

ANATOMY OF *HYGROPHILA SCHULLI* A: WELL KNOWN AYURVEDIC HERB

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ABSTRACT

Hygrophila schulli (Buch-Ham.) MR and SM Almeida (Syn. *Hygrophila auriculata* (K. Schum.) Heine, *Asteracantha longifolia* (L.) Nees) is a reputed ayurvedic herb known as Ikshura, Ikshugandha and Kokilkasha. All parts of the plant are medicinally useful. To some extent information about its phytochemicals is available; however, no data is available regarding anatomy, which is very important from pharmacognostic point of view. In order to standardize the drug, detailed morphological, anatomical (structure of root, stem and leaf, vessel elements of root and stem, leaf architecture, trichomes etc.) and dermatological features were studied. *Hygrophila schulli* can be characterized on the basis of combination of characters like development of anomalous cambia in old stem, presence of abnormal stomata, isobilateral leaf, marginal veinlets free and forming loops and various types of crystals.

Keyword: Anatomy, Ayurvedic herb, *Hygrophila schulli*

INTRODUCTION

Hygrophila schulli (Syn. *Hygrophila auriculata* (K. Schum.) Heine, *Asteracantha longifolia* (L.) Nees) is reputed ayurvedic herb known as Ikshura, Ikshugandha and Kokilaksha. All parts of plant are medicinally useful. The plant is sweet, sour, bitter, aphrodisiac and tonic. Root is diuretic, anti-inflammatory, used in ascites, vesical calculi, jaundice and dysentery. Leaves are used in jaundice, rheumatism and diseases of urinogenital tract. Seeds are rejuvenating, nervine tonic and useful in gonorrhoea and renal disorders (Warrier *et al.* 1996). The plant is also extensively used in folk medicine for body pain, impotency, jaundice, malaria, rheumatism, body swelling, tuberculous fistula and as aphrodisiac; leaves are used as vegetable (Jain 1991).

Several medicinal plants have been screened for potential antioxidant activity because of no side effects and economic viability (Auudy *et al.* 2003). Antinociceptive activity of leaves is comparable to aspirine (Shanmugasundaram and Venkataraman 2005). Radical scavenging effects of *H. schulli* were found to be of quite high level (Doss *et al.* 2009). Hepatoprotective activity has been attributed to increased regeneration of hepatocytes and inhibitory effects on microsomal enzymes (Gurusamy *et al.* 2010). Standardization of plant material is necessary to avoid the adulteration. Here an attempt is made to study the anatomy of the herb in details for the first time.

MATERIALS AND METHODS

Plant material was collected from Amravati Dist. Maharashtra. Anatomy of root, stem and leaf was studied. For the anatomical studies freshly handcut sections were observed under microscope and camera lucida sketches were made. Dried pieces of old root and

stem were selected for maceration to observe vessel elements. Thin slices of roots and stems were treated with macerating fluid prepared by mixing 5% solution of HNO₃ and 5% solution of K₂Cr₂O₇ for 12 to 24 in cavity blocks. The macerate was then thoroughly washed with water and vessel elements were stained with 1% aqueous safranin and mounted in glycerin. Measurements were made by ocular scale lens and camera lucida sketches were drawn. Classification of Radford *et al.* (1974) is followed for categorizing the vessel elements. Leaf constants such as stomatal frequency, stomatal index, palisade to spongy ratio (as seen in T.S.), PR value were determined (Kokate *et al.* 1996).

