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# Morphological and Anatomical Characteristics of *Camellia sinensis* (L.) Kuntze from Two Different Localities

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## Abstract

Morphological and anatomical characteristics of *Camellia sinensis* (L.) Kuntze belonging to family Theaceae were studied at Department of Botany, University of Mandalay. The specimens were collected from Naung Cho Township of Northern Shan State and Mogok Township of Mandalay Region from June to October, 2017. The morphological and anatomical characteristics of leaves, stems and roots were studied, described, discussed and their photographs and photomicrographs were also presented. In morphological characteristics, the sizes of leaves, petioles and the numbers of petals were showed variable from one locality to another. The anatomical characteristics showed the differences in thickness of cell layers, the numbers and sizes of vascular bundles of leaves, stems and roots. The sclereids were observed in the ground tissues of petioles and midribs. The vascular bundles of stems were collateral type and roots were radial type and polyarch. The morphological and anatomical characteristics are useful in species confirmation and certain identification.

**Keywords:** *Camellia sinensis* (L.) Kuntze, Morphology, Anatomy.

## Introduction

The family Theaceae comprises 19 genera and 600 species. The only genus economically important in the family is *Camellia* which includes about 120 species. These species were found in Cambodia, China, North East India, Indonesia, Southern Japan, South Korea, Laos, Malaysia, Myanmar, Nepal, Philippines, Thailand, Vietnam (Wu *et al.* 2007).

In Myanmar, tea production is thought to have originated from the Palaung people on the Shan Plateau, parts of which are more than 6000 feet above sea level (So Pyay Thar 2016). Tea plant is grown in the Northern

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Shan State, Southern Shan State and Sagaing Region. Myanmar tea differs in quality according to the cultivation and processing (Kyaw Kyaw Sann 2009). Laphet, tea is a popular and important in Myanmar culture (Pyie Phyong Maung *et al.* 2012). The chemical components of green tea chiefly include polyphenols, caffeine and amino acids. Tea also contains flavonoids and has anti-oxidant properties. Tea flavonoids reduce inflammation, which have antimicrobial effects and prevent tooth decay (Tariq *et al.* 2013).

The systematic study on *Camellia sinensis* (L.) Kuntze and their detailed anatomical structure were performed in the present research work. The main objectives of this research are to study the morphological and anatomical characteristics of leaves, stems and roots of *Camellia sinensis* (L.) Kuntze from two different localities and to provide the specific information of morphological and anatomical characteristics for certain identification.

## **Materials and Methods**

*Camellia sinensis* (L.) Kuntze belonging to family Theaceae were collected from Naung Cho Township, Northern Shan State and Mogok Township, Mandalay Region, from June to October 2017. The collected specimens were studied and identified in the Department of Botany, University of Mandalay with the help of literatures (Hooker 1875, Backer 1946 and Dassanayake 1996).

For anatomical study, the small portions of the specimens were cut into the 15-25  $\mu\text{m}$  thick sections by using a rotary microtome. The dehydration, infiltration, embedding, staining and mounting were made according to Johansen's method (1940).

