

Leaf epidermal patterns of section *Siderostictae* (*Carex*, Cyperaceae) in Korea

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韓國産 대사초屬 (사초屬, 사초科) 의 잎의 表皮型

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Abstract

Scanning electron microscopic and light microscopic observation of both leaf epidermis of Korean species of section *Siderostictae* revealed species-specific epidermal patterns. Epidermal patterns of the leaf blades are characteristic and useful in classification of species level; shape and arrangements of subsidiary cells in stoma, interstomata, fundamental cell walls, silica body and prickles. These data of epidermal characters are used for classification and identification in the present studies.

Introduction

Korean species of section *Siderostictae* are *Carex siderosticta* Hance, *C. ciliatomarginata* Nakai and *C. okamotoi* Ohwi (Ohwi 1936, Park 1946, and Nakai 1952). Kitamura et al. (1968) reported *C. ciliatomarginata* Nakai as *C. siderosticta* Hance ssp. *pilosa* Koyama of section *Laxiflorae*. Later, Oh (1972) had also confirmed that Korean species of section *Siderostictae* are *C. siderosticta* Hance, *C. ciliatomarginata* Nakai and *C. okamotoi* Ohwi. This study was aimed to find relationships among the

three species *C. siderosticta*, *C. ciliatomarginata* and *C. okamotoi* with observation of the detailed characteristics of epidermal patterns of leaf blades by using light microscope and scanning electron microscope.

Materials and Methods

For the observation of epidermal patterns of section Siderostictae of Korean Cyperaceae in the present study, species available only at herbarium specimens (Table 1) were used. All specimens used in this study are in the Department of Biology, Sungshin Women's University (SWU).

Table 1. Materials and localities under study.

Specimens	Localities and date
<i>Carex siderosticta</i> Hance	Mt. Chunmasan (1978. 6. 2.) HSWU*
<i>C. ciliatomarginata</i> Nakai	Mt. Sobacksan (1969. 5. 10.) HSWU
<i>C. okamotoi</i> Ohwi	Mt. Kyeryongsan (1971. 6. 2.) HSWU

*: Herbarium of Sungshin Women's University

Leaf materials used in this study were obtained from herbarium specimens (Table 1). Leaf surfaces of segment obtained from the widest portion of the leaf blades of basal leaves (mature leaves) were taken, softened by boiling in water at 100°C for 30 min. and then fixed in formalin acetic alcohol. The peeled epidermis were observed under a Olympus BH-light microscope (LM). In measuring the size of stomata, the lateral subsidiary cells were included and an average of 10 measures was given in micron. For the scanning electron microscope (SEM) observation, the fixed leaves were dehydrated in the series of graded acetone solution and were fixed to specimens stubs with Ion sputter JFC-1-100, coated with gold/palladium and observed at the acceleration voltage of 15 KV with an JEOL-JSM T 300 scanning electron microscope (SEM). Photographs were taken with Kodak VP 20 and contact printing was done with kodabromide paper. The combined use of both light microscope and scanning electron microscope permitted the reasonably rapid observation of leaf blades.

Results

Carex siderosticta Hance

LM; Subsidiary cells of stomata are triangular shaped. Stomata are 48.2-50.2-51.8 micron long (minimum-average-maximum) and 55.3-61.4-64.3 micron wide. A few rows of the stomata alternate with many rows of fundamental epidermis cells. The cell wall of fundamental epidermis cells is strongly

wavy. The long cell is 46.4-59.1-71.4 micron long and 82.1-92.3-103.5 micron wide. Silica bodies are rounded, one per cell(Metcalf 1960).

SEM ; Intercostal; many rows long cell, square or rectangular, uniform, walls sinuous, interlocking, stomata 2-rows/zone, subsidiaries parallel to dome-shaped, interstomatals long and narrow, inflated, ends straight or shortly U-shaped, prickles present only on abaxial surface(Ellis 1979, Palmer and Tucker 1981).

***C. ciliatomarginata* Nakai**

LM ; Subsidal cells of the stomata are triangular shaped. Stomata are 35.7-37.5-41.1 micron long and 46.4-49.4-53.6 micron wide. Five rows of the stomata alternate with many rows of fundamental epidermis cells. Cell wall of fundamental epidermis cells is sinuous wavy. The long cell is 32.1-38.9-42.8 micron long, 50.0-58.4-64.4 micron wide, and prickles is present at both leaf blades.

SEM ; Costal; short cells 2/rows, silica body 2-3 per cell, end rounded straight. Intercostal zone; many rows long cell, square or rectangular, uniform, walls sinuous, interlocking, stomata 5 rows/zone. Subsidiaries parallel to low-domed, interstomatals short and narrow, non-inflated, end shortly U-shaped, prickles present at the both surfaces.

***C. okamotoi* Ohwi**

LM ; Subsidal cells of the stomata are triangular shaped. Stomata are 39.3-41.8-46.4 micron long and 41.1-48.9-60.7 micron wide. There are four rows of stomata in the intercostal zone. The cell wall of fundamental epidermis are strong or sinuous wavy. The cell length is 46.4-67.1-89.3 micron and width is 44.6-51.1-60.7 micron.

SEM ; Intercostal; many rows long cell, square or rectangular, non-uniform walls straight or sinuous interlocking, stomata two rows/zone, subsidiaries parallel to low-domed, interstomatals short and narrow, non-inflated ends shortly V-shaped, prickles absent.

