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Originals

Epidermal Microstructures of the Leaf, Leaf Sheath and Culm Sheath in the Japanese Slender Bamboos of Two Genera *Sasa* and *Sasamorpha* (Bambusaceae)

Kanji NAMIKAWA and Osamu KOBAYASHI

Biological Laboratory, Sapporo College, Hokkaido University of Education,
5-3-1 Ainosato, Kita-ku Sapporo, 002 JAPAN

ササ属とスズタケ属8種の葉，葉鞘，稈鞘の表皮微細構造

並川寛司，小林　修

北海道教育大学札幌分校生物学教室　002 札幌市北区あいの里 5−3−1

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Epidermal microstructures of the foliage leaves, leaf sheaths and culm sheaths of eight Japanese slender bamboos, which belong to four sections of the genus *Sasa* and to its allied genus *Sasamorpha,* were examined with a scanning electron microscope to study the taxonomic relationships between the species. These microstructures are very characteristic, and the results obtained were analyzed by a matching coefficient of Sokal and Michener (1958). Seven species of the genus *Sasa* were classified into four different groups, which correspond with the taxonomic rank of the sections proposed by Suzuki (1979). Further, the sect. Lasioderma is more closely related to the genus *Sasamorpha* than the other sections of the genus *Sasa* in the epidermal microstructure.

Introduction

The comparative morphology on the epidermal microstructure has been providing valuable information on the taxonomical relationships in various groups of higher plants, e. g., *Carex* (Toivonen and Timonen 1976), *Cyperus* (Denton 1983) and *Kobresia* (Rajbhandari and Ohba 1988).

The taxonomy and phylogeny of Bambusaceae, especially on the genus *Sasa* and its allied genera, have not yet been settled (Suzuki 1978, Murata 1989).

We have made a comparative observation on epidermal microstructures of the foliage leaves, leaf sheaths and culm sheaths of eight species of two genera *Sasa* and *Sasamorpha* using a scanning electron microscope (SEM).

Materials and methods

The species observed are as follows: *Sasa kurilensis* (Rupr.) Makino et Shibata, *S. pubiculmis* Makino var. *chitosensis* (Nakai) S. Suzuki, *S. takizawana* Makino et Uchida var. *lasioclada* (Makino et Nakai) S. Suzuki, *S. senanensis* (Fr. et Sav.) Rehder, *S. megalophylla*

Makino et Uchida, *S. chartacea* Nakai, *S. samaniana* Nakai, and *Sasamorpha borealis* (Hack.) Nakai. The nomenclature follows those of Suzuki (1978).

The materials used in this study were obtained from the herbarium specimens which had been collected in central Hokkaido, in September, 1989. The collecting data have already been investigated in our previous article (Namikawa and Imakita 1992).

The middle portions of foliage leaves, leaf sheaths and culm sheaths were cleaned in 50% ethyl alcohol with an ultrasonic cleaner for a few minutes to get rid of foreign particles. Next, they