## **Results**

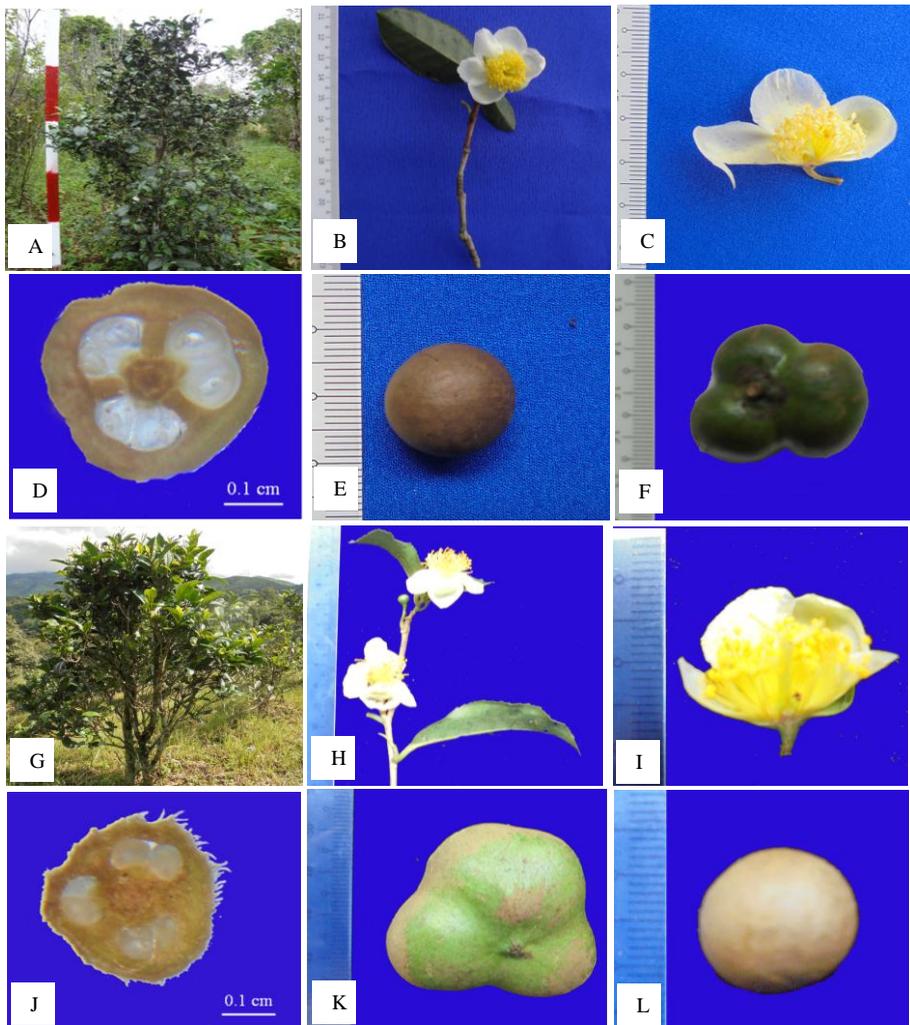
### **1. Morphological Studies**

#### **1.1 *Camellia sinensis* (L.) Kuntze. Trudy Im. S. 10: 195. 1887.**

Family	:	Theaceae
Scientific Name	:	<i>Camellia sinensis</i> (L.) Kuntze.
Common name	:	Tea
Myanmar name	:	Laphet
Flowering period	:	August to November

#### **1.1 Morphological characters of *Camellia sinensis* (L.) Kuntze from two different localities ( Figure 1)**

Perennial shrubs or small trees, 3 - 5 m in high from Naung Cho and 5-8 m in high from Mogok. Stems terete, stout, leaf scar presents. Leaves



**Figure 1 Morphological characters of *Camellia sinensis* (L.) Kuntze from two different localities**

- |                  |                   |                                 |
|------------------|-------------------|---------------------------------|
| A. Habit,        | B. Inflorescence, | C. L.S of flower from Naung Cho |
| D. T.S of ovary, | E. Fruit,         | F. Seed from Naung Cho          |
| G. Habit,        | H. Inflorescence, | I. L.S of flower from Mogok     |
| J. T.S of ovary, | K. Fruit,         | L. Seed from Mogok              |

