

## Anatomical Studies of the Genus *Solidago* (I)

On the Leaves of the Genus *Solidago*

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미역취속 식물의 해부학적 연구 (I)

미역취속 식물의 잎에 대하여

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The internal structure and surface view of the leaves of the genus *Solidago* have been clarified. A key based on the anatomical features has been constructed.

### Introduction

*Solidaginis Herba* (一枝黃花) has been used as a folk medicine for the treatment of a coughing, a headache, a jaundice, a sore throat, a whooping cough, a convulsion, etc. in China,<sup>1)</sup> a kidney trouble and a ureteritis in Korea.<sup>2)</sup> From the entire plant of *Solidago virga-aurea* L. var. *leio-carpa* A. Gray, caffeic acid, quercetin and quercitrin,<sup>3)</sup> chlorogenic acid, rutin, astragaln,<sup>3-4)</sup> cyanidin 3-gentiobioside<sup>4)</sup> have been reported. The water extract showed an antimicrobial action,<sup>5)</sup> favorable effect in a bronchitis, kidney trouble and congestion.<sup>6)</sup>

About 125 species of the genus *Solidago* are distributed in the world, mostly of North America, 2 or 3 in Europe, a few in Mexico and South America,<sup>7)</sup> and 3 varieties in Korea.<sup>8)</sup> A detailed anatomical study on the genus *Solidago* has not yet been reported, therefore, we clarify the internal structure and surface

view of the genus *Solidago* spp. growing in Korea and Japan. In the present paper, we report the comparative anatomical structure on the leaves.

### Experimental

#### I. Materials

1. *Solidago virga-aurea* L. var. *asiatica* Nakai: Obtained from the medicinal plant garden of Kyung-hee University (Oct. 1982).

2. *S. virga-aurea* var. *gigantea* Miq.: Obtained from the medicinal plant garden of Kyunghee University (Oct. 1982).

3. *S. altissima* L.: Collected at Takaoka, Toyama, Japan (Jun. 1980).

#### II. External appearance

1. *S. virga-aurea* var. *asiatica*: Stem is stout, branched above, 35~85cm high. Leaves are thin, ovate, acuminate and the bases are obtuse, sharply serrate, glabrous or sparingly pubescent on upper, glabrous on beneath, 7~9cm long and

1.5~5cm wide, abruptly contracted into margined petioles; heads are 12~14mm high, 3 to 5-flowered; bracts of the involucre are linear and obtuse; achenes are glabrous or nearly so.

2. *S. virga-aurea* var. *gigantea*: Stem is stout, branched above, 15~70cm high. Leaves are thin, ovate, acuminate and the bases ones are obtuse sharply serrate, glabrous or sparingly pubescent on upper, glabrous on beneath, 4~10cm long and 1.5~4cm wide, abruptly contracted into margined petiole; heads are 12~15mm high, 3 to 5-flowered; bracts of the involucre are linear and obtuse; achenes are pubescent.

3. *S. altissima*: Stem is stout, branched above, pubescent, or hirsute nearly throughout, 20~80cm high. Leaves are lanceolate, triple-nerved, acute at each end, roughish above and pubescent beneath, the lower ones are sharply serrate and petioled, 3~6cm long and 4~12mm wide, the upper is smaller, often entire, sessile; heads are 1.5~2.5mm high, usually numerous, secund on the spreading or recurving branches of the usually large panicle; bracts of the involucre are linear, obtuse or acutish; achenes are glabrous or somewhat pubescent.

### III. Investigation method

A transverse section is obtained from a middle portion of a leaf as usual and maceration of the xylem of the midrib is carried out with the Schultze's method. For the view of the surface, 5 square millimeter of the middle portion is opened into both sides after pervading with Eau-de-Javell solution and washed with water before investigation.

### IV. Internal structure (Fig. 1-B) and surface view (Fig. 1-D)

#### 1. *Solidago virga-aurea* var. *asiatica*

A transverse section of midrib (Fig. 1-B) at the middle portion of a leaf reveals a generally slight concave on upper surface and a distinctly

convex on lower surface. The both epidermis consist of epidermal cells (ep, 15~25 $\mu$ m in diameter) and stomata (sto), they are covered with cuticle layer about 1 $\mu$ m in thickness. In the midrib, only median vascular bundle (220~250 $\mu$ m in diameter) occurs, the one is comparatively simple in structure, collateral and orbicular. The xylem elements (Fig. 1-C) of the median vascular bundle consist of spiral vessels (C<sub>1</sub>), pitted vessels (C<sub>2</sub>) and fibers (C<sub>3</sub>), the phloem consists of small and thin-walled sieve cells (s). The median vascular bundle is not supported by bundle sheath. Collenchyma (co) arises beneath both epidermis in 1~3 rows.

