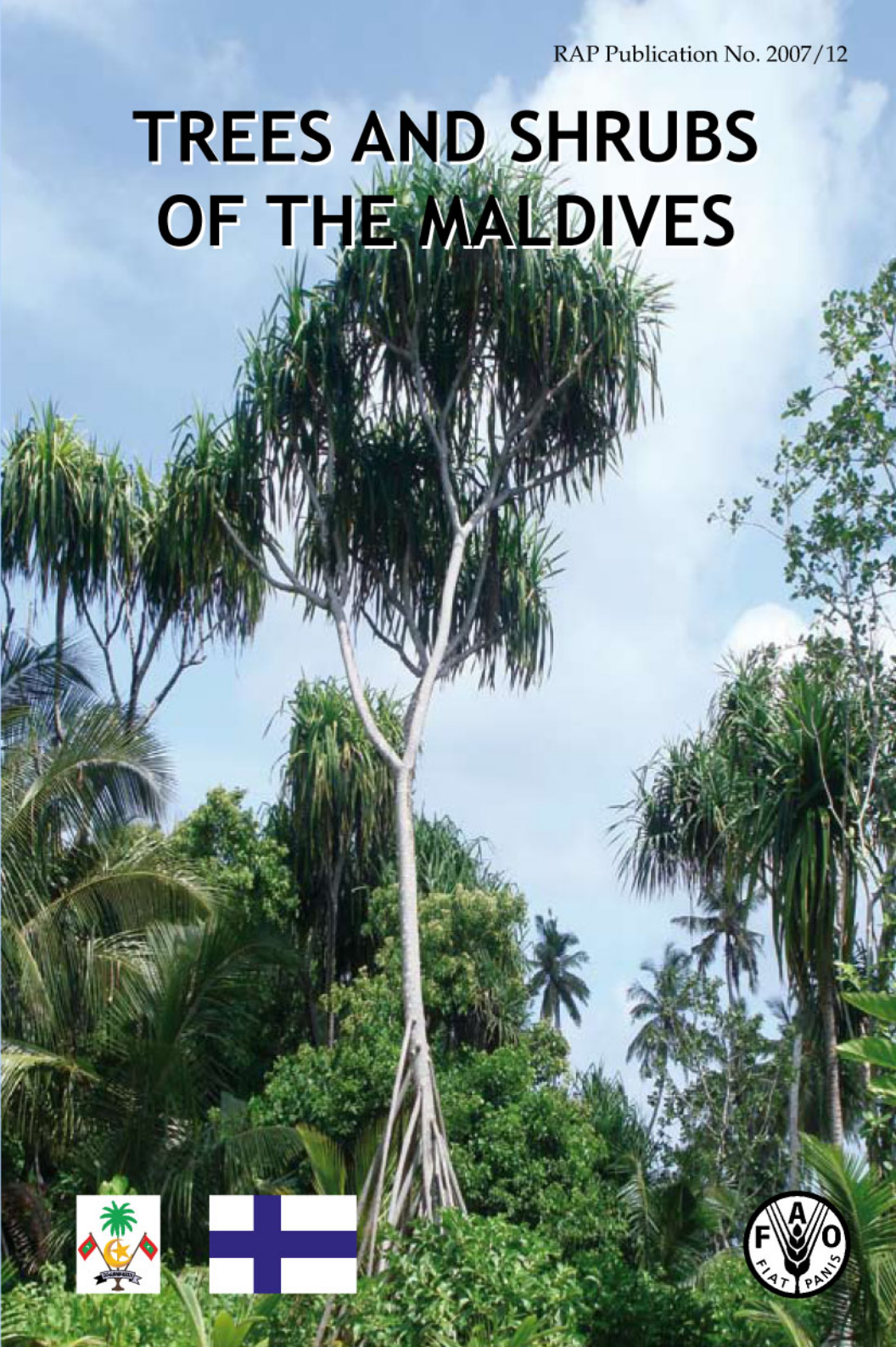
RAP Publication No. 2007/12

TREES AND SHRUBS OF THE MALDIVES



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Trees and shrubs of the Maldives

