Bark is the Hallmark

Dipanjan Ghosh

The bark of a tree is essential for its survival on this planet. Trees show great diversity in their bark morphology which helps in the taxonomic identification of the species. This article discusses various peculiarities, chemical constituents and commercial uses of the bark.

Introduction

Floral characters, i.e., sexual features concealed within the flowers, largely constitute the basis for the categorization of plants. Likewise, the bark also shows features which differ in different trees and are of great diagnostic value. The bark of a tree is like the skin of an animal. It protects the plant from all harmful forms of life such as fungi, insects, parasitic plants, as well as from desiccation and other natural adversities. Removal of bark can therefore be fatal to trees, half grown or full grown. Besides, bark diversity can be used in many cases as a useful taxonomic trait.

What is Bark?

Bark refers to the dead tissues wrapping the stem. From the botanical point of view [1], bark demarcates all tissues external to vascular cambium, i.e., secondary phloem, primary phloem, cortex, periderm and tissues (if any) outside the periderm. *Rhytidome* or *outer bark* is the dead part of the bark comprising the periderm and tissues external to it. The living part of the bark inside the rhytidome is often referred as the *inner bark* (*Figure* 1). Usually bark is prominent in the stems and roots of aged woody plants belonging to dicotyledons and gymnosperms. Monocotyledonous angiosperms generally lack bark. It is developed during secondary growth of the plant and by the activities of the cork cambium, i.e., phellogen.

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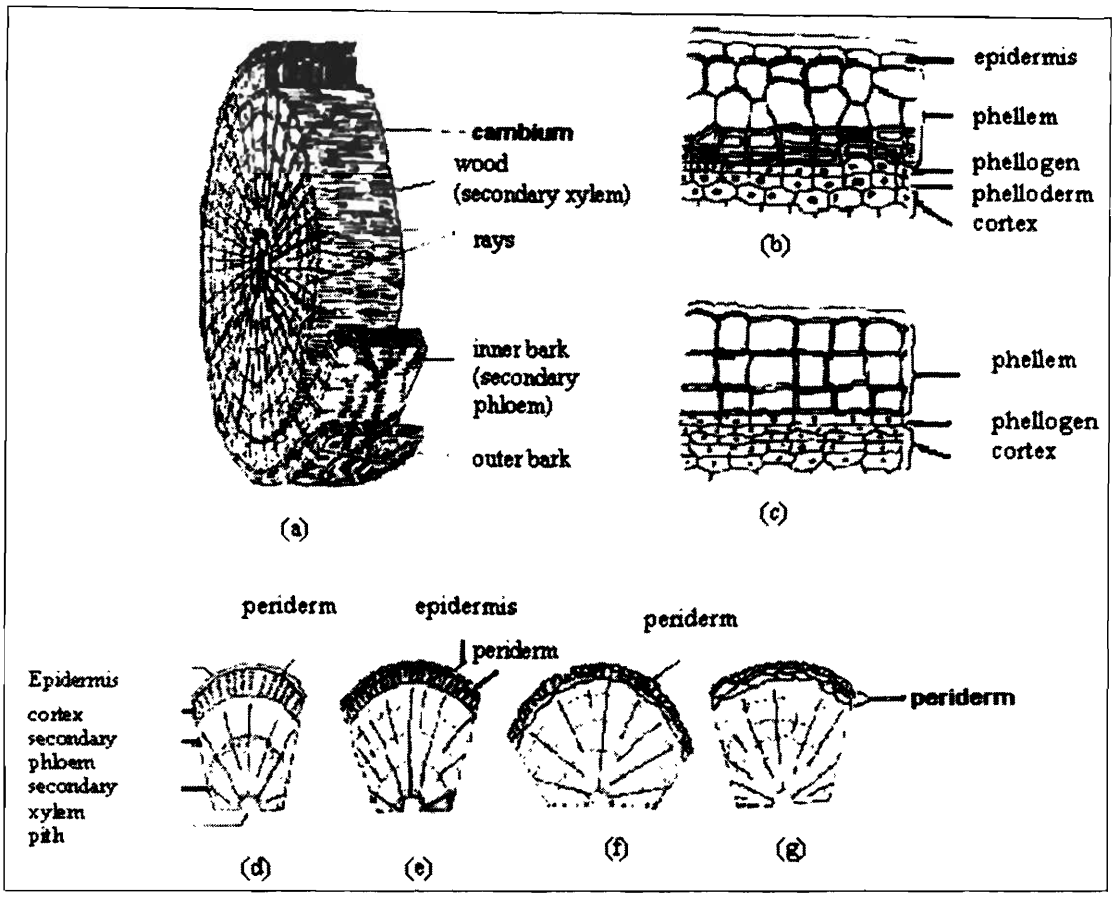

