

CHAPTER - 6
Anatomical Studies

Anatomical Studies

6.1. INTRODUCTION

Taxonomy being a multi-disciplinary subject, various parameters contribute to the pool of taxonomic data. The initial and prime need of taxonomy is to identify the species and to understand its relationships. It is the morphological data which has been mostly utilized from the beginning of taxonomic studies for plant identification. Because, plants are enriched with external almost unlimited forms or states of morphological characters which can be easily recognized with naked eye or through a simple magnifying lens. So, morphological characteristics have often represented the basis of taxonomic studies in plants (Adedeji 2005) and are very significant in classification. However, sometimes it becomes difficult to distinguish the closely related species with their too much similar or overlapping morphological characteristics. Under such troubled situation one or more other available techniques need to be used for differentiation and identification. Advanced skills like phytochemistry and DNA sequencing are providing data in recent times; but classical data-sources like anatomical studies have been used successfully since ancient times to clear up innumerable identification problems (Gilani *et al.* 2002; Lande 2009). The most accepted works on anatomical study has been presented in '*Systematic Anatomy of the Dicotyledons*' by Solereder (1908) and '*Anatomy of Dicotyledons*' by Metcalfe & Chalk (1950). Bailey (1951) has published an outstanding paper to justify and for the utilization of anatomical data in classification and for delineating the phylogeny.

Comparative anatomy has proved useful in systematic purposes (Agbagwa & Ndukwu 2004). It has played a crucial role in solving the problems of misplaced and anomalous taxa. By microscopical assessment it has been possible to assign sterile plant specimens to a family or even to a genus. So, anatomy proves very helpful for identifying herbarium or fresh specimens which are not accompanied with any reproductive organ i.e. flowers and/or fruits (Metcalfe & Chalk 1950). Anatomical methods are also used as important tools to provide the botanical identity of commercial samples like medicinal as well as spice plants and thus play an essential aspect in checking adulteration.

On the other hand plasticity of characters is a serious matter (Carlquist 2001). Most of the ecological adaptations have been given an idea about dissimilar divergences among the same species growing in different habitats. However, all these adaptations, must not be supposed to be quite general. If that was so, all species which were belonging to the same ecological condition would acquire the same biological and structural appearance, even if they were from the most widely separated systematic groups. Supplementary to this, habitat and climate do not omit anyone definite type of biological as well as anatomical structure, to be correlated with these factors, upon all the species of a general geographical area. So, it can be said that the species carry definite diagnostic characters, which may vary in extent.

Though data from anatomical studies is continuously added, the information is just fragmentary and we still stand on the first level of information only. On the basis of review of literature it may be concluded that, so far, no anatomical study was done on the members of Lauraceae nor any kind of

observations stated on those growing in Terai-Duars region of West Bengal except their antioxidant values (Choudhury *et al.* 2013a) and external morphological characterization (Choudhury *et al.* 2013b, 2014). Therefore, the main aim of present study is to investigate some anatomical features of some species of Laurels growing in the study area. So, for the present dissertation the anatomical characterization of petiole, leaf and stem of eight economically important Laurels has been taken up, which may contribute to understand the similarities and dissimilarities among those for their effective identification even in the sterile condition.

6.2. RESULTS

The results of anatomical studies on the recorded species of two genera of Lauraceae from the study area are presented below in alphabetical order:

6.2.1. *Cinnamomum bejolghota* (Buchanan–Hamilton) Sweet

6.2.1.1. Anatomy of stem (Figure 6.1.A & Table 6.1.)

- a. Epidermis:** Single layered oval cell as with cutinized epidermis.
- b. Cortex:** The sub-epidermal layer consists of semi-circular cells with lignified, thick outer anticlinal walls. In between the periderm and phloem, the cortex is present in a narrow zone, where the cells are thin walled, polyhedral and compact. Then the cortex is gradually transformed into phloem. Outer surface of stem is characterised by islands of sclerenchyma in pericyclic region, which are connected by an even band of stone cells in this species. Many secretory cells, tannin, stone cells, oil globules and acicular raphides are present in cortex region.
- c. Vascular bundle:** Open vascular bundle includes outer thick and continuous cylinder of the phloem. Phloem elements in the outer part are crushed and forming thick dark lines. The Xylem

Table 6.1. Anatomical characteristics of stem of different Laurels

Plants	Microscopic characteristics						
	Plant part	Scalarified tissue	Secretory cells	Stone cells	Blast fibers	Oil globules	Raphides or prismatic crystals
<i>C. bejolghota</i>	Stem	-	+++	-	+	+	++
<i>C. camphora</i>		+	++	-	++	+++	-
<i>C. tamala</i>		++	+++	++++	++	++	+++
<i>C. verum</i>		++	++++	+++	+	+++	++
<i>L. assamica</i>		+++	+	+	++	+	-
<i>L. glutinosa</i>		+++	++	+	++	++	-
<i>L. laeta</i>		+++	++	+	++++	+	-
<i>L. monopetala</i>		++++	+	++	+++	+	-

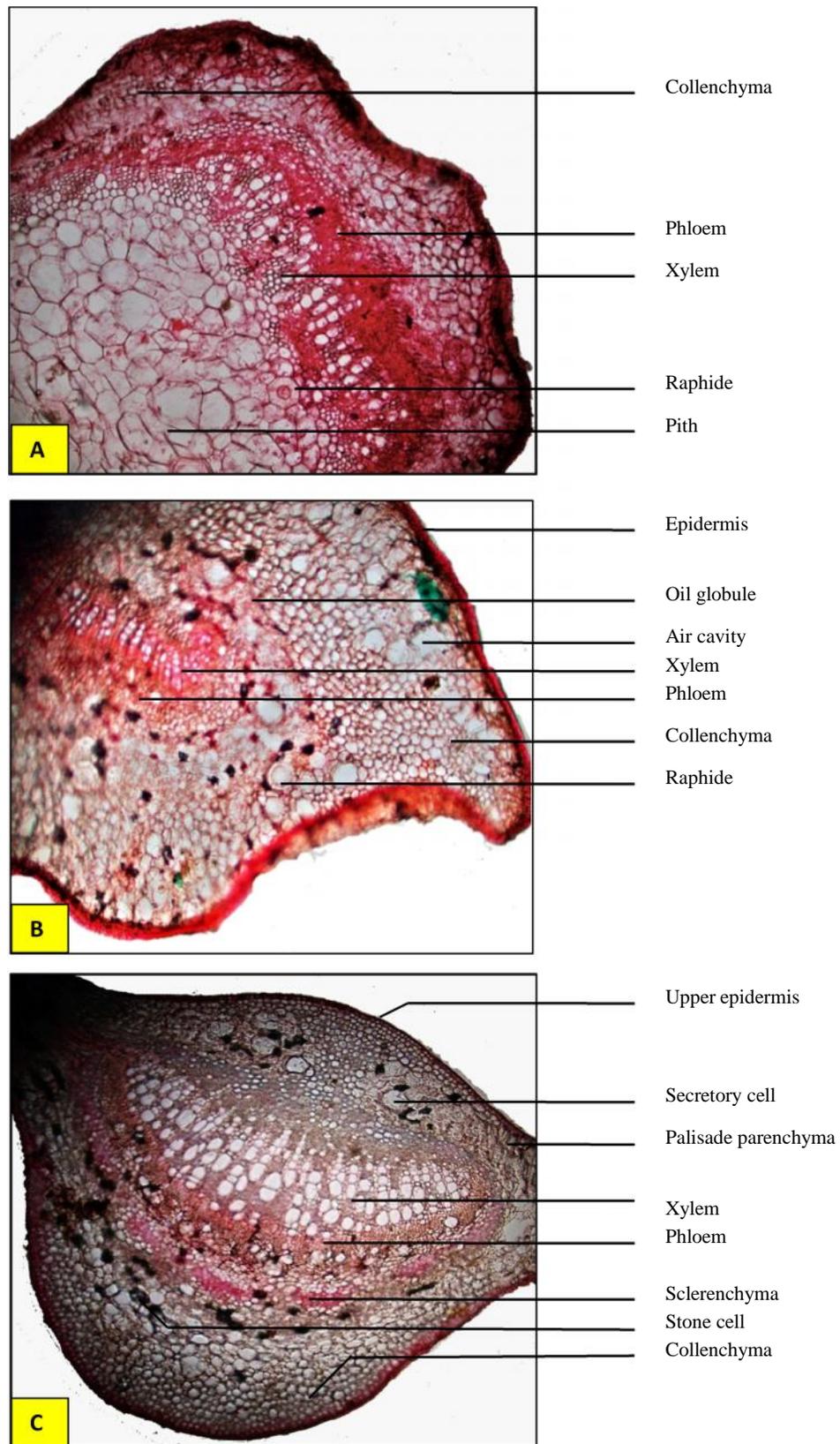


Figure 6.1. *Cinnamomum bejolghota* transverse section of **A**- Stem; **B**- Petiole; **C**- Lamina

cylinder is comprises of vessels and fibres. The vessels are elliptical, wide and thin walled. They occur in long radial multiples or in solitary. Xylem fibres are lignified thick-walled.

d. Pith: Wide pith is occupied by thin walled, compact and circular parenchymatous cells. There are also many secretory cells, oil droplets, acicular raphides and stone cells.

