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RESEARCH ARTICLE

Musa indandamanensis L. J. Singh: A New Species (Musaceae) from the Bay Islands, India

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ABSTRACT: In the present study *Musa indandamanensis* L. J. Singh is described and illustrated as a new species from Little Andaman, the Bay Islands, India.

KEY WORDS: Bay Islands, India, Little Andaman, *Musa indandamanensis*, new species.

INTRODUCTION

The genus *Musa* L. (Linnaeus, 1753) belongs to the family Musaceae; which includes two other genera viz. *Ensete* Bruce *ex* Horaninow (1862) and *Musella* (Franchet) Wu (1978). Wild *Musa* species are largely distributed in some tropical rainforests, wet evergreen forests to deciduous forests of low rain fall zones. India is recognized as one of the major centre for wild bananas. Its genetic diversity spread across northeastern states, Western Ghats, and Andaman and Nicobar Islands (Roxburgh, 1832; Kurz, 1867; Hooker, 1892; Jacob, 1952; Prain, 1904; Duthie, 1960; Gamble, 1967; Hore et al., 1992; Singh and Uma, 2000; Daniel and Umamaheswari, 2001; Daniells et al., 2001; Singh et al., 1998, 2001; Gogoi, 2013; Sabu et al., 2013a, b). The genus *Musa* L. is most diversified and comprises about 70 species (Simmonds and Weatherup, 1990; Wu and Kress, 2000; Wong et al., 2001, 2002; De Langhe et al., 2002, 2009; Häkkinen and Sharrock, 2002; Häkkinen and Meekiong, 2004; Häkkinen and Wang, 2007, 2008a, b; Häkkinen and Väre, 2008a, b, c; Häkkinen et al., 2008, 2010, 2012; Häkkinen, 2009, 2010; Ly et al., 2012). According to Feng et al. (2009) c. 52 species are reported to occur wild in the world and c.15 species are reported to occur in India. The Bay Islands, one of the centre of hot spots of plant diversity in India, a region where the wild bananas have not been explored systematically because it has received little attention from taxonomists. In the present study *Musa indandamanensis* L. J. Singh is described as a new species from the Bay Islands, India with conservation status.

MATERIAL AND METHODS

During floristic explorations in the forested areas of Little Andaman, the author has collected some interesting specimens of wild banana. After critical examination, consultation of herbaria specimens and literatures, the author has concluded that the species could be described as novelty. Hence a new species *Musa indandamanensis* L. J. Singh is described and illustrated by completing the entire INIBAP *Musa* Descriptor List (IPGARI- INIBAP/ CIRAD, 1996). It is growing in wild in the tropical rain forests of Little Andaman Island.

In addition, seed germination was conducted at Dhannikhari Experimental Garden Cum Arboretum (DEGCA), Botanical Survey of India, Andaman and Nicobar Regional Centre. The station is located in the equatorial belt at Nayashahar about 16 km from Port Blair and exposed to have warm and humid tropical climate, with the temperature ranging from 18° to 35°C. It receives heavy rain fall from both south west and north east monsoons with the average annual rain fall ranging from 3000 to 3500 mm. Cyclonic winds accompanied by thunder and lightning are very frequent. January to March have fairly dry weather with scanty rain fall. The mean relative humidity is rather high and usually remains between 66% and 85% throughout the year. Thus the climate is suitable for rapid germination. The seeds, seedlings and suckers are introduced and transplanted for multiplication and conservation. A detailed description of the new species of wild banana, Musa *indandamanensis* L. J. Singh along with illustration, photographs and relevant notes are provided here for easy identification and collection. The descriptive terms here follow the traditional banana taxonomy as used by (Simmonds, 1962, 1966 and Argent, 1976).

TAXONOMIC TREATMENT

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Musa indandamanensis L. J. Singh ***sp. nov.***

Figs. 1–4

Type: India, Andaman & Nicobar Islands, Little Andaman, Hut Bay, Krishna Nalah, N' 10°40'58.6" E' 092°32'12.9", ± 23 m, 04.04.2012, Lal Ji Singh 29530 (holotype: CAL!; isotype: PBL!).

