Soneva Kiri

botanical diversity at soneva kiri

Results from a preliminary botanical survey at Soneva Kiri Resort

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summary

BOTANICAL DIVERSITY AT SONEVA KIRI

Soneva Kiri resort is situated on the island of Koh Kood, which is one of the most undisturbed islands of Thailand. The amount of different ecosystems present, along with the relatively unspoiled environment, causes the island to support a very large diversity of life. To get a better understanding of how rich this diversity actually is, an introductory botanical survey was conducted on the resort property. This report will first give a better insight into why such a large biological diversity can be found here.

The plants focused on in this botanical survey were mainly the most common or the most notable examples found on the Soneva Kiri property. During the survey over a hundred different species were found, of which some 56 different genera and species, and 42 different families could be identified. Many of these plants have an important ecological, economical or medicinal significance in various areas where they naturally occur. Because of the large biodiversity present on this island and on this property, the report remains a work in progress. It will be supplemented as new species are identified over time and shall function as a reference guide for those who are interested to know more about the natural environment on Koh Kood.

Finally the report will also provide some explanation about the scientific terms used and about the systematics of biological classification.

Acknowledgements

Many thanks go out to Bob Harwood, without whom I would not have been able to compile this report.

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glossary

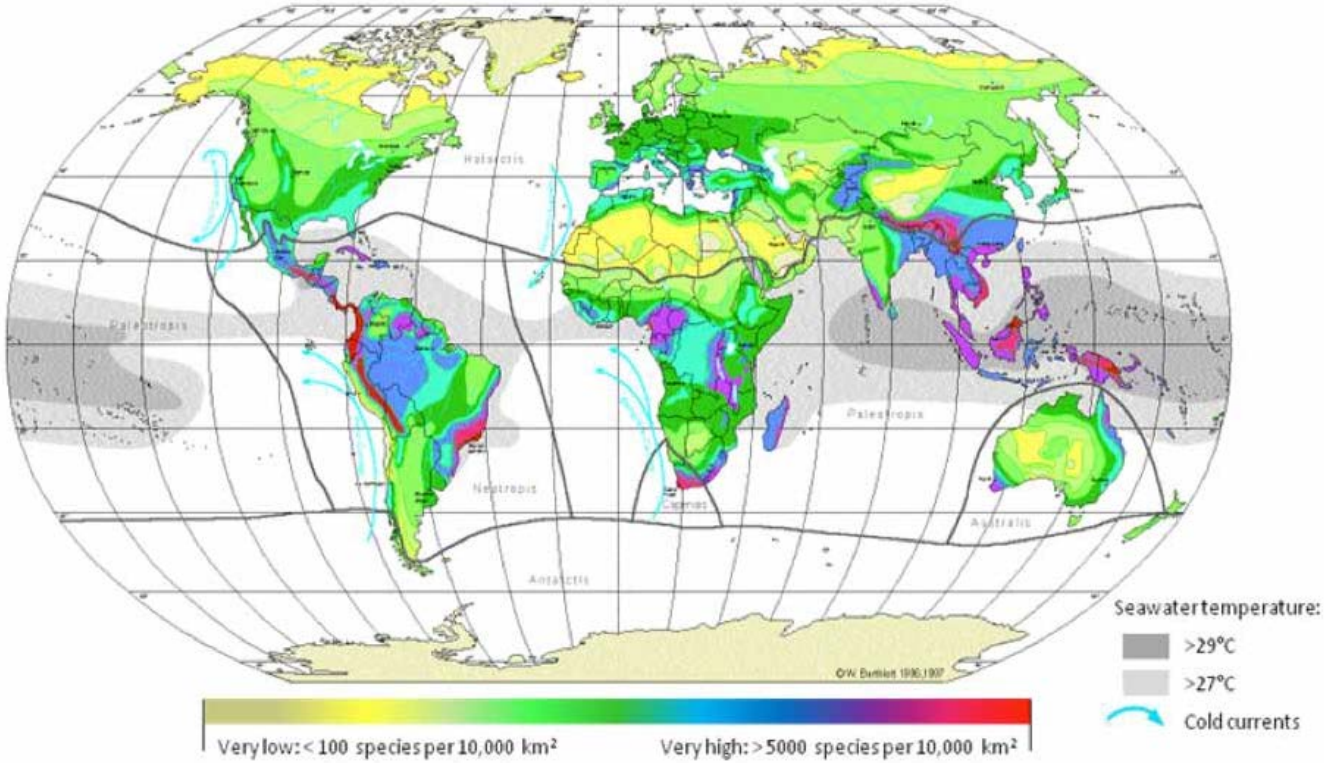
Adaptation (evolutionary)	A trait with a current functional role in the life of an organism that has evolved and is maintained by means of natural selection.
Biodiversity	The variety of and within different types of life on earth. Different measures for biodiversity exist. It can refer to genetic variation, ecosystem variation, or species variation within a given area, biome or on the entire planet.
Botany	The scientific discipline of plant studies
Bract	A bract is a modified or specialised leaf which in some plant species accompanies the reproductive structure. Bracts are almost always different from normal foliage leaves. In some cases, especially in flower clusters, they function as an attractant to pollinators, as normally the petals would.
Bulb	A short stem with fleshy leaves or leaf bases that functions as a food storage during dormancy
Cotyledon	First leaf to emerge from germinating seed, plants are either monocots
	(one first leaf), or dicots (two first leaves).
Dicot	Plants with seedlings bearing two cotyledons. Often these plants have secondary growth, meaning that they have specialised tissues that form an ever thicker wooden stem during their lifetime.
Ecosystem service	Services that species, or communities of species contribute to an ecosystem balance and the people that depend on it. These services are classified as supporting, provisioning, regulating, and cultural services. These terms serve as a tool for highlighting the importance of keeping ecosystems intact by providing the ability to quantify the long-term economic value of their characteristics.
Endemic	The ecological state of a species being unique to a defined geographic location or habitat type. This is opposed to indigenous, where species are also found elsewhere.
Epiphyte	Plants that grow in or on other plants and trees; epiphytes comprise the largest plant diversity in tropical rainforests.
Epipetric	Growing on a rock surface, these plants are also called lithophytes.
Genus (plural: genera)	Taxonomic level of classification, the genus and species names are always written in italics. The genus name starts with a capital first letter and species is written only in small letters.

glossary

Herb (adjective: herbaceous)	Monocot, no secondary growth/ no wood formation
Inflorescence	Flower cluster
Infructescence	Fruit cluster
Lithophyte	Plants that grow in or on rock surfaces, also called epipetric plants.
Monocot	Plants with seedlings bearing only one cotyledon. These plants are always herbaceous, meaning they do not produce wood.
Morphology	Specific structural features of an organism; growth form. Before the advent of genetics, morphology was the main basis for scientific classification of species.
Pseudobulb	A storage organ derived from a thickening of a part of the stem between leaf nodes. This structure is typical for epiphytic orchids.
Spp. (abbreviation for *species pluralis*)	Species belonging to genus unknown, or referring to all species within genus. Because of the enormous diversity of plants in the tropics, identification often depends on the smallest details of flowers and fruits. If plants are not flowering or fruiting, it is often impossible to identify them to species level with certainty.
Rhizome	A modified underground stem of a plant which is different from a root. Often it sends out roots and shoots from its nodes, allowing some plants to spread.
Stomata	Tiny openings or pores which allow for gas exchange or “breathing”, usually situated on the underside of leaves.
Stipule	An outgrowth on the base of either side of a leaf stalk. The shapes of these stipules, or the scars of fallen-off stipules, are important characteristics for species identification.
Succulent	Plants having some parts that are more than normally thickened and fleshy, usually to retain water in dry climates or soil conditions.
Taxonomy	The scientific discipline of defining and naming groups of organisms based on shared characteristics.

Tropical rainforests

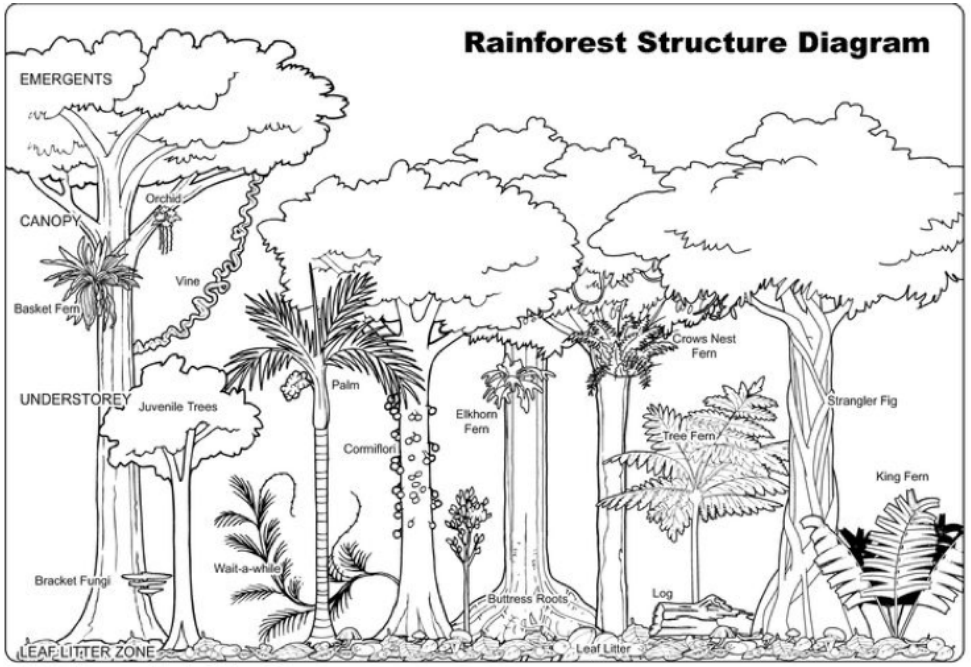
Tropical rainforests are widely regarded as the most biodiverse terrestrial (land based) ecosystems. The amount of different plant and animal species in these ecosystems is unrivaled (image below). An exampe to compare: A typical undisturbed temperate forest in western Europe contains around 10 species of trees that grow thicker than 10 centimetres per hectare, where a tropical rainforest may contain more than 300 species per hectare. When it comes to the total number of plant species, the comparison is just as impressive. For instance the entire surface of the British isles supports some 3842 different vascular plant species. Thailand supports at least 10,000 species, and new ones are still being described on a regular basis. Animal diversity across the world is even larger and follows a similar pattern.



This map shows the estimated diversity of vascular plants across the planet. In temperate areas most plants have already been scientifically described, while in tropical regions new species are still being discovered on a regular basis. The largest diversity occurs in areas which are covered by tropical rainforests.

introduction to biodiversity

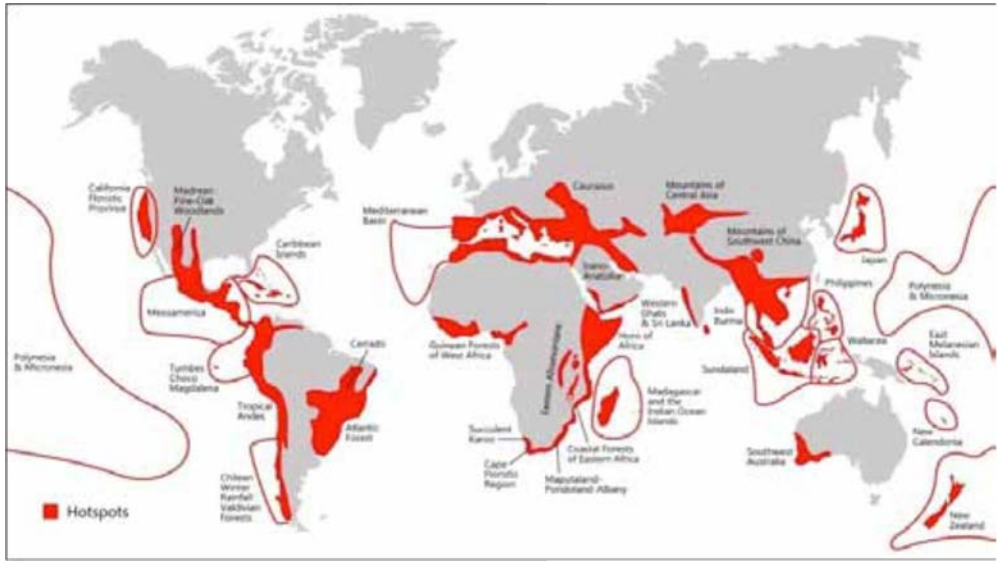
Interestingly though, the largest diversity of plants in a typical tropical rainforests is not found on the forest floor, but in the tops of the trees, where most sunlight is available. A tropical rainforest consists of many different vegetation layers (image below). The highest layers, the canopy and the so called emergent forest giants towering above, are dominated by epiphytes, which in Asia are mostly represented by ferns and orchids. These epiphytes comprise an entire, unique ecosystem by themselves as they provide habitats to many different fungi, animals, and other plants.



A diagram of the typical structure of a tropical rainforest, showing some typical and recognisable plant and tree species. The largest diversity of plants in tropical rainforests is composed of epiphytes that occur on the branches in the canopy of the forest.

Aside from tropical rainforests being exeedingly rich in numbers of species in general, the forests in Southeast Asia have another interesting characteristic, they are a so called biodiversity hotspot (image on next page). Biodiversity hotspots are places in the world that, regardless of the total number of species, support a large number of endemics. Endemics are species of plants, animals, or fungi that occur only in this particular eco region of the world, and nowhere else.

It is thought that this high number of endemics is a result from a general clustering of extraordinarily high biodiversy in a given area. Areas with high numbers of endemics are considered to be of especially high conservation value. Around the world 35 areas are qualified as biodiversity hotspots. They represent just 2.3% of Earth's total land surface, but they support more than half of the worlds plant species as endemics, and nearly 43% of bird, mammal, reptile and amphibian species as endemics. Unfortunuately, all these hotspots are highly threatened by human activity.



The locations of the land-based biodiversity hotspots in the world. Most of these occur in the (sub-) tropics.

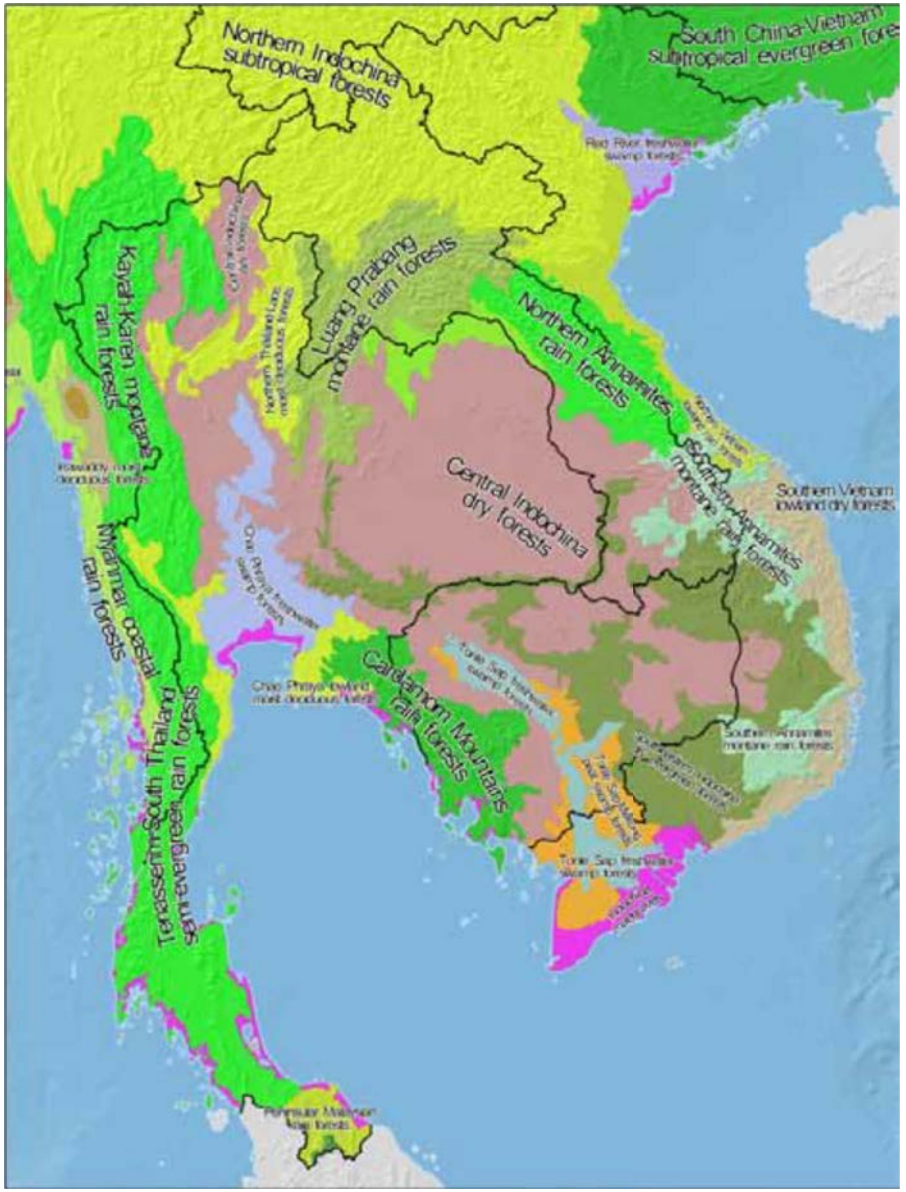
Thailand and Koh Kood

Thailand is a country with an awesome natural diversity. Due to the geographic and climatic variation within the country it hosts a number of different ecoregions, from the mountainous seasonal forests in the North, the dry forests in the northeast, to the lush tropical rainforests in the south. Each of these ecoregions supports its own variety of plant, fungal, and animal species, where of course some of the diversity overlaps.