6.2.1.2. Anatomy of petiole (Figure 6.1. B & Table 6.2.)

- a. Epidermis:** In outline of petiole exhibits convex at adaxial side and abaxial side concave. The cells are sinuous and with many scarifications. The epidermis is of thin-walled small squarish cells.
- b. Mesophyll:** The hypodermis is parenchymatous with air cavities present in regular intervals. The ground tissue consists of large sized parenchymatous cells, followed by a thick semicircular layer of crushed cells. Secretory cells, stone cells, oil globules and raphides or prismatic crystals are also present in ground tissue.
- c. Vascular bundle:** The arc shaped vascular strand is occupying the entire petiole. Xylem elements are in parallel lines and each line of xylem is having 5 – 8 cells. On the lower end of the xylem strands occurs a thin horizontal band of phloem. It includes a thick collateral vascular bundle with an abaxial horizontal pad of sclerenchyma.

Table 6.2. Anatomical characteristics of petiole of Laurels

Plants	Microscopic characteristics							
	Plant part	Hypodermis	Air cavities	Sclarified tissue	Secretary cells	Stone cells	Oil globules	Raphides or prismatic crystals
<i>C. bejolghota</i>	Petiole	Parenchymatous	++++	++	++++	+++	+++	+++
<i>C. camphora</i>		Colenchymatous	++	+	+++	+++	++++	+++
<i>C. tamala</i>		Parenchymatous	+++	+	+++	+++	++++	++++
<i>C. verum</i>		Parenchymatous	+++	++	++++	++++	++++	+++
<i>L. assamica</i>		Parenchymatous	+	+++	+	+	++	+
<i>L. glutinosa</i>		Parenchymatous	++	+++	++	+	++	++
<i>L. laeta</i>		Parenchymatous	++	++	++	++	+	+
<i>L. monopetala</i>		Parenchymatous	++	++++	++	+++	+	++

6.2.1.3. Anatomy of lamina (Figure 6.1. C & Table 6.3.)

- a. Epidermis:** Epidermal cells are single layered covered with smooth cuticle, thin on upper surface and thick on lower. These cells are sinuous and stomata are confined to lower.
- b. Mesophyll:** Uniseriate upper epidermal layer is followed by double layers of chloroplast filled palisade cells. The palisade cells are radially elongated. In between the lower epidermal cells and palisade cells there are several layers of loosely arranged spongy parenchyma cells in the mesophyll with intercellular spaces. These spongy parenchyma cells are also chlorenchymatous.

Abundant deposits of yellow or golden yellow mucilage or secretory cells occur in mesophyll layer. Lysigenous cavities containing oil are present within mesophyll. Oil globules are distributed in lamina cells. Acicular raphides are more common in the cell adjacent to the vascular bundle (stele) and in spongy parenchyma.

- c. Vascular bundle:** Stele represented by a single shallow crescentic, collateral close vascular bundle; with xylem on the upper side and phloem towards the lower side. The xylem bundles are arranged in approximately 6 – 8 radial rows.

Table 6.3. Anatomical characteristics of lamina of different Laurels

Plants	Microscopic characteristics						
	Plant part	Epidermis	Sclerified tissue	Secretory cells	Stone cells	Oil globules	Raphides or prismatic crystals
<i>C. bejolghota</i>	Lamina	Cell wall Sinuous	++	++++	+++	+++	++++
<i>C. camphora</i>		Cell wall straight	++	++++	+++	++++	+++
<i>C. tamala</i>		Cell wall Sinuous	+++	+	+++	++++	+++
<i>C. verum</i>		Cell wall Sinuous	++	+++	+++	++++	+++
<i>L. assamica</i>		Cell wall Sinuous	++++	++	+	++	+
<i>L. glutinosa</i>		Cell wall Sinuous	++++	+++	++	++	+
<i>L. laeta</i>		Cell wall Sinuous	+++	++	++	+	+
<i>L. monopetala</i>		Cell wall Sinuous	++++	++	++	+	++

6.2.2. *Cinnamomum camphora* (Linnaeus) J. Presl

6.2.2.1. Anatomy of stem (Figure 6.2. A & Table 6.1.)

- a. Epidermis:** Single layered oval cells as with cutinized epidermis. Epidermal cell walls are slightly curved.
- b. Cortex:** The sub-epidermal layer consists of semi-circular cells with thick, lignified outer anticlinal walls. In between the periderm and phloem, the cortex is present in a narrow zone. Sclerenchymatous patches occur around the vascular bundle. Stone cells and raphides are absent. Few oil globules are present in cortex.
- c. Vascular bundle:** Open vascular bundle includes outer thick and continuous cylinder of the phloem. Phloem elements in the outer part are crushed and forming thick dark lines. Blast fibres are abundant. The Xylem cylinder is comprises of vessels and fibres. The vessels are elliptical, wide and thin walled. They occur in long radial multiples or in solitary. Xylem fibres are lignified thick-walled.
- d. Pith:** Wide pith is occupied by thin walled, compact and semi circular parenchymatous cells.

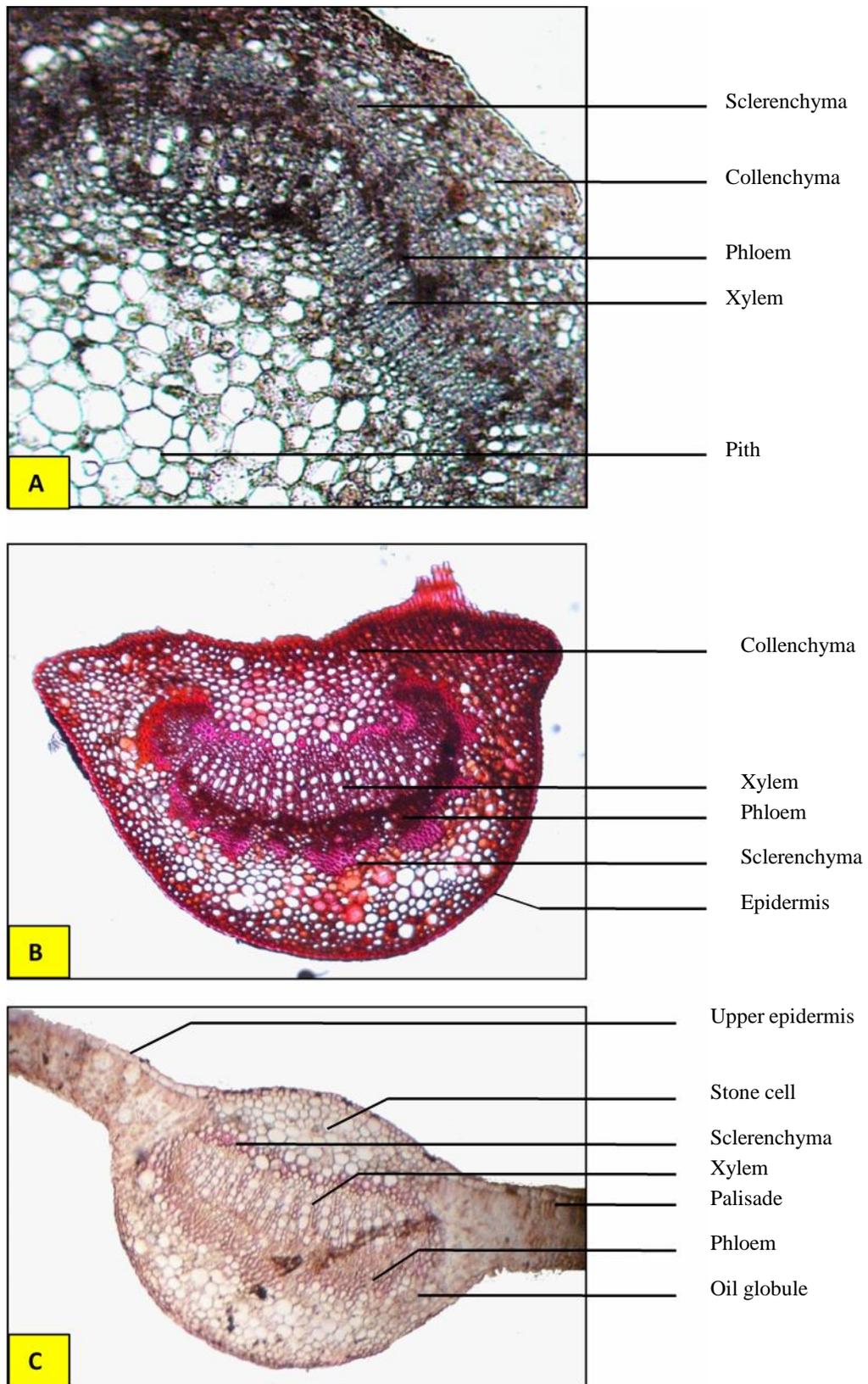


Figure 6.2. *Cinnamomum camphora* transverse section of **A-** Stem; **B-** Petiole; **C-** Lamina

6.2.2.2. *Anatomy of petiole* (Figure 6.2. B & Table 6.2.)

