

Epidermal patterns of leaf blades in Korean sedge taxa characterized by SEM and LM (II. *Cyperus*)

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주사전자현미경과 광학현미경에 의한 방동산이속 (*Cyperus*) 식물의
잎의 表皮型 研究

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Abstract

The epidermal patterns of seven taxa (6 species and 1 variety) of Korean genus *Cyperus* were investigated by using light microscope and scanning electron microscope. Epidermal patterns of the leaf blades may be depending upon the species and can be useful for identification and classification of *Cyperus*. The major characteristics elucidated in this study were shape and arrangement of subsidiary cells in stomata, wavy of intercostal cell wall, shape of interstomatal, cuticle, papillae, prickles and silica body.

Introduction

Since 1969, I have reported in several papers on the epidermal patterns of the leaf blades on Korean sedges (1969, 1971, 1973, 1974a, 1974b, 1980a, 1980b, 1985, 1987) and have confirmed the epidermis as an important characteristic for the sedge identification. The author have found that the epidermal patterns of the leaf blades may be important taxonomic characters at the genera and species level. Author believed that epidermal patterns can be elucidated using light microscope and scanning electron microscope. In this study compared the results of LM with SEM observations on the epidermal characters of some taxa of sedges.

Materials and Methods

Herbarium specimens of six species and one variety (Table 1) were used in this study stored in the Department of Biology, Sungshin Women's University (SWU). The leaf blades in basal leaves were taken at the widest portions, in boiling water for 30 min. or 1hr. and fixed in F.A.A.. The epidermis peeled and observed under an Olympus BH-light microscope (LM). The lateral subsidiary cells were included for measuring the size of stomata, value in table 2 were averages of 10 measurements given in micron. For SEM observation, the leaves were to fixed F.A.A. dehydrated in graded acetone and were afixed to specimens stubs with ion sputter JFC-1,100, coated with gold/palladium. Epidermal patterns were observed at the accelerating voltage of 15KV with JEOL, JSMT 300 SEM. Micrographs were taken with Kodak Vp 20, 10 roll film and contact printed on Kodakbromide paper. The light and electron microscopes were permitted to use together for the reasonably fast observation of leaf blades. The terminology used here by Metcalfe (1960) and Ellis (1979) is followed by Palmer and Tucker (1981), and Oh (1987).

Table 1. List of voucher specimens for epidermal patterns of the leaf blades on sedge family

Specimens	Localities and date
<i>Cyperus amuricus</i> Maximowicz	Daeshinri, Kyunggido, 1972. 9.10.
<i>C. exaltatus</i> var. <i>iwasakii</i> (Makino) T. Koyama	Moeuchangdong, Kyunggido, 1972. 10.2.
<i>C. glomeratus</i> Linné	Ewha Women's Univ., Seoul, 1972. 9.28.
<i>C. iria</i> Linné	Mockpo, Chullanamdo. 1969. 8.5.
<i>C. orthostachyus</i> Fr. et Sav.	Pyungnae, Kyunggido, 1981. 9.16.
<i>C. rotundus</i> Linné	Chejudo, 1973. 10.9.
<i>C. serotinus</i> Rottb.	Oloodong, Seoul, 1973. 8.28.

Results

The smallest stoma of the present genus *Cyperus* was observed on the leaves of *Cyperus rotundus* (23-26-28 μ long and 23-25-28 μ wide), whereas the largest *C. serotinus* (52-54-57 μ long and 25-28-30 μ wide). As for the shape of subsidiary cells, sub-triangular shape was observed in *C. exaltatus* var. *iwasakii*, *C. glomeratus* and *C. rotundus*; the high-dome shape in *C. orthostachyus*, the dome shape in *C. amuricus* and *C. iria*; the low-dome shape in *C. serotinus*. The size of intercostal cells ranged between 90-115-145 μ long, 18-22-27 μ wide and 37-42-48 μ long, 15-17-18 μ wide. The wall of the intercostal cells were sinuous wavy in *C. amuricus*, *C. exaltatus* var. *iwasakii*, *C. rotundus* and *C. serotinus*; deeply wavy in *C. glomeratus*; shallowly wavy in *C. orthostachyus*; slightly sinuous wavy in *C. iria*. The silica

body in most of *Cyperus* were A₂-shape, otherwise, the silica body not confirmed in *C. orthostachyus* (Table 2).