Scanning electron microscopic epidermal patterns key to species of section *Siderostictae* in Korea

- A. Long cell of fundamental epidermis is square or rectangular, uniform
 - B. Interstomatals are long, narrow, inflated, ends straight or shortly, U-shaped and prickles are present only on abaxial surface *C. siderosticta*
 - B. Interstomatals are short, narrow, non-inflated, ends shortly, U-shaped and prickles are present at the both surfaces *C. ciliatomarginata*
- A. Long cell of fundamental epidermis is square or rectangular, non-uniform *C. okamotoi*

Table 2. Some important characters of section *Siderostictae* using SEM

Characters	<i>Carex siderosticta</i>	<i>C. ciliatomarginata</i>	<i>C. okamotoi</i>
Subsidal cells	dome	low-dome	low-dome
Interstomatal cells	long, narrow inflated ends straight or short U-shaped	short, narrow non-inflated ends short U-shaped	short, narrow non-inflated ends short V-shaped
Prickles	* ab (+), ad (-)	ab (+), ad (+)	ab (-), ad (-)
Shape of the intercostal cell	square or rectangular uniform	square or rectangular uniform	square or rectangular non-uniform
Wall of the intercostal cell	sinuous interlocking	sinuous interlocking	straight or sinuous interlocking

* ; ab: abaxial surface, ad: adaxial surface

Table 3. Some important characters of section *Siderostictae* using LM

Characters	<i>Carex siderosticta</i>	<i>C. ciliatomarginata</i>	<i>C. okamotoi</i>
Subsidal cells	triangular	triangular	triangular
Size of stomata (average)	50.2 × 61.4** (length × width)	37.5 × 49.4 (length × width)	41.8 × 48.9 (length × width)
Wall of the intercostal cell	strong wavy	sinuous wavy	strong or sinuous wavy
Size of the intercostal cell (average)	59.1 × 92.3 (length × width)	38.9 × 58.4 (length × width)	67.1 × 51.1 (length × width)

** ; micron

Discussion

A comparison of the cellular details of the leaf surface shows that the epidermal patterns of the 3 taxa of the section *Siderostictae* are similar. Epidermal cells of the adaxial surface are rectangular or nearly square in outline. A typical abaxial leaf surface of the section *Siderostictae* has several longitudinal rows of stomata, flanked by two or more rows of rectangular epidermal cells in the regions between intercostal zone and shorter rectangular cells containing silica bodies over the vascular bundles (Plate).

Scanning electron micrographs of the abaxial surface revealed similar patterns among representative taxa (Plate, 6).

The stomata are generally restricted to the abaxial surface and are paracytic with two prominent guard cells and two subsidiary cells oriented parallel to the stomatal pore. Subsidiary cells in stomata are classified dome and low-dome shaped (Metcalf 1960); the dome type is observed in *C. siderosticta* and the low-dome type in *C. ciliatomarginata* and *C. okamotoi*.

The intercostals are long, narrow, inflated ends straight or short and U-shaped in *C. siderosticta*. The interstomatals are short, narrow, non-inflated, ends short U-shaped the first form in *C. ciliatomarginata* U-shaped, The latter form in *C. okamotoi* V-shaped.

The epidermis of *C. siderosticta* are present hairy on the abaxial surface. *C. ciliatomarginata* are hairy both surface of the leaf blade and *C. okamotoi* were without hair. Therefore, the three species can be easily recognized by the characteristics of leaves. The walls of the intercostal cells are sinuous wavy and interlocking in *C. siderosticta* and *C. ciliatomarginata*. Whereas those of the walls of the intercostal cells are straight or sinuous wavy and interlocking in *C. okamotoi*. The number of silica bodies are varied in species; one per cell in *C. siderosticta*, two to three per cell in *C. ciliatomarginata*, and *C. okamotoi* not confirmed.

With the result of this study, it is confirmed that the above three taxa are distinctly different species in Korea.

요 약

한국산 사초과(Cyperaceae)식물중 대사초류(Sect. Siderostictae)에 속하는 대사초(*Carex siderosticta*), 털대사초(*C. ciliatomarginata*)와 지리대사초(*C. okamotoi*)의 잎의 표피형을 광학현미경(LM)과 주사전자현미경(SEM)으로 비교하였다. 그 결과 3종을 동정·분류할 수 있는 특징을 보았다. 아울러 주사전자현미경(SEM)에 의한 특징으로 검색표를 만들었다.

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Explanation of Plate

Plate : Scanning electron and light micrographs of epidermal patterns of leaf blades.

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| 1. <i>Carex siderosticta</i> (ab. SEM X350) | 2. <i>C. ciliatomarginata</i> (ab. SEM X350) |
| 3. <i>C. okamotoi</i> (ab. SEM X350) | 4. <i>C. okamotoi</i> (ab. SEM X500) |
| 5. <i>C. okamotoi</i> (ab. SEM X1500) | 6. <i>C. siderosticta</i> (ab. SEM X1000) |
| 7. <i>C. siderosticta</i> (ab. LM X250) | 8. <i>C. ciliatomarginata</i> (ab. LM X250) |
| 9. <i>C. okamotoi</i> (ab. LM X250) | |