- a. **Epidermis:** T.S. of petiole shows adaxial side with slightly out curving edges, whereas the abaxial side is sharply convex. Epidermis is cutinized and single layered.
- b. **Mesophyll:** In colenchymatous hypodermis several oil, mucilage and tannin cells are found but air cavities are absent.
- c. **Vascular bundle:** The vascular bundle is arc shaped with incurving edges surrounded by a thick continuous zone of sclerenchyma. The xylem is present towards the adaxial side whereas phloem towards the abaxial side that is adjacent to the sclerenchymatous zone.

6.2.2.3. *Anatomy of lamina* (Figure 6.2. C & Table 6.3.)

- a. **Epidermis:** Cells are single layered covered with smooth cuticle, thin on upper surface and thick on lower. Epidermal cells are tetragonal to polygonal in shape, moderately sinuous and stomata confined to lower surface.
- b. **Mesophyll:** Uniseriate upper epidermal layer is followed by single layer of chloroplast-filled palisade cells. In between the lower epidermal cells and palisade cells there are several layers of loosely arranged spongy parenchyma cells in the mesophyll with intercellular spaces. These spongy parenchyma cells are also chlorenchymatous. Abundant deposits of yellow or golden yellow mucilage or secretory cells occur in mesophyll layer. Lysigenous cavities containing oil are present within mesophyll. Oil globules are distributed in laminar cells. Raphides are absent.
- c. **Vascular bundle:** Stele represented by a single shallow crescentic, collateral and close vascular bundle; with xylem on the upper side and phloem towards the lower side. The xylem bundles are arranged in approximately 10–12 radial rows.

6.2.3. *Cinnamomum tamala* (Buchanan–Hamilton) Nees & Ebermaier

6.2.3.1. *Anatomy of stem* (Figure 6.3. A & Table 6.1.)

- a. **Epidermis:** Single layered oval cell as with cutinized epidermis.
- b. **Cortex:** The sub-epidermal layer consists of semicircular cells with lignified, thick outer anticlinal walls. In between the periderm and phloem, the cortex is present in a narrow zone, where the cells are thin walled, polyhedral and compact. Then the cortex is gradually transformed into phloem. Sclerenchymatous patches are present around the phloem. Many secretory cells, tannin, stone cells, oil globule and acicular raphides are present in cortex region.
- c. **Vascular bundle:** Collateral open vascular bundle includes outer thick and continuous cylinder of the phloem. Phloem elements in the outer part are crushed and forming thick dark lines. The Xylem cylinder is comprises of vessels and fibres. The vessels are elliptical, wide and thin walled. They occur in long radial multiples or in solitary. Xylem fibres are lignified thick-walled.
- d. **Pith:** Wide pith is occupied by thin walled, compact and circular parenchymatous cells. There are also many secretory cells, oil droplets and stone cells.

6.2.3.2. *Anatomy of petiole* (Figure 6.3. B & Table 6.2.)

- a. **Epidermis:** In outline of petiole exhibits concave at adaxial side and convex on abaxial side. The cells are sinuous and with many scarifications. The epidermis is of thin-walled small squarish cells.

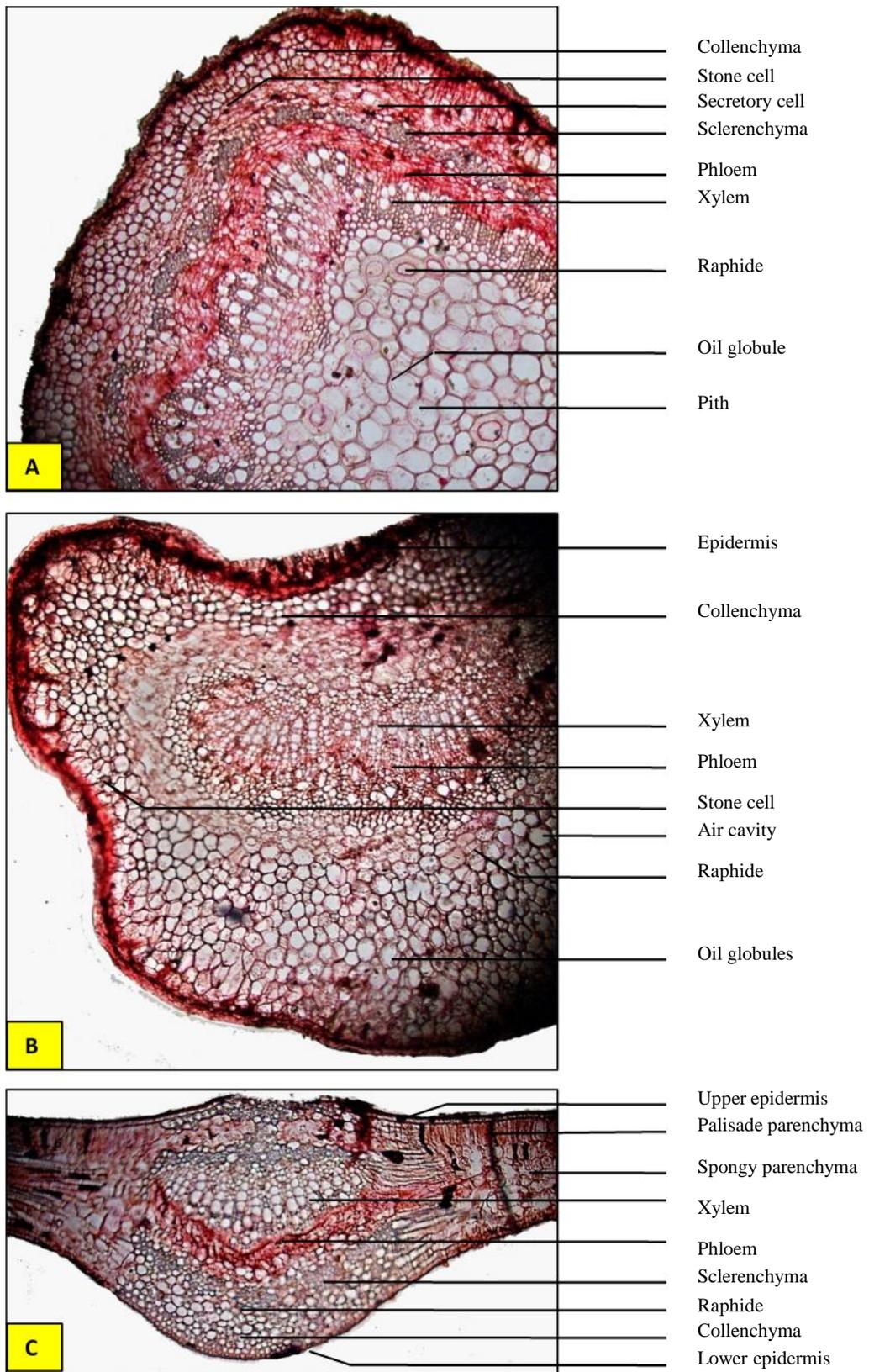


Figure 6.3. *Cinnamomum tamala* transverse section of **A-** Stem; **B-** Petiole; **C-** Lamina

- b. **Mesophyll:** The hypodermis is parenchymatous with air cavities present in regular intervals. The ground tissue consists of large sized parenchymatous cells, followed by a thick semi circular layer of crushed cells. Secretory cells, stone cells, oil globules and raphides or prismatic crystals are also present in the ground tissue.
- c. **Vascular bundle:** The arc shaped vascular strand is occupying the entire central region. Xylem elements are in parallel lines and each line of xylem is having 3 – 8 cells. On the lower end of the xylem strands occurs a thin horizontal band of phloem. It includes a thick collateral vascular bundle with an abaxial horizontal pad of sclerenchyma.