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Foreword

The Maldives is endowed with blue seas, green forests and rich island vegetation of which every Maldivian is proud. These forests and trees are used by the islanders primarily as a source of timber but also for medicinal and culinary purposes amongst many others. For their effective conservation and sustainable management it is essential for relevant information on the identity, ecology and use of each species to be catalogued and disseminated. The 'Forestry programme for early rehabilitation in Asian tsunami effected countries', which is supported by the Government of Finland and coordinated by the FAO Regional Office for Asia and the Pacific, took the initiative to publish this important book and we are sure it will be welcomed and used both by the people and residents of Maldives and by the many visitors the country receives each year.

The FAO Regional Office for Asia and the Pacific with funding from the Government of Finland, are particularly proud to have played a role in supporting production of this book and, more widely, to have provided support for the advancement of forestry and conservation in the Maldives. Recognition of the values of trees and forests and the environment is climbing the global agenda and through this publication we hope that awareness will be raised amongst Maldivians and others interested in studying the wide range of trees and shrubs present in this picturesque group of islands.

We would like to thank the author , Dr. Selvam Vaithilingam, for his meticulous and hard work and Dr. Ravishankar Thupalli, Chief Technical Advisor of the Maldivian component of the FAO Forestry tsunami programme, for his guidance and assistance in bringing this important book into being. Thanks are also due to Mr. Abdul Majeedh Mahir, Mr. Mohamed Naseem and Mr. Hussain Faisal of the Ministry of Fisheries, Agriculture and Marine Resources for their contribution.

This work is the first of its kind in Maldives and contains information on 100 species including broadleaves, mangroves, pandanus, palms and casuarinas. We believe this book, with its abundant and colorful pictures, will serve as a stimulus for Maldivian people and conservationists alike and will further promote the propagation and conservation of 'Forests and Trees for a Green Maldives'.

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Assistant Director-General and
Regional Representative for Asia and the Pacific
Food and Agriculture Organization of
the United Nations

Abdhullah Kamaludeen
Minister for Fisheries, Agriculture
and Marine Resources
Government of Maldives

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Trees and Shrubs of the Maldives

Introduction

The human race depends on forests, trees and other vegetation for its survival and well-being. Women, men and children are attracted and attached to trees, shrubs, herbs and other vegetation for various reasons and purposes. Some trees are culturally valuable and some others are important in terms of social norms and beliefs as well as traditional systems but many of them are essential to satisfy basic human needs such as food, shelter, clothing and employment. They also play an important role in safeguarding environmental integrity. In an atoll environment like the Maldives, they are also important for reasons such as stabilization of sand and protection against salt spray. Trees and shrubs also play a critical role in reducing the impact of natural calamities, such as tidal waves and tsunamis on human lives and properties (Danielsen *et al*., 2005; Selvam, 2005).

As in many small islands, vegetation in the Maldives has changed both quantitatively and qualitatively over time due to overexploitation by increasing human populations, unsound land use practices, poor land tenure policies and intentional and unintentional introduction of exotics and commercial species (Wills and Gardiner, 1901; Zuhair, 1997). Such changes have made the islands of the Maldives, their ecosystems and human populations more vulnerable to natural calamities such as cyclones, tidal waves and tsunami and man-made calamities such as rising sea levels.

Taking these facts into consideration, this book on "Trees and Shrubs of the Maldives" aims to improve awareness of the trees and shrubs of the Maldives and their ecological importance; provide an overview of their local uses and potential role in increasing the economic security of Maldivian communities; and outline propagation and management techniques for their cultivation.

The Maldives

Geography

The Maldives is a large archipelago of 1190 coral islands, spreading over 860 km in a north-south direction in the Indian Ocean and covering an

area of 90,000 sq km. Only 202 of these islands are inhabited. The islands are grouped into 26 natural atolls and 19 atolls for administrative purposes (Fig. 1). These atolls are situated atop a 1600 km long undersea mountain range called as Laccadive-Chagos Ridge, which extends into the Central Indian Ocean from the south-west coast of the Indian subcontinent. Most of the atolls consist of a ring-shaped live coral reef supporting numerous islands. Most of the islands are small and vary in size between 0.5 and 5 sq km. They are flat and without hills or rivers. Nearly 80% of the land area is less than 1 m above mean high tide level (MHAHE, 1999).