Plant suckering freely, 3–5 suckers, position vertical, robust stature of 11–11.30 m height with cylindrical inflorescence having green bract. Mature pseudostem covered with old brown leaf sheath underlying colour yellowish green with brownish red blotches, 11–11.30 m long, 45–55 cm in diameter at base, young pseudostem light green with silvery white appearance. Petiole: 90–121 cm long, margin curved inwards, bases winged and clasping the pseudostem. Lamina: 300–380 × 80–90 cm, obliquely obtuse at base, truncate at apex, green adaxially, medium green abaxially, midrib dorsally light green, ventrally yellowish green. Veins 262–298 pairs. Inflorescence: spike 45–52 cm long green, cylindrical, first horizontal and then falling vertically downwards, peduncle 58–72 cm long, base clasping the pseudostem, fully mature inflorescence with fruit bunch lux (axis) 2.5–3.0 m long, male bud cylindrical sometimes lanceolate, green, deeply imbricate, outer face of bract green and inner face medium green or yellowish green. Bract: 17.6–27 × 7.5–9.5 cm, basal flower hermaphrodite, 20–30 per bract in 2-rows, 4.5–5 cm long, yellow. Pedicel: 1.8–2.0 cm long. Tepals: 2, margin incurved, upper small, apex rounded, retuce, crispate with apicule c. 2.5 × 1.4 cm, 0.9 cm wide at base; lower large, c. 5 × 1.5 cm, 1.2 cm wide at base, fringed, 5-lobed (toothed), internal two small c. 0.8 cm long, outer three large toothed tip, c. 0.9 cm long. Stamen: 5, rather longer than the tepals, Filament: filiform, rusty brown, c. 2.5 cm long. Anther: 2-celled, yellow or cream, c. 3.5 cm long, linear. Ovary: 3 celled, straight, c. 2.5 cm long, light green with many ovules in two rows per locule. Style: 5.8 cm long, latrose, yellow or brownish yellow. Stigma: globose, brown or black c. 0.5 cm in diamete. Bunch lux axis: up to 3 m long with 10–15 hands. Fruit: 18–30 per hand, 7.5–10.0 × 3.5–4.0 cm, apex acute, 6–8 mm long; stalk: 2.5–3.5 cm long, angled, slightly curved, green, immature green peal colour becoming yellowish orange with brownish red blotches and immature fruit pulp white become yellowish orange, soft much sweet at maturity. Seeds 0.9 × 0.7 cm, numerous with starch pulp, irregular, bright black, subglobose or angular, large, hard, c. 6 mm in diameter, counted up to 300 per fruit, viable.

Flowering and fruiting: November–April.

Ecology: Grows near water stream bank or low slopes of forest areas of Little Andaman. Presently, under *ex-situ* conservation at DEGCA, Botanical Survey of India, ANRC Port Blair, South Andaman.

Distribution: India, Andaman & Nicobar Island, Little Andaman, Hut Bay, Krishna Nalah, (N' 10°40'58.6" E' 092°32'12.9") Jheenaga Nalah (N' 10°33'56.0" E' 92°31'45.5", ± 20 m), Ravindra Nagar forest Areas (N' 10°42'31.6" E' 092°31'57.3", ± 19 m), Sunderpur (N' 10° 38'16.0" E' 92°32'17.9", ± 25 m), Prabhash Mundi (N' 10°40'55.2" E' 92°35'14.3", ±45 m), endemic.

Paratype: India, Andaman & Nicobar Islands, Little Andaman, Jheenga Nalah, ± 20 m, 05.04.2012, *Lal Ji Singh 29532* (PBL); Ravindra Nagar, ± 19 m, 18.11.2012, *Lal Ji Singh 29568* (PBL); Sunderpur, ± 25 m, 17.04.2013, *Lal Ji Singh 29588* (PBL); Prabhash Mundi ± 45 m, 19.04.2013, *Lal Ji Singh 29599* (PBL).

Etymology: The new species named after Indian Island Andaman: a center for richest and unique plant diversity with endemism.

Note: It is quite probable that the new species also found in other forest areas of the Bay Islands. The plants are propagated sexually by seeds and asexually by suckers in the wild. It shows wide range of variation in growth. The species grows in the moist evergreen forested areas, where they have attain remarkable size of pseudostem, leaves, inflorescence and fruit bunch lux axis.

Seed germination: Seed germination is being monitored in climate of DEGCA, Botanical Survey of India, Andaman and Nicobar Regional Centre (N' 11°34'29.6" E' 092°40'25.9" c. 100 m alt.) as a part of conservation. Mature seeds germinated in 2 to 3 weeks after sowing. The average percentage of seed germination ranges from 69% to 83%. They remain viable for 4–5 months. Sometimes it gives 100% germination without any dormancy breaking treatment. When the freshly harvested seeds without drying sown in soil under natural condition with temperature close to 30°C, it germinated readily within 21 days to give 90% to 97% but showed 60% germination after 3 months of storage.