6.2.3.3. Anatomy of lamina (Figure 6.3.C & Table 6.3.)

- a. **Epidermis:** Cells are single layered covered with smooth cuticle, thick on upper surface and thin on lower. Epidermal cells are sinuous and stomata confined to lower surface.
- b. **Mesophyll:** Uniseriate upper epidermal layer is followed by one layer of chloroplast-filled palisade cells. The palisade cells are radially elongated. In between the lower epidermal cells and palisade cells there are several layers of loosely arranged spongy parenchyma cells in the mesophyll with intercellular spaces. These spongy parenchyma cells are also chlorenchymatous. Abundant deposits of yellow or golden yellow mucilage or secretory cells occur in the mesophyll. Lysigenous cavities containing oil are present within mesophyll. Oil globules are distributed in laminer cells. Acicular raphides are more common in the cell adjacent to the vascular bundle (stele) and in spongy parenchyma.
- c. **Vascular bundle:** Stele represented by a single shallow, crescentic, collateral and close vascular bundles; with xylem on the upper side and phloems towards the lower side. The xylem bundles are arranged in approximately 10 – 12 radial rows.

6.2.4. *Cinnamomum verum* J. Presl

6.2.4.1. Anatomy of stem (Figure 6.4. A & Table 6.1.)

- a. **Epidermis:** Single layered oval cells as with cutinized epidermis.
- b. **Cortex:** The sub-epidermal layer consists of semi-circular cells with lignified, thick outer anticlinal walls. In between the periderm and phloem, the cortex is present in a narrow zone, where the cells are thin walled, polyhedral and compact. Then the cortex is gradually transformed into phloem. Outer surface of stem is characterised by islands of sclerenchyma in pericyclic region, which are connected by an even band of stone cells in this species. Many secretory cells, tannin, stone cells, oil globules and acicular raphides are present in cortex region.
- c. **Vascular bundle:** Stele represented by collateral open vascular bundle includes outer thick and continuous cylinder of the phloem. Phloem elements in the outer part are crushed and forming thick dark lines. Blast fibres are rare in *C. verum*. The Xylem cylinder is comprises of vessels and fibres. The vessels are elliptical, wide and thin walled. They occur in long radial multiples or in solitary. Xylem fibres are lignified thick-walled.
- d. **Pith:** Wide pith occupied by thin walled, compact and circular ground cells. There are also many secretory cells, oil droplets and stone cells.

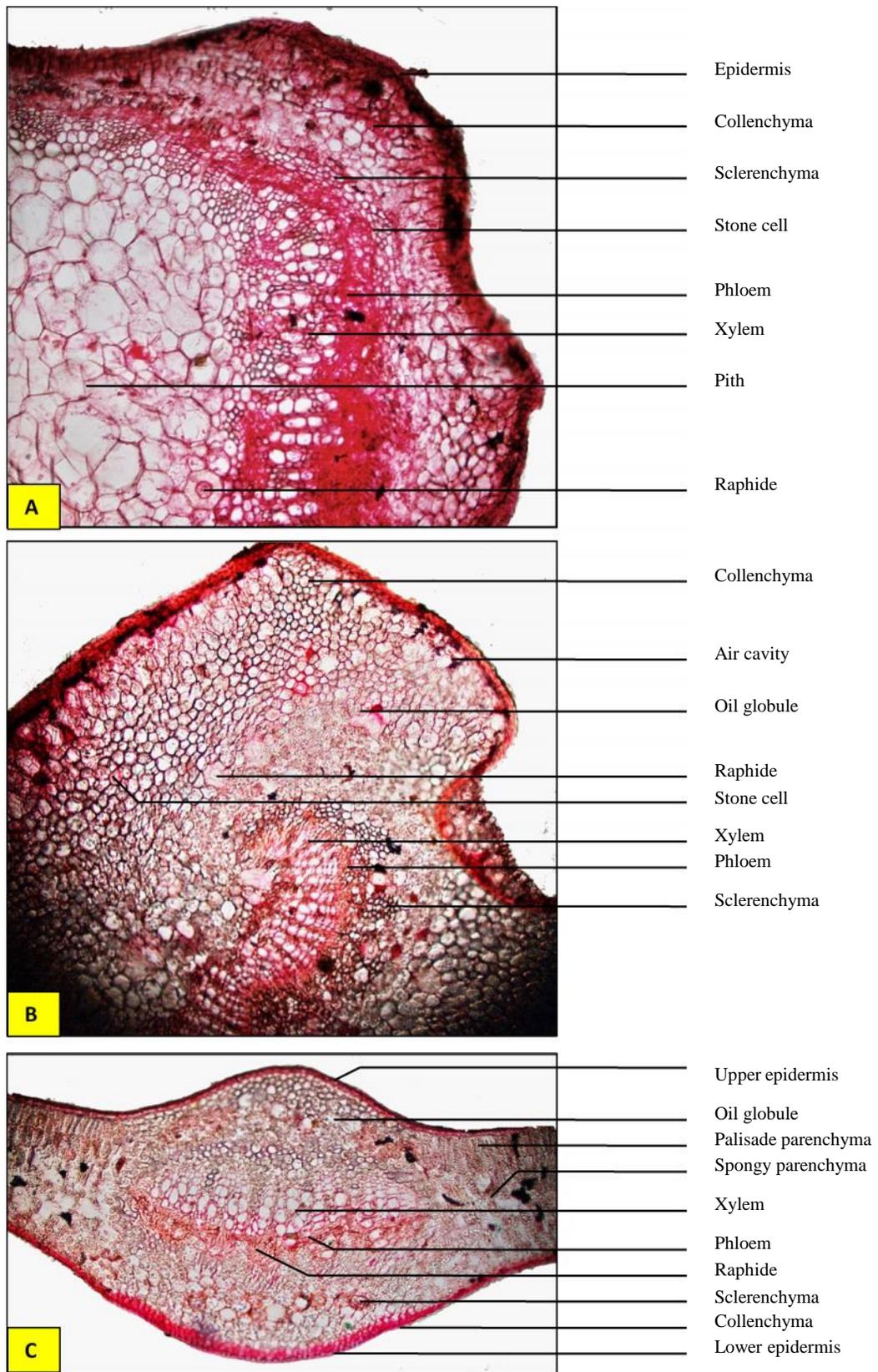


Figure 6.4. *Cinnamomum verum* transverse section of **A**- Stem; **B**- Petiole; **C**- Lamina

6.2.4.2. *Anatomy of petiole (Figure 6.4. B & Table 6.2.)*

- a. **Epidermis:** In outline of petiole exhibits slightly convex at adaxial side and abaxial side enormously convex. The cells are sinuous and with many scarification. The epidermis is of thin-walled small squarish cells.
- b. **Mesophyll:** Hypodermis is parenchymatous with air cavities present in regular intervals. The ground tissue consists of large sized parenchymatous cells, followed by a thick semi-circular layer of crushed cells. Secretory cells, stone cells, oil globules and raphides or prismatic crystals are also present in ground tissue.
- c. **Vascular bundle:** The arc shaped vascular strand is occupying the entire central area. Xylem elements are in parallel lines and each line of xylem having 3 – 8 cells. On the lower end of the xylem strands occurs a thin horizontal band of phloem. It includes a thick collateral vascular bundle with an abaxial horizontal pad of sclerenchyma.

6.2.4.3. *Anatomy of lamina (Figure 6.4. C & Table 6.3.)*

- a. **Epidermis:** Cells are single layered covered with smooth cuticle, thin on upper surface and thick on lower; cells are sinuous and stomata confined to lower surface.
- b. **Mesophyll:** Below the upper epidermis two layers of chlorenchymatous palisade cells and loosely arranged chlorenchymatous spongy cells, with prominent intercellular spaces, between the lower epidermal cells and palisade cells form the ground tissue. Abundant deposits of yellow or golden yellow mucilage or secretory cells occur in the mesophyll. Lysigenous cavities containing oil are present within mesophyll. Oil globules are distributed in laminer cells. Acicular raphides are more common in cells adjacent to the vascular bundle and in spongy parenchyma.
- c. **Vascular bundle:** Stele represented by a single shallow crescentic, collateral close vascular bundle; with xylem in the upper side and phloem towards the lower. The xylem bundles are arranged in approximately 10 – 12 radial rows.

6.2.5. *Litsea assamica Hooker f.*

6.2.5.1. *Anatomy of stem (Figure 6.5. A & Table 6.1.)*

- a. **Epidermis:** Single layered with squarish cells with the heavy cuticle, unicellular hairs few.
- b. **Cortex:** The sub-epidermal layer consists of semicircular cells with thick, lignified outer anticlinal walls. In between the periderm and phloem, the cortex is present in a narrow zone, where the cells are thin walled, polyhedral and compact. Then the cortex is gradually transformed into phloem. Sclerenchymatous patches are present around the phloem. Many secretory cells, tannin, stone cells, oil globules and acicular raphides are present in cortex region.
- c. **Vascular bundle:** Open vascular bundle includes outer thick and continuous cylinder of phloem. Phloem elements in the outer part are crushed and they also collapsed into thick dark lines of tannin. The Xylem cylinder is comprises of vessels and fibres. The vessels are elliptical, wide and thin walled. They occur in long radial multiples or in solitary. Xylem fibres are lignified thick-walled.
- d. **Pith:** Wide pith is occupied by thin walled, compact and circular parenchymatous cells. There are also many secretory cells, oil droplets, acicular raphides and stone cells.