Thailand currently faces many severe environmental problems that came with rapid economic development; heavy pollution, overfishing and deforestation, each causing a range of long-term detrimental effects on biodiversity and local communities. Forest cover in the last century has dropped from over 60% in the early 20th century to less than 30% at present. Around one third of surface waters in Thailand is so polluted that it is considered to be unsuitable for any use. Despite these issues, Thailand still boasts one of the richests biological diversity in the world.

Koh Kood is one of the few remaining relatively unspoiled places in Thailand. The island is a good example of where different ecoregions and ecosystems come together. Koh Kood's land surface has a varied geography inlcuding hills and boasts a relatively large lowlying area that is gets temporarily inundated by by the sea. This area on the west side of the island is therefore covered with mangrove forest. Mangrove forests are very important ecosystems in terms of the services they provide. Mangrove forests offer flood protection, erosion reduction, carbon storage, and nurseries for fish and crustaceans. It is estimated that mangrove ecosystems are essential for the reproductive success of 75 – 90% of tropical commercial seafood species.

Climatically Koh Kood is similar to the south of Thailand, and due to the proximity to Cambodia it shares much of its forest diversity with the largely unexplored and untouched rainforests of the Cardamom Mountains. By far the largest part of Koh Kood is therefore covered with tropical rainforest, most of which is still in its untouched state, because of the low population density. A map showing all the natural ecosystems of the region is shown on the next page.



introduction to biodiversity

Soneva Kiri

Award-winning luxury resort Soneva Kiri is located on Thailand's fourth largest but least populated island, Koh Kood; just one hour by private plane from Bangkok. The resort comprises 36 vast pool villas, ranging in size from one to six bedrooms, all of which are nestled amidst 41 hectares (102 acres) of lush tropical rainforest with spectacular ocean views.

Highlights of the resort include an open-air Cinema Paradiso, an observatory, a giant moulded bamboo playground for children shaped like a manta ray, and the spectacular treetop Dining Pod.

With an unrivalled combination of luxury, authentic Thai experiences, and mouth-watering organic food, Soneva Kiri encompasses barefoot Intelligent Luxury at its best.

plant list

Here the results from three days of fieldwork at Soneva Kiri are listed. During the field work, over a hundred different species of plants were found. However not all of them could be identified down to species or even genus level with the available expertise and information. After some more thorough research about the individual examples found, a total of 59 different genera and species, and 42 different families could be relatively accurately described.

The findings are listed according to the logical taxonomic systematic and in alphabetical order. So chapters are arranged according to plant families and subchapters according to genera and species when this information is available. The information in these chapters focuses mostly on interesting particularities of the plants such as possible human uses or ecological importance. Also, where available, the common English names are given. All the scientific botanical descriptions are left out as only experienced botanists will be able to decipher these.

Anacardiaceae (cashew family)

The **cashew**, **sumac**, or **mango** family of flowering plants contains 70 genera and 650 species of trees and shrubs. Most have inconspicuous flowers and contain a highly poisonous, blister forming, sometimes milky sap that turns black on exposure to the air. In fact often sawing or burning wood from this family can be highly dangerous if sawdust or smoke particles are inhaled, as it can create burns in the lungs. Some species are also dangerous to touch.

Despite the strong defences these plants have evolved, the family contains many economically important species. Notable examples include the mango, marula, pistachio, cashew, sumac and poison ivy.

Anacardium occidentale (cashew)

The **cashew** tree is an evergreen tropical tree that is known for its main economic uses, the cashew seed and cashew apple. The tree is native to northeastern Brazil, but is now widely cultivated across the tropics. It can grow up to about 14 metres tall. The tree is most well-known for its seed, the “cashew nut”. However in the tropics where these trees are grown, also the sweet, astringent, so called “cashew apple” is widely consumed, either fresh, as a juice, or fermented into a liquor. Interestingly, the cashew apple has nothing to do with an actual apple. In fact, botanically speaking, it is not even a fruit. Rather the cashew apple is a swollen fruit stalk that serves to lure animals, which through consumption of this part, disperse the single-seeded fruit. Another economic use for this tree is the shell of the seed, which provides chemicals that are used in lubricants and paints. At Soneva Kiri this tree can be spotted fruiting in the dry season. It is especially noticeable around the airport, where ripe fruits drop onto the road.

The picture shows ripening cashew fruits in varying stages of development. Note how the fruit stalk slowly swells up to produce the so called “cashew apple”.

Mangifera spp. (mango)

This is better known as the mango genus. It contains approximately 69 species, with the best-known being the common mango *(M. indica)*, of which a number have been planted across the resort, along with the Thai mango *(M. siamensis)*. The genus is has its largest diversity in subtropical and tropical Southeast Asia, with a number of this species also to be found on Koh Kood. Many members are canopy forming trees in tropical lowland rainforests and can reach a height of 30-40 metres. Besides the common mango, some 26 other species bear edible, fleshy fruits.

Mangifera siamensis, the Thai mango

Annonaceae (custard apple family)

The Annonaceae or **custard apple family** of flowering plants consists of trees, shrubs and sometimes lianas. In this family some 130 genera with 2106 species have been described. The family is concentrated in the tropics with about 900 species in the Americas, 450 in Africa, and the rest in Asia.

Many species in this family bear large, edible, pulpy fruits which have many names in the family's South American range. Edible species include the custard apple, cherimoya, soursop (guanabana), sweetsop, ilama, soncoya, and biriba. The names of many of these fruits are often used interchangeably.

Recently is has been found that the consumption of *Annona muricata* or soursop might be the causative agent in "atypical parkinsonism". The fruits contain a chemical called annonacin, which is thought to be the causative agent for many Parkinsonian conditions in the native range of this fruit. Exposure usually takes place through traditional food and natural medicines. Many species in this family actually contain the chemical, so the effects are now being thoroughly studied to get a better understanding of this possible health hazard.

Comparatively little is known about the Asian species as only a few attempts have been made by scientists to study and classify the family in this region. The wild member of this family found in Soneva Kiri Resort could unfortunately not be identified down to genus or species level, because the identification key for this area is still a work in progress.

An unknown member of the Annonaceae family at Soneva Kiri resort

Annona squamosa (custard apple)

In some villas we have planted this small tree also known as **custard apple, sweetsop,** or **sugar apple** as decoration. This fruit is widely cultivated and sold in Southeast Asia, but it is actually native to South America. It is the most widely cultivated member of the Annona genus. The flesh is sweet and fragrant, and somewhat resembles custard in taste and texture, hence the name. The fruit is unique among Annona fruits in that it is segmented. The segments easily separate when ripe, thereby exposing the interior.

The well-known and very tasty custard apple

Apocynaceae (dogbane family)

This family of flowering plants includes tree, shrubs, herbs, succulents and vines. Its common name is the **dogbane family**. Most genera in this family are native to the tropics and subtropics, with some members occurring in temperate areas.

Members of this family are often characterised by having showy, radial symmetric flowers, making them popular ornamental plants. Most are highly toxic and therefore have limited economic use. One member of this family is notable because of its high concentration of ibogaine alkaloid compounds which are used as a hallucinogen in certain central African tribal ceremonies.

Plumeria spp. (frangipani)

Plumeria is commonly known as **frangipani** and is a genus of flowering shrubs and small trees native to Central and South America. It is easily recognisable by its beautiful fragrant flowers and is propagated easily from cuttings, which is exactly the reason why members of this genus are widely cultivated in other parts of the world as ornamental plants. The flowers are most fragrant at night in order to lure sphinx months to pollinate them. The flowers have no nectar, and simply mislead their pollinators with the scent. The moths inadvertently pollinate the flowers by transferring pollen from flower to flower in their fruitless search for sugar-rich nectar. Since these trees are not native to this area, the individuals found in Soneva Kiri Resort could not be identified down to species level using local identification keys.

Mangifera siamensis, the Thai mango

Araceae (arum family)

The **arum family** is a family with very characteristic flowers. The "flowers" are actually not flowers but inflorescences (flower clusters) called a "spadix", which is very often accompanied by, or sometimes partially enclosed in a "spathe". A spadix is actually a cone-shaped inflorescence, which holds many small flowers, typically with female flowers at the bottom, and male flowers at the top. A spathe is actually a specialised and highly modified bract that resembles a large petal, and accompanies the spadix to serve as an attraction to pollinators.

This family consists of 107 genera and over 3700 species, most of which occur in the Americas. Many well known indoor plants are from this family and the most impressive species, the largest inflorescence in the world, is native to Southeast Asia. The two genera from this family that were found at Soneva Kiri could at the time not be identified to species level because they were not flowering and in one case also not fruiting at the time of discovery.

A flowering Aglaonema sold for ornamental purposes.

Aglaonema spp.

Aglaonema is a genus that is native to moist tropical forests of Asia and New Guinea. Plants from this genus have been cultivated in Asia as luck-bringing ornamental plants for centuries. The plants are also popular houseplants because of their shade tolerance and attractive-looking leaves, of which a wide array of cultivars exist. Plants from this genus do not tolerate cold and may already die from temperatures below 15°C. The plants are also poisonous to ingest because of a high concentration of calcium oxalate crystals in its tissues. The examples found on Koh Kood all occur close to the sea, which shows that they have a high tolerance to salt.

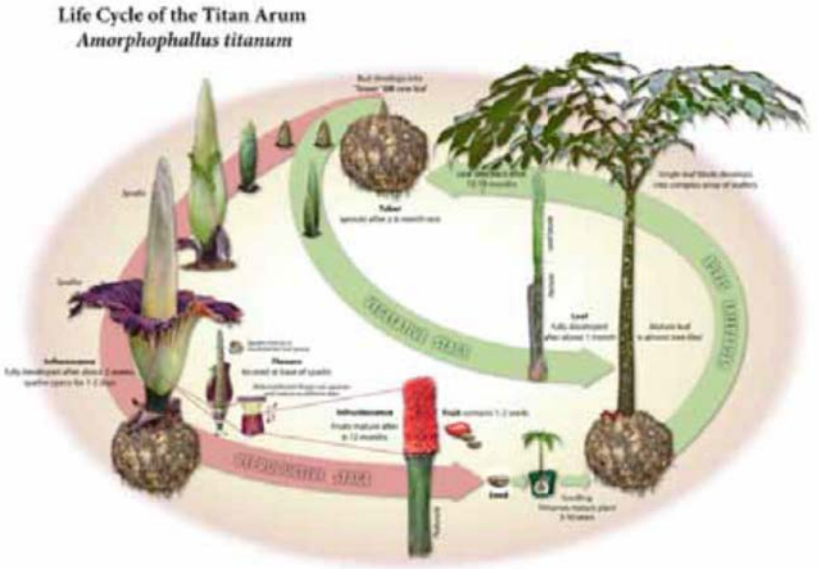
A wild example bearing fruits.

Amorphophallus spp.

The scientific name *Amorphophallus* is derived from the Ancient Greek amorphous, "without form" and phallus, "penis", referring to the shape of the prominent and often brightly coloured spadix. The genus consists of some 200 species, native to Asia, Africa, Australia, and some Pacific islands.

The species of this genus vary from small to massive, with the largest one being the largest inflorescence in the world, the titan arum *(Amorphophallus titanum)*. All species grow from an underground bulb-like structure. From the top of this bulb a single leaf, often with many leaflets, is produced that in larger species can be several metres across. Because of the size and colouring, this leaf is easily mistaken for being a tree. Once the bulb has matured, the leaf dies and is replaced by a single inflorescence.

The examples found at Soneva Kiri are a different species, but still bear some of the same typical characteristics, albeit in a different size.



The life cycle of the largest member of the genus Amorphophallus. This life cycle is typical for the entire genus.

Arecaceae (palm family)

The **palm** family is one of the best known and most cultivated plant families in the world. As palms have so many common uses they are one of the most economically important plants. Examples of uses are coconut products, oils, dates, palm syrup, nuts, rattan cane, carnauba wax, raffia, and increasingly timber, which is known for its specific colour tones and lack of growth rings. The wide variety of uses is also the reason why they have been important to humans throughout much of known history.

Palms are flowering plants with roughly 200 genera and around 2600 species described. They grow in an extremely wide variety of habitats, from tropical rainforests to deserts. Most species however are restricted to warm climates as only few tolerate (mild) frost. Most people have stereotypical view of palm trees with coconuts on a beach, which is indeed the most recognisable species. Few know that palms actually exhibit a wide range of physical characteristics and growth forms, namely shrubs, trees, and vines in many different shapes and sizes.

An image showing how rattan palms climb into the canopy

Calamus spp. (rattan palm)

Calamus is a genus among several genera better known as **rattan palms**. This genus holds an estimated 400 species, all native to tropical and subtropical Asia, Africa, and Australia. The ones found at Soneva Kiri are climbing with slender, reedy stems lined with sharp (and nasty) spines. While climbing through the trees the stems may grow to lengths of around 200 metres. In some cases the stems can become too heavy for the supporting tree to hold, causing the tree to be felled. This is a natural and essential process in tropical rainforest dynamics and succession.

A detailed picture of a rattan stem, with some nasty spines

Caryota spp. (fishtail palm)

Caryota is the genus of **fishtail palm**s, owing to their typical leaf shapes. It is one of the few palm genera with bipinnate fronds (splitting twice). There are about 13 known species, all native to (sub)tropical Asia, northern Australia, and the South Pacific. The most well-known species of this genus is *Caryota urens*, which is used to produce palm wine.

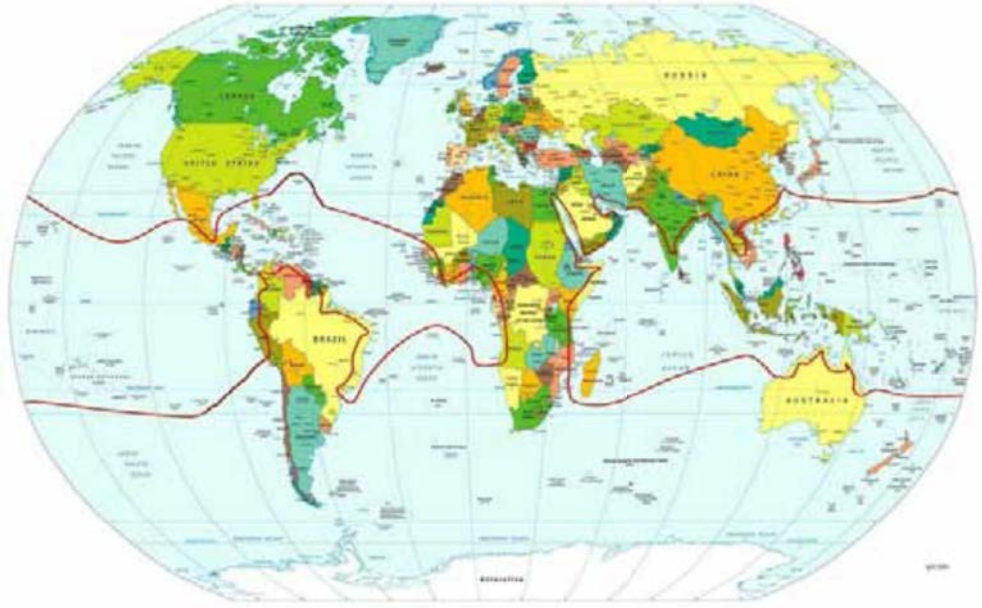
A typical fishtail palm, easily recognised by the shape of its compound fronds.

Cocos nucifera (coconut palm)

The coconut palm is easily the most well-known and recognisable palm species. It is the only accepted species of the genus *Cocos*. For most westerners, the coconut palm is mostly associated with beautiful tropical beaches in exotic holiday destinations (such as Soneva Kiri).

