13. APPENDIX – I

LIST OF PUBLICATIONS

Mondal S, Basu SK and Chowdhury M (2016) In vivo seed germination and seedling morphology of *Phoenix dactylifera* L. and *Phoenix sylvestris* (L.) Roxb. NBU Journal of Plant Sciences, 10(1): 45–48.

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Mondal S, Basu SK and Chowdhury M (2018) *Areca triandra* Roxb. ex Buch.-Ham. (Arecaceae): new record for West Bengal, India. Plant Archives, 18(2): 1700–1702.

Mondal S and Chowdhury M (2018b) Rattans diversity in West Bengal, India. Advances in Plant Sciences, 31(2): 159–165.

Mondal S, Basu SK and Chowdhury M (2019) *Calamus pseudoerectus* (Arecaceae), a new species from the Eastern Himalaya, India. Journal of Threatened Taxa, 11(5): 13605–13610. https://doi.org/10.11609/jott.4493.11.5.13605 - 13610.

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13. APPENDIX – II

REPRINTS

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Short Communication

Calamus pseudoerectus (Arecaceae), a new species from the eastern Himalaya, India

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Calamus pseudoerectus (Arecaceae), a new species from the eastern Himalaya, India

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PLATINUM OPEN ACCESS

Abstract: *Calamus pseudoerectus* (Arecaceae or Palmae), a new species of rattan from the hilly slopes of Mukti and Mahananda rivers at Darjeeling District of West Bengal in the eastern Indian Himalaya, is described and illustrated. This species closely resembles two Indo-Myanmar species, *C. erectus* Roxb. and *C. arborescence* Griff. It, however, is distinguished by its short and extremely slender stem, spine ornamentation, pendulous, long-branched inflorescence, and minute fruits with fimbriate scales. A comparative study among *C. pseudoerectus* sp. nov., *C. erectus* Roxb., and *C. arborescence* Griff. is provided. Conservation status of this species is proposed as Endangered (EN) as per IUCN.

Keywords: *Calamus arborescence*, *Calamus erectus*, new taxa, Palmae, Rattans.

Calamus L. is the largest genus of the family Arecaceae (Palmae) with about 520 species worldwide, mostly distributed in the Asia-Pacific region and Africa (Dransfield et al. 2008; Baker 2015; Baker & Dransfield 2016). The spiny climbing and non-climbing rattans, the source of the commercial rattan cane, are distributed from tropical Africa, India to Fiji, southern China through Malay Archipelago to northern Australia (Baker & Dransfield 2014). *Calamus* is most species-rich in the southeastern region of Asia, with 183 species occurring across the Malay Peninsula, Philippines, Borneo, Sumatra, and Java (Baker & Couvreur 2012; Govaerts et al. 2013) and 52 species recognized from New Guinea (Baker et al. 2002; Baker & Dransfield 2006). Baker & Dransfield (2014) added 14 more species of *Calamus* from New Guinea. The lower hills of the eastern Himalaya and the Terai parts are quite rich in *Calamus* species, with 28 species reported from China (Pei et al. 1991), seven from Bangladesh (Alam 1990), eight from Bhutan (Noltie 1994), and nine from Nepal (Paudel & Chowdhary 2005). In India, Beccari (1894) reported 72 species of *Calamus* from undivided British India for the first time; presently, around 36 species and three varieties of *Calamus* are recorded from various parts of the Himalaya, Western Ghats, and the Andaman & Nicobar Islands (Basu & Basu 1987; Renuka 1987; Basu 1992). A total of 18 species of the genus *Calamus* L., *Plectocomia* Mart. ex. Bl., and *Daemonorops* Bl. were reported from various altitudes of West Bengal (Mondal & Chowdhury 2018). During exploration of palms and canes in the various lower hills and riverine forests along small streams ('khola') and rivers of the Darjeeling Himalaya, a few interesting specimens of *Calamus* were collected from Muktikhola (26^{0}49'26"N & 88^{0}13'22"E, 822m) and Choklong riverine

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forests (26°51'42"N & 88°21'45"E, 609m) of Mahananda Wildlife Sanctuary on the hillslopes of the Mukti and Mahananda rivers, respectively. After extensive morphologic comparisons in key herbaria (Herbarium, BSI, Central National Herbarium (CAL), Hebarium, BSI, Eastern Regional Centre, Shillong (ASSAM), Herbarium, BSI, Sikkim Himalya Regional Center, Gangtok (BSHC), and Herbarium, University of North Bengal (NBU), matching with some digital herbarium of Herbarium, Royal Botanical Garden, Kew (K), Herbarium, National Taiwan University (TAI) Herbarium, Royal Botanical Garden, Edinburgh (E), and extensive literature search (Renuka 1987; Alam 1990; Pei et al. 1991; Basu 1992; Noltie 1994; Paudel & Chowdhary 2005; Baker & Couvreur 2012; Govaerts et al. 2013; Baker & Dransfield 2014), it was found that it is a new species for science. The new taxon is carefully described and illustrated and a comparison of diagnostic morphologic characters with two allied Indian species, *C. erectus* Roxb. (Hort. Bengal. 72. 1814) and *C. arborescence* Griff. (Calcutta J. Nat. Hist. 5.33.1845), are presented (Table 1). Of the 36 species in India, two species, *C. erectus* and *C. arborescence*, are completely different from the others in respect of lack of knee, cirrus, and flagella. Similar character-bearing species from southeastern Asia are *C. acaulis* A.J. Hend., N.K. Ban & N.Q. Dung from Vietnam and *C. oxycarpus* Becc., *C. macrorhynchus* Burret, *C. erectus* Roxb., and *C. dianbaiensis* C.F. Wei from China. The new species is close to this group and lacks knee, cirrus, and flagella.

Taxonomic treatments

Calamus pseudoerectus sp. nov.

S. Mondal, S.K. Basu & M. Chowdhury,
Betgara, Otla bet [Nepali] (Image 1; Fig. 1).

Similar to *Calamus erectus* Roxb. and *C. arborescence* Griff. in respect of having similar types of ocrea and devoid of knee, flagella, and cirri, but distinct by big, branched inflorescence, minute and scattered spines, and very small fruits with fimbriate fan-shaped scales. It further differs by having scattered spines on leaf sheath and rachis, while in *C. erectus* and *C. arborescence*, spines are clustered and whorled. It is further characterized by pendulous big inflorescence, sheath with white and brownish-black powdery dust, conspicuous ocrea, oblong fruits, 5mm × 1mm, brown.

Holotype: 10044 (CAL), 08.ii.2018, India, West Bengal, Darjeeling District, Muktikhola hillslopes, 26°49'26"N & 88°13'22"E , 822m, coll. S. Mondal & M. Chowdhury.

Isotype: Calcutta University Herbarium (CUH), NBU (10044).

Cluster-forming rattan, erect up to 11m long. Stem solid, with sheaths 18–20 cm diameter, without sheaths 12–13.5 cm diameter; internodes 5–9.8 cm long, 12.1–13.2 cm diameter. Leaf ecirrate, 1.56–3.37 m long; flagella absent; sheath blackish-brown, caducous scales, sparsely variable sized blackish-brown armed with minute and few long flat spines along zone of adnation between inflorescence and sheath; knee absent; petiole 1–1.2 m long, young petiole with white powdery dust, mature petiole base with dense brown dust, covered with irregular small spines, base flat, leaf sheath closed with spongy, thick sheath fibers on both edges; leaflets 38–43 on each side of rachis; rachis 1.3–1.8 m long; glabrous, rarely spines on both edges, leaflets linear-ensiform, 41–75 cm × 2.1–4.1 cm, leaflets alternate in equidistance at base and terminal part, but opposite at middle; green beneath, narrowly elliptic to linear, mid leaflets 71–76.5 cm × 4.8–5.6 cm; apical leaflets 39.6–41.8 cm × 1.6–2.1 cm, apical leaflet scarcely united at base; fine spines 3–6 mm long, on major veins of both abaxial and adaxial surfaces; inflorescences long, looping, 2.10–2.40 m long, non-flagelliform, branched to 1 order, one pistillate and one staminate flower lies in each node; pistillate flowers deeply embedded on rachis node, sterile staminate flowers lies at base of pistillate flowers; prophyll strictly tubular, 14–32 cm × 4.8–3.1 cm tightly sheathing, opening asymmetrically at apex, with brown indumentums similar to that of the sheath, very sparsely armed with minute recurved spines, sometimes with fine bristles around bract opening; peduncular bracts one or two, peduncular up to 1.12m long, 1.3cm diameter, with irregular spine on margin and adaxial surface, rachis bract 5.6–14.4 cm × 3.3–5.2 cm, similar to prophylls; primary branches (rachillae) 25.6–134.2 cm apart, rachillae 2–3 at each nodes; rachillae alternate, straight, 10.3–27.6 mm × 1.6–2.5 mm; rachilla bracts 1.3–1.6 cm × 2.3–2.8 cm, similar to prophylls; floral bracteoles tubular, 0.7–1.4 cm × 1.8–2.5 cm, asymmetrically opened; pistillate flowers oval, 0.6–0.4 cm × 0.4–0.5 cm, sessile, lacking indumentums; calyx 0.4cm diameter, connate at base, three-lobed; lobes 0.6cm × 0.4cm; corollatubular at base, 0.4–1.1 cm × 1.6cm long, tip three-lobed; lobes triangular, 0.6mm long; ovary globose; stigma three, prominent; sterile staminate flower narrow, 0.7cm × 0.3cm, solitary, sessile, attached at base of pistillate flowers, calyx 0.4cm diameter, connate at base, three-lobed; lobes 0.6cm × 0.4cm; tubular at base, corolla 0.4–1.1 cm × 1.6cm, tip three-lobed; lobes triangle, 0.6cm long; sterile stamens six; separate fertile male plants not seen. Fruits very

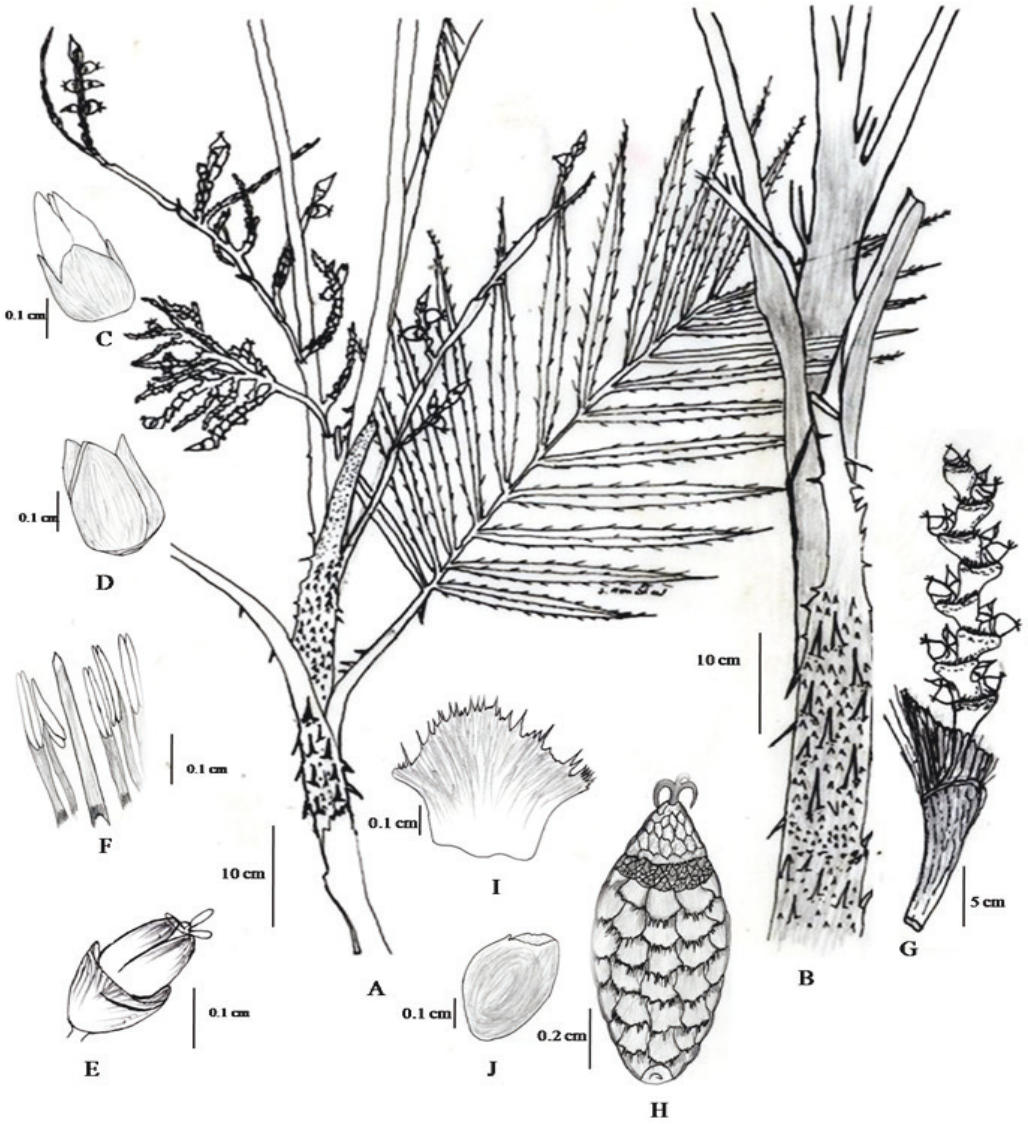

Figure 1. ***Calamus pseudoerectus*** **sp. nov.: A, B - habit with leaf sheaths, leaves, and inflorescence | C - sterile staminate flower | D - calyx | E - pistillate flowers | F - sterile stamens | G - rachilla with female and sterile male flower | H - mature fruit | I - scales | J - seed. © Sujit Mondal.**

small, ellipsoid, 0.7–0.8 mm × 0.3–0.4 mm, rusty brown, with three distinct stigmatic projection, 0.1–0.2 mm long, covered with longitudinal rows of scales, reddish brown, 0.4–0.8 mm × 0.3–0.5 mm, scales not regular, fan-shaped, margins fimbriate, arranged in nine rows; one-seeded. Seeds oblong, 0.5cm × 0.1cm, brown.

Phenology: Flowering: December–February; Fruiting: February–May.

Distribution: India (West Bengal, Darjeeling District).

Habitat: Hill slopes of riverine forests at lower hills, associated with bushes of *Lantana camara* L., *Mikania micrantha* Kunth, *Pandanus nepalensis* H. St. John, *Curcuma aromatica* Salisb., *Alstonia neriifolia* D. Don, and *Wallichia caryotoides* Roxb.

Uses: Leaves are used as thatch; local peoples use fruits for diabetes.

Etymology: The specific epithet is given as the new species is quite closer to the Indian rattan *C. erectus*.

Additional specimen examined (paratypes): 10212 (NBU), one specimen collected on 12.iv.2018, West Bengal, Darjeeling District, Shivkhola hillslopes, 26^{0}51’42”N & 88^{0}21’45”E , 609m, coll. S. Mondal & M. Chowdhury.

Notes: This species was discovered from the lower hills of Darjeeling District of India around 16km away from Siliguri City. *Calamus pseudoerectus* is presently known from four populations in the lower hill forests of Darjeeling District of West Bengal in the eastern Himalaya. Three populations were found at Murtikhola and one population at Shivkhola area of Mahananda WS.

Table 1. Morphologic comparison among *Calamus erectus* Roxb., *C. arborescens* Griff., and *C. pseudoerectus* sp. nov.

Characters	*Calamus erectus* Roxb.	*Calamus arborescens* Griff.	*Calamus pseudoerectus* sp. nov.
Sheath	With yellow powdery dust	Powdery dust absent	Whitish at young and blackish-brown powdery dust, sparsely variable sized armed or spines
Spines	Dense, in oblique rows	Dense, in oblique rows	
Pattern	Comb-like, whorl, dense	Comb-like, whorl	
Size (cm)	4–7	1–4	2–3
Colour	Yellow	Black	Blackish-brown
Rachis			
Size (m)	3–3.5	2–2.5	1.3–1.8
Spine type	Dense long spines	Dense long spines	Glabrous or rarely spines
Pattern	Spine 1–2 or whorled, comb-like	Whorled, comb-like	Rarely on both edge
Petiole			
Size (m)	0.5–1.5	0.5–1.5	0.5–1.2
Spines	Whorled, comb-like	Whorled, comb-like	Single, rarely on edge
Leaves			
Leaflets	25–40	25–39	38–43
Number (pair)	60–80 × 3.5–5	80–100 × 5–6	41–75 × 2.1–4.1
Size (cm)	Leaflets alternate in equidistance, green beneath	Leaflets opposite in equidistance, white beneath	Leaflets alternate in equidistance at base and terminal part, but opposite at middle; green beneath
Arrangement			
Terminal leaflets	Joined at half of their length	Joined at half of their length	Joined at one-fourth of their length
Prophyll	Tubular, short	Tubular, very long	Tubular, long
Sizes (cm)	7–10	20–30	14–32
Type	Uniform, upper parts soft, lacerate	Uniform, lacerate above	Opening wider, upper parts fibrous,
Colour	Green	Green	Whitish-greenish-brown
Spines	Thickly	Thickly	Absent
Texture	Papery, tattering apices	Papery, tattering apices	Leathery, strong
Inflorescence	Short, round	Pendulous, compressed	Pendulous, compressed
Size (m)	1–2	1.6–2	2.10–2.40
Peduncle	Round, strongly armed with black comb-like spines	Compressed, strongly armed with black comb-like spines	Compressed, pedicle unarmed, smooth
Rachillae	Rachillae 1 at each node, female flower rarely with sterile male flower	Rachillae 1 at each node, female flower rarely with sterile male flower	Rachillae 2–3 at each node, each female and sterile male flower together in each node throughout
Pistilate flowers			
Stigma	Deciduous	Deciduous	Persistent
Fruit	Big	Big	Very small
Shape	Ovoid-ellipsoid	Obovoid-ellipsoid	Ellipsoid
Size (cm)	3–5 × 2–2.5	2–2.2 × 0.5–0.7	0.7–0.8 × 0.3–0.4
Colour	Brown	Brown	Rusty brown
Stigmatic projection	Absent	Absent	Present
Scales			
Shape	Boat-shaped	Boat-shaped	Fan-shaped
Size (mm)	6–7 × 9–11	6–7 × 9–11	0.4–0.8 × 0.3–0.5
Margin	Brown, entire	Reddish, entire	Reddish-brown, fimbriate
Vertical rows	12	12	9
Seed			
Size (cm)	Big, 2.7 x 1.3	Big, 1.2 x 0.6	Small, 0.5 x 0.1
Colour	Yellow	Yellow	Brown

Each population is with an average of 10–15 individuals. Altogether, 40–60 individuals were observed. We examined several pistillate inflorescences and every time found minute fruits with seeds and fimbriate scales. The present study did not record staminate specimens.

Given the size of the area is about 60km^2 (area of occupancy <500km^2 and area of occurrence <5000km^2), number of locations four (≤5), and threats to the habitat, we recommend *Calamus pseudoerectus* under the status of Endangered (EN; IUCN Standards & Petitions Subcommittee 2014). The type locality is the part of the Himalayan hotspot (Myers et al. 2000) and faces tremendous adverse anthropologic pressure including tea gardens, road and house construction, huge forest resource collections by local people, and ecotourism. As *C. pseudoerectus* grows in the open forest of Mahananda WS where human infiltration is huge due to the presence of nearby tea gardens and ecotourism sites, the existing habitat needs to be protected by the forest department for the sake of in situ conservation of this new species.

Image 1. ***Calamus pseudoerectus*** **sp. nov. at Darjeeling District of West Bengal, India: A, B - habit | C - stem | D - inflorescence | E - sheath | F - petiole | G, H - sheath with fiber | I - rachilla | J - pistillate flower | K - sterile staminate flower | L - sterile stamens | M - mature fruit | N - fimbriate scales | O - seed. © Sujit Mondal.**

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DAEMONOROPS TERAIENSIS (ARECACEAE) A NEW SPECIES FROM TERAI OF DARJEELING, INDIA

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Abstract

Daemonorops teraiensis (Arecaceae or Palmae), a new species of rattan from Dalkajhar forest of Darjeeling district of West Bengal, India, is described and illustrated. This species has close resembles with *Daemonorops jenkinsiana* (Griff.) Mart. distinguished by its completely different armatures on knee, petiole, rachis, leaflets number, sizes, female rachis size and flowers number.

***Key words*:** *Daemonorops teraiensis,* new taxa, Dalkajhar forest, India

Introduction

The genus *Daemonorops* Blume (Arecaceae) comprises about 114 species distributed in tropics and subtropics of southeastern Asia extending to southeast China, Malaysia to New Guinea (Dransfield et al. 2008). Terai and foothills of Darjeeling district is rich with dense vegetation and also houses various species of palms and canes (Mondal & Chowdhury 2018, Mondal *et al*., 2019). A good number of Canes were recorded from the Dalkajhar forest of Terai and few very large population of *Daemonorops* are growing in Terai and foothills of Mahananda wildlife sanctuary and Jore Pokhri Wild life sanctuary of Darjeeling district. Beccari (1832) first time estimated 27 species of *Daemonorops* from undivided British India. Presently 6 species of *Daemonorops* were reported from India, *Daemonorops jenkinsiana* (Griff.) Mart is only species that found in N and NE India whereas, rest 5 species were described from Western Ghats and the Andaman & Nicobar Islands (Basu, 1992; Renuka 2011). *Daemonorops jenkinsiana* (Griff.) Mart. is only species reported from China (Pei *et al*., 1991), Bangladesh (Alam 1990) and Bhutan (Noltie 1994). During exploration of palms and canes in the forest of Terai and foothills of Eastern Himalaya of Darjeeling District, one interesting specimen of *Daemonorops* was collected from the Dalkajhar forest near Bagdogra (Jore Pokhri Wildlife Sanctuary 26°41'42" N, 88° 17' 14" E, Alt. 145 m) in the month of January, 2017. Initially the plant was seems to be *Daemonorops jenkinsiana* (Griff.) Mart. but after extensive morphological comparisons (Table 1) with various herbarium specimens of key herbaria (CNH, ASSAM, BSIH, and NBU) and also matching with some digital herbarium of K, TAI, it is considered as a new species for its remarkable dense armatures on leaves, leaflets number, sizes, female rachis size and flowers number. To understand the population size and ecology, it was observed periodically since last two successive years (2017-2019). Finally the specimen was carefully described here along with necessary photographs and illustrations.

Taxonomy

Daemonorops teraiensis S. Mondal & M. Chowdhury, *sp. nov.* [Fig.1, Image 1]

Type: INDIA. West Bengal: Darjeeling District, Dalkajhar forest at terai of Darjeeling (Jore Pokhri Wildlife Sanctuary) 26° 41'42"N, 88° 17' 14" E, Alt. 145 m, 01.05.2018, S. Mondal & M. Chowdhury 0070; (holotype CAL, isotype NBU)

Diagnosis: Distinguished by its extremely unique armatures on knee, petiole, rachis, leaflets number, sizes, female rachis size and flowers number.

Climbing rattan, 6–8 m tall; stem erect, covered with sheath, 8–12cm in diameter, internodes 10–12cm; without sheath up to 10.4 cm in diameter; *sheath* tubular, 16–26 cm long dense, light brown with flat, papery spines, base conical, 0.8–4.2cm long, internodes 11.5–15cm long. Leaves cirrate; leaf excluding cirrus 1.85–2.43m long, cirrus 1–1.19 m long; knee conspicuous, covered with dense brown scurf, spines except both longitudinal side, spines flattened, deep brown to blackish spines in series or scattered; *petiole* 8.5–13 cm long, 2–2.8 cm broad at middle, scurfy outside, flat to slightly convex above, 5–6 rows of dense spines on abaxial and adaxial surface, margin without spines; rachis with strong digitate dense spines on adaxial surface and claw shaped on abaxial surface, spines at concave side 2–8 mm and convex side 2–18 mm long. Ocrea conspicuous, scarcely developed, tightly sheathing, mouth with fine short rusty bristles up to 3.4 cm long, rachis 1.90–2.14 m long; *leaflets* 72–80 on each side of rachis; equidistant, alternate to sub opposite, 18–24 × 48–52 cm long, apical leaflets 0.6–1 × 1.8–2.2 cm, 3 nerved, each with fine bristles, bristles 0.4–1.2cm long, on mid-veins bristles on both abaxial and adaxial surfaces sparsely spinous on lower edges, spine 4–6 hook shaped, joined at the base, 4–9 mm; Inflorescence subaxillary not very broadly fusiform or inserted above the mouth of their sheaths, not very broadly fusiform after opening; *male flowers* oblong in bud, 2×5 mm; calyx copular, with yellow powdery dust corolla with 3 oblanceolate petals; 3–4 mm × 1–2 mm; stamens 6; 2–3 mm long, subulate, connate and thickened at base; *female flowers* 2–3 in number on each side; 4–5 mm long; calyx copular, 2–3 mm long, truncate; corolla distinctly veined, with deeply divided lanceolate petals; each 3.5–4.5 × 1–2 mm; ovary ovoid to globose, stigmas 3, Fruit globose, 1.8 cm in diameter.

