

Comparative Foliar Epidermal Studies in *Coix lacryma-jobi* L. and *Coix aquatica* Roxb. (Poaceae)

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Abstract

As micromorphological knowledge was not available for *Coix aquatica* Roxb., the foliar epidermal studies were carried out for *Coix lacryma-jobi* L. and *Coix aquatica* Roxb. with the aim of determining the patterns of variation in their epidermal characteristics and assessing their value in species identification. Comparative foliar analysis was carried out by using light microscopy, after following routine scraping method. The characters of diagnostic importance in the identification of *C. aquatica* are the sparsely distributed prickly hairs with long pointed apex in the abaxial epidermis and dumbbell shaped silica cells in both the epidermises. The diagnostic characters for *C. lacryma-jobi* are the cross shaped silica cells and dumbbell shaped on the abaxial and adaxial epidermis respectively. The observed differences in certain micromorphological characters helps in identification of presently studied two species of *Coix*.

Keywords: *Coix*, foliar epidermis, prickly hair, silica cells and angular prickles.

Introduction

The genus *Coix* belongs to the family Poaceae which comprises of about 900 genera and 10,000 species throughout the world (GPWG, 2001). *Coix* is a genus of about 5 species, native to tropical Asia (Clayton and Renvoize, 1999; Watson and Dallwitz, 1992 onwards); commonly known as Job's tears, Christ's tears, adlai, Kasai and Kahudo. It is halophytic to hydrophytic to mesophytic; growing along the margin of the water bodies. In India, 4 species are noticed in wild state and are often cultivated as a border to roads and paths. The utricles are used for decoration, medicine, as food, as flour or for the production of beer and ornaments. The leaves are also used as fodder and for thatching by tribal people (Jain and Benerjee, 1974).

The grass family Poaceae is known for its wide diversity and complexity and so has posed many problems to the taxonomists using the traditional methods, based on gross morphology and described the leaf epidermis as the second most important character after cytology for solving taxonomic problem (Srivastava, 1978). Of all the non-reproductive organs, the leaf is the most widely used plant organ in plant taxonomy (Stace, 1984). Following the works of Metcalfe (1960) which today serve as standard references to plant anatomy, the use of vegetative anatomical characters in taxonomy became a routine procedure. Since then, the immense value of the leaf epidermis and vegetative anatomy in grass systematics has been demonstrated by many workers (Srivastava, 1978; Renvoize, 1982; Ogundipe and Olatunji, 1991).

Perusal of literature suggests that there are no reports on micromorphology of *Coix aquatica* Roxb., Watson and

Dallwitz (1992 onwards) have described micromorphology of *Coix lacryma-jobi* L. only. Hence, in the present study we have described the patterns of variation in epidermal characteristics, to assess their value in species identification, classification and in establishing the taxonomic relationships between the two species of *Coix*.

Materials and methods

Both the species of *Coix* i.e. *C. lacryma-jobi* and *C. aquatica* were collected from the natural vegetation near-by Konark temple, Orissa and Vadodara district, Gujarat respectively from India. Details of the voucher specimens are deposited in BARO herbarium with Accession number RJD/64 and RJD/56 respectively (Department of Botany, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara-390002, Gujarat, India). For micromorphological study, the leaves from the middle of the culms (3rd and 5th) were used throughout the preparation. The peels were made by scraping pieces of fresh or softened dried leaves (Glycerine: Water mixture) with the help of safety razor blade and stained it with the saffranin and phenol to be mounted in glycerine (Hilu and Randall, 1984). Adaxial and abaxial leaf surfaces from both the species were studied at ×400 magnification and individual cells were identified and measured by micrometer. 20-25 peels were made from each species of several dozen of leaves. All the peels were examined and the representative areas were photographed using Leica research microscope using ×40 objective. Final counts of different cells (average of 50 observations) summarized in the Tab. 1 and 2.

Results and discussion

The characteristic epidermal micromorphological features for both the taxa have been depicted in the Fig. 1 and numerical variation in Tab. 1 and 2.

Coix lacryma-jobi L.