Figure 1. (a) Diagram showing portion of a woody stem with both outer and inner bark. (b) Distribution of phellem, phellogen and phelloderm layers in the periderm of Populus deltoides. (c) The periderm of Solanum dulcamara showing no phelloderm layer and the phellem layer is only covered by cuticle instead of epidermis. (d-g) Diagrams showing (in cross section) the position, shape, and extent of the additional periderms formed in a woody stem (aged from 1 to 4 years) on which the first formed periderm develops as an entire cylinder close to the epidermis. (All the diagrams have been redrawn from [2].).

The development of the bark is initiated by the formation of cork cells. These cork cells eventually give rise to the major part of the bark, i.e., periderm. Periderm comprises three layers of tissues:

a) ***The phellogen:*** It is the secondary lateral meristem comprising tannin-rich cells. The constituent cells divide tangentially

producing new tissues both centrifugally and centripetally. The derivative results in the increase of girth of the plant axis.

b) ***The phellem:*** The phellem or cork cells are produced on the outer side of the phellogen. Mature cork cells are dead, prismatic in shape, and thin walled (e.g., *Betula*) or thick walled (e.g., *Eucalyptus*) [2] In some cases, the cell walls are covered with a waxy substance, suberin, which is impermeable to gases and water.

c) ***The phelloderm:*** Cells of the phelloderm layer are produced on the inner side of the phellogen. These cells are living and resemble those of the cortical stem cells. These phelloderm cells may be photosynthetic (e.g., *Bursera*) or may also act as starch storage tissues [3].

In aged plants, periderm formation occurs by degrees of layers. Consequently, the tissues exterior to it become cut off from the nutrition and water supply, resulting in their death. This leads to the development of hard and thick crust of dead tissue on the

Box 1. Chemical Constituents of the Bark

The bark is composed of various chemical components. In the strict sense, most of these components are excretory materials of plant:

a) ***Carbohydrates and related compounds:*** Compounds containing C, H and O as polyhydroxy aldehyde or ketone alcohol, e.g., starch, pectin, etc.

b) ***Glycosides:*** Substances which on hydrolysis yield one or more sugars, e.g. vanillin, salicin, etc.

c) ***Tannins:*** Complex chemicals with phenolic structure, capable of combining with proteins, eg., cinchotannic acid, gallotannic acid, etc.

d) ***Volatile oils:*** Essential oils which have the odoriferous principle., eg., cinnamon oil, rose oil, etc.

e) ***Resins:*** Solid or semi-solid amorphous products of complex chemical nature.

f) ***Alkaloids:*** Nitrogenous crystalline or oily compounds, usually basic in nature, e.g. quinine, reserpine, etc.

Apart from these, the bark also possesses some inert constituents mainly mucilage and calcium oxalate.

Figure 2. Scaly bark of Pinus roxburghii (Family: Pinaceae).

periphery of the plant axis. Again this dead outer crust increases in thickness due to further addition of cork layers which enclose patches of cortical tissues and dry phloem, ultimately producing thick bark. The bark tissue produces a new layer each year, pushing the earlier layer outwards, i.e., the oldest bark is always outside.

Bark is generally absent in monocotyledonous angiosperms. However, in perennial monocots different types of protective tissues are found on the stems [4]. For instance, in Royal Palm (*Roystonea regia*), a white and smooth hard periderm is developed on the trunk, which remains on the stem throughout the life of the plant like that of dicot-bark. Again the thickened stems of *Cordyline*, *Curcuma* and some other perennial monocotyledons are provided with a special kind of suberized protective tissue known as *storied cork*.

Diversity of Bark

Figure 3. Papery bark of Psidium guajava (Family: Myrtaceae).

The bark differs in different species of plants and is characterized by certain peculiar structural features. The texture of the bark is influenced by the manner of the formation of the periderm, age of the plant and climatic conditions. The colour and condition of the outer surface also offers useful characters.