Flowering: March – May **Fruiting:** April – June

Distribution: Known only from few bushes at Dalkajhar forest near Bagdogra, Darjeeling, West Bengal.

Habitat: Sub-tropical forest in the Terai of Darjeeling, West Bengal, India (alt 140-150 meter)

Uses: Local tribal people eat the tender shoots and use dried leaf as fuel. Fruits are favorite food of wild elephants.

Vernacular name: Kanra bet (Nepali).

Etymology: The specific epithet '*teraiensis'* is derived from the type habitat topography i.e., right bank of Teesta river with undulating land commonly known as *Terai* of Darjeeling district of West Bengal, India.

Notes: *Daemonorops teraiensis* was discovered from the Dalkajhar forest near Bagdogra of Darjeeling district is presently known from only two populations at study area where each population is with an average of 10–14 individuals. Altogether, 20–28 individuals were observed and the given size of the area is about 40 km^2 (area of occupancy <500 km^2 and area of occurrence <5000 km^2), number of locations two (≤5), and threats to the habitat, we recommend this new species under the status of Endangered (EN; IUCN Standards & Petitions Subcommittee 2014) and also endemic. The type locality is a part of Himalayan hotspot (Myers *et al*., 2000) and faces extreme adverse threats including extension of tea gardens, road, huge forest resource removal by forest dwellers and ecotourism. As *Daemonorops teraiensis* grows in the margin of open forest associated with Bengdubi tea garden of Dalkajhar forest of Jore Pokhri WLS where human infiltration is huge due to the presence of nearby tea gardens and ecotourism sites, the existing habitat needs to be protected by the forest department for the sake of in situ conservation of new species.

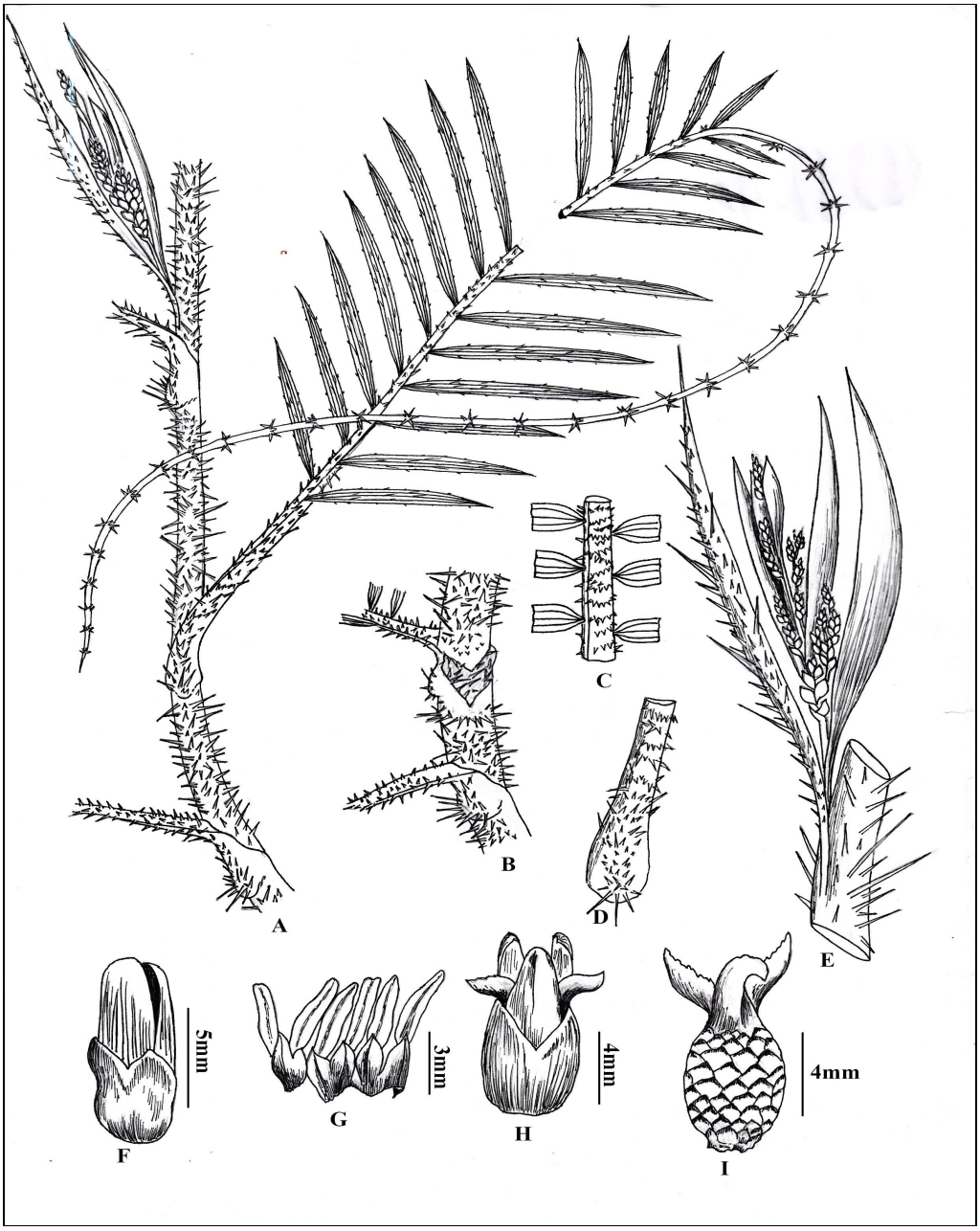

Fig. 1 : *Daemonorops teraiensis* S. Mondal & M. Chowdhury, *sp. nov.* **A, B–** Habit sketch; **C–** Armature on adaxial surface of petiole & rachis; **D–** Armature on abaxial surface of petiole & rachis; **E–** Inflorescence; **F–**Male flower; **G–**Anther; **H–**Female flower; **I–**Fruit. © *Papiya Saha*

Table 1 : Morphological comparison among *Daemonorops jenkinsiana* (Griff.) Mart. and *Daemonorops teraiensis* sp. nov.

Characters		***Daemonorops jenkinsiana* (Griff.) Mart.**	***Daemonorops teraiensis sp. nov.***
Stem	*Without sheath*	2 – 3 cm diameter	9 – 10.4 cm diameter
	Internodes	15 – 20 cm long	10 – 12cm long
Leaf	*With cirrus*	Upto 5 meter long	Upto 3 meter long
	Sheath	28-40 cm long cm long, 2-3 cm in diameter	16 – 26 cm long cm long, 8 – 12 cm in diameter
	Armature on sheath	Green to brown, flattened, conical, deflexed spines, upto 3cm long	light brown with flat, papery spines, conical, upto 4.2 cm long
	Armature on knee	Dense packed throughout knee, spines needle like	Dense except both side glabrous, flattened spines
	Petiole	15 – 20 cm long, 5 cm broad at widest part	8.5 – 13 cm long, 2 – 2.8 cm broad at widest part
	Armature on petiole	Strong digitate claws, straight at petiole margin	5-6 rows of dense spines on abaxial and adaxial side, margin without spines
	Armature on Rachis	Sparsely, spines on adaxial side and one or two jointed on abaxial side	dense spines on adaxial side and claw shaped on abaxial side
	Armature of cirrus	Uniform, claw shaped,	Variable, clustered, upward and downward mixed type
	Leaflets number	60 – 70 on each side	72– 80 on each side
	Size (cm)	40 – 70 x 2 – 4	18 – 48, 1.8 – 2.2 wide
	Size (cm)	7 – 16	3.5 – 9.6
Female partial inflorescence	*Female rachillae*	6-7 in number on each side,1.5-1.6cm long	2-3 in number on each side, 4 – 5 mm long
	Female flowers	5 – 5.5 mm long	4 – 5 mm long

Image 1: *Daemonorops teraiensis* S. Mondal & M. Chowdhury, *sp. nov.* **A, B**– Habit,
C– Armature of abaxial surface of petiole & rachis **D–** Armature of abaxial surface of petiole & rachis;
E–Shapes of male spadix; **F**–Shapes of female spadix; **G**–Male flower; **H** Female flower; **I**– Fruit. © *Sujit Mondal*

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Rattan Diversity in West Bengal, India

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Among 5 Indian rattans genera, three (*Calamus, Daemonorops* and *Plectocomia*) are recorded from the boundary of West Bengal, mostly concentrated in mixed forest of Terai, Duars of sub Himalayan forest and lower hills up to 1500m altitude of Himalaya. A total of 18 species of rattans were enlisted and among them *Calamus nambariensis* Becc., *C. longisetus* Griff., and *Plectocomia bractealis* Becc., are first time recorded from West Bengal. The natures of clumping, rhizome branching pattern, phenology, ethnobotany etc. were recorded along with photography.

Keywords : Rattan, Diversity, West Bengal

INTRODUCTION

Rattan (family: Arecaceae, subfamily: Calamoideae) is an important forest product of South-East Asia because they contribute structural complexity (Putz 1991), shelter (Sunderland 2004) and food (Henderson 1986, Lee 1995, Sunderland & Dransfield 2002, Kidyoo & McKey 2012). In India, J.D. Hooker (1894) first time accounted 105 species of rattans from undivided British India and presently around 46 species and 3 varieties of *rattans* were recorded from various parts of Himalaya, Western Ghats and Andaman & Nicobar Islands (Basu & Basu 1987; Basu 1992; Basu and Chakraverty 1994; Renuka 1987). Recent report of rattans in India denotes, 4 rattan genera comprising about 60 species of which 32 species are endemic (George & Joshi 2012). In West Bengal three genus (*Calamus, Plectocomia* and *Daemonorops*) out of five rattans genera of India, were recorded. Destruction of their natural habitat, the evergreen forests, has affected even the board genetic base of rattan. In present time various rattans is not available in their natural habitat to meet the demands of the rattan industry. So cultivation and conservation of rattan is needed. The nature of clumping, branching pattern of the rhizome, phenology, ethnobotany etc. are of much silvicultural importance (Sultan 1992). For conserving the rattan resources of West Bengal, some serious action is needed towards the cultivation of wild species for commercial use. Some institution like Botanic Garden, Horticulture Garden etc. with high rainfall areas can play an important role in the *ex-situ* conservation of indigenous rattans species.

Characters of Rattans

Habit: Rattans are either single stemmed or clump forming. *Leaf:* leaves are large, pinnately compound and spirally arranged on the stem. *Cirrus* and *flagellum:* The cirrus and flagellum are special climbing organs by which climbing species of canes fix itself on a support. Cirrus is a whip like extension of the leaf rachis and is armed with a series of spines, hooks and claws. All members of *Daemonorops* and *Plectocomia* and some species of *Calamus* of West Bengal are cirrate. A flagellum is the whip like appendage similar to cirrus, but originating from the uppermost part of the leaf sheath. A flagellum is known only in the genus *Calamus* but not all species of *Calamus* are flagellate. *Inflorescence:* Two major types of flowering, hapaxanthic and pleonanthic are distinguishable among the rattans (Dransfield 1979). In hapaxanthic flowering the topmost nodes of rattans produce inflorescences more or less simultaneously and the stem dies after flowering or fruiting whereas in pleonanthic, the stem continues to produce inflorescence, and the stem can continue to grow after flowering. *Fruit:* All true rattans fruits are covered by vertical rows of reflexed overlapping scales. The scales are hard, shiny and frequently grooved vertically along the mid line. Fruit usually one seeded; the outer fleshy layer is called sarcotesta.

MATERIAL AND METHOD

Study area : The State of West Bengal lies between 21° 45'-27° 16' N latitude and 85° 55'- 89° 56' E longitude, covering a geographical area of about 88,752 sq km. Entire area is composed of five agro-climatic zones *i.e.,* Darjeeling Himalaya, Terai - Duars region, Western undulating highland and plateau, North and South Bengal plains and Gangetic delta with diversified biota.

Methods : Extensive field surveys were done in entire study area in three pre-dominant seasons during last five years (2013-2018). All the rattans species and their population, economic and ethnic uses were recorded in details and preserve voucher specimens through entire conventional herbarium techniques (Jain & Rao, 1977). The mounted specimens were taken under critical study and identified initially matched with the pre-identified specimens in NBU-

Herbarium and also with character matching with the different Taxonomic literature by various authors (Prain, 1903; Basu 1992, 1994; Basu & Mondal, 2012, 2013, 2015; Mondal, Basu & Chowdhury, 2016, 2017a, 2017b & Cook, 1996). Some unidentified specimens were taken to CAL for matching with herbarium consult with experts in different taxa was also consulted for finalization.

RESULT AND DISCUSSION

Rattan is one of the most important forest products of the subfamily Calamoideae under tribe Calameae of Arecaceae. Present study records a total of 18 species of rattans belonging mostly to the genera *Calamus* (14 sp), *Daemonorops* (1 sp) and *Plectocomia* (3 sp). Artificial Dichotomous Keys for the recorded genera and species ware constructed based on significant reliable and easily observable vegetative, flower and fruit characters. All these species were enumerated below along with their local names, short description, availability status, flowering and fruiting periods and phytogeography.

Enumerations:

Key to the genera

1a. Hapaxanthic cane; inflorescence develops in the axil of upper reduced leaves. ..... *Plectocomia*

1b. Pleonanthic cane; inflorescence mostly in the axil of normal leaves..... 2

2a. Inflorescence with tight, sheathing, persistent bracts.... *Calamus*

2b. Inflorescence with loose, boat shaped or spatulate non-sheathing bracts... . *Daemonorops*

CALAMUS Linn.

Key to the Species

1a. Leaf with cirrus..... 2

1b. Leaf ecirrate..... 6

2a. Leaf sheath smooth outside, unarmed..... *C. inermis*

2b. Leaf armed with short to long spines or spicules..... 3

3a. Leaflets remotely sub-equidistant on rachis..... *C. nambariensis*

3b. Leaflets alternate or sub-opposite..... 4

4a. Leaf sheath more or less smooth on upper part, lower part infrequently armed with flattened, subulate spines *C. khasianus*

4b. Leaf sheath spines subulate, seriate to subseriate, closely packed 5

5a. Stem robust leafsheath bright green ..... *C. latifolius*

5b. Stem slender, leaf sheath bright green with brown blotches ..... *C. floribundus*

6a. Stem erect, leaf sheath without flagellum..... 7

6b. Stem climbing, leaf sheath with flagellum..... 8

7a. Inflorescence compact, non pendulous..... *C. erectus*

7b. Inflorescence not compact, pendulous ..... *C. acanthospathus*

8a. Leaf sheath with heavily armed, strong 6-7 m long flagellum..... *C. flagellum*

8b. Leaf sheath with sparsely armed, comparatively slender flagellum 9

9a. Male and female flower rachillae in scorpioid..... *C. leptospadix*

9b. Male and female rachillae not in scorpioid..... 10

10a. Leaf sheath armed with dense, broad based spines in rows, joined at base ..... *C. tenuis*

10b. Leaf sheath armed with scattered, needle-like, ... 11

11a. Primary bracts after opening form a laminar appendage..... *C. guruba*

11b. Primary bract do not form laminar appendage..... 12

12a. Leaf sheath with broad based black spine; tiger striped ..... *C. longisetus*

12b. Leaf sheath with subulate spines; fruits scale not tiger striped..... 13

13a. Uppermost leaflets digitately grouped..... *C. gracilis*

13b. Uppermost leaflets not digitately grouped or fascicled..... 14

14a. Terminal leaflets conspicuously connate at base 15

14b. Terminal leaflets slightly connate at base..... *C. kingianus*

15a. Leaflets lanceolate, distinctly grouped, irregular with 2-3 leaflets..... 16

15b. Leaflets fascicled irregular..... *C. viminalis*

Calamus acanthospathus Griff., Calc. J. Nat Hist. 5: 39. 1845; Basu, Rattans Ind. Monogr. Rev. 126. 1992; Noltie, Fl. Bhut. 3(1): 421. 1990. *Calamus feanus* Becc., Hook. f., Fl. Brit. Ind. 6: 448. 1892. "***Phekri Bet***".

Robust rattan, stem solitary sometimes cluster forming, to 28m height with leaf sheath to 4 cm in diameter, flagellum about 1.5 - 2m long; leaflets alternate, 46 cm long, 5 - 7cm broad at middle. Inflorescence to 3 - 4m long, flagelliform. Fruit ellipsoid, endosperm sub ruminate; embryo basal. *Flowering* and *Fruiting:* May -November. *Population status:* Rare

Uses: Cane is collectively used for making cane bridges over mountain streams by local ethnic groups.

Specimen examined: West Bengal, Kurseong, 20.06.2016, Mondal and Chowdhury 09858, NBU herbarium.

Calamus erectus Roxb. Fl. Ind. 3: 774. 1832; Becc., Hook. f., Fl. Brit. Ind. 6: 438. 1892; Prain, Beng. Pl. 2: 1099. 1906; Noltie, Fl. Bhut. 3(1): 419. 1990. Basu, Rattans Ind. Monogr. Rev. 69. 1992. ***"Kadam bet, sitar supari"***.

cluster forming shrubs dioecious cane. flagellum or cirrus absent. Stem with leaf sheath 3.5 to 6 cm in diameter. Leaves ecirrate, 3 - 4.9 m long; leaf sheath without 3-7m long, rachis armed below with irregular to whorled straight spines. Inflorescence interfoliar, 1 m long, Fruit oblong, covered by 12 vertical rows, ellipsoid, 3 cm x 2 cm, endosperm ruminate; embryo basal.

Flowers & Fruiting: April - October. *Population status:* Common
Distribution: Thailand, Myanmar, Bangladesh, And India: Sikkim, Assam, Meghalaya, Manipur, West Bengal (Bangdubi forest, Sevoke).
Uses: Young endosperm and fruit are edible and also anti-diabetic.
Specimen examined: West Bengal, Darjeeling, Bangdubi, 02.05.2016 Mondal and Chowdhury 09862, NBU herbarium, West Bengal, Darjeeling, Kalijhora, 16.11.2017 M ndal and Chowdhury 09807, NBU herbarium, West Bengal, Jaldhaka, 30.04.2018 Mondal and Chowdhury 10178, NBU herbarium.

Calamus flagellum Griff., ex Mart., Calc. J. Nat. Hist. 3: 333 1853; Becc., Hook. f., Fl. Brit. Ind. 6: 439. 1832; Noltie, Fl. Bhut. 3(1): 420. 1990; Basu, Rattan Ind. Monogr. Rev. 74.1992. ***"Pultibet, Rabi bet".***
Clustering, large diameter rattan. Stem with sheath 5 cm in, leaves ecirrate, flagella and knee present. Inflorescence flagelliform, 7 - 7.5 m long; bracts tubular. Fruits about 4 cm long, yellowish or brownish, scales deeply channelled at middle; seed terete in cross section; embryo basal.
Flowering & Fruiting: June - October. *Population Status:* Rare; Endangered (Renuka 2011)
Distribution: Bangladesh, Bhutan, India; Sikkim, Assam, Meghalaya, West Bengal (Darjeeling- Mirik, Alipurduar)
Uses: A large cane similar to *Calamus inermis*, much sought after cane for furniture making.
Specimen examined: West Bengal, Mirik, 20.07.2015 Mondal and Chowdhury 09853, NBU herbarium; West Bengal Alipurduar, Dalgaon forest 20.09.2017 Mondal and Chowdhury 09855, NBU herbarium.

Calamus floribundus Griff. Calc. J. Nat. Hist. 5: 56. 1845; Becc., Hook. f., Fl. Brit. Ind.6: 444. 1892; Basu, Rattan Ind. Monogr. Rev. 115. 1992.
Clustering, medium sized rattan. Stem with sheath 5 cm in diameter without sheath 2.5 cm in diameter. Leaves ecirrate; lanceolate, 4 - 6 nerved, to 55 cm long, 3 - 5 cm wide at middle. Inflorescence flagelliform, 1.5 - 2m long. Fruit drupe, globose, beaked, 8 mm in diameter; scales in 14 series, obtuse, shinning, superficially channelled at middle, gray yellow; seed sub orbicular.
Flowering & Fruiting: April - June. Population Status: Rare; Endangered
Distribution: Bangladesh, Myanmar, India; Assam, Meghalaya, Arunachal Pradesh, Mizoram and Nagaland. West Bengal (Shivkhola, Darjeeling).
Uses: It is used for basket making and other handicrafts, rope etc.
Specimen examined: West Bengal, Darjeeling, Shivkhola 27.03.2018 Mondal and Chowdhury 09856, NBU herbarium.

Calamus gracilis Roxb., Fl. Ind. ed. 3: 781. 1832; Becc., Hook. f., Fl. Brit. Ind 6: 453. 1893; Prain, Beng. Pl. 2: 1098. 1906; Basu, Rattans Ind. Monogr. Rev. 111. 1992. ***"Udham bet"***.
A cluster forming, slender climber, 30 m height. Leaves ecirrate, 70 cm long; flagella armed; ocrea small; knees present; male and female both inflorescence flagelliform. Fruit scales yellow; seed ovoid, endosperm ruminates.
Flowering & Fruiting: April - November. *Population Status:* Rare
Distribution: Africa to Australia; NE India, West Bengal (Terai and Duars)
Uses: Use for furniture.
Specimen examined: West Bengal, Darjeeling, Mahananda Wild Life Sanctuary, 17.06.2017 Mondal and Chowdhury 09852, NBU herbarium.

Calamus guruba (Buch-Ham) ex Mart. Hist. Nat. Palm. 3: 211. 1853; Becc., Hook. f., Fl. Brit. Ind. 6: 449. 1892; Prains, Beng. Pl., 2:1099.1906; Noltie, Fl. Bhut. 3(1): 422. 1990; Basu, Rattan Ind. Monogr. Rev. 94. 1992. ***"Sundi bet, Jali bet, Jai bet"***.
A high slender thicket climber, 25 m long. Leaves ecirrate, leaf sheath with prominent knee and long flagellum. Male and female inflorescences flagelliform, to 1-3m long, Fruits rounded, 6 mm in diameter, 17 - 18 vertical rows.
Flowering & Fruiting: October - March. *Population Status:* Rare; Near Threatened (Renuka 2011)
Distribution: Asia to Australia; NE India. West Bengal (Terai)
Uses: This rattan is largely used for making rough baskets.
Specimen examined: West Bengal, Alipurduar, Khoerbari range 29.04.2018 Mondal and Chowdhury 10170, NBU herbarium.

Calamus leptospadix Griff., Calc. Jour. Nat. Hist. 5: 49. 1845; Becc., Hook. f., Fl. Brit. Ind. 6: 44. 1832; Noltie, Fl. Bhut. 3(1): 420. 1990; Basu, Rattans Ind. Monogr. Rev.77.1992. ***"Dhangri Bet, Rab Bet, Rani Bet, Mugri Bet"***.
Cluster forming, small diameter climber; stem 10 m long, Leaves without cirrus, leaf sheath with flagellum, knee present; ocrea present, Male and female inflorescence flagelliform. Fruit globose; endosperm homogeneous.
Flowering & Fruiting: March - October. *Population Status:* Rare; Vulnerable (Renuka 2011)
Distribution: Asia; NE India. West Bengal (Terai & Duars)
Uses: Split canes are strong and durable and used for making chair bottoms.
Specimen examined: West Bengal, Darjeeling, NBU Campus, 20.08.2014 Mondal and Chowdhury 10174, NBU herbarium.

Calamus longisetus Griff., Calc. Jour. Nat. Hist. 5: 36. 1845; Becc., Hook. f., Fl. Brit. Ind. 6: 440. 1832; Basu, Rattans Ind. Monogr. Rev.102.1992. ***"Ali bet, Jungli bet"***.
A strong climber, upto 20 m long; internodes 45cm long. Leaves ecirrate, arching, 4 - 5.5m long. Male and female inflorescences flagelliform, 7 - 8m long, Fruits obconical to ellipsoid, 3.5cm long. Seed oblong, endosperm homogeneous.
Flowering & Fruiting: October - June. *Population Status:* Rare; Least Concern (Renuka 2011)

Distribution: Asia; NE India. West Bengal (Terai and Duars)
Uses: The tribal people eat the ripe fruits and used leaves for thatching.
Specimen examined: West Bengal, Darjeeling, Kalijhora, 16.11.2017 Mondal and Chowdhury 09864, NBU herbarium.

Calamus tenuis Roxb., Fl. Ind. 3: 780. 1832; Becc., Hook. f., Fl. Brit. Ind. 6: 447. 1832; Prain, Beng. Pl. 2: 1098. 1906; Noltie, Fl. Bhut. 3(1): 421. 1990; Basu, Rattan Ind. Monogr. Rev. 84. 1992. ***"Jati bet, Pani bet, sanchi bet"***.
A thicket slender climber. Leaves ecirrate upto 1 m long, knee prominent. Male inflorescence slender, flagelliform, 3.5 - 4mm long. Female inflorescence long flagellate. Fruit broadly globose; 1 - seeded, seed globose, endosperm not ruminate.
Flowering & Fruiting: September - October and April - May.
Population Status: Rare; Least Concern ver 3.1 (IUCN)
Distribution: Asia; NE India; West Bengal (Gangetic plains, Western highlands and plateau)
Uses: Cane is used for making rough baskets and useful raw material for furniture.
Specimen examined: West Bengal, Malda, 20.08.2017, Mondal and Chowdhury 10172, NBU herbarium.