Climate

The climate of the Maldives is equatorial, warm and humid with two pronounced monsoon seasons, the south-west and the north-east monsoon seasons. The temperature is fairly constant throughout the year with a mean annual temperature of 28°C. The average summer temperature ranges between 26.3 and 31.8°C and winter temperature between 25.1 and 30°C. The diurnal variation is very small, rarely exceeding 6°C. April is the hottest month with an average temperature of 30.8°C and October is the coolest with an average of 25°C. Relative humidity is high throughout the year, ranging from 73 to 85%.

The annual average rainfall in Maldives is 1890 mm. The rainfall in the southern atolls is greater with an annual average of 3050 mm, whereas it is only 1520 mm in the northern atolls. The south-west monsoon, which extends from the end of April to the end of September, brings heavy rain to the entire archipelago. The rainfall decreases considerably during the north-east monsoon season that prevails from December to March and during this season periods of drought may be experienced, particularly in the northern group of islands. However, the weather patterns of the Maldives do not always confirm to the monsoon patterns of South Asia. For example, heavy rain over the whole country has been known to occur continuously for up to one week even during the midst of the dry season.

The Maldives is outside the main area of tropical cyclones and therefore gales are uncommon and cyclones are very rare. However, during the south-west monsoon season strong winds and storms may hit the archipelago and can cause severe damage. On average, it is reported that thunder storms hit the Maldives on 23 days per year and strong winds on 12 days per year. In May 1991 tidal waves, created by violent monsoon winds, caused damage to thousands of houses, jetties and piers and flooded arable land with seawater. The damage caused was estimated at US $30 million.