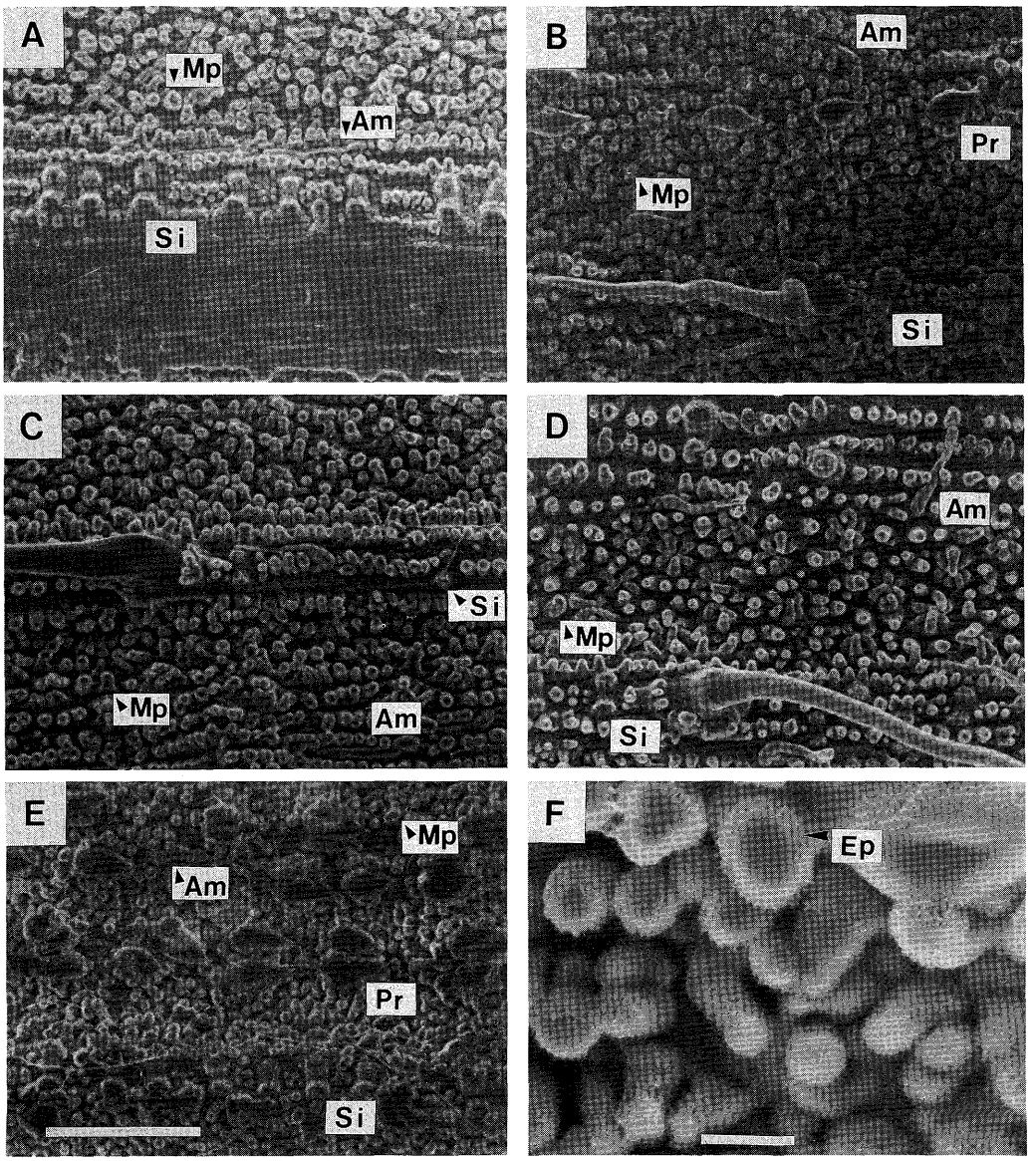

Fig. 1. Abaxial surface configurations of the foliage leaves. A: *Sasa kurilensis*. B and F: *S. pubiculmis* var. *chitosensis*. C: *S. senanensis*. D: *S. chartacea*. E: *Sasamorpha borealis*. Signs are explained in the text and Table 1. Scale-line = 100 μm except for Figure F (10 μm).

were dried in a desiccator, coated with gold (0.02 μm in thickness) in an ion coater (JEOL JFC-1100E) for 2.5 min, and then observed with SEM (JEOL JSM-T100) at accelerating voltages of 15 kV. In every species, observations were carried out in six to twelve specimens.

