An Anatomical Study of Clematis in Korea

by

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I. Introduction

Nakai reported Korean *Clematis* as 21 species and 14 varieties on Synoptical Sketch of Korean Flora in 1952, and Lee (1970) recently reviewed Korean *Clematis* and described 16 species, 11 varieties and 5 forma.

An anatomical studies of *Clematis* have been partially done by Metcalfe (1950) and Tamura (1956, 1965).

In this study, the author tried to find useful anatomical characters for Korean *Clematis* taxonomy.

This study was conducted under the supervision of Dr. Yong No Lee, Prof. of Botany at Ewha Womans University, to whom I am grateful for his kind and valuable guidance in many ways throughout the investigation.

II. Materials and Methods

A. Materials

The materials for the study consisted of dry leaf blades, petioles and stems that were preserved in the Herbarium of Ewha Womans University. The widest portion of the leaf blades were used for observation.

They are as follows:

<i>Clematis apiifolia</i> DC.		Moonkong, Kyongbook
<i>Clematis brachyura</i> Maximowicz		Kwangnung, Kyonggido
<i>Clematis davidiana</i> Schneider		Dosunsa, Kyonggido
<i>Clematis ianthina</i> Koehne var.		
<i>violacea</i> Nakai		Hambak, Kangwondo
<i>Clematis koreana</i> Komarov		Mt. Hallasan, Chejudo
<i>Clematis mandshurica</i> Maximowicz		Wooildong, Seoul
<i>Clematis patens</i> Morren & Decaisne		Mangwalsa, Seoul
<i>Clematis trichotoma</i> Nakai		Sangdong, Kangwondo
<i>Clematis heracleaefolia</i> DC.		Hambak, Kangwondo

B. Methods

The stems and petioles were softened by boiling in water for about two hours, and these were cut by hand with a razor blade. The widest portion of the leaf blades were softened by hot water for about thirty minutes and peeled by hand with a razor blade.

Observation was made under the microscope with 40 and 100 magnification. Stomata were measured with a micrometer, while observing epidermis under 100 magnification. The pictures for drawings were taken of each cross section of stem, petiole and epidermis.

III. Observation

Clematis apiifolia DC.

Stem: The Stem is hexagonous, and the epidermis is one layered. The Cortex is sclerenchymatous, and the cork is 2-3 cell layered and brown colored. Phloem fibres are well developed. The endodermis is significant and brown colored. Six major vascular bundles and 6 interfascicular bundles are present in every internode (Fig. 1:5).

Petiole: The petiole is pentagonous and horseshoe shaped and the epidermis is one layered. The cork is 2-3 cell layered. Phloem fibres are well developed. Six major vascular bundles are in the petiole (Fig. III:3).

Abaxial surface: Stomata are 34 microns long and 25 microns wide. The cell walls are shallowly wavy (Fig. IV:3).

Clematis brachyura Maximowicz

Stem: The stem is hexagonous, and the epidermis is one layered. The cortex is 3-4 cell layered and thinly sclerenchymatous. Phloem fibres are well developed. The endodermis is not defined. Six major vascular bundles are usually present with variable number of interfascicular bundles in the stem (Fig. 1:1). The vascular bundles gradually decrease from base to upper portion of the internodes (22, 20, 18, 16, 14, 12).

Petiole: The petiole is prominently pentagonous horseshoe shaped, and the epidermis is one layered. The cortex is present under the epidermis. The phloem fibres are well developed. Six major vascular bundles and 4 interfascicular bundles are in the petiole (Fig. III:1).

Abaxial surface: Stomata are 41 microns long and 30 microns wide. The cell walls are shallowly wavy (Fig. IV:1).

Clematis davidiana Schneider

Stem: The stem is hexagonous, and the epidermis is one layered. Sclerenchymatous cork is 2-4 cell layered and adjacent to the phloem fibres, which are abundant and brown colored. Six major vascular bundles with 6 to 18 interfascicular bundles are present in every internode from the base to the upper portion of the stem (Fig. II:8-9).

