

Morphological and Anatomical Characteristics of *Coix* Species in Upper Myanmar

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Abstract

The present paper deals with the study on the morphological and anatomical characters of three wild *Coix* species naturally occurring in Upper Myanmar, namely *Coix aquatica* Roxb, *Coix gigantea* Koenig. ex. Roxb. and *Coix lacryma-jobi* L. belonging to family Gramineae (Poaceae). These studied species were perennial erect monocious grasses and can be grown in moist areas up to 2m tall. The stems (culms) were glabrous sometimes purinose, branched and green to dark green in color. Leaves were large, elongated and sheathing at the base. Male racemes are drooping or erect spikelets projecting from the mouth of utricule and dark green in color. Female spikelets are enclosed within head-like utricule. False fruits are compressed in one side, ovoid or bottle-shaped and green or brownish black in color. A anatomical character of leaf (lamina and leaf sheath) and stem of *Coix aquatica* Roxb, *Coix gigantea* Koenig. ex. Roxb. and *Coix lacryma-jobi* L. were studied and described with photographs.

Keywords : *Coix* , Anatomical characters, leaves

Introduction

Myanmar is a rich source of information on cereal crops. In addition to rice and maize, other some true cereals are likely to be treated as major species although they were grown locally and in small amount. Some *Coix* species are usually grown as secondary food crops or used for feed or industrial purposes. Job's tears is mainly used traded locally only. It is often considered as a reserve food in time of scarcity. Although Job's tears was enjoyed locally by many people, Job's tears is still decreasing in popularity in favour of higher yielding cereals, mainly rice and maize. However, it has some advantages over these other cereals. Job's tears are less susceptible to diseases and pests, it can be grown where other crops are difficult to cultivate and it does not need much care. Moreover, it is more nutritious than other cereals. Although having these advantages, any research attention has hardly so far been given to Job's tears.

The present work was carried out on the following aims and objectives. To know about the lesser known cereal useful *Coix* species because of their economic uses; to know and compare about the morphological and anatomical characters of *Coix* species with other cereal useful plants such as Maize and Sorghan and to investigate the economic importance and usefulness of *Coix* plants. In the present study, morphological and some anatomical characteristics of the three wild *Coix* species were studied and presented with photographs and sketches.

Materials and Methods

Coix species were collected from Mandalay Division, Kachin State and Shan State during the flowering period from October 2010 to January 2015 growing as wild and cultivated. Identification of specimen were carried out by using a digital camera and literatures (Hooker 1879; Backer 1934; Dassanayake 1999, Hundley & Chit Ko Ko and Kress *et al.*(2003)

After collection, some of the specimens were studied in fresh stage and other was pressed and dried at room temperature.

Anatomical study was carried out from free hand sections using razor blades. Chloral hydrate solution was used as a clearing agent. The sections were stained in a few drops of safranin. The stained sections were temporarily mounted in glycerine enclosed with a coverslip. The temporary mount of stained section and macerated

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element were studied, measured and the distinct characters were recorded by the light microscope. Photomicrographic records were also prepared by the light microscope with digital camera.

Results

1. Morphology

In this study, most of the species have linear to lanceolate ovate leaves. In *C. aquatica*, the leaf blade is linear and truncate at base, entire at the margin, acute at the apex, glabrous at both surfaces and pale green in color; those of *C. gigantea* were linear to lanceolate, truncate to nearly rounded at the base, acute at the apex and dark green in color. Leaves are large, elongated and sheathing at the base and wavy in *C. gigantea*. Leaf-blades are lanceolate to ovate lanceolate, acute to acuminate at the apex, glabrous on both surfaces and green color in *C. lacryma-jobi*.

In the present work, the most significant characters were observed in inflorescences of the three species studied. In *C. aquatica*, the inflorescences were solitary and mostly 2-3 fascicled in nature. Male spikes were light green and drooping at maturity.