In the surface view (Fig. 1-D<sub>1-2</sub>), the upper surface consists of only polygonal epidermal cells and of which cell walls show slightly wave. Stomata and micro hairs (mih) occur in the lower surface (D<sub>2</sub>). Stomata are 33~36 $\mu$ m long and 23~26 $\mu$ m in diameter, they are anomocytic type.<sup>9)</sup> Micro hairs are 50~60 $\mu$ m long and are comprised of two cells, basal and distal cells. The former is smaller in diameter than the latter, and their cell walls are very thin (about 0.5 $\mu$ m in thickness).

#### 2. *S. virga-aurea* var. *gigantea* (Fig. 2, A-C)

A transverse section of a midrib (Fig. 2-B) reveals a generally slight convex on upper surface and a distinctly convex on lower surface. Three vascular bundles occur, one median (400~500 $\mu$ m in diameter) and 2~3 small ones (70~120 $\mu$ m in diameter). The xylem elements of the median vascular bundle consists of spiral vessels, pitted vessels and fibers. The phloem consists of small and thin-walled sieve cells. Collenchyma arises beneath both epidermis in 1~2 rows. In the upper (Fig. 2-C<sub>1</sub>) and lower surfaces (C<sub>2</sub>), micro hairs (70~80 $\mu$ m long) occur.

#### 3. *S. altissima* (Fig. 2, D-F)

In the transverse section of a midrib (Fig.

Table I. The comparative anatomical characteristics of *Solidago* spp.

Elements	Species	<i>S. virga-aurea</i> var. <i>asiatica</i>	<i>S. virga-aurea</i> var. <i>gigantea</i>	<i>S. altissima</i>
Shape of upper surface of midrib		slightly concave	slightly convex	slightly concave
Number of vascular bundles		1	2	1
Diameter of median vascular bundle( $\mu\text{m}$ )		220~250	400~500	200~250
Micro hairs, occurrence <sup>1)</sup>		a	b	b
length ( $\mu\text{m}$ )		50~60	70~80	35~40
Multicellular hairs <sup>2)</sup>		a	a	b
Stomata		anomocytic type	anomocytic type	anomocytic type

1) a: occur only on lower surface; b: occur on both surfaces

2) a: glabrous or occur sparsely; b: occur on both surfaces

2-E), the upper surface reveals a slight convex and the lower surface a distinctly convex. Only a median vascular bundle (200~250 $\mu\text{m}$  in diameter) occur in the midrib. Collenchyma arises beneath both epidermis in 1~2 rows. In the upper (Fig. 2-F<sub>1</sub>) and lower surfaces (F<sub>2</sub>), multicellular hairs and micro hairs occur. The multicellular hairs occurring on the upper surface are generally shorter (120~150 $\mu\text{m}$  long) than those (150~270 $\mu\text{m}$  long) on the lower surface. The micro hairs are very short (35~40 $\mu\text{m}$  long), comprised of basal and distal cells. The former is shorter and smaller in diameter than the latter. The stomata presenting on the lower surface are anomocytic type.<sup>9)</sup>

## Results

I. The characteristics of the internal structure and surface view of *Solidago virga-aurea* var. *asiatica*, *S. virga-aurea* var. *gigantea* and *S. altissima* are shown in Table 1.

II. A key based on the anatomical features of a leaf, as presented in this paper, has been constructed.

Key for Identification of *Solidago* spp. by Anatomical Characteristics

1. Micro hairs are 50~80 $\mu\text{m}$  long and mult-

icellular hairs are glabrous or occur sparsely

2. Only median vascular bundle occurs in midrib and is 220~250 $\mu\text{m}$  in diameter, micro hairs present only on lower surface and are 50~60 $\mu\text{m}$  long, and the upper surface of midrib reveals a slight concave.....*S. virga-aurea* var. *asiatica*

2. Median vascular bundle and 2 small ones occur in midrib and the former is 400~500 $\mu\text{m}$  in diameter, micro hairs present on both surfaces and are 70~80 $\mu\text{m}$  long, and the upper surface of midrib reveals a slight convex.....*S. virga-aurea* var. *gigantea*

1. Micro hairs are 35~40 $\mu\text{m}$  long and a number of multicellular hairs occur...*S. altissima*

III. The type species of the genus *Solidago* is *S. virga-aurea*, three varieties of it are growing in Korea, *S. virga-aurea* var. *asiatica*, *virga-aurea* var. *gigantea* and *S. virga-aurea* var. *coreana*. Among of them *S. virga-aurea* var. *asiatica* is popular species, the others are few. They are very similar in their appearance but *S. virga-aurea* var. *asiatica* and *S. virga-aurea* var. *gigantea* can be distinguished by anatomical elements; the diameter of median vascular bundle, the number of vascular bundles in midrib, the length of micro hairs, etc.