Petiole: Petiole is pentagonous or horseshoe shaped, and the epidermis is one layered. A cork layer is present under the epidermis, and five or 6 major vascular bundles with 4 to 9 interfascicular bundles are present in the petiole (Fig. III: 8, 9).

Abaxial surface: Stomata are 37 microns long and 29 microns wide. Cell walls are shallowly wavy (Fig. V:8).

Clematis heracleaefolia Decaisne

Stem: The Stem is hexagonous, and the epidermis is one layered. The cork is 2-3 cell layered, and sclerenchymatous cortex is not well developed. Endodermis is present, and xylem and pith rays are lignified. The number of vascular bundles are similar to *Clematis davidiana* Schneider.

Petiole: The petiole is pentagonous or horseshoe shaped, and the epidermis is one layered. A cork layer is present, and the number of vascular bundles are similar to *Clematis davidiana* Schneider.

Abaxial surface: Stomata are 50 microns long and 36 microns wide. Cell walls are shallowly wavy (Fig. V:9).

Clematis ianthina Koehne var. *violacea* Nakai

Stem: The stem is hexagonous, and the epidermis is one layered. The cork is 2-3 cell layered, Sclerenchymatous cortex is present, and phloem fibres are well developed. The endodermis is significant, and six major vascular bundles are present in every internode while interfascicular

bundles decrease from the base to the upper portion of the stem (Fig. 1:4).

Petiole: The petiole is horseshoe shaped, the epidermis is one layered, and the cork is 1-2 cell layered. Six major vascular bundles are in the petiole (Fig. III:6).

Abaxial surface: Stomata are 36 microns long and 28 microns wide. Cell walls are shallowly wavy (Fig. V:5).

Clematis koreana Komarov

Stem: The stem is elliptically round, and the epidermis is one layered. The cork is 2-3 cell layered, and the sclerenchymatous cortex is especially thick. Phloem fibres are well developed, and six major vascular bundles are present in the second internode from the flower of the peduncle (Fig. I:3).

Petiole: The petiole is round horseshoe shaped, and the epidermis is one layered. A cork layer is present, and five major vascular bundles with 2 interfascicular bundles are in the petiole (Fig. II:4).

Abaxial surface: Stomata are 54 microns long and 38 microns wide. Cell walls are not wavy (Fig. V:6).

Clematis mandshurica Maximowicz

Stem: Stem is hexagonal, and the epidermis is one layered. The cortex is 3 cell layered, and phloem fibres are well developed. Six major vascular bundles are usually present with 6 to 9 interfascicular bundles, and the number of vascular bundles decrease from the base to the upper portion of the stem (Fig. 1:2).

Petiole: The petiole is pentagonal horseshoe shaped, the epidermis is one layered, and the cortex is 2-3 cell layered. Five major vascular bundles are present (Fig. III:2).

Abaxial surface: Stomata are 52 microns long and 38 microns wide. Cell walls are shallowly wavy (Fig. IV:2).

Clematis patens Morren & Decaisne

Stem: The stem is hexagonal, and the epidermis is one layered. Cork is present, the cortex is sclerenchymatous, and the phloem fibres are well developed. Endodermis is present and brown colored. Six major vascular bundles are present from the base to the upper portion of the internodes (Fig. II:7).

The number of vascular bundles in peduncles are correlated to the number of the perianth and presently 10 to 14.

Petiole: The petiole is round horseshoe shaped, the epidermis is one layered, and the cork is 2-3 cell layered. Six major vascular bundles are in the petiole (Fig. III:7).

Abaxial surface: Stomata are 49 microns long and 37 microns wide. Cell walls are deeply wavy (Fig. V:7).

Clematis trichotoma Nakai

Stem: The stem is hexagonal, the epidermis is one layered, and the cork is 2-3 cell layered. The cortex is sclerenchymatous, and six major vascular bundles are usually present in every internode while the number of interfascicular bundles gradually decrease from base to upper portion of the stem (Fig. 1:6).

Petiole: The petiole is horseshoe shaped, and the epidermis is one layered. Five major vascular bundles with 2 interfascicular bundles are in the petiole (Fig. III:5).

Abaxial surface: Stomata are 39 microns long and 29 microns wide. Cell walls are deeply wavy (Fig. III:4).