simple, alternate, exstipulate, petioles 0.3 - 0.8 cm by 0.2 - 0.3 cm from Naung Cho and 0.2 - 0.8 by 0.2 - 0.3 cm from Mogok; leaf blades ovate or oblong elliptic, dark green; glabrous on both surfaces; serrate along the margin; cuneate at the base; acuminate at the apex. Inflorescences axillary cluster of cyme; 1 - 3 flowered from two different localities; peduncles short, dark green and glabrous. Flowers bisexual, actinomorphic, hypogynous, creamy white or pale yellow, showy, fragrant; pedicels short, dark green, glabrous; bracts small, caduceous. Sepals 5, concave, dark green, glabrous on both surfaces, persistent. Petals 5 - 7 from Naung Cho and 6 - 7 from Mogok, obovate, free in two whorls. Stamens numerous, free, filament filiform; anthers ditheous, dorsifixed. Carpels 3, fused; ovary superior, 1 or 2 ovules in each locule on the axile placentae, silky tomentose; styles stout, trilocular or sometimes bilocular, 1 or 2 ovules in each locule on the axile placentae; styles stout, glabrous; stigmas trifold. Capsules woody, subglobose. Seeds rounded or plano-convex, pale brown, nonendospermic.

## 2. Anatomical Studies

### 2.1 Internal structure of the leaves of *Camellia sinensis* (L.) Kuntze from two different localities ( Figure 2 and 3)

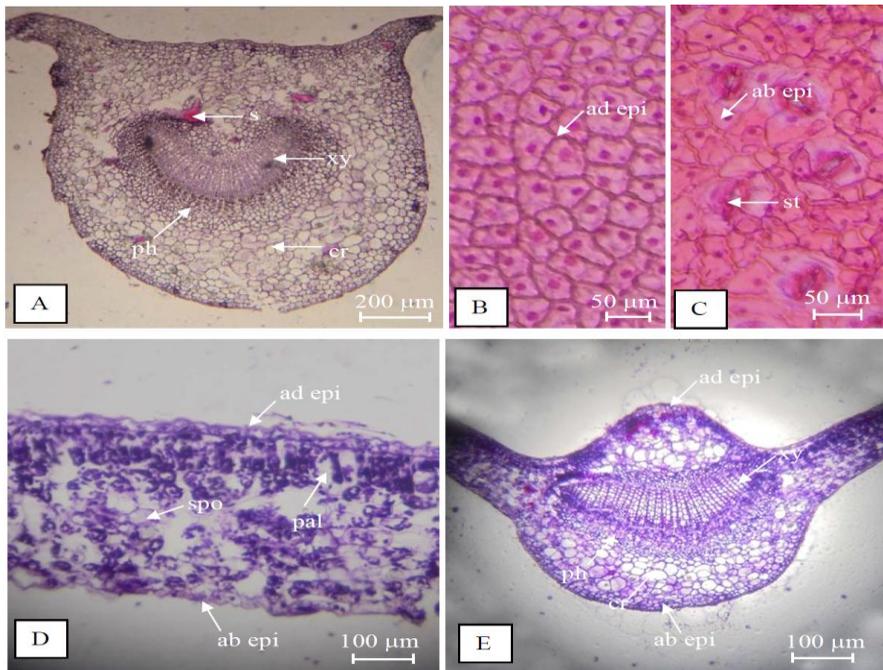
#### Petiole

In transverse section, the petioles of *Camellia sinensis* (L.) Kuntze studied were shield-shaped in outline, with two prominent wing. Distinguishable into dermal, ground and vascular tissue systems.

**Dermal Tissue System:** Composed of epidermal cells. In transverse section, epidermis 1 - layered on both surfaces, the cell barrel in shape, compact, outer and inner walls convex, anticlinal walls straight.

**Ground Tissue System:** Composed of collenchymatous and parenchymatous tissues. Collenchymatous tissue below the adaxial epidermis, 2 to 5 - layered from Naung Cho and 2 to 6 - layered from Mogok, the cells oval or rounded in shape; collenchymatous tissue above the abaxial epidermis, 1 to 4 - layered from Naung Cho and 2 to 6 - layered from Mogok; parenchymatous cells above the vascular bundle, 9 to 15 - layered from Naung Cho and 9 to 26 - layered from Mogok, the cells oval or rounded in shape; parenchymatous cells below the vascular bundle, 4 to 15 - layered from Naung Cho and 9 to 15 - layered from Mogok, the cells oval in shape.

