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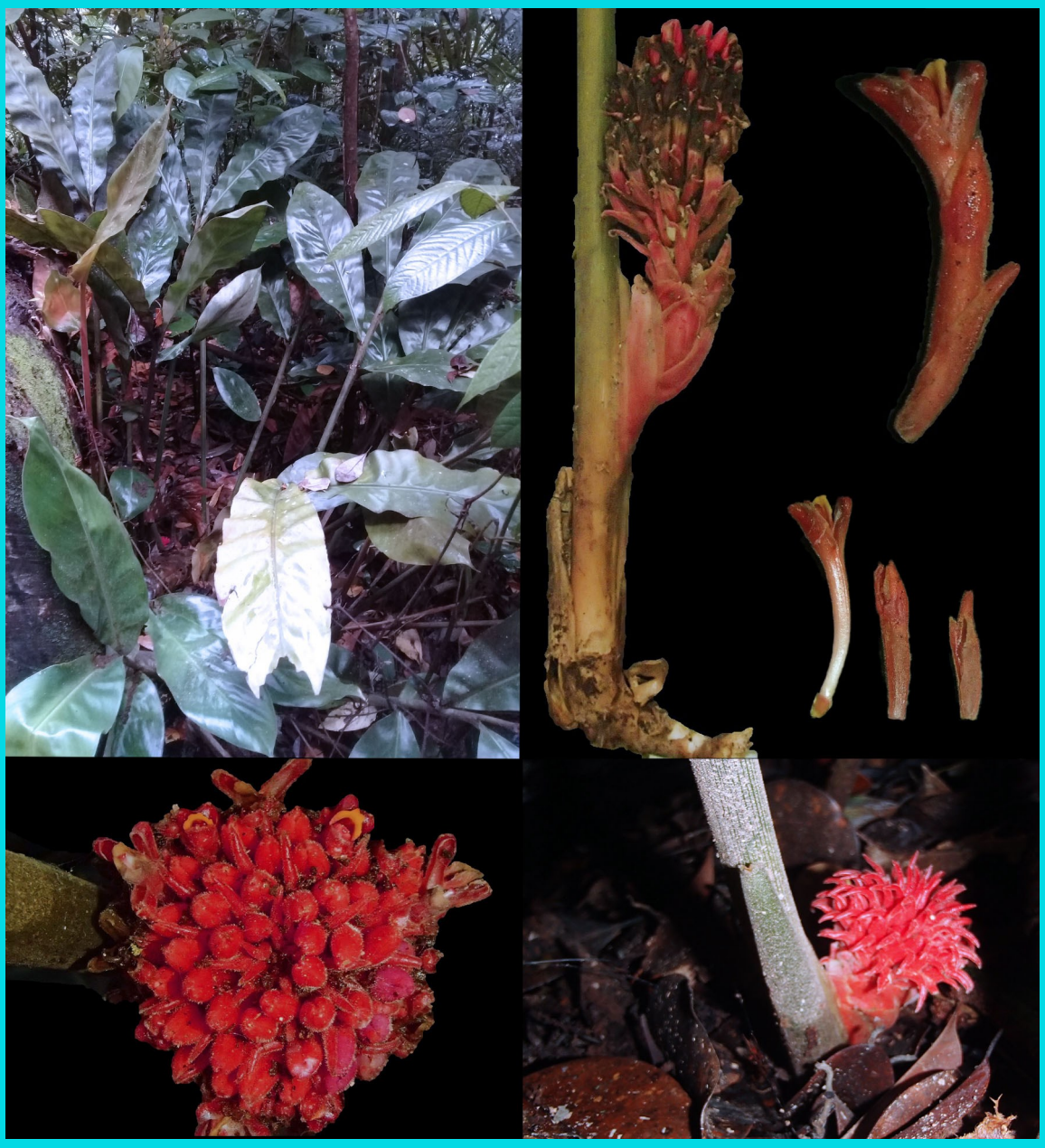

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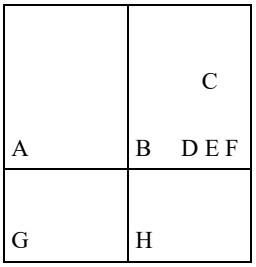

Cover images: *Plagiostachys strobilifera* var. *conica* Salasiah & Meekiong. A. Habit. B. Inflorescence, lateral view. C. Whole flower, lateral view. D. Flower with calyx removed. E. Calyx. F. Bracteole. G. Inflorescence, aerial view. H. Young inflorescence. A–G. *Salasiah 0003*; *H. Salasiah et al. 0014*. Photos by Salasiah Mohamad.