Results and discussion

The following epidermal microstructures of the foliage leaves were observed in all eight species: saddle-shaped silica bodies (Si), micro processes of cuticle (Mp) and scale-like epicuticular wax (Ep). Figure 1 shows the abaxial surface microstructure in the five representatives, *S. kurilensis* (A), *S.*

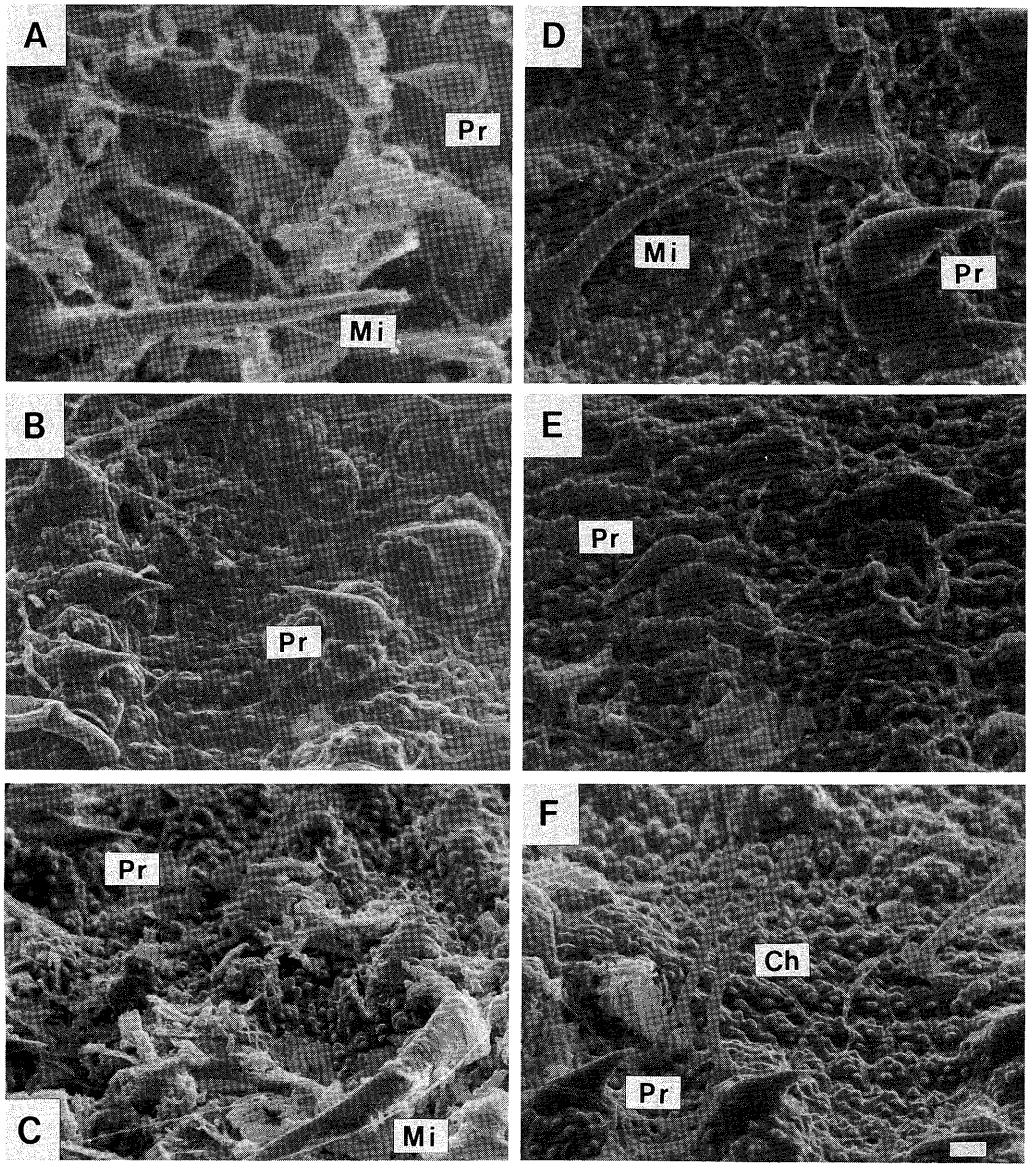

Fig. 2. Microstructures of the leaf sheaths (A–C) and culm sheaths (D–F) of three species; *Sasa pubiculmis* var. *chitosensis* (A, D), *S. megalophylla* (B, E) and *Sasamorpha borealis* (C, F). Signs are explained in the text. Scale-line = 10 μm.

pubiculmis var. *chitosensis* (B, F), *S. senanensis* (C), *S. chartacea* (D) and *Sasamorpha borealis* (E).