Across the world, the coconut is mostly known for its enormous versatility as seen in the many uses of its different parts. The coconut palm naturally occurs throughout the tropics and subtropics in coastal areas, as its fruits are naturally buoyant and disperse by floating around the oceans and germinating when washing up on a suitable shore. The domesticated variety of coconut has a thinner husk and comparatively more "meat". As the coconut can naturally only disperse through water, any trees found further inland have to be put there by humans (see picture on the next page). The domesticated variety has lost much of its buoyancy and can therefore only be dispersed by humans.

Coconuts are part of the daily diets of many people. When immature, coconuts are often harvested because they contain a large quantity of "water" and sweet, jelly-like flesh. When mature, they still contain some water, but are mostly used for their nutritious and oil-rich kernel, hard shell, and fibrous husk. Increasingly coconut wood is used as timber because it is considered a sustainable resource, has a particular texture and look, and no growth rings. The leaves are often used as decoration, building materials, or even as a part of food wrappings. Use of coconuts is so old and widespread that in many societies that use it, it has a great cultural and even religious significance.



The natural range of distribution of the coconut palm. As coconuts spread by drifting on the open ocean, their native range surrounds every tropical ocean.

Licuala spp. (fan palm)

Licuala is a genus of so called **fan palms** with about 150 recognised species. The leaves have a mostly circular (palmate, or fan-shaped) outline. It is commonly found in the tropical rainforests of southern China, Southeast Asia, New Guinea and the western Pacific Ocean islands.

A typical fan palm, of which many can be found around Koh Kood

Nypa fruticans (mangrove palm)

The **nipa palm** or **mangrove palm** is a rather unusual palm tree. It is the only palm considered adapted to the mangrove biome, and its trunk grows beneath the ground with only the leaves and flower stalk growing upwards above the surface. The leaves grow up to 9 metres in height and it produces woody, buoyant nuts that are distributed with the tides.

Nipa palms are native to the areas surrounding the Pacific and Indian Oceans. They grow in soft mud and slow-moving tidal and river waters that are rich in nutrients. In its native range, there are quite a number of economic uses for this plant.

The Nipa palm has a very high sugar-rich sap yield. This can be fermented into alcohol, which can be used for alcoholic beverages or biofuel. On some Indonesian islands the sap is used to feed pigs during the dry season. It is said that it will give a particular sweet flavour to the meat. On these islands the young leaves are used to wrap tobacco for smoking. In the Philippines and Malaysia, the flower cluster can be tapped before is blooms to yield a sweet sap that is collected to produce a local alcoholic beverage called tuba. When this is distilled it used to make arrack, a Southeast Asian type of spirit.

The leaves are often used as roof material for thatched houses or dwellings, as well as in many types of basketry and thatching. In Thailand, the immature fruits are used as a dessert ingredient, consisting of sweet, translucent, gelatinous balls. The large stems are buoyant, and therefore often used in Burma to train swimmers.

A nipa palm in its natural inundated mangrove habitat, these can be easily seen close to the Benz Restaurant

Aspleniaceae (spleenwort family)

The **spleenwort** family is a family of ferns containing two genera and an unknown (at least in excess of 700) number of species. One of the genera is being disputed as a member of this family, and is currently being genetically studied to confirm the correct classification.

The name spleenwort is derived from an old belief, based on the so called doctrine of signatures. This doctrine dates back to the time of the ancient Greeks, and states that herbs that resemble various body parts are usable for treating ailments of those body parts. This was theologically justified as that God would have wanted to show people what plants are useful for. In the case of spleenworts, this would be to treat ailments for the spleen, due to the spleen-shaped spore-clusters on the underside of the fronds. Species from this family are nowadays mostly used as ornamental plants with the bird's-nest ferns commonly being sold as house plants.

Ecologically these ferns are quite interesting. Many species are epiphytes (growing in other plants and trees) or epipetric (growing in or on rock). In general, epiphytes represent some of the largest botanical diversity in tropical rainforests, and they support an entire, unique ecosystem. Many of these ferns form cup, or nest-shaped structures holding water and fallen leaf litter in trees, thereby providing habitats for many other plant, fungal, and animal species. One remarkable fact is that this ecological role by ferns is almost only represented in African and Asian forests. In the Americas, this role is fulfilled mostly by bromelias, which through convergent evolution have similar growth forms.

Asplenium nidus (bird's-nest fern)

The **bird's-nest fern** is a common sight in the tropical rainforests of Asia. It is one of the most easily visible epiphytic ferns. It forms large simple fronds that grow 50-150 centimetres long and 10-20 centimetres broad, and visually resemble banana leaves. When the fronds die and get brown, they roll back to create a massive leaf nest in the branches and trunks of trees. This plant is very common as a houseplant, as it has a minimum temperature tolerance of 10°C and its nutrient requirements are low. In Taiwan, the sprouts of this species are being cut into small pieces, fried with garlic and chilli, and eaten as a vegetable.

When seeing this fern grow, it becomes very apparent where this species got its common name from

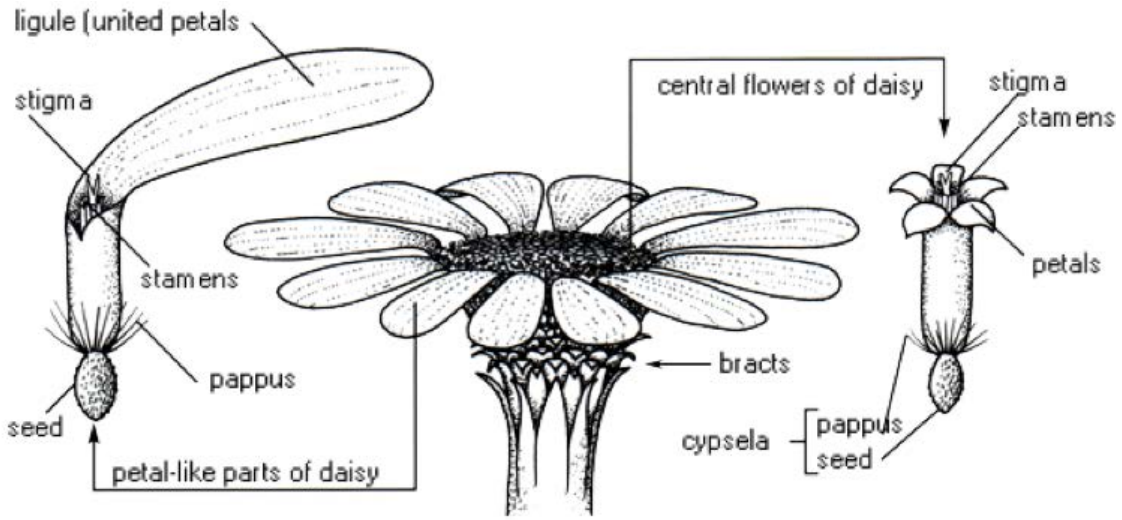
Asteraceae (daisy family)

The **composite, sunflower,** or **daisy** family is one of the largest plant families in the world. In terms of numbers of species, this family is only rivalled by the orchid family. It is unclear which family is actually larger, because it is estimated that not all species have yet been identified and accepted. Presently 1620 genera and more than 23,600 species have been scientifically accepted. Most members of the family are herbs, but a large number are also shrubs, vines or trees. Where orchids have their largest distribution in the tropics, composites are more strongly represented in temperate climates.

Well known examples of species in this family are sunflowers, daisies, dahlias, chrysanthemums, and calendula. Most members of this family are herbs, but there is also a significant number of shrubs, vines, and trees. The family has a worldwide distribution, from the tropics to the Polar Regions, colonising almost every possible habitat. Unlike the pattern observed in most plant families, most species from this family actually occur in temperate regions.

Because it is such a large family, the Asteraceae are economically very important, providing many products such as cooking oils, sunflower seeds, sweetening agents, artichokes, herbal teas, lettuce and wormwood. Many species also produce copious amounts of nectar, making them a prime source of honey.

This family is very easy to recognise by their flowers, which always occur clustered on a "head", in which many flowers compose one inflorescence, looking like a single flower. The flowers on the head are made up of ray florets or disk florets. Some flowers are only made up of either one, but many combine the two. Typically the disc florets make up the centre fertile part of the cluster, and the ray florets form the sterile rim around the centre, functioning as an attraction to pollinators. Every fertile flower produces a single seed and a so called pappus, a plume that allows for wind dispersal.



A daisy is a great example of the "composite head" arrangement of flowers that is so typical for this family

Sphagneticola trilobata (trailing daisy)

This herb is commonly known as the **Singapore daisy**, **trailing daisy**, **creeping-oxeye**, and **wedelia**. The plant is native to Mexico, Central America, and the Caribbean, but it now grows throughout the tropics. The plant has a very wide ecological tolerance range and quickly forms mats up to 30 cm in height. This a main reason why it is widely cultivated as an ornamental groundcover.

The fact that it tolerates so many different environments, and grows so quickly, has lead to the species being listed as one of IUCN's (International Union for Conservation of Nature) "100 worst invasive species". The plant mostly spreads vegetatively, not by seeds, meaning that every living part of the plant can generate a completely new plant. This allows it to quickly form a dense ground cover, crowding away and preventing other plant species from regenerating.

This herb can be spotted all over the resort, as it grows and spreads very quickly, and flowers year-round.

Vernonia cinerea (ironweed)

Vernonia, or **ironweed** is a genus containing about 1000 species of herbs, all bearing intense purple flowers. *Vernonia cinerea*, or **little ironweed** is a very common perennial herb that flowers year-round. It is native to tropical Africa and Asia, but has spread throughout the tropics. While some species of this genus have some economic uses, little ironweed does not.

Although the small flowers have an apparent typical shape, the species of this genus are well-known for hybridizing in areas where different species' ranges overlap. This makes classification and identification rather difficult as it leads to confusion about morphological characteristics.

Begoniaceae (begonia family)

The **begonia** family of flowering plants comprises about 1400 species occurring throughout the (sub) tropics. All but a single species are of the genus *Begonia*. The only other genus in the family only occurs on the Hawaiian Islands and has only a single species. Begonias often have bright and colourful flowers, and are therefore well-known and widely cultivated as houseplants. The begonias found at Soneva Kiri are quite inconspicuous, epipetric (growing on rock) plants with small white flowers. They can be most easily spotted growing on rocks close to the treepod. Although the family is easy to recognise due to its characteristic flowers, it requires very specific expertise to identify it to species level.

Begonias have a very recognisable flower shape. Colouration and size are highly variable, as well as its habitats and overall growth forms. The members from the genus most often encountered on Koh Kood are lithophytes, growing in the lower, shady and humid parts of the forest. It can also often be found on rocks near waterfalls.

Blechnaceae

Blechnaceae is a family of ferns containing two to nine genera and some 240-260 species with a worldwide distribution. Most are ground dwelling, but some, like the one found here at Soneva Kiri, are climbers. Many species of this family are characterised by their young opening fronds being red-coloured.

Stenochlaena palustris

This is an edible medicinal fern species. Some chemicals isolated from this fern called “acylated flavonol glycosides” are found to have antibacterial properties. Extracts prepared from the fern have been shown to exhibit antifungal and antioxidant properties. Therefore in the folk medicines of India, Malaysia and the Philippines, leaves from this fern are used as remedies for fever, skin diseases, ulcers, and stomach-ache. The educational district of Diliman (Tagalog name for this fern) in Quezon City is named after this fern.

The example most easily spotted at Soneva Kiri resort grows close to the entrance of the spa, where it climbs into a cocos palm.

Casuarinaceae (ironwood family)

She-oaks, cassowary, or ironwood trees are a small family of shrubs and trees consisting of 4 genera and about 70 species and are native to the (sub) tropical regions surrounding the Indian Ocean and Western tropical Pacific. *Casuarina spp.* trees are a common sight on the beaches of Southeast Asia, where they are often seen growing close to coconut palms. These trees superficially resemble pine trees with their thin, needle-like leaves and fruits that somewhat resemble pine cones. The trees are actually flowering plants and are characterized by so called "drooping equisetoid (meaning "looking like horsetail") twigs", evergreen foliage, and cone-like fruiting bodies. Members of this family harbour a symbiosis with a nitrogen fixing bacterium genus called *Frankia*. The ability to fix nitrogen from the air is a specific adaptation to nutrient-poor conditions and is shared with the pea/bean family, but the nitrogen-fixing bacteria in *Casuarina* are from a different origin.

Casuarina equisetifolia

Casuarina equisetifolia is the only species of this family that can be spotted on Koh Kood. It is an evergreen tree growing to 6-35 m tall. The tree species is highly valued as firewood, sometimes called "the best firewood in the world", because it burns well even when freshly cut, and releases a lot of heat for a relatively long period of time. This is the main reason why it is often harvested in its native range. However because of its sturdiness, dense and deep rooting growth, ability to tolerate salt and grow in loose sand, it is a very useful tree in the prevention of coastal erosion. Therefore in Indonesia the tree is increasingly and successfully planted on eroding beaches for this purpose.

Causarinas can grow quite large. These trees are very common on the beaches of Southeast Asia, including on South Beach at Soneva Kiri Resort.

Clusiaceae (mangosteen family)

The Clusiaceae, or **mangosteen** family is primarily tropical family of plants including about 14 genera and 595 species of trees and shrubs. This family has a comparatively large variation in morphology, making species belonging to it difficult to classify. A particular feature sometimes found is this family, and very rarely in others, is the fact that it sometimes rewards its pollinators not with pollen or nectar, but rather with resin. This resin is used by some bee species in nest construction. However as the large morphological diversity suggests, also pollen and nectar are common in different species of this family.

Some well-known and economically relevant species of this family are the South American mammee apple, and more famously the purple mangosteen. The purple mangosteen is a very popular fruit because of its mild but sweet flavour which is liked by many.

Calophyllum inophyllum

Calophyllum inophyllum is a slow-growing, low-branching tree with an irregular crown. It is native to Southeast Asia, and east Africa. The tree tolerates various types of soil, among which coastal sand, clay and even degraded soil. It is often found in coastal regions and nearby lowland forests. The tree is widely cultivated as an ornamental plant in all tropical regions because of its decorative leaves, fragrant flowers and spreading crown.

The tree has quite a few other uses as its wood is hard and strong, making it suitable for construction and boatbuilding. Its seeds are rich in a thick, green, inedible medicinal oil. This so called tamanu oil is used in skin care, but can also be used as motor oil, and for the production of biodiesel. Because the tree grows well in many soil types and has many uses, on some pacific islands it is considered sacred.

This tree is planted around guest areas for it beautiful and fragrant flowers

Combretaceae (leadwood family)

The **leadwood** family of flowering plants includes about 600 species of trees, shrubs, and lianas in 18 genera which are widespread in the subtropics and tropics. The family includes three genera of mangrove trees, and the African leadwood tree, which is valued for its hard timber. Trees of this family are often rich in chemicals that can have a number of medicinal uses.

Lumnitzera racemosa (Tonga mangrove)

The common name for this tree is the **black mangrove**, or **Tonga mangrove.** It is native to the tropical coastal areas surrounding the Indo-West Pacific region. Just as other mangrove trees, this species is very important for coastal protection, and prevention of erosion, thereby providing an important ecosystem service.

A special adaptation of this species is its pneumatophores, or aerating roots. As trees also need to breathe air, the pneumatophores are a specialized trait of many mangrove trees which allow the trees to grow in waterlogged soil. Contrary to the aerating roots from the Rhizophoraceae family of mangroves, which grow from the stem and branches curving downward, the pneumatophores of this species grow upwards out of the soil surrounding the tree. These roots somewhat resemble hundreds of needle like structures sticking out of the soil during low tide. Contrary to what the common name suggests, this tree is not related to the "mangrove family". Its adaptation for being able to thrive in a mangrove environment has evolved separately.

To the left and example where the roots are inundated, to the right an example at low tide. The one on the right can be seen next to the arrival jetty.

Terminalia catappa (beach almond)

Terminalia is a genus comprising around 100 species of large trees distributed across the tropics. The genus derives its name from the Latin terminus, referring to the fact that the leaves always appear at the very tips of the shoots. The species found here at Soneva Kiri is very salt tolerant and mainly found close to the coast. Its common names therefore include **beach almond** and **sea almond**. It has many other names in the wide range in which it naturally occurs. This range encompasses the tropical regions of Africa, Asia and Australia.

The tree grows up to 35 metres tall and is widely cultivated in tropical regions as an ornamental tree, mostly for the deep shade its large leaves provide. The fruits are edible and taste slightly acidic. The leaves and bark are very rich in chemicals, causing it to be used in different herbal medicines. Uses include the treatment of liver ailments, dysentery and diarrhoea. The leaves are also found to contain antioxidants and chemicals that show activity against choroquine-resistant malaria parasites.