Conservation status: In addition to taxonomy, conservation of wild bananas is also poorly resolved. In the Bay Islands the population of wild bananas are currently restricted to few localities and disturbed by incursion of human. A distributional survey on wild bananas was carried out recently from April 2011 to April 2013 in forested areas of Andaman and Nicobar Islands. The results indicate that approximately 20% localities of wild bananas were lost during the last decade because of natural and human induced stresses. The over exploitation by local people for manifold value and staple food for elephants leading to threats but they have never been properly conserved. Due to which wild Musaceae: *Musa acuminata* Colla, *Musa balbisiana* Colla var. *andamanica* Singh, Sreekumar,

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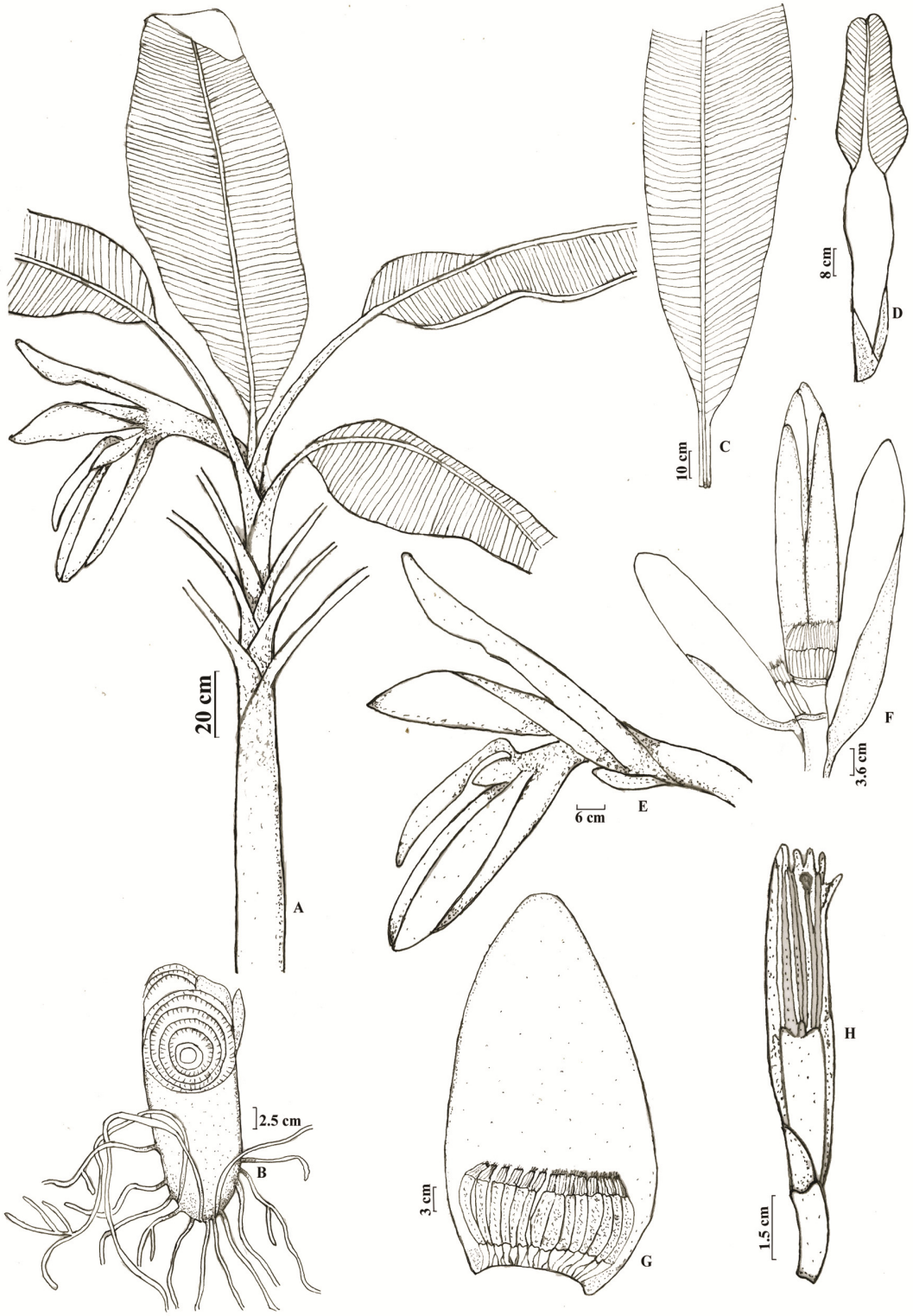