In this study, other significant characters were also to be observed in fruit characters of the three studied species. In *C. aquatica*, the false fruits were ovoid or globose, very hard and shiny, yellow to yellowish brown in color. The false fruits were compressed in one side, ovoid or sometimes bottle-shaped, brown or brownish black, in color and very hard in *C. gigantea*. The false fruits of *C. lacryna-jobi* are variable in size, shape, color and hardness. These were soft or hard, shiny and grey, yellowish brown, purplish or black in color.

2 .Anatomy

2.1 *Coix aquatica* Roxb., Fl. Ind. ed 2. 3. 571 1832

A. Anatomy of Leaves

(i) **T.S of lamina:** The lamina of *Coix aquatica* Roxb showed typically isobilateral, venation parallel. Distinguishable into dermal, ground and vascular tissue system.

Dermal tissue system: In surface view, the epidermal cells of both surfaces parenchymatous, elongated, parallel arranged; stomata occurred on both surface, stomata with triangular subsidiary cells, stomata diacytic, occurred in parallel rows. In transverse section, upper and lower epidermis 1-layered; compact, large, rounded or oval parenchymatous cells; cuticle smooth and thin. **Ground Tissue System:** Mesophyll consisted of spongy cells only, parenchymatous, compact, 3 to 5 layered, spherical or polygonal, chloroplasts abundant, intercellular spaces absent. **Vascular Tissue System:** Vascular bundles are closed-collateral type, circular in general outline, embedded in the songy parenchymatous cells, numerous; xylem towards the upper epidermis and phloem towards the lower epidermis; in large vascular bundle, xylem consisted of four distinct vessel (metaxylem); protozylem towards the adaxial side with xylem parenchyma; phloem consisted of a small number of sieved tubes and companion cells, phloem parenchyma absent; sclerenchymatous bundle sheath encircled the vascular bundle, xylem consisted of very small number of tracheids and parenchyma encircled by bundle sheath, bundle sheath sclerenchymatous, one-layered.

(ii) **T.S of Leaf-sheath:** Typically isobilateral, venation parallel. Distinguishable into dermal, ground and vascular tissue system.

Dermal Tissue System: Composed of epidermal cells and a few stomata. In tranverse section, epidermal cells of both surfaces parenchymatous, compact, smallcylindrical or barrel-shaped; cuticle thin. **Ground Tissue System:** Mesophyll consisted of spongy cells only, parenchymatous, compact 13-28- layered, spherical or

oval or polygonal air cavity large. **Vascular Tissue System:** Vascular bundle towards the lower epidermis, closed collateral, circular and oval; xylem towards the upper epidermis and phloem towards the lower epidermis; xylem consisted of four distinct vessels, a small number of tracheids between two large vessels (metaxylem); phloem consisted of a small number of sieve tube and companion cells; parenchymatous bundle sheath present.

B. T.S of Stem: Stems circular or rectangular in transverse section, crescent shaped at near spike. Distinguishable into dermal, ground and vascular tissue system.

Dermal Tissue System: In transverse section, the epidermal cells 1-layered, compact, parenchymatous, thin-walled, rectangular, small, cuticle thick. **Ground Tissue System :** Composed of outer sclerenchymatous and inner parenchymatous cortical cells. Sclerenchymatous cells 2 to 5 layered, mostly 2, polygonal and forms a narrow zone of hypodermis; not differentiated into cortex, endodermis and pericycle, cells smaller nearer the periphery than the centre, polygonal or spherical, intercellular spaces very small. **Vascular Tissue System :** Closed collateral, scattered in the ground tissue and lie closer together nearer the periphery than the centre, completely surrounded by a sheath of sclerenchyma; phloem composed of sieve-tubes and companion cells; xylem consisted of four distinct vessels arranged in the form of a Y, and smaller number of tracheids.