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ANATOMICAL STUDIES ON *WALLICHIA NANA* GRIFF., A WILD PALM OF ASSAM, INDIA

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ABSTRACT
MEHMUD, S. & ROY, H. 2020. Anatomical studies on *Wallichia nana* Griff., a wild palm of Assam, India. *Reinwardtia* 19(2): 97–102. — The present communicated research is a study based on the observation of free hand transverse section of leaf, stem and root and epidermal morphology of lamina in *Wallichia nana*, a species distributed in North-eastern states of India. Occurrence of paracytic stomata was noted on both surfaces of the lamina but comparatively more on lower surface. Number of metaxylem vessel recorded in lamina is single whereas, one to two in stem, petiole and roots. Presence of mucilage sacs recorded in the cortex of both petiole and stem.

Keywords: Anatomy, epidermal morphology, lamina, petiole, root, stem.

ABSTRAK
MEHMUD, S. & ROY, H. 2020. Studi anatomi *Wallichia nana* Griff., jenis palem liar dari Assam, India. *Reinwardtia* 19(2): 97–102. — Penelitian ini merupakan studi berdasarkan pengamatan irisan melintang daun, batang dan akar serta morfologi epidermis helaian daun *Wallichia nana.* Palem jenis ini tersebar di India bagian Timur Laut. Stomata parasitik dijumpai pada kedua permukaan daun tetapi lebih banyak ditemukan pada permukaan bawah daun. Pembuluh meta-xilem tunggal dijumpai pada helaian daun, namun jenis pembuluh ini dijumpai satu sampai dua buah pada batang, tangkai daun dan akar. Pada bagian korteks tangkai daun dan batang terdapat kantung-kantung lendir.

Kata kunci: Akar, anatomi, batang, helaian daun, morfologi epidermis, tangkai daun.

INTRODUCTION

Wallichia Roxb., is a small palm genus with eight species known from Bangladesh, Bhutan, China, India, Myanmar, Thailand and Vietnam (Henderson, 2009). Five species occur in India, viz. *Wallichia caryotoides* Rox., *Wallichia disticha* T. Anderson, *Wallichia nana* Griff., *Wallichia oblongifolia* Griff. and *Wallichia triandra* (J. Joseph) S.K.Basu. The range of distribution of all these species in the country is West Bengal and the states of northeast India (Renuka & Sreekumar, 2012). *Wallichia nana* is a small, erect palm distributed mainly in Assam, Arunachal Pradesh and Meghalaya; *W. disticha* and *W. oblongifolia* were also reported from Assam (Henderson, 2007 & 2009). The species *W. nana* is hepaxanthic. (Renuka & Sreekumar, 2012).

Based on the presence of connate calyx of staminate flower, the species was transferred from *Arenga nana* (Griff.) H.E.Moore to *Wallichia nana* Griff., in a revision by Henderson (2007). Both genera are placed in the Caryoteae and basic anatomical features of both the genus based on examined materials *e.g. Arenga saccarifera*, *A. wighii*, *A. undulatifolia* as well as *Wallichia densiflora* and *W. disticha* provided by Tomlinson (1961). A detailed anatomical study was conducted on *Wallichia densiflora* Mart. (= *W. oblogifolia* Griff.) from India by Pawar (1988). The present study was carried out to work out the detail anatomy of lamina, petiole, stem and root of this species. Quality photographs are also added to justify the study.

MATERIALS AND METHODS

Samples representing the species were collected from different parts of Assam during the months of September to February. The samples were preserved in formalin for anatomical study and processed for voucher specimen based on standard procedure (Jain & Rao, 1977). A herbarium specimen deposited to ASSAM (ASSAM 96256) and its duplicate submitted to Herbarium of Department of Botany, Cotton University. Identification of the species was confirmed by literatures (Henderson, 2007 & 2009; Renuka & Sreekumar, 2012) and by herbarium visits (ASSAM, CAL).