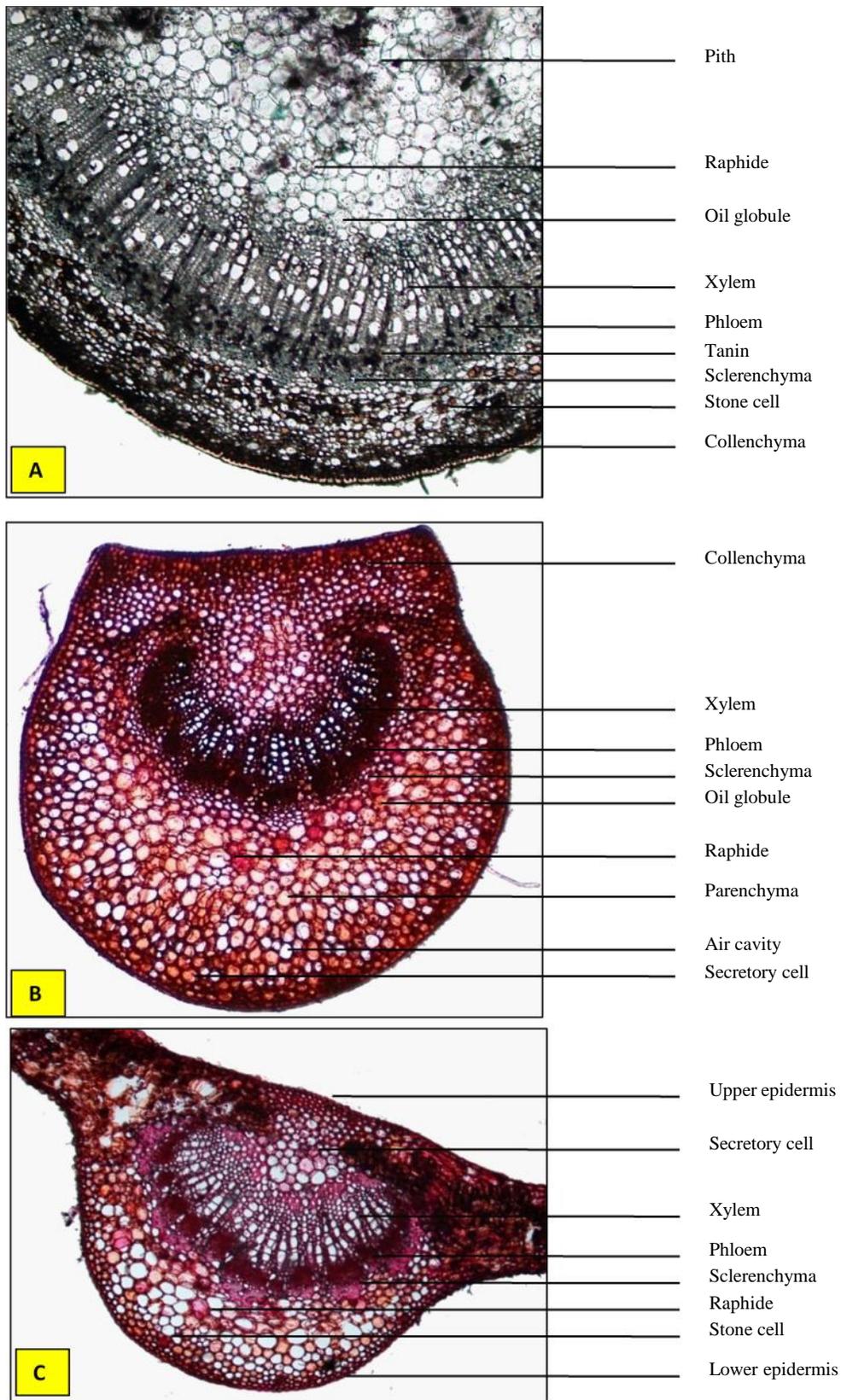


Figure 6.5. *Litsea assamica* transverse section of **A-** Stem; **B-** Petiole; **C-** Lamina

6.2.5.2. *Anatomy of petiole (Figure 6.5. B & Table 6.2.)*

- a. **Epidermis:** Single layered cutinized epidermis with unicellular hair. The epidermal layer of the petiole is thin comprises of small squarish cells. In outline of petiole exhibits almost round in basal portion where, upper portion is flat in shape.
- b. **Mesophyll:** The hypodermis is parenchymatous with air cavities present in regular intervals. The ground tissue consists of large sized parenchymatous cells, followed by a thick semi-circular layer of crushed cells. Secretory cells, stone cells, oil globules and acicular raphides are also present in ground tissue.
- c. **Vascular bundle:** The arc shaped vascular strand is occupying the entire central region. Xylem elements are in parallel lines and each line of xylem is having 3 – 6 cells. On the lower end of the xylem strands occurs a thin horizontal band of phloem. Below the phloem zone, wide circular masses of sclerenchymatous fibres are situated. It includes a thick collateral vascular bundle with an abaxial horizontal pad of sclerenchyma.

6.2.5.3. *Anatomy of lamina (Figure 6.5 C & Table 6.3.)*

- a. **Epidermis:** The adaxial cells are tabular covered with thick smooth cuticle; where as abaxial cells are rectangular and slightly thicker and undulated. In epidermal wall many scarifications are found.
- b. **Mesophyll:** The mesophyll cells consist of thick region of 2 – 4 layered palisade and 4 or 5 layered of spherical or lobed cells of spongy parenchyma. Some of these cells are modified into circular or four angled secretory idioblasts which are more frequent, distributed randomly in mesophyll tissue. Calcium oxalate crystals or acicular raphides and oil globules are present in the cells adjacent to vascular bundle and in spongy parenchyma.
- c. **Vascular bundle:** Stele is represented by a small collateral close vascular bundle; with xylem on the upper side and phloem towards the lower side and surrounded by the sclerenchymatous bundle sheath. The xylem bundles are arranged in approximately 5 – 12 radial rows.

6.2.6. *Litsea glutinosa (Loureiro) Robinson*

6.2.6.1. *Anatomy of stem (Figure 6.6. A & Table 6.1.)*

- a. **Epidermis:** Single layered with squarish cells along with heavy cuticle, unicellular hairs few.
- b. **Cortex:** The sub-epidermal layer consists of semi-circular cells with thick, lignified outer anticlinal walls. Inner to the lignified hypodermal layer, a narrow zone of 2 – 4 layers of periderm is formed. The periderm is followed by fairly 3 – 4 layered parenchymatous cortex.
- c. **Vascular bundle:** The vascular cylinder is thick as well as hollow. It includes outer thick and continuous cylinder of the phloem. Phloem elements in the outer part are crushed and forming thick dark lines. The Xylem cylinder comprises of vessels and fibres. The vessels are elliptical, wide and thin walled. They occur in long radial multiples or in solitary. Xylem fibres are lignified thick walled.
- d. **Pith:** Wide pith is occupied by thin walled, compact, circular parenchymatous cells and large central lysigenous cavity.