There were remarkable differences among the species on the presence of adpressed microhairs (Am) and prickles (Pr) on the abaxial surface of foliage leaves. *Sasamorpha borealis* and two species of the sect. Lasioderma have gently curved Am and cuneiform Pr over on the whole surface (Figs. 1B, E), while two species of the sect. Crassinodi lack the latter structure. *S. kurilensis* has Am only on the intercostal zone, and two species of the sect. Sasa lack Pr on the intercostal zone. These species-specific characters are summarized in Table 1, along with the taxonomic position of eight bamboo species.

With regard to leaf sheaths and culm sheaths, a well-developed cuticle with micropapillae and epicuticular wax were observed in all species. Figure 2 shows the surface microstructure of leaf (A–C) and culm sheaths (D–F) of the three representatives, *S. megalophylla* (A), *S. pubiculmis* var. *chitosensis* (B) and *Sasamorpha borealis* (C). The sections Lasioderma and Crassinodi have slender microhairs (Mi) and stout Pr on both leaf and culm sheaths, while *S. kurilensis* and *S. senanensis* lack any of these appendages there (Table 1). Both *S. megalophylla* and *S. senanensis* belong to the sect. Sasa, but the former can be distinguishable from the latter in having Pr on the culm sheaths. *Sasamorpha borealis* characteristically has slender and apically blunt clavellate hairs (Ch) on the culm sheath (Fig. 2F). In addition to these structural differences, the genus *Sasamorpha* and the sect. Lasioderma have a more-dveloped

Table 1. Characters of the surface microstructures of the foliage leaves, leaf sheaths and culm sheaths in the two genera of *Sasa* and *Sasamorpha* observed by SEM.

Species	Foliage leaves				Leaf sheath		Culm sheath			Fig. no.
	Costal zones		Intercostal zones							
	Am[1]	Pr[2]	Am	Pr	Ep[3]	Mi[4]	Mi	Pr	Ch[5]	
Genus *Sasa*										
sect. Macrochylamis										
S. kurilensis	−	−	+[6]	−[7]	S[8]	−	−	−	−	1A
sect. Lasioderma										
S. pubiculmis var. *chitosensis*	+	+	+	+	D[9]	+	+	+	−	1B, 1F, 2A, 2D
S. takizawana var. *lasioclada*	+	+	+	+	D	+	+	+	−	
sect. Sasa										
S. senanensis	+	+	+	−	S	−	−	−	−	1C
S. megalophylla	+	+	+	−	S	−	−	+	−	2B, 2E
sect. Crassinodi										
S. chartacea	+	−	+	−	S	+	+	+	−	1D
S. samaniana	+	−	+	−	S	+	+	+	−	
Genus *Sasamorpha*										
S. borealis	+	+	+	+	D	+	−	+	+	1E, 2C, 2F

[1]Am: adpressed microhair. [2]Pr: prickle. [3]Ep: epicuticular wax. [4]Mi: microhair. [5]Ch: clavellate hair. [6]+: present. [7]−: not seen. [8]S: scarce. [9]D: developed.

scale-like wax on the leaf sheath than other sections of the genus *Sasa*.

Based on Table 1, a proximity analysis for these species was made by matching coefficient of Sokal and Michener (1958), to clarify inter-specific relationships. The matching coefficient is: $Ssm = N_{jk}/N$, where N is the number of characteristics chosen and N_{jk} is the number of matching characteristics between two species j and k. A similarity matrix based on the above calculations was then subjected to a clustering by the average linkage method, and the result is investigated in the dendrogram (Fig. 3).