Calamus inermis T. Anders., Jour. Linn. Soc. 21: 11 1869; Becc., Hook. f., Fl. Brit. Ind. 6: 455. 1893; Basu, Rattans Ind. Monogr. Rev. 53. 1992.
A non- clump forming climbing canes. Stem large 4 - 6cm with leaf sheath. Knee with very prominent wrinkles at base. Leaves cirrate. Female inflorescence to 1 - 1.5m long, Fruit ellipsoid, about 2 - 3cm long, 1.7 cm wide at middle; fruit scales in 18 rows, deeply channelled at middle.
Flowering and Fruiting: January - October. Population Status: Less common
Distribution: Asia; NE India. West Bengal (Darjeeling Himalaya).
Uses: For making chair frames and used for police sticks.
Specimen examined: West Bengal, Rongtong, 24.12.2017, Mondal & Chowdhury 5817, NBU herbarium.

Calamus khasianus Becc., Ann. Roy. Bot. Gard. Calcutta 11: 431. 1908; Basu, Rattan Ind. Monogr. Rev. 61. 1992.
Cluster forming, medium diameter rattan. Leaves ecirrate, 5 - 6m; leaf sheath with prominent knee. Inflorescence to 1.5 - 2m long. Fruit globose, scales deeply channelled; seed globose, endosperm ruminate; embryo basal.
Flowering & Fruiting: April to January; *Population Status:* Rare; Near Threatened (Renuka 2011)
Distribution: Asia; NE India. West Bengal (Terai and Duars)
Uses: it is used in furniture industry for making chair bottoms and frame works.
Specimen examined: West Bengal, Alipurduar, Buxa, 29.04.2018 Mondal and Chowdhury 10180, NBU herbarium.

Calamus latifolius Roxb. Fl. Ind. 3: 775. 1832; Becc., Hook. f., Fl. Brit. Ind. 6: 445.1892; Prain, Beng. Pl. 2: 1099. 1906; Noltie, Fl. Bhut. 3(1): 423. 1990; Basu, Rattan Ind. Monogr. Rev. 65. 1992. ***"Korak Bet, Horna Bet"***.
A moderately robust climber, leaflets upto 50 cm long. Stem with prominent unarmed knee. Inflorescence 150 - 180cm long. Fruit globose, 1- seeded; seed globose, blackish, roughly pitted.
Flowering & Fruiting: July - February. Population Status: Rare
Distribution: Asia; NE India. West Bengal (Darjeeling Himalaya)
Uses: Cane is moderately strong and used for making rough baskets, walking sticks.
Specimen examined: West Bengal, Darjeeling, 20. 08. 2016, Mondal and Chowdhury 10179, NB herbarium.

Calamus nambariensis Becc., Roy. Bot. Garden Calcutta 11: 433. 1908; Basu, Rattans Ind. Monog. Rev. 56. 1992.
A robust climber; stem up to 20m long. Leaves cirrate; prominent knee. Inflorescence simply decompounds. Fruit globose to ovoid or ellipsoid, stalked, 2.7 cm in diameter; fruit scales in 21 rows.
Flowering & Fruiting: July - February.
Population Status: Less common; Vulnerable (IUCN)
Distribution: Asia; NE India; West Bengal (Terai and Duars)
Uses: Cane is strong, and exported from Assam to other states for making furniture frames.
Specimen examined: West Bengal, Darjeeling, Dalgaon range 20.02.2017 Mondal and Chowdhury 10183, NBU herbarium.

Calamus viminalis Willd., Sp. Pl. 2: 203. 1799; Prain, Beng. Pl. 2: 1098. 1906; Basu, Rattans Ind. Monogr. Rev. 117. 1992. Calamus viminalis var. fasciculatus (Griff.) Becc., in Hook. f., Fl. Brit. Ind. 6: 444. 1892. "Boro Bet, Hasali Bet, Kiring Bet".
A thicket Clustering climber, stem up to 20-35 m long. Leaves ecirrate, distinct knee with long flagellum. Inflorescence flagelliform. Fruit to 8.5 - 9mm in diameter, seed globose,
Flowering & Fruiting: November - May.
Population Status: Rare; Least Concern (Renuka 2011).
Distribution: Asia; NE India; West Bengal (Darjeeling Himalaya)
Uses: The strong cane is used for various purposes, for making baskets, chair bottoms.
Specimen examined: West Bengal, Darjeeling, Sukna 20.01.2018 Mondal and Chowdhury 10182, NBU herbarium.

DAEMONOROPS Bl.
Daemonorops jenkinsiana (Griff.) Mart., Hist. Nat. Palm. 3: 327. 1850; Becc., Hook. f., Fl. Brit. Ind. 6: 462. 1893; Prain, Beng. Pl. 2: 1088. 1906; Noltie, Fl. Bhut. 3(1): 424. 1990; Basu, Rattans Ind. Monogr Rev. 40. 1992. ***"Golak Bet, Golla Bet, Cheka Bet, Dudhia Bet. Dangri Bet"***.
Big climbing rattans. Leaves cirrate, cirrus 3-5m long, knee distinct. Inflorescence cymbiform. Fruit globose; seed globose, endosperm ruminate.
Flowering & Fruiting: July - May.
Population Status: Common; Near Threatened (Renuka 2011)
Distribution: Asia; India; West Bengal (Darjeeling Himalaya, Terai and Duars)
Uses: The leaves of *Daemonorops jenkinsiana* are used for thatching and fruits are favourite food of wild elephants.
Specimen examined: West Bengal, Darjeeling, Bangdubi forest 12.01.2018 Mondal and Chowdhury 10198, NBU herbarium; W.B, Darjeeling, 12.04.2017 Mondal and Chowdhury 09873, NBU herbarium.

PLECTOCOMIA Mart. ex Bl.

Key to the species

1a. Leaflets green above, white below, acute or acuminate, not filamentous at apex; bracts densely tomentose outside..... .... *P. assamica*

1b. Leaflets green on both sides, apiculate, filamentous; bracts finely tomentose outside..... 2

2a. Axis of the ultimate flower branches covered with dense rust coloured tomentum; fruits densely villous outside .... *P. himalayana*

2b. Axis of the ultimate flower branches almost smooth; fruits not densely villous outside, smooth .... *P. bractealis*

Plectocomia assamica Griff., Calc. Jour. Nat. Hist. 5: 97. 1845; Becc. in Hook. f., Brit. Ind. 6: 479. 1893; Basu, Rattan Ind. Monogr. Rev. 32. 1992. ***"Runul bet"***.

A clustering cane, stem with leaf sheath about 3.5 - 4cm in diameter. Leaves cirrate, 1.7 - 2m long including cirus. Inflorescence 1 - 2m long. Fruits globose, seed globose.

Flowering & Fruiting: March - September.

Population Status: Rare; Vulnerable (Renuka 2011)

Distribution: Endemic to NE India; West Bengal (Darjeeling Himalaya)

Uses: The tribal's people of the forests use long canes for making high hanging bridges over small mountain streams and rivulets

Specimen examined: West Bengal, Darjeeling 20.08.2016 Mondal and Chowdhury 1020, NBU herbarium.

Plectocomia bractealis Becc., Roy. Gard. Calcutta 12 (2): 22. 1818; Basu, Rattan Ind. Monogr. Rev. 35. 1992.

High climbing rattan. Leaves cirrate about 2.1 m long. Bracts on flower branches of female inflorescence 8-8.5 cm x 3 cm covered with indumentums. Female flowers 5 in each bracts, pedicillate, bracteolate; bracteoles 7-16 mm long.

Flowering & Fruiting: Not Known. *Population Status:* Rare

Distribution: Endemic (Upper Assam.) to NE India; West Bengal (way from Garidhura to Kurseong).

Uses: Tender shoot of these rattan used for vegetable.

Specimen examined: West Bengal Darjeeling 20.08.2016 Mondal and Chowdhury 09861, 10175, NBU herbarium.

Plectocomia himalayana Griff. in Calc. Journ. Nat. Hist. 5:100. 1845; Becc., Hook. f. Fl. Brit. Ind. 6: 478. 1893; Noltie, Fl. Bhut. 3(1): 425. 1990; Basu, Rattan Ind. Monogr. Rev. 32. 1992. ***"Tehri bet, Rano bet, Tokri bet"***.

Cluster forming, medium sized canes. Stem with leaf sheath, 3 - 4cm in diameter. Leaves cirrate, 1.8 - 2.5cm long; leaflets 35 - 40cm long. Inflorescence 1.5m to 2m long. Fruit 1.4 cm in diameter, not woody out side; scales arranged in longitudinal series with papillose margins, obtuse tips; depressed, seed orbicular, 1 - 2cm in diameter.

Flowering: March to May. *Fruiting:* Not Known.

Population Status: Rare; Least Concern ver 3.1 (IUCN)

Distribution: Asia; India; Arunachal Pradesh, Sikkim and West Bengal (Darjeeling)

Uses: Cane is soft therefore unsuitable for making furniture. Used by the local people for tying fences and for making baskets.

Specimen examined: West Bengal Darjeeling 20.08.2016 Mondal and Chowdhury 09863, 09854, NB herbarium.

CONCLUSION

The population of many useful rattan species are drastically disappearing from various parts of West Bengal due to huge habitat loss and direct collection of such species for furniture industry. But the Population of such species inside the in-situ conservatories of Darjeeling Himalaya, Terai and Duars region is still rich. Only *Calamus tenuis* is growing in lower and middle Bengal whereas other 17 species of rattans are only growing in forested areas and hilly slops of lower hills of North Bengal. Species of *Daemonorops* are growing in terai and few species of *Calamus* are quite common in Mixed Plain Forest and lower hilly slops of North Bengal (Upto 600m). *Plectocomia* is a highly valuable rattans mainly found in Middle and Upper Hill Forest from 2000-3000m of Darjeeling Himalaya. It was once a very low value product meant for inexpensive and often traditional furniture, but today it has grown in demand and is now a high value material after timber and bamboos. Rattans are mostly used for making basket, furniture small households articles, decorative items; umbrella handles walking sticks, etc. It is one of the important raw materials of small scale industry of West Bengal as well as India.

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Fig. A. *Calamus nambariensis* Becc.; **B.** *C. viminalis* Willd.; **C.** *Daemonorops jenkinsiana* (Griff.) Mart.; **D.** *C. guruba* Buch. - Ham.; **E.** *C leptospadix* Griff. ; **F.** *C. longisetus* Griff. **G.** *C gracilis* Roxb.; **H.** *Plectocomia bractealis* Griff.

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Observation on *Nypa fruticans* Wurmb., the estuarine palm of Sundarbans and its introduction in non-halophytic condition of North Bengal

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Nypa fruticans Wurmb., is one important and rare economically important palms in the tidal creeks of Sundarbans, situated in the estuarine coastal district of West Bengal. The plant is fast disappearing in its natural habitat due to scarcity of fresh water flow from the upper riches, over exploitation for making charcoal and thatching materials. Present study attempt to conserve this saline species in non-saline areas of North Bengal University campus for the conservation and also to understand the seed germination of *Nypha fruticans.*

Key Words: *Nypa fruticans;* Sundarbans; non-halophytic; North Bengal.

Introduction:

Nypa fruticans Wurmb., with its underground stems and long erect pinnate leaves arising straight from the ground level is very picturesquein appearance in the tidal creeks of Sundarbans, situated in the estuarine coastal district of West Bengal. *Nypa fruticans* is also a dominant component in the tidal ecosystem of Andaman and Nicobar Islands. It is popularly known as *Golpata.* Its present population in Sundarbans is reducing at a faster rate and the natural population of this estuarine palm is only as a few colonies existed in some small pockets of the tidal region. The loss of population of *Nypa fruticans* in Indian Sundarbans is due to relative scarcity of fresh water flow from the upper riches and also due to over exploitation for making charcoal and leaves for using as thatches. It is reported that leaves of *Golpata* are durable and last for about 10 years. It is also reported that sap extracted from the peduncle is sweet and make into syrup in Philippines and other South East Asian countries. Apart from India *Nypa fruticans* has distribution in Sri Lanka, Bangladesh, Mayanmar, Peninsular Malaysia and Philippines. It also occurs in some tidal areas of Northern Cape of Australia. It has doubtful occurrence in the Mahanadi mangrove ecosystem area in Orissa (Haines 1921) but not been confirmed in the latter field surveys (Sastry et. al. 1989).

Materials and Methods

For collection of ripe fruits from the natural habitat and for studying the natural habit condition of *Nypa fruticans* a study trip was arranged in March and continued to November in Jharkhali forest, a part of the Sundarbans Biosphere Reserve.Here a lively colony of *Nypa fruticans* still exists. In *Nypa fruticans* under natural conditions due to vivipary emergence of shoot occur while the fruit is still attached with the fruiting head. About 100 fruits/ seeds were carefully collected from their natural habitat in Sundarbans and placed in moist sawdust so that the propagules should not get dried. Fruits/ seeds were brought inthe Botany Department, North Bengal University for trial cultivation. Collected fruits/ seeds were placed in fine net and placed in a pan containing pond water. After a week fruits/ seeds started germinating. Each germinating fruits were placed in the moist soil with the spouting portion kept above the soil level. Finally each pot along with the sprouting fruits were placed in a water filled cementedtank so that the sprouting portion remain above the water level.The first shoot opened as a trifoliate leaves after which second, third and fourthemerges. But the plant reaches a height of only 11 cm after about 4 month of growth. The young growing palms were successfully transferred in bigger pots and placed in the water body in NBU medicinal plant garden. Till date all the plants were looking healthy and producing new leaves at regular intervals.

Nypa fruticans Wurmb., Verh. Batav. Genootsch. Kunsten 1: 349.1779; Beec. & Hook. *f.*, in Hook. *f.*, Fl. Brit. Ind. 6: 424.1892; Prain, Beng. Pl. 2: 1094.1903; Parkinson, Forest Fl. Great Nicobar Isl. 464. 1999;

Basu & Chakraverty, Manu. Cult. Palms in Ind. 92. 1994. [***Gol Pata (Bengal.), Neetipana (Mal.), Gubna (Hind.)***] (Fig. A)

Gregarious stemless palms, root- stock prostate, thick, long, Leaves arising from the root stock, pinnatisect, 5-6 m long, leaflets linear lanceolate, pelicate, 1.5-2.5m long, waxy-glaucous underneath, with bifurcate, soft spine like scales along the undersurface of the midrib, petiole 1.5-2 m long stout. Spathes many; inflorescence terminal, branched, erect in flower, drooping in fruit. Flower monoecious, male flower minute, mixed with bractioles, arranged in catkins on lateral branches of the inflorescence; female flower larger arranged in globose terminal heads. Fruit 12-16 x 6-10 cm ovoid or globose, syncarpous, with hexagonal 1- seeded carpels and pyramidal tips; pericarp fleshy, fibrous; endocarp spongy.

Field Observation

The emergence of the inflorescence in *Nypa fruticans* is strictly seasonal. A shoot produces 3-4 spadices from September to November and anthesis in male flowers take place first. The male and female flowers are borne on structurally different spikes at different positions of the inflorescence. The females are terminal inthe form of large head. The first inflorescence that emerges in September finishes its anthesis in male and female flowers between October and November. Overlapping of male and female spikes just below the terminal pistillate head grow longer and arch on female flowers for facilitating pollination. Male flowers are borne on dense spikes that terminate the severalorders of lateral branches. When the female flower comes to the stage of receptivity, a colorless sticky substance is secreted from the vagina like opening of the carpel. After several attempts the exact stages of receptivity was visualized in the early morning after sunrise. The sticky substance gradually dried up as the day progress. The male spikes developing from the lower axis sometimes open for anthesis even much latter than the uppers once. It has been observed that the flowers when enclosed within the spathes develop considerably, thus reduce the gap period from opening of spathes to anthesis.

Nypa fruticans Wurmb., although a typical component of mangrove ecosystem and grow under natural condition in the tidal regions where there is plenty of mixture of sweet and saline water. Our present observation shows that in Sundarbans a decrease in the population of *Nypa fruticans* may be due to absence or decrease in the flow of riverine water in the estuarine system. It also proves that *Nypa fruticans* may not be acomponent of strictly tidal region with high salinity of the tidal water. Therefore it has the capacity to grow in the non-saline zone also. Due to its peculiar habit and growing horizontally in the mud flat, it is rarely cultivated as ornamental palm;we have observed thata good healthy colony of this palmis growing gregariously along aedge of a sweet water pond in the Governor house in Kolkata. It is also reported that a good colony of *Nypa fruticans* is existing in an artificial cemented tank in the Theosophical Society's Garden at Adyar in Chennai (Basu and Chakraverty 1994). A healthy colony of this palm was also seen in a sweet water pond in a residential garden in South Kolkata. *Nypa fruticans* has been reintroduced along the edge of a sweet water pond in the Acharya Jagadish Chandra Bose Indian Botanic Garden in Howrah. In all these localities *Nypa* palms were growing healthy and spreading and also producing inflorescence flowers and fruits with viable seeds. With this *ex-situ* presence of *Nypa* palms in non-saline areas, we thought it prudent to introduce *Nypa fruticans* in the North Bengal University campus in a sweet water pond which is far away from its natural habitat of Sundarbans for studying its performance right from the seed germination to rising of seedlings and their final plantation at the selected site.

Seedling morphology

Primary roots are 4-6 cm long, brownish in color, with absence of root hair, primary adventitious roots are short, first leaf or eophyll is 5.7 cm long. Second leaf 7.5 cm and third leaf 11.9 cm long, seedling leaves are glabrous, lamina linear lanceolate, fourth leaf linear lanceolate glabrous 15- 32cm long, and 1.3-2.1 cm width.

Conclusion

A study on propagation, plantation and growth performance of estuarine *Nypa fruticans* in non-saline condition is very much significant. The germination of *Nypa fruticans* is an incipiently

Fig. A : The Nypa palm, *Nypa fruicans*, in Sunderban Biosphere Reserve. B: Nypa palm in Theosophical Society's Garden at Adyar in Chennai, C: Mature seeds of Nypa palm, D: Germination technique of Nypa palm seeds, E-F: Seedling of Nypa palm, G: Hand drawing of Male and Female inflorescence of *Nypa fruticans*, H-I: Young plant of Nypa palm in North Bengal University.

viviparous type where the hypocotyls pierce out of seed coat but not form the exocarp at the time of dispersal. Our observation on the growth pattern of *Nypa fruticans* seedling in *ex-situ* non-saline condition will be helpful for its conservation.

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INDIGENOUS METHOD OF 'SUGAR CAKE' (*PATALI*) PRODUCTION FROM *BORASSUS FLABELLIFER* L. IN WEST BENGAL, INDIA

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Abstract

Sugar cake or *Patali* is basically prepared from the watery sweet sap of *Borassus flabellifer* L. Most of the poor villagers of South 24 Parganas of West Bengal make this sugar cake using their inherent traditional method and marketed for their survival. The sugar cakes or *Patali* is eaten as raw and also used in the preparation of various famous delicious Bengali sweets. The present work records the stepwise entire indigenous method of *Patali* or *Sugar cake* preparation from *Jaggery* (Gur). Necessary stepwise records along with the photographs are presented in this article.

Key words : *Borassus flabellifer, Patali* or sugar cake, indigenous knowledge, economic value.

Introduction

The indigenous people of the tropical world from the pre-industrial period have an intimate relationship with the natural resources of their environment. Among the most economically important food plants of the world are mostly belongs to three families *i.e.*, grass family (Poaceae), the legume family (Fabaceae) and the palm family (Arecaceae). The utility of these three plant families are known to human kind since the ancient time (Basu and Chakraverty, 1994; Basu and Mondal, 2015). India is a country of many cultures and rich in diversified traditional knowledge to make traditional foods from different plant products. *Borassus flabellifer* L. is most important economic palm in India and the watery sap is used in the making of Jaggery (Gur) or fermented into toddy. Many village levelartisans are thriving on this Jaggery making industry. This sugar cake or *Patali* is sometimes used to make the various delicious traditional foods and commonly used in various Bengali sweets. *'Moaa'* and *'Murki'* are the very famous traditional food materials of Bengal and these are made with puffed paddy mixed with hot liquid *Patali*. Globally some work has been done on the utility of Palm and recognize as one of the most important economic crop in the tropics (Anyawu *et al.*, 1982). In India, a good number of workers published their articles on utility and conservation of Palm (Basu, 1991).

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Materials and Methods

The survey was made during the period of 2014–2016 and the data was collected from the experienced *Patali* maker from the study area. Some *Patali* makers who are making *Patali* generation after generation were selected from various villages and interviewed in details and entire method was documented and photographed stepwise very carefully (Chowdhury, 2012). Several villages like *Hinchakhali, Nikarighata, Moukhali, Jahukhali, Korakat*i, Jayrampur, Basiram, Millonmore, Ietkhola, Bodhukulla, Kamarpara etc. of the district of 24 Parganas of West Bengal, India. Patali is also prepared in few villages of Burdwan, East & West Medinipur and Bankura District. The making of *Patali* includes mainly two distinct phases *i.e.*, i) collection of plant sap as key ingredient from the male and female inflorescences of *Borassus flabellifer* L. during the month of February to early June of each year and ii) preparation of *Patali* from that sap through the traditional methods.

Results and Discussion

During winter indigenous people of some districts of costal and dry areas of West Bengal are found busy to collection of sweet sap from the inflorescences of mature trees of *Borassus flabellifer* L. They are also taking lease of such a good number of trees for this sweet sap from the land owners who are having such land with many *Borassus flabellifer* trees. The freshly collected sweet sap may be sell as sweet drink or used for the preparation of sugar cake or *patali* (plate 1). The entire process of sugar cake preparation was documented and a step wide method for the patali preparation is described below.

Process of sap collection

Indigenous people or *'Seuli'* collect sweet sap from the cutting site of male and female inflorescence, therefore the tapping season commences with the flowering season from end of the February to early June. In order to obtain the maximum quantity of sap, tapers must possess a high degree of technical skill for the collection of sweet sap; as well as the physical strength is needed to climb up on the tall *Borassus* trees. 3 to 4 pitcher is hanged into the scratched inflorescence. In male inflorescence, spadix is bind with a rope and obliquely cut by a sharp knife but in female inflorescence, young immature fruits are selected and cut it obliquely by a sharp knife and sweet sap is collected at the intervals of 8 to 10 hrs. After 8 to 10 hrs cutting site again should be scratched out and new pitcher is hanged and entire process continues for 3 days. Whole process again repeats after 3 days gapping. In starting, male inflorescence produces large amount of sweet sap compare to female inflorescence.

Making of Patali from sap

Sometimes sweet sap is sold in door to door in various villages of 24 Parganas. On the other hand *patali* is used from sweet sap. The sweet sap yield per tree is varying with the duration of sap collection and it has been found that the less quantity gives high quality or density sap and vice-versa. Correct approximate numerical data for first 3 days of sap collection in respect of Sugar cake yield is as following:

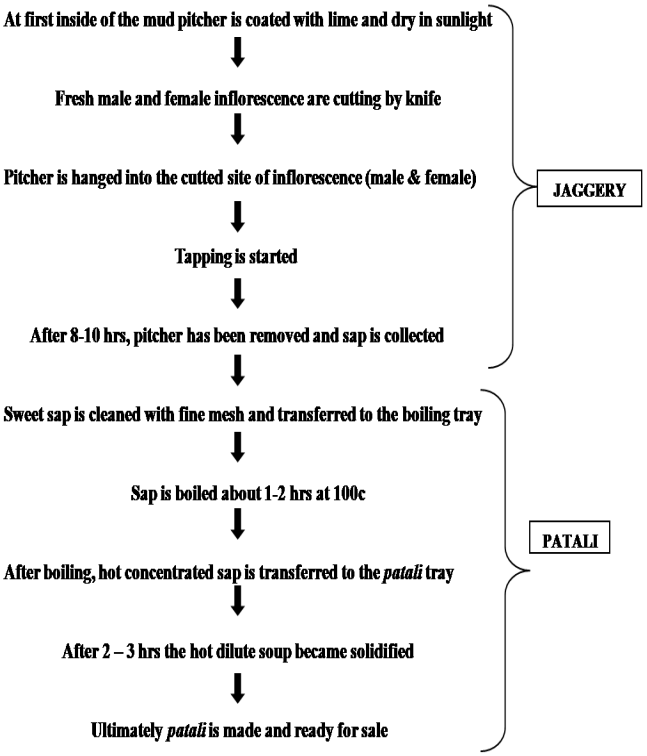
1st day : Sap quality is high but quantity is low, and total sugar cake yield is around 1 – 1.5 kg

2nd day : Sap quality and quantity is medium, and total sugar cake yield is around 2 – 2.5 kg

3rdday : Sap quality is low and quantity is high and total sugar cake yield is 3 kg or above

Generally, 5 litter sweet sap yields around 1.2 kg *patali*. After 3 days, one mature tree produces around16–25 litter sweet sap that gives around 4.3 – 6.7 kg sugar cake or *patali* and their market value retailer is Rs. 80 – 100 per kg whereas retailers sell it around Rs. 150 – 180 per kg. Local people sometimes buy this fresh sweet sap at morning at the rate of Rs 5 – 10 per 250 ml for their direct consumption because it good for bowl clearance.