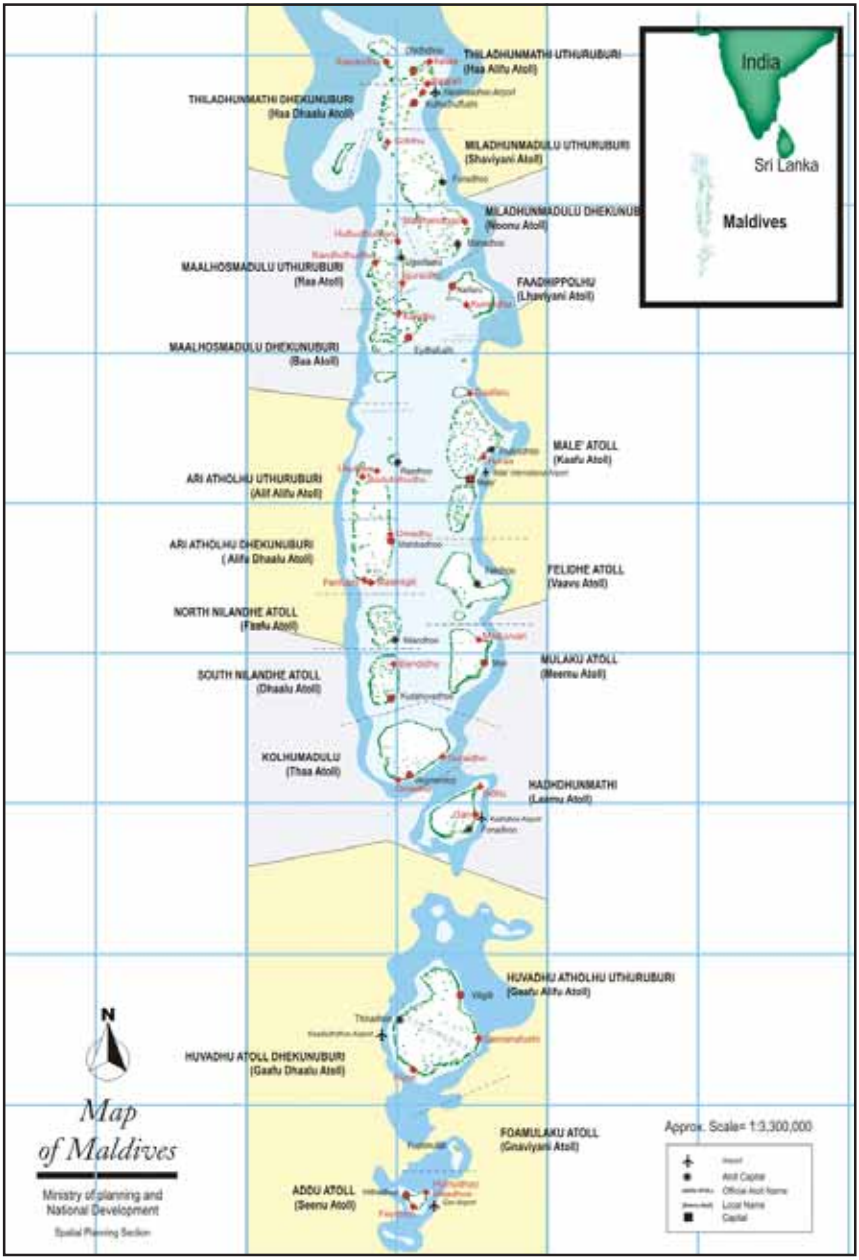

Fig. 1. Map of the Maldives

Soil

The soils of the Maldives are geologically young and consist of substantial quantities of the unweathered coral parent material, coral rock and sand. In most of the places, soils are coarse in texture and shallow in depth with a top layer of brown soil (0 to 40 cm in depth) followed by a transition zone on top of the underlying parent material of coral reef limestone (MFAMR, 1995). In some low-lying areas and areas subjected to significant mechanical breakdown from human activity, fine deep soils are found with accumulated deposits of clay. In a lagoon environment (locally called *kulhi*) the depth of the clay may be substantial due to the accumulation of material from marine and biological sources over a long period of time (MEEW, 2006). In many places, top layers of the soils have a weakly developed structure and at times a 30 cm thick hard-pan layer cemented with calcium carbonate is present, preventing penetration of the roots of most plants except large trees. The water-holding capacity of the soil is very poor due high porosity and very high infiltration rates.

The soils of the Maldives are generally alkaline with pH values between 8.0 and 8.8. This is mainly due to the presence of excess calcium and, soils containing higher levels of humus, as in depressions and lagoons, are less alkaline. The soils are generally poor and deficient in nitrogenous nutrients, potassium and several micronutrients particularly iron, manganese and zinc. Though the phosphorus content of the soils is high it is present mostly in the form of calcium phosphate and, thus, remains unavailable to plants.

Plant communities

Though the climate of the Maldives provides ideal conditions for luxuriant growth of tropical trees and shrubs, other factors such as salinity, the highly calcareous nature of soils and the salt-laden winds create harsh environmental conditions. This is one of the main reasons why the number of species in the Maldives, either native or naturalized, is limited.

The islands of the Maldives can, in general, be divided physiographically into three zones namely, i) the foreshore or lower beach, ii) the beach crest (beach top) and iii) the inner island. The foreshore can be further divided into high tide and high-storm levels. The high tide level is normally located at an elevation of 0.5 m above mean sea level and high storm level, which is beyond the reach of normal tides, is located at about 0.8 to 0.9 m. The storm level is affected by storm waves and is composed of gravel or shingle. The average elevation of the beach crest is about 1.2 m and the

inner islands are at about 1.45 m above mean sea level **(**Morner *et al*., 2003**).** Each of these zones provides relatively uniform environment with its own associated plant community. Plant community found in different physiographic zones of the Maldives is more or less similar to plant association reported in Nukunonu Atoll of Western Samoa (Parham, 1971).