RESULTS AND DISCUSSION**Macromorphology**

Wild, marshy, armed, stout, woody, annual, 1 - 2 ft tall; stem subquadrangular, purplish green, young parts pubescent; nodes swollen, hispid below each node. Leaves simple, rough, sessile, hispid on both the sides, oblong-lanceolate, 8 - 11 x 1.5 - 2.5 cm, in whorl of 6 each, the outer 2 much larger than the inner 4, entire, ciliate, midrib prominent, base hairy; thorns axillary, straight, 2.5 x 3 cm long, glossy yellowish-brown. Flowers in axillary clusters of eight at each node; bracts 1.5 - 1.7 cm, lanceolate, hairy and margin ciliate; bracteoles linear-lanceolate, 0.9 - 1.2 cm long, hairy and ciliate with hyline margin. Calyx 4 partite; sepals linear-lanceolate, unequal, one much larger, all linear-lanceolate, 1.3 - 2 cm long, pubescent with ciliate hyline margin. Corolla purple blue, 2.5 - 3 cm long, tube 1.2 - 1.5 cm long, gibbous at mouth, widely 2 lipped, lips subequal; upper lip 2 fid with oblong truncate lobes, lower lip with yellow blotch, deeply 3 lobed; lobes oblong and rounded, minutely pubescent.

Stamens 4, didynamous; filaments glabrous, 8 - 12 mm, one long and one short filament united at base forming pairs; anthers 2 celled. Ovary glabrous; style slightly pubescent, filiform. Capsule 1 - 1.3cm long, linear-oblong, pointed at apex and rounded at base, 4 - 8 seeded; seeds brown, ovoid, pubescent with white mucilaginous hairs.

Micromorphology

Root tetrarch to pentarch (**Fig. 1**). Pith small, parenchymatous; cells thin-walled; towards the base pith gradually becomes broader. Endodermis and pericycle distinct. Epiblema gets peeled off very early. Outer 2 - 3 cortical layers persist, consisting of compactly arranged somewhat polygonal cells; cell walls of outermost layer comparatively thicker. With growth files of cells of middle cortex get detached tangentially and thus producing large air chambers. Cells of trabeculae divide tangentially to produce files of cells, which in turn detach to form more trabeculae to keep pace with the growing root. Inner cortex 2 - 3 layered; cells parenchymatous, thin-walled, enclosing small air spaces; with time cells divide radially as well as tangentially. Some of the cells of inner cortex become thick walled, lignified. Raphides present in cortex. (**Fig. 2**)

Secondary growth normal (**Fig. 3**). Vessels scattered, solitary or in uniseriate tiers; cylindrical, long, mostly tailed, tails long at least of one end. Perforation plates horizontal to oblique. Vessels fall in three categories - 1. Extremely small (Class A 168 - 175 x 18 - 27 μ m), 2. Very short (Class B 213 - 243 x 15 - 21 μ m), 3. Moderately short (Class C 155 - 294 x 18 - 21 μ m) (**Fig. 4**). Rays mostly uniseriate; few biseriate; multiseriate against protoxylem poles. Phloem with scattered stone cells. Cells of inner cortex divide repeatedly forming a multilayered cambium. However, further behaviour of this cambium can not be noted as plant comes to the end of life cycle till this time.

Young stem roughly squarish, shallowly grooved laterally and convex dorsiventrally (**Fig. 5**). Epidermis single layered showing non chlorophyllose bands and chlorophyllose bands with stomata; stomata diacytic monocyclic, hemibicyclic and bicyclic; cells cutinised and cuticularised. Cystoliths present (**Fig. 6**). Hypodermis collenchymatous, 3-4 layered, interrupted by chlorenchyma below stomata. Cortex parenchymatous with numerous air chambers; cells containing few chloroplasts. Endodermis and pericycle not distinct; cambium in the form of continuous ring. Vasculature in the form of 6 patches. Along the 4 angles vascular elements well differentiated; below the grooves vasculature gets differentiated somewhat at later stage. Cambium produces little amount of phloem to the outer side and conjunctive tissue to the inner side between vascular patches. In later stage of development

vasculature gets differentiated on dorsiventral sides, thus in all producing 8 vascular patches alternating with conjunctive tissue. During late stage of development few xylem elements are produced in the region of conjunctive tissue. Phloem in the form of continuous ring, with scattered stone cells. Pith large, parenchymatous, enclosing small intercellular spaces. Cells containing rod and needle shaped calcium oxalate crystals. (**Fig. 7**)

