doi.org/10.1007/s12225-009-9145-z>
- Gogoi R, Borah S. *Musa markkui* (Musaceae), a new species from Arunachal Pradesh, India. *Gardens' Bulletin Singapore*. 2013;65:19-26.
- Allen R, Plummer J, Gogoi R. *Musa markkui*. The IUCN Red List of Threatened Species 2021:e.T123707235A191642817. <https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T123707235A191642817.en>. Accessed on 23 December 2022.
- Joe A, Sabu M. Wild ornamental bananas in India: an overview. *South Indian Journal of Biological Science*. 2016;2:213-21. <https://doi.org/10.22205/sijbs/2016/v2/i1/100402>
- Mao AA, Odyuo N, Verma D, Singh P. Check list of flora of Nagaland. Botanical Survey of India, Ministry of Environment, Forests & Climate Change; 2017.
- International Cooperation Centre of Agricultural Research for Development. Descriptors for banana (*Musa* spp.). *Internat. Plant Genetic Resources Inst*. 1996:p55.
- Cheesman EE. Classification of the bananas: the genus *Musa* L. *Kew Bulletin*. 1947;1:106-17. <https://doi.org/10.2307/4109207>
- Cheesman EE. Classification of the bananas. *Kew Bulletin*. 1948;1:17-28. <https://doi.org/10.2307/4118909>
- Cheesman EE. Classification of the bananas: critical notes on species: *Musa ornata*. *Kew Bulletin*. 1949;1:24-28. <https://doi.org/10.2307/4119031>
- Cheesman EE. Classification of the Bananas. III. Critical Notes on Species. *Musa sanguinea*. *Kew Bulletin*. 1949;4(2):133-35. <https://doi.org/10.2307/4113662>
- Cheesman EE. Classification of the Bananas. III. Critical Notes on Species. *Musa velutina*. *Kew Bulletin*. 1949;4(2):135-37. <https://doi.org/10.2307/4113663>
- Simmonds NW. Botanical Results of the Banana Collecting Expedition, 1954-5. *Kew Bulletin*. 1956;11(3):463-89. <https://doi.org/10.2307/4109131>