Long cells: Rectangular; walls thick, sinuous; inter stomatal cells relatively longer with concave ends. Short cells: Present over and between the veins, paired with cork cell. Anticlinal walls: Straight. Stomata: Large, frequent, paracytic type, subsidiary cells triangular. Microhairs: Bicellular with rounded-dome shaped cap cell, cap cell much longer than the basal cell, $45-50 \times 7-8 \mu$, Width/Length

0.14. Silica bodies: Dumbbell shaped, alternate with short cell files of the costal zones and in 1-3 rows over veins, $21-25 \times 12-15 \mu$; Prickle hairs: With swollen rounded base and sharp pointed apex, over the veins, $30-45 \times 10-12 \mu$ (Fig. 1: f-j).

Metcalf (1960) pointed out that most of the characters of the leaf epidermis such as shape of the subsidiary cells of the stomata, micro hairs, prickly hairs and silica bodies are important in systematics of the family Poaceae. Recently numerous researchers have given importance to plant micromorphological characters. Whang *et al.* (1998) has differentiated the 17 species of *Oryza* on the basis of leaf epidermal characters along with the silica cells. Acedo and Llamas (2001) has given the micromorphological charac-

Tab. 1. Descriptive statistics of leaf epidermal attributes of *Coix aquatica* Roxb.

Trait	Minimum (μ)	Maximum (μ)	Mean (μ)	Standard Dev. (μ)	Standard Error (μ)
Length of stomata	45	51	48	1.73	± 1.23
Width of stomata	18	21	19.5	1.22	± 0.86
Length of long cells	120	150	135	3.87	± 2.75
Width of long cells	12	15	13.5	1.22	± 0.86
Length of Interstomatal cell	100	130	115	3.87	± 2.75
Width of Interstomatal cell	12	15	13.5	1.22	± 0.86
Length of Prickle hair	30	45	37.5	2.74	± 1.94
Width of Prickle hair	12	15	13.5	1.22	± 0.86

ratio 0.16. Silica bodies: Cross shaped on abaxial epidermis and Dumbbell shaped on adaxial epidermis, alternate with short cell files of the costal zones and in 1-3 rows over veins, $21-25 \times 27-30 \mu$ (for cross shaped), $21-25 \times 12-15 \mu$ (for Dumbbell shaped); Prickle hairs: With swollen rounded base and sharp pointed apex, over the veins, $25-40 \times 10-12 \mu$ (fig. 1: a-e).

Coix aquatica Roxb.

Long cells: Rectangular; walls thick, sinuous; inter stomatal cells relatively longer with concave ends. Short cells: Present over the veins only, paired with cork cell. Anticlinal walls: Straight. Stomata: Large, frequent, paracytic type, subsidiary cells triangular. Microhairs: Bicellular with rounded-dome shaped cap cell, cap cell much longer than the basal cell, $60-70 \times 8-10 \mu$, Width/Length ratio

0.16. Silica bodies: Cross shaped on abaxial epidermis and Dumbbell shaped on adaxial epidermis, alternate with short cell files of the costal zones and in 1-3 rows over veins, $21-25 \times 27-30 \mu$ (for cross shaped), $21-25 \times 12-15 \mu$ (for Dumbbell shaped); Prickle hairs: With swollen rounded base and sharp pointed apex, over the veins, $25-40 \times 10-12 \mu$ (fig. 1: a-e).
 ters in *Bromus* for systematic relationship. Observations regarding the leaf epidermis of *Coix* are in accordance with the report of the Renvoize (1982), wherein general trend of leaf micromorphological and anatomical characters are described for the members of Andropogoneae at generic level. Micromorphological features of *Coix lacryma-jobi* has been described by the Watson and Dalwitz (1992 onwards). The leaf epidermal layers of *C. aquatica* and *C. lacryma-jobi* showed significant degrees of variations in terms of the micromorphological characters found in them. In both the species shape of silica cells, arrangement of the angular hairs and prickly hairs showed significant differences between *C. aquatica* and *C. lacryma-jobi*. The long cells found in the epidermis of *C. aquatica* were longer than *C. lacryma-jobi*. The long cells found in *C. lacryma-jobi* were 20-25 rowed on the abaxial and 4-10 rowed

Tab. 2. Descriptive statistics of leaf epidermal attributes of *Coix lacryma-jobi* L.