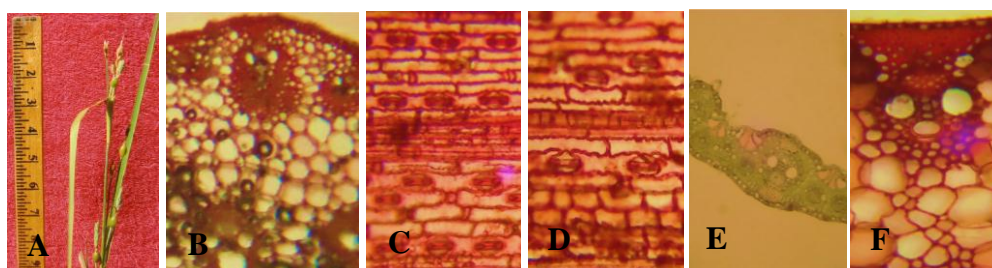


Figure 1. *Coix aquatica* Roxb. A. Inflorescence; B. T.S of Stem; C. Upper Surface view; D. Lower Surface view; E. T.S of Leaf; F. T.S of Leaf sheath.

2.2 *Coix gigantea* Koenig ex. Roxb., Hort. Beng. 66. 1814

Anatomy of Leaves

(i) T.S of lamina

The lamina of *Coix gigantea* L. showed typically isobilateral, venation parallel. Distinguishable into dermal, ground and vascular tissue system.

Dermal tissue system: composed of epidermal cells and guard cells of stomata. In surface view, the epidermal cells of both surfaces parenchymatous, elongated, parallel arranged; stomata occurred on both surfaces, diacytic. In T.S, upper and lower epidermis 1-layered; compact, large, rounded or oval parenchymatous cells; cuticle smooth and thin; cuticle smooth and thin.

Ground Tissue System: Mesophyll consisted of spongy cells only, parenchymatous, compact, 3- to 4- layered, spherical or oval, chloroplasts abundant.

Vascular Tissue System : Vascular bundles are closed-collateral, oval; xylem consisted of four distinct vessel (metaxylem); protoxylem towards the adaxial side; phloem consisted of sieved tubes and companion cells; sclerenchymatous bundle sheath encircled the vascular bundle, xylem consisted of tracheids and parenchyma encircled by bundle sheath, bundle sheath sclerenchymatous, one-layered.

(ii) T.S of Leaf-sheath: Typically isobilateral, venation parallel. Distinguishable into dermal, ground and vascular tissue system.

Dermal Tissue System: Composed of epidermal cells and a few stomata. In transverse section, epidermal cells of both surfaces parenchymatous, compact, large, polygonal or barrel-shaped; cuticle thin.

Ground Tissue System: Mesophyll consisted of spongy cells only, parenchymatous, compact 13-64- layered, air cavity large. **Vascular Tissue System:** Vascular bundle towards the lower epidermis, closed collateral, oval and elongated, embedded in the spongy parenchymatous cells, small in number; xylem consisted of four distinct vessels arranged in the form of a Y, a small number of tracheids between two large vessels (metaxylem); protoxylem towards the upper side with large water containing cavity; phloem parenchyma absent; parenchymatous bundle sheath encircled one-layered.

B. T.S of Stem: Stems circular in transverse section. Distinguishable into dermal, ground and vascular tissue system.

Dermal Tissue System: In transverse section, the epidermal cells 1-layered, compact, parenchymatous, thin-walled, rectangular, small, cuticle thick.

Ground Tissue System: Composed of closed ring of outer sclerenchymatous and inner parenchymatous cortical cells. Sclerenchymatous cells 2-to3-layered, polygonal a narrow zone of hypodermis; inner parenchymatous not differentiated into cortex, endodermis and pericycle, cell smaller nearer the periphery than the centre, polygonal.

Vascular Tissue System: Closed collateral, lie closer together nearer the periphery than the centre, peripheral ones are smaller in size than the central ones, surrounded by a sheath of sclerenchyma; phloem composed of sieve-tubes and companion cells, phloem parenchyma absent; xylem consisted of four distinct vessels arranged in the form of a Y, and smaller number of tracheids.