Fig. 1. ***Musa indandamanensis*** **L. J. Singh. A: Magnified view of plant. B: Sucker with a portion of pseudo stem. C: Leaf base with petiole. D: Leaf sheath. E: Infloresence. F: Magnified view of basal flowers. G: Bract with flowers. H: Hermaphrodite flower.**

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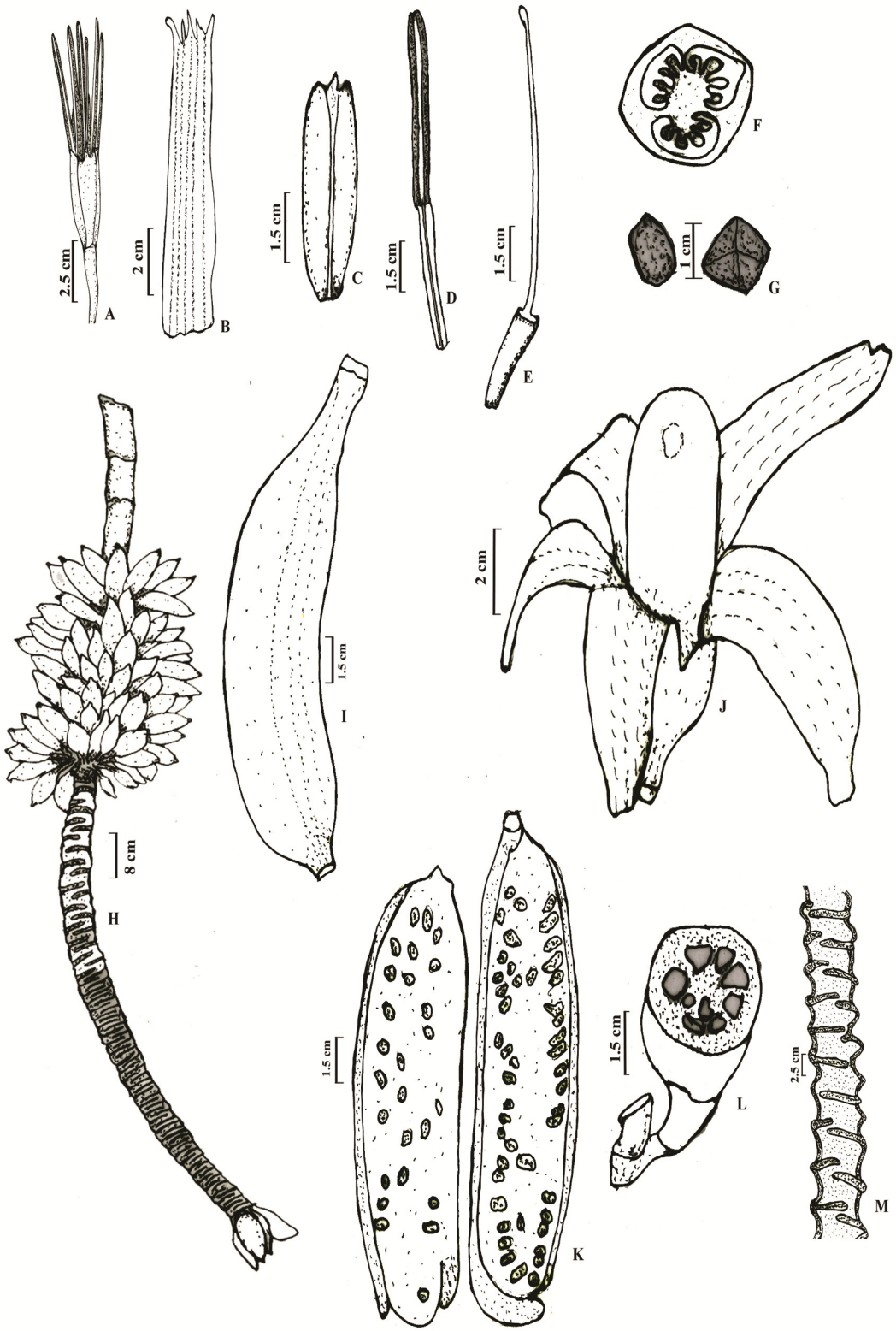


Fig. 2. ***Musa indandamanensis*** **L. J. Singh. A: Open flower. B: Lower tepal. C: Upper tepal. D: Stamen. E: Pistil. F: Ovary in C.S. 40x. G: Seeds. H: Infloresence axis with fruit bunch lux. I–J: Fruit. K: Fruit in L. S. L: Fruit in T. S. M: Magnified view of bunch lux axis.**