This tree is common on the beaches and provides some welcome shade

Convolvulaceae (morning glory family)

This is a well known family in Thailand, the **morning glory** family. The family contains some 60 genera and more than 1650 species. Most species in this family are herbaceous vines, but some are trees shrubs and herbs. Very often the stems of these plants are winding, hence their name which is derived from the Latin *convolvere*, "to wind". Members of this family can be recognised by their funnel-shaped, radially symmetrical flower consisting of five fused petals.

Morning glory itself is actually the common name for over a 1000 species belonging to many genera, and most easily recognised by their showy flowers. The type of morning glory widely used in Thai cuisine can often be observed floating in large mats on the large rivers in Thailand and is also called water spinach (latin name *Ipomoea aquatica*). Another member of this family that is widely used as foodstuff is the sweet potato due to its starchy tuberous roots.

One climbing/winding member of this family found in the resort could not be identified to genus or species level because it was not flowering. The other was fortunately easy.

Ipomoea pes-caprae (beach morning glory)

Beach morning glory is a creeping vine that occurs on the upper parts of tropical beaches worldwide. It is one of the most common and most widely distributed salt tolerant plants that also provides a prime example of oceanic dispersal by floating seeds that resist salt water. It is also one of the first plants to colonise newly formed sand dunes, and is most often found on the seaward side of slopes, sending long runners down towards the lower part of the dune. This makes it a primary sand stabiliser that contributes to reducing beach erosion.

These flowers can be seen at every beach on Koh Kood, as well as on many other tropical beaches

Dilleniaceae

This family consists of about a dozen genera, and a few hundred species, found in the tropics and sub-tropics and entire Australia. Most of the members are woody plants like lianas or trees. There are also some herbaceous species in the family. Leaves of the family are generally wide and well-developed; however in some species they are heavily modified.

The family is known for its large morphological diversity. Also its position in taxonomic classification is uncertain. Geneticists do not yet fully agree on how to classify this family, and whether it should actually have to be divided among a number of other evolutionary groups.

Economic uses for this family are limited. Most members have showy and colourful fruits, and the fruits of some species, like the one found at Soneva Kiri, are edible.

Dillenia indica (elephant apple)

This member of the family is native to tropical south-eastern Asia, where it is also called elephant apple, due to the fact that elephants are particularly fond of them, and one of the few animal species that can actually reach and eat the fruits. The fruits are also edible to humans, but not very popular due to its bitter-sour taste and fibrous texture. In India they are used in some curries, jams, jellies, and often mixed with coconut and spices in certain chutneys.

These trees bear many edible fruits. When fruiting one can easily see there are many of these trees around the resort

Ebenaceae (ebony family)

The **ebony** family contains a disputed number of four to seven genera and about 768 species. The family occurs throughout the warmer areas of the world, but its largest diversity is found in the tropical rainforests. The family is most well-known for the species that provide the highly prized ebony timber. This heavy, hard, very finely grained, dark wood was once widely used for different ornamental purposes as it is easily machined, and takes a very nice smooth finish. Nowadays many of the timber providing species have become threatened or endangered due to overharvesting, leading to strict international restrictions being imposed on its trade. Some species in the family, such as the persimmon or kaki, are cultivated for their fruit. Fruits from this family are often very rich in tannins, and therefore need to be absolutely ripe before being suitable for consumption.

Diospyros spp.

Diospyros is by far the largest genus of the family, containing over 700 species of trees, shrubs and small bushes. The majority are native to the tropics, with only very few species inhabiting temperate regions. Depending on their main use, the individual species are commonly known as persimmon or ebony trees. Many species are conspicuous trees and of high local ecological importance in their native ecosystems. A large amount of butterfly species rely on the foliage of these trees as food for their caterpillars. Trees from this genus are highly valued for their timber. One other well-known member is the tree that bears kaki fruits. The large diversity of this genus in Southeast Asia made it too difficult to identify the individual found in Soneva Kiri to species level.

These trees bear berries which typical shape and arrangement makes them easily recognisable as a family to botanists

Elaeocarpaceae

This is a comparatively small family of flowering plants with approximately 605 species of trees and shrubs in 12 genera. The species of this family occur across the tropics and subtropics, with a few temperate-zone species. *Elaeocarpus* is by far the biggest genus within the family with a total of some 350 species.

Elaeocarpus spp.

Trees from this genus are easily recognised by the old leaves that turn bright red before being shedded. Also they bear attractive pearl-like fruits which are often colourful. Another notable feature of this genus is the drooping, often frilly, small clusters of flowers. In some areas in Asia the fruits of these trees are used for making pickles and chutney. The trees in Soneva Kiri were neither flowering nor fruiting during the field survey, so they could not be identified to species level.

The leaves of these trees colour bright red before falling off. This makes the trees relatively easily recognisable.

Euphorbiaceae (spurge family)

This plant family is commonly known as the **spurge** family. It occurs in tropical, subtropical and temperate climates. Among botanists it is known for its wide variety in growth forms, ranging from small herbs, to vines, to big trees, to cactus-like succulents. In fact they are so morphologically variable that botanists often joke "if you can't seem to identify a plant, it's most likely a euphorbia". This makes it difficult to classify this family purely on morphological characteristics. Since the last decade taxonomy based on genetics has gained a strong foothold, making identification and classification of this family more accurate.

The family is quite large, with about 300 accepted genera and some 7500 species, with most members occurring in the tropics and the majority of species being found in Tropical Asia. Most members of this family are herbs, but some, especially in tropical regions, are shrubs or trees. Some are succulent and resemble cactus species, a prime example of convergent evolution, where similar environmental circumstances lead to similar growth forms. These cactus-like euphorbias are often mistaken by laypersons for cacti.

The family contains a large variety of toxic substances, which are not only dangerous, but often also have medicinal properties. Some subfamilies are characterised by leaching a milky, sometimes poisonous, white latex. This is the primary source of natural rubber in the world. Other plants from this family with economic uses include cassava, castor oil plant, Barbados nut, and some medicinal species.

Many likely members of this family were found in the resort. But due to the large morphological variability in this family, only a few could be identified with certainty to genus level, and only one to species level.

Croton spp.

Croton is a genus containing a very large number of species, occurring throughout the tropics. The exact number of species is unknown but suspected to be ranking in the thousands. The genus is also very morphologically diverse. Genetic studies are presently being conducted to get a better overview of the number of species included in the genus, and which should be categorised as different. Plants from this genus are often used as ornamental plants, but some are also renowned for their medicinal properties.

One well-known member of this genus is *Croton tiglium*, commonly called croton. It is a tree or shrub native to Southeast Asia that is used for producing croton oil. This oil extracted from the seeds is used as a purgative. However nowadays, at least in western countries, the oil is no longer allowed to be sold for this purpose as the effects are too violent and considered dangerous to health.

At Soneva Kiri we have multiple members of this genus, among which likely also *Croton tiglium*. Unfortunately the members of the genus in the resort could not be identified to species level with absolute certainty.

The tree on the left and the bush on the right are very good examples of the great morphological diversity within the family of Euphorbiaceae. These examples both belong to the genus Croton, and yet look very different.

Hevea brasiliensis (rubber tree)

The **Pará rubber tree** or more commonly, r**ubber tree,** is a very economically important member of the Euphorbiaceae family and Hevea genus, native to South America. The main reason for its economic importance it its milky latex exudates which is periodically extracted from the tree for the production of natural rubber. Because of the economic importance of this tree it been extensively propagated across the tropics. As the climate and soil on Koh Kood are ideal for growth of these trees, before the increase in tourism, rubber plantations have along with fishery long been one of the primary sources of income for the local population. Today, Thailand is still the world's largest producer of natural rubber.

In the wild, the tree can reach a height of up to 30 metres, but in plantations it is usually cut down before it reaches that age. The latex occurs in latex vessels in the grey-whitish bark. These vessels spiral up the tree in a right-handed helix. The latex acts as a protection from parasites, and for quick healing of inflicted wounds. In well maintained plantations, the trees are generally not very large because they grow more slowly when being tapped for latex, and because production decreases in old trees. In and around Soneva Kiri a number of large, old trees can be found. These are most likely remnants of abandoned plantations. In ageing plantations, the trees are often cut for use as timber or firewood.

Rubber plantations can be widely spotted around Koh Kood. Before the growth of the tourism industry, these plantations provided the main source of income for local people, along with fishery.

Fabaceae (pea family)

The **legume, pea**, or **bean family** is the third largest plant family in the world after the composites and orchids, with 630 genera and over 18,860 species. The family includes trees, shrubs, herbs, and vines, which are usually easily recognised by their fruits (commonly known as pods, or more correctly, legumes), compound leaves, and often (but not always) characteristic flower shape. It has a worldwide distribution with many members of this family having the ability to fix nitrogen from the air and turn it into the essential plant nutrient nitrate. This gives them the ability to grow in many areas that would be too infertile for other plants.

Because the family has so many species, growth forms, and such a wide distribution, it contains many economically important species. Plants from this family have provided staple human foods for millennia. Therefore they have, along with cereals, some fruits and tropical roots, been closely related to human evolution.

A relatively large number of species are important agricultural and food plants, including peanuts, peas, beans, liquorice, carob, alfalfa, tamarind and soybean. The ability to fix nitrogen is also widely recognised by farmers, who until the advent of artificial fertilisers often used plants from this family to increase the soil quality of their lands. This characteristic also makes them a key element of stability for many of the ecosystems in which they occur.

Albizia spp. (silk tree)

Albizia is a genus containing about 150 species of mostly fast-growing, short-lived, subtropical and tropical trees and shrubs. Members of this genus naturally occur throughout the tropics and are commonly named **silk plants, silk trees, sirises,** or in the case of Southeast Asian timber species, **East Indian walnut.** The small flowers are quite easily recognised by occurring in small clusters and a large number of long, showy stamens.

Albizias are important sources of timber, forage, and medicine. Some are also popular ornamental plants for their attractive flowers.

The flowers, pods and compound leaves make this tree attractive to look at and also easily recognisable as a genus

Bauhinia spp. (mountain ebony)

This genus contains more than 500 species across the tropics and some of them are commonly known as **orchid tree** (although they are not related to orchids), **mountain ebony**, or in India and Pakistan as **kachnar.** The example found in Soneva Kiri is actually not a tree, but a small shrub. At the time it was found it was not flowering, but the genus could still be easily recognised by its distinctive leaf shape.

Bauhinia saccocalyx, a species very common in Thailand

Butea monosperma (flame-of-the-forest)

This medium-sized dry season-deciduous tree grows up to about 15 metres tall and is more commonly known as the flame-of-the-forest, bastard teak, or parrot tree. The tree is native to South Asia, grows relatively slowly, and during the dry season, when its leaves are shed, it flowers abundantly. In some areas in India it makes up a large percentage of forest trees. So when the forest leaves are shed in the dry season and the trees of this species flower, it is like the forest is on fire. Its pronounced appearance, mainly in Indian forests, has caused the tree to appear quite often in folk traditional and religious literature.

Economic uses for the tree include timber, resin, fodder, medicine, and dye. The dye derived from this tree is often used as a colour in the Holi festival.

The flowers of this tree are very conspicuous. At Soneva Kiri it can be seen flowering on the beachfront close to the View Restaurant during the dry season.

Dendrolobium spp.

Dendrolobium is a relatively small genus of 18 accepted species of shrubs, and some 8 species that still require scientific classification. Most species have very similar looking small white flowers and small slightly curved seed pods. All are found in the tropical regions surrounding the Indian Ocean. This makes it difficult to distinguish between species as identification comes down to the smallest details. The roots of some species are used as a medicine to strengthen bones and increase muscle growth.

This small tree can be seen right next to the arrival jetty.

Mimosa pudica (shy plant)

This Latin *pudica* means "shy, bashful or shrinking", which is exactly what this plant is well known for. Common names include the **shy plant**, **sleepy plant**, **humble plant**, **sensitive plant**, and **touch-me-not**. It is a creeping herb that is often cultivated for the fact that it has a defensive adaptation which causes its compound leaves to fold inward and droop when disturbed, re-opening a few minutes later. The plant is native to Central and South America, but it has by now spread as a weed across the tropics.

The plants grow up to a length of about 1.5 metres and have a prickly stem. The flowers are pale pink to purple, with the showy bits actually being made up of the many stamens. Aside from the plant being well known for its movement, it is presently also being studied for its chemical constituents. The main chemical is the toxic alkaloid mimosine. This chemical is found to have potential positive effects on the control of a widespread tropical parasitic roundworm disease, and it seems to inhibit the toxicity of the venom of the monocled cobra.

The shy plant in its full flowering glory

Pithecellobium dulce (monkeypod)

This is a species of tree growing up to about 10 to 15 metres. The tree is native to the Pacific Coast of tropical Central and South America, but has been widely introduced in other tropical parts of the world. In Hawaii it is regarded as an invasive species. Because of its wide distribution, the tree now has many common names, depending on where it grows. The English common name is **monkeypod**. It has a spiny trunk and greenish-white, fragrant flowers, of which the stamens make up the showy parts. The flowers produce a thick pink pod that opens when ripe, exposing an edible sweet pulp. The tree is very drought resistant and therefore widely planted as a street tree.

The plant also has medicinal properties, which have been widely used in traditional medicine of the indigenous people of the Americas. The pulp and bark help to reduce tissue swelling and stop bleeding, causing it to be used against gum ailments, toothache and haemorrhages. The bark extract also has uses against diarrhoea and tuberculosis. Leaf extract is used to treat gall ailments and to prevent miscarriage. And the seeds being ground and then used to clean ulcers.

The edible pulp surrounding the seeds is clearly visible when the fruit is ripe. A large example of this tree grows next to the entrance of the host restaurant

Pterocarpus spp. (padauk)

This genus contains 35 species of trees, occurring throughout the tropics. Common names include **padauk, mukwa**, and **narra.** The scientific name is derived from Ancient Greek and means “wing fruit”, referring to the peculiar shape of the seed pods in this genus.

The genus is highly valued for its timber. Padauk wood is very tough, stable in use, termite and decay resistant, and has a reddish colour which is sought after for decorative purposes. Often padauk is sold as rosewood, but true rosewood has a finer texture. The chemicals that make the trees of this genus so resistant to termites and decay can also be extracted to be used as herbal medicines for treatment against skin parasites and fungal infections.

The unusual seed pods that give this tree its scientific name are very conspicuous

Senna alata (candle bush)

The candle bush is a shrub native to Mexico, but is now being widely cultivated in other tropical regions for its ornamental flowers. In Southeast Asia it is being considered and invasive species. The shrub grows up to 3 to 4 metres tall and has large 50 to 80 cm long compound leaves that fold inwards during the night. The inflorescence resembles a yellow candle, hence the common name. The fruit is a relatively large pod, growing up to 25 cm long.

Aside from being used as an ornamental plant, the species also has important medicinal properties. The leaves contain chemicals that provide effective treatment against fungal and ringworm infections. The plant is also known to have laxative effects when ingested.

The typical candle-shaped inflorescences that give the plant its common name

Goodeniaceae

This family of flowering plants contains 12 genera and about 404 species. Most species are found in Australia, except for *Scaevola*, which occurs throughout the tropics. Most species in this family are well-adapted to water stress, meaning that they are often found in (semi-)dry or saline conditions, as salt also causes water stress for plants. Most species in this family are herbs with spiral leaves and symmetrical flowers.

Scaevola taccada (beach cabbage)

This common beach shrub is also known as **beach cabbage, sea lettuce, magoo** (Maldivian language), and many other names in its native range of the tropical Indo-Pacific. It is quite a large bush that can reach up to 4 metres in height. It typically grows on sandy or pebbly soils very close to the sea, such as on beaches, where it is exposed to the salt spray. Leaves are crowded at the stem tips and slightly succulent, with a fleshy-looking yellowish green colour. Both fruits and flowers are white, and the shrub flowers year round. The flowers have a fan-like shape, which gives them the name **fanflower**, or **half-flower.** The fruits float in seawater and are dispersed by the ocean currents.

The plant highly salt-tolerant and is easily propagated from cuttings. Often, when an area has been disturbed, this plant is one of the first species to re-colonise the area. This combination of traits causes it to be regularly planted for landscaping purposes, for the prevention of coastal erosion, and for protection of other cultivated plants from the salt spray.

Parts of the plant are used in Asian and Polynesian traditional medicine. Suggested properties of the plant include that of an antidiabetic, antipyretic, anti-inflammatory, anticoagulant, and skeletal muscle relaxant, supposedly without any adverse side effects.

These bushes are a common sight on many tropical beaches.

Irvingiaceae

This is a very small family of only 3 genera and 20 species. It is named after the Scottish Royal Navy surgeon and avid plant collector Dr Edward George Irving (1816-1855). The family was previously included in the mango and cashew family, as their fruits are edible and resemble small mangoes. Genetic research has shown that this is a separate family.