Key to the species of Korean *Clematis* are based on several anatomical characteristics:

- A. Cork cell well developed
 - B. Stem round or hexagonous, with a constant number of vascular bundles present in every node from base to upper portion of stem
 - C. Six major bundles only present in every internode
 - D. Cell wall wavy, stomata 49 microns long, 38 microns wide.....*Clematis patens* Morren & Decaisne
 - D. Cell wall not wavy, stomata 54 microns long, 38 microns wide....*Clematis koreana* Komarov
 - C. Six major vascular bundles with 6 to 18 interfascicular bundles present
 - D. Stem very long, climbing, 6 major bundles with 6 interfascicular bundles present, cell wall wavy, stomata 34 microns long, 25 microns wide..*Clematis apiifolia* DC.
 - D. Stem erect, rather short, with 6 major vascular bundles with 6 to 12 interfascicular bundles present
 - E. Fundamental epidermal cell smaller than later one, stomata 37 microns long, 29 microns wide.....*Clematis davidiana* Schneider
 - E. Fundamental epidermal cell larger than former one, stomata 50 microns long, 36 microns wide.....*Clematis heracleaefolia* DC.
 - B. Stem round or hexagonous, constant number of major vascular bundle present in every internode, while interfascicular bundles decrease from the base to the upper portion of stem
 - C. Cell wall deeply wavy, stomata 39 microns long, 29 microns wide*Clematis trichotoma* Nakai
 - C. Cell wall not deeply wavy, stomata 36 microns long, 28 microns wide.....*Clematis ianthina* Koehne var. *violacea* Nakai
- A. Cork cell not developed, stem hexagonous
 - B. Stomata 41 microns long, 30 microns wide.....*Clematis brachyura* Maximowicz
 - B. Stomata 52 microns long, 38 microns wide.....*Clematis mandshurica* Maximowicz

IV. Conclusion

Tamura studied the petiolar anatomy of the *Ranunculaceae* in 1962. The most Korean herbaceous and woody *Clematis* were chosen in this study. Their stems, petioles and edpidermal patterns were studied.

The cross sections of the herbaceous species *Clematis brachyura* Maximowicz and *Clematis mandshurica* Maximowicz do not present cork layers, but *Clematis apiifolia* DC. *Clematis davidiana* Schneider, *Clematis ianthina* Koehne var. *violacea* Nakai, *Clematis koreana* Komarov, *Clematis patens* Morren & Decaisne, *Clematis trichotoma* Nakai and *Clematis heracleaefolia* DC. have well developed cork layers.

The number of the vascular bundles in the stem is variable among the species of *Clematis* and the portion of the internodes from the base to the upper portion. Herbaceous *Clematis brachyura*. Maximowicz showed 14, 16, 18, 20, 22 vascular bundles from the different internodes and

Figure I. Cross section of stem

1. *Clematis brachyura* Maximowicz 2. *Clematis mandshurica* Maximowicz 3. *Clematis koreana* Komarov
 4. *Clematis ianthina* Koehne var. *violacea* Nakai 5. *Clematis apiifolia* Decaisne 6. *Clematis trichotoma* Nakai
 7. *Clematis patens* Morren & Decaisne (peduncle) 8. *Clematis heracleaefolia* Decaisne 9. *Clematis davidiana* Schneider

Figure III. Cross section of petiole

1. *Clematis brachyura* Maximowicz 2. *Clematis mandshurica* Maximowicz 3. *Clematis apiifolia* Decaisne
 4. *Clematis koreana* Komarov 5. *Clematis trichotoma* Nakai 6. *Clematis ianthina* Koehne var. *violacea*
 Nakai 7. *Clematis patens* Morren & Decaisne 8. *Clematis heracleaefolia* Decaisne 9. *Clematis davidiana*
 Schneider