Secondary growth normal in early stages. Vessels scattered, solitary or in uniseriate tiers; shorter than root vessels, cylindrical to quadrangular, fall in two extremely small (Class A 99 - 135 x 21 - 24 μ m) and very short (Class B 180 - 186 x 15 - 21 μ m). Perforation plates horizontal. Tails short, on one end or on both the ends, unequal (**Fig. 13**). In later stage of development patches of cambia originate in secondary xylem producing irregular patches of large parenchymatous, loosely placed; cells with some water storage cells; few of the cells showing further division. These cambia may be produced deep within secondary xylem or in secondary phloem. Rays mostly uniseriate, few biseriate. Phloem with scattered stone cells. Cork cambium originating in pericyclic region inside the endodermis. (**Fig. 8-12**)

Node Unilacunar, single trace; however before entering the leaf base trace divides to give 3 vascular bundles; central large and two lateral ones small.

Leaf base concave on upper side winged; wings clasping the stem. Epidermis cutinised and cuticularised. Hypodermis collenchymatous, single layered on upper and lower side. Ground tissue parenchymatous, cells thin-walled with large intercellular spaces. Cells containing fan shaped crystals. Vasculature in the form of central large crescent and 2 lateral traces going to wings. (**Fig. 14a & 14b**)

Lamina amphistomatous. Epidermis single layered, cutinised and cuticularised; cells almost polygonal, angles blunt. Stomata dicytic; mono and hemibicyclic. Abnormal stomata with one aborted guard cell also present. Cystoliths solitary with blunt ends (**Fig. 15a & b**). Orientation vertically oblique to rarely vertical from midrib to margin. (**Fig. 16**)

Mesophyll differentiated into palisade and spongy parenchyma. Palisade present below both the epidermis. Upper palisade 3 layered towards midrib, gradually becoming 2 layered onwards to margin; cells compactly placed. Lower palisade two layered; however, cells shorter than that of upper palisade, loosely placed with large air spaces. Between upper and lower palisade few layers of spongy parenchyma present. Vein bundles embedded in mesophyll; bundle sheath non-chlorophyllose (**Fig. 17a**). Palisade continuous upto margin, cells shorter, vein bundle present in margin. (**Fig. 17b**)

