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Epigeal Cryptocotyly in *Madhuca indica* J. F. Gmel. (Sapotaceae)

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Abstract: An unusual case of epigeal cryptocotyly found in *Madhuca indica* J. F. Gmel. (Syn. *Bassia latifolia* Roxb.) of Sapotaceae is described and discussed in this study. The morphological characters shown by *M. indica* seedlings such as thickened hypocotyl, thick woody seed coat and non photosynthetic haustorial cotyledons are closely related to its epigeal cryptocotyly. The incidence of epigeal cryptocotylar germination in angiosperms seems to be scarce in available literatures. Such knowledge of germination and seedling morphology can throw some light in the silvicultural practices of this tree.

Key word: *Madhuca indica*, seedling, morphology, germination, Sapotaceae

INTRODUCTION

Madhuca indica J. F. Gmel. (Syn. *Bassia latifolia* Roxb.), commonly known as mahua (butter tree), is a large deciduous tree which belongs to the family Sapotaceae. The tree is indigenous to the Central India and commonly distributed in Andhra Pradesh, Bihar, Gujarat, Madhya Pradesh, Orissa, Uttar Pradesh and West Bengal. This tree is generally identified by thick leathery leaves and small, pale or dull white musk-scented flowers in clusters near the end of branches. It is widely cultivated for the production of oil from its oleaginous seeds which is used for skin-care, to manufacture soaps or detergents and as a vegetable butter. It can also be used as a bio-diesel (Ghadge and Raheman, 2005). The oil cake is used as bio fertilizer, organic manure and as feed for fish and cattle.

Seedling may be defined as a plant produced from seeds, in distinction to plant propagated artificially (Jackson, 1928). After germination, majority of dicotyledons follow either phanerocotylar (when the cotyledons emerge from the testa) or cryptocotylar (when the cotyledons do not emerge from the testa) types of seedling development (Duke, 1965). As to the position of the cotyledons in relation to the soil surface, the germination is said to be epigeal (cotyledons are raised above the soil surface) or hypogeal (cotyledons remain in the soil). In general, cryptocotylar seedling is associated with hypogeal germination and phanerocotylar seedling corresponds to epigeal germination.

Epigeal cryptocotylar germination seems to be unusual in seedling development. Garwood (1996), Ricardi (1999) and Franceschini (2004) had observed such germination pattern for some members of the family Annonaceae. Similar germination was described for *Virola sebifera* Aubl. by Flores and Rivera (1989). In the Indian context, Kamilya and Paria (1994) reported such incidence of epigeal cryptocotyly in *Jatropha multifida* Linn. Besides this, there is no earlier report of epigeal cryptocotylar germination in investigated Indian flora.

Bokdam (1977) has worked on seedling morphology of 46 species belonging to 25 genera of African Sapotaceae and observed phanerocotylar germination as general characteristics for this family. As such the purpose of this study was to report epigeal cryptocotylar germination in *Madhuca indica* J. F. Gmel. (Sapotaceae) and morphological characters associated with this unusual type of germination and also to discuss the importance of seedling morphology in cultivation and management of this economically important species.

MATERIALS AND METHODS

Seeds of *Madhuca indica* were collected from different parts of West Bengal, India during the months of July-August 2007. The seeds were washed, air dried and sown in the earthen pots and the developmental stages of seedlings were recorded and studied during germination. Seedlings of different stages representing possible intra-specific diversity were also collected from natural habitats. The natural seedlings were studied and compared with those of raised ones using a Wild M3 stereomicroscope. At least 10-15 specimens of different growth forms were studied from different habitats. The

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seedlings were photographed and documented in the way of Herbarium sheets. The voucher specimens were deposited in Calcutta University Herbarium (CUH), India. The morphology was described following standard terminology (Burger, 1972; Hickey, 1973; Bokdam, 1977; Devogel, 1980).

RESULTS AND DISCUSSION

The seeds of *M. indica* is ellipsoid, shining smooth, brown, 3.54±0.2 cm×2.2±0.15 cm, with hilum longitudinally adpressed on edge of the seed. The seed coat is hard and sclerenchymatous (Fig. 1a-e) and the embryo is nonchlorophyllous.