i) Plant communities of the foreshore

The foreshore or lower beach zone, which includes the beach area between the high tide line and the beach crest, is totally exposed to wave action, wind and salt spray. It is unstable and composed mainly of coarse coral sand in the lower portion and shingle. As a result of the harsh environmental condition, this zone supports no vegetation except occasional creeping sand-binders such as *Ipomoea littoralis* and *I. biloba* along with a few individuals of *Launaea pinnatifida* and *Portulaca alata* in the upper portion.

ii) Plant communities of the beach crest

The beach crest or beach top rises gradually and sometimes abruptly to a height of 0.8 to 1 m above the high tide line and includes a stable beach frontage composed of coral sand and rubble. Like the foreshore environment, it is also exposed to winds and salt spray and its lower margin is occasionally or, in the case of an eroding beach, regularly inundated by seawater during spring tides. The beach crest may extend 5 to 20 m inland and provides a suitable environment for strand plant communities including a distinct association of trees and shrubs and a few sand-binding creepers and herbaceous plants. These strand plant communities include:

a) the *Scaevola taccada* scrub community, which forms an effective windbreak of about 3 to 4 m height on the seaward side of the islands immediately above spring tide level. It is normally found on sandy soils or soils dominated by coral rubble. It is the most common scrub community found on beach crests of both northern and southern islands of the Maldives.

b) the *Pemphis acidula* scrub community, which is commonly found on elevated reef rock, coral conglomerate beach rock or hard pan coral in open sites at or above the high tide level. Pure stands of closely growing *Pemphis acidula* trees, which are impenetrable, can be seen in

these areas and it is usual for the roots of these trees to be regularly wetted by seawater during high tide. In sandy areas *Pemphis acidula* can also be seen growing in association with a similar looking plant, *Suriana maritime*. These areas may have coral rock at very shallow depths.

c) the *Tournefortia argentea* community is found as a dominant strand community of the beach crest particularly in drier places in some of the northern islands. It is located very close to or just above the high tide line and may not form an effective windbreak as the trees do not grow closely together. It is sometimes associated with *Pandanus tectorius* and *Scaevola taccada.*

d) the *Guettarda speciosa* community is normally found only on highly elevated beach crests and is characterized by the presence of other species such as *Scaevola taccada, Pandanus tectorius* and a scattering of *Pisonia grandis* and *Cordia subcordata* trees.

iii) Plant communities of the inner island

The microclimate of the inner islands, protected by the beach-crest communities, supports the growth of a number of trees and shrubs, which occur either in pure stands or as a mixed forest (Forsberg, 1957). In many islands coconut plantations are present immediately adjacent to beach-crest vegetation and in moist areas the shelter provided by a complete coconut tree canopy supports the growth of under story tree species such as *Morinda citrifolia* and *Guettarda speciosa*. In some places, *Pandanus odoratissimus, Calophyllum inophyllum* and *Hibiscus tiliaceus* are also found in low numbers within coconut groves (Forsberg, 1957). In some other, particularly moist, areas small pure stands of *Hernandia nymphaeifolia*, *Cordia subcordata* and *Barringtonia asiatica* are present. In drier places including the northern group of islands, pure stands of *Hisbiscus tiliaceus* and *Premna serratifolia* are also seen. Where extensive coconut plantations are not present mixed species forest is the most common vegetation type found next to beach-crest scrub community. The principal tree species in these forests are *Pandanus, Hibiscus tiliaceus*, *Cordia subcordata, Hernandia nymphaeifolia, Calophyllum inophyllum, Barringtonia asiatica, Ochrosia oppositifolia, Guettarda speciosa, Adenanthera pavonina* and *Terminalia catappa.* These mixed forests also support good growth of under story species such as *Allophylus cobbe, Morinda citrifolia* etc. No regular features in terms of the dominance, frequency or density of tree and shrub species are prominent in the mixed forests. In many islands the original distribution of trees and shrubs has been greatly disturbed by the establishment of

extensive coconut plantations. As a result, beach-crest scrub communities and mixed forests are only found up to a short distance from the shoreline in many of the islands before merging into coconut plantations. As described in the species fact sheets, most of the trees and shrubs present in the beach scrub community and mixed forests are tolerant of salt-laden winds, salt spray, soil salinity and shallow nutrient-poor soils.