**Vascular Tissue System:** A large vascular bundle embedded in the ground tissue, crescent-shaped in outline, collateral type, xylem on the adaxial side and phloem on the abaxial side; phloem 6 to 10 - layered from Naung Cho and 5 to 8 - layered from Mogok. Phloem composed of sieve tubes element,



**Figure 2 Internal structure of leaf of *Camellia sinensis* (L.) Kuntze from Naung Cho Township**

A. T.S of petiole. B. Adaxial surface view of lamina. C. Abaxial surface view of lamina. D. T.S of lamina. E. T.S of midrib.

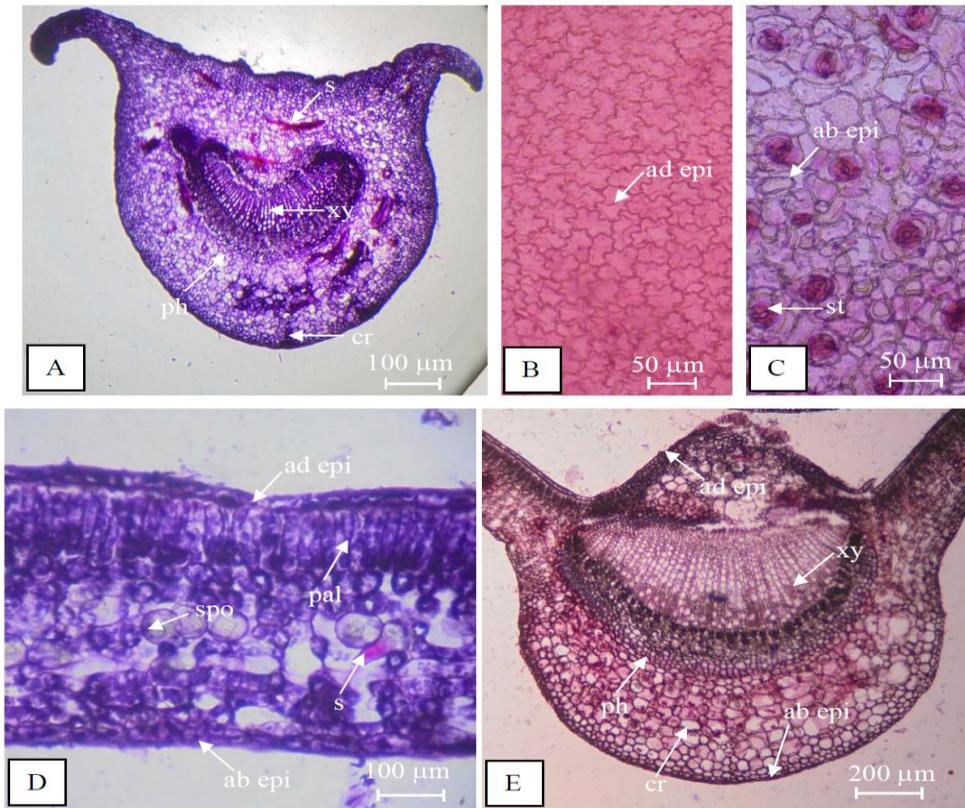
(ab epi = abaxial epidermal cell, ad epi = adaxial epidermal cell, cr = cortex, pal = palisade parenchyma cell, ph = phloem, s = sclereid, spo = spongy parenchyma cell, st = stoma, xy = xylem)

companion cells, fibers and phloem parenchyma. Xylem 6 to 10 - layered from Naung Cho and 4 to 8 - layered from Mogok. Xylem composed of vessel elements, tracheids, fibers and xylem parenchyma.

