

Anatomical Studies of the Genus *Solidago* (II)

On the Stems and Roots

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미역취속 식물의 해부학적 연구 (II)

식물의 줄기 및 뿌리에 대하여

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The internal structures of the stem and root of the genus *Solidago* have been elucidated. A key based on the anatomical features of them was also established.

Introduction

In the previous paper,¹⁾ the internal structures and surface views of the leaves of the genus *Solidago* had been clarified, and a key based on the anatomical characteristics had been established. In the present paper, we clarify the comparative anatomical structures on the stem and root of the genus *Solidago*.

Experimental

1. Material

The same as reported previously.¹⁾

2. Internal structures

1) *Solidago virga-aurea* L. var. *asiatica* Nakai (Fig. 1)

The transverse feature of stem (Fig. 1-A) shows more or less circular in outline. The outermost tissue, the epidermis(ep) which is composed of circular to elliptical cells, and the

outer cell wall is thickened (7~10 μ m) and covered with 1~1.5 μ m of cuticle layer. The cortex consists of 7~10 layers of collenchymatous cells(co), these cells are packed with some of brown substances but no crystals and starch grains are found. The bast fibers(bf) occur 70~100 in number at the innermost region of cortex. The secretory cells occur rarely. The xylem is consisted of vessel(v), tracheid and xylem fibers. Almost of vessels are pitted vessels(vp) but occur rarely helical vessels(vh), the pitted vessels have bordered pit-pairs.²⁾ The phloem consists of small and thin walled sieve cells. The pith(m) is composed of parenchymatous cells which are 70~120 μ m in diameter.

The transverse feature of root (Fig. 1-B) shows also circular in outline. The outermost tissue, the epidermis is composed of circular or elliptical cells. The parenchymatous cells(p) of cortex are 20~40 μ m in diameter and the cell walls of these are thickened (5 μ m). At the innermost of cortex, secretory cells(sec) appear

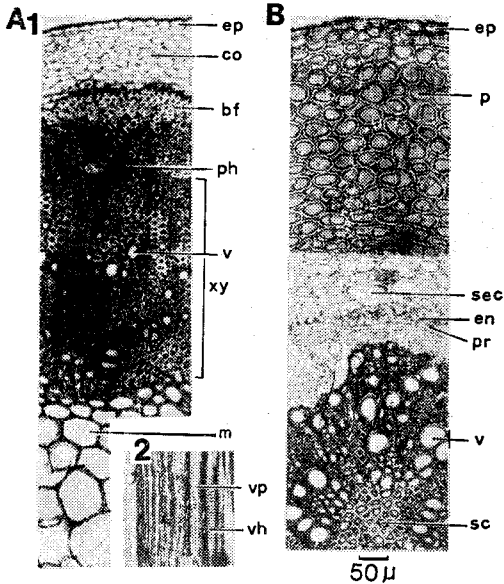


Fig. 1. *Solidago virga-aurea* var. *asiatica* A₁: Transverse section of stem; A₂: Longitudinal section of stem; B: Transverse section of root.

4~6 in number and are 40~50 μ m in diameter. The fibers(f) present at the pericycle(pr). The vascular bundle is a amphicribal type,^{3a)} that is, the phloem(ph) surrounds the xylem(xy). The stele of this species is a protostele type.^{3b)} The vessels are 20~50 μ m in diameter and the center of the stele is composed of sclerenchymatous cells(sc).

2) *Solidago virga-aurea* var. *gigantea* Miq.

In the stem, the epidermis is composed of circular to elliptical cells and the outer cell wall is thickened and covered with 1~1.5 μ m of cuticle layer. The cortex consists of 15~30 layers of collenchymatous cells. The bast fibers occur 150~250 in number at the innermost region of cortex. The pith is composed of parenchymatous cells, which are 100~150 μ m in diameter. In the root, the epidermis is circular or elliptical cells. The parenchymatous cells of cortex are 20~40 μ m in diameter and the cell walls of these are thickened. At the innermost of cortex, secretory cells appear 6~10 in number and are

40~80 μ m in diameter. The fibers present at the pericycle. The vessels are 20~50 μ m in diameter and the center of the stele is composed of sclerenchymatous cells.

3) *Solidago altissima* L. (Fig. 2)

In the stem (Fig. 2-A), the epidermis is composed of elliptical cells and their cell walls are not thickened (2~3 μ m). The cortex consists of 10~15 layers of collenchymatous cells but the cell walls are slightly thick. The bast fibers occur 30~90 in number at the innermost region of cortex. The secretory cells are found and 50~70 μ m in diameter. The xylem is composed of vessel, tracheid and xylem fibers. Almost of vessels are pitted vessels. The phloem is consisted of small and thin walled sieve cells. The pith is composed of parenchymatous cells, which are 70~160 μ m in diameter.