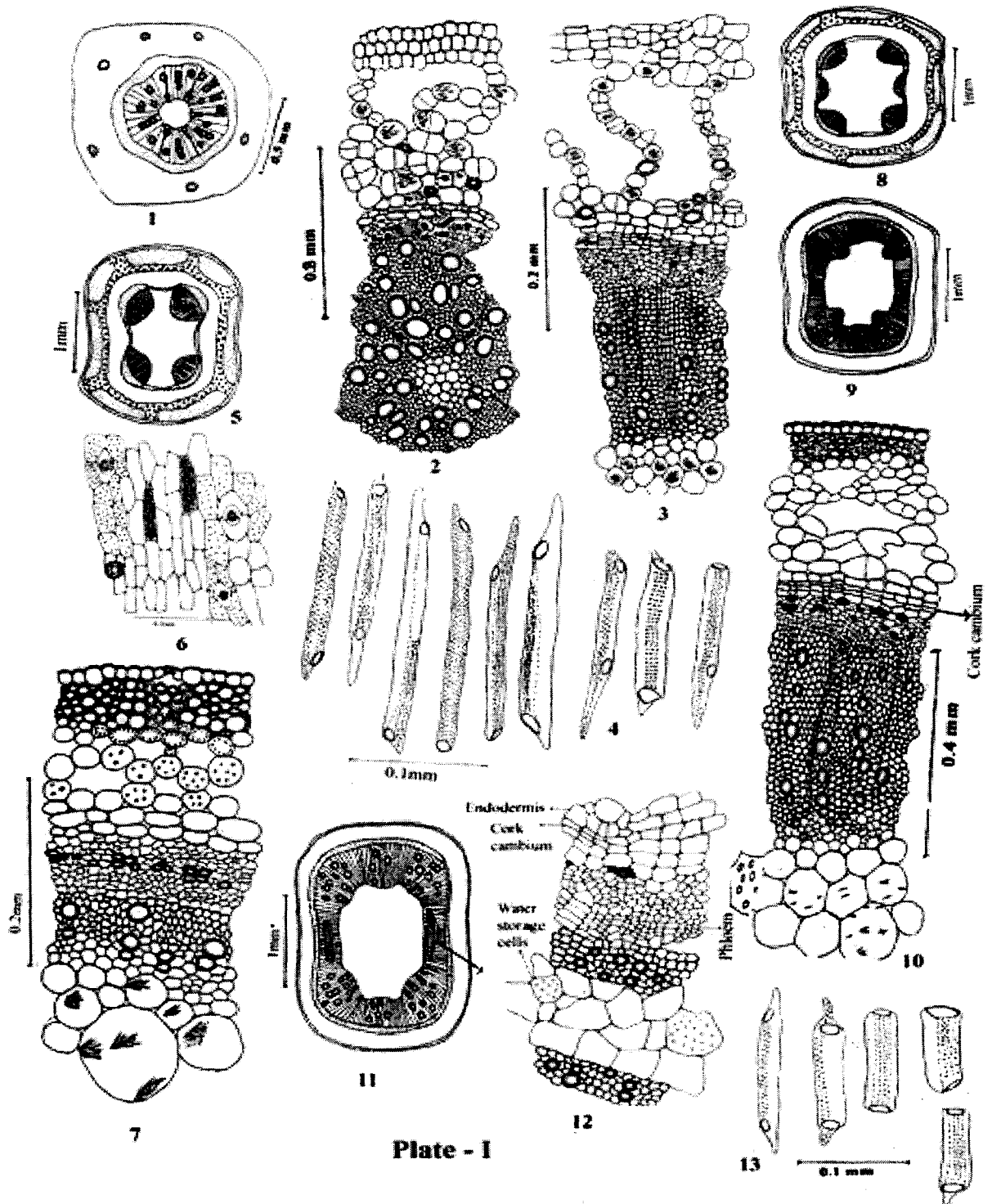


Plate - I

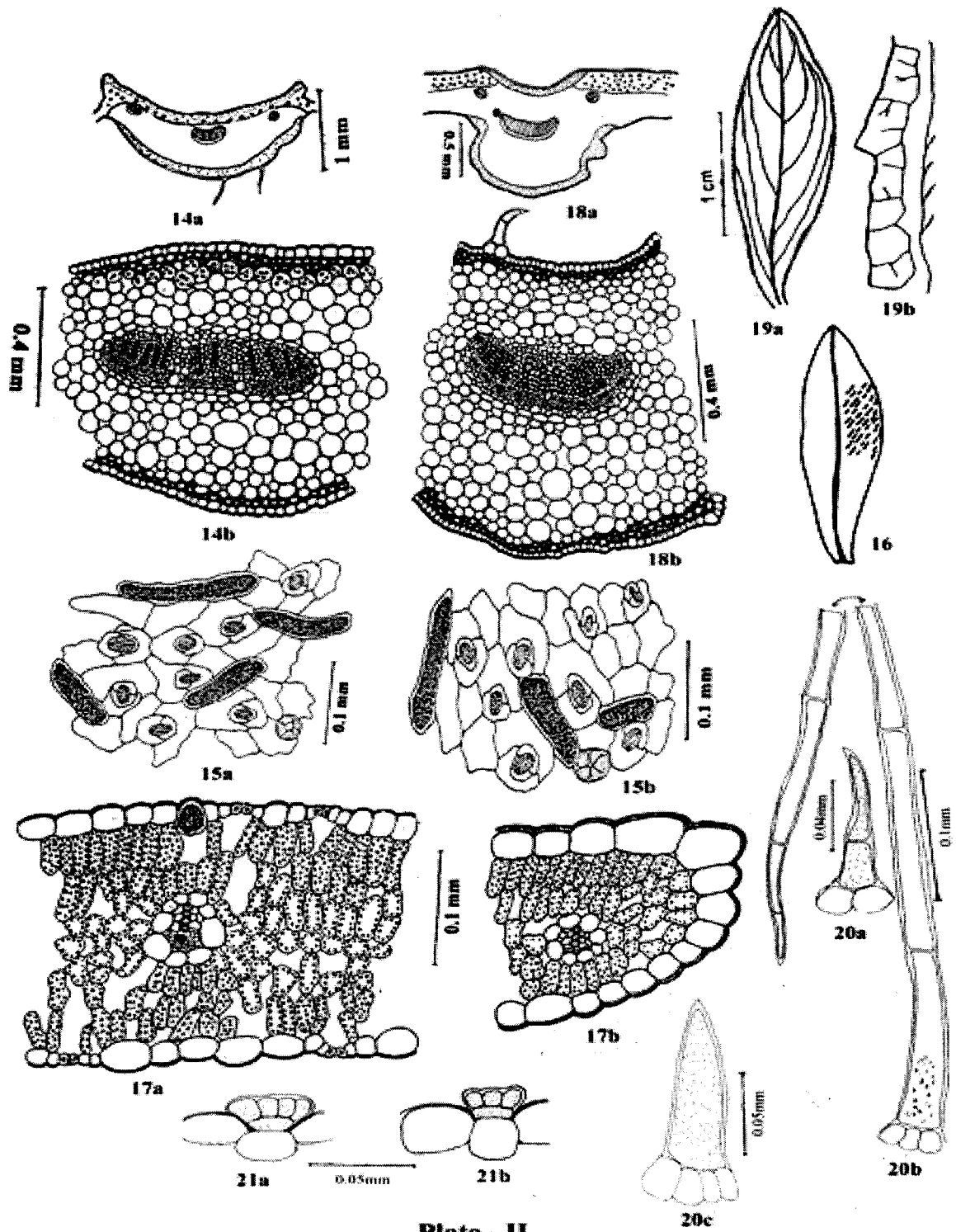


Plate - II

Midrib: Epidermis single layered, cells cutinised and cuticularised. Hypodermis chlorenchymatous. Ground tissue parenchymatous enclosing conspicuous air spaces. Vasculature in the form of single large crescent. Vessels in series separated by thin-walled polygonal cells. Phloem many layered with scattered stone cells. (Fig. 18a & b)

Venation: - Eucamptodromous (Fig. 19a) Primary vein massive, straight, unbranched. Secondary veins in 4 – 5 pairs, moderately thick, curved uniformly, unbranched, diverging at 30° – 45°, divergence of upper secondary veins more obtuse than the lower ones; intersecondary veins composite. Tertiary veins random, reticulate. Areoles medium, irregular, imperfect, random. Marginal venation looped (Fig. 19b).

Leaf constants:

a. Upper epidermis - Stomatal frequency – 42.2/mm²
Stomatal index – 18.75 %;

b. Lower epidermis - Stomatal frequency – 49.6/mm²,
Stomatal index – 28.86 %, Palisade : Spongy – 1: 1.07,
PR - 10

Trichomes – Simple as well as glandular; present on both stem and leaf.

Simple trichomes: – unicellular broad 0.41µm to 0.45 µm long and multicellular; walls rough, 0.36 µm to 2 µm. (Fig. 20a – c). Glandular trichomes with single, short stalk cell and 6 - 8 celled head. (Fig. 21a & b)

In most of the respects anatomy of *H. schulli* is in confirmation with general anatomical features of

Acanthaceae. However, many features characterize the herb. These are –

1. Vasculature confined to four angles of young stem
2. Development of anomalous cambia in secondary xylem and phloem of stem,
3. Presence of class A, and B type of vessel elements,
4. Presence of water storage cells in stem pith,
5. Abnormal stomata with single guard cell; subsidiary cells in one or more cycles,
6. Mesophyll with large intercellular spaces and palisade in more than one layers present below both the epidermis i.e. lamina isobilateral,
7. Venation eucamptodromous with marginal veinlets free or forming loops
8. Presence of both simple and glandular trichomes on young parts and
9. Presence of cystoliths, raphides and styloides. These features characterize the drug material.

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