### 2.3 Internal structure of the stems of *Camellia sinensis* (L.) Kuntze from two different localities (Figure 4 and 5)

In transverse section, the stems of *Camellia sinensis* (L.) Kuntze were circular in outline, 1925.0 - 3500.0  $\mu\text{m}$  in tangential diameter, 1825.0 - 2850.0  $\mu\text{m}$  in radial diameter from Naung Cho and 2200.0 - 2450.0  $\mu\text{m}$  in tangential diameter, 2175.0 - 2425.0  $\mu\text{m}$  in radial diameter from Mogok.

**Dermal Tissue System:** In transverse section, epidermis 1 - layered, the cells oval to barrel in shape, 7.5 - 15.0  $\mu\text{m}$  in length and 7.5 - 17.5  $\mu\text{m}$  in width from Naung Cho and 12.5 - 22.5  $\mu\text{m}$  in length and 7.5 - 17.5  $\mu\text{m}$  in



**Figure 3 Internal structure of leaf of *Camellia sinensis* (L.) Kuntze from Mogok Township**

A. T.S of petiole. B. Adaxial surface view of lamina. C. Abaxial surface view of lamina. D. T.S of lamina. E. T.S of midrib. F. Vessel element. G. Tracheid. H. Fiber.

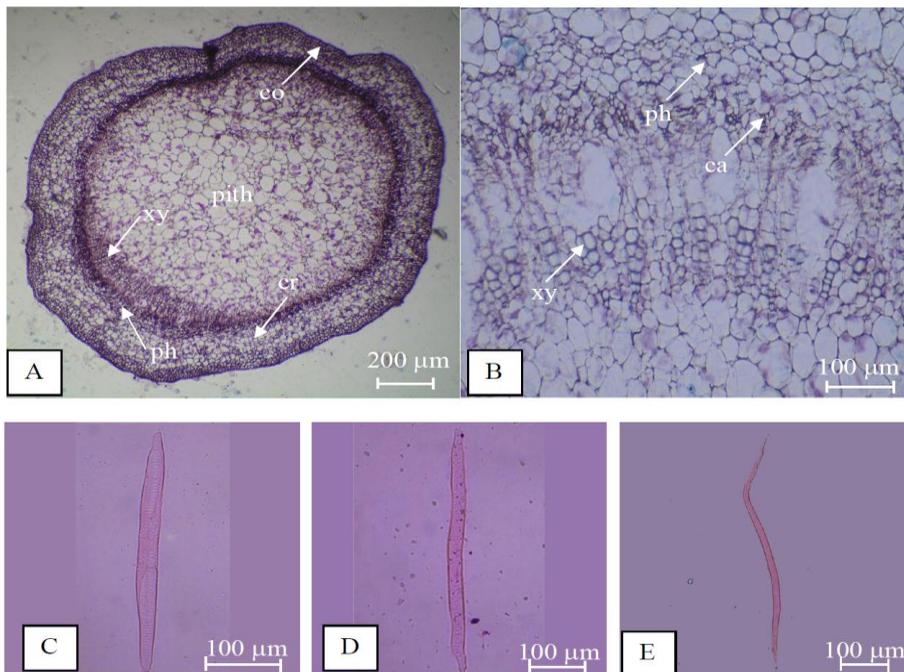
(ab epi = abaxial epidermal cell, ad epi = adaxial epidermal cell, cr = cortex, pal = palisade parenchyma cell, ph = phloem, s = sclereid, spo = spongy parenchyma cell, st = stoma, xy = xylem)

width from Mogok, outer and inner walls convex, anticlinal walls straight.