Irvingia malayana (wild almond)

This large tree is also known as **wild almond** and can grow up to 50 metres tall, with a diameter of up to 50 centimetres. Due to their shape, its yellow fruits somewhat resemble small mangos. The tree is native to Southeast Asian lowland rainforests. In Thailand its wood is often used in construction and charcoal production. Its seeds are relatively large and are often being roasted and eaten as food.

The individual found at Soneva Kiri grows right in front of The View restaurant

Lamiaceae (mint family)

The **mint** or **deadnettle** family is a large family of flowering plants containing about 236 genera and 6900 to 7200 species with a cosmopolitan distribution. The original family name was Labiatae, derived from the easily recognisable flowers which are bilaterally symmetrical and have a clearly distinguishable upper and lower "lip" (labia in Latin). Leaves always appear oppositely, with each pair at right angles to the previous one, or whorled. Stems are often square in cross section, but this also occurs in other plant families.

Many plants in this family are aromatic and therefore it includes many culinary herbs. Examples are basil, mint, rosemary, sage, thyme, oregano, lavender, marjoram, and savory. Most species are herbs, but some are shrubs or trees, with teak being a well-known example of this. Many members of this family are known for being very easy to propagate from cuttings.

Many members of the Verbenaceae family have been reclassified as Lamiaceae after genetic analysis.

Vitex acuminata (black plum)

The genus *Vitex* has about 250 species which are commonly known as **chastetrees**. *Vitex acuminata* is also known as the black plum and is native to Southeast Asia and Northern Australia. Vitex is one of the genera that were transferred from the Verbenaceae family to Lamiaceae as a result of genetic studies.

The small flowers of this species are quite beautiful when viewed very closely

Lecythidaceae (Brazil nut family)

The **Brazil nut** family contains about 20 genera and some 250-300 species of woody plants. The family has by far the largest representation of species in tropical South America, where it of enormous ecological importance. Species of this family are in many areas dominant among canopy forming trees and also serve many traditional human uses in their native range.

Barringtonia spp.

Barringtonia is one of the few genera from this family that is not native to South America. Instead they naturally grow in the tropical areas surrounding the Indian Ocean. The genus contains some 65 species of trees and shrubs, most of which only naturally occur on Borneo. Some of the trees belonging to this genus are known as **freshwater mangrove** or **Indian oak**. A number of species in this family are known to have antibiotic, antifungal, and pain-killing properties, causing parts of the plants to be widely used in traditional medicine in their native ranges.

Members from this genus are easily recognisable by their large leaves, crowded at the tips of branches. They are quite abundantly present at Koh Kood, but at the time of discovery the individuals were neither flowering nor fruiting so identification to species level was not possible.

Barringtonia can be easily spotted around the resort. This is a somewhat larger example close to the eco sala.

Lygodiaceae (climbing fern family)

Lygodium spp.

Lygodium is the only genus of the family Lygodiaceae, or **climbing ferns.** The genus contains 40 species of which most are native throughout the tropics, and a few species occurring in temperate regions. Some *Lygodium* species are now becoming very problematic invasive species in some areas where they have been introduced outside of their native range.

Some species of Lygodium are used in folk medicine to treat skin ailments, swelling, and dyssentry. The examples found in the resort are likely among these species.

The spore clusters of this climbing fern are positioned at the leaf margins. This makes this fern genus easy to recognise.

Lythraceae (loosestrife family)

The **loosestrife** family of flowering plants contains 31 genera and 620 species, most of which are herbs, and only few are shrubs and trees. The family has a worldwide distribution, but most members are found in the tropics. Well-known members of this family include henna and pomegranate.

Lagerstroemia spp. (crape myrtle)

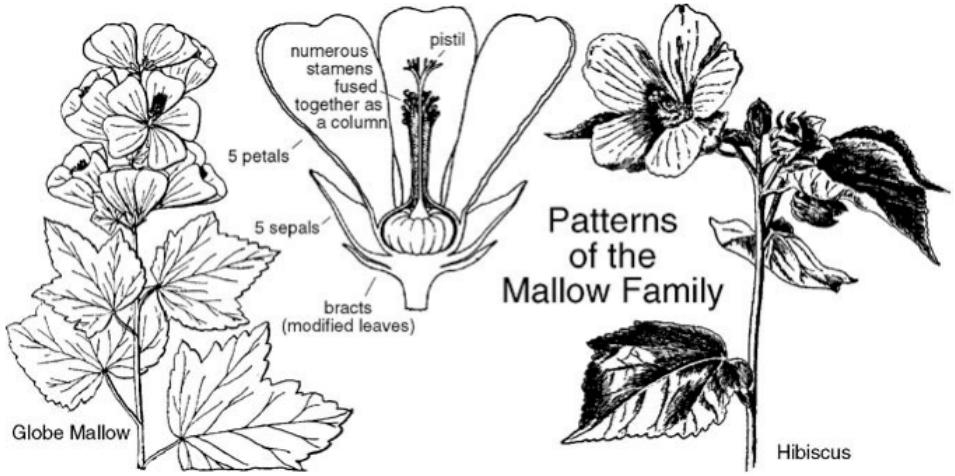
At Soneva Kiri we have at least two species belonging to this genus which is more commonly known as **crape myrtle** or **crepe myrtle**. The genus contains 56 species which are all native to tropical Asia, Northern Australia, and parts of Oceania. All species are woody, but their size can widely vary, from less than 50 cm tall, to up to 30 metres tall. Most species are cultivated for their colourful and long-lasting flowers, which in Thailand occur during the rainy season.

On Koh Kood trees from this genus are abundant. This causes parts of the forest canopy to colour purple during several weeks of the rainy season. This colourful blossom is also why members from this genus are widely cultivated as ornamental trees. When the tree is not flowering it can still be fairly easily recognised by its flaky gray-brownish bark that is shedded year round.

On the left side a purple coloured forest canopy at the east coast of Koh Kood during the early rainy season, when many of these trees are flowering. On the right a single inflorescence clearly showing the individual purple coloured flowers.

Malvaceae (mallow family)

The **hibiscus** or **mallow family** is a large and very easily recognisable by the shape of its flowers. The family is estimated to contain 243 genera and more than 4200 species. Well-known members of the family include durian, kola nut, cotton, cacao, okra and baobab. The flowers of many species are typical in that it often has five large and colourful petals. The stamens are five to numerous and often form a long tube around the stigma. The flowers are therefore often used in art and as decoration, often being associated with tropical islands and exotic tribes. Of course many variations exist to this most stereotypical flower shape.



A schematic showing the details of the easily recognisable flowers from the mallow family. Especially flowers from the genus Hibiscus are very characteristic.

Hibiscus tilliaceus (beach hibiscus)

With 300 species Hibiscus is the largest genus in this family. The **sea** or **beach hibiscus** is probably the easiest to spot around the resort as it is very common in coastal areas surrounding the tropical Indo-Pacific. It has also been naturalised in coastal areas in the tropical Atlantic and Caribbean. The trees can reach a height of 4-10 metres and flower year-round. Upon opening, the flowers are bright yellow with a dark red centre. Over the course of the day, the flower colour gradually changes to orange, and finally red, before falling off the tree.

The tree is used in a variety of applications, such as boat or raft construction, firewood, furniture, and wood-carvings. The tough and fibrous bark can be made into rope and used for sealing cracks in boats. The bark and roots are sometimes boiled to produce a cooling tea and to reduce fevers. The young shoots are in some regions eaten as vegetables

A beach hibiscus in the morning. These are very common around Koh Kood and in fact in many coastal areas in the tropics

Microcos tomentosa (shiral)

The **shiral** is a flowering shrub or small tree that is native to Southeast Asia and China. The plant is used as a source of fibre, wood, traditional medicine and edible fruits.

In traditional Chinese medicine the plant is believed to have positive effects on the digestive system. It is also used against other ailments such as colds, hepatitis, heat stroke, and diarrhoea. However during clinical trials none of these alleged effects have been proven. Therefore any results from using this plant might be attributable to the placebo effect.

The easiest way of recognising this common tree is by the irregularly shaped leaf tips.

Sterculia lanceolata (tropical chestnut)

This tree is native to Southeast Asia, grows up to about 14 metres tall, and has very characteristic fruits. The fruits consist of five dehiscent capsules that turn into a yellow-red colour while ripening. When ripe the fruits split open on the underside and reveal a number of black seeds. The bark fiber is sometimes used to make bags and paper.

The example of Sterculia lanceolata growing at Soneva Kiri can be found right next to the parking lot besides the arrival jetty.

Melastomataceae

This is a relatively large family of flowering plants containing some 200 genera and over 4500 species. Most are perennial herbs, shrubs, or small trees. Many members of this family are easily recognised by their distinctive leaf venation. Often the leaves have three or more parallel longitudinal veins with the secondary veins in between in a sort of "ladder" arrangement. Another major distinctive feature which the Latin name is derived from is that the stomata (breathing holes) on the underside of the leaf appear black when observed through a magnifying glass.

Melastoma spp.

Melastoma is a genus with about 50 species distributed around Southeast Asia, India and Australia. Currently the genus is undergoing a taxonomic revision based on genetics. These plants are widely planted for their ornamental value because they bear bright purple flowers.

The leaf venation of this genus is very typical. In some species the secondary veins in between the main parallel veins give the surface a "ladder-like" appearance

Memecylon caeruleum (blue strawberry tree)

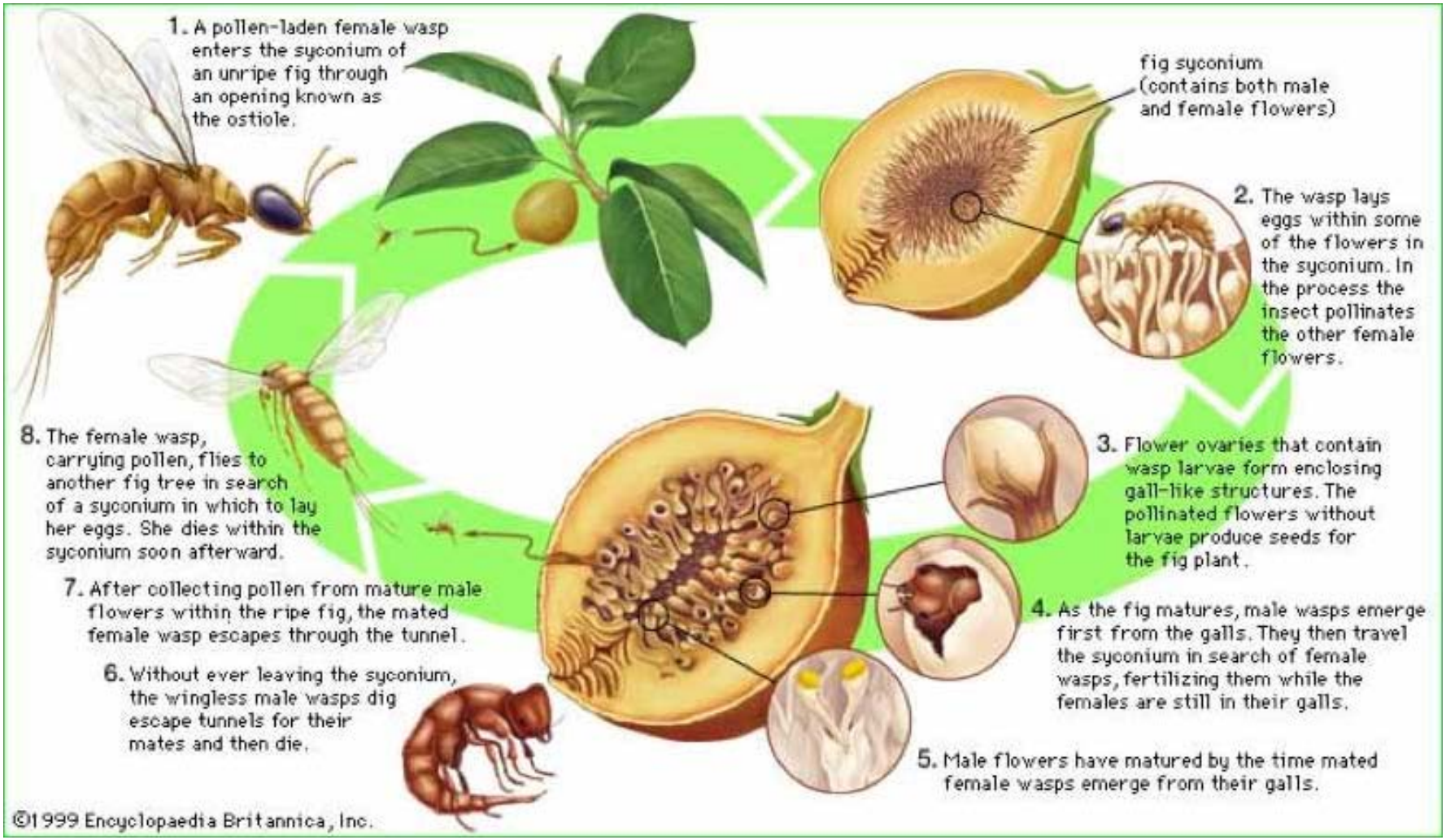
The genus *Memecylon* has only recently been added to the Melastomataceae family. Before it used to be classified as its own family, but recent genetic analysis has shown it should be reclassified. Memecylon caeruleum is also called the **blue strawberry tree**, because its flowers somewhat resemble the shape of strawberries. It is a small tree with leathery leaves and a very typical flower shape. The tree grows best in the understory of tropical rainforest and has no known uses.

The shape of the blue flowers somewhat resembles strawberries, hence the common name

Moraceae (fig family)

The **fig** or **mulberry** family is a family of flowering trees, shrubs and lianas containing some 40 genera and over 1000 species. The family is widespread across the subtropics and tropics. Well known examples are (strangler) figs, banyan trees, breadfruit, jackfruit and mulberry. Almost all members of this family have a milky white sap and contain inconspicuous compound flowers. Figs are very easy to recognise by their very typical “fruits”, which are actually “encapsulated” flower and fruit clusters. At Soneva Kiri several jackfruit and mulberry trees have been planted. The family is also widely represented by wild members.

While the family is easily recognisable, tropical figs can be notoriously difficult to identify to species, or even genus level. The reason for this is that the inflorescences and fruiting bodies by which many plant species are identified are often very similar-looking on the outside and even inside. Some are even so similar-looking that to be identified, they require strong magnifying optics, while even in some cases this will not work. Luckily many fig species are highly pollinator specific, meaning they are only pollinated by a single type of insect (fig wasp). Therefore some of these plants can be most easily distinguished by observing and identifying their pollinator insect, an often very tiny fig wasp. For most wild trees and lianas of this family found at Soneva Kiri field identification proved to be too difficult.



Many people do not know figs are actually clusters of tiny flowers and fruits. Many figs have a specialised life cycle, which is the result of a highly specific mutualistic interaction with its pollinator.

Artocarpus spp. (jackfruit)

This is the only tree that could be identified to genus level as it was bearing quite characteristic fruits. *Arthocarpus* is the **jackfruit** or **breadfruit** genus and the fruits from this particular example do indeed resemble small jackfruits. The genus contains about 60 species that mostly occur throughout Southeast Asia. The scientific name is derived from the Ancient Greek words artos ("bread") and karpos ("fruit"). Many species of this genus bear edible fruits and are commonly cultivated across Southeast Asia.

To the right, the wild Artocarpus tree which grows right in front of The View restaurant. Below one of its fruits

Muntingiaceae

This is a very small family, containing only three genera with each only one species. They are all native to the tropical regions of the Americas. The species after which the family is named is widely distributed across the tropics for its edible fruit.

Muntingia calabura (Jamaica cherry)

Common names for this sole species of the genus *Muntingia* include **calabur tree, capulin, Jamaica cherry, Panama berry, strawberry tree, Singapore cherry, Sabah cherry**, and some more local names in its introduced range. It is a small tree that grows around seven to twelve metres tall and has slightly drooping branches. Its flowers are small and white, and have a slightly unpleasant smell. It does yield many small berry-like light red fruits that are edible, sweet and juicy.

It is a fast-growing pioneer species that thrives on poor soils, and is able to tolerate conditions where other plants would perish, such as high salinity, acidity, alkalinity, and drought. It is widely cultivated for its edible fruit, and has become naturalised in many other parts of the tropics, including Southeast Asia. When given enough sun and water, it will grow rapidly. As a pioneer plant, it increases soil quality, and makes its surroundings habitable for other plants. In some areas however it is considered an invasive species as it outcompetes indigenous plants.

In Soneva Kiri we have many of these small trees growing in the host area, and a bigger one amidst the wastewater treatment ponds, where they yield large quantities of fruits, mostly during the wet season.