Germination starts from third week after planting. The seedling axis gradually becomes thicker from collet to hypocotyl region during the development of juvenile leaves. The seedling morphological characters were observed till six to eight juvenile leaves developed and are described below:

Seedling type epigeal, cryptocotylar. Tap root 4.5-13.2 cm, hard, yellowish brown, with branched or unbranched side roots. Hypocotyl not enlarging (1-1.7 cm), glabrous, thickened, strong. Cotyledons two, secund, ellipsoid, 3-4.5 cm ×2-3 cm, succulent, exstipulate, petiolate, covered by shining brown persistent hard seed coat; petiole flattened, yellowish creamy, encircling the hypocotyl, 1.0-1.6 cm long, glabrous. Internodes first one strongly elongating, 3-10 cm long, scarcely hairy; next internodes provided with pubescent hairs, second one 2.5-4.5 cm long, third one 0.6-1.2 cm long, fourth one 1.0-1.6 cm long, stem slender, straight. First two leaves opposite, simple, stipulate, stipules free lateral, petiolate; petiole channeled above, hairy, 0.4-0.7 cm long; blade elliptic, 3.0-4.2 cm×1.7-2.1 cm, base balance asymmetric, base attenuated, apex acute-acuminate, margin entire, surface hairy, hairs more abundant along midrib, veins pinnately arranged; midrib or primary vein raised above, more prominent below; secondary veins sunken above, raised below, no. of secondary veins 9-11 pairs, venation pattern brochidodromous. Subsequent leaves alternate, simple, stipulate, petiolate, blade elliptic or ovate-elliptic, third leaf 3.5-5.5 cm ×1.7-2.7 cm, fourth one 3.6-6.5 cm ×1.7-2.7 cm, characters of stipule, petiole, lamina and venation are similar to that of first two leaves (Fig. 1).

The investigated taxon, *Madhuca indica*, is characterized by some important features in its seedling morphology and germination which serve as marker characters for identification. *Madhuca indica* shows unusual cryptocotylar, epigeal germination pattern, where the intact seed is carried above the ground due to rapid growth of hypocotyl during germination, which is rare among the investigated angiosperms. In the seedling of