**Ground Tissue System:** Composed of cortex, endodermis, pericycle and pith. The cortex differentiated into outer collenchymatous tissue and inner parenchymatous tissue. The outer collenchymatous tissues composed of 2 to 6 - layered from two different localities. The inner parenchymatous tissues composed of 4 to 9 - layered from two different localities, intercellular space present. Endodermis and pericycle were indistinct. Pith composed of

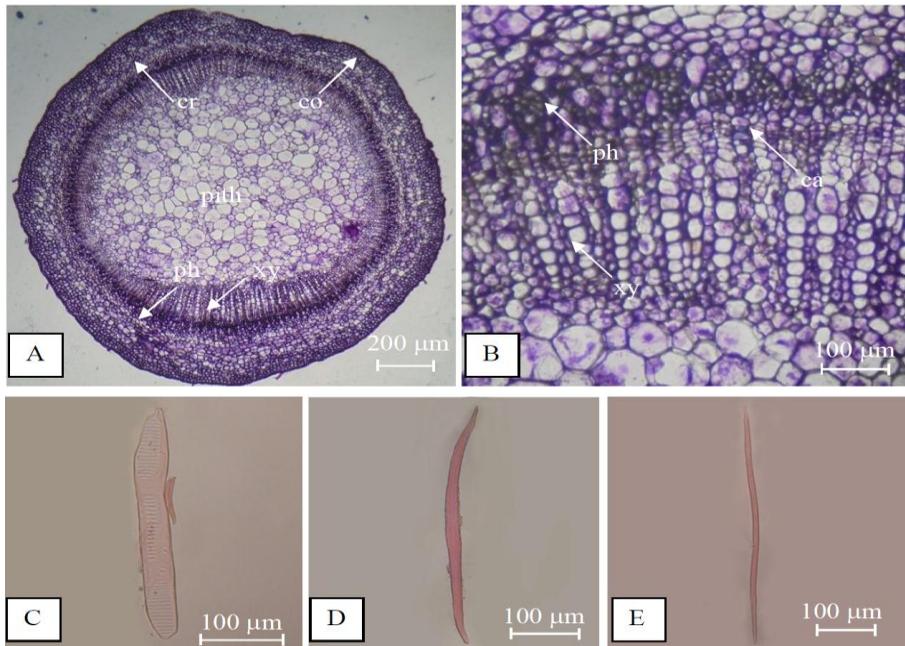
parenchymatous cell, thin - walled, the cells oval or rounded or polygonal in shape, thin-walled, intercellular space present.

**Vascular Tissue System:** Vascular bundles embedded in the ground tissue, the bundles arranged in a continuous circular ring, collateral type, 175.0 - 222.5  $\mu\text{m}$  in thick from Naung Cho and 120.0 - 400.0  $\mu\text{m}$  in thick from Mogok; phloem outer and xylem inner. Phloem composed of sieve tubes elements, companion cells, fibers and phloem parenchyma. Xylem arranged in radial rows, 2 to 7 - layered from Naung Cho and 5 to 10 - layered from Mogok, the layers 25.0 - 150.0  $\mu\text{m}$  thick from Naung Cho and 82.5 - 170.0  $\mu\text{m}$  thick from Mogok, the cells rounded or polygonal in shape, 10.0 - 35.0  $\mu\text{m}$  in length, 7.5 - 27.5  $\mu\text{m}$  in width from Naung Cho and 10.0 - 25.0  $\mu\text{m}$  in length 12.5 - 30.0  $\mu\text{m}$  in width from Mogok. Xylem composed of vessel elements, tracheids, fibers and xylem parenchyma.



**Figure 4 Internal structure of stem of *Camellia sinensis* (L.) Kuntze from Naung Cho Township**

- A. T.S of stem showing an outline    B. Close up view of vascular bundle  
 C. Vessel element                      D. Tracheid                      E. Fiber  
 (ca = cambium, co = collenchyma cell, cr = cortex, epi = epidermis,  
 ph = phloem, xy = xylem)



**Figure 5 Internal structure of stem of *Camellia sinensis* (L.) Kuntze from Mogok Township**

- A. T.S of stem showing an outline    B. Close up view of vascular bundle  
 C. Vessel element    D. Tracheid    E. Fiber  
 (ca = cambium, co = collenchyma cell, cr = cortex, ph = phloem, xy = xylem)