Trait	Minimum (μ)	Maximum (μ)	Mean (μ)	Standard Dev. (μ)	Standard Error (μ)
Length of stomata	45	51	48	1.73	± 1.23
Width of stomata	30	32	31	1.00	± 0.71
Length of long cells	90	135	112.5	4.74	± 3.36
Width of long cells	30	36	33	1.73	± 1.23
Length of Interstomatal cell	100	120	110	3.16	± 2.24
Width of Interstomatal cell	30	36	33	1.73	± 1.23
Length of Prickle hair	25	40	32.5	2.74	± 1.94
Width of Prickle hair	10	14	12	1.41	± 1.00

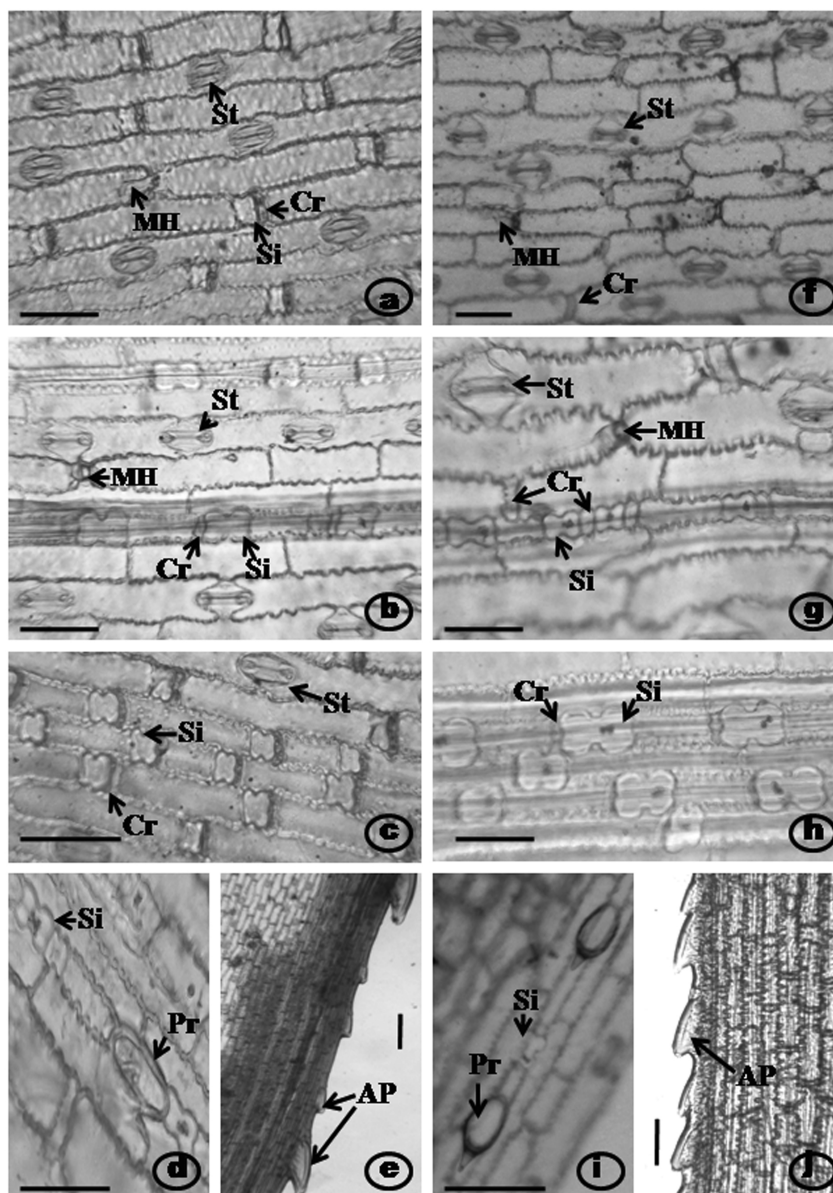


Fig. 1. a. Abaxial epidermis of *C. lacryma-jobi* showing cross shaped silica cells paired with Cork cells, Microhair and stomata.
 b. Adaxial epidermis of *C. lacryma-jobi* showing cross shaped silica cells paired with Cork cells, base of Microhair and stomata.
 c. Costal region of abaxial epidermis of *C. lacryma-jobi* showing cross shaped silica cells paired with Cork cells and stomata.
 d. Adaxial Prickle hairs of *C. lacryma-jobi* showing silica cells and Prickle hairs with blunt apex.
 e. Angular hairs on the leaf margin of *C. lacryma-jobi* showing discontinuous row of smaller and larger sized Angular Prickles.
 f. Abaxial epidermis of *C. aquatica* showing Cork cells, Microhair and stomata.
 g. Adaxial epidermis of *C. aquatica* showing dumbbell shaped silica cells paired with Cork cells, Microhair and stomata.
 h. Costal region of abaxial epidermis of *C. aquatica* showing three rows of dumbbell shaped silica cells paired with Cork cells.
 i. Adaxial Prickle hairs of *C. aquatica* showing silica cells and Prickle hairs with sharp pointed apex.
 j. Angular hairs on the leaf margin of *C. aquatica* showing continuous row of Angular Prickles of equal sizes.
 (Bar = 50μ; Figure legend. St: Stomata, MH: Microhair, Si: Silica cell, Cr: Cork cell, Pr: Prickle hair, AP: Angular Prickle).

between the veins on the adaxial surface while, the long cells recorded in *C. aquatica* were 10-16 rowed and 8-12 rowed between the veins on the abaxial and adaxial epidermis respectively. Microhairs were seen sparsely distributed in both the epidermis of both the species of *Coix*, longer in *C. aquatica* (70 μ) and *C. lacryma-jobi* (50 μ) (Fig. 1 a and g). Formerly, Amarsinghe and Watson (1990) have already described the significance of microhair morphology in *Eragrostis* for infrageneric classification.