Musaceae (banana family)

The **banana** family is native to tropical Africa and Asia and contains two genera and 95 species. The plants are all herbs that have overlapping basal leaf sheaths. These sheaths form a "pseudostem" that makes some members resemble woody trees, but they are in fact giant herbs. Cultivated bananas are of enormous worldwide economic importance. Cultivated bananas are very often hybrids between a number of wild species, or polyploids (having more than two gene copies) of a single species.

Koh Kood harbours a number of both cultivated and wild banana species. The edible banana Musa acuminata is widely grown for its fruits in various cultivars. Across the resort Musa ornata is planted for its attractive pink flowers and in the forest wild banana plants can be seen growing. These are likely of the species Musa siamensis. This can however not be said with certainty, as banana plants have a strong tendency towards polyploidy (multiplication of own genes within the individual, leading to different character traits), or to hybridize (mix between species).

The bright pink inflorescence of Musa ornata or the "flowering banana" is the reason why it is widely planted across the resort as an ornamental plant

The small light yellow flowers of a wild banana of unknown species found in the forest of Koh Kood. The bananas will not grow very large and contain many seeds, making them unattractive for consumption.

Myristicaceae (nutmeg family)

The **nutmeg** family of flowering plants contains about 20 genera and some 440 species of trees and shrubs and is more widely known as the nutmeg family. The family is present in the Americas, Europe, and Asia, but is most strongly represented in the tropics.

Members of this genus are typically trees with a red coloured sap and essential oils that pose as irritant or toxic defense mechanisms that repel herbivores. Wood is often pink to reddish due to the colouring of the sap. Foliage is often aromatic and leaves are generally dark green and somewhat leathery. Flowers are usually inconspicuous, occur in a cluster and often emit a pungent odour.

Other than the most famous use, nutmeg, most species from this family are large trees that yield valuable timber. Some essential oils destilled from the sap and resin from these trees have antifungal properties and show antimicrobial activity. Also the resin of some tree contains hallucinogenic or delirium inducing alkaloids.

The example of this family found at Soneva Kiri is a large tree that grows next to the entrance of Villa 49

Myrtaceae (myrtle family)

The **myrtle** family is a large family with an estimated 130 to 150 genera and over 5600 species with a wide distribution throughout the warmer regions of the world. New genera and species are still regularly being discovered and described, so the numbers keep rising. Species from this family are common in many of the world's biodiversity hotspots. Well-known examples from this family are eucalyptus, cloves, guava, allspice, and rose apple. All species are woody and contain essential oils. In most flowers, the stamens are very conspicuous, brightly coloured and numerous, and form the main attraction to pollinators.

Syzygium spp. (rose apple)

This genus, also known as **bush cherries**, **satinash**, and **rose apple**, contains about 1200 species with native ranges around the tropical Indian and pacific oceans. The highest number of species occurs in Malaysia and Northern Australia. Many species are still poorly known and have not been taxonomically described.

Aside from the rose apple, which is widely planted across the resort for its edible fruits, there are also some wild members of this genus to be found. On the left the small ripening fruits of an example near the beach. On the right the beautiful flowers with conspicuous stamens next to the road to the beach.

Ochnaceae

This genus contains about 33 genera and about 550 species, but this is currently still under revision. The family has a pantropical distribution, and where species occur outside the tropics, they are cultivated. Most species are small trees or shrubs, but in a few cases they are herbaceous.

Ochna spp. (Mickey-Mouse plant)

Ochna is a genus comprising 86 species of evergreen trees and shrubs more commonly known as bird's-eye bushes or Mickey-Mouse plants, a name derived from the shape of the drupelet fruits. These are native to tropical Africa, Asia and the Mascarene Islands. The scientific name of the genus is derived from the Ancient Greek word Ochne, which means wild pear, as the leaves have a similar appearance. Several species from this family are widely cultivated as decorative plants.

This small but beautiful open flower has already dropped the seeds that, combined with the flower, give it the name Mickey-Mouse plant

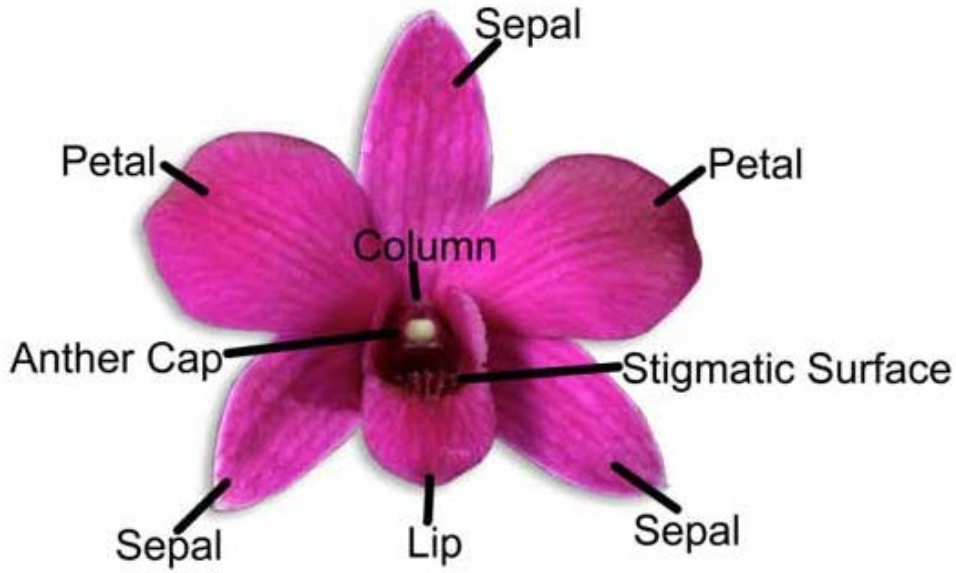
Orchidaceae (orchid family)

The orchid family is arguable the largest plant family in terms of numbers of species. It is only rivalled by the composite family. Because exact numbers of species in both families are unclear it is not known which family is actually larger, because verified data on members of the families is continually being amended. The family contains 880 genera and some 26,000 species. This number nearly equals the number of bony fishes, is more than twice the total number of bird species, and more than four times the number of mammal species.

The family has a worldwide distribution, with by far the largest number occurring in tropical rainforests. Here they make up the bulk of the diversity of epiphytes. Among botanists, orchids are known for their highly specific interaction with their pollinators. The flowers often have highly complex structures and characteristics that allow it to be pollinated by only a single animal species. These highly specific plant-pollinator interactions that occur so widely in the family, are thought to be the main reason for the enormous diversity of orchids found in nature.

Orchids are very abundant on Koh Kood and many different species can be found in the forests. Some can be found flowering at certain times of the year. Unfortunately most orchids do not flower at the same time of the year. Therefore most can be more easily recognised as being an orchid by their simple leaves with parallel veins, pseudobulbs (storage organs typical for orchids, looking like a thickening of the stem between the rhizome and base of the leaf, or between the leaf nodes), areal rhizomes, and their epiphytic or epipetric growth. The diversity on Koh Kood can be easily observed as in some areas near waterfalls up to 8 different species can be found growing on a single rock.

Unfortunately none of the orchids could be identified down to genus or species level because they were not flowering, or due to the sheer number of species requiring highly specialised knowledge.



The typical bilaterally symmetrical flower of an orchid. Many orchids grown for ornamental purposes are actually hybrids that do not exist in the wild. In the wild many colour and shape variations to this basic layout exist. Orchids are good examples of the highly specific mutualistic plant-pollinator interactions that have evolved over time. Many orchids a structured in such a way they can be pollinated by only one type of animal.

On the left side an epiphytic orchid flowering. The colour of this orchid suggests it is pollinated by a species of bumblebee. The moment a bumblebee lands on this orchid to feed on its nectar, it releases a "pollen package" that sticks to the back of the bumblebee. When the bumblebee visits another flower of this species, the "package" will fit precisely into a specific "slot", thereby fertilising the flower.

On the right side a wild example of an orchid found close to a waterfall on Koh Kood. This example is a lithophyte where the lip is the biggest attractive part of the flower, with most other parts being strongly reduced. The flowers do have a very long nectar-containing spur and become highly fragrant during the night. This, combined with the pale red colour, suggests the flower is pollinated by a moth with a very long tongue. The darker leaves covering the rock above the flowering orchid are also orchids, but not flowering at the time the picture was taken.

Phyllanthaceae

This family of flowering plants contains between 54 and 60 genera and some 2000 species. It used to be part of the Euphorbiaceae family, but has been recently revised and been made a family of its own. One feature that clearly distinguishes it from Euphorbiaceae is that none of the members of Phyllanthaceae contain latex. Members from this family can be trees, shrubs and herbs and have a worldwide distribution, with the largest diversity in the tropics.

Antidesma spp.

Antidesma is a variable genus ranging from short shrubs to tall trees, approaching 30 metres in height. Leaves are relatively large (up to 20 centimetres), oval shaped, and leathery. This genus is unisexual, meaning that male and female flowers are found on separate individual plants. This is unlike most plants, which have bisexual flowers, meaning that the male and female parts are found on the same individual flower. The flowers of this genus often have an unpleasant odour. Fruits are spherical and just under a centimetre in diameter. They are white when immature, gradually turn red, and then black.

A branch with male flowers from an Antidesma tree

Breynia vitis-idaea

This plant is also called officinal breynia and is a tree-like species that is native in India, Southeast Asia, Taiwan, and Okinawa. It is actually a shrub that grows up to 3 metres tall and has egg-shaped leaves. It contains a number of toxic glycoside chemicals which have been used by indigenous peoples to obtain aquatic food sources. By crushing or bruising the branches and putting them in small water bodies, the chemicals released dissolve in the water and poison any fish that might be present.

The ovate, alternating leaves, with fruits growing at the top of each leaf node, are easy to recognise.

Polypodiaceae

This is a relatively large family of ferns with more than 60 genera divided into three tribes and around a 1000 species. By far most species are tropical epiphytes, meaning they only grow in other trees. Only a few species grow in soil, most of which occur in temperate climatic regions.

Drynaria spp. (basket fern)

The 16 species from this genus are known as **basket ferns**. They are all epiphytic or epipetric and are native to tropical Africa, Asia, Australia and Oceania. Basket ferns are characterised by the presence of two types of fronds, fertile foliage fronds and sterile nest fronds. The foliage fronds can get quite large, up to about 1.2 metres long, with elongated stalks. The nest fronds are smaller and are persistent, meaning that when they die they do not fall off and form a characteristic "basket" that collects litter and holds water. The litter breaks down into humus, from which the plants derive their nutrients. The fronds grow from rhizomes which are anchored to a tree or rock, are creeping, and densely covered in brown scales.

An interesting feature of these ferns is that they have specialised nectar-secreting structures on the bases of the frond lobes or on the underside of the fronds. The nectar is rich in sugars and amino acids and likely functions as an attractant to ants. These ants then protect the ferns and aid in spore dispersal.

The big baskets that form provide a habitat for a multitude of species among which are insects, other plants and even many water-borne fungi. Also they provide shelters for some types of snakes. Human uses are very widespread Thailand, Laos, Vietnam, Taiwan, and China in the form of traditional medicine for treatment of bone injuries. Recent pharmaceutical research has shown that these plants are indeed effective in prevention of osteoporosis, increase bone density, and positively affect bone healing. The plants are also shown to possess a wide range of antimicrobial activity.

These basket ferns are very common throughout Southeast Asia, and can also be seen growing on many trees on Koh Kood

Platycerium spp. (elkhorn fern)

This epiphytic fern is commonly known as the **staghorn**, or **elkhorn fern**. The genus contains about 18 species, which are native to the tropical and temperate regions of South America, Africa, Southeast Asia, New Guinea, and Australia. The shape of these ferns is very characteristic and recognisable due to the uniquely shaped fronds.

The adult plants have crested roots growing from a short rhizome (modified root-like stem) that attach it to a tree. The rhizome bears two types of fronds. The large, shield-shaped basal fronds protect the ferns roots from damage and desiccation. The antler shaped fertile fronds hanging below bear spores on their under surface. The basal fronds form an open crown that catch falling forest litter for nutrients and water.

The elkhorn ferns are among the most easily recognisable ferns and are commonly cultivated as ornamental plants. The peculiarly shaped ferns grow on trees and rocks and are widely found in tropical gardens. A mature individual can grow more than a metre wide. Often the litter collected in the crown provides a habitat for other plant species.

Pteridaceae

This is a large family of ferns containing 50 genera and some 950 species. Members of this family have either creeping or erect rhizomes and are mostly growing in the soil or on rocks. The leaves are almost always compound and the spore clusters typically grow on the margins of the leaves. Some scientists suggest that this family should be split into four separate families. But at this moment insufficient data exists to provide a comprehensive and robust basis to support a possible revision.

Acrostichum aureum (mangrove fern)

This fern is known as the **golden leather fern**, **swamp fern** or **mangrove fern**, referring to its leathery leaves and dependence on a semi-aquatic existence. The fern is quite salt tolerance, causing it to be commonly found in mangrove habitats. The species can grow to a relatively massive size with fronds up to about 2 metres long. It can be found in tropical and sub-tropical mangrove forests, salt marches and on riverbanks around the world. Despite the fact that the species is salt tolerant, it does grow better in fresh water environments. In saline environments it however faces less competition from other plants, which is why it is commonly found there.

Some examples of the swamp fern can be seen growing around the Spa among other dense vegetation. The spa is constructed in a swampy mangrove area, which is ideal for this plant.

Rhizophoraceae (mangrove family)

This family contains 16 genera and 149 species of which many are commonly known as the salt-tolerant mangrove trees. The scientific name of the family is derived from the Ancient Greek words rhiza, meaning “root”, and phoros, meaning “bearing”, referring to the easily recognisable stilt-roots. These plants have some special adaptations to thrive in the mangrove environment.

Members from this family are highly salt tolerant and able to grow in waterlogged soil. Salt is a strong inhibitor of growth in most plants as it leads to an enormously increased amount of water stress for their cells. Most plants will simply die with only a minor amount of salt reaching their roots. Only relatively few species are therefore able to grow in a saline environment, using some special adaptations to get rid of the salt. Members from this family dispose of excess salt through an internal pumping system and glands in the leaves. On the surface of the leaves, brine is secreted that sometimes crystallises into small salt grains that stay on the surface. The high salt concentration in these excretion pores does damage the area surrounding the pores, causing older leaves to be covered with holes.
Permanently waterlogged soil is another inhibitor of plant growth. Most plants “breathe” carbon dioxide through small pores called stomata in their leaves. This is used in the photosynthesis process to create sugars. Just like all multicellular organisms, trees also need oxygen to sustain their cellular respiration. Trees “breathe” this oxygen with their roots. Now if the roots are permanently inundated, they cannot exchange gasses at the rate needed to sustain their life. Therefore these mangroves have stilt-roots as an adaptation to be able to breathe even when the soil is waterlogged.

These roots also have a very important ecological function as they prevent soil erosion, and protect the land behind the mangroves from waves and even tsunamis. Moreover, up to 95 percent of seafood species in tropical seas depend on mangroves for their reproduction, where among the roots, eggs and young animals are being sheltered against predators.

Another typical feature of this family is that on many species the seeds germinate on their own energy while still attached to the parent tree. Some seedlings then drop into the water to be dispersed by the currents. The germinated seedling then has a higher chance of being able to settle somewhere and survive to grow into an adult tree. In some other species the seedlings develop a heavy, straight taproot that penetrates the mud when it drops from the parent tree, thereby effectively being planted.

A typical member of this family, growing with stilt-roots in salt water.

Bruguieria gymnorrhiza (black mangrove)

The **black mangrove** is a small tree growing up to 10 metres high. It is most often found on the seaward side of mangrove swamps, often accompanied by Rhizophora species. The roots from this tree are somewhat less "stilty" than those of Rhizophora. The trees are most easily distinguished by their typical flower shape, with narrow and tapered red coloured sepals, and the explosive release of pollen. When mature, the spindle-shaped fruits drop and become embedded in the mud, where they rapidly develop roots. In the Maldives the green pods are eaten as a cooked vegetable. They are first peeled and then boiled. The water has to be discarded and renewed at least four times before the fruits are edible.

Although many mangrove trees from this family appear very similar in the way they grow, the genus Bruguieria has very distinct reproductive structures. Actually the red parts which are so clearly visible in this picture are not the flowers, but rather the sepals left behind after the rest of the tiny flower inside falls off.

Rhizophora mucronata (red mangrove)

The red mangrove or Asiatic mangrove is a species of mangrove found in coastal areas and on riverbanks around the tropical Indo-Pacific. It is a small to medium size tree that, dependent on the salt concentration, can grow between 10 and 25 metres in height. Close to the sea, the trees usually stay smaller due to salt stress. The seeds and leaves of the trees provide food for crabs, and also form part of the diet of the crab-eating macaque, which is also common on Koh Kood.