## 2.5 Internal structure of the roots of *Camellia sinensis* (L.) Kuntze from two different localities ( Figure 6)

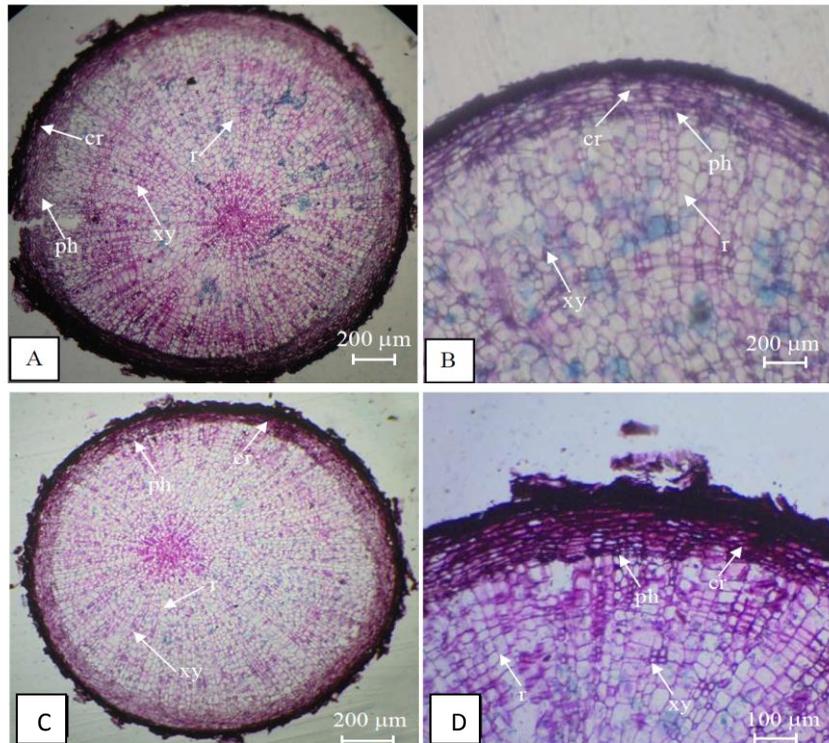
In transverse section, the roots of *Camellia sinensis* (L.) Kuntze were circular in outline, 2575.0 - 3000.0 µm in tangential diameter, 2550.0 - 3375.0 µm in radial diameter from Naung Cho and 2000.0 - 3300.0 µm in tangential diameter, 2125.0 - 3250.0 µm in radial diameter from Mogok.

**Dermal Tissue system:** The epiblema is crushed and the initiation of periderm is formed.

**Ground Tissue System:** Composed of cortex, endodermis, pericycle and pith. Cortex composed of homogenous parenchyma cell, 5 to 7- layered, the cells barrel or polygonal in shape from two different localities. Endodermis and pericycle indistinct. Pith absent.

**Vascular Tissue System:** Vascular bundles radial type, polyarch, rays cells occur between the xylem and phloem cells. Phloem distributed at the

periphery of the xylem. Phloem composed of sieve tubes elements, companion cells, fibers and phloem parenchyma. Xylem arranged as a continuous cylinder, 375.0 -2250.0  $\mu\text{m}$  thick from Naung Cho and 850.0 - 1825.0  $\mu\text{m}$  thick from Mogok, the cells polygonal or rounded in shape. Xylem composed of vessel elements, tracheids, fibers and xylem parenchyma.