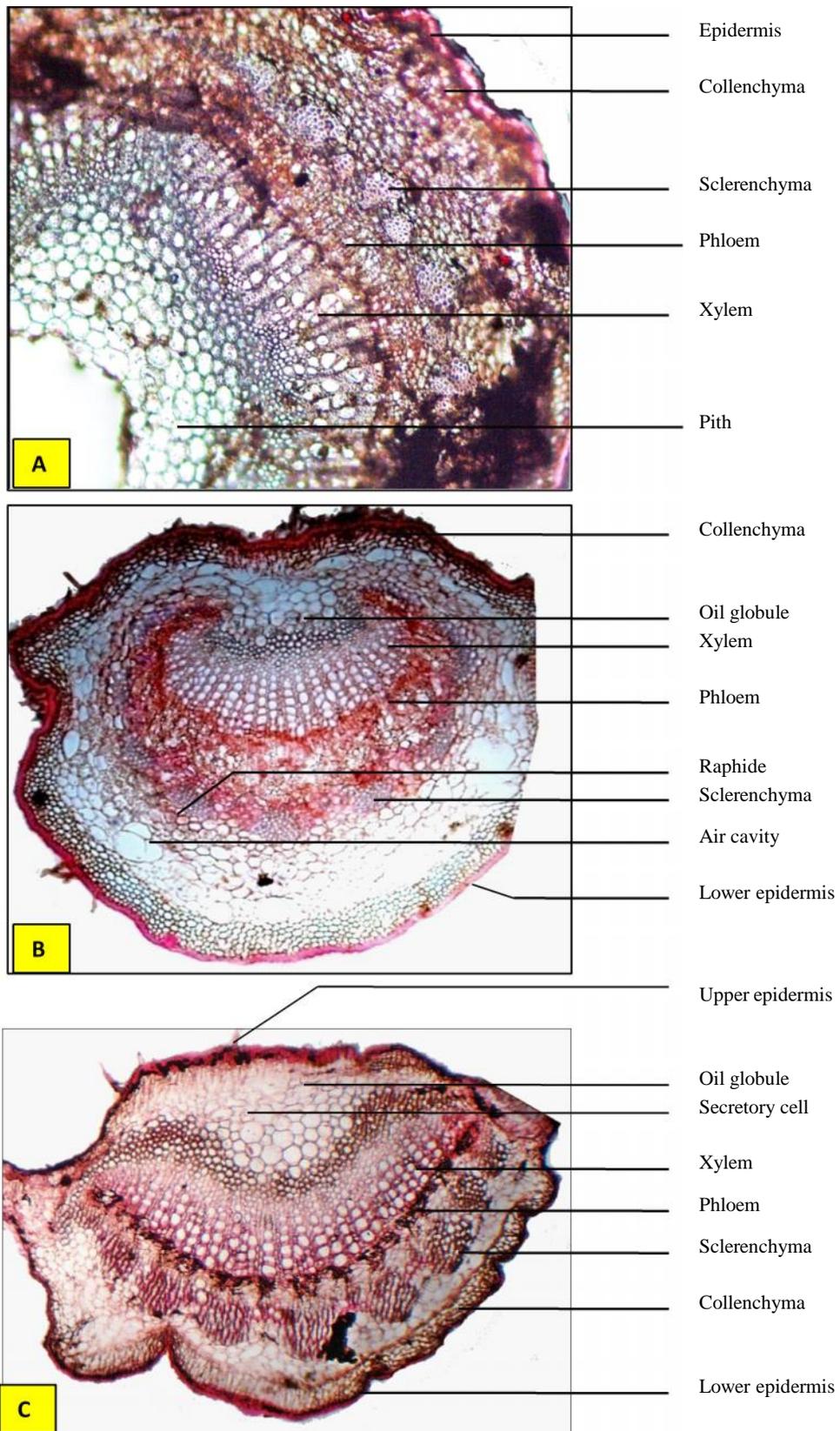


Figure 6.6. *Litsea glutinosa* transverse section of A- Stem; B- Petiole; C- Lamina

6.2.6.2. *Anatomy of petiole (Figure 6.6. B & Table 6.2.)*

- a. **Epidermis:** Single layered cutinized epidermis with unicellular hairs. The epidermal layer of the petiole is thin comprises of small squarish cells. In outline, petiole exhibits slightly concave at adaxial side, while the abaxial side is convex.
- b. **Mesophyll:** The hypodermis is parenchymatous with air cavities present in regular intervals. The ground tissue consists of large sized parenchymatous cells, followed by a thick semicircular layer of crushed cells. Secretory cells, stone cells, oil globules and acicular raphides or prismatic crystals are also present in ground tissue.
- c. **Vascular bundle:** The arc shaped vascular strand is occupying the entire central region. Xylem elements are in parallel lines and each line of xylem is having 3 – 6 cells. On the lower end of the xylem strands occurs a thin horizontal band of phloem. Below the phloem zone, about five to six wide circular masses of sclerenchymatous fibres are situated. It includes a thick collateral vascular bundle with an abaxial horizontal pad of sclerenchyma.

6.2.6.3. *Anatomy of lamina (Figure 6.6. C & Table 6.3.)*

- a. **Epidermis:** The adaxial cells are tabular covered with thick smooth cuticle; whereas abaxial cells are rectangular, slightly thicker and undulated. In epidermal wall many scarifications are found.
- b. **Mesophyll:** The upper epidermal layer is followed by two layers of pillar like palisade cells. In between the lower epidermal cells and palisade cells there are 4 or 5 layers of spherical spongy parenchyma with inter cellular spaces. Some of these cells are modified into circular or four angled secretory idioblasts which are more frequent, distributed randomly in mesophyll tissue. Calcium oxalate crystals or acicular raphides and oil globules are present in the cells adjacent to vascular bundles and in spongy parenchyma.
- c. **Vascular bundle:** Stele is represented by a small collateral and close vascular bundle; with xylem on the upper side and phloem towards the lower side and surrounded by the sclerenchymatous bundle sheath. The xylem bundles are arranged in approximately 4 – 10 radial rows.

6.2.7. *Litsea laeta (Nees) Hooker f.*

6.2.7.1. *Anatomy of stem (Figure 6.7. A & Table 6.1.)*

- a. **Epidermis:** Single layered with squarish cells along with heavy cuticle, unicellular hairs few.
- b. **Cortex:** The sub-epidermal layer consists of semi-circular cells with lignified, thick outer anticlinal walls. In between the periderm and phloem, the cortex is present in a narrow zone, where the cells are thin walled, polyhedral and compact. Then the cortex is gradually transformed into phloem. Sclerenchymatous patches are present around the phloem.
- c. **Vascular bundle:** Open vascular bundle includes outer thick and continuous cylinder of phloem. Phloem elements in the outer part. The Xylem cylinder is comprises of vessels and fibres. The vessels are elliptical, wide and thin walled. They occur in long radial multiples or in solitary. Xylem fibres are lignified thick-walled with wide lumen.

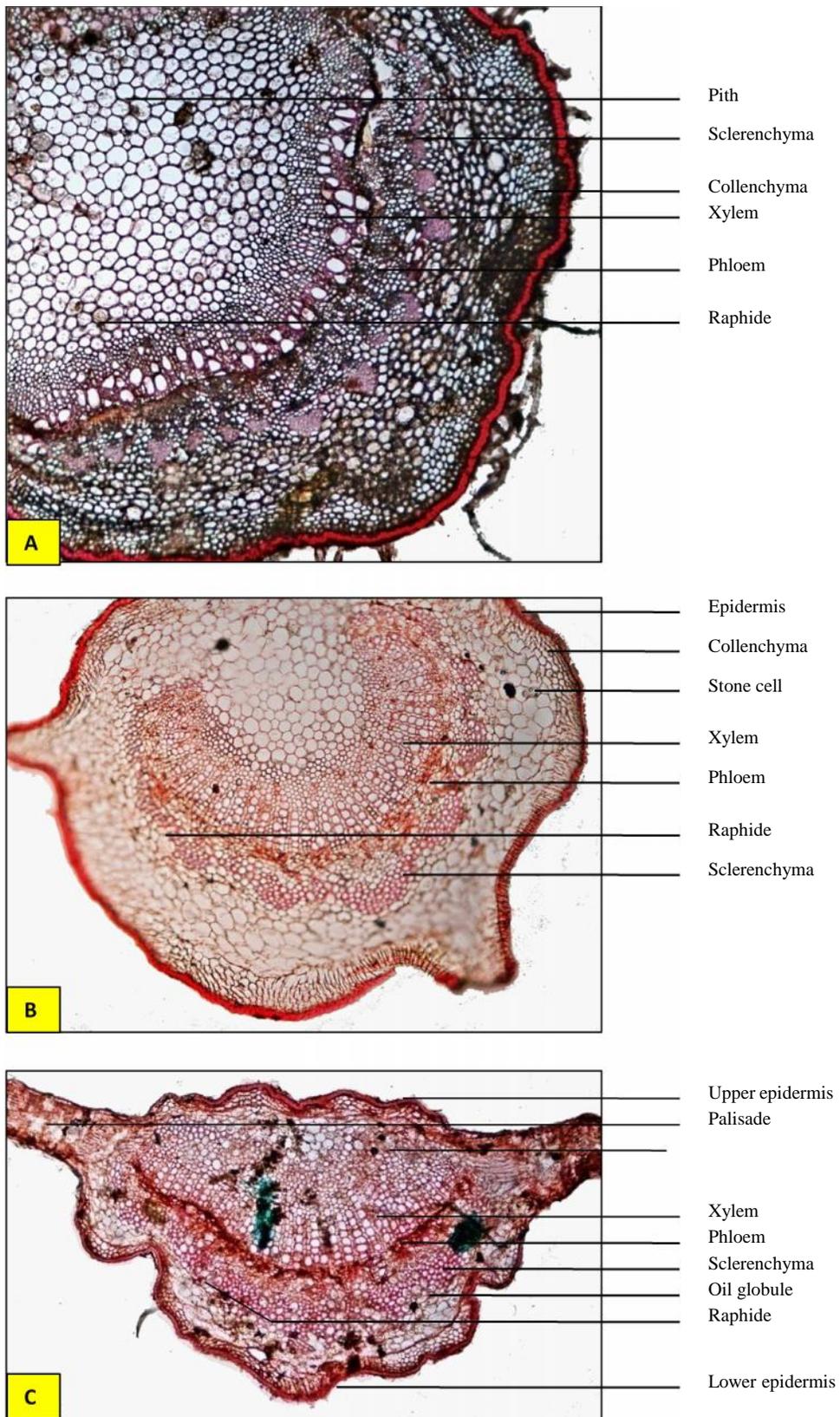


Figure 6.7. *Litsea laeta* transverse section of **A-** Stem; **B-** Petiole; **C-** Lamina

- d. **Pith:** Wide pith is occupied by thin walled, compact and circular parenchymatous cells. There are also many secretory cells, oil droplets and stone cells.