Sharp new blades were used for free hand and transverse fine cross sections of the leaflets, petiole, stem, and root. Sections with quality features selected for double staining with

alcoholic grade passed and were mounted in DPX. For epidermal study of leaf the suggested procedures (Talukdar & Devi, 2016; Karmakar *et al*., 2017) with slight modification where, small pieces of lamina are placed only in 3% NaOH solution and after three days the pieces were washed carefully and then both upper and lower epidermal layers were scratched, thin layers were then stained with safranin. Measurements and photographs were taken by computer attached light microscope (Lawrence Mayo) as well as through mobile phone camera. Published literatures for identification of stomata (van Cotthem, 1970) and for description of tissue (Magellam & Tomlinson, 2015; Anna-Santos *et al*., 2015; Millan & Kahn, 2010; Horn *et al*., 2009) were followed in the present study.

RESULTS

The species is up to 1.2 m long, stem delicate; stems covered with leaf sheath is around 2 cm in diameter; after removing the sheath and covered by brown hairs the stem is around 1 cm across. Leaf is 40–60 cm long, pinnate, leaflets lanceolate, serrated 25–30 cm long and 3-4 nos. per side of the rachis, terminal leaflets connate and bi-lobbed. Mid vein is abaxially prominent; venation parallel, the upper surface of the pinnae is green whereas lower surface is silvery white. Ligule is around 8–9 cm long and fibrous. Inflorescence terminal, around 20 cm long, fruits are white to light green, ellipsoid and up to 2 cm long (Fig. 1A-C). The species can be distinguished from other species included in the genus, with small stem size, presence of ligule, numbers of leaflets and ellipsoid fruits as also mentioned by Henderson (2007 & 2009).

Transverse section of the lamina. A transverse section of dorsiventral lamina with abaxially prominent mid vein (Fig. 2A-E) shows single layered epidermis with thick cuticle in both surface. Indumentums presents in abaxial surface. Epidermal cells are ovate or rectangular *ca.* 5 µm in both surfaces; stomata present in observed on both surfaces. Next to epidermis is one or two layers of hypodermis consisting of round or rectangular or irregular cells of 8–11 µm. Hypodermis is followed by 3-4 layers of round to ovate or rectangular chlorenchymatous cells of 7–10 µm; in this layer few scattered fiber bundles present along with fibrovascular bundles comprises single or double metaxylem vessel 8–10 µm, one phloem strand 20.3 µm and protoxylem one or absent.

Mid vein appears ovate in transverse section. Epidermal cells are similar to lamina. In adaxial surface, below the epidermis one or two layer of hypodermis consisting of hexagonal or round chlorenchymatous cells present, another two or three layers of elongated rectangular cells in the hypodermis extends up to the mid vein. In abaxial surface, the mid vein is covered by single epidermal layer. The fibrovascular bundle in mid vein composed of thick walled fiber cells and two to three vascular bundles of 75.31 × 50.24 µm are scattered in middle of the vein; metaxylem one 12–18 µm, one kidney shaped phloem strand 34.71 × 13.49 µm; protoxylem round, three to four 11–13 µm; ground parenchymatous cells are round and thin walled. Few solitary phloem bundle present in the periphery.

Fig. 1. A. Habit of *Wallichia nana* Griff., B. Infructescence (graph unit: 2.5 mm). C. Stem with ligule. Scale bars: A= 10 cm; B & C= 2 cm. Photos by S. Mehmud.