Clematis mandshurica Maximowicz showed 12 to 15 vascular bundles from different internodes of the stem. The vascular bundles of the stem in *Clematis brachyura* Maximowicz and *Clematis mandshurica* Maximowicz gradually decrease from the base to the upper portion. The stomata of *Clematis mandshurica* Maximowicz are 52 microns long and 38 microns wide, and *Clematis brachyura* Maximowicz are 41 microns long and 30 microns wide. These size differences of stomata are correlated with chromosome numbers as *Clematis brachyura* Maximowicz is $2n=16$, and *Clematis mandshurica* Maximowicz is $2n=32$. The author considered *Clematis brachyura* Maximowicz to be more primitive than *Clematis mandshurica* Maximowicz according to the histology, chromosome numbers, and inflorescence. *Clematis koreana* Komarov and *Clematis patens* Morren & Decaisne had cork layers and the most simple arrangement of the vascular bundles in the stem. These two species

had only six major vascular bundles in the stem. *Clematis apiifolia* DC. constantly showed 12 vascular bundles from the base to the upper portion in every internode. Both *Clematis davidiana* Schneider and *Clematis heracleaefolia* DC. constantly showed 12 and 24 vascular bundles from the base to the upper portion in every internode. Their vascular bundles in the petioles were 9 and 15. *Clematis ianthina* Koehne var. *violacea* Nakai and *Clematis trichotoma* Nakai constantly showed six major vascular bundles in every internode while interfascicular bundles decrease from the base to the upper portion of stem.

Six was found as the number of major vascular bundles through the 9 species in the stem of *Clematis*. The number of vascular bundles in the petioles were different according to the species. The waviness of the cell wall the size of the stomata and the epidermal patterns of leaf blades were different among the species. These are considered to be important characteristics for classification of the *Clematis*.

Figure IV. Epidermis of leaf blade

1. *Clematis brachyura* Maximowicz 2. *Clematis mandshurica* Maximowicz 3. *Clematis apiifolia* Decaisne
4. *Clematis trichotoma* Nakai
5. *Clematis ianthina* Koehne var. *violacea* Nakai 6. *Clematis koreana* Komarov 7. *Clematis patens* Morren & Decaisne
8. *Clematis davidiana* Schneider 9. *Clematis heracleaefolia* Decaisne

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개 요

한국산 으아리속의 해부학적 연구
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우리나라의 *Clematis* 속은 16종 11변종 5아종으로 되어있다. 이 연구는 우리나라에 나는 으아리속 *Clematis* 중에서 대표적인 9종의 줄기, 잎대 표피를 세포조직학적으로 연구한 것이다.

이 속은 콜크가 발달된 목본형과 콜크가 발달되지 않은 초본형으로 크게 나눌수 있다. 줄기의 관다발수는 종류에 따라서 다르고 또 마디에 따라서도 변화되는 것이 있다. 초본형으로 나타나는 외대으아리 *Clematis brachyura* Maximowicz는 줄기의 관다발수가 아랫마디에서 윗쪽 마디로 올라가면서 22, 20, 18, 16, 14로 적어진다. 또한 으아리 *Clematis mandshurica* Maximowicz도 줄기의 중간에서 윗쪽을 향하여 15에서 12로 줄어지는 것을 볼수 있다. 외대으아리의 기공은 으아리에 비해 적고 염색체수는 외대으아리가 $2n=16$ 이고 으아리가 $2n=32$ 로 되어있다. 즉 외대으아리의 염색체수가 배로 된 식물이 으아리인것 같다.

콜크층을 지닌 층으로써 줄기의 관다발수가 일정한 것은 세잎종덩굴, 큰꽃으아리, 사위밀빵, 조희풀, 자주조희풀이었고 변화가 있는 것은 종덩굴과 할미밀빵이었다. 이들 줄기의 횡단면에서 관다발수가 가장 적은 것은 세잎종덩굴과 큰꽃으아리였고 가장 많은 것은 자주조희풀과 조희풀이었다.

특히 줄기의 관다발수가 어느 것을 막론하고 뚜렷하게 큰것이 6개이고 이 기본수 이외에 첨가되어 나타나는 관다발의 수는 종류에 따라서 달라지고 있다. 잎의 표피형의 세포에 크기와 기공의 크기, 기본 표피세포벽의 굴곡은 종류에 따라서 달라지고 있어서 으아리속의 종 분류에 큰 도움이 되는 형질이라고 볼 수 있다.