Preparation of *patali*



Economic value and uses of *patali*

The peoples of 24 Parganas are basically dependent on agriculture and agricultural based product. They are lives in very remote places and earns from the saline vegetation. Most of them are directly and indirectly dependent on Sundarban biosphere reserve. The socio economic status of the poor and ethnic people of 24 Parganas are directly depends on the sweet sap collection and *Patali* production. Various types of sweet dishes are prepared by *patali*. Among these the *Naru*, *Moaa*, Murki etc. of Jaynagar is famous in West Bengal. This *patali* is used in various religious activity of Hindu and Muslim community. From this point of view, *patali* is very popular for their economic as well as utility value. The *patali* is more useful in the preparation of famous delicious *Moaa*, known as *Moaa* of Jaynagar. Presently this product is highly demandable among the states as well as country. Now a days, this product is exporting for other countries. *Patali* is also useful in the preparation of various types of sweets like as *Sandesh, Rasgolla* etc. and their

Plate 1 : **A**. Pitcher (Vaar) coated with lime, **B**. Female inflorescence is covered with pitcher, **C**. An ethnic people carrying the sweet sap, **D**. Mixing all the sweet sap, **E**. The pitcher with full of sweet sap, **F**. Preparing for boiling, **G**. Concentrated sweet sap, **H**. Spreading sweet sap, **I & J**. Two types of patali, **K, L & M**. Sailing patali in local markets.

demand and market value is higher than the other types of sweets.

Conclusion

Sugar cake or *Patali* is a very popular and have a great socio-economic impact in some parts of West Bengal. Most of the tribal community of the study area directly or indirectly depends on this. But this indigenous knowledge is being destroyed day by day due to lack of sap collector and sugar cake makers. Urbanization and the demand of growing greedy populations are the major threat to this traditional knowledge. So to save our tradition, we must have to aware about the conservation of this indigenous system of *Patali* processing and encourage the persons who are involved in this indigenous *sugar cake* making industry, otherwise such valuable knowledge will disappear in near future.

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Research Article

In vivo seed germination and seedling morphology of *Phoenix dactylifera* L. and *Phoenix sylvestris* (L.) Roxb.

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Abstract

A comparative study of *Phoenix dactylifera* L. and *Phoenix sylvestris* (L.) Roxb. has been done in the Medicinal Plant Garden in North Bengal University. The germination status of mature seeds of two species *in vivo* condition was recorded. It was seen that *Phoenix dactylifera* prefers natural pH (45.5) where as *Phoenix sylvestris* prefer acidic soil with pH (6-7). During this study total seed output, times of germination, first aerial leaf, veneration pattern and reproductive capacity were calculated.

Key words: Seed germination, Seedling morphology, *Phoenix dactylifera, Phoenix sylvestris,* West Bengal, India.

Introduction

The family Arecaceae (Palmae) is one of the largest monocotyledonous family, comprising over 212 genera with about 2,779 species distributed worldwide (Basu and Chakraverty, 1994). *Phoenix dactylifera* L. and *Phoenix sylvestris* (L.) Roxb. belongs to the Subfamily Coryphoideae, tribe Phoeniceae of the family Palmae (Arecaceae). Basu and Chakraverty (1994) reported a total of 17 species of *Phoenix* are growing in different parts of the World. Species of *Phoenix* are growing in diverse habitats that occupy swamps, deserts, mangroves and coastal areas. Most of *Phoenix* species originate in semiarid region, but usually occur near high ground water levels, riverside or springs. About 92 species and 4 varieties of wild and semi wild palms representing of 21 genera are distribution in India. They are chiefly occurring in three major geographical regions, viz. Peninsular India, Eastern and North-Eastern India and Andaman & Nicobar Islands. A very few species of palm taxa are also occur in the rest parts of India, particularly in the sub-Himalayan valleys and plains of northern India, semi-arid parts of Western India, Gangetic plains, estuarine or mangrove forests of Ganga and Mahanadi delta, moist hilly tracts of Orissa, South and North Bihar (Basu and Chakraverty, 1994). *Phoenix dactylifera* and *Phoenix sylvestris* are distributed from Canary Islands through sub-tropical and tropical Africa, the Arabian Peninsula, the Indian subcontinent and Indo-china to Hongkong (Uhl and Dransfield, 1987). In India these palms are grown as ornamentals because of their beautiful showy structures. Apart from the ornamental use, both the species having great economic values due to their delicious nuts, sweet sap, timber etc.

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Materials and Methods

Mature fruits of both the species have been collected from the natural sources during the month of July, 2015 and 20 numbers of seeds of each species were sown in pot with three replica. The standard pH for germination and growth of seedlings of each species were tested in laboratory. Progress of seeds germination were studied after regular interval. To record the seed behavior and seedling morphology, conventional methods were

Table 1: Seed shape, size and weight measurements

Taxa	Ave. Length (cm)	Ave. Breadth (cm)	Shape index	Size index	Seeds Weight (gm)	
					1 seed	100 seed
Phoenix dactylefera	1.86	0.94	1.98	1.75	1.34	134
Phoenix sylvestris	2.28	1.32	1.73	3.01	1.73	173

Table 2: Seed output and Reproductive capacity

Taxa	Seed output			Reproductive capacity			
	Fruits/ plant	Seeds/ Fruit	Seed output	Germination %	Viable %	NonViable %	RC Value %
Phoenix dactylifera	2013	1	2013	71.67	71.67	28.33	131.15
Phoenix sylvestris	3341	1	3341	93.33	93.33	6.67	239.87

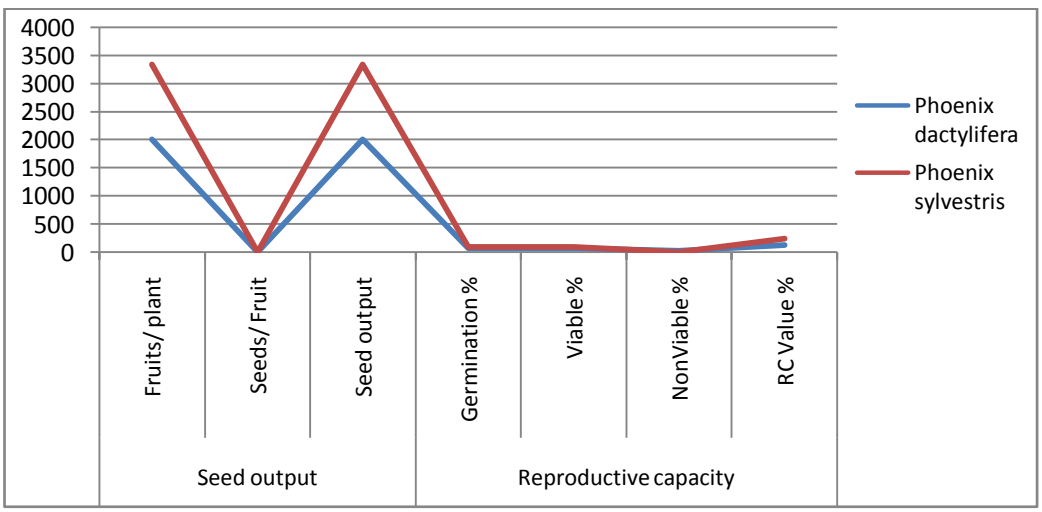

Fig. 1. Graph showing comparative study of Reproductive capacity and Seed output of *Phoenix sylvestris* and *Phoenix dactylifera*.

followed as suggested by Chowdhury (2009), Bose and Paria (2015).

This part of work also attempt to determined the average seed output and average seed germination for both the species. The average seed output of a plant is determined by taking 10 plants that were selected at random and counted separately.

Mean value is calculated for average seed output. The collected seeds were then dried out in air and stored in a desiccator. During seed count, number of fruit per plant, seeds per fruit also counted. Seed shape, seed colour and other seed morphology along with seed weight were also been noted. Seed shape and size, germination Percentage, reproductive capacity and seed output were calculated following the methods as suggested by Hill *et al*. (1986), Salisbury (1942) and Chowdhury (2009).

Result and discussion

Present study mainly focused on the entire seed morphology and reproductive capacity of *Phoenix dactylifera* and *Phoenix sylvestris* at garden condition at University of North Bengal (Figure 2). It was clearly recorded that the

seeds of *Phoenix dactylifera* preferred acedic (pH 6-7) soil for germination where *Phoenix sylvestris* prefer germination in sandy soil with basic (pH 45.5) condition. During this study it was found that the rate of seed germination of *Phoenix dactylifera* is very less where as *Phoenix sylvestris* showing good and satisfactory result. The first seedling leaf tip is more or less obtuse in *Phoenix sylvestris* whereas acute leaf tips in *P. dactylifera*. During germination in *P. dactylifera* the length of the remote tubule is on average 7cm whereas around 19 cm in *P. sylvestris* were recorded. It was also seen that first aerial leaf of the seedling of *Phoenix dactylifera* consists of 7 parallels veins where as *phoenix sylvestris* consists of 5 parallel veins with vigorous rooting system.

Fig. 2. Mature tree (A); seeds (C); seedlings (F); undivided main root system (J) of *P. sylvestris*; Mature tree (B); germinated seeds (D & E); seedlings (G & H); divided main root from the adjacent point (I) of *P. dactylifera.*

The details of the seed output, '%' of germination and Reproductive capacity for both the species were also calculated and given in Table 1 & 2. The entire calculated data shows that the *P. sylvestris* showing the higher seed production and also reproductive capacity (239.87%) than that of *P. dectylifera* (131.15%) and the comparative analysis was given in fig. 1.

Conclusion

Further detail studies regarding the seedling morphology of *Phoenix dactylifera, P. sylvestris, P. paludosa, P. acualis* will be taken for better understanding of the taxa through seedling morphology. Because of the genus *Phoenix* needs a long time for flowering which is very much essential for taxonomical identification, moreover the genus *Phoenix* is also dioecious in nature, so the study of seed and seedlings morphology can help us to during the segregation of male and female plants at juvenile stage for cultivation for better yield.

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Local, medicinal and ethnic uses of some indigenous and introduced Palms

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Introduction

The indigenous people of the tropical world from the preindustrial period have an intimate relationship with the natural resources of their environment. Wild and cultivated plants and wild and domesticated animals both provided all the food and other they needed for living. The grass family (Poaceae), the legume family (Leguminoceae) and the palm family (Palmae) (Arecaceae) are the three important plant families that contribute most for the world's food source. The utility of these three plant families are known to humankind since the ancient time.

Palms occupy a very important position among all economic plants, as they are one of the major sources of man's food. One of the twelve plants basic to human nutrition is Coconut, a palm. Tender leaves, young inflorescence, pith of the stem, fruits and seeds, endosperm of many palms are edible and provide all the nutritive materials for healthy living. The four extensively domesticated palms in the plant kingdom are *Cocos nucifera, Phoenix dactylifera, Areca catechu* and *Elaeis guineensis.* Semi wild palms such as *Borassus flabellifer, Phoenix sylvestris, Caryota urens, Arenga pinnata, Livistona jenkinsiana, Phoenix paludosa, Phoenix rupicola, Wallichia disticha, Licuala peltata, Trachycarpus martianus* and several species of wild palms and canes have also local and commercial uses as source of food, sugar, wine, oil, fibers and various other items of uses such as building material, furniture in the form of wood, cane, and leaves. Soft young leaves are also useful for making various household items. Due to high nutritive and medicinal values of the edible portion of Coconut palm, Date palm and Areca palm, they are commercially cultivated. Local, medicinal, commercial and ethnic uses of indigenous palms however are more to be known through extensive survey, wide interaction and document research. Basu (1991, 2012) Basu and Chakraverty (1994) and Basu *et al.* (2011-2013) has recorded food and medicinal uses of some indigenous palms and canes. Now efforts were made to record more information on different uses of indigenous palms, some information are of great interest not earlier known.

Observation and record on uses of different indigenous palms

***Cocos nucifera* L.** is widely cultivated pan tropical palm with a strong presence in India as cultivated crop. Coconut palm in average produces up to 75 fruits per year. Fruits and all parts of the palm are useful and have significant local, ethnic and economic value. Its versatility is sometimes noted in its naming in Sanskrit as *Kalpa Briksha* or the tree of life. Coconut flowers always adorn auspicious occasion, in Hindu wedding. The flowers are stood in brass urn and placed in prominent position. Coconut husk is now used as potting medium while the fibers have great demand in the manufacture of ropes, mats, rubberized mattress for cots and various other furnishing items of great commercial value. Coconut fiber is the raw material of large scale coir industry. The nut provides oil for cooking and making margarine. The sap derived from incising the peduncle of the inflorescence is drunk as neera or fermented to produce toddy. The white endosperm of coconut is delicious and eaten raw as wholesome food contains proportionate amount of carbohydrate, protein and fat. After drying the endosperm is shredded and consumed after mixing with other dried fruits. The dried endosperm when it separates out of the hard endocarp or the shell is called copra. The copra is the raw material for extraction of coconut oil (Fig 2 H) which is largely used as cooking medium, hair oil, and for making good quality bath soap, shampoo, shaving creams etc. Coconut oil cake is an excellent animal feed. The sweet sap extracted from the peduncle is made into brown sugar or jaggery or for brewing into wine or vinegar. Tender coconut water is a refreshing drink and 120 ml of tender coconut water contains 93.9

Plate 1: A. Palmyra palm (*Borassus flasbellifer* L), tapping of sap from the peduncle; B. Sweet "Patali"made from Palmyra sap; C. Hand fan made from leaf of palmyra palm; D. Talsas; E. Fancy items made from palmyra leaf; F. Kosha Kushi copper replica of Areca palms prophyll and bract; G. Arecaq nut in local market for sale; H. Areca nut tree.

gm of water, 5.9 gm of carbohydrate, 10 mg of calcium, 0.1 mg of iron, 0.01 mg of vitamin B1,2 mg of vitamin C, 0.14% protein, 0.13% fat and very high percentage of potassium and sodium (Basu 2012). Tender coconut water acts as diuretic and can be used in any type of fever. It is a cleanser of the kidneys and gall bladder. However, person suffering from kidney disorder should not drink tender coconut water due to the presence of sodium and potassium salts. Green coconut water with good amount of salt and vitamins act as relieving agent against indigestion. Highly sterilized in nature, coconut water is used as useful additive in preparing tissue culture medium. It was reported that coconut water was used as an emergency short term intravenous hydration fluid to the injured soldiers during the Second World War by the army doctors in the war zone. This was possible because highly sterilized coconut water has a high level of sugar and salt that made it possible for use in the blood stream, much like dextrose water solution. Root, bark, flowers and leaf charcoal of coconut also have medicinal properties. The soft downy substance from the lower surface of the leaf is used as haemostatic. The astringent roots are used for curing dysentery and other intestinal ailments. It was observed in some remote villages of South 24 Parganas in West Bengal and also in Assam that old village women were putting a kind of black powder they called it as *"gul"* between their lower lip and tooth. On enquiry it was known that the black powder contained coconut leaf charcoal mixed with tobacco dust. Coconut leaves are used for making brooms. Leaves are stripped away leaving the veins tied together to form a broom (Fig 2 F). Leaves provide materials for baskets, roofing thatch and woven into mats. Coconut shell is used for making *Hookka* an improvised apparatus for smoking tobacco (Fig 2 J). Shirt buttons are also curved from hard shell of coconut. It is also used for making eco friendly spoon and bowl. Top grade activated charcoal is made from burning coconut shell. Coconut timber comes from the trunk; and is increasingly being used as ecologically sound substitute for hardwoods. In Hindu wedding ceremony, a coconut is placed over the opening of the earthen pot representing a womb (Fig G). Hindus often initiate the beginning of any new activity by breaking a coconut to ensure the blessing of God and successful completion of the activity. The roots of coconut palm are used as dye, a mouth wash, and a medicine for dysentery. The shredded piece of root is used by the village folks as a tooth brush.

***Areca catechu* L.** popularly known as Betel nut palm is one of the most widely cultivated economic palms. The most useful parts of the plant are the fruit and seed. The hard seed contains several alkaloids of medicinal values. The hard seed is largely chewed as masticator along with betel leaf (Fig 1 G). In the Indian Subcontinent the chewing of betel leaf and areca nut dates back to the pre Vedic period Harappan Empire. Formerly in India and Sri Lanka it was a custom of the royalty to chew areca nut and betel leaf. Kings had special attendants carrying a box with ingredients for good chewing session. There was also a custom to chew areca nut and betel leaf among lovers because of its breath freshening and relaxant properties. There was also a sexual symbolism attached to the chewing of nut and leaf. The areca nut represented the male and the betel leaf the female. It is also considered an auspicious ingredient in Hinduism therefore the nut is still used along with betel leaf in the religious ceremonies or in *puja*. The shape of two copper utensils named *Kosha* and *kushi* used during *puja* suggest to the shape of prophyll and bract of *Areca catechu* inflorescence (Fig 1 F). The Khasi tribal, old or young, consume fermented endosperm of the nut along with betel leaf and lime for warming up of the body. It is also considered as week narcotic. Dried immature nut is chewed by the local people in Darjeeling hill for warming up of the body during severe cold. In Assam it is a tradition to offer *Pan-tamul* (Betel leaves and raw areca nut) to guests after tea or meals in a brass plate with stand called *Bota* or *Bata* in Bengali. Among the Assamese the areca nut also has a variety of uses during religious and marriage ceremonies, where it has the role of a fertility symbol. A tradition of upper Assam is to invite guests to wedding reception by offering a few areca nut with betel leaves by each household while their blessings are solicited. Areca nut is aromatic and known to intoxicate when first taken. The younger generation now both in the cities and suburbs rarely chews the betel nuts. Most of the present day consumption is confined to older and

Plate 2: A. Collection of sap from Date palm *(Phoenix sylvestris)*; B. Sap collector (Sewli); C. Jaggery is made after boiling of sap; D. Broom made from shredded date palm leaves; E. Tribal children playing on mat made of date palm leaves; F. Village women selling basket and brooms made of coconut leaves; G. Uses of green coconut in ritual (Saraswati Puja); H. Copra and coconut oil; I. Hokka made of coconut shell.

working class people. Bavappa *et al.* (1982) mentioned medicinal uses of areca nut palm, such as treatment of leucoderma, leprosy, cough, fits, worms, anemia and obesity. It is also used as a purgative and in ointment, along with several other ingredients for treatment of nasal ulcers. Areca nut tastes pungent, spicy, bitter as well as sweet; it has the properties to expel gas, to remove phlegm and bad odor. Powdered seed is anthelmintic due to presence of alkaloid arecoline, tannin and gallic acid. The young shoot causes abortion during early pregnancy. The pressed juice of the pericarp is applied for treating the injury caused by spider bite or honey bees. In Ayurvedic medicine, the nut is used in the treatment of headaches, fever, rheumatism and good remedy against bad breath. Apart from medicinal and several other uses young pot grown *Areca catechu* is also used as an interior landscape palm. It is often used in large indoor areas such as malls and hotels. While grown indoor in pot it is slow growing and won't fruit or reach full size to become non accommodative in the indoor environment. *Areca triandra* Roxb. and *Areca nagensis* Griff. are the two species very similar in appearance; their nuts are chewed like areca nut in Naga land and Manipore. The former species is suckering palm of low height and grown as ornamental palm in the gardens. It is versatile in appearance that form dense clump of slender and pale green stem. The deep green pinnate *leaves* are very ornamental and easy to cultivate in any site around the garden where shade and water is available.

***Arenga pinnata* (Wurmb.) Merr.** commonly known as sugar palm is one of the most useful semi wild palms of South East Asian region. It has a distribution in the North East India along with other palm species of this genus. Almost all parts of the plant are useful in one form or other. Its importance as an economic palm crop was felt much earlier by Dr William Roxburgh, father of Indian Botany in 1819, he wrote "I cannot avoid recommending (it) to everyone who possesses land near the coast of India to extend cultivation, thereof as possible". It is most unfortunate that this species, of all tropical crops should have been given greater consideration, for it is easily managed and certainly inexpensive to cultivate. This species is very well cultivated on a pan tropical scale in the moist areas as an additional plantation crops and have potential to be added to the minor economy of many undeveloped rural areas. With proper management it might very well prove to be very highly profitable plant. Although its products are of diminishing importance to the sophisticated people but possess its utility as eco friendly materials. To many rural people of Indo Malayan region, the sugar palm is of primary importance as food supply source, dessert, sweetening agent, medicine and beverage. Miller (1964) recorded in details the ethno botanical information of this useful palm species.

The terminal bud or "cabbage" of *Arenga pinnata* is edible and highly prized for salad whether raw or cooked. However removal of bud terminates the life of the palm. The very young etiolated leaves and petiole and the pith of the young stem, are occasionally eaten in soup. They are said to be relished as a pickled preserve by the rural people of Manipur in North East India. In Malaya the inedible fruit of sugar palm is called *buah batu* , in Bali it is called as *bilulu*, in Java *asa tja rubuk*. The Indonesians commonly prepare a favorite comfiture called *tjang-kaling* from the white more or less cartilaginous slippery immature endosperm of sugar palm.

The half ripened fruits of *Arenga pinnata* are burnt to facilitate removal of the innumerable and exceedingly irritating crystals from the pericarp. After the seeds are washed and the seed coat removed, the endosperm is soaked in lime water for several days. Finally it is boiled or steeped in various sugary spicy solutions that impart flavor to its natural insipidness. It is then eat as a type of sweetmeat. In Java or elsewhere the trees when no longer productive for sugar tapping are felled and cut into short sections or the bole may be split lengthwise, pith is scooped out with the help of a wooden mallet to obtain starchy sago. The pith contains a mass of woody fibrous materials and other impurities. The starch in suspension is drawn of into a wooden or earthen settling tank. After several changes of water and further settling and separation from debris sago starch is recovered and allowed to dry in sun. About 75 kg of edible starch is available from the trunk of a mature tree and the hollowed trunk is used as water pipe. (Johnson 1991). Yield of starch decrease

Plate 3: A. Cane furniture. B. Umbrell handle/walking sticks made of cane; C. Use of cane in rituals. (Kunke made of *Calamus tenuis*). C/1. Split cane woven in cot and chair; D. Naga tribal displaying their cane products; E. Ornaments (Necklace) made of split cane.

after several years of tapping for sugar. The fresh sap of *Arenga pinnata* is sweet and may be drunk in fresh state like fresh sap of *Phoenix saylvestris* or *Borassus flabellifer* palms. With little fermentation the sap is transformed into mild wine. One liter of sap under proper oxidation may yield as much as one liters of four percent vinegar. *Arenga pinnata* is a monoecious palm with irregular flowering habit. Variability exists between the relative ages of this palm upon reaching maturity. Some trees may be tapped when five to six years of age, but the average appears to be around 10-12 years (Miller 1964).There is also much variability in the yield from individual male inflorescences. The female inflorescence contains comparatively little sap for tapping. When the male flowers begin to shed their pollen, the peduncle has usually reached its greatest stage of elongation. The approximate period between the openings of the male bracts and the start of tapping operation is about 70 days. The heavy male inflorescence is tied to a higher leaf for support when the entire peduncle is pounded lightly all round with a stick for several minutes every day for 2-3 weeks. The inflorescence will then be severed only at its immediate base without disturbing the remaining peduncle before tapping the peduncle again. Sometimes the cut end of the peduncle is rubbed with chili powder then covered with banana leaf for several days until the sap flows freely. The sap tends to drip freely and profusely and is collected in the vessel attached with the cut end of the peduncle inserted into the mouth of the vessel. Collection is usually made twice daily, once in the morning and in the afternoon, each time a thin slice is removed from the peduncle. The maximum flow per individual peduncle is reached within the first 3 weeks of tapping and flow may continue for -10 weeks or more. A 20 years old sugar palm was reported to have yielded as much as 15 liters of sweet sap per eight hours period. The average yield ranges between 3-6 liters per day from a single peduncle (Blatter 1926). The black leaf sheath fiber is water resistant and known as "gomuti fiber "earlier used for tying boats. The extract from the root of sugar palm is used as medicine for kidney stone. It is supposed to hasten the dissolution of the stone. The fermented sap is utilized for its curative properties against tuberculosis and as preventive against dysentery as well as chronic constipation.