6.2.7.2. *Anatomy of petiole (Figure 6.7. B & Table 6.2.)*

- a. **Epidermis:** Single layered cutinized epidermis with unicellular hair. The epidermal layer of the petiole is thin comprises of small squarish cells. In outline of petiole exhibits almost round with three appendages.
- b. **Mesophyll:** The hypodermis is parenchymatous with air cavities present in regular intervals. The ground tissue consists of large sized parenchymatous cells, followed by a thick semi-circular layer of crushed cells. Secretory cells, stone cells, oil globules and acicular raphides or prismatic crystals are also present in ground tissue.
- c. **Vascular bundle:** The arc shaped vascular strand is occupying the entire central region. Xylem elements are in parallel lines and each line of xylem is having 3 – 8 cells. On the lower end of the xylem strands occurs a thin horizontal band of phloem. Below the phloem zone, about five to six wide circular masses of sclerenchymatous fibres are situated. It includes a thick collateral vascular bundle with an abaxial horizontal pad of sclerenchyma.

6.2.7.3. *Anatomy of lamina (Figure 6.7. C & Table 6.3.)*

- a. **Epidermis:** The adaxial cells are tabular covered with thick rough cuticle where as abaxial cells are rectangular, slightly thicker and undulated. In epidermal wall many scarifications are found.
- b. **Mesophyll:** The mesophyll cells consist of thick region of 2 – 4 layered palisade and 4 or 5 layered of spherical or lobed cells of spongy parenchyma. Some of these cells are modified into circular or four angled secretory idioblasts which are more frequent, distributed randomly in mesophyll tissue. Calcium oxalate crystals or acicular raphides and oil globules are present in the cells adjacent to vascular bundle and in spongy parenchyma.
- c. **Vascular bundle:** Stele is represented by a small collateral vascular bundle; with xylem on the upper side and phloem towards the lower side and surrounded by the sclerenchymatous bundle sheath. The xylem bundles are arranged in approximately 4 – 10 radial rows.

6.2.8. *Litsea monopetala (Roxburgh) Persoon*

6.2.8.1. *Anatomy of stem (Figure 6.8. A & Table 6.1.)*

- a. **Epidermis:** Single layered with squarish cells along with heavy cuticle, unicellular hairs many.
- b. **Cortex:** The sub-epidermal layer consists of semi-circular cells with thick, lignified outer anticlinal walls. Inner to the lignified hypodermal layer, a narrow zone of 2 – 4 layers of periderm are formed. The periderm is followed by fairly 3 – 4 layered parenchymatous cortex. Sclerenchymatous patches are scattered in cortex.
- c. **Vascular bundle:** Open vascular bundle includes outer thick and continuous cylinder of phloem. The Xylem cylinder is comprises of vessels and fibres. The vessels are elliptical, wide and thin walled. They occur in long radial multiples or in solitary. Xylem fibres are lignified thick-walled.
- d. **Pith:** Wide pith is occupied by thin walled, compact and circular parenchymatous cells.

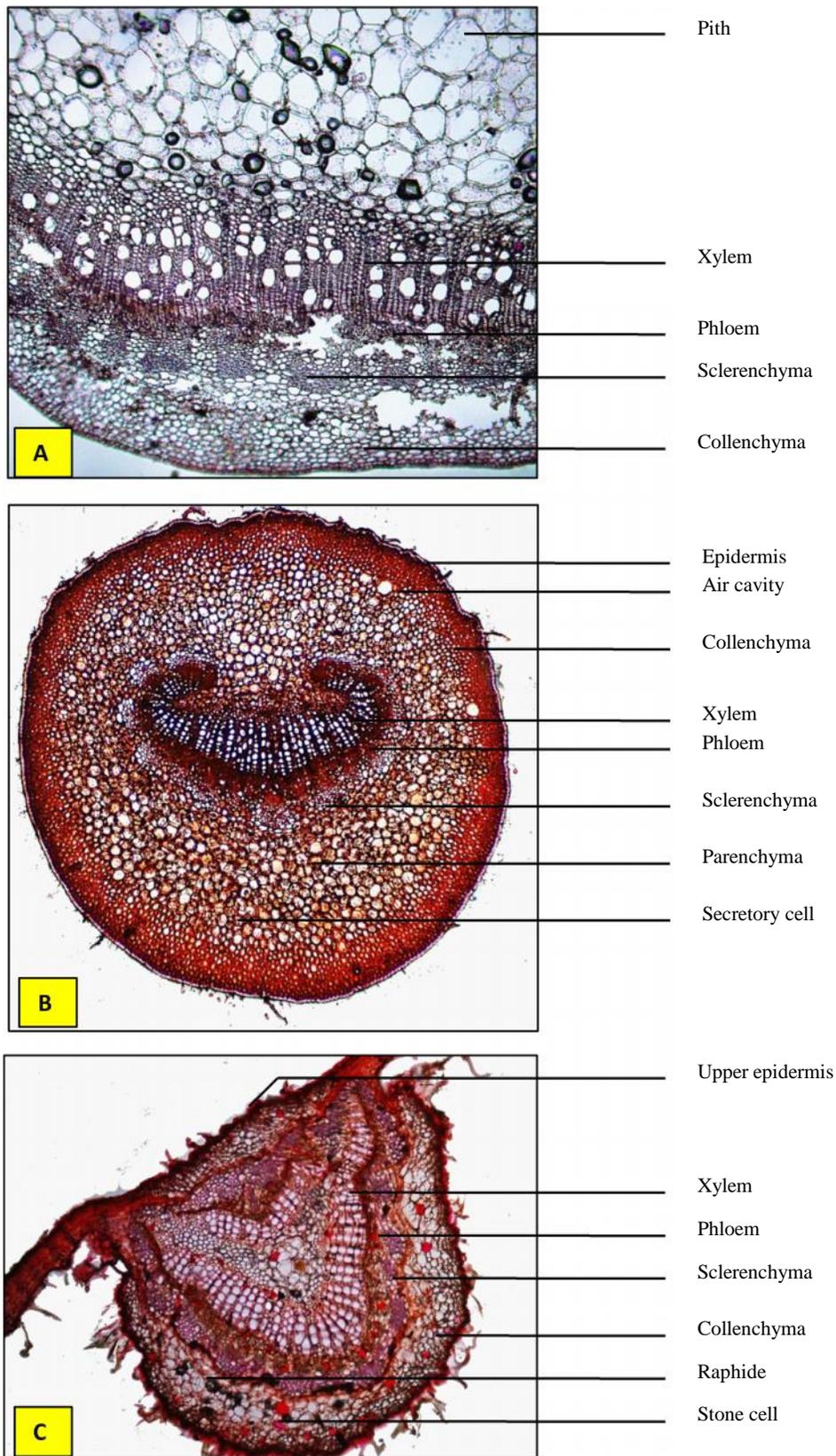


Figure 6.8. *Litsea monopetala* transverse section of A- Stem; B- Petiole; C- Lamina

6.2.8.2. Anatomy of petiole (Figure 6.8. B & Table 6.2.)

- a. **Epidermis:** Single layered cutinized epidermis with unicellular hair. The epidermal layer of the petiole is thin comprises of small squarish cells. In outline of petiole exhibits almost round.
- b. **Mesophyll:** The hypodermis is parenchymatous with air cavities present in regular intervals. The ground tissue consists of large sized parenchymatous cells, followed by a thick semi-circular layer of crushed cells. Secretory cells, stone cells, oil globules and acicular raphides or prismatic crystals are also present in ground tissue.
- c. **Vascular bundle:** The arc shaped vascular strand is occupying the entire central region. Xylem elements are in parallel lines and each line of xylem is having 5 – 13 cells. On the lower end of the xylem strands occurs a thin horizontal band of phloem. Below the phloem zone, wide circular masses of sclerenchymatous fibres are situated. It includes a thick collateral vascular bundle with an abaxial horizontal pad of sclerenchyma.