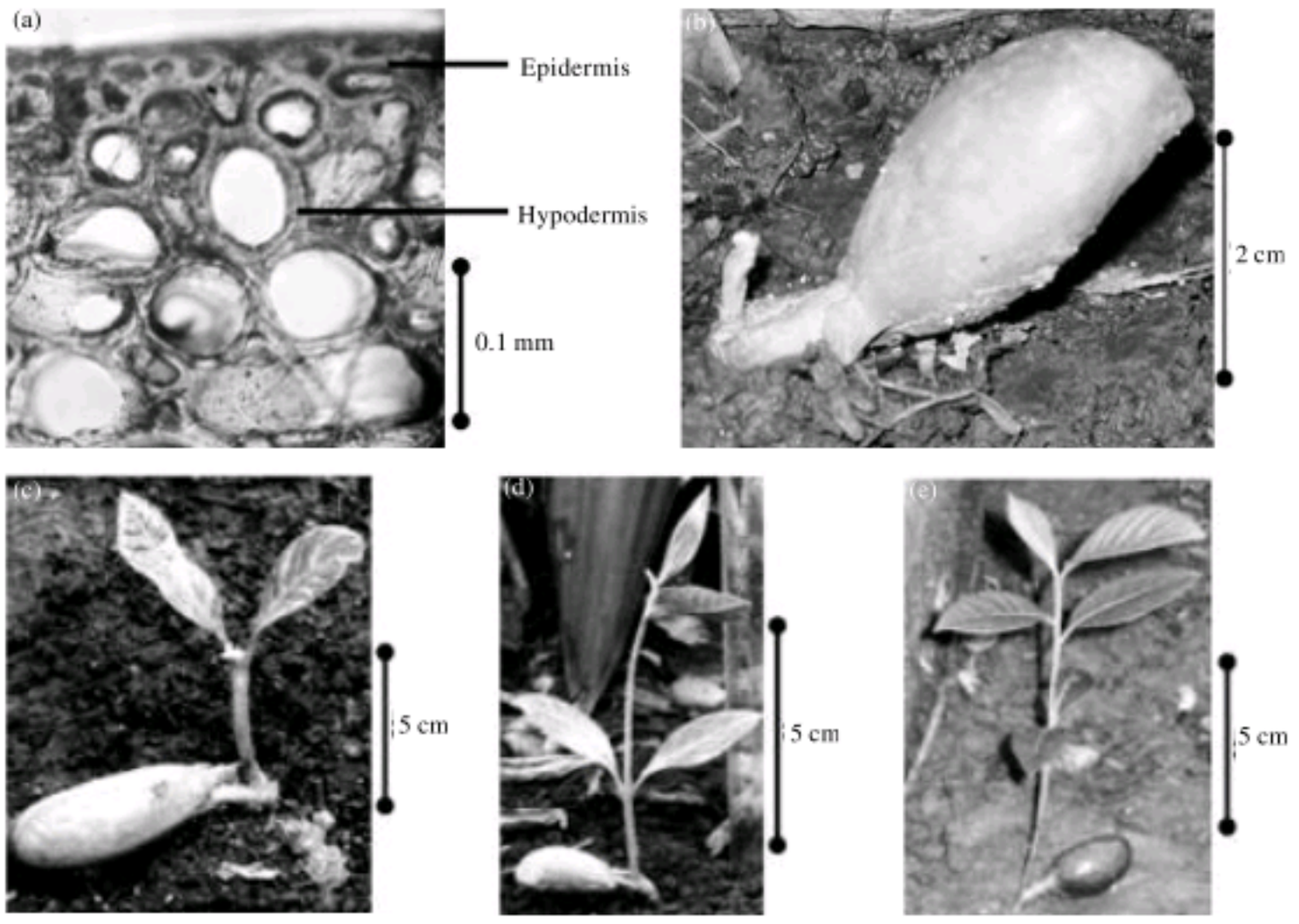

Fig. 1: *Madhuca indica* J. F. Gmel. (Sapotaceae): (a) a portion of cross-section of seed-coat, (b) germinating seed; (c-e) different stages of seedling development, (c) two leaves stage, (d) four leaves stage and (e) six leaves stage

Madhuca indica, the hypocotyl provides mechanical support to cotyledons in coming out above soil surface but the growing hypocotyl does not have sufficient strength to raise the seed above the ground level as in *Jatropha multifida* Linn. (Kamilya and Paria, 1994), it is hooked and seed gets to the ground surface. The cotyledons remain enclosed within hard seed coat, being never exposed except their petioles and remaining persistent up to 7-8 leaves stage.

The morphological characters of seeds found in *Madhuca indica* such as woody sclerenchymatous seed coat, nonchlorophyllus embryo are related to epigeal cryptocotylar germination. The hard seed coat shields the embryo against temperature-humidity variations and microorganism invasions, but it is considered unfavourable as it slows down the germination (Franceschini, 2004).

Seedling morphological characters, e.g., thickened hypocotyl and non-photosynthetic haustorial cotyledon (cryptocotylar seed) are related to this type of germination in *Madhuca indica*. Similar features were observed by Franceschini (2004) for epigeal cryptocotylar germination in *Rollinia salicifolia* (Annonaceae). The seedlings of *Madhuca indica* is further characterized by glabrous hypocotyl, hairy internodes, opposite phyllotaxy of first two leaves and alternate arrangement of subsequent leaves which may help in the identification of taxa at juvenile stage i.e., much before the stages of flowering and fruiting. Further, cryptocotyly in plants are generally considered as a primitive characteristic. The cryptocotylar germination ensures the stability and survival of the seedling even under adverse environmental conditions, as the growing seedling derives dual advantage, i.e., nutrient support from the cryptocotylar seed and photosynthates from green juvenile leaves at the initial growing stage of the seedling until the detachment of the seed. Thus, this thorough knowledge of germination stages to the development of seedlings can be beneficial in cultivation and management of such plants of high potential values. This will also help in *ex situ* and *in situ* conservation of such economically important species.

The results presented here represent the first record of this type of germination in Sapotaceae for India.

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