Caryota urens* L.** and ***Caryota obtusa Griff. are the two palms that are found in the cool upland area and in the sheltered valleys of north eastern India. The former species is also found in the peninsular India and Andaman and Nicobar Islands. The leaf sheath fiber has multifarious uses for making ropes; brushes etc. Strong petiole and rachis of the leaf have local uses for making handle for brushes. These are all made by the village artisans and are found in the local village markets. The pith of these palms yield starch which is considered almost equal in quality of the starch obtained from Indonesian sago palm *Metroxylon sagu.* The palm cabbage is edible and consumed after cooking as vegetable, the root bark is used for treatment of rheumatic swelling and snake bite poisoning. The fresh root is also used for treating tooth ailments and is burnt; the charcoal obtained is used for cleaning metal objects. The local people use tender flower paste for promoting the growth of lustrous hair. *Caryota urens* is known locally as *kittul* palm, when it start flowering by the emergence of inflorescence the peduncle is severed and from the cut end of the peduncle yields plentiful supply of sweet sap until the peduncle gets dried up. A tree produces huge quantity of sweet sap from the subsequently developed inflorescences for a period of 4-7 years until the tree dies. The fermented sap contains enough vitamins and protein. According to the local custom of the Gonda tribe each male member of the family should grow a *kittul* palm for his own consumption of fermented sap. According to the local system son should not touch or draw sweet sap from the tree planted by his father. This practice indirectly helps to maintain the semi wild population of *Caryota urens.* Karbis of Assam and Mikir tribes uses the seed as masticator.

Borassus flabellifer L. widely known as Palmyra Palm is particularly associated with the Tamils of South India, who have found extensive uses of it since ancient times. The main use of this palm is in making jaggery or fermented into toddy. Numerous village level artisans are thriving on this jaggery making industry. In Palmyra palm sweet sap is collected by cutting off the upper part of the peduncle, (Fig 1 A) therefore the tapping season commences with the flowering season from February to July. In order to obtain the maximum quantity of

sap, tapers must possess a high degree of technical skill for the delicate operation involved; as well have the physical strength and agility to climb tall Palmyra palms. Apart from sap, fruit of Palmyra palm is edible. If the female Palmyra palm is not tapped and allowed to bear fruits, the immature fruits possess a jelly like sweet delicacy known locally as *talsas* and have a large local market (Fig 1 D). The local people used to bury the mature seeds in raised mound just to allow them to germinate; the primary shoot developed is consumed as vegetable. The fibrous coating of the seed in ripe fruits consist of a sweet pasty material, which after collecting and straining, is made into a dough by combining it with grated coconut, wheat flour, rice flour and palm *gur*. The dough is formed into small ball which are either rolled and fried as pancake or fried as they are. This preparation is a must to all Hindu families in the eastern part of India particularly in Bengal on the birth day of Lord Krishna. The leaf base of Palmyra palm yields high quality fibers for industrial purposes. About 80% of this raw fibre is exported to Japan and the western countries and a good earning for India (Davis 1985). The other parts of the tree are also useful. Mature stem is hard and termite resistant and durable. Beams made from mature stem are in great demand in rural areas as roof support. A 75 year old tree when felled brings the owner about 5000 rupees. Therefore used in the village for making roof beams of thatched and semi permanent masonry houses. Stem pieces are also used as fuel wood in brick kilns. A study by Davis and Johnson (1987) states that Palmyra palm has suddenly become vulnerable to rapid destruction due to over utilization of the stem for brick kilns. Unopened leaves are collected from the semi wild palms. These leaves are soft therefore used for making baskets and various other fancy handicrafts. Leaf blade is separated from the midrib and cut into two halves with the help of hatchets. The middle parts are separated from the midrib boiled and soften then dyed red, blue or pink then dried to make different fancy items (Fig 1 E). Mature leaves are cut and made into hand fans (Fig 1 C) which have great demand as household item. The excessive cutting of both tender and mature leaves from the crown for different uses make the trees unhealthy and these defoliated Palmyra palms die in large number as they cannot withstand draught. Palmyra toddy apart from other uses is considered beneficial for inflammatory ailments, and dropsy. It is diuretic and is prescribed for chronic gonorrhea and amoebiasis. A toddy poultice prepared from unfermented fresh toddy and rice flour is a stimulant application on ulcers. The potash from the ash of the flower with sugar cane molasses is given for enlarged spleen. The palm candy is a good relieving agent against cough and cold. To the rural poor Palmyra palm is a source of cheap medicine.

The genus *Phoenix* L. is one of the larger members in the Palm family, most popular in terms of its usefulness to humankind and of commercial and local importance. Phoenix means a person or thing of unsurpassed beauty or excellence. Some species of this genus are most popular for landscape use as they are hardy adaptable palms growing in many varied climates from extreme tropics, to the arid desert and even in the cooler subtropical and temperate climates throughout the world. *Phoenix sylvestris* (L) Roxb. is one of the most useful semi wild to wild palms in India. Freshly obtained sap of this semi wild date palm is clear as water having 12-15% sugar and is delicious drink rich in vitamins. Application of lime in the collecting pot delays the fermentation of the sap. When sweet sap is boiled thick syrup (Fig2 C) is obtained which is consumed in various ways. After sufficient boiling, sweet sap condenses into palm sugar blocks known in local language as *Patali*. This *patali* is at the present market rate is about Rs200.00 per kg, more expensive than refined cane sugar. On an average a full grown *Phoenix sylvestris* tree in one season from November to February yields sufficient quantity of sap, which after boiling, produces about 40 kg of *patali* at present rate valued about Rupees 8000/- depending on flavors (Basu 2012). For collecting and processing of sugary sap, and for marketing the end product, several village level artisans and traders are involved who earn their livelihood solely by the utilization of this very common semi wild palm. The tappers of *Phoenix* palms are locally called as "Sewli." (Fig 2 & B). Sap tapping from a date palm is a risky job, now a day's young villagers are not get tempted to work as Sewli as a result sap collection is getting reduced during tapping season. In West Bengal, Basirhat and Taki of North 24

Paraganas are well known for production of best quality patali. Immature leaves of *Phoenix sylvestris* are used for making baskets, brooms and floor mats. At present, stems of felled sugar date palms are used as fuel to fire the earthen pots and tiles. Several tile manufacturing unit in eastern India using logs of *Phoenix sylvestris* in their furnaces as the cost of coal is higher. It is doubtful how long these kiln owners will be able to get the logs of this semi wild palm at a cheaper rate than coal unless the tree owners are tempted to sell their productive trees at a time of distress. Fruits of *Phoenix sylvestris* are edible although the pulp is thinner than Arabian dates these are consumed by the locals that contain good quantity of protein, fatty acid, carbohydrate, enzymes, minerals, calcium and phosphorus. The fruit extract is rich in vitamin B and Vitamin C and contains about 85 % sugar. The root of this palm is a good analgesic due to its heavy properties. It is very effective in nervous disorders due to its sweet taste. It is also a good aphrodisiac agent as it is cold in potency. Root powder is very effective in strengthening the nervous system. It relieves from pain and also relieves from respiratory disorder. It helps in improving the general health condition. It also relieves from fever. *Phoenix acaulis* Buch.-Ham. ex Roxb. and *Phoenix loureirii* Kunth are useful for their leaves and stems. Leaves of both palms are used by the villagers for making baskets and brooms (Fig 2 D). The price of brooms made of leaves of *Phoenix loureirii* in local market in Shillong and other places is about Rs 10 or more depending on the size. *Phoenix rupicola* T. Anders. or the cliff date palm grows in the mountainous forests of North East India is gradually losing its natural habitats. It is the canopy of leaves that sets its identity among all other *Phoenix* species. The leaves which grow to about 3.1 m long are bright green in color and the leaflets are arranged in one plane on the midrib or the rachis of the leaf which give the leaf a flat in appearance. This combine with leave's unique, natural curving, arching and twisting results in a very graceful form of the palm. Due to its soft non spiny leaves it has become a potent landscape material in big gardens. Upper part of the stem , the cabbage portion, is edible and consumed by the local people as vegetable.

Licuala peltata Roxb., has great demand to the local people of Manipur, Mizoram and Tripura and in Bangladesh for the use of its large orbicular leaves as rain hats. Split lamina is used for making baskets, mats etc. Over exploitation of leaves and stem of this single stemmed palm is one of the causes of its depletion in the wild. Fresh nut of *Livistona jenkinsiana* Griff. is used by the Mikir tribes as masticator. Leaves are in universal use throughout Assam and Arunachal Pradesh for covering the top of the huts and roof of the boat and also for making rain hats. Singh *et al.* (2010) studied the biology and utilization of this palm of North East India and Arunachal Pradesh in particular. According to them a number of products are made of *Livistona jenkinsiana* palm, particularly its leaves and fruits which has great cultural, food and livelihoods values for Adi tribe of Arunachal Pradesh. Leaves chiefly used as thatch, for covering the roof of their huts, *doolies,* and boat, also for making baskets and hand fans. The leaves are an integral part of using them to pack meat of wild boars during special occasion (Singh *et al.* l.c.). Petioles are used for making mats, midrib of the leaflets are stripped of and tied collectively to make as brooms. Leaf sheath fibers are strong and durable therefore local tribal make ropes. It is also reported that soft shoot (Cabbage) is also eaten as vegetable (l.c.). Pericarp of ripe fruits is also edible. Seed also contains good amount of oil in its kernel and a potential source of commercial oil production where this palm is largely cultivated in North East India. Among other semi wild palms, *Arenga westerehoutii* Griff. have multifarious uses.

Canes are recognized as one of the most useful forest product in India. From utility point of view, their position is next to timber and possibly equal to that of bamboo (Basu 1985). The tribal people of North East India make extensive use of long canes of *Plectocomia* and *Daemonorops* for making cane bridges. Split strings from the slender canes are used as cordage and dragline for catching fishes. Strong but slender canes are used for making bows and arrows. Large leaves as thatch. A section of 3 m long cane, when cut and held vertically, yields sap that trickles down the cut end. A 2 m long piece of *Plectocomia himalayana* Griff. provides enough potable water to quench the thirst of four workers in dry season Basu (1992). Canes play an important role in the rural economy employing many people

in the remote areas, who earn their livelihood through extraction of canes, cleaning and processing. In Arunachal Pradesh strong and long canes of *Plectocomia assamica* Griff., are used for hanging cane bridges over streams and rivers. Urban people are employed in the small scale industries and cottage industries manufacturing cane furniture and other articles. The thick canes are used for making furniture frames, walking sticks, police sticks, umbrella handles and batons (Fig 3. A, B, C,). Thinner once are used for making baskets a large number of which are used in tea gardens and the rough ones are used in the railways and collieries. Split canes are largely used for making seats and backs of chairs, lamp shade and many other fancy items. Medicinal uses of canes have been reported. It is stated that the roots of *Calamus rotang* L in combination with other herbs are useful against snake bite or sting of scorpion. The root is also useful for its antidysenteric, antibilous, tonic, febrifuge and depuration properties Basu (1992). Fruits of *Calamus longisetus* Griff., and *Calamus tenuis* Roxb. are edible, seeds are chewed as masticator.

Canes in traditional life styles and religious practices

Now a day's ornaments made of split cane have become popular to young women in the rural areas especially in the Eastern and North Eastern India (Fig. 3E). Some species of canes are used in tribal rituals and festivals. To Bengali Hindus, a small specially designed container made of Pani Bet (*Calamus tenuis*) known as "Kunke" when filled with newly harvested paddy symbolizes Lakhsmi, the Goddes of prosperity. In each harvesting season in Bengal known as "Nabanya", the Kunke is filled with fresh paddy replacing the previous year's collection and after wrapping with new cloth, it is worshipped.

During the marriage ceremonies of Hindus in West Bengal, the Bridegroom puts a little vermilion on the Kunke first then the vermilion attached to the side of the Kunke is put on the forehead of the bride to signify that she is now his wife (Fig. 3A). Canes are also used for making the frame works clay images of Hindu God and Goddesses, but at present due to the high cost of canes, frame works are made with split bamboos as substitute of cane. Ethno botanical studies of Palms in India is yet to take shape and may probably get the foot hold on this rapidly expanding subject in future when ethno botanical uses of Indian palms will eventually become better known. According to our present estimate about 18 species of *Calamus*, one species of *Daemonorops* and 2 species of *Plectocomia* have different kinds of uses.

Extraction of canes from the forest is a laborious process. Shorter length canes are pulled down by hand but for collecting longer canes these are to be separated from the supporting trees with the help of a tree climber to avoid damage to the middle and upper part of the cane as the lower most part of the cane is useless. The soft upper most part of the cane is also discarded because these are not suitable for making furniture frames. Canes are ready for extraction when the leaf sheath becomes detached from the stem. After harvesting leaf sheaths are removed and the entire cane is cut into 4 meter long billets which are tied together and kept in the erect position for drying.

The use of canes in India is spreading and there is no dearth of consumer demand in spite of several substitutes for cane products having come into the market.

There are several other indigenous palm species which have limited local uses. There is scope of further studies on the local and ethnic uses of palms in India. For this extensive field and documentation work is necessary. ..

Acknowledgment

It was Dr. S. K. Jain, FNA former Director of Botanical Survey of India who thought for a study on the ethnic uses of indigenous palms, which was not properly documented earlier and wanted the senior author to undertake a study on it. This initial study is therefore an outcome of respected Dr. S. K. Jain's wishes. Part of this study was conducted with the financial support from the DOEN, Govt. of India project on palms and canes of North East India. Thanks are due to the Joint Director, Indian Botanic Garden, Botanical Survey of India, Howrah, Secretary CEO of the AHSI for providing facilities of the respective gardens for undertaking this study.

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ANNOUNCEMENT

The APT and SEB both are registered scientific societies. The APT is availing 80G benefit under Income Tax Act; SEB has also availed this. It requires some charitable work for the society. Hence it is announced that for both APT and SEB, life membership fees from taxonomists and ethnobotanists, who are cancer patients and physically challenged/ handicapped (as certified by concerned authorities) will be condoned w.e.f March 2014. No life membership fees will be charged from such members. It is being duly notified for information to all members.

Notification for Best Ph.D. Thesis Award in Angiosperm Taxonomy

Association for Plant Taxonomy (APT) invites nominations for **'Dr B V Shetty Award'** for best Ph.D. thesis in Angiosperm Taxonomy (Floristics, Revisionary Work) from Indian candidates whose duration of award (Date of notification) of Ph.D. degree would be between 1.08.2015 – 31.07.2016 from any UGC approved university. The application duly forwarded by supervisor/ Head of the Dept. must reach on or before 31.08.2016. For details contact:

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(E-mail: veenachandra007@sify.com)

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Observation on Genus *Licuala* Thunberg (Palmae, Arecaceae) in India

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The genus *Licuala* Thunb. of family Palmae (Arecaceae) comprises about 108 species with a distribution range in the eastern tropics. In India only three species *viz. Licuala peltata, Licuala paludosa* and *Licuala spinosa* have been recorded so far from the main land and insular region in Andaman. *Licuala grandis* a native palm of Vanuatu was introduced long ago and now widely cultivated as ornamental palm. A detail taxonomic account of the above mentioned four species is presented here.

Key Word: Genus *Licuala* Thunb.; India

Introduction:

The genus *Licuala* belongs to the Subfamily Coryphoideae of the family Palmae, comprising of about 108 species (Uhl and Dransfield 1987) with distribution range from India to South China, South East Asia to Malesia, Queensland and the Solomon Island in the Pacific. Species diversity is mostly encountered in Malaya, Borneo and New Guinea. Most of the species grow as understory plants, either single stemmed or in clusters and gregarious in formation. Some species are seen in the estuarine regions and tolerant to partial salinity as seen in case of *Licuala spinosa* which is the most wide spread species. *Licuala grandis* a native palm of Vanuatu (New Hebrides) is cultivated as ornamental palm throughout the tropical world. In India it is one of the most popular exotic ornamental palms grown in the gardens or as potted house plants. Gage (1912) first recorded this species in cultivation in the Royal Botanic Garden, Calcutta, (Indian Botanic Garden, Howrah) and now named as AJC Bose Botanic Garden, Howrah. Becc. and Hook.f (1832) in the flora of British India volume 6, recorded 14 species of *Licuala* out of which only three species were recorded from the present geographical regions of India. These species are *Licuala peltata*, *Licuala paludosa* and *Licuala spinosa*. *Licuala peltata* has a very interesting distribution both in the mainland of India and Andaman Islands, Bangladesh and in Myanmar. *Licuala spinosa* and *Licuala paludosa* both are insular species have no natural distribution in the Indian mainland but cultivated in the some big gardens for botanical and horticultural interests.

Licuala peltata is one of the most beautiful fan leaved palms in the Indian flora. In the main land of India, its major distribution areas are located in the different states of North East India. It has a very scanty distribution in Saranda forest of Jharkhand. Parkinson (1924) wrote that extensive local use of leaves known as Selai pathi or mota pathi and stems for making thatched houses had reduced its population in some of the islands of the Andaman Islands. This magnificent palm was not found in the Port Blair region. Das (1983) mentioned that people of Chittagong Hill tracts extensively use the leaves of *Licuala peltata* for stuffing rain hats, known locally as Jumai or Mathi. He also reported that due to shortage of leaves the local people were compelled to use substitute for protecting them from rains. Natural habitat of *Licuala peltata* is normally under the canopy of large trees on moist forest floor. From the North Eastern States no report was available regarding its present population density in the forests although it was recorded in the Red Data Book of Indian Plants as one among the endangered plant of North East Indian Flora. Efforts were made to bring this beautiful fan leaved palm into cultivation. As this species is a single stemmed palm, the only possible method of propagation is by seed germination. At AJC Bose Garden, Howrah, (former Indian Botanic Garden) a specimen plant exists in the Large Palm House (Basu 1979). Seed setting never occurred in that plant in cultivation therefore propagation of this species was not possible in the above mentioned botanic garden. The Agri Horticultural Society of India has successfully introduced *Licuala peltata* in their garden from seeds collected from the wild source (Basu & Mondal 2012). After

some barren season, this beautiful palm is now setting fruits in the AHSI garden. The percentage of viable seeds is low at present.

Licuala spinosa and *Licuala paludosa* under natural condition are found as swamp coastal flora or along the edge of large water bodies. These two species are cluster forming and form huge colony of several upright slender stems and a very attractive crown of orbicular leaves. *Licuala spinosa* in cultivation grows luxuriantly in moist shady places even along the edges of lakes and ponds. In the AJC Bose Botanic garden there are several colonies of this species growing in the open in the Palmetum. *Licuala paludosa* is not popular in cultivation. Both the species were introduced in the above mentioned botanic garden at the beginning of the nineteenth century. Griffith (1845) recorded both *Licuala spinosa* and *Licuala paludosa* from the Company's botanic garden in Howrah (now AJC Bose Botanic Garden).Both the species are fertile in cultivation and produce fertile seeds in large quantity. Among exotic species, *Licuala grandis* of Vanuatu is characteristic for its undivided glossy palmate leaves and huge bunch of cherry red fruits during fruiting season. It prefers to grow under the shade. All the indigenous species are characterized by their orbicular and deeply segmented palmate leaf blade and long slender petiole.

LICUALA

Thunberg, Kongliga vetenskaps Acadamiens Nya Handlingar 3:286. 1782. Becc. & Hook.f. Fl. Brit. Ind. 6: 430. 1832. Beccari in Ann. Roy. Bot. Gard. Calcutta 13: 1-231, 1931. Furtado in Gard. Bull. Strait settlement 11:. 378-403. 1940. Uhl & Dransfield General Palmarum 1987. Basu &Chakraverty in Manual of Cultivated Palms in India. Pp.40. 1994. *Pericycla* Blume,; Rumphia 2:47. 1838 ("1836").

Solitary or cluster forming monoecious palm, dwarf to intermediate in height. Stem slender, erect or inclined; aerial part of the stem annulate. Leaves palmate, persistent after drying; leafsheath with fibrous or netlike outgrowths; petiole slender, mostly strongly dented along margins; hastula conspicuous on adaxial side; leafblade orbicular, entire or deeply divided along the abaxial rib to form single to multifolded segments apical part of the leaflets bifid at apex. Inflorescence interfoliar, pleonanthic, monoecious, shorter or longer than leaves; prophyll bicarinate; peduncle and axis of inflorescence covered with tubular bracts; fertile part of inflorescence with a spicate rachilla on each node or with much ramified flower branches ending in rachillae. Flowers solitary or in groups, sessile or pedicellate, bracteates. Calyx cupular, 3 fid; corolla longer than calyx, 3 lobed, hairy outside; stamens 6 epipetalous; filaments flattened, connate at base to from a cup with 6 projections, each bearing an anther. Ovary 3 carpellate, nearly free; 1 ovule in each carpel. Fruit globose, ovoid; endocarp crustaceous; seed basally attached; endosperm homogeneous.

Tomlinson (1961) pointed out a characteristic anatomical feature in the leaves by the presence of transverse fiber sclereid in the mesophyll tissue. The structure of fibrous and matty bracts on the inflorescence axis is sheath like and thin but firmly attached to the main axis. In all the indigenous species of *Licuala*, the fibre skeleton is composed of N.V.F. bundles which are circular to oval in cross section and made of solid septate cells. The bundles are lined below the epidermis and closely knit. The vascular bundles are also characteristically sheathed on the adaxial side. As the bracts are not sufficiently thick, the accumulation of fibre near the surface causes shredding of the entire bract from the margin.

Disrtibution: About 108 species; only three species have natural distribution in India (West Bengal, Jharkhand, Sikkim, North East India, Andaman and Nicobar Islands) and the exotic species (*Licuala grandis*) is extensively cultivated as ornamental palm.

Key to the Species

1a. Stem solitary.....2

1b. Stem clusterforming.....3

2a. Leaf blade orbicular, very large, deeply segmented, segment 16 in number. Inflorescence erect from the leafaxis much longer than leaves. Flower branches (rachillae) solitary from node, pendulous.....*peltata*

2b. Leaf blade rotundate, undivided. Inflorescence as long as leaves, paniculately branched .....*grandis*

3a. Leaf blade orbicular, deeply segmented, petiole armed with small conical spines.....*paludosa*

3b. Leaf blade orbicular, deeply segmented, petiole with distinct angular spines..... *spinosa*

Plate 1

Fig. 1 Leaf of *Licuala paludosa*

Fig. 2 Leaf of *Licuala spinosa*

Fig. 3 Leaf of *Licuala grandis*

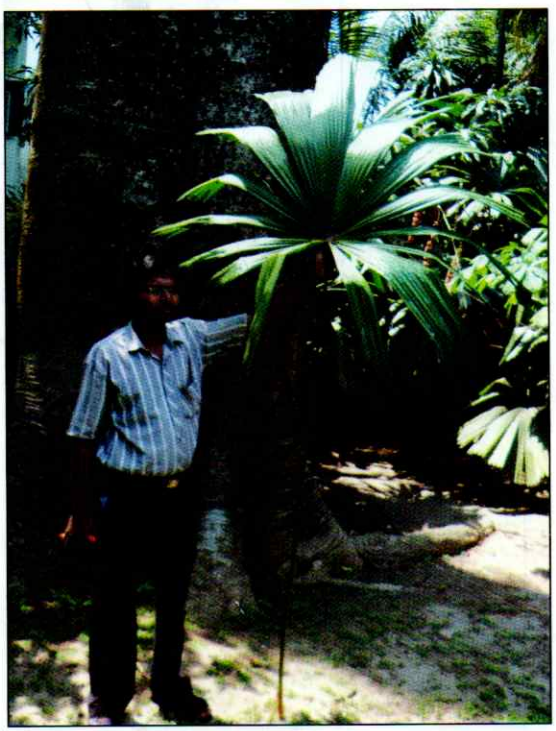

Fig. 4 Leaf of *Licuala peltata*

Plate 2

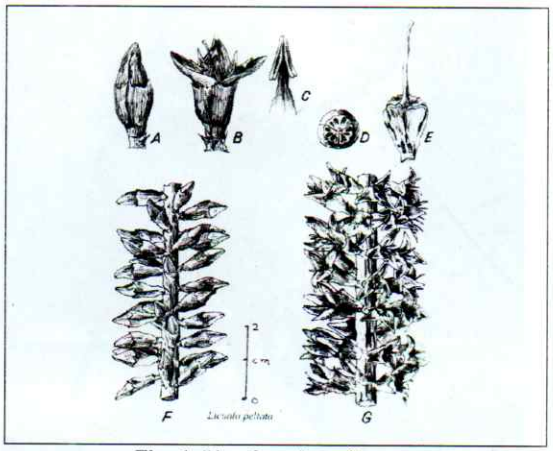

Fig. 1 *Licuala peltata* flowers

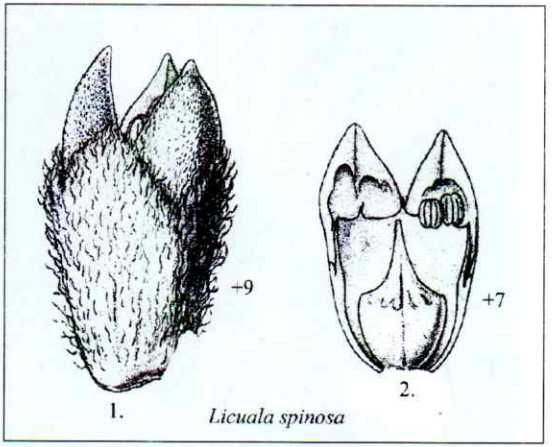

Fig. 2 *Licuala spinosa* flower

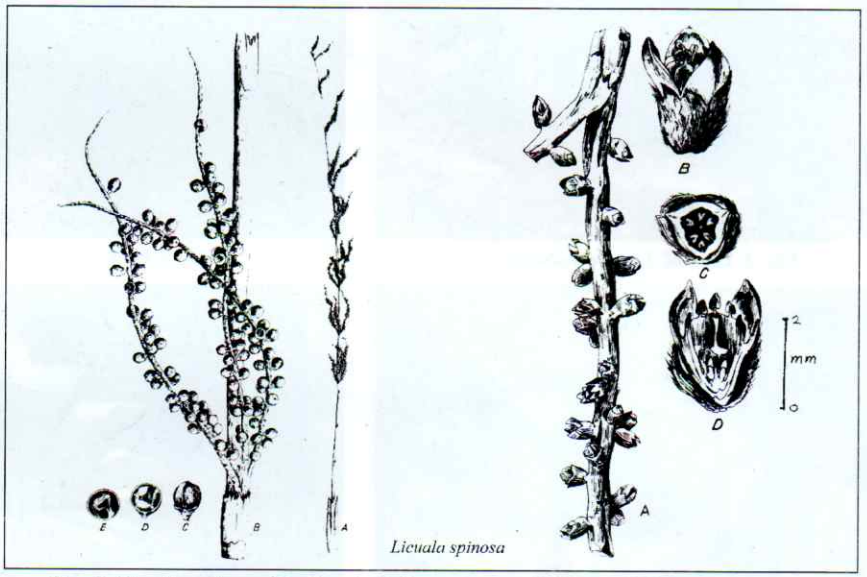

Fig. 3 *Licuala spinosa* (Portion in inflorescence and dissected flowers)

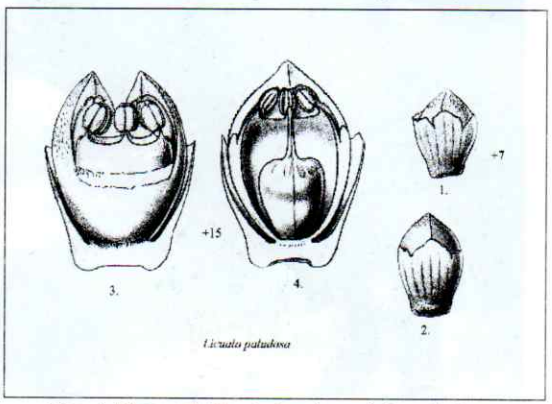

Fig. 4 Dissected floral drawing of *L. paludosa*.