**List of Abbreviations:** co, collenchyma; ep, epidermis; h, hair; mih, micro hair; s, sieve

cell; sto, stoma; v, vessel

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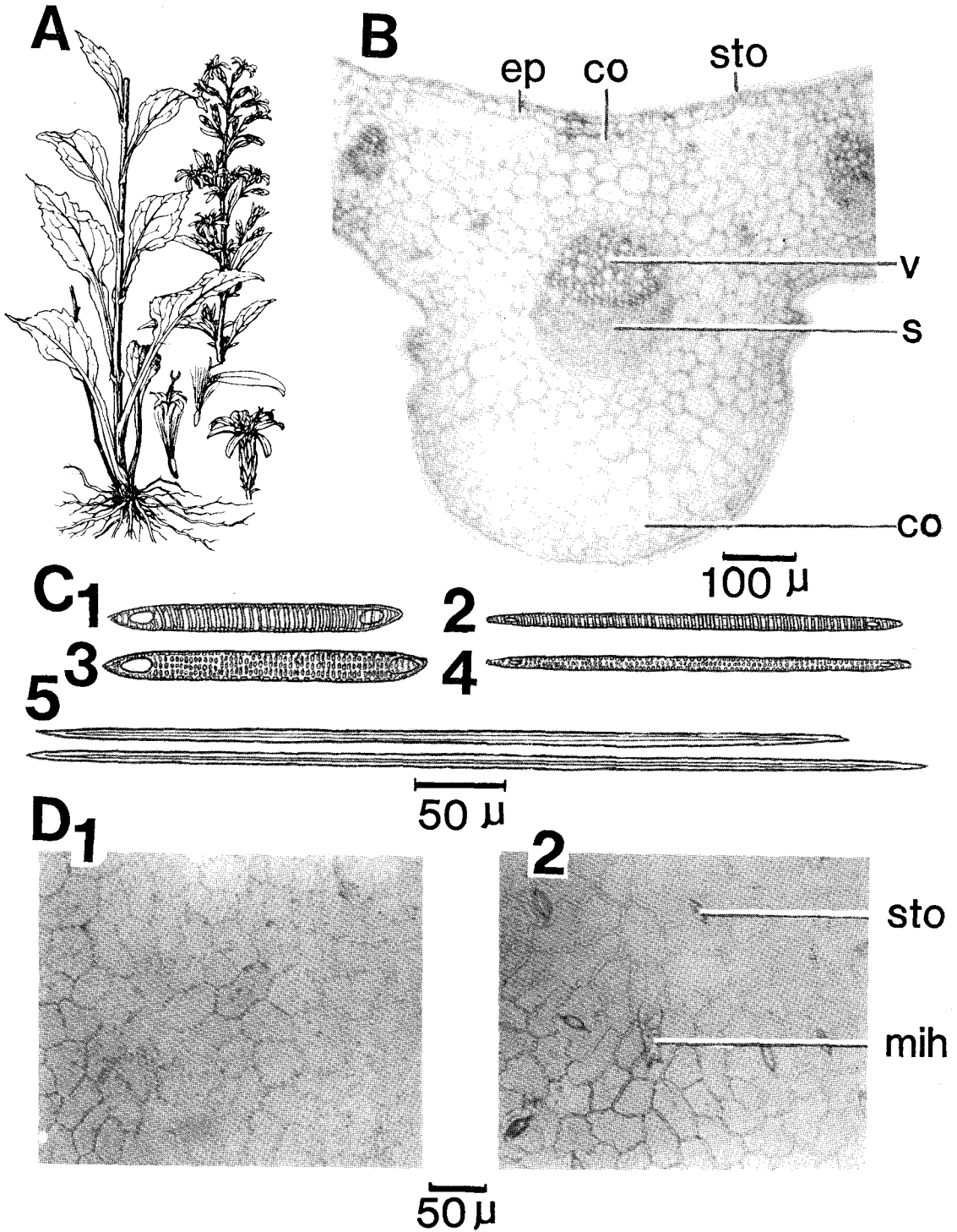


Fig. 1. *Sclidago virga-aurea* var. *asiatica*. A: Sketch of entire plant; B: Internal structure of midrib; C<sub>1-5</sub> Xylem elements of median vascular bundle (1-2, Spiral vessels; 3-4, Pitted vessels; 5-6, fibers) D<sub>1-2</sub>: Surface views (1, Upper; 2, Lower).