In many plants like neem (*Azadirachta) and* asupala (*Polyalthia*), the different layers of rhytidome adhere to one another to form a thick and deeply grooved bark. In oak (*Quercus*) and teak (*Tectona*), the rhytidome contains large quantities of fibres which are associated with hard cork cells resulting in fibrous bark. In chatian (*Alstonia*), jackfruit (*Artocarpus*), chenar (*Platanus*) and child-life (*Putranjiva*), successive periderms are formed as entire cylinders producing ring bark. Scaly bark (*Figure* 2) is observed in pine (*Pinus*) and pear (*Pyrus*), etc., which is developed when the periderm is formed in the form of overlapping scales. The bark of eucalyptus (*Eucalyptus*), guava (*Psidium*) (*Figure* 3) etc., is intermediate between the previous types. These genera exhibit bark which peels off in the form of

relatively large papery strips. Jarul (*Lagerstroemia*) has a flaky bark. The small, brown flakes are shed in winter to reveal a smooth white bark that protects the tree. Arjun (*Terminalia*) and noni (*Morinda*) have crocodile bark or cracked bark, whose individual segments or units look like cubes. Deciduous trees like mandar (*Erythrina*) and red silk cotton (*Bombax*) (*Figure* 4) have thorny bark that protects the tree from predators and helps in reducing transpiration.

Figure 4. Thorny bark of Bombax ceiba (Family: Bombacaceae)

Nature of Bark in Some Common Tree Genera

Ten well-known tropical woody dicot plant genera, mostly of Indian origin and few exotic genera acclimatized to Indian conditions, were taken into consideration for studying the nature of barks. All of the samples examined under each genus were of minimum ten years age. Certain characteristic features of these barks are described below in *Table* 1.

Table 1. Characteristic Features of Some Barks.

a)	Common Name	:	Bel or Wood Apple
	Botanical Name	:	*Aegle marmelos* (L.)Corr
	Family	:	Rutaceae
	Bark-type	:	Hard, compact; segmented into thin striations; occasionally studded with needle-like spines.
b)	Common Name	:	Chatian or Devil Tree
	Botanical Name	:	*Alstonia scholaris* (L.) R. Br.
	Family	:	Apocynaceae
	Bark-type	:	Hard, more or less smooth, greyish-black in colour externally and brown internally; commonly called 'dita bark'.
c)	Common Name	:	Jack fruit Tree
	Botanical Name	:	*Artocarpus heterophyllus* Lamk.
	Family	:	Moraceae
	Bark-type	:	Smooth and compact bark, sometimes with parallely arranged vertical cracks; greyish black in colour.

Table 1. continued...

d)	Common Name	:	Neem or Margosa
	Botanical Name	:	*Azadirachta indica* A. Juss.
	Family	:	Meliaceae
	Bark-type	:	Very hard, thick, deeply grooved; divided into irregular striations; texture rough with greyish brown in colour.
e)	Common Name	:	Eucalyptus
	Botanical Name	:	*Eucalyptus globulus* Labill.
	Family	:	Myrtaceae
	Bark -type	:	Smooth and soft bark; thin outer layer peels off as large papery strips; brown in colour
f)	Common Name	:	Aam or Mango
	Botanical Name	:	*Mangifera indica* L.
	Family	:	Anacardiaceae
	Bark -type:		Thick, brown, fragile bark with uneven surface comprising distinct protuberances due to abnormal secondary growth.
g)	Common Name	:	Drumstick or Horse-radish
	Botanical Name	:	*Moringa oleifera* Lam.
	Family	:	Moringaceae
	Bark -type	:	Soft bark almost resembles a thermocol, compact, devoid of any cracks; beautifully designed into more or less pentagonal compartments.
h)	Common Name	:	Asupala or Mast
	Botanical Name	:	*Polyalthia longifolia* (Sonner.) Thw.
	Family	:	Annonaceae
	Bark - type	:	Thick and very hard bark, compact but sometimes segmented into rectangular blocks.
i)	Common Name	:	Sal
	Botanical Name	:	*Shorea robusta* Gaertn. f.
	Family	:	Dipterocarpaceae
	Bark-type	:	In young plants bark is hard and compact; in mature stages it is provided with vertical cracks.
j)	Common Name	:	Teak
	Botanical Name	:	*Tectona grandis* L.
	Family	:	Verbenaceae
	Bark-type	:	Thick, soft and fragile bark; divided into thin fibrous strips; light brown or grey in colour.