6.2.8.3. Anatomy of lamina (Figure 6.8. C & Table 6.3.)

- a. **Epidermis:** The adaxial cells are tabular covered with thick smooth cuticle where as abaxial cells are rectangular, slightly thicker. In epidermal wall many scarifications are found.
- b. **Mesophyll:** The upper epidermal layer is followed by four layers of pillar like palisade cells. In between the lower epidermal cells and palisade cells there are 4 or 5 layers of spherical spongy parenchyma with inter cellular spaces. Some of these cells are modified into circular or four angled secretory idioblasts which are more frequent, distributed randomly in mesophyll tissue. Calcium oxalate crystals or acicular raphides and oil globules are present in the cells adjacent to vascular bundle and in spongy parenchyma.
- c. **Vascular bundle:** Stele is represented by a small collateral vascular bundle; with xylem on the upper side and phloem towards the lower side and surrounded by the sclerenchymatous bundle sheath. The xylem bundles are arranged in approximately 4 – 12 radial rows.

6.3. DISCUSSION

In this study, anatomical characteristics of eight economically important Laurels from the Terai-Duars region of West Bengal were examined in order to provide useful as well as additional information to the systematics. This is the first anatomical report on the members of Lauraceae from this part of the country. It is well known that the anatomical characters varies greatly as well as has significant values in many genera of this family such as *Cinnamomum*, *Laurus*, *Apollonias* etc. (Kamel & Loutfy 2001; Baruah & Nath 2006; Makbul *et al.* 2006). It is also recorded that, the presence and distribution of secretory cells, main bundles, mesophyll, indumentum (hairs) and surface features are mainly important identical features in different species of *Cinnamomum* (Kamel & Loutfy 2001). In these species of *Cinnamomum* under the present study, the shape of petiolar vascular bundle is a unique characteristic. The two ends of vascular bundle is curved towards the centre and thereby giving a wide arc-shaped appearance.

In the present study, the structural differences are found in several parts like stem, leaf and petiole. In all the studied taxa leaves were hypo-stomatic, the cells of the upper epidermis are different from the lower ones. Two types of cells were observed i.e. angular and sinuate, and the cells are often elongating over the veins. The similar results were observed by Christophel & Rowett (1996) on Australian Laurels.

Chamberlain (1975) reported the parameters of vascular bundles in stem, leaf and petiole, cells of cortex and pith are some of the most important characters in angiosperm classification and phylogeny. It is also well known that the distribution sites and the average number of collenchymatous cells are important in comparative anatomical studies (Özörgücü *et al.* 1991). In the present study most of the characters are similar in both the genera but distribution of stone cells, air cavities, distribution of sclerenchyma are dissimilar. On the basis the differentiations and similar anatomical characters Higher Archival clustering were drawn. This study concluded that there are two constant clustered groups in these two genera based on similarity in anatomical characters (Figure 6.9). These groups are: (1) *Litsea monopetala*, *L. glutinosa*, *L. laeta* and *L. assamica* and (2) *C. bejolghota*, *C. tamala*, *C. verum* and *C. camphora*, share a wealth of anatomical characters. But, it has been noticed that *C. camphora* is different from other *Cinnamomum* spp on the basis of similarity curve.

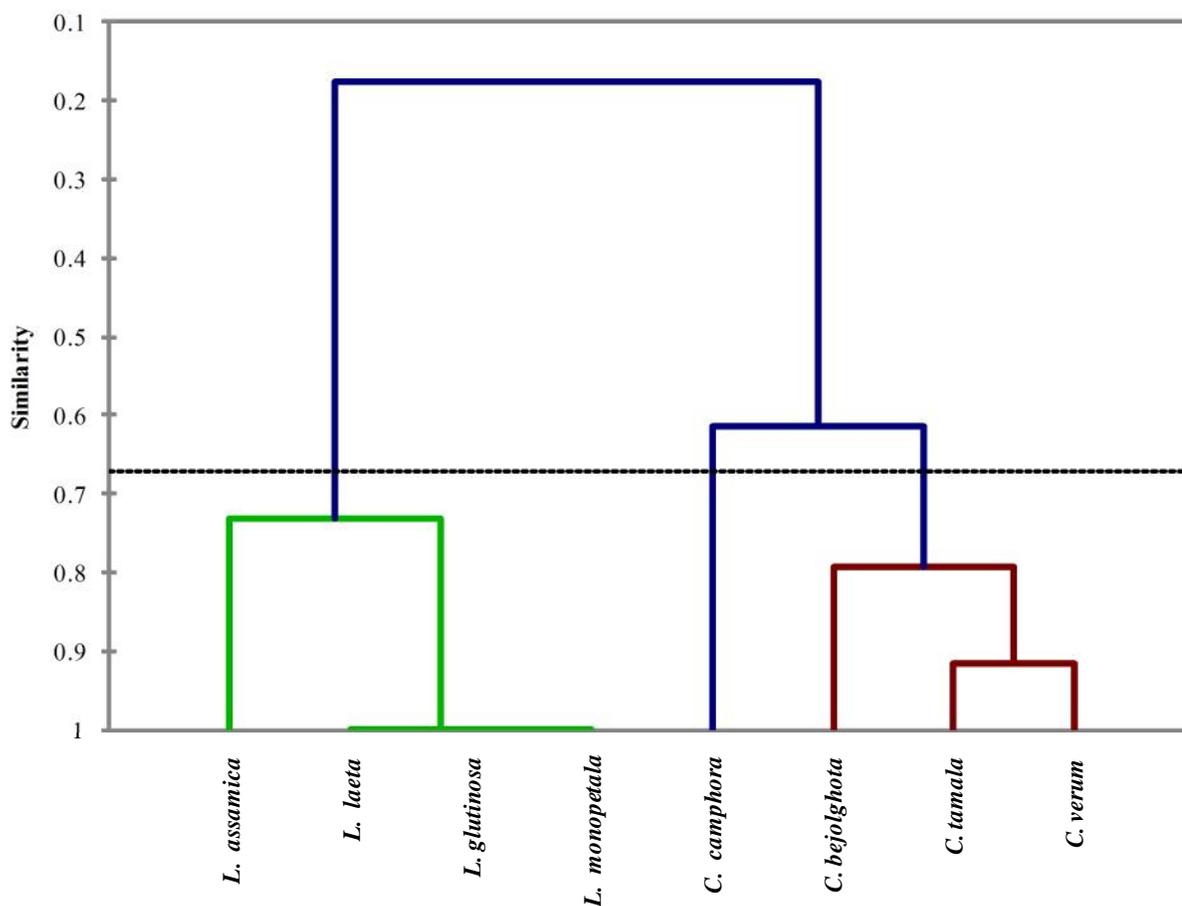


Figure 6.9. Cladistic approach of studied taxa on the basis of anatomical characters of different parts (stem, petiole and leaves)

As a whole, it is needed to be pointed out that the anatomical characters at the species level of these two genera under study found quite helpful at least in their identification and, on the other hand, such characters are also useful to recognize the adulterants of these spices or crud drugs.

6.3.1. An artificial key of the studied taxa based on the investigated anatomical characters is presented as below:

1a. Lamina and petiole not hairy	2
1b. Lamina and petiole hairy	5
2a. Raphides or prismatic crystals present in lamina and stem cells; hypodermis of petiole parenchymatous	3
2b. Raphides or prismatic crystals absent in lamina and stem cells; hypodermis of petiole colenchymatous	<i>C. camphora</i>
3a. Crowded oil globules present in stem cells; stone cells present in stem; xylem bundles of lamina arranged in 10 – 12 radial rows.....	4
3b. Oil globules unusual in stem cells; stone cells absent in stem; xylem bundles of lamina arranged in 6 – 8 radial rows	<i>C. bejolghota</i>
4a. Sclarified tissue present around vascular bundle of petiole; blast fibers many in stem	<i>C. tamala</i>
4b. Sclarified tissue scattered in vascular bundle of petiole; blast fibers rare in stem	<i>C. verum</i>
5a. Medullary cells thin walled, compact and circular	6
5b. Medullary region occupied by one large central lysigneous cavity ..	<i>L. glutinosa</i>
6a. Cross section of petiole almost circular; phloem elements of stem do not collapsed into thick dark line of tannin	7
6b. Cross section of petiole flattened above and rounded below; phloem elements of stem collapsed into thick dark line of tannin ...	<i>L. assamica</i>
7a. Adaxial epidermis of lamina with thick and rough cuticle; vascular bundle in lamina U-shaped	<i>L. laeta</i>
7b. Adaxial epidermis of lamina with thin and smooth cuticle; vascular bundle of lamina triangular	<i>L. monopetala</i>