**Figure 6 Internal structure of root of *Camellia sinensis* (L.) Kuntze from two different localities**

A. T.S of root, B. Portion of T.S of root from Naung Cho

C. T.S of root, D. Portion of T.S of root from Mogok

(cr = cortex, en = endodermis, pe = pericycle, ph = phloem, r = ray cell, xy = xylem)

### Discussion and Conclusion

The morphological and anatomical characteristics of *Camellia sinensis* (L.) Kuntze from Naung Cho Township, Northern Shan State and Mogok Township, Mandalay Region were studied. The plants were shrubs or small trees. The leaves were simple, alternate, margin serrate and exstipulate from

the two different localities. These characters were agreed with Wu *et al.* (2007). The sizes of leaves were variable from one locality to another. The sizes of leaves from Naung Cho were smaller than the leaves of Mogok. The sizes of petioles were also slightly different from one another.

Inflorescences were axillary cluster of cymes. These characters were agreed with Wadhwa (1996), Yun-fei & Nian-he (2007) and Wu *et al.* (2007). The sizes of flowers were slightly different. Sepals were 5, concave, dark green, glabrous on both surfaces, persistent. These characters were agreed with Backer (1934). Petals obovate, free in two whorls, the outer whorls smaller than the inner, green patches present at the tip of outer petals, glabrous. These characters were agreed with Wu *et al.* (2007). The number of petals were 5 - 7 from Naung Cho and 6 - 7 from Mogok. Fruits were woody, subglobose and seeds rounded or plano-convex from the two different localities. These characters were agreed with Dassanayake (1996) & Mahmood *et al.* (2010).

In anatomical characteristics, the transverse section of petioles, laminae, midribs, stems and roots were composed of dermal tissue system, ground tissue system and vascular tissue system. The transverse sections of petioles were observed in shield-shaped from two different localities. The size of cell, the number and thickness of cell layers were differed from one another. The sclereids were found in collenchymatous and parenchymatous cell of petioles from the two different localities and more abundance in Mogok Township. The vascular bundles were collateral type and crescent shaped. These characters were agreed with Metcalf & Chalk (1950).

In surface view of laminae, dermal tissues composed of 1 - layered of epidermal cells and cuticle thin on both surfaces. Anomocytic types of stomata present on abaxial surface of lamina from two different localities, and these characters were agreed with Metcalf & Chalk (1950) and Duarte (2006).

In transverse sections of laminae, the thickness was different from one locality to another. The number of palisade and spongy mesophyll layers were differed from each other, 1- or 2 - layered from Mogok Township and 1 - layered from Naung Cho Township. These characters were agreed with Metcalf & Chalk (1950) and Kalra *et al.* (2013).

The transverse sections of midribs were observed semicircular-shaped in outline. The numbers, sizes of cells and thickness of cell layers were different from one locality to another. The sclereids were found in the cortex of midribs and stem. The vascular bundle was crescent-shaped from

two different localities. These characters were agreed with the Metcalf & Chalk (1950) and Kalara *et al.* (2013).

In transverse section, the stems were observed circular-shaped in outline from two localities. The size of stems, the number and thickness of cell layers were slightly differed from one locality to another. Endodermis and pericycle were indistinct. Piths were cellular large, thin walled parenchymatous cell from two different localities. The vascular bundles of stems were collateral type, phloem outward and xylem inward these characters were agreed with Metcalf & Chalk (1950).

The transverse sections of roots were circular-shaped in outline from two different localities. The size of roots were slightly different from one locality to another. The sizes, the numbers and thickness of cell layers were different from one locality to another. The cortex composed of homogenous parenchyma cells. Vascular bundles were radial type and polyarch from two different localities. These characters were agreed with Metcalf & Chalk (1950).

In conclusion, the morphological and anatomical characteristics of *Camellia sinensis* (L.) Kuntze from two different localities were similar in structure. The size of leaves and flowers, number and size of petals were different from one locality to another. The size of cells, the number and thickness of cells layers were also different from one locality to another. It is hope that these finding will be useful in the identification and classification of the species. In addition, tea and tea leaf were popular and economic important in Myanmar and this research will provide the requirements of valuable information on *Camellia sinensis* (L.) Kuntze in Myanmar.

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