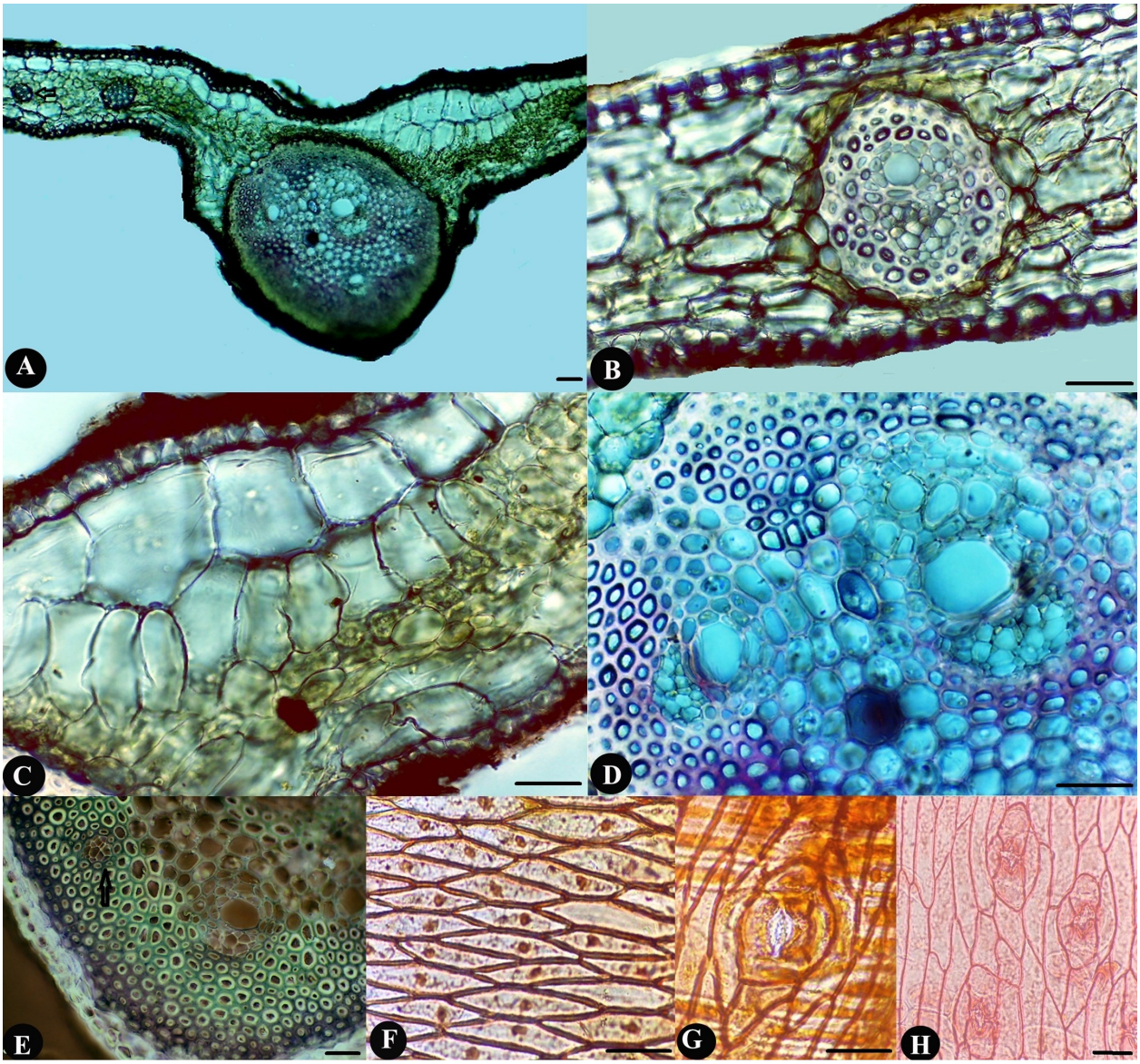

Fig. 2. Anatomy of *Wallichia nana* Griff., A. An outline of the lamina with fiber bundle (arrow) and mid vein. B. Fibrovascular bundle in lamina. C. Extension of tissues near mid vein. D. Fibrovascular bundles of mid vein. E. Phloem strand in periphery of mid vein (arrow). F. Upper epidermal cells. G. Stomata of upper epidermis. H. Stomata of lower epidermis. Scale bars: A = 50 µm; C = 10 µm; B, D, E, F, G & H = 20 µm. Photos by S. Mehmud.

Epidermal morphology of the lamina. Epidermal cells of upper surface are tapering and elongated 49–53 µm long and 7–9.8 µm wide, (Fig. 2F); stomata paracytic few in upper surface *ca.* 26 µm (Fig. 2G). Epidermal cells in lower surface is similar to size as upper but cells are not tapering like upper surface, stomata type same but numbers more than upper surface (Fig. 2H).

Petiole. The petiole is covered by brown indumentums and undulated in outline. The outermost epidermis is single layer, cells are round to rectangular 7–8 µm, thick walled; hypodermis 1-2 layers of thin walled ovate to rectangular cells 9–10 µm; cortex 1-2 layers, with few mucilage sacs of 10 × 22 µm are present at intervals. The peripheral fibrovascular bundles are 150–153 µm and composed of single or double vessels metaxylem 27–30 um; phloem single strand 14–36 µm above the metaxylem, phloem cells 2–6 µm, thin walled; protoxylem two to five 14–15 µm arranged opposite to the phloem strand. Ground parenchyma with round to hexangular cells 24–30 µm where scattered fibrovascular bundles 79–113 µm, metaxylem vessels 33 µm one or two, phloem stand *ca.* 38 µm single, protoxylem abnsent or one to five 12–14 µm or absent. Tannin cells present frequently. (Fig. 3A-D).