Human uses of the tree include use as firewood, and as timber for construction of buildings and fish traps. The fruits can be cooked and eaten, or the juice can be extracted to make wine. Young shoots are sometimes consumed as vegetables. The Bark is used for dye, and in tanning. Various parts of the plant are used in traditional folk medicine in its native range.

This is one of the most common mangrove trees in the tropical Indo-Pacific. It is however easily mistaken for other species, with which it often forms hybrids, making identification even more difficult.

Rubiaceae (coffee family)

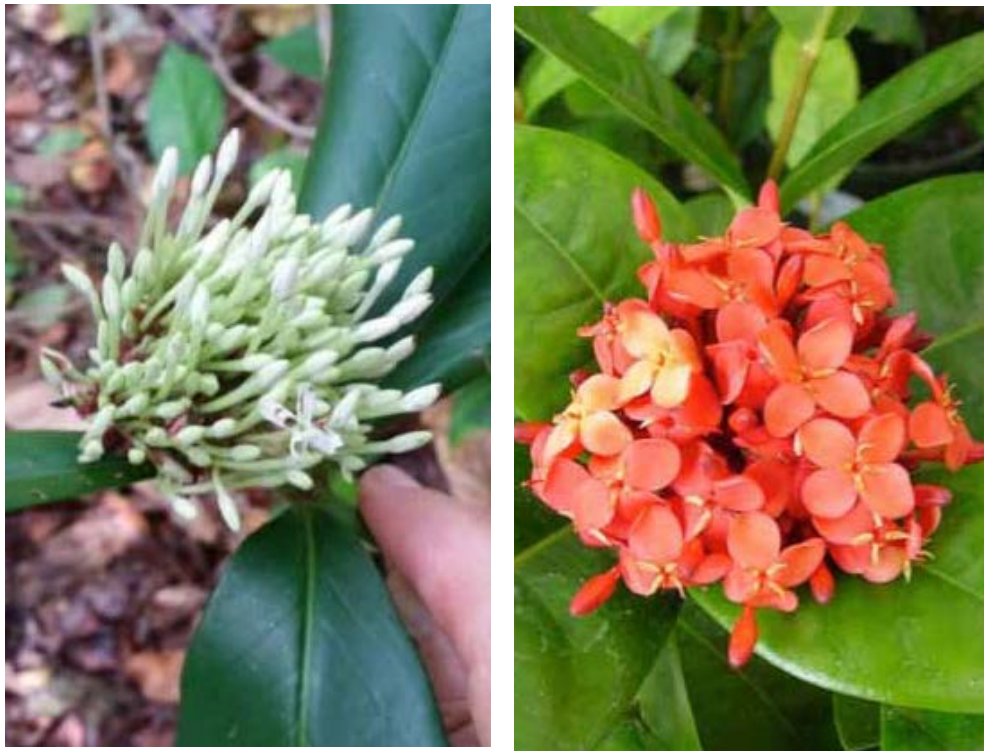
This is the fourth largest family of flowering plants with 611 genera and more than 13,000 species. It is more commonly known as the coffee, bedstraw, or madder family. The family has a worldwide distribution and many different growth forms. The largest diversity is concentrated in the subtropics and tropics. Despite the large variety in growth forms, the family is actually easily recognisable by botanists due to a number of morphological characteristics being very consistent throughout the family.

The family has large ecological importance for a number of reasons. The flowers are very often rich in nectar and therefore provide a food source for bees, butterflies, and birds. Some of the species have developed mutualistic relationships with ants. The seeds provide a habitat to certain ant colonies with food and shelter, leading to the ants protecting the plants from parasites and herbivores.

Economically important genera include *Coffea*, or the coffee plant, Cinchona, the source of quinine used in malaria treatment, some dye plants, and many ornamental cultivars.

Ixora spp.

The **black mangrove** is a small tree growing up to 10 metres high. It is most often found on the seaward side of mangrove swamps, often accompanied by Rhizophora species. The roots from this tree are somewhat less “stilty” than those of Rhizophora. The trees are most easily distinguished by their typical flower shape, with narrow and tapered red coloured sepals, and the explosive release of pollen. When mature, the spindle-shaped fruits drop and become embedded in the mud, where they rapidly develop roots. In the Maldives the green pods are eaten as a cooked vegetable. They are first peeled and then boiled. The water has to be discarded and renewed at least four times before the fruits are edible.



On the left, a wild example of Ixora growing in the forest close to the beach. On the right, a cultivated example which can often be seen planted for its ornamental flowers, which are known to attract butterflies.

Lasianthus hirsutus

This plant naturally inhabits the understory of primary tropical rainforest. Along with the 179 other members of the genus, this species has no known human use. The species of this genus are best described in the Flora of China botanical reference work. This species has bright blue-purplish fruits that are often hidden beneath the leaves, making them somewhat hard to spot.

One has to be very mindful of the environment to be able to spot the well-hidden blue fruits.

Morinda citrifolia (cheese fruit)

This plant is commonly known as **noni, beach mulberry, cheese fruit, great morinda,** and **Indian mulberry**. It is native to Southeast Asia and Northern Australia, but nowadays has a much wider range. This plant has a wide range of ecological tolerances, causing it to be found in a very wide range of habitats. The plant bears flowers all year round and bears a compound fruit. The fruit releases a pungent odour when ripening, hence the name cheese fruit, or sometimes even vomit fruit.

The fruit is often eaten by fruit bats, which are attracted to the smell. The bats are an important contributor in seed dispersal. The plant often has a mutualistic interaction with weaver ants. The ants make nests from the leaves, and then protect the plant from parasites and herbivores.

In some regions the fruit is called a starvation fruit as it is, because of its strong smell and bitter taste, mostly eaten only as a famine food. In Southeast Asia however, the fruit is often consumed as a staple food, either raw or cooked, with salt, or in a curry. In Thai cuisine, the leaves are often used as a green vegetable, and the fruit is sometimes added as an ingredient of som tam. The seeds are also edible when roasted. In traditional Chinese medicine, the roots are used to treat abdominal pain, impotence, and menstrual disorders.

A noni branch with an open flower and a ripening fruit, seen growing next to The View restaurant

Mussaenda spp.

This is a genus of tropical and subtropical flowering plants native to Asia and Africa. The genus contains some 194 species of small trees, some of which are cultivated as ornamental plants. On Koh Kood they are quite common in the wild, where they mostly occur in disturbed (open) areas of the forest. The plants are relatively easily recognised by their small yellow flower clusters, which are accompanied by a white bract.

This small tree is very common on Koh Kood where the forest has been cut. The flowers are often very small but the large white bracts still make the plants easy to spot.

Ophiorrhiza spp.

This genus contains about 380 to 425 species of which most are endemic to the Western Ghats mountain range in India. A number of species are also native in Southeast Asia. Many species of this genus contain the chemical camptothecin (CPT), which is an alkaloid precursor in the production of chemotherapeutic cancer treatment medicines.

A typical flower and fruit cluster of Ophiorrhiza. The plant is quite small and easy to overlook.

Psychotria spp.

This is one of the largest single genera of flowering plants, containing around 2000 species. Plants from this genus occur across the tropics, and most often exist as small understory trees in tropical forests.

The name of the genus is derived from the fact that many species produce the psychedelic chemical dimethyltryptamine (DMT). This is the reason why plants from this genus are widely used in religious and spiritual ceremonies of native inhabitants of the Central and South American rainforests.

Psychotria bush next to a tree. The Psychotria is bearing small green fruits.

Sapindaceae (soapberry family)

This family of flowering plants is also known as the **soapberry family**. It comprises 140 to 150 genera and some 1400 to 2000 species. Well known species from this family are maple, horse chestnut, lychee, rambutan, and guarana. Members from this family occur in temperate to tropical regions throughout the world. Many contain a milky, latex sap, and mildly toxic saponin chemicals with soap-like qualities.

Zollingeria dongainensis (Khi Non)

This tree is native to Thailand, Cambodia, and Vietnam. In Thailand the tree is more commonly known as **Khi Non**. Extracts from the plants are used in cosmetics, soaps and shampoos. It is also being studied for possible toxic properties against mosquito larveae. The winged and colourful fruits of this plant are sold in the potpourri trade as “wild tulip flowers”. Often the wings are frayed into broad bristles in processing, resembling a feather. At other times the wings may be curled and wrapped around the centre, resembling a small springroll.

The irregular size of the leaflets is something that is not very common in plants with compound leaves. This is one of the characteristics used to identify this species.

Smilacaceae (greenbrier family)

The **greenbrier** family of flowering plants contains two genera and some 315 species of woody and herbaceous climbing vines. The family occurs throughout the tropical and warm temperate regions of the world. Most of the woody species have thorns, and most of the herbaceous species are smooth.

Smilax spp. (greenbrier)

Smilax is a genus of about 300-350 species, found across the warm temperate and tropical areas worldwide. Plants in this genus are commonly known as **catbriers, greenbriers, prickly-ivys,** and **sarsaparilla.** On their own the plants will grow as shrubs which form dense impenetrable thickets. When growing near other structures or trees they will grow as climbing vines, up to ten metres high, with their hooked thorns and tendrils allowing them to hold onto branches. The leaves are heart-shaped and have a wide variety of sizes in the different species.

Smilax plants are very damage tolerant and capable of growing back from their rhizomes after being cut down or burned. This, combined with the fact that the seeds are easily spread by animals over large areas, can make some species noxious weeds that are difficult to get rid of. The most important use of this genus is in sarsaparilla drinks and root beers in the Caribbean and North America. Of some species the roots are used in cooking for use as a vegetable. Also some species have a wide range of traditional medicinal uses.

This climbing vine has tendrils and often also hooks which help it to climb up to ten metres high, often completely smothering the host structure or plant.

Verbenaceae (vervain family)

This mainly tropical family of flowering plants contains trees, shrubs and herbs, and is more commonly known as the **verbena**, or **vervain** family. The most recognisable feature of this family is that its small flowers occur in heads, spikes, or clusters, many of which have an aromatic smell.

Lantana camara (wild-sage)

This species of flowering plant is also known as **big-sage, wild-sage**, or **red-sage.** Because of its showy, often multiple coloured flowers, it is a popular garden plant. This has caused it to spread from its native range in Central America to over 50 countries, where its ability to grow in a wide variety of habitats has in many areas caused it to become an invasive species. Often this plant will outcompete other species of native plants, leading to a reduction in biodiversity. The flowers of this plant are arranged in clusters and come in many different colours including yellow, orange, red, pink and white. After the flower is pollinated, it will change colour, typically from yellow to a more reddish shade. In some traditional herbal medicines the plant has been used for treating a variety of ailments. Research suggests the plant could indeed have beneficial properties for reducing ulcer development and to treat respiratory infections.

This example was found close to the beach at Soneva Kiri. It shows clearly the colour variation of flowers that can occur even in a single individual.

Stachytarpheta spp. (blue snakeweed)

The species of this genus found at Soneva Kiri and around Koh Kood is either *S. jamaicensis*, *S. cayennensis*, or a hybrid between these. Both are native to the Caribbean and South America, look very similar, and are well known invasive species outside of their native ranges. The plants are known as **blue snakeweed**, **Brazilian vervain**, **Jamaican vervain**, **Brazilian tea**, **bastard vervain**, and **nettleleaf**. Outside of their native ranges, the plants often hybridize, making them even more difficult to identify.

The flowers are rich in nectar and therefore popular with many butterflies. The leaves of both species have uses in traditional medicine. The leaves are boiled into a tea as a "cooling" tonic to relieve fever, to treat asthma, and stomach ulcers. Extracts are also used for dysentery, pain, and liver disorders. Laboratory tests indicate that the plants indeed have anti-inflammatory properties.

This weed is not native to Southeast Asia, but is still very commonly seen in this region. Its small flowers produce nectar and are therefore often visited by small bees and butterflies.

Vitaceae (grape family)

The **grape** family of flowering plants contains 12 genera and 940 species of all woody plants. The name of the family is derived from the genus *Vitis*, which is the grapevine genus. This genus, containing some 60 species, is the only one in the family that is of economic importance due to its edible berries that are also used to produce wine.

Leea indica (bandicoot berry)

This large shrub is also known as **bandicoot berry** and is very common as undergrowth in secondary and disturbed evergreen forests. It is native to tropical Southeast Asia, Australia, Pacific Islands, and the Western Ghats of India.

Based on its morphological characteristics, the genus Leea used to be classified as its own family, Leeaceae. But since it has been genetically studied it is now considered to be part of the Vitaceae family. The genus contains approximately 70 species which are distributed throughout tropical Asia, New Guinea, Australia, and some parts of Africa.

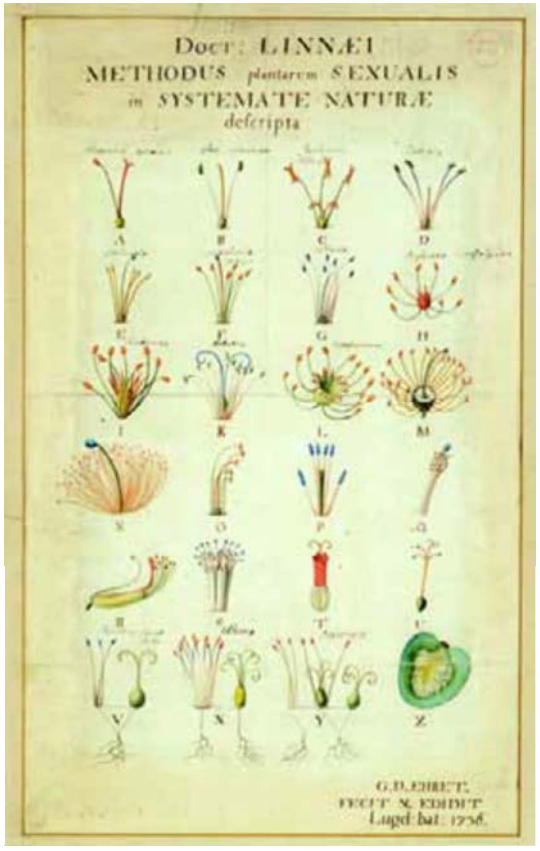
The leaves of this plant contain phenolic compounds which are found to have antioxidant effects. It is even suggested that these compounds contribute in countering colon cancer.

The berries on this example are not ripe. Eventually their colour will shift to deep red

Explaining natural diversity

The enormous diversity found in (especially tropical) ecosystems worldwide might seem overwhelmingly complex at first glance, and has long puzzled the mind of people trying to understand it. This trying to understand and systematize biological diversity is called the field of taxonomy. Some say taxonomy is the actually oldest existing profession (perhaps rivalling that other "oldest profession"). Throughout history, people have been trying to find explanations for why the diversity is so large, why certain patterns are observed, and how it all came to be like this. Many different hypotheses and suggestions have been made by various scientific and religious scholars alike. Also many different systems have been devised to classify the patterns observed in the natural environment.

Most of these suggested classifications later turned out to be false and based on too many improvable assumptions. The person who did come up with a logical system of classification was the Swedish botanist, physician, and zoologist, Carolus Linnaeus (1707-1778) (picture on the right). He is now considered to be the father of modern taxonomy, and considered one of the fathers of modern ecology.



While Linnaeus provided the means to more or less accurately classify organisms, he still did not provide an explanation as to why the patterns in nature are as they are. During his lifetime, people in the scientific community in Europe were, like everybody else, deeply religious and assumed that God's creation was the cause of everything observed. But even during this period, more and more people started to see that the concept of creationism did not provide all the answers for what was being observed.

A number of scholars in the period of the late 1700s and 1800s independently made suggestions and observations to explain patterns seen in the natural environment. The Belgian monk Gregor Mendel (1822-1884) conducted experiments which proved that organisms inherit character traits from their parents. Although he proved heritability, he failed to come up with an explanation for the mechanism behind this.

At the time, the significance of his discoveries was not understood. Interestingly many naturalists, including Charles Darwin, came up with hypotheses to explain the natural diversity. But they all failed to recognise that this was in part to be explained by so called Mendelian heritability. Of course in those times, the field of genetics had yet to be discovered.

The theory of evolution, for which Charles Darwin (1809-1882) laid the foundation with his book On the Origin of Species by Means of Natural Selection (1859), was one of the ways the large diversity and patterns therein were explained. The revolutionary aspect of this theory was that he did not try to describe patterns in single organisms, or organism families. Rather his theory was based on cataloguing vast numbers of examples of geological discoveries, fossils, and existing animals, including selectively bred domesticated animals. Darwin did suggest that for his theory to be correct, a form of heredity was required. The explanation that he gave for heredity however turned out to be wrong.