The epidermal characters by SEM were as follow: the shape of intercostal long cells were observed long and narrow, non uniform in *C. orthostachyus*; rectangular, uniform in *C. serotinus* and *C. glomeratus*; in rectangular, and non-uniform the rest of *Cyperus* species, *C. amuricus*, *C. exaltatus* var. *iwasakii*, *C. iria* and *C. rotundus*. The wall of the intercostal long cells were the sinuous wavy in *C. glomeratus*, the deeply wavy, chainform, raised in *C. serotinus*, straightly sinuous, raised in *C. amuricus*, *C. exaltatus* var. *iwasakii*, *C. iria*, *C. orthostachyus* and *C. rotundus*. The shape of stomata were the high-dome, non-inflated and U-shaped in *C. orthostachyus*; the low-dome, non-inflated, and U-shaped in *C. amuricus*, *C. exaltatus* var. *iwasakii*, and *C. glomeratus*; the low-dome, inflated, and U-shaped in *C. iria* and *C. serotinus*; the low-dome, inflated and V-shaped in *C. rotundus* (Figs. 1-12).

Epidermal characters and key of the 7 examined species of the Korean *Cyperus* were as below.

Cyperus amuricus Maximowicz

LM: Subsidal cell dome shaped. Stomata 40-42-43 microns long and 28-29-32 microns wide.

Four rows of stomata present at intercostal zone. Long cell 80-103-128 microns long and 17-22-25 microns wide, the cell wall sinuous. Fourteen rows of long cell present at intercostal zone. Silica body A₂-shaped.

SEM: Intercostal; many rows long cell, square-rectangular, non-uniform, walls straightly sinuous, raised. Stomata; 4-rows/zone, subsidiaries parallel to low-dome shaped, non-inflated, interstomatal short and narrow, ends shortly, U-shaped. The surfaces of the epidermal cell were rough and thick. Cuticle well developed and wax-hypha covered on the adaxial surface (Figs. 1,2).

Cyperus exaltatus subsp. *iwasakii* (Makino) T. Koyama

LM: Subsidal cell sub-triangular shaped. Stomata 38-42-30 microns long and 25-27-33 microns wide. Four rows of stomata irregularly present at intercostal zone. Long cell 85-100-118 microns long and 23-25-28 microns wide, the cell wall sinuous. Eleven rows of long cells present at intercostal zone. Silica body A₂-shaped.

SEM: Intercostal; many rows long cell, square-rectangular, non-uniform, walls straightly sinuous, raised. Stomata; 4 rows/zone, subsidiaries parallel to low-dome shaped, non-inflated, interstomatal short and narrow, ends shortly, U-shaped. The surface of the epidermal cells were rough and thick. Cuticle well developed (Figs. 3,4).

Cyperus glomeratus Linné

LM: Subsidal cell sub-triangular shaped. Stomata 35-36-40 microns long and 22-26-28 microns wide. One rows of stomata alternate with 1-2 rows of fundamental epidermis cells. Long cell 72-101-136 microns long 18-22-28 microns wide, the cell wall deeply wavy. Seven

to ten long cell rows present at intercostal zone. Silica body A_2 -shaped.

SEM: Intercostal; many rows long cell, square-rectangular, uniform, walls sinuous. Stomata; many rows/zone, subsidiaries parallel to low-dome shaped, non-inflated, interstomatals short and narrow, ends shortly, U-shaped. The surface of the epidermal cells are rough (Figs. 5,6).

Cyperus iria Linné

LM: Subsidal cell dome shaped. Stomata 35-40-47 microns long and 23-28-32 microns wide. One row of stomata alternate with few rows of fundamental epidermal cells. Long cell 90-115-145 microns long and 18-22-27 microns wide, the cell wall slightly sinuous. Many rows of long cell present at intercostal zone. Silica body A_2 -shaped.

SEM: Intercostal; 4-5 rows/zone, square-rectangular, non-uniform, walls straightly sinuous, raised. Stomata; 2-rows/zone, subsidiaries parallel to low-dome shaped, inflated, interstomatals long and narrow, ends shortly, U-shaped. The surface of the epidermal cells rough and thicked. Cuticle well developed on the both leaf surfaces (Figs. 7,8).

Cyperus orthostachyus Fr. et Sav.

LM: Subsidal cell high-dome shaped. Stomata 40-42-47 microns long and 28-31-33 microns wide. One row of stomata alternate with 2-3 rows of fundamental epidermal cells. Long cell 57-73-83 microns long 20-22-25 microns wide, the cell wall shallowly undulated. Five to eight rows of long cell present at intercostal zone. Silica body were not confirmed.