Stem. Thin transverse section of the stem (Fig. 3E-F) shows a single layered cuticular epidermis; epidermal cells thick walled, ovate or round to rectangular *ca.* 10.34 µm; hypodermis 1-2 layer of thin walled round to hexangular cells, without intercellular spaces; cortex 3-4 layers of thin walled round to angular cells, not well developed or narrow associated with fiber bundles and few round to rectangular mucilage sacs at regular intervals. The peripheral fibrovascular bundles *ca.* 145.7 µm, metaxylem vessels one or two *ca.* 31.66 µm; phloem strand single *ca.* 44.7 µm, protoxylem 4-6 nos. The ground parenchyma cells *ca.* 8.2 µm are thin walled, round to rectangular or hexangular present and without intercellular spaces. Central fibrovascular bundles *ca.* 69.12 µm are scattered, metaxylem vessel *ca.* 12.45 µm, single or double; single phloem strand *ca.* 26.56 µm; protoxylem present or absent. Few transverse fiber bundles and tannin cells are also present.

Roots. Roots light yellow, the epidermis is single layered consists of rectangular cells. Inner to epidermis is three to six layers of round to polygonal thick walled cells *ca.* 12 µm present. Cortex multi layered composed of thin walled round to hexagonal compact cells 27–30 µm. Fiber bundles scattered in the cortex. Elongated air cavities of *ca.* 140 µm arranged in between endodermis and cortex. The stele is composed by a circular single layer endodermis, cells *ca.* 8 µm, pericycle single layer and cells are 2 × 14 µm. In the peripheral region of stele the phloem strand and xylems are alternately arranged. Phloem strands are round or elongated 19–21 µm, metaxylem vessel one or two 32–35 µm. The central pith is with round to angular thin walled cells and without any intercellular spaces. (Fig. 3G).