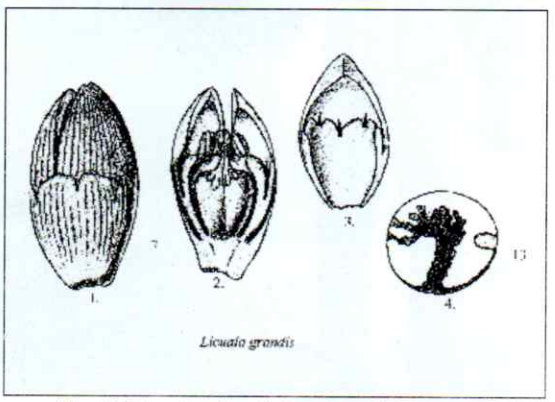

Fig. 5 Dissected floral drawing of *L. grandis*

Plate 3

Fig. A *Licuala grandis* with fruits

Fig. B *Licuala peltata* with fruiting spadix

Fig. C Petiole with hastula of various species of Licuala

1. Petiole with hastula of *Licuala paludosa* (spineless upper part of petiole); 2. Petiole with hastula of *Licuala spinosa* (spines all along the petiole); 3. Petiole of *Licuala peltata* (strong spines on petiole)

Licuala paludosa Griff. Calcutta J. Nat. Hist. 5: 323 (1844). Basu & Chakraverty in Manual of Cultivated Palms in India .42.1994.

Common Name: Swamp fan palm

Description: A clusterforming fanleaved palm. Stem 2.5-4 m long, 3-4 cm in diameter at middle, unarmed, more or less smooth. Leaf blade orbicular, 7-9 partite,about a meter long, spreading to all direction; petiole slender, to 50 cm long, subtrigonous, armed along margins, except towards upper part, with small, black, shortly conical curved teeth; segments cuneate, lateral ones oblique, acutely 2-3 lobes at apices, other more or less truncate with 4 broad, bifid lobes; hastula linear, 2 cm long, gradually attenuate at apex. Inflorescence interfoliar, stout, with about 8 spreading branches; peduncular and rachis bracts broad, lacerate at mouth. Flowers bisexual, sessile, glabrous, minute; calyx cup shaped 2 mm broad; petals very short, ovate. Fruit globose 5-6 mm in diameter.

Distribution: India (Andaman Islands), Malaya Peninsula, Thailand

Note: This species is close to *Licuala spinosa* in shape but differs from *L. spinosa* by its smooth prominently ringed stem and slender petiole, less spiny along the margins on upper part. Flowers are also small and turbinate.

Cultivation: In cultivation, this species is mostly confused with *L. spinosa.* It prefers to grow in moist shady areas.

Licuala peltata Roxb. ex Buch-Ham. in Mem. Wern. Soc. 5: 313. 1826. (1824). Griff. In Calc. Journ. Nat Hist. 5: 325. 1845. Becc. in Hook.f. Fl. Brit. Ind. 6: 430. 1892. Basu and Chakraverty in Manual of Cultivated Palms in India 42. 1994.

Common Name: Salai pathy, mota pathi

Description: Stem solitary, erect, 2-3 m long, slender, to 15 cm in diameter near base, with persistent leaf bases on upper part of the stem. Leaf blade palmate, orbicular, 12 to 30 partite, to 1.5 m in diameter; segments variously connate, many toothed at margins; teeth 2cm to4cm, very versatile in length and breadth, obtusely 2 fid. Petiole strongly armed with curved spines from base to upper portion, 1.2 m or more long, plano comvex in cross section. Inflorescence with long stout peduncle, flattened at base, erect from the leaf axil, much longer than leaves, peduncle long , stout; primary axis cane like, covered with series of 15-30 cm long leathery bracts, each scurfy outside. Flower solitary from node, pendulous, axillary to fertile bracts, to 40 cm long; sterile base of flower branches adnate at its base to primary axis, thickly tomentose out side. Flowers solitary, in loose spirals, pedicillate, thickly tomentose, unopened flowers about 1 cm long. Calyx campanulate, with 3 short marginal projections, densely ciliate. Corolla deeply 3-lobed; each lobe about 1 cm long, lanceolate, reflexed, densely ciliate. Stamens with filaments connate at base, adnate to corolla. Overy turbinate; carpels coherent by their apices; ovules solitary, erect; style filiform, stigmas 3, at the same level with anthers, placentation basal. Ripe fruits ellipsoid, 1-seeded, deep orange in colour; in fruits perianth persistent.

Flowering and Fruiting: September-November, April- May.

Distribution: Assam, Meghalaya, Arunachal Pradesh, Tripura, Manipur and Jharkhand.

In a healthy tree flower branch bear about 350 solitary flowers but not all of them develop into fruits. When fruits mature due to weight of the fruits inflorescence axis bends down from the erect position. Due to destruction of natural habitats in the North East India its population is depleting at a faster rate. This species is listed as endangered palm in the Indian Flora.

Uses: Local people use large leaves as rain hats. Leaves are used as thatch. Spitted lamina is used to make mats, bags, baskets for local use. It is reported that wild elephants prefers to eat green emerging leaves and lower part of the stem. Known locally as Chattapat, and Kurkuti.

Chromosome number: 28. Sharma and Sarkar 1956.

Cultivation: Efforts were made to bring this beautiful fan palm into cultivation. As a single stemmed palm, the only possible method of propagation was through seed germination. Seed setting was not regular in cultivated plants may be due to absence of pollinating vectors. It is

grows luxuriantly in the moist shady places. Plants grown in the Green Houses have much larger deep green leaves and longer inflorescences. Flower branches always hang high above the canopy of leaves. Fruiting is irregular in the introduced plants.

Conservational Status:

Vulnerable. World status not threatened. This widely distributed palm of the Indian subcontinent has suffer from over exploitation.

Licuala spinosa Wurmb. Verh. Genootsh. Kunsten 2: 474. 1780. Becc. & Hook.f. Fl. Brit. India 6: 431. 1832. Basu & Chakraverty Manual of Cultivated Palms in India 42. 1994.

Common Names: Palas, Jungli selai (Hindi), Mangrove Fan Palm, Spiny Licuala Palm

Description: A cluster forming fan leaved palm. Stem slender, 2-3 m long, 6-9 cm in diameter. Leaf scars prominent on the stem. Leaves orbicular to reniform, about 18 partite; with petiole about 1.5 m long: leaf sheath triangular, strongly fibrous at margins, petiole slender, obtusely trigonous in cross- section; armed throughout at margins, with angular spines; leaf blade orbicular, about 60 cm tip of the hastula to the tip of the middle segment; lateral segments obliquely praemorsed; 3-4 lobed; median segments 10-11 lobed. Inflorescence interfolier; erect, then arching out, longer than leaves, to 3.5 m long; primary flower branches 6-10 in number, alternate, adnate to primary axis at base; lower branches divided into 3-5 ultimate flower branches (rachillae). Flowers sessile, irregular or in cluster of 2-3 flowers. Calyx copular, 2 mm long, 3 toothed , ciliate outside. Corolla little longer than calyx, 3- lobed; lobes lanceolate, acuminate. Stamens with filaments short, setaceous; anthers oblong-ovate; ovary turbinate bearing filliform style. Ripe fruits obovoid, 5-7 mm long, pedicellate, deep red in colour.

Flowering: September-December. **Fruiting:** May-June.

Distribution: India (Andaman Islands), Southeast Asia. In Andaman Islands it usually grows in damp swampy mangrove areas and often growing in small patches.

Cultivation: It grows luxuriantly in moist shady places even along the edges of fresh water tank. Being a cluster forming palm this species grows into a big colony of several shoots. In India it is not very popular in field cultivation. However, when grown in pot it remains in juvenile form for several years therefore grown as potted ornamental palm.

Uses: Leaves are sometimes used as thatch and food wrapping. In Cambodia, bark used in combination with other drugs for treatment of tuberculosis. In Malaysia, meristem infusion is taken orally as antidote to poisoning. In Thailand, leaf juice used to treat centipede bites.

In Borneo, the leaf's fireproof durability is of critical utility in preparing blowpipe dart poison –the latex of *Antiaris toxicaria* tree is held on a folded boat-shaped young leaf of *L. spinosa*, and held over a small flame for about a week.

Licuala grandis. H.Wendl. III. Hort. 27: t. 412 (1880). Basu & Chakraverty in Manual of Cultivated Palms in India .41.1994.

Common Name: Ruffled fan palm, vanuata fan palm, palas payung, ruffled lantan palm.

Description: Stem solitary, prominently annulate, clean, to 4 m long, to 12 cm in diameter near base with persistent leaf bases just below the crown. Leaves palmate, dark green, ascending to spreading in all direction; petiole slender armed with curved spines; leafblade rotundate, stiff, plaited, more or less entire, margins shallowly lobed; lobes obtuse; hastula concave, acute. Inflorescence interfoliar, arching outward from the axils, 100-120 cm long, with 3-4 primary branches closely sheathed under deep green glossy, leathery bracts. Flowers bisexual, irregularly disposed on rachillae; each 3 mm long, slightly pedicellate; sepals forming a tube with 3 ciliated lobes. Corolla tubular with 3 distinct ciliated concave petals with their lip slightly incurved. Stamens 6; filaments connate at base, attached to the throat of the corolla tube; carpels 3, free, joined at style; stigma simple. Ripe fruits cherry red, globose, 1.5 cm in diameter, smooth with fleshy mesocarp, endocarp brittle; endosperm homogeneous within growth from the seed wall.

Flowering & Fruiting: August-September; May-July.

Distribution: New Hebrides.

Cultivation: This species is widely cultivated as indoor decoration plants. In the Calcutta climate it is difficult to grow this palm in full sun therefore mostly cultivated under the shade of large trees or in the green houses.

Uses: The leaves are use as roof cover in thatched huts. The entire leaf lamina gives an additional advantage for water-proofing. They are placed consecutively one upon the other so that the abaxial side of the petiole of the one above interlocks with the adaxial petiole of the one below, thus forming a relatively close knit cover.

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OBITUARY

Dr. Debendra Bijoy Deb (1st April 1924 - 11th June 2013)

Dr. D. B. Deb, born at Srimangal in Sylhet (now in Bangla Desh) graduated from M. C. College, Sylhet in 1946. He obtained his M.Sc. degree in 1949, Ph.D. under Prof. I. Banerjee in 1956 and D.Sc.in 1975, all from the University of Calcutta. He started his career in 1950 as a Lecturer in Botany in Nogaon College, Assam and was Head, Dept. of Botany at D.M.College, Imphal and M.B.B.College, Agartala. During teaching he worked on flora of Manipur and Tripura. He joined Botanical Survey of India in 1961 as Systematic Botanist at Shillong. He headed the Industrial Section, Indian Museum, Kolkata and The Indian Botanic Garden. After superannuation in 1982, he worked as Emeritus Scientist till 1988 but was active in research till 2009. He knew Latin, German and Russian languages besides English.

For over 60 years, he worked on Indian regional floras, taxonomy, ecology, economic botany and medicinal plants. His areas of main concern were North-Eastern States. He visited research Institutes of USSR, UK, France and Germany. He discovered several new taxa of plants. Dr. Deb contributed above 250 research papers and authored,"*The Flora of Tripura State*"(2 vols.) and "*Rubiaceae of India*" . He guided several researchers in Plant Taxonomy and Ethnobotany for Ph.D. He was an authority on family Rubiaceae besides Solanaceae and Liliaceae.

Dr. Deb was a recipient of Jubilee Research Medal and Prize in Science (1972), Dr. Debabrata Chatterjee Memorial Medal and Prize in Systemic Botany (1978), first Fr. Santapau Medal by Association for Plant Taxonomy (1999) , T.M.Hynniewta Biodiversity Gold Medal(2010) by East Himalayan Society for Spermatophyte Taxonomy and Bruhl Medal of Asian Society. A simple and disciplined man, Dr. Deb was among seven botanists of the world to be awarded a certificate of merit by International Organization on Solanaceae. He was an Honorary member of Association for Plant Taxonomy. He left for his heavenly abode on 11th June 2013. APT condoles the demise of Dr.D.B.Deb.

S. K. Jain & Santosh K. Agarwal

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Precocious flowering in *Dypsis lutescens*

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The paper presents the first record of terminal flowering in ***Dypsis lutescens***. A group of seedlings among many normal seedlings from the same population exhibit behavior of vegetative development and flower neotenically. All abnormal seedlings produced spicate terminal inflorescence with rudimentary flower clusters irregularly disposed on the floral axis.

Introduction

Dypsis lutescens (H. Wendl.) Beentje and Dransfield (Syn. ***Chrysalidocarpus lutescens*** H. Wendl.) of family Palmae (Arecaceae) is commonly known to the nurserymen as **Areca palm**. It is a native palm of Madagascar, introduced in India long ago as ornamental palm. Due to its cluster-forming habit, arching densely pinnate leaves and its ability to thrive best in warm humid condition, it has positioned itself as the most popular ornamental palm in India. Due to its hardy nature, this species is used largely in landscape gardening and as pot-grown ornamental house plant for interior decoration. The upper most portions of its glossy green young feathery leaves are very decorative and used in large quantity in floral decoration.

In adult form, it is a cluster forming pinnate leaved palm with terete stem, about 5 cm in diameter, annulate, yellowish-green in colour. In local condition this species grows up to 6 m from the ground. Forking of the stem near ground or above is a common feature. Development of inflorescence is pleonanthic and axillary to leaves, interfoliar at emergence and infrafoliar at the fruiting stage, decompound with a central axis and lateral branches divided up to second order. Flower clusters are spirally disposed on the rachilla, in triads of two lateral male flowers and a middle female flower. Development and opening of flowers in the cluster is protandrous.

Under normal conditions when this palm is grown in ground, its flowering starts after about three to four years of planting. It retains its vegetative form for several years when grown in pot until it gets pot-bound, becomes unhealthy and ceases to grow. This palm is never seen producing inflorescence when grown in pot. A pot-bound palm, when planted in the ground, gets rejuvenated and grows normally and produces normal axillary inflorescences in due time. As there is a great demand for ***Dypsis lutescens*** as an ornamental palm for interior decoration or as decorative garden palm, every year a large number of seedlings are raised by germinating seeds in the nursery of the Agri-Horticultural Society of India's Garden at 1, Alipore Road, Kolkata. Due to the suckering habit of this species, vegetative propagation is possible by splitting the suckers with roots. The suckers are grown separately as new plants. Vegetative propagation is not a regular practice and also not economic for raising large number of young plants.

An interesting flowering phenomenon was observed in several seedlings of ***Dypsis lutescens*** that were raised from freshly collected seeds from a clump at the southern side of the Birla Laboratory in the garden (see Figs 1-4). These seedlings were about six months old and all were transplanted in 4 inch earthen pots containing a mixture of equal proportions of garden loam and powdered leaf mould. All of these seedlings were in the juvenile stage as evident from the presence of bilobed leaves only, characteristic of Arecoid group of palm in their

A

B

C

Precocious Flowering *Dypsis Lutescens*.

A. Juvenile leaves with sheath, B. (Right) Terminal Flowering absent, normal growth. (left) seedling with terminal flowering, C. Developing fruit in terminal inflorescenece.

juvenile stage of development. All abnormal seedlings produced spicate terminal inflorescence with rudimentary flower clusters irregularly disposed on the floral axis. From the same collection, other seedlings were normal.

Observations

Measurement of abnormal seedling

- First seedling leaf sheathing, non-leafy in appearance, connate at base with tapering tip.
- Second seedling leaf or the first foliage leaf (Eophyll), with its 4 cm long basal sheath encircling the base, petiole 3 cm long, leaf blade bilobed.
- Third seedling leaf, with basal sheath 5 cm long, 1.5 cm cm wide at base, petiole 4 cm long, leaf blade bilobed, each 10 cm long, 1.2 cm broad at middle.
- Fourth seedling leaf, basal sheath 6 cm long, petiole 4 cm long, leaf blade 12 cm long
- Fifth seedling leaf, basal sheath 5 cm, petiole 5 cm leaf blade 12 cm long.
- Terminal inflorescence, sterile axis 8 cm long, with 1.2 cm long basal stalk

After a month of observation, it was revealed that only one abnormal seedling among the whole lot had a premature fruit and in others, flowers ceased to grow further and flower clusters on the terminal axis did not develop for opening but dropped. As the terminal vegetative buds of these abnormal seedlings were transformed into reproductive phase, there was no further chance of vegetative growth and the seedlings were at the withering state. The most interesting part of this observation was that the rest of the seedlings of the same lot were normal and each of them was producing new leaves as usual.

Discussions

There are records of monocarpic behavior and production of terminal inflorescence development in ***Cocos nucifera,*** which normally produces axillary inflorescence in pleonanthic mode of development. It was also reported that the terminal inflorescence development took place in the dwarf form and the plants were short-lived and bore only female flowers (Menon and Pandalai 1958, Basu and Chakraverty 1996). There were reports of precocious flowering in ***Arenga pinnata*** and ***Corypha utan*** (Basu 1987). Both of these palm species, after long years of vegetative growth, produce terminal inflorescence and the trees die after maturation of fruits. In ***Arenga pinnata*** there was further development of axillary inflorescence in the besipetal sequence till the tree died of exhaustion. There was a report of precocious flowering in ***Dypsis lutescens*** (Essig 1971) where it was observed that the plant flowered about 20 months after planting, but it was not apparent from the observations whether the flowering was terminal or axillary.

Precocious flowering is of rare occurrence and may be due to environmental influence or imbalance in the growth and development substances. Essig (1971) pointed out that the state of flowering is separated from the state of non-flowering by only a thin line even in seedlings. This is the first record of terminal flowering in ***Dypsis lutescens.*** It is not understood why a group of seedlings among many normal seedlings from the same population should change their behavior of vegetative development and flower neotenically.

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Inventory of Shade Trees in Tea Gardens of Sub-Himalayans Region of West Bengal, India

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Abstract:
A floristic exploration on shade trees at different tea gardens of Sub-Himalayan Terai and Duars of West Bengal was carried out time since 2013. A total of 45 species of Angiosperm representing 34 genera of 15 families were recorded from the study areas. Leguminosae shows the highest number of shade trees comprising 13 genera and 22 species. For each and every species correct name, field status, flower & fruiting and necessary photographs has been given.

Keywords: *Tea garden, shade trees, distribution.*

1. Introduction

Sub-Himalayan region of West Bengal is located within the Himalayan biodiversity Hotspot zone and is very rich in biodiversity. Darjeeling district of this state is also famous for three 'T' *i.e.* Tea, Timber and Tourism. Among these, Darjeeling Tea is the most famous in world due to its beautiful essence. Economical backbone of these areas also directly depends on huge amount of Tea production from different sub-Himalayan tea gardens that are also attracts the tourist from the different parts of the world.

Tea is grown under a canopy of trees which provide partial shade that is quite essential for good tea leaf production. High sunlight at sub-Himalayan areas burns or damages the young tea leaves and can abruptly reduces the leaf production because shed trees are directly related to total yield of tea production. A good number of Garden friendly tree species are planted in various tea garden for proving partial shades and also reduces soil erosion and the impact of rainfall drops, enrich soil fertility and organic matter content through leaf litter and support diverse flora and fauna, especially many bird species (Kalita *et. al*, 2014). The shade trees play an important role in increasing productivity o f the tea bushes under the environment of sub-Himalayan regions of West Bengal. During summer, the temperature of the leaves of unshaded tea plants became very high and causes some damage. Without shade trees, yield of tea is limited. Thus to increase tea yields, a canopy of moderate shade is essential under the conditions of sub-Himalayan regions of West Bengal. The importance of shade pattern and selection of shade trees were carried out by several workers like Visser (1961), Hadfield (1974) and Mohotti (2004). Since the later part of 20^{th} century planting of shade trees among tea bushes became a practice in plains of North East India, *Albizia chinensis* was the first tree used as shade tree. *Albizia odoratissima, Dalbergia sissoo, Erythrina indica* etc. were also introduced simultaneously in different tea gardens (Barua, 2007).

2. Materials and Methods

2.1. Study Area

The present study was conducted in sub-Himalayan terai and duars regions that are situated at foothills of Himalayan Hotspot of West Bengal, India. Extensive surveys were conducted in different tea plantations areas of the study area. Among the various tea gaden some repeatedly visited gardens are Matigara tea estate, Gaya Ganga tea garden, Hansqua tea garden, Dagapur tea estate, Gulma tea

estate, Kamalpur tea estate, Denguajhar tea estate, Damdim tea estate, Bagrakot tea estate, Batabari tea estate, Dyna tea estate, Kurti tea estate, Banarhat tea estate, Dalgaon tea estate etc.

2.2. Data Collection

The present data were collected from several tea estates during August2013 to March 2015. During the field survey a large number of fertilespecimens have been collected for genuine identification. Collected specimens were processed and herbarium specimens were prepared following standard herbarium techniques by Jain and Rao (1977). Identification has been made by matching with herbarium sheets of CAL and NBU Herbarium and also using different published literatures (Prain, 1903; Bose *et at*., 1998). All the vouchers specimens of recorded species and field records are deposited at NBU herbarium.

3. Result and Discussion

During the present study, a total of 45 species representing 34 genera of 15 families of angiosperms were enlisted (Table 1).Among the collected species Leguminosae shows highest percentage with 22 species comprising 13 genera (38%) followed by 5 species of Meliaceae (14%) comprising 5 genera. Phyllanthaceae, Lythraceae and Myrtaceae each family show the 2 species of 2 genera (Fig.1). Apocynaceae, Rubiaceae, Anacardiaceae, Cannabaceae, Boraginaceae, Moraceae, Euphorbiaceae, Malvaceae, Simaroubaceae and Lauraceae shows 3% generic components of the entire tree flora of the tea plantations areas (Fig.2).It was noticed during survey that the legume trees are most dominating because of its compound leaf and bushy appearance in tea plantations areas. The popular permanent shade trees among the farmers and gardeners of this sub-Himalayan region include *Albizia odoratissima, Albizia chinensis, Albizia lebbeck, Albizia procera, Erythrina indica, Dalbergia sissoo, Melia azedarach*etc.

Since shade tree species used in the tea plantations have to protect the tea plants from detrimental effects of direct sun, the plant must have a single layered canopy with small leaves. Moreover, the leafless period of the plant should not coincide with the drought period of the tea growing areas. Due to increasing popularity of tea as beverage, the tea industry faced tremendous pressure for higher production to meet the demand of consumers. Under the present situation, the scope of extending plantation area becomes limited.Gradually, other leguminous species with pinnately compound small leaves and shorter leafless period like *Albizia odoratissima, Erythrina variegata, Albizia procera, Dalbergia sissoo* etc. were tried with varying degrees of success.