2.3 *Coix lacryma-jobi* L., Sp. Pl. ed. 1, 972. 1753

Anatomy of Leaves

(i) **T.S of lamina:** The lamina of *Coix lacryma-jobi* L. showed isobilateral. Distinguishable into dermal, ground and vascular tissue system.

Dermal tissue system: composed of short cylindrical epidermal cells and guard cells of stomata. In surface view, the epidermal cells of both surfaces parenchymatous, long or short cylindrical, parallel arranged, abundant.

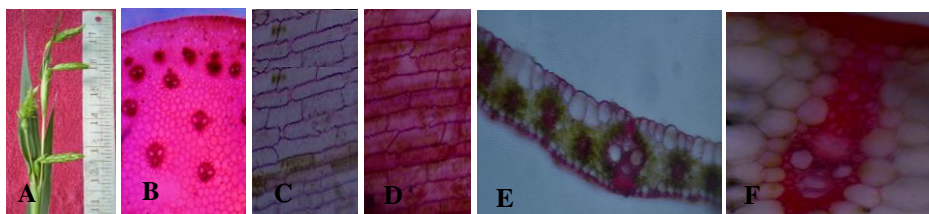


Figure 2. *Coix gigantea* Koenig ex. Roxb. A. Inflorescence; B. T.S of Stem; C. Upper Surface view; D. Lower Surface view; E. T.S of Leaf; F. T.S of Leaf sheath

stomata occurred on both surface. In transverse section, upper and lower epidermis 1-layered; compact, large, rounded parenchymatous cells; cuticle smooth and thin; cuticle smooth and thin.

Ground Tissue System: Mesophyll consisted of spongy cells only, parenchymatous, compact, 4- to 5- layered, spherical or oval, chloroplasts abundant, intercellular spaces absent.

Vascular Tissue System: Vascular bundles are closed-collateral, rounded or oval, many; xylem consisted of four distinct vessel (metaxylem); protoxylem with xylem parenchyma towards the adaxial side; phloem consist of sieved tubes and companion cells; sclerenchymatous bundle sheath encircled the vascular bundle, xylem consisted

of very small number of tracheids and parenchyma encircled by bundle sheath, bundle sheath sclerenchymatous, 2-3 layered.

(ii) T.S of Leaf-sheath: Typically isobilateral, venation parallel. Distinguishable into dermal, ground and vascular tissue system.

Dermal Tissue System: Composed of epidermal cells and a few stomata. In transverse section, epidermal cells of both surfaces parenchymatous, compact, small barrel-shaped; cuticle thin.

Vascular Tissue System: Vascular bundle towards the lower epidermis, closed collateral type, circular and oval in outline, embedded in the spongy parenchymatous cells, small in number; xylem towards the upper epidermis and phloem towards the lower epidermis; xylem consisted of four distinct vessels arranged in the form of a Y, a small number of tracheids between two large vessels (metaxylem); phloem consisted of a small number of sieve tubes and companion cells; parenchymatous bundle sheath encircled.

B. T.S of Stem: Stems circular in transverse section. Distinguishable into dermal, ground and vascular tissue system.

Dermal Tissue System: the epidermal cells 1-layered, compact, parenchymatous, thin-walled, rectangular, small, cuticle thin.

Ground Tissue System: Composed of outer sclerenchymatous and inner parenchymatous cortical cells. Sclerenchymatous cells 2 to 3 layered, forms a narrow zone of hypodermis; inner parenchymatous cells extend from below the sclerenchymatous layers to the centre, cells smaller nearer the periphery than the centre, polygonal.

Vascular Tissue System: Closed collateral, lies scattered in the ground tissue and lie closer together nearer the periphery than the centre, oval or circular, surrounded by sclerenchymatous sheath ; phloem composed of sieve-tubes and companion cells; xylem consisted of four distinct vessels arranged in the form of a Y, and smaller number of tracheids.