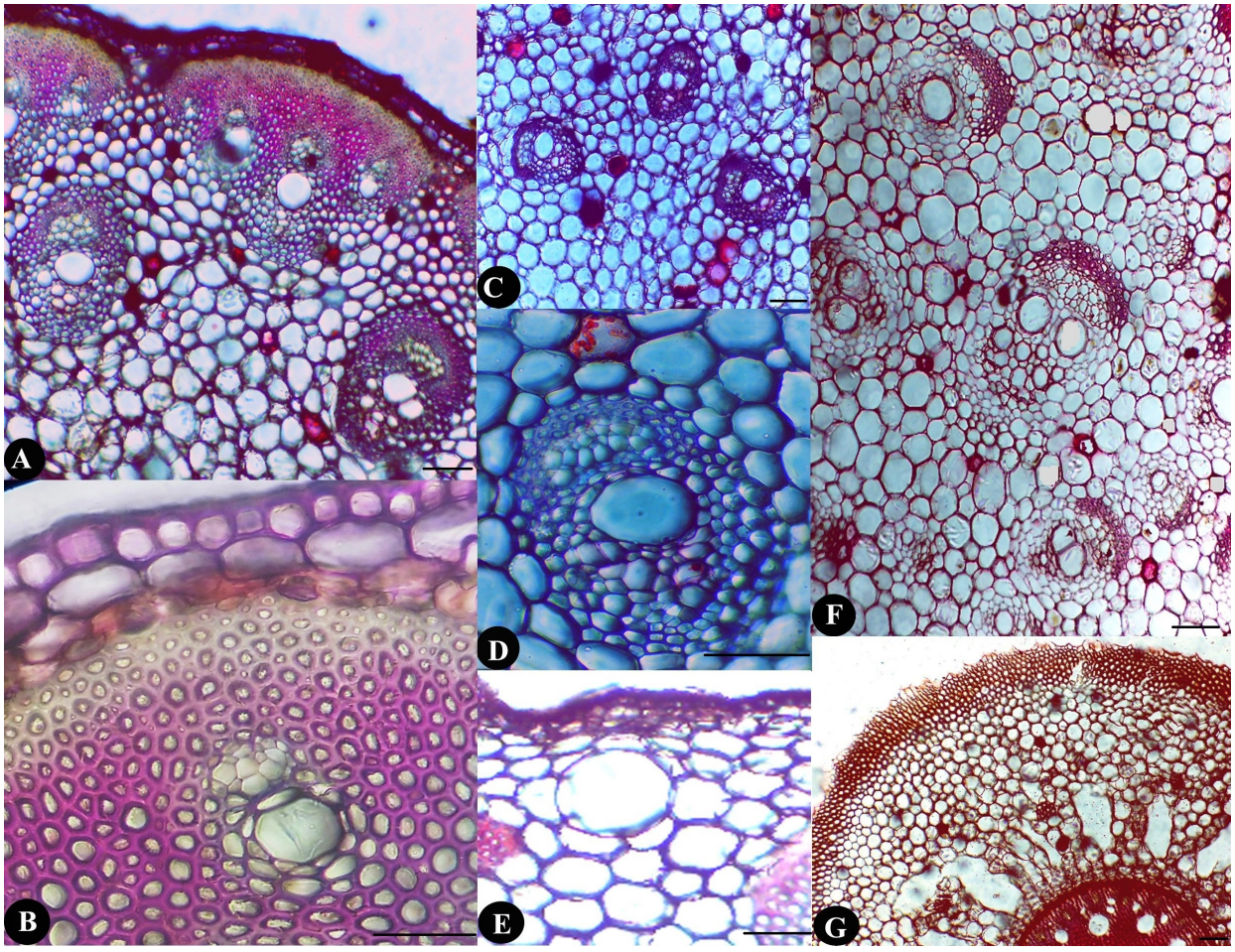

Fig. 3. Anatomy of *Wallichia nana* Griff., A. Outline of petiole. B. Epidermis to peripheral fibrovascular bundle of petiole. C. Scattered fibrovascular bundle in mid portion of the petiole. D. A complete fibrovascular bundle of petiole. E. Transverse section of stem. F. Fibrovascular bundles form mid portion of the stem. G. Outline of root. Scale bars: A, E & F = 20 µm; B, C, D & G = 30 µm. Photos by S. Mehmud.

DISCUSSION

The observation noted in the present study shows similarity between *W. nana* and other species of the genus in regard to features like presence of cuticle, thick-walled epidermis, nature of hypodermis and scattered fiber bundles in the cortex. Stomata found to be distributed in both the surfaces of lamina in *W. nana* while reported only in abaxial surface of *W. disticha* (Tomlinson, 1961). The fibers present in lamina of *Arenga* but it is species specific among the members of *Wallichia*, as absent in *W. caryotoides* and *W. disticha* and frequent in *W. densiflora* (Tomlinson, 1961) and in our study its presence was noted in the lamina of *W. nana.* In the petiole of *W. nana* central vascular bundles are scattered and similar observation recorded by Tomlinson (1961) in leaf axis of *W. densiflora*; metaxylem vessels in both petiole and stem generally one but two in few vascular bundles with single phloem strand. Presence of single metaxylem in leaf axis and double vessels in stem of *Arenga*; whereas, one to two vessels in leaf axis, and two vessels in stem of *Wallichia* (Tomlinson, 1961) and similar observation recorded in *W. nana* in the present study is an additional support to the transfer of the species from *Arenga* to *Wallichia* by Henderson (2007). It was also interesting to note that the presence of stomata in adaxial surface of *W. nana*, not reported both in *Arenga* and *Wallichia* (Tomlinson, 1961). Mucilage sacs in the petiole and stem of *W. nana* are another important feature, also reported by Pawar (1988) in *W. densiflora.* Round to rectangular epidermal cells noted in petiole and stem of *W. nana* against columnar shape in *W. densiflora* reported by Pawar (1988) whereas Thomas & De Franceschi (2013) reported cone shaped in *Arenga* (or *Wallichia*).

CONCLUSION

The role of stem anatomy in systematic and phylogenetic analysis of palms species was described (Henderson & Stevenson, 2006; Thomas & De Franceschi, 2013). Thomas & Boura (2015) conducted a study on stem anatomy and vessels diameter to analyze correspondences between anatomy and climate, and concluded that stem anatomy correlated the climate and shows phylogentic signals; therefore, the present anatomical observation may prove useful in such other research programmes in future.

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