SEM: Intercostal; many rows/zone, square-long and narrow, non-uniform, walls straightly sinuous, raised. Stomata; 2-rows/zone, subsidiaries parallel to high-dome shaped, non-inflated, interstomatals short, ends shortly, U-shaped. The surface of the epidermal cells rough and thicked. Cuticle well developed on the both leaf surfaces. Silica bodies are distinct. (Figs. 9,10).

Cyperus rotundus Linné

LM: Subsidal cell sub-triangular shaped. Stomata 23-26-28 microns long and 23-25-28 microns wide. The rows of stomata irregularly present at intercostal zone. Long cell 37-42-48 microns long and 15-17-18 microns wide, the cell wall sinuous. Many rows fundamental epidermal cell present at intercostal zone. Silica body A_2 -shaped.

SEM: Intercostal; many rows/zone, square-rectangular, non-uniform, walls straightly sinuous, raised. Stomata; 2 rows/zone, subsidiaries parallel to low-dome shaped, inflated, interstomatals short, ends shortly, V-shaped. Cuticle well developed on the abaxial surface and thicked (Fig. 11).

Cyperus serotinus Rottb.

LM: Subsidal cell low-dome shaped. Stomata 52-54-57 microns long and 25-28-30 microns wide. One row of the stomata alternate with 2-4 rows of fundamental epidermis cells.

Long cell 70-92-108 microns long and 25-29-35 microns wide, the cell wall much sinuous. Ten rows of long cell present at intercostal zone. Silica body A₂-shaped.

SEM: Intercostal; many rows long cell, square-rectangular uniform, walls deeply wavy and chainform, raised. Stomata; 2-3 rows/zone, subsidiaries parallel to low-dome shaped, inflated, interstomata long and narrow, ends straight shortly, U-shaped. Cuticle well developed (Fig. 12).

Table 2. Epidermis characters of Korean sedge using LM

Species	Shape of subsidal cells	Size of stomata(μ)	Wavy of intercostal cell wall	Silica body
<i>Cyperus amuricus</i>	dome	42 × 29	sinuous	A ₂
<i>C. exaltatus</i> var. <i>iwasakii</i>	sub-triangular	42 × 27	sinuous	A ₂
<i>C. glomeratus</i>	sub-triangular	36 × 26	deeply	A ₂
<i>C. iria</i>	dome	40 × 28	slightly sinuous	A ₂
<i>C. orthostachyus</i>	high-dome	42 × 31	shallowly	not confirmed
<i>C. rotundus</i>	sub-triangular	26 × 25	sinuous	A ₂
<i>C. serotinus</i>	low-dome	54 × 28	sinuous	A ₂

Key to epidermis of leaf blades on genus *Cyperus* (LM observation)

- A. Subsidal cell high-dome or sub-triangular shaped
 - B. Subsidal cell high-dome shaped *Cyperus orthostachyus*
 - B. Subsidal cell sub-triangular shaped
 - C. Cell wall deeply wavy *C. glomeratus*
 - C. Cell wall not deeply wavy, sinuous
 - D. The rows of stomata irregularly present at the intercostal zone
..... *C. rotundus*
 - D. Four rows of stomata irregularly present at the intercostal zone
..... *C. exaltatus* var. *iwasakii*
- A. Subsidal cell, dome, low-dome shaped or not
 - B. Subsidal cell dome shaped
 - C. Four rows of stomata present at intercostal zone *C. amuricus*
 - C. One row of stomata alternate with few rows of fundamental epidermis cells
..... *C. iria*
 - B. Subsidal cell low-dome shaped *C. serotinus*

Key to the SEM epidermis characters of the leaf blades on genus *Cyperus*.