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Sharma and Bandyopadhyay including the new species disappearing locally in several relatively open disturbed areas. Frequent destruction of pseudostem and fruits by elephants posed major threat to the new taxon. The new taxon has been collected only from five localities in Little Andaman and of about 6–18 plants in a clump. No population was located from other regions of Andaman Islands and drastic disappearance of mixed forest habitat indicates the *Musa indandamanensis* L. J. Singh is considered critically endangered and threatened based on IUCN Red List Categories and Criteria (IUCN, 2011). As a part of conservation program, presently these wild Musaceae are under *ex-situ* conservation at DEGCA, Botanical Survey of India, Andaman and Nicobar Regional Centre. This centre is recognized as potential active conservation centre for wild bananas in the Bay Islands. In forested areas the free suckering and multiplication of the species both from rhizome as well as from seeds were observed in the habitat. It has great socio-economic significance like other wild bananas including the large variety of wildlife feed on the fruits of banana. These include frugivorous bats, birds, rats, monkeys and elephants. These act as dispersal agents as other parts of world (Liu et al., 2002a, b; Tang et al., 2005; Meng et al., 2008).

DISCUSSION

The wild relatives of bananas have attracted much less attention but, even so, a certain amount of taxonomic, cytogenetic, molecular and evolutionary works have been carried out time to time by various workers. More recently, Häkkinen et al. (2012) stated that science has not progressed much in the understanding of the natural species of *Musa*. Sabu et al. (2013 a, b) stated that no comprehensive work on the family or genera in particular has been carried out since Hooker (1892). The only work after Hooker covering the whole India is the mere enumeration by Karthkeyan et al. (1989). Here *Musa indandamanensis* L. J. Singh is described and illustrated as a new species from the Bay Islands, India. The Bay Islands possess a distinct identity, not only because of its geography, history and culture but also because of the unique and richest biodiversity of its natural ecosystem and constitute one of the hotspots of biodiversity. This is the largest archipelago system and contributes rich and unique plant-diversity among few most diverse phyto-geographical regions of the world because of the close proximity of this archipelago to the equator and geographical isolation from the major land masses of South and South East Asia. In India more systematic explorations will be required to elucidate what species still exist in the wild. Besides, most of the studies on the effect of environment on *Musa* are restricted to the edible species. There is a need to know more about the response of the wild species that provide genetic bases for edible genotype. In future the present new species: *Musa indandamanensis* L. J. Singh might be a choice of genetic base for plant breeders to develop high yielding, disease resistant variety of parthenocarpic edible banana. The great socio-economic significance of bananas has been accepted as the symbol of prosperity and fertility in India. However, the vast genetic diversity of wild bananas is being threatened. Hence *in-situ* as well as *ex-situ* conservation of wild species of bananas are required not only in India, also at global level. The present study also concludes that successful seed germination and subsequent seedling growth in the wild require fruit pulp, moist humus, porous humid soil under the canopy and temperature close to 30°C for rapid germination. Seedling emergence was inhibited by the removal of fruit pulp from seed surface. The banana seeds show varying degrees of dormancy and they respond differently to various dormancy breaking treatments. The dormancy and germination of seeds may be related to physical, morphological and physiological factors or combination of these factors. Temperature and moisture are major factors which affect their viability and germination (Bhat, 1994; Chin, 1996; Graven et al., 1996; Baskin and Baskin, 1998, 2004; Baskin et al., 2000; Puteh et al., 2011). In case of *Musa indandamanensis* L. J. Singh the freshly harvested seeds have high moisture content which increases the degree of germination on the exposed soil surface whereas the degree of germination is reduced for dry seeds.

The new taxon is remarkably distinct from other known wild sect. *Musa* with green bud in respect to its stature growing to a height of 11.30 m and robust nature, much long inflorescence with green bract, c. 72 cm long peduncle and fruit bunch lux axis a length of 3.0 m long, green coloration with silvery appearance of pseudostem is distinct from other basic green colored pseudostem and most distinct feature is the strongly imbricate nature of male bud like *Musa acuminata* L. A. Colla subsp. *burmannica* N.W. Simmonds. While in majority of them it is convolute in nature (Colla, 1820; Cheesman, 1947, 1948, 1949, 1950; Simmonds, 1956). Besides, this affinity the new species is highly differentiated from subspecies *burmannica* N.W. Simmonds by its yellowish and wax less foliage, light brown markings on the pseudostem, compact pendulous bunch and purple bracts (Dodds and Simmonds, 1948; Simmonds, 1953, 1954, 1956, 1959, 1960, 1962, 1966; De Langhe, 1960; Stover and Simmond**,** 1987; Nasution, 1991; Wong et al., 2001; Pollefeys, et al., 2004). Pedicel is c. 2.0 cm long while in others either it is short or sessile. The peel and pulp colour of fruit