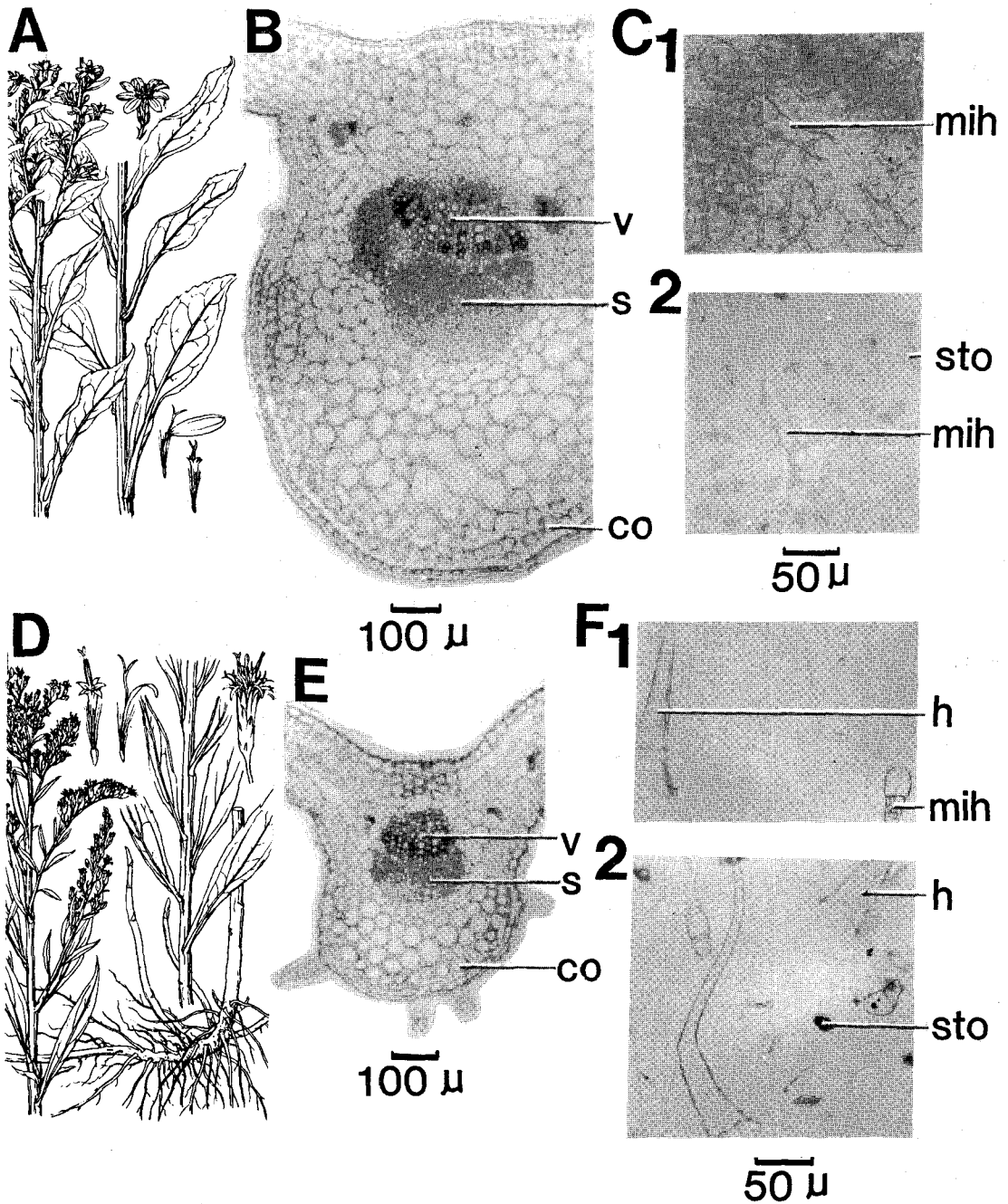


Fig. 2. A-C: *Solidago virga-aurea* var. *gigantea*; A: Sketch of entire plant; B: Internal structure of midrib; C<sub>1-2</sub>: Surface views (1, Upper; 2, Lower). C-D: *S. altissima*; D-F: Same as those of A-C of *S. virga-aurea* var. *gigantea*.