The above description of the plant communities of the Maldives islands and the overview of the ecology, propagation, management and economic uses of different species given in the following fact sheets provide a background to the opportunity that exists for the establishment of multi-tiered multispecies coastal bioshields or green belts. Such bioshields are essential for the ecological security of the Maldives islands and the economic security of the Maldivian people in light of future coastal hazards and predicted increases in sea levels.

How to use this book

How this book is organized

In this book 100 species selected on the basis of wide consultation are grouped as a) Broad leaved trees and shrubs, b) Mangrove trees and shrubs, c) Palm trees, d) Pandanus trees and shrubs and e) Narrow leaved tree - Casuarina. The fact sheets for each species include the following information:

i) Scientific name

ii) Synonyms

iii) Family name

iv) Common name(s) and Dhivehi name(s)

v) Species description

vi) Uses and

vii) Ecology, propagation and management.

Each species is illustrated with a combination of colour photos and drawings showing habit, bark, leaf structure, inflorescence, flowers, fruits and other characteristic features useful in identification. Under the heading ‘uses’, information on how the Maldivian community utilize different parts of the tree or shrub is given together with details relating to potential commercial use. Information on the soil types in which particular

trees and shrubs flourish and their tolerance to various environmental conditions such as salt spray, soil salinity, drought and wind, etc., is also given. Trees and shrubs useful in creating coastal bioshield are indicated and major methods of propagation are given for each species along with management information. References providing additional information on ecology, propagation and management of different species are given at the end of the book.

Technical terms relevant for the identification of trees and shrubs

To assist identification of featured trees and shrubs, plant physical attributes have been described with the minimum usage of technical terms. Some traditional botanical terms that may not be familiar to users have, however, been included and are explained here with illustrations provided to assist simple identification.

Leaves

Simple leaf: A leaf with a single leaf blade is called a simple leaf or a solitary leaf. The leaf blade may be entire or dissected into lobes or divided pinnately or palmately as shown below.

Entire: simple leaf that has no incisions

Pinnately lobed: simple leaf that has many lobes that are arranged on either side on the midrib

Palmately lobed: simple leaf that is divided into three or more distinct lobes, like the fingers of a hand

Bi-lobed: simple leaf that is divided into two lobes

Compound leaf: A compound leaf is a leaf where the incisions are such that the leaf is cut into distinct separate blades called leaflets. All the leaflets of a compound leaf are oriented in the same plane. When the compound leaf falls from the tree, it falls as a unit. In a compound leaf, the midrib is the rachis on which the leaflets are borne.

Pinnately compound leaf: leaf that has many leaflets, which are arranged in pairs on either side the rachis (looks like a feather)

Paripinnately compound leaf: pinnately compound leaf with no terminal leaflet

Imparipinnately compound leaf: pinnately compound leaf with a single terminal leaflet

Bipinnately compound: compound leaf that is twice pinnate with compound leaflets arranged on both sides of a central stalk

Palmately compound: compound leaf with many leaflets diverge from a common point (like the fingers of a hand)

Trifoliate: compound leaf that has only three leaflets, one at the tip and two below

Leaf shapes

Leaf shape refers to the outline of the leaf blade. The following are the main types of leaf shapes:

Linear: leaf that is long and narrow, with parallel or nearly parallel sides. Length of the leaf is generally more than ten times the width.