- A. The shape of intercostal long cells were long and narrow, non-uniform
 *C. orthostachyus*
- A. The shape of intercostal long cells were rectangular, non-uniform or uniform
- B. Non-uniform stomata were low-dome shaped inflated or non-inflated
- C. Inflated, U-shaped or V-shaped
- D. U-shaped
- E. Cell wall deeply wavy, chainform *C. serotinus*
- E. Cell wall straightly sinuous *C. iria*
- D. V-shaped *C. rotundus*
- C. Non-inflated
- D. Cuticle well developed at the both surfaces *C. exaltatus* var. *iwasakii*
- D. Cuticle well developed at the adaxial surface *C. amuricus*
- B. Uniform, stomata were low-dome shaped, non-inflated *C. glomeratus*

Table 3. Epidermal characters of Korean sedge using SEM

Species	Shape of long cell	Wall of long cell	Shape of stomata and interstomata	Cuticle	Papillae	Prickles
				(* +: present, -: absent)		
<i>Cyperus amuricus</i>	rectangular	straightly	low-dome	ab: -	-	-
	non-uniform	sinuous	non-inflated	ad: +	-	-
<i>C. exaltatus</i> var. <i>iwasakii</i>	rectangular	straightly	low-dome	ab: +	-	-
	non-uniform	sinuous	non-inflated	ad: +	-	-
<i>C. glomeratus</i>	rectangular	sinuous	low-dome	ab: -	-	-
	uniform		non-inflated	ad: -	-	-
<i>C. iria</i>	rectangular	straightly	low-dome	ab: +	-	-
	non-uniform	sinuous	inflated	ad: +	-	-
<i>C. orthostachyus</i>	long and narrow	straightly	high-dome	ab: +	-	-
		sinuous	non-inflated	ad: +	-	-
<i>C. rotundus</i>	rectangular	raised	U-shaped			
	non-uniform	sinuous	inflated	ab: +	-	-
<i>C. serotinus</i>	rectangular	raised	V-shaped	ad: -	-	-
		deeply chainform	low-dome inflated	ad: +	-	-
	uniform	raised	U-shaped			

Discussion

In this study, many epidermal characters were found to be important for the species classification and identification of Korean sedge: the shape of subsidiary cell, the wavy of intercostal cell wall and the presence/absence and forms of silica bodies. Many systematists have studied gross morphology, spikelet, achenes and foliage characters and also histological patterns of stem and leaves: Schuyler (1971), Walter (1975), Toivonen and Timonen (1976), Denton (1983) and Oh (1980a, 1980b, 1985a, 1985b, 1987) studied the leaf blades and achenes epidermal patterns of several sedge with scanning electron microscope, and they used them to identify and classify of the sedge groups. According to the present study, these characters can be used only demarcating taxa below the species level.

In this study, LM observation was different from SEM observation on the epidermal characters of some taxa of sedges. In LM observation of genus *Cyperus*, each plant was distinguished by shape of subsidiary cell, wavy of intercostal cell wall. On the other hand, in SEM observation it was classified by shape of long cell, interstomatal shape. Expressly, three dimensional shape in the arrangement and presence of cuticle and papillae were observed.

In conclusion, the epidermal patterns of *Cyperus* seem to be very useful characteristics for classifying species. It is required to further study that the epidermal characters by combining LM and SEM might be very useful for the study of sedge family taxonomy.

摘 要

방동산이속(*Cyperus*) 식물의 잎의 표피형에 대한 연구로서 6종 1변종에 대하여 광학현미경과 주사전자현미경을 사용하여 표피형을 조사하였다. 표피형의 구성요소는 종류에 따라서 차이가 있어 방동산이속 식물의 감별 및 분류에 사용할 수 있는 좋은 형질이 된다고 사료되었다. 주로 조사된 특징은 기공의 크기, 부세포의 모양과 배열, 긴세포의 벽과 모양, 규소체, 가시털, 유두상돌기 등의 유무와 모양이 조사되었다.

Acknowledgement

This research was supported by a grant of Korean Science Foundation. I thank Mr. Young-Ki Lee, Graduate student of the Department of Zoology, Seoul National University, who helped taking scanning electronic micrographs.

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Explanation of Plates

Figs. 1-12. SEM photomicrographs of the leaf epidermis in several members of *Cyperus* (Scale = μm). Figs. 1,2. *C. amuricus* (ab. $\times 500$, ad. $\times 500$); Figs. 3,4. *C. exaltatus* var. *iwasakii* (ab. $\times 750$, ad. $\times 350$); Figs. 5,6. *C. glomeratus* (ab. $\times 350$, ad. $\times 350$); Figs. 7,8. *C. iria* (ab. $\times 1000$, ad. $\times 500$); Figs. 9,10. *C. orthostachyus* (ab. $\times 500$, ad. $\times 500$) Fig. 11. *C. rotundus* (ab. $\times 750$); Fig. 12. *C. serotinus* (ab. $\times 500$).