The transverse feature of root (Fig. 2-B) shows circular in outline. The outermost tissue, the epidermis is composed of circular or elliptical cells. The parenchymatous cells of cortex are

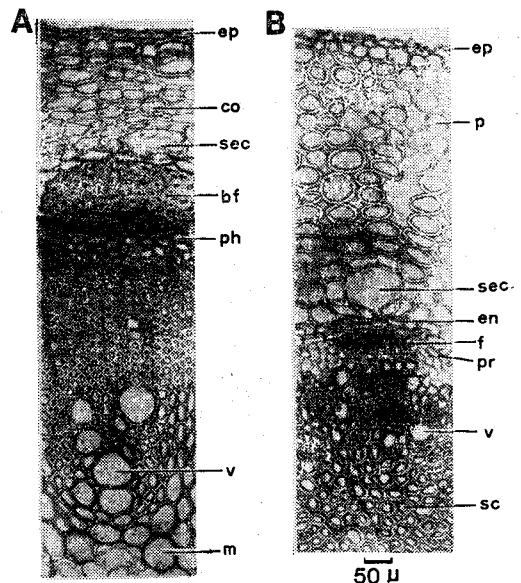


Fig. 2. *Solidago altissima* A: Transverse section of stem; B: Transverse section of root.

30~70 μ m in diameter and the cell walls of these are thickened (5 μ m). At the innermost of cortex, secretory cells appear 6~8 in number and are 100~150 μ m in diameter. The fibers present at the pericycle. The stele of this species is a protosteles, the vessels are 20~40 μ m in diameter and the center of the stele is composed of sclerenchymatous cells.

Results and Discussion

1. The characteristics of the internal structures of *Solidago virga-aurea* var. *asiatica*, *S. virga-aurea* var. *gigantea* and *S. altissima* are shown in Table 1 and 2.

2. The stele of the roots of the genus *Solidago* is a protosteles type,^{3b)} which is considered to be a most primitive phylogenetically.

3. The genus *Solidago* is a widespread one in the world about 125 species,⁴⁾ but 3 varieties in Korea.⁵⁾ *Solidago virga-aurea* var. *asiatica* and *S. virga-aurea* var. *gigantea* distributing in Korea show very similar appearances but can be classified by the anatomical characteristics, collenchymatous cells of cortex and bast fibers in the stem, number of secretory cells in the root, etc.

4. A key based on the anatomical features of the stem and root of the genus *Solidago* has been constructed as shown in Table 3.

Table I. Comparative anatomical characteristics of Stem of *Solidago* spp.

Elements	Materials	<i>S. virga-aurea</i> var. <i>asiatica</i>	<i>S. virga-aurea</i> var. <i>gigantea</i>	<i>S. altissima</i>
Thickness of cuticle layer		1~1.5 μ m	1~1.5 μ m	1~1.5 μ m
Thickness of outer cell walls in epidermis		7~10 μ m	7~10 μ m	2~3 μ m
Collenchymatous cells of cortex		7~10 layers	15~30 layers	10~15 layers
cell wall of collenchymatous cell		distinctly thick	distinctly thick	slightly thick
Bast fibers		70~100 fibers	150~200 fibers	30~90 fibers
Diameter of vessels		10~25 μ m	10~25 μ m	20~70 μ m
Diameter of fibers		10~14 μ m	10~14 μ m	10~14 μ m
Diameter of pith cells		70~120 μ m	100~150 μ m	70~160 μ m

Table II. Comparative anatomical characteristics of root of *Solidago* spp.

Elements	Materials	<i>S. virga-aurea</i> var. <i>asiatica</i>	<i>S. virga-aurea</i> var. <i>gigantea</i>	<i>S. altissima</i>
Cell wall of parenchyma		thick (5 μ m)	thick (5 μ m)	thick (5 μ m)
Number of secretory cells		4~6	6~10	6~8
Diameter of secretory cells		40~50 μ m	40~80 μ m	100~150 μ m
Starch and crystal		absent	absent	absent
Diameter of vessel		20~50 μ m	20~50 μ m	20~40 μ m
Fibers in pericycle		absent	present	present

Table III. A key for identification of *Solidago* spp. by anatomical characteristics.

1. Outer cell wall of epidermis in stem is thick (7~10 μ m), secretory cells in root are small (40~80 μ m)	
2. Cortex of stem is composed of 7~10 layers of collenchymatous cells, and bast fibers occur 70~100 in number.....	<i>S. virga-aurea</i> var. <i>asiatica</i> .
2. Cortex of stem is composed of 15~30 layers of collenchymatous cells, and bast fibers occur 150~250 in number.....	<i>S. virga-aurea</i> var. <i>gigantea</i> .
1. Outer cell wall of epidermis in stem is thin (2~3 μ m), secretory cells in root are large (100~150 μ m).....	<i>S. altissima</i>

List of Abbreviations: bf, bast fiber

co, collenchyma; en, endodermis; ep, epidermis; f, fiber; m, pith; p, parenchyma; ph, phloem; pr, pericycle; sc, sclerenchyma; sec, secretory cell; v, vessel; vh, helical vessel; vp, pitted vessel; xy, xylem.

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