Now, a day's some spice plants like *Cinnamomum verum*, *Piper nigrum* are also planted within the tea gardens of this region as alternative crops. Some medicinal or cereal plants like *Justicia adhatoda, Cajanus cajun, Jatropha curcas* etc. are planted as fencing along with roadsides or marginal areas.The waste lands of tea gardens are very rich in dense bushes with various weeds and important wild medicinal plants that are frequently used treat various diseases by tribal tea garden workers (Orao. Munda, Santal etc).

Scientific Name	Vernacular Name	Fertile	Status
Acacia auriculiformis Benth. [Leguminosae]	Akash mani/ Sonajhuri	March-February	Less common
Acacia myrtifolia (Sm.) Willd. [Leguminosae]	-	March- December	Less common
Acacia lenticularis Benth.[Leguminosae]	Kakur	April-October	Less common
Leucaena leucocephala (Lam.) de Wit[Leguminosae]	-		Less common
Adenanthera pavonina L. [Leguminosae]	Rakta Kambal	March-September	Rare
Ailanthus integrifolia (Pierre) Noot.[Leguminosae]	Gokul	March-April	Rare
Albizia chinensis (Osbeck) Merr. [Leguminosae]	Chakua	March-July	Abundant
Albizia lebbeck (L.) Benth.[Leguminosae]	Sirish	June-September	Abundant
Albizia schimperiana Oliv.[Leguminosae]			Common
Albizia odoratissima (L.*f*.) Benth.[Leguminosae]	Kakur Sirish	May-July	Very common
Albizia procera (Roxb.) Benth.[Leguminosae]	Koroi	May-August	Abundant
Albizia richardiana (Voigt) King & Prain[Leguminosae]	-	August-October	Less common
Albizia saman (Jacq.) Merr.[Leguminosae]	-	May-August	Very common
Alstonia scholaris (L.) R. Br.[Apocynaceae]	Chattim	October-December	Common
Artocarpus chaplasha Roxb.[Moraceae]	Chaplash	March-April	Rare
Artocarpus lacucha Buch.-Ham.[Moraceae]	Dahua	March-August	Rare
Azadirachta indica A.Juss.[Meliaceae]	Neem	April-June	Common
Bauhinia purpurea L. [Leguminosae]	Rakta kanchan	October-February	Rare
Bischofia javanica Bl. [Phyllanthaceae]	Kainjal	February-April	Rare
Eucalyptus robusta Sm. [Myrtaceae]	Eucalyptus	August-March	Rare
Lagerstroemia speciosa (L.) Pers.[Lythraceae]	Jarul	August-October	Common
Butea monosperma (Lam.) Taub. [Leguminosae]	Palas	January-April	Less common
Senna siamea (Lam.) H.S.Irwin & Barneby[Leguminosae]	Manjuri	June-December	Abundant
Cassia fistula L. [Leguminosae]	Badar lathi	March-May	Abundant
Chukrasia tabularis A.Juss.[Meliaceae]	Chikrassi	May-July	Common
Dalbergia sericea G.Don[Leguminosae]	-	April-May	Abundant
Dalbergia sissoo DC.[Leguminosae]	Shisu	March-May	Abundant

Derris robusta (DC.) Benth.[Leguminosae]	-	April-May	Common
Delonix regia (Hook.) Raf.[Leguminosae]	Gulmohar	April-July	Abundant
Duabanga grandiflora (DC.) Walp.[Lythraceae]	Bandorhulla	February-July	Common
Phyllanthus emblica L.[Phyllanthaceae]	Amlaki	July-December	Common
Ehretia acuminata R.Br.[Boraginaceae]	Kula-aja	March-July	Common
Erythrina variegata L. [Leguminosae]	Madar	February-April	Common
Firmiana colorata (Roxb.) R.Br.[Malvaceae]	Mula	March-July	Rare
Litsea glutinosa (Lour.) C.B.Rob. [Lauraceae]	Kukur	March-July	Less common
Litsea monopetala (Roxb.) Pers. [Lauraceae]	Bara Kukur	May-August	Less common
Mangifera indica L. [Anacardiaceae]	Aam	February-May	Common
Melia azedarach L. [Meliaceae]	Ghora neem	Februay-April	Abundant
Neolamarckia cadamba (Roxb.) Bosser	Bol Kadam	June-August	Common
Psidium guajava L. [Rubiaceae]	Piara	Throughout the year	Rare
Parkia timoriana (DC.) Merr. [Leguminosae]	Supota	November-March	Rare
Swietenia macrophylla King [Meliaceae]	Mahagoni	May-October	Common
Toona ciliata M.Roem. [Meliaceae]	Tun	March-June	Common
Trema orientalis (L.) Bl. [Cannabaceae]	Jibon	Throughout the year	Abundant
Trewia nudiflora L. [Euphorbiaceae]	Pituli	October-January	Common

Table 1: Analytical Data of the Collected Specimens with Their Field Status

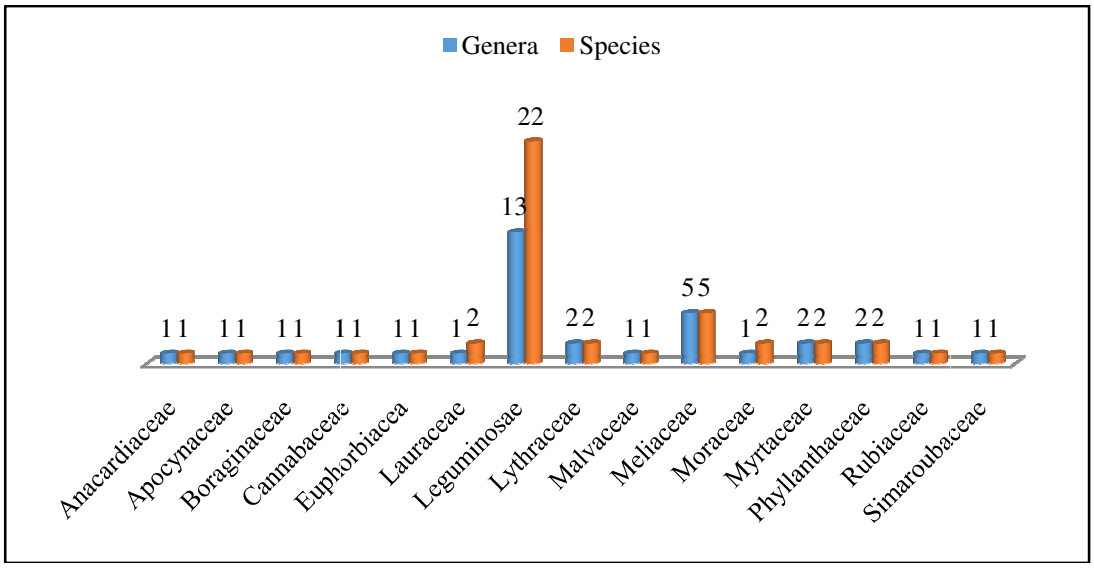

Figure 1: Family showing the number of genera and species

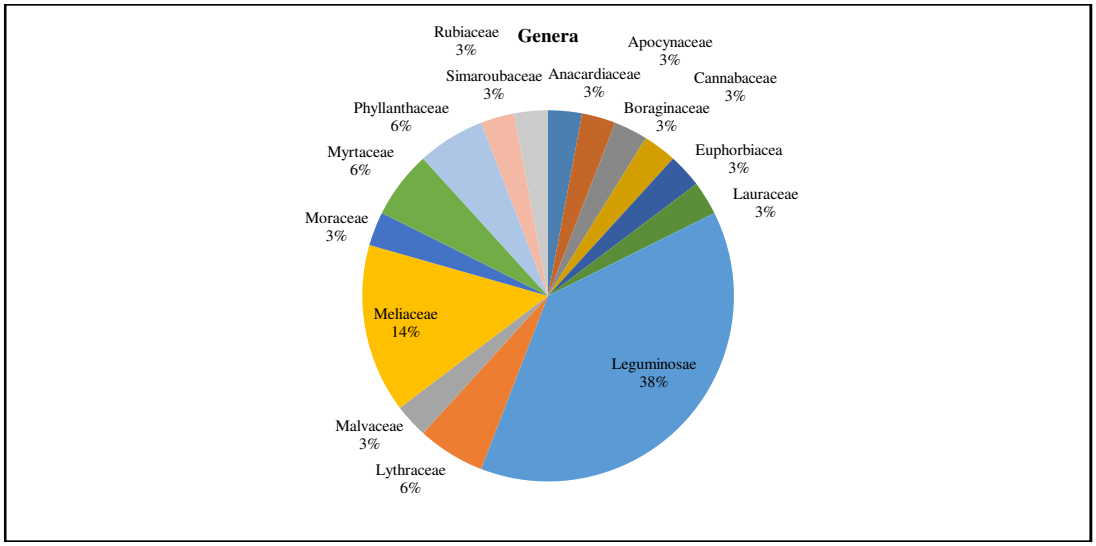

Figure 2: Family wise generic percentage of available trees of the study areas

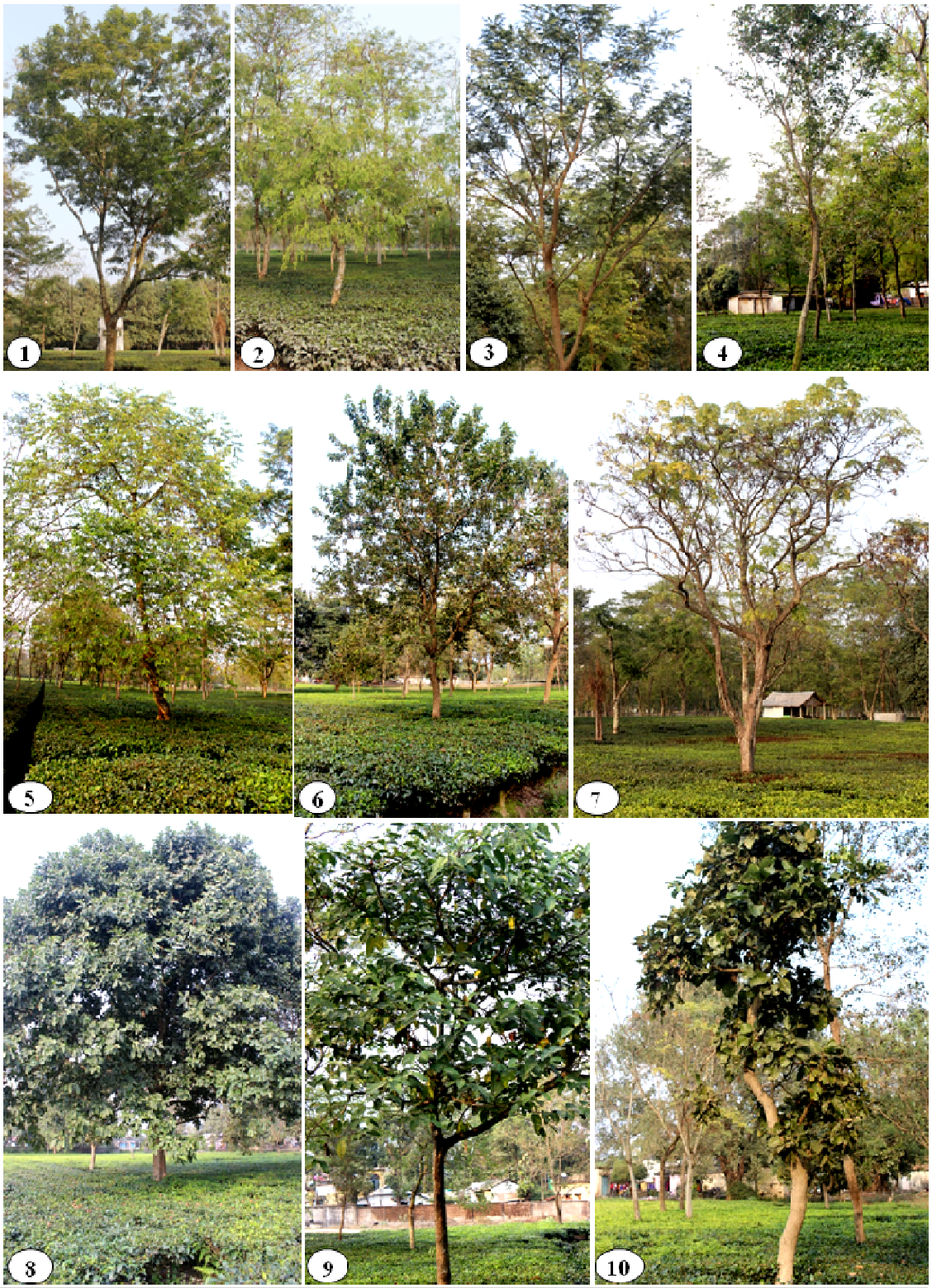

Plate. 1. **1.***Albizialebbeck*; **2.***Albiziaprocera*; **3.** *Delonixregia*; **4.** *Dalbergiasissoo*; **5.** *Tremaorientalis*; **6.** *Ehretiaacuminata*; 7. *Meliaazedarach*; **8.** *Litseamonopetala*; **9.** *Neolamarckiacadamba*; **10.** *Buteamonosperma*

Figure 3

4. Acknowledgment
Authors are thankful to the all dignitaries of Tea Estate for allowing us and assisting the present survey works. The first author is also thankful to UGC (RGNF), Govt. of India for their financial assistance to complete the said work.

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RESEARCH ARTICLE

Vascular plants association in Gabgachi-Bhatia wetland complex in Maldah district of West Bengal, India

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Received: 11 February 2016 /Accepted: 11 September 2016

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Keywords Gabgachi-bhatia wetland • Maldah • Vascular flora

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Introduction

Wetland means the areas those are with sufficient wetness. The soil of the wetlands is generally very rich in nutrients and that nutrient rich soil with sufficient waters provides ideal environment for the existence of a rich floral and faunal diversity. Very recent estimation by the ISRO (2011) recorded total wetland area with aquatic vegetation in the Maldah district of the state of West Bengal is 12906 hectors during post- monsoon season. The Indian wetlands support 20 % of total biodiversity which covers around 1200 plant species of the country (Deepa & Ramachandra, 1999; Maheswari, 1960; Gopal, 1995; Cook, 1990). Wetlands of West Bengal occupied 9% of total wetlands area of the Indian sub-continent and are the habitat of 380 macrophytes including many species of mangroves (Ghosh, 2003). The district of Maldah is located in between 24º 40′ 20″ and 25º 32′ 08″ N latitude and between 87º 45′ 50″ and 88º 28′ 10″ E longitude and is covering an area of 3733 sq km (Map 1). The district consists mainly of low lying plain land that slowly rolls toward south extending up to the northern bank of the river *Ganga*. The district is composed of three major topographical zones i.e., *Tal*, *Diara* and *Barind*. The study area, Gabgachi-Bhatia Beel complex (24º53'06" N and 88º11'42.35" E) is one of the largest wetland complexes in Maldah district distributed over 1800 hectors. It is situated in the English Bazar block of Maldah Sadar sub-division (Fig. 1). During rainy season it gets connected with the Bhatia wetland in Bangladesh. This wetland complex is composed of several permanent water bodies like *Gabgachhi* 1, *Gabgachhi* 2, *Sonatola beel*, *Abhirampur*, *Nander beel* and *Malanchapally beel* (Table 1) along with temporarily waterlogged areas. During monsoon all water bodies are merged together forming a large water body with average depth of 7 – 8 m in monsoon and 3 – 3.5 m in summer. The wetland macrophytic vegetation of this area supports all kinds of fresh water aquatic plants (Prain, 1903; Chowdhury & Das, 2009, 2010, 2011, 2013, 2014). We provide an update list of vascular plants of this wetland complex of the district Maldah.

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TAXONOMY, PHENOLOGY AND ETHNOBOTANY OF PALMS IN WEST BENGAL

THESIS SUBMITTED FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY IN SCIENCE (BOTANY)
UNDER THE UNIVERSITY OF NORTH BENGAL

Submitted by

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Table 1: Major important water bodies of Gabgachi-bhatia wetland complex

Major water bodies	Area (hac)	Longitude	Latitude	Ave. water Depth (m)
Gabgachhi Beel 1	32.52	24°58'10.40 N	88°08'14.86" E	2.0 – 2.8
Gabgachhi Beel 2	31.28	24°57'12.44" N	88°08'35.71" E	2.0 – 2.8
Sonatola Beel	6.90	24°59'36.34" N	88°07'13.06" E	3.0 – 3.2
Abhirampur Beel	30.20	24°57'15.44" N	88°08'30.81" E	2.0 – 4.2
Nander Beel	26.85	24°57'631.56" N	88°08'37.70" E	3.0 – 5.2
Veoa Beel	5.85	24°57'657.02" N	88°08'55.15" E	1.0 – 4.2
Ruimari Beel	9.30	24°56'140.41" N	88°08'37.71" E	1.5 – 3.8
Bahagala Beel	6.98	24°56'11.27" N	88°08'53.23" E	2.0 – 4.3
Chirakelty Beel	4.45	24°57'04.99" N	88°08' 51.13" E	1.6 – 4.0
Malanchapally Beel	300	24°57'64.29" N	88°09' 14.93" E	2.0 – 6.2
Chatra Beel	120	24°59'9.44" N	88°07'346.16" E	1.0 – 3.2

Materials & methods

Floral survey was executed by random sampling during the years 2003 – 2013 and plants were sampled throughout the year especially in three predominant seasons. Aquatic plants those grow in the middle of water bodies were collected using locally available wooden Boats. All the collected specimens were processed into mounted herbarium specimens following Jain & Rao (1977) and were identified using local floras (Prain 1903; Naskar, 1990; Cook, 1996) and matched at NBU-Herbarium and CAL. For updated nomenclature www.theplantlist.org was consulted for all names. All the voucher specimens and the relevant field note book were deposited at NBU-Herbarium.

Season wise quadrate data were computed and analyzed following Phillips (1959) and Misra (1966) leading to the determination of different parameters like frequency (F), density (D), abundance (A) and their relativity. IVI (Important Value Index) were also determined for constructing the list of most important species of this habitat. Different diversity indices are applied to determine the concentration of dominance, species diversity and species richness of the lake vegetation. Simpson index ($\lambda = \Sigma pi^2$; Where, 'pi' is the proportional abundance of the 'i^{th}' species and pi = ni/N) was utilized to determine the concentration of dominance (Simpson, 1949), Shannon – Weiner index ($H' = -\Sigma [(ni/N) \ln (ni/N)]$; Where, 'ni' is the number of individuals of a species and 'N' is the total number of species in the habitat studied) for species diversity (Shannon & Weiner, 1963) and Menhinick index ($D = S/\sqrt{N}$; Where, S = Total number of species observed and N= Total number of individuals observed) for species richness (Menhinick, 1964) of the community. The life form of collected plant species were calculated and compared with Raunkiaer's normal values (Raunkiaer, 1934).

Results and discussion

Flora

The present study enlisted a total of 283 species of flowering plants and 6 pteridophytes and is presented alphabetically along with their habit and life-forms in Table 1. Among the angiosperms there are 166 species of dicotyledons representing 107 genera from 43 families and 126 species of monocotyledons belonging to 61 genera, representing 13 families. Six species of pteridophytes from 6 families were also recorded from the study area. The enlisted floristic elements of Gabgachi-Bhatia wetland were classified into ten habit groups with their percentile representation (Figure 2).

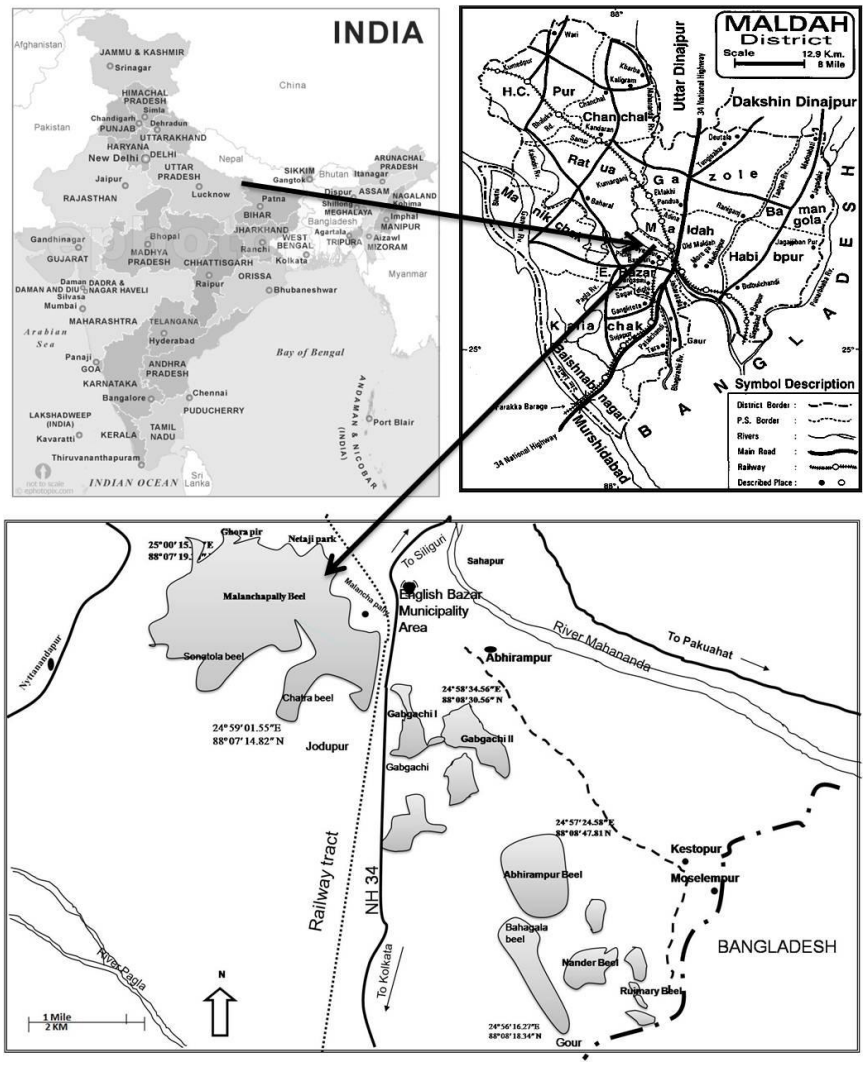

Figure 1: Map showing the location of Gabgachi – Bhatia wetland complex in the district of Maldah, India

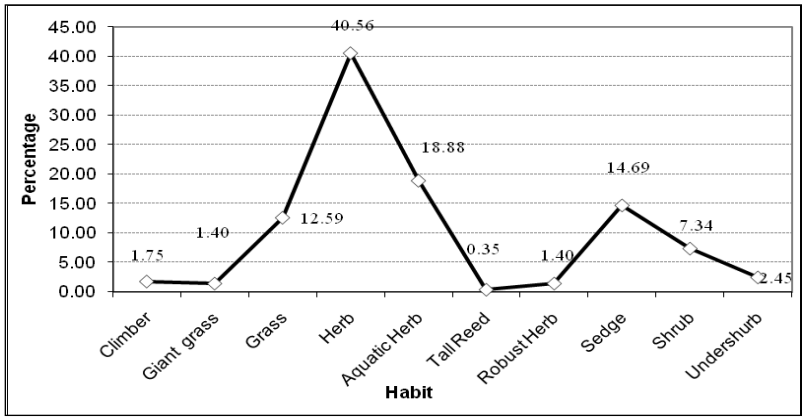

Figure 2: Percentage wise habit-group distribution of wetland plants

Table 1: List of vascular flora of Gabgachi-Bhatia wetland of Maldah district of West Bengal, India

[Abbreviation used: LIFE FORM: CR = Cryptophyte; CH = Chameaphyte; H = Hemicryptophyte; P = Phenerophyte; T = Therophyte]

SPECIES	HABIT	LIFE FORM
ACANTHACEAE		
Hygrophila auriculata (Schumacher) Heine	Herb	CR
Hygrophila difformis (Linnaeus) Sreem & Bennet	Aquatic Herb	CR
Hygrophila polysperma (Roxburgh)T. Anderson	Aquatic Herb	T
Justicia diffusa Willdenow	Herb	H
Justicia simplex D. Don	Herb	H
Nelsonia canescens (Lamarck) Sprengel	Herb	CH
Rungia pectinata (Linneaus) Nees	Herb	P
ALISMATACEAE		
Sagittaria guayanensis Humboldt, Bonpland & Kunth	Aquatic Herb	T
Sagittaria sagittifolia Linneaus	Aquatic Herb	T
AMARANTHACEAE		
Alternanthera paronychioides St. Hill	Herb	T
Alternanthera philoxeroides (Martius) Grisebach	Aquatic Herb	CH
Alternanthera sessilis (Linneaus) R. Brown *ex* DC.	Herb	CH
Amaranthus blitum subsp. *oleraceus* (Linneaus) Costea	Herb	H
Amaranthus spinosus Linneaus	Herb	CH
Amaranthus viridis Linneaus	Herb	CH
Celosia argentea Linneaus	Herb	T
Digera muricata (Linneaus) Martius	Herb	T
APIACEAE		
Centella asiatica (Linneaus) Urban	Herb	T
APONOGETONACEAE		
Aponogeton crispus Thunberg	Aquatic Herb	T
Aponogeton natans (Linneaus) Engler	Aquatic Herb	CH
ARACEAE		
Colocasia esculenta (Linneaus) Schott	Robust Herb	T
Cryptocoryne retrospiralis Fischer *ex* Wydler	Aquatic Herb	T
Oenanthe javanica Linneaus	Herb	T
Pistia stratiotes Linneaus	Aquatic Herb	CR
Typhonium flagelliforme (Roxburgh) Blume	Herb	CR
Wolffia arrhiza (Linneaus) Horkel *ex* Wimmer	Aquatic Herb	T