In the dendrogram, seven species of the genus *Sasa* should be classified into four groups, since two species of the sect. Sasa do not match with each other only in a single item (Pr on the culm sheath). This grouping completely corresponds to the section of the genus *Sasa* proposed by Suzuki (1978). The present observation shows that the comparative morphology on the epidermal microstructure is of great advantage for the classification of the sections within the genus *Sasa*.

Further, the matching between the sect. Lasioderma and the genus *Sasamorpha* is very high and is found in seven items. To date, a number of morphological, ecological and biogeographical studies have demonstrated a close relationship between the sect. Lasioderma and the genus *Sasamorpha* (Tatewaki 1940, Suzuki 1961). The present result also implies that the sect. Lasioderma might be transferred from the genus *Sasa* to the genus *Sasamorpha,* although the data are still insufficient.

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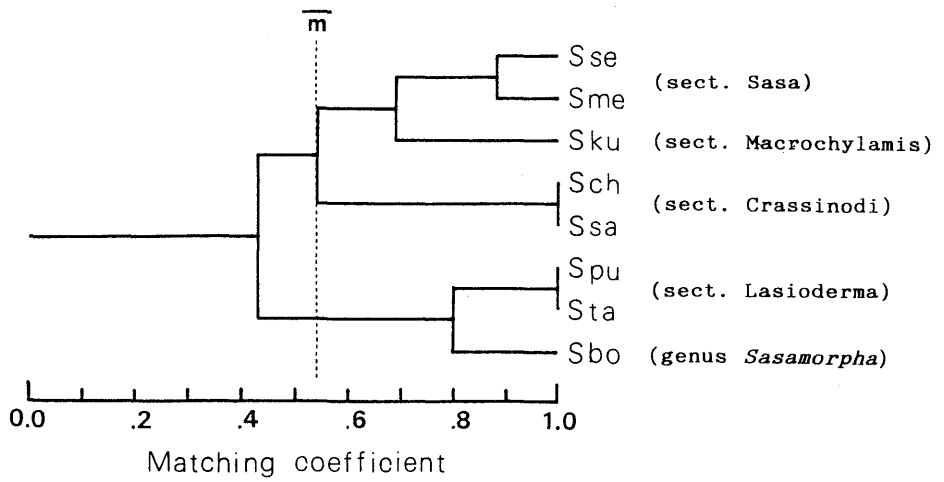

Fig. 3. A dendrogram of eight species in two genera *Sasa* and *Sasamorpha,* derived from a taximetric analysis of microstructures of the foliage leaves, leaf sheaths and culm sheaths. Abbreviations: Sse, *Sasa senanensis*; Sme, *S. megalophylla*; Sku, *S. kurilensis*; Sch, *S. chartacea*; Ssa, *S. samaniana*; Spu, *S. pubiculmis* var. *chitosensis*; Sta, *S. takizawana* var. *lasioclada*; Sbo, *Sasamorpha borealis*.

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要 旨

ササ属（*Sasa*）植物7種（チシマザサ，イブリザサ，チトセザサ，クマイザサ，オオバザサ，ミヤコザサ，アポイザサ）とスズタケ属（*Sasamorpha*）植物1種（スズタケ），合計8種について走査電子顕微鏡を用い，葉，葉鞘，稈鞘の表皮の微細構造の観察を行った．8種の分類学的な類縁関係を解析するために，種特異的な微細構造から種間の一致係数（Sokal and Michener 1958）を算出した．その結果ササ属の7種は4つのグループに分けられ，これらは鈴木（1978）の提唱した節と対応した．さらに表皮微細構造から見る限り，ナンブスズ節はササ属の他の節よりもスズタケ属と高い類縁を示した．