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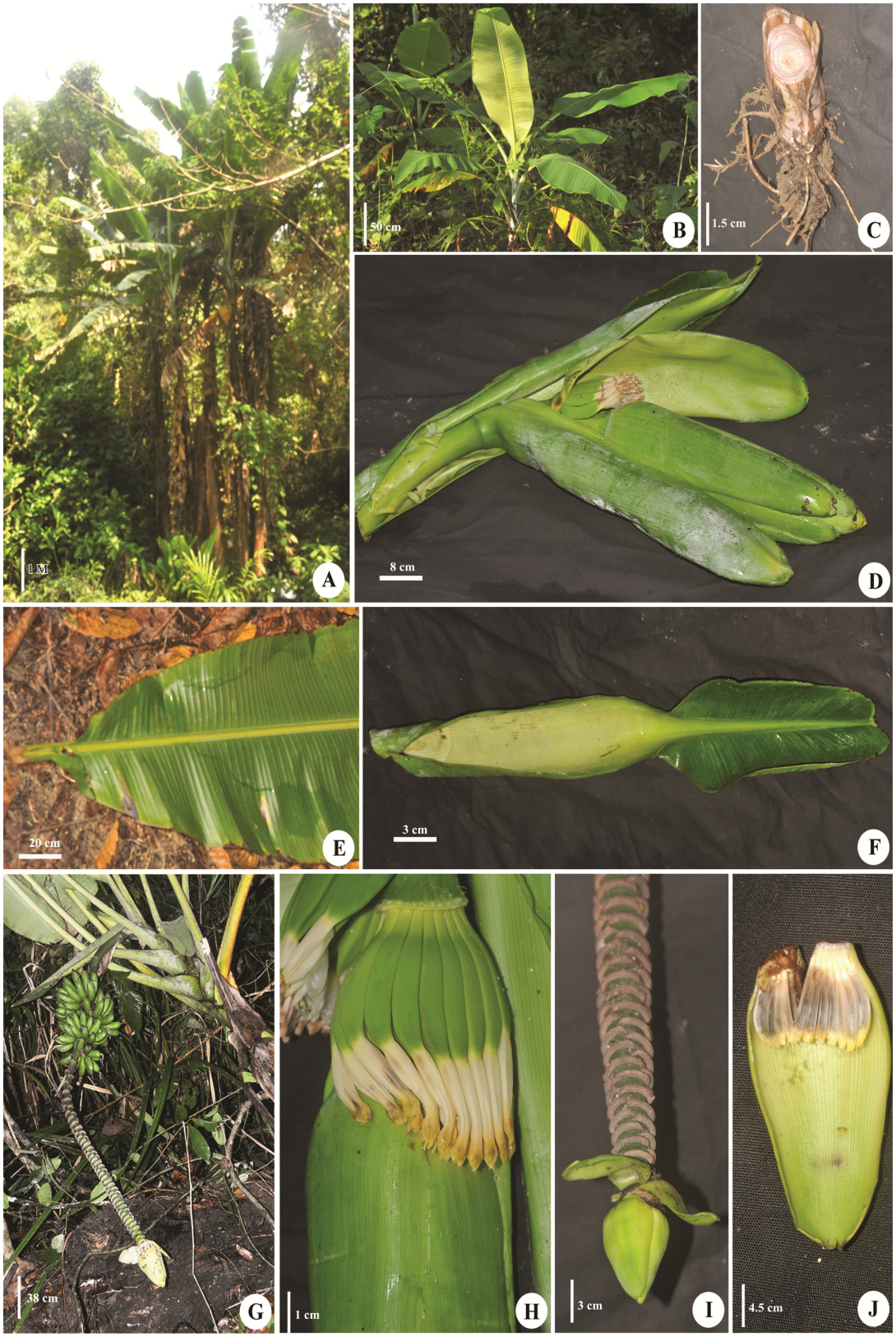


Fig. 3: *Musa indandamanensis* L. J. Singh. A: Habit. B: Magnified view of Plant. C: Sucker with a portion of pseudo stem. D: Inflorescence. E: Leaf base with petiole. F: Leaf sheath. G: Inflorescence with Fruit bunch lux. H: Magnified view of basal flowers. I: Magnified view of apex with Inflorescence. J: Bract with flowers.