Lanceolate: leaf that looks like a lance, very long but narrow blade, widening about the base and tapering at the top, broadest point below the middle

Oblanceolate: leaf that is shaped like an inverted lance, broader at the top end than at the middle and tapering towards the base

Ovate: leaf that looks like a hen's egg, broadest point of the leaf is below the middle

Obovate: leaf that has an inverted egg shape

Elliptic: leaf that is longer than wide, narrow to round ends and widest at or about the middle. Leaf length is at least two times the width

Oblong: leaf that is longer than broader with the sides more or less parallel for most of the length of the leaf. The length is usually less than ten times the width

Cordate: leaf that looks like a heart, having two equal more or less round lobes at the base

Peltate: leaf like a shield with a flat leaf blade and a central leaf stalk

Leaf apices

This refers to tip of the leaves. The following are some of the major types of leaf tips:

Acute: sharply pointed tip

Acuminate: tapering to a long point

Apiculate: tip with a short, sharp, but not stiff, point

Obtuse: blunt, rounded tip

Emarginate: tip with a swollen notch at the apex

Mucronate: terminating abruptly by a short sharp point at the apex

Leaf bases

The following are the common types of bases noticed in many of the plants:

Attenuate: tapering gradually

Acute: pointed, forming less than a right angle

Obtuse: blunt, usually more than a right angle

Truncate: appearing as if the base is cut off, nearly straight across

Auriculate: having an ear shaped part at the base

Leaf margins

The following are the common types of margins found in leaves.

Entire: even and unbroken margin

Sinuate: margin with deep and rounded incisions

Serrate: margin toothed like a saw, with fine teeth pointing outwards

Undulate: margin which is wavy

Crenate: margin with shallowly round teethed

Leaf arrangement

Alternate: only one leaf is present at a node and leaves are on the same plane

Opposite: two leaves inserted opposite to each other on the stem

Spiral: leaves arranged singly but they arise all around the stem facing different planes

Whorled: three or more leaves radiating from a single point facing different planes

Flowers

Flowers are the most remarkable feature of angiosperms (flowering plants). They show striking variations in colour, shape and smell and therefore are considered as an important external feature of a plant that can be used for the identification of a plant species. The following is the cross section of a flower showing the different parts (Fig. 2):

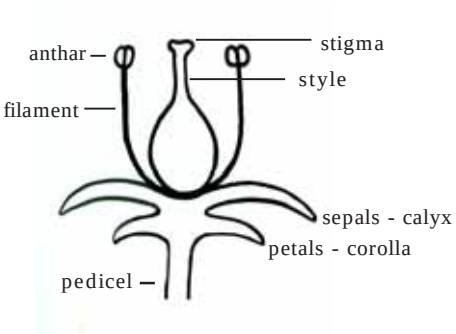

Fig. 2. Longitudinal section of a flower

Inflorescence

An inflorescence is a group or cluster of flowers on a plant. It is otherwise called a flower head or flower cluster. The stalk of the inflorescence is called the peduncle and the stalk of an individual flower is called the pedicle. Flowers arise in the axils of reduced leaf-like structures called bracts and a cluster of bracts is known as involucre.

An inflorescence is single when all the flowers are gathered in the same single pattern and it is called compound when a complex pattern is formed from other single patterns.

Single inflorescences

Main types of single inflorescences are as follows:

Raceme: a simple elongated inflorescence with stalked flowers; length of the stalk is equal in all the flowers

Spike: it is similar to raceme but flowers attached directly to the peduncle

Spadix: a thick fleshy spike, surrounded or subtended by a spathe (a large, often showy bract); flowers usually unisexual and minute

Corymb: it is similar to raceme but length of the stalk is unequal. It is flat topped with the oldest flower at the end of the main axis

Cyme: it is similar to corymb and flat topped with the youngest flower at the end of the main axis

Umbel: flowers are with equal stalk length and they arise from a single point from the top of the peduncle

Compound inflorescence

The following are the main types of compound inflorescences:

Panicle: it is formed by several racemes clustered together

Compound umbel: it is formed by several umbels clustered together

Fruits

Fruits are the seed-bearing organ of a plant, which display a wide range in size, shape and colour. It is another external feature that is used for identifying plants.

Pod: long dry fruit consisting of a seedcase, which splits open to release its seeds

Drupe: fleshy fruit having a single hard stone that encloses a seed

Berry: small, juicy fruit having the whole wall fleshy

Capsule: dry fruit that develops from two or more carpels (female reproductive unit of a flower comprising stigma, style and ovary)