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ASTERACEAE		
Ageratum conyzoides Linnaeus	Herb	T
Blumea hieraciifolia (D. Don) DC var *hieraciifolia*	Herb	T
Blumea lacera (Burman *f.*) DC.	Herb	T
Caesulia axillaris Roxburgh	Herb	T
Centipeda minima (Linnaeus) A. Brown & Ascherson	Herb	H
Cirsium arvense (Linnaeus) Scopoli	Herb	T
Cotula anthemoides Linnaeus	Herb	T
Cotula hemisphaerica (Roxburgh) Bentham & Hooker *f.*	Herb	T
Eclipta prostrata (Linnaeus) Linnaeus	Herb	T
Elephantopus scaber Linnaeus	Herb	T
Emilia sonchifolia (Linnaeus) DC.	Herb	T
Enydra fluctuans Loureiro	Aquatic Herb	T
Chromolaena odorata (Linnaeus) R. M. King & H. Robison	Shrub	CH
Gnaphalium purpureum Linnaeus	Herb	T
Gnaphalium polycaulon Persoon	Herb	T
Pseudognaphalium affine (D. Don) Anderberg	Herb	T
Laphangium luteoalbum (Linnaeus) Tzvelev	Herb	T
Grangea maderaspatana (Linnaeus) Poiret	Herb	H
Ixeris polycephala Cassini	Herb	CH
Launaea aspleniifolia (Willdenow) Hooker *f.*	Herb	T
Mikania micrantha Kunth	Climber	T
Parthenium hysterophorus Linnaeus	Robust Herb	CR
Sonchus asper (Linneaus) Hill	Herb	T
Sphaeranthus indicus Linnaeus	Herb	CH
Acmella paniculata (Wallich *ex* DC.) R.K. Jansen	Herb	T
Vernonia cinerea (Linneaus) Lessing	Herb	CR
Xanthium indicum Koenig *ex* Roxburgh	Shrub	T
ATHYRIACEAE		
Diplazium esculentum (Retzius) Swartz	Herb	T
BORAGINACEAE		
Coldenia procumbens Linnaeus	Herb	CH
Cyanoglossum lanceolatum Forsskal	Herb	T
Heliotropium indicum Linnaeus	Herb	T
Heliotropium ovalifolium Forsskal	Herb	T

CARYOPHYLLACEAE		
Polycarpon prostratum (Forsskal) Ascherson & Scherff	Herb	CR
Stellaria wallichiana Bentham *ex* Haines	Herb	T
CAMPANULACEAE		
Wahlenbergia marginata (Thunberg) DC.	Herb	T
CERATOPHYLLACEAE		
Ceratophyllum demersum Linnaeus	Aquatic Herb	T
CHENOPODIACEAE		
Chenopodium album Linnaeus	Herb	H
CLEOMACEAE		
Cleome viscose Linnaeus	Undershurb	T
COMMELINACEAE		
Commelina benghalensis Linnaeus	Herb	T
Commelina diffusa Burman *f.*	Herb	T
Commelina longifolia Lamarck	Herb	T
Commelina suffruticosa Blume	Herb	T
Cyanotis axillaris (Linnaeus) D. Don *ex* Sweet	Herb	T
Murdannia nudiflora (Linnaeus) Brenan	Herb	CR
Murdannia spirata (Linnaeus) Bruechner	Herb	T
CONVOLVULACEAE		
Evolvulus nummularius (Linnaeus) Linnaeus	Herb	CH
Ipomoea aquatica Forsskal	Climber	T
Ipomoea carnea ssp. *fistulosa* (Choisy) D. Austin	Shrub	H
Merremia hedaracea (Linnaeus) Urban	Climber	T
Operculina turpethum (Linnaeus) Silva Manso	Climber	T
COSTACEAE		
Cheilocostus speciosus (J. Koenig) C.D.Specht	Shrub	T
CYPERACEAE		
Bulbostylis densa (Wallich) Handle-Mazzetti *ex* Karsten & Schenck	Sedge	T
Cyperus compactus Retzius	Sedge	T
Cyperus compressus Linnaeus	Sedge	CH
Cyperus cyperoides (Linnaeus) Kuntze	Sedge	CH
Cyperus difformis Linnaeus	Sedge	CH
Cyperus digitatus Roxburgh	Sedge	CR
Cyperus distans Linneaus *f.*	Sedge	CR
Cyperus flavidus Retzius	Sedge	CR

Cyperus halpan Linnaeus	Sedge	CR
Cyperus imbricatus Retzius	Sedge	CR
Cyperus iria Linnaeus	Sedge	CR
Cyperus niveus Retzius	Sedge	H
Cyperus pilosus var. *pilosus* Vahl	Sedge	H
Cyperus polystachyos Rottboell	Sedge	H
Cyperus rotundus Linnaeus	Sedge	H
Cyperus tegetiformis Roxburgh	Sedge	H
Cyperus tenuispica Steudel	Sedge	H
Eleocharis congesta D. Don	Sedge	T
Eleocharis palustris R. Brown	Sedge	T
Eleocharis retroflexa (Poiret) Urban ssp. *chaetaria* (Roemer & Schultes) Koyama	Sedge	T
Eleocharis tetraquetra Nees	Sedge	T
Fimbristylis aestivalis (Retzius) Vahl	Sedge	CH
Fimbristylis annua (Allioni) Roemer & Schultes	Sedge	CR
Fimbristylis dichotoma (Linnaeus) Vahl	Sedge	CR
Fimbristylis dipsacea (Rottboell) C.B. Clarke	Sedge	CR
Fimbristylis littoralis Gaudich	Sedge	H
Fimbristylis miliacea (Linnaeus) Vahl	Sedge	H
Fimbristylis squarrosa Vahl	Sedge	H
Fimbristylis tenera Schultes	Sedge	T
Fimbristylis tetragona R. Brown	Sedge	T
Fuirena ciliaris (Linnaeus) Roxburgh	Sedge	T
Kyllinga brevifolia Rottboell	Sedge	T
Kyllinga nemoralis (J. R. Forster & G. Forster) Dandy *ex* Hutchinson & Dalziel	Sedge	T
Schoenoplectus articulatus (Linnaeus) Palla	Sedge	T
Schoenoplectus grossus (Linnaeus *f.*) Palla	Sedge	T
Schoenoplectus juncoides (Roxburgh) palla	Sedge	T
Schoenoplectus lateriflorus (Gmelin) Lye	Sedge	T
Schoenoplectus mucronatus (Linnaeus) Palla	Sedge	H
Schoenoplectus supinus (Linnaeus) Palla	Sedge	CH
ELATINACEAE		
Bergia ammannioides Roxburgh	Undershurb	T
EUPHORBIACEAE		
Chrozophora rottleri (Geiseler) Jussieu *ex* Sprengel	Herb	CR
Croton bonplandianus Baillon	Herb	CR

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Euphorbia heyneana Sprengel	Herb	CH
Euphorbia hirta Linnaeus	Herb	CR
Jatropha gossypifolia Linnaeus	Undershurb	H
ERIOCAULACEAE		
Eriocaulon cinereum R. Brown	Aquatic Herb	CH
GENTIANNACEAE		
Centaurium centaurioides (Roxburgh) Rao & Kamathy	Herb	T
HALORAGACEAE		
Myriophyllum indicum Willdenow	Aquatic Herb	CR
Myriophyllum tuberculatum Roxburgh	Aquatic Herb	T
HYDROCHARITACEAE		
Hydrilla verticillata (Linnaeus *f.*) Royel	Aquatic Herb	CH
Ottelia alismoides (Linnaeus) Persoon	Aquatic Herb	T
Najas graminea Delile	Aquatic Herb	T
Najas indica (Willdenow) Chamisso	Aquatic Herb	T
Nechamandra alternifolia (Roxburgh *ex* Wight.)	Aquatic Herb	T
Blyxa octandra (Roxburgh) Planchon *ex* Thwaites	Aquatic Herb	T
Vallisneria spiralis Linnaeus var. *denseserrulata* Mikino	Aquatic Herb	T
HYDROLEACEAE		
Hydrolea zeylanica (Linnaeus) Vahl	Aquatic Herb	CR
LAMIACEAE		
Anisomeles indica Linnaeus	Herb	CR
Clerodendrum indicum (Linnaeus) Kuntze	Shrub	T
Clerodendrum viscosum Ventenat	Shrub	T
Leucas indica (Linnaeus) R. Brown *ex* Vatke	Aquatic Herb	CH
Pogostemon stellatus (Loureiro) Kuntze	Aquatic Herb	CH
LEMNACEAE		
Lemna perpusilla Torrey	Aquatic Herb	T
Spirodela polyrrhiza (Linnaeus) Schleiden	Aquatic Herb	T
LYGODIACEAE		
Lygodium flexusum (Linnaeus) Swartz	Climber	CR
LYTHRACEAE		
Rotala densiflora (Roth) Koehne	Herb	H
Ammannia baccifera Linnaeus	Herb	T
Nesaea brevipes Koehne	Undershurb	CR
MALVACEAE		

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Corchorus aestuens Linnaeus	Herb	T
Corchorus fascicularis Lamarck	Robust Herb	T
Melochia corchorifolia Linnaeus	Herb	T
Pentapetes phoenicea Linnaeus	Shrub	CR
Sida acuta Burman *f.*	Shrub	T
Sida cordifolia Linnaeus	Herb	T
MARSILEACEAE		
Marsilea minuta Linnaeus	Aquatic Herb	T
MENYNTHACEAE		
Nymphoides hydrophylla (Loureiro) Kuntze	Aquatic Herb	T
Nymphoides indica (Linnaeus) Kuntze	Aquatic Herb	T
MOLLUGINACEAE		
Glinus lotoides Linnaeus	Herb	T
Glinus oppositifolius (Linnaeus) A. DC.	Herb	T
Mollugo pentaphylla Linnaeus	Herb	T
MORACEAE		
Ficus heterophylla Linnaeus *f.*	Shrub	CH
NELUMBONACEAE		
Nelumbo nucifera Gaertner	Aquatic Herb	CR
NYMPHAEACEAE		
Nymphaea nouchali Burman *f.*	Aquatic Herb	CR
Nymphaea pubescens Willdenow	Aquatic Herb	CR
Euryale ferox Salisbury	Aquatic Herb	T
ONAGRACEAE		
Ludwigia adscendens (Linnaeus) Hara	Climber	T
Ludwigia octavalvis ssp. *sessiliflora* (Micheli) Raven	Undershurb	CH
Ludwigia perennis Linnaeus	Shrub	T
OXALIDACEAE		
Biophytum sensitivum (Linnaeus) DC.	Herb	T
Oxalis corniculata Linnaeus	Herb	H
PAPAVARACEAE		
Argemone maxicana Linneaus	Herb	T
Fumaria indica (Haussknecht) Pugsley	Herb	T
LAMIACEAE		
Ocimum basilicum Linnaeus	Undershurb	T
LEGUMINOSAE		
Aeschynomene indica Linnaeus	Herb	CH

Alysicarpus bupleurifolius (Linnaeus) DC.	Herb	CR
Alysicarpus monilifer (Linnaeus) DC.	Herb	T
Alysicarpus vaginalis (Linnaeus) DC.	Herb	H
Desmodium gangeticum (Linnaeus) DC.	Herb	H
Desmodium triangulare (Retzius) Merrill	Herb	T
Desmodium triflorum (Linnaeus) DC.	Herb	T
Mimosa pudica Linnaeus	Herb	T
Medicago lupulina Linnaeus	Herb	T
Senna sophera (Linnaeus) Roxburgh	Shrub	T
Senna tora (Linnaeus) Roxburgh	Undershurb	T
LENTIBULARIACEAE		
Utricularia aurea Loureiro	Aquatic Herb	CR
Utricularia gibbosa Linnaeus ssp. *exoleta* (R. Brown) P. Taylor	Aquatic Herb	T
Utricularia inflexa Forsskal var. *stellaris* (Linnaeus *f*.) Taylor	Aquatic Herb	T
LINDERNIACEAE		
Lindernia antipoda (Linnaeus) Alston	Aquatic Herb	CH
Lindernia ciliata (Colsmann) Pennell	Herb	T
Lindernia cordifolia (Colsmann) Merritius	Herb	T
Lindernia crustacea (Linnaeus) F. Mueller	Herb	CH
Lindernia hirsute (Bentham) Wettstain	Herb	T
Lindernia multiflora (Roxburgh) Mukerjee	Herb	P
Lindernia oppositifolia (Retzius) Mukerjee	Herb	P
Lindernia parviflora (Roxburgh) Haines	Herb	T
Lindernia pusilla (Willdenow) Boldingh	Herb	T
PARKERIACEAE		
Ceratopteris thalictroides (Linnaeus) Brongniart	Aquatic Herb	T
Ceratopteris pteridoides (Hooker) Hieronymus	Aquatic Herb	CH
PHYLLANTHACEAE		
Phyllanthus fraternus Webster	Herb	CR
Phyllanthus urinaria Linnaeus	Herb	CR
Phyllanthus virgatus Froster	Herb	CR
Sauropus quadrangularis (Willdenow) Mueller	Shrub	T
PLANTAGINACEAE		
Veronica anagallis-aquatica Linnaeus	Herb	CR
POACEAE		
Axonopus compressus (Swartz) P. Beauvois	Grass	T

Brachiaria reptans (Linnaeus) Gardner & Hubb	Grass	T
Desmostachya bipinnata (Linnaeus) Stapf	Grass	T
Dichanthium annulatum (Forsskal) Stapf	Grass	T
Brachiaria distachya (Linnaeus) Stapf	Grass	T
Coix aquatica Roxburgh	Grass	T
Crytococcum accrescens (Trinius) Stapf	Grass	T
Cynodon dectylon (Linnaeus) Persoon	Grass	H
Perotisindica (Linnaeus) Kuntze	Grass	T
Rottboellia cochinchinensis (Loureiro) W.D. Clayton	Grass	CR
Oryza rufipogon Griffith	Grass	CH
Oryza sativa Linnaeus	Grass	T
Dactyloctenium aegyptium (Linnaeus) Willdenow	Grass	T
Digitaria bicornis (Lamarck) Roemer & Schultes	Grass	T
Leptochloa panicea (Retzius) Ohwi	Grass	T
Digitaria ciliaris (Retzius) Koeler	Grass	CH
Echinochloa colona (Linneaus) Link	Grass	T
Echinochloa crus-galli (Linneaus) P. Beauvois	Grass	T
Echinochloa stagnina (Retzius) P. Beauvois	Grass	T
Eleusine indica (Linneaus) Gaertner	Grass	T
Eragrostis atrovirens (Desfontaines) Trinius *ex* Steudel	Grass	T
Eragrostis gangetica (Roxburgh) Steudel	Grass	CH
Eragrostis pilosa (Linneaus) P. Beauvois	Grass	CH
Pannisetum polystachyon (Linneaus) Schult	Grass	CH
Eragrostis tenella (Linneaus) Beauverd *ex* Roemer *et* Schultes	Grass	T
Eragrostis unioloides (Retzius) Nees *ex* Steudel	Grass	CH
Imperata cylindrica (Linnaeus) Raeuschel	Giant grass	T
Leersia hexandra Swartz	Grass	CH
Oplismenus burmannii (Retzius) P. Beauvois	Grass	CH
Panicum repens Linnaeus	Grass	T
Paspalidium flavidum (Retzius) A. Camus	Grass	CR
Paspalidium punctatum (Burman) A. Camus	Grass	CR
Paspalum conjugatum Bergius	Grass	CR
Paspalum distichum Linnaeus	Grass	T
Paspalum scrobiculatum Linnaeus	Grass	CH
Saccharum spontaneum Linnaeus	Giant grass	P
Sacciolepis indica (Linnaeus) Chase	Grass	P

Sacciolepis interrupta (Willdenow) Stapf	Giant grass	T
Sataria glauca (Linnaeus) P. Beauvois	Grass	T
Sporobolus diander (Retzius) P. Beauvois	Grass	T
Vetiveria zizanioides (Linnaeus) Nash in Small	Giant grass	T
POLYGONACEAE		
Persicaria barbata Linnaeus	Shrub	CR
Persicaria barbata (Linnaeus) Hara ssp. *stagnina* (Buch-Hamil. *ex* Meisn) Sojak	Herb	CR
Persicaria hydropiper Linnaeus	Aquatic Herb	CR
Persicaria orientalis (Linnaeus) Assenov	Shrub	CR
Persicaria pubescens Blume	Herb	CR
Persicaria decipiens (R. Brown) K. L. Wilson	Herb	CR
Rumex dentatus Linnaeus	Herb	H
Rumex maritimus Linnaeus	Herb	H
Polygonum plebeium R. Brown	Herb	H
PONTADARIACEAE		
Eichhornia crassipes (Martius) Solms	Aquatic Herb	T
Monochoria hastate (Linnaeus) Solms	Aquatic Herb	T
Monochoria vaginalis (Burman *f.*) C. Presl	Aquatic Herb	T
PORTULACCACEAE		
Portulaca oleracea Linnaeus	Herb	H
Ranunculus sceleratus Linnaeus	Aquatic Herb	H
PRIMULACEAE		
Anagallis arvensis Linnaeus	Herb	H
POTAMOGETONACEAE		
Potamogeton crispus Linnaeus	Aquatic Herb	H
Potamogeton nodosus Poiret	Aquatic Herb	H
RUBIACEAE		
Dentella repens (Linnaeus) Forster	Herb	H
Oldenlandia corymbosa Linnaeus	Herb	T
Oldenlandia diffusa (Willdenow) Roxburgh	Herb	CR
Oldenlandia biflora Linnaeus	Herb	H
SALVINACEAE		
Azolla pinnata R. Brown	Aquatic Herb	T
Salvinia cucullata Roxburgh *ex* Bory	Aquatic Herb	T
Salvinia natans (Linnaeus) Allioni	Aquatic Herb	T
SCROPHULARIACEAE		
Bacopa monnieri (Linnaeus) Pennell	Aquatic Herb	CR

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Limnophila heterophylla (Roxburgh) Bentham	Aquatic Herb	CR
Limnophila indica (Linnaeus) Druce	Aquatic Herb	CR
Scoparia dulcis Linnaeus	Aquatic Herb	T
Limnophila repens Bentham	Herb	T
Limnophila sessiliflora (Vahl) Blume	Aquatic Herb	P
Mazus pumilus (Burman *f.*) Steenis	Herb	T
Mecardonia procumbents (Miller) Small	Herb	T
SOLANACEAE		
Datura stramonium Linnaeus	Shrub	H
Nicotiana plumbaginifolia Viviani	Herb	T
Physalis minima Linnaeus	Herb	CR
Solanum nigrum Linnaeus	Herb	CH
Solanum sisymbriifolium Lamarck	Shrub	CH
Solanum surattense Burman *f.*	Shrub	CH
Solanum torvum Swartz	Shrub	T
SPHENOCLEACEAE		
Sphenoclea zeylanica Gaertner	Shrub	T
TYPHACEAE		
Typha angustifolia Chaubard	Herb	T
URTICACEAE		
Pouzolzia hirta (Blume) Hasskarl	Tall Reed	H
Pouzolzia zeylenica (Linnaeus) Bennet	Herb	H
VERBANACEAE		
Lippia javanica (Burman *f.*) Sprengel	Shrub	T
Phyla nudiflora (Linnaeus) Greene	Herb	CR
POLYGALACEAE		
Polygala glomerata Loureiro	Herb	CR

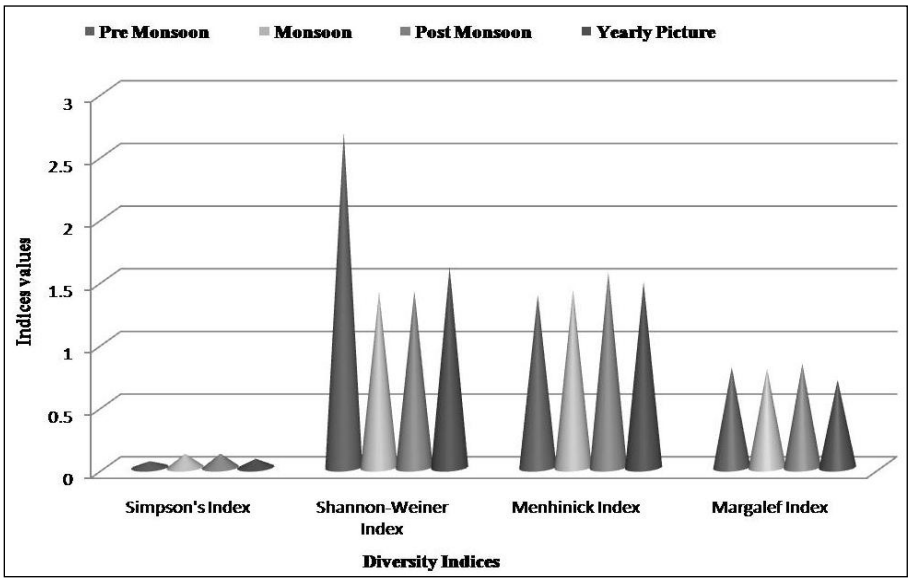

Figure 3: Graph showing the season wise diversity indices values

Phytosociology

Phytosociological analysis of vegetation is quite important as it gives clear idea about the composition of vegetation and the importance of different existing species. To understand the community structure, 121, 78 and 87 quadrate samplings were executed at random, respectively, in pre-monsoon, monsoon and post-monsoon seasons. Aggregating all the pre-monsoon, monsoon and post-monsoon quadrate data in a single head and further computation shows the overall annual phytosociological vegetation structure of this wetland. The recorded data also include the presence of total 13247 individuals of 163 species; those were found within 286 quadrates in the sampling area. The analyzed data shows that *Eichhornia crassipes* [F =45.45; RF =6.80], represents the highest F and RF, followed by *Alternantheara philoxeroides* [F =22.38; RF =3.35] and *Cynodon dectylon* [F =19.93; RF =2.98. *Azolla pinnata* [D =9.34; RD =20.17] shows maximum D and RD, followed by *Lemna perpusilla* [D = 5.27 & RD =11.37] and *Eichhornia crassipes* [D =2.32 & RD =5.00]. *Lemna perpusilla* [A=167.33 & RA=13.047] shows maximum Abundance (A) and Relative Abundance (RA), followed by *Azolla pinnata* [A=133.60 & RA=10.41], *Spirodela polyrrhiza* [A=66.20 & RA=5.16] and *Gnaphalium polycaulon* [A=28 & RA=2.18]. Maximum IVI was scored by *Azolla pinnata* [IVI =31.63] followed by *Lemna perpusilla* [IVI =24.88], *Spirodela polyrrhiza* [IVI =18.96] and *Eichhornia crassipes* [IVI =12.20]. On the other hand, *Phyllanthus fraternus* showed the minimum value [IVI=0.14].

Analysis of quadrate data of three different seasons exposed the clear picture of Species Diversity and Species Richness of this wetland complex (Fig. 3). For the annual picture, Shannon-Weiner Index for Species Diversity was calculated to be 1.60 and the highest value exhibits 2.68 during post-monsoon, when pre-monsoon shows 1.41 and monsoon shows 1.40. The Simpson Index for Concentration of Dominance was observed at 0.07. The value is much higher (0.11) during post -monsoon and is followed by pre-monsoon and monsoon with same value 0.05. The Species Richness value was calculated using Menhinick (1964) and Margalef (1968) Indices. Menhinick Index for Species Richness shows 1.42 for yearly picture. Post-monsoon shows higher value of 1.56, followed by pre-monsoon and monsoon with same value 1.38. Margalef Index shows yearly value of 0.67. Post-monsoon shows highest value with 0.83, followed by pre-monsoon (0.79) and monsoon (0.77). This work records 292 plant species of angiosperms and pteridophytes and comparative analysis with Raunkiaer's normal spectrum is given in Fig. 4. The life forms of various species of this wetland complex shows that the 55.95% of total flora are Therophytes, followed by Cryptophytes (17.48), Hemicryptophytes and Chamaephytes with equal value of 13.28 and Phanerophytes with 2.09 (Figure 4).

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