The characters of diagnostic importance in the identification of *C. aquatica* are long and sharply pointed prickly hairs present in adaxial epidermis only (Fig. 1 i) while with blunt apex in *C. lacryma-jobi* (Fig. 1 d). In addition to prickly hairs, angular prickles are recorded on the margin of the leaves with significant variation in size and arrangement (Fig. 1 e and j). The diagnostic characters for *C. lacryma-jobi* are the cross shaped silica cells over and between the veins in the abaxial epidermis which were absent in *C. aquatica*. Adaxial epidermis of *C. lacryma-jobi* and both the epidermis of *C. aquatica* shows presence of dumbbell shaped silica cells over the veins only. These micromorphological characters clearly separate the two species of *Coix*. Krishnan *et al.* (2004) has already classified the south Indian grasses on the basis of phytoliths, i.e. silica bodies.

Moreover, veins are of 3 rowed of silica cells in abaxial epidermis (Fig. 1 c and h) while single rowed in adaxial epidermis of both the species. In addition, abundance of stomata and silica cells was observed on the abaxial epidermis of the *C. lacryma-jobi* (Fig. 1 a) than the *C. aquatica* (Fig. 1 f), while stomata were found sparsely distributed on the adaxial epidermis of both species (Fig. 1 b and g). But the arrangement of the stomata still showed some differences in that, the stomata present were 10-12 banded between the veins on the abaxial and 1-4 banded between the veins on the adaxial epidermis of *C. lacryma-jobi*. In *C. aquatica*, the stomata were seen 3-4 banded between the veins on the abaxial and 4-6 banded between the veins on the adaxial epidermis. Due to the close relationships between the two species, some characters such as stomata, shapes of the subsidiary cells, long cells, the microhairs and cork cells seen among the accessions of the two species studied could not adequately distinguish between *C. aquatica* and *C. lacryma-jobi*. Although the width of stomata showed slight differences, the length of stomata found in the two species were almost the same. In addition, the average widths of long cells seen in the adaxial epidermis of the two species were more or less the same. The present study reveals that some of the characters, which were present in the two species, may be typical of the genus despite the many micromorphological variations between them.

Conclusions

The characters of diagnostic importance in the identification of *C. aquatica* are long and sharply pointed prickly

hairs, angular prickles on the margin of the leaves and absence of cross shaped silica cells. While, presence of prickly hairs with blunt apex and cross shaped silica cells are the characteristic features of *C. lacryma-jobi*. These micromorphological characters clearly separate the two species of *Coix*.

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