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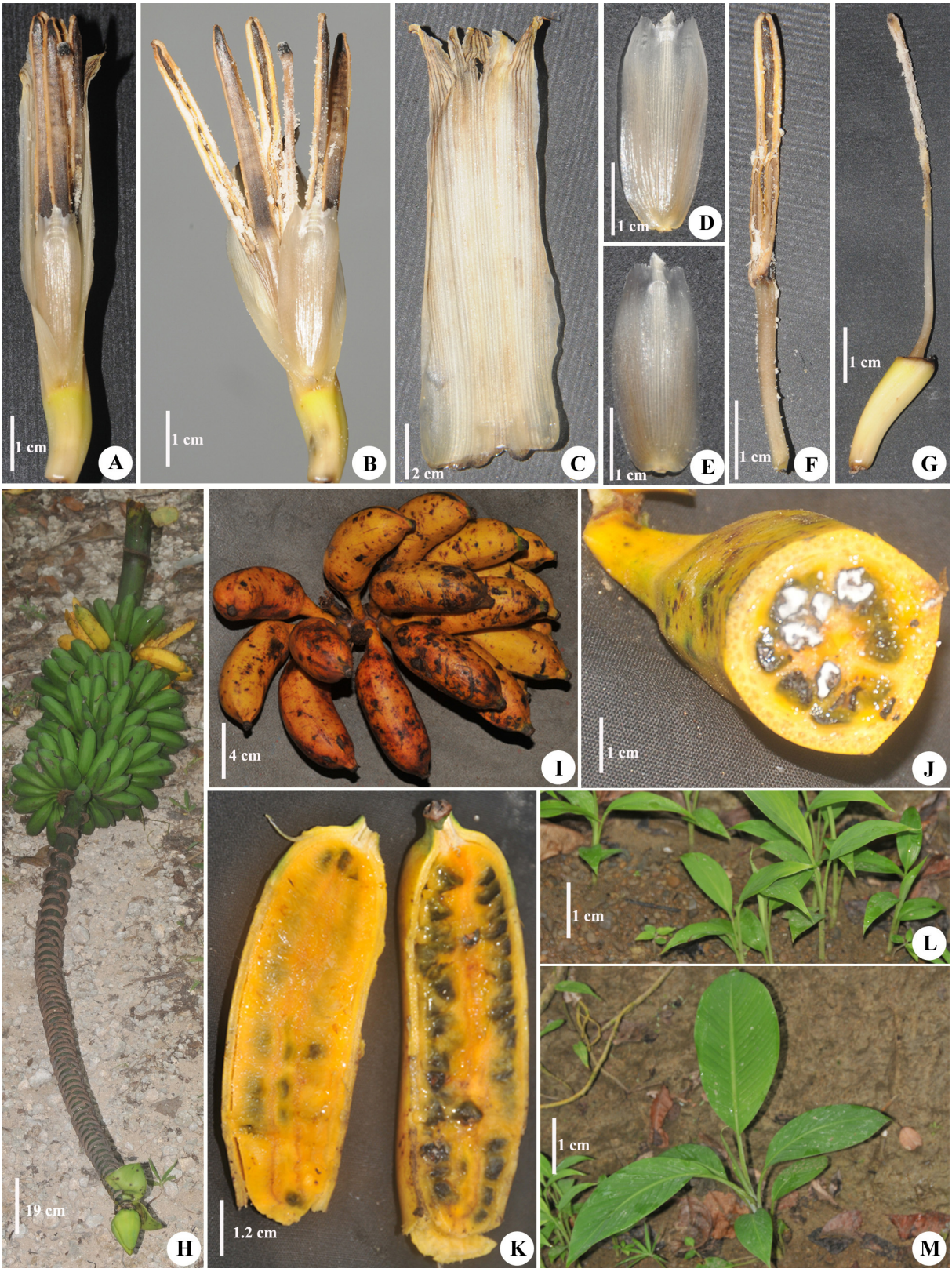


Fig. 4: ***Musa indandamanensis*** **L. J. Singh. A & B: Herma phrodite Flower. C: Lower tepal. D & E: Upper tepal; Dorsal and ventral view. F: Stamen. G: Pistil. H: Infloresence axis with Fruit bunch lux. I: Single fruit hand. J & K: Fruits. L & M: Seedlings.**

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becomes yellowish orange at maturity with c. 3.5 cm long stalk and many more seeds which recognized as much distinctive features. These distinctive features suggest its unique species status within *Musa* section. The new species appears to be closely related to *Musa banksii* (F. Muell.) var. *singampatti* T.G. Nayar. This closely related species is characterized by its glaucous, green and wax less foliage with light green midrib, green pseudostem with black blotches at or near the leaf sheath and petiole, compact pendulous bunch and deep imbricate, lanceolate, dark violet bract (Nayar, 1952; Simmonds, 1953, 1954, 1956, 1960, 1962, 1966; Häkkinen and Väre, 2008c) and it is highly distinct from the new species in morphology of vegetative and floral characters (Table 1). A key to the species of *Musa* from the Bay Islands is given below to facilitate identification.