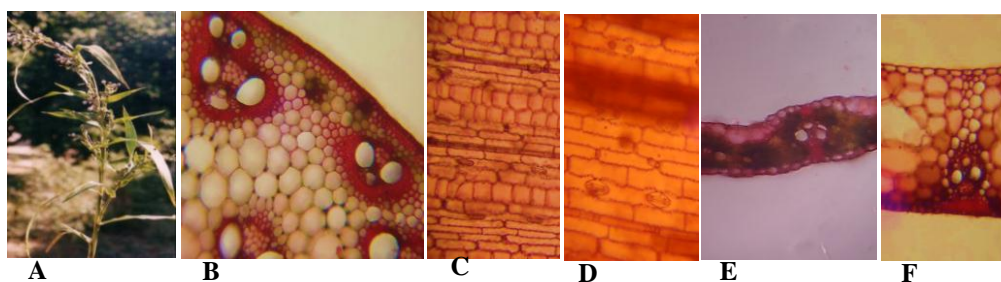


Figure3. *Coix lacryma-jobi* L. A. Inflorescence; B. T.S of Stem; C. Upper Surface view; D. Lower Surface view; E. T.S of Leaf; F. T.S of Leaf sheath

Discussion and Conclusion

In this study, *Coix aquaticus* is perennial, floating and creeping plants with succulent stems which can reach a length of over 15 m which were according to Bor (1960). In this species, upper surface of the leaves is densely covered with bristle-like hairs; ripe involucre abruptly constricted at the neck into a beak which was agreed to Hooker (1897). In this study, *C. gigantea* was mostly found in moist area and sometimes grow on dry soil up to 2 m tall which were in accordance with Hooker (1897), Bor (1960) and Dassanayake (1994). Leaves of *C. gigantea* were large elongated and linear to lanceolate in this work which were agreed with Dassanayake (1994). Male spikes are arising from leaf axils of main stem, solitary or 2-6 fascicles, drooping or pendulous as described by Dassanayake (1994).

In the present work, it has been found that *C. lacryma-jobi* was perennial, erect, robust and tufted grasses up to 1 m high and its culms were much branched, spreading below, slightly compressed and glabrous, which were in accordance with Hooker (1897), Small (1933) and Dassanayake (1994). The fruits of *C. lacryma-jobi* in this work were variable in size, shape, color and hardness, grey, yellowish brown, purplish or black in color, hard and shiny which were agreed with Hooker (1897), Small (1933), Rhind (1945) and Bor (1960). Culms were much branched, spreading below, solid, which were in agreement with Dassanayake (1994), Grubben and Partohardjono (1996). In the anatomical characters of these three *Coix* species, in this study, epidermis of the leaf is composed of elongated, parallel-arranged parenchymatous cells. Upper epidermis and lower are one-layered thick and composed of large rounded or oval or short cylindrical parenchymatous cells. Esau (1953) stated that leaves with relatively undifferentiated mesophyll, as found in many hydrophytes, have no palisade tissue. Thus the species studied in this work were likely to be hydrophytes in leaf anatomical characters.

Vascular bundles of the leaves found in these three species are closed collateral and oval or spherical in shape. In the T.S of leaf sheath, the vascular bundles are encircled by the parenchymatous bundle sheath which was one-layered thick. Esau (1953) also described that grass leaves have two kind of sheaths; entirely parenchymatic with chloroplasts, and relatively thick walled sheaths without chloroplasts. Among Gramineae, many representatives of Panicoideae have single thin-walled sheaths around the small vascular bundles which was found in *C. lacryma-jobi* in this study.

In the T.S of stem in these species, the epidermis is composed of one-layered, thin-walled, and oval or rectangular-shaped parenchyma cells. Ground tissue in these species were not differentiated into cortex, endodermis and pericycle. In the present study, it was also found that the vascular bundles in stems of these three *Coix* species were also scattered in the ground tissue and closer together nearer the periphery than the centre.

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