Table 1. continued...

Figure 5.
a) Wood apple bark.
b) Chatian bark.
c) Jack fruit bark.
d) Neem bark.
e) Eucalyptus bark.
f) Mango bark.
g) Drumstick bark.
h) Mast tree bark.
i) Sal bark .
j) Teak bark.

Box 2. Amazing Facts

While conducting observations on certain plants to study bark diversity, a few interesting facts have emerged:

The bark of *Psidium guajava* L. is associated with an edible fungus *Auricularia auricula-judae,* taking its nutrition from the dead tissues.

Bark of *Mangifera indica* L. secretes a colourless fluid which provides nourishment to the wood ants and thus a myrmecophilous relationship is developed.

On *Artocarpus heterophyllus* Lamk. trunk, certain crustose lichens are often seen to grow on portions of the bark not exposed to light.

Soft tissues of the bark of *Moringa oleifera* Lam. provide nourishment to the butterfly caterpillar which in turn protects the plant from enemy attacks.

Auricularia on Psidium bark.

A common crustose lichen on jack fruit bark.

Bark Benefits

Primarily the utility of bark in a plant is to protect the underlying soft tissues from desiccation as well as from mechanical injuries, fungal and parasitic attacks. Besides, pressure generated due to increase in girth of plant axis initiated by the secondary growth of the stellar region is compensated by the well defined bark.

Apart from its necessity to plant, bark is used commercially in tanning of leather, in boat building, textile industry, as source of fibres, food flavouring material, medicines, cork, etc.

Bark from the common oak (*Quercus suber*) and from several other genera particularly in the Anacardiaceae, is the source of tannins used commercially. The aboriginal people of North America use birch (*Betula papyracea*) bark to cover canoes and tepees (a sort of tent). Natives of Guyana make canoes of the bark of purple heart (*Copaifera pubiflora*) and of West Indian locust (*Hymenaea courbaril*). Coats are made by the indigenous people of British Columbia from pine bark and garments from elm (*Zelkova serrata*) bark are worn by the Ainu of Japan. The outer bark of *Betula utilis* is used as paper substitute. The bark of *Bauhinia vahlii* yields fibres termed 'selu' which are utilised for making ropes. The cinnamon sticks used in flavouring foods are obtained from the bark of young saplings of the cinnamon tree (*Cinnamomum zeylanicum*). An aromatic, transparent resin known as 'laldhuna' obtained from the bark of sal (*Shorea robusta)* is widely used as an incense and to caulk boats and ships. Commercial cork is obtained mainly from the bark of *Quercus suber*. The features that give commercial value to cork are its imperviousness to gases and liquids and its strength, elasticity and lightness [1]. A yellow dye, extracted from the bark of noni (*Morinda angustifolia)*, is used for dyeing carpets and turbans.

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and there is voluminous literature available on this subject. Bark extracts of *Rhamnus purshiana*, a native of Western North America, is used as a purgative and intestinal tonic. The alkaloids extracted from the dried *Cinchona* bark are used in the treatment of malarial fevers and are also used as antiseptic as well as tonic. India has an age-old tradition of utilizing bark material for the preparation of various remedies and antidotes. The bark of *Azadirachta indica* is widely used in the treatment of skin diseases. The juice of this bark is used in flatulence. The bark of the root of *Aegle marmelos* is used in intermittent fever and heart trouble. The 'dita bark' of *Alstonia scholaris* produces a bitter astringent which is applied in the treatment of stomach pain, ulcers, chronic diarrhoea and dysentery. The paste of *Michelia*

champaka bark is effective against rheumatism. The decoction of ashoka (*Saraca indica)* bark is used as a remedy for defective menstruation.

Epilogue

Bark, the hard outer covering of the stem, branches, and roots of a tree is easily distinguished from the wood by its unique features which can be employed in identifying tree genera. Bark is essential for the survival of a plant for long periods and protects it from the extremes of the environment. Bark based products are utilized for various anthropogenic uses. However, certain signatures on bark provide taxonomic tools to the students of botany in tree identification. The comparative study of bark morphology might help in determining the interrelationship of plants.

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Suggested Reading

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We cut nature up, organize it into concepts, and ascribe significances as we do, largely because we are parties to an agreement to organize it in this way an agreement that holds through our speech community and is codified in the patterns of our language.

– *Benjamin Lee Whorf*, 1897 – 1941