A key to the genus Musa in the Bay Islands

1a. Fruits 20–30cm long ……..…… ***M. paradisica***
1b. Fruit < 15 cm long …….. 2
2a. Bract green …….. 3
2b. Bract brown/ dark purple ……..…. 4
3a. Pseudostem up to 11.5 m high, fruits 18–30 per hand, 7.5–8 cm long ……..…… ***M. indandamanensis***
3b. Pseudostem up to 8 m high, fruits 6–12 per hand, 5–9 cm long …… ……..… ***M. textilis***
4a. Fruits 8–14 cm long; seeds 7 mm in diameter ……... ……..... ***M. acuminata***
4b. Fruits 7.5 cm long; seeds 5 mm in diameter …….. …….. ***M. balbisian a var. andamanica***

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Table 1: Comparision of *Musa indandamanensis* L. J. Singh *sp. nov. and Musa banksii* (F. Muell.) *var. singampatti* Nayar T.G.

Characters	*Musa indandamanensis* L.J. Singh	*Musa banksii* (F. Muell.) *var. singampatti* T.G. Nayar
1. Plant stature	11–11.30 m tall	5 m tall
2. Pseudostem	Up to 11.30 m long, 45–55 cm in diameter at base, yellowish green with brownish red blotches. Young pseudostem light green with silvery white appearance.	3–5 m long, c. 20–25 cm in diameter at base, green with black blotches at or near the junction of leaf sheath and petiole.
3. Petiole	90–121 cm long, margin incurved, base winged and clasping with silvery white appearance.	60–75 cm long, slender with narrow margin and without waxy bloom.
4. Lamina	3–3.8 m long, 80–90.6 cm wide, adaxially green, abaxially medium green with obliquely obtuse laminar bases, midrib light green with silvery white appearance	About 2 m long, 60 cm wide, glaucous, green on both sides with midrib light green, oblong fairly symmetrical on either sides with rounded laminar bases.
5. Inflorescence	First horizontal and then falling vertically down wards, spathes cylindrical and green.	Horizontal on the fruit bearing axis then pendant in the male flower region, spathes lanceolate and violet.
6. Bract	Dark green outside, light or yellowish green with linear streaks inside, light green in the younger region with silvery white appearance, cylindrical, obtuse at apex.	Dark violet outside, brownish with linear streaks inside, paler in the younger region with waxy bloom, lanceolate, acute at apex.
7. Basal Flowers	Hermaphrodite, 20–30 per bract in 2 rows.	Hermaphrodite, 14 per bract in 2 rows.
8. Tepal	Golden yellow, united: 5 cm long, free, crispate with apicule, 2.5 cm long.	Yellowish white, united, 4 cm long, free, translucent, 2 cm long,
9. Anther	Linear, yellow or cream	Linear, brownish
10. Ovary	Bright green, 2.5 cm in length.	Pale green, 4 cm in length.
11. Fruit	7.5–8.0 × 3.5–4 cm, 18–30 per hand, rind and pulp yellowish orange at maturity and much sweet with prominent apex.	8–10 cm × 3–3.5 cm, 6–12 per hand, rind yellow at maturity, fruit pulp as usual and scanty sweet, apex not prominent.
12. seed	Bright black, 0.9 cm across.	Dull black, 0.5–0.8 cm across

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自印度海灣島發現的芭蕉屬（芭蕉科）新種：*Musa Indandamanensis*

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摘要：海灣島是印度的植物多樣性熱點之一，由於芭蕉屬系統分類資訊的貧乏，因此這也是印度眾多芭蕉屬分類關係未解的地區之一。本文基於文獻回顧以及對形態特徵之觀察，發表了海灣島上的芭蕉屬新種 *Musa Indandamanensis*，並提供分類描述及手繪圖。此物種為分布在小安達曼群島森林區域的極稀有物種。

關鍵詞：海灣島、印度、小安達曼群島、*Musa indandamanensis*、新種。

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