Only in 1953 when James Watson and Francis Crick discovered the structure of DNA, it was understood that this was in fact the carrier of genetic instructions and heredity. With this major discovery, the scientific discipline of genetics was born. Only now the significance of Mendel's work was recognised. The discovery of DNA as the carrier of heritability filled up the final missing link in the theory of evolution. With our current understanding of genetics, combined with all the patterns observed, there is no doubt in the scientific community that evolutionary theory provides the ultimate explanation for the diversity seen in the natural environment.

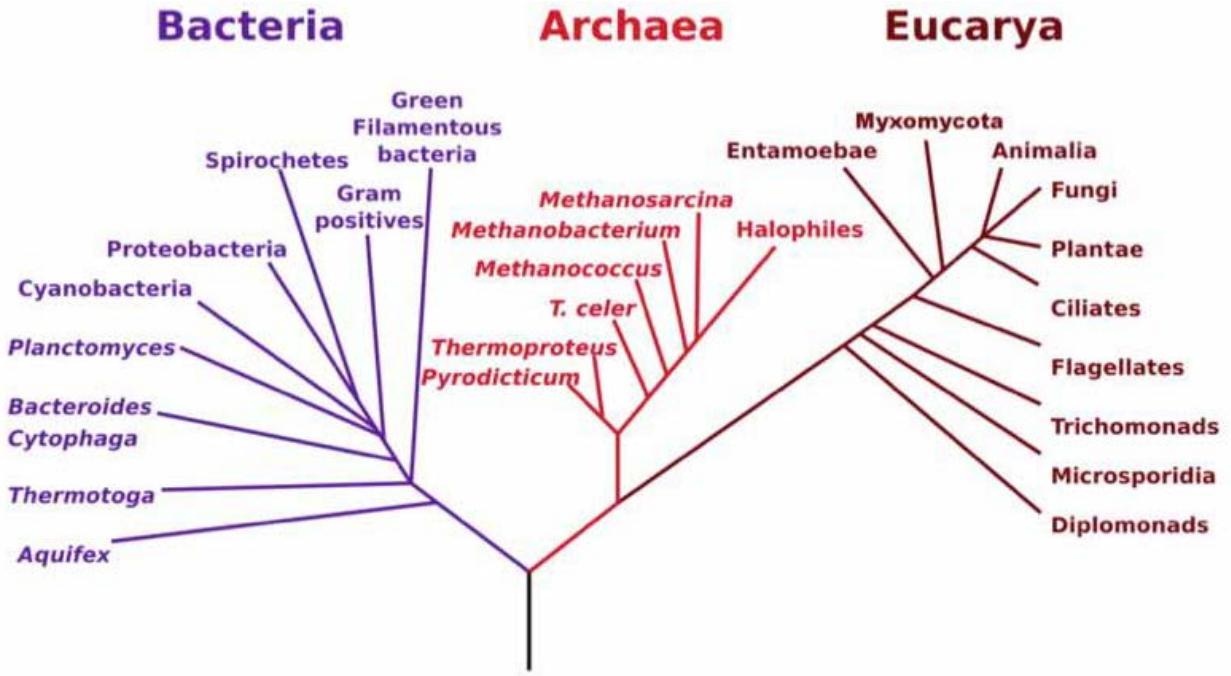
In everyday use, the term "evolutionary theory" might suggest that it is merely an unproven theory, a guess or hunch at best. However when scientist speak of a theory, they mean quite something different. A scientific theory is a coherent, well-substantiated, well-supported, and well-documented explanation for a range of observations. It ties together the facts about something, providing an explanation that fits all the observations, and can be used to make predictions. Therefore in science, a theory is the ultimate goal, the explanation of patterns observed. Other examples of scientific theories are the theory of relativity and quantum field theory in physics, and game theory in mathematics. While the theory of evolution provides the best explanation for almost all observations made in biology, it does not in itself provide the tools to explain these observations, nor does it give an explanation for the origin of life itself.

Development of taxonomic classification

Taxonomy is a field in biological sciences that works at defining groups on the basis of shared characteristics, and giving names to those groups. It provides the tool to explain observations made about patterns in biological diversity. This way it helps getting a better understanding of how different species are evolutionarily related to each other, and ecologically interact.

Before people knew of the existence of single-celled organisms like bacteria, or the workings of cells themselves, organisms were categorised into two kingdoms: animals and plants. When microscopes were invented and people got the ability to see single cells, it was discovered that a cellular level, fungi, plants, animals, and bacteria are in fact very different organisms. With the ability to see single cells, life was newly divided into two initial categories called domains. These domains were the prokaryotes or bacteria, with very simple and small cells, and eukaryotes, with large, complicated cells which allow for the formation of multicellular organisms.

These domains are then divided into kingdoms, according to cellular characteristics. This way it was for instance discovered that fungi are actually more related to animals than to plants. And only relatively recently, with the help of molecular techniques, it was found that a third domain exists: Archaea (picture below). These cells are also very simple prokaryotes, but fundamentally differ in their building blocks and metabolisms, and are therefore characterised as different from bacteria. Archaea are actually found to be more closely related to eukaryotes, based on their similar metabolism.



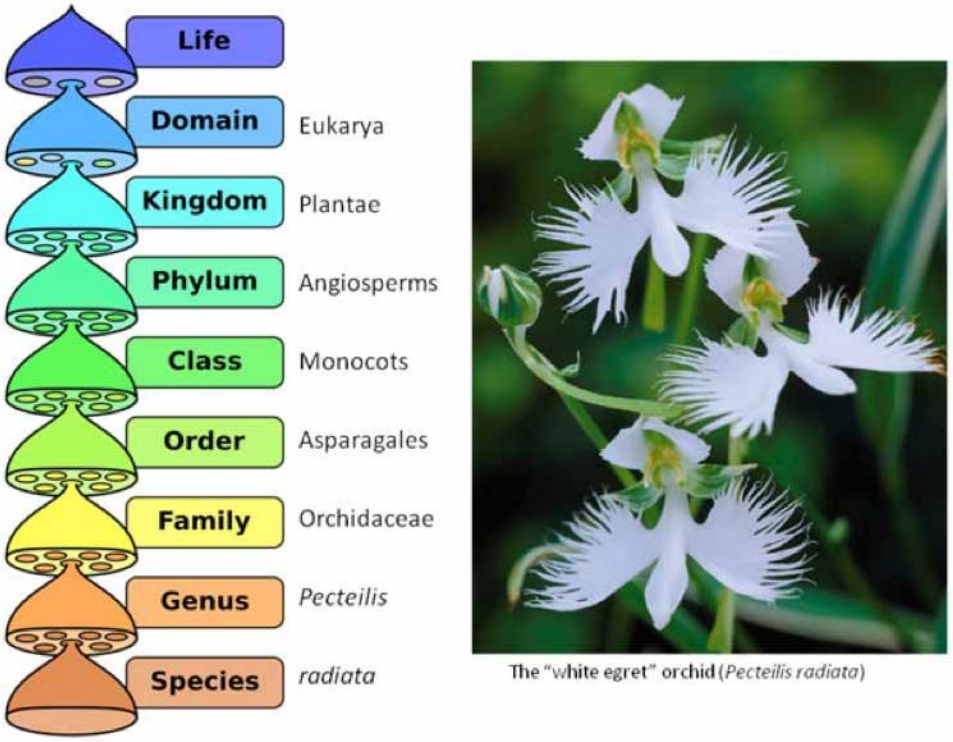
The currently accepted basic evolutionary tree of life, showing the three domains and currently accepted kingdoms. Of all organisms, bacteria are estimated to be by far the most diverse in terms of species numbers, and make up a total biomass that far exceeds that of all plants and animals combined.

Modern classification

Nowadays, most organisms are categorised according to their basic cellular structure and genetic similarities. The levels of classification are based on fundamental similarities up to a certain level of complexity.

The terms used for every level of classification follow a certain nomenclature. This way, a scientist will immediately be able to tell what level is being referred to. Nomenclature also differs per taxonomic discipline (e.g. botany, the study of plants; zoology, the study of animals; mycology, the study of fungi; or bacteriology; the study of bacteria), to clarify what kind of organism is being referred to. An example of how this classification works is shown in the image on the next page.

Individual organisms are always referred to in binomial nomenclature, meaning the genus and the species name. The genus is always written with a capital letter and species always with a small letter. Both names are always written in italics to show the level of classification that is being referred to. This binomial nomenclature was invented by Carolus Linnaeus and is being used to this day.



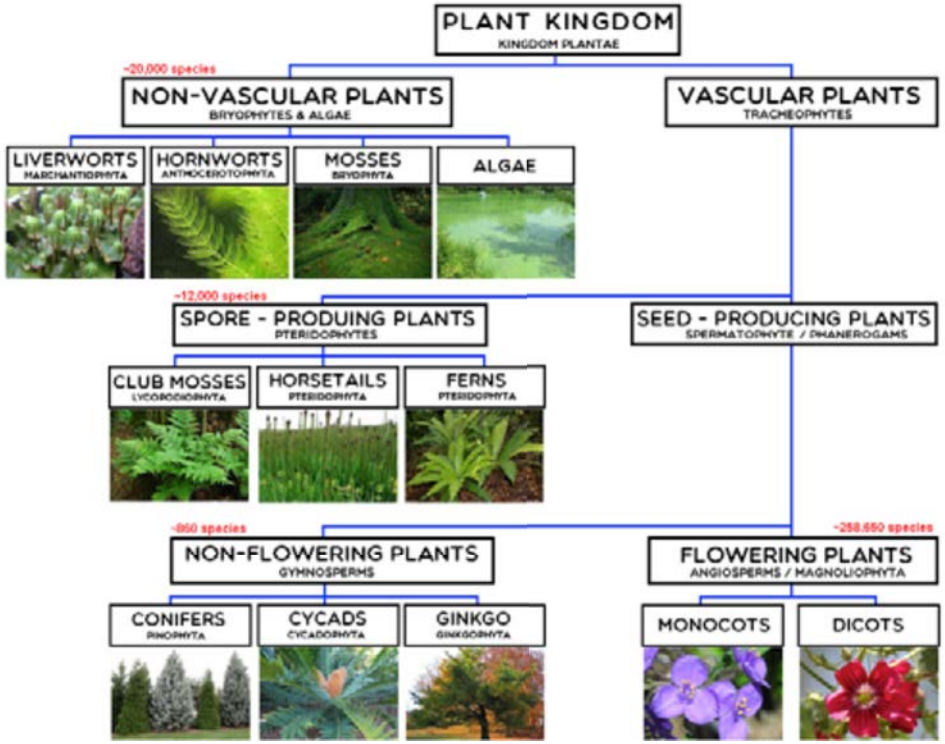
The current system of classification, with an example of a full classification of an orchid, a member of one of the most diverse plant families in the world.

some background: how does taxonomy work?

For most people, animal diversity and characteristics often capture the imagination. The enormous amount of animals and their peculiarities fascinate and impress many people. Plants can however be equally impressive if one considers the fact that they cannot move. Unlike animals, plants cannot hide from adverse conditions, run away for danger, or find mates by themselves to reproduce. Plants have had to find other ways to deal with the difficulties of existing in their natural environments. The many different adaptations that plants had to develop to deal with their environments has led to the most beautiful flowers, to most poisonous of trees, the most bulbous cacti, and many more interesting traits. The often unfathomable "cleverness" of plant adaptations to cope with the environmental characteristics they are stuck in has led them to inhabit all but the coldest environments on this planet.

By now, a total of around 310,000 different plant species have been described. It is estimated that the total number of plant species reaches up to about 390,000. The field of botany tries to describe and categorise these plants according to complexity and adaptational similarities (schematic on next page). This categorisation starts with the differentiation between vascular and non-vascular plants, where non-vascular plants are older, less complex and limited in their size because they have no tissues for transportation of nutrients (see picture below).
Within the vascular plants there are plants that produce spores, and plants that produce seeds for reproduction and dispersal. Here the spore plants are older, and at a fundamental level simpler. The seed plants are separated into non-flowering and flowering plants. Non-flowering plants are simpler in their reproduction as they release their pollen into the air, to be transported by the wind to a potential mate.

Flowering plants comprise the largest diversity and complexity of all plants. They are often highly adapted to their pollinators, which very often are insects, but also many other animals. Flowers basically function as an advertising sign directed towards specific pollinators that are sensitive to it. Often these pollinators evolved their sensitivity or capability to pollinate a specific plant along with the evolution of the plant, a process called co-evolution.



The modern scientifically accepted classification of fundamentally different groups of plants.

Plant field identification

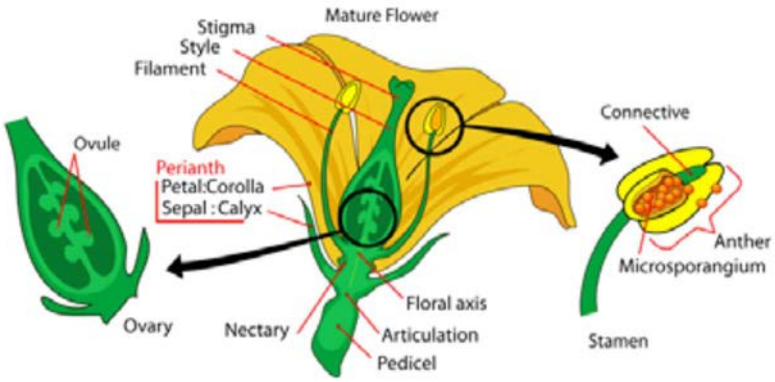
Taxonomists and true field botanists are increasingly rare occupations. Fieldwork purely for taxonomic discoveries is difficult and expensive to organise. Also, it is becoming increasingly difficult to find new species as it is estimated that most species have already been described, based on their morphology. Increasingly taxonomic classification and re-classification is the work of laboratory based geneticists working on the Angiosperm Phylogeny Group (APG) system, which aims to verify the classification of all living flowering plants.

Although scientific classification is no longer based on morphological characteristics, it is rather difficult to bring all the necessary laboratory equipment into the field. Therefore, in fieldwork, botanists still rely on morphology to identify the species they are looking at.

In the field, identification has to be based on field guides and dichotomous (yes or no selection of the presence of certain traits) identification keys. For every floristic region in the world (a region with a similar type of vegetation), a different flora (descriptive reference database) exists. In the tropics these floras are often a work in progress as new species are continuously identified or reclassified. There are many different variations in plant structures, and even within closely related taxonomic groups of plants, the rule is that there is variation.

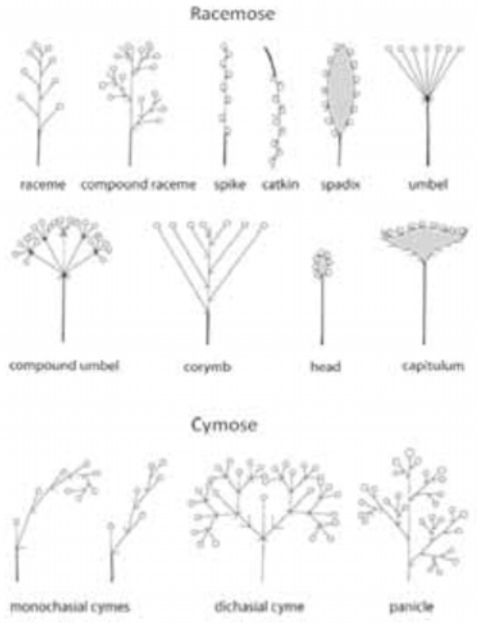
Here I show a number of characteristics of plants that botanists would be looking for when trying to identify plants in the field. Leaf shapes morphology applies for most groups of vascular plants. Flower morphology of course only applies for flowering plants. As spore plants (ferns and horsetails) and conifers do not produce flowers, here one would have to look at the tiniest details of spore clusters or pinecones. Identification of non-vascular plants such as mosses, liverworts and hornworts is an entire discipline in itself as their diversity is enormous, they occur in inconspicuous or difficult to reach places, and their small often small size requires microscopes to identify the different parts.

In most plants, the reproductive structures (flowers) are the most important part for successful identification. Leaf shapes, colours, and sizes can be highly similar between unrelated species, or variable in very much related species. Flowers are often highly characteristic for certain plant families and therefore give a good lead for field identification. In order to be able to distinguish between flowers a botanist has to know the basic parts of any flower (schematic image on next page).



Generalised basic flower morphology. This is the standard for all flowering plants, however in the wild this basic layout will rarely, if at all, be found. In the wild many hundreds of thousands of variations to this general layout exist, with parts missing, reduced, or enlarged, and different symmetries, colours, sizes, and shapes.

While the individual flowers themselves in many cases provide enough information for successful identification, this is not always the case. Often just as important is the way the flowers are arranged. Certain plant families (for instance the sunflower family) have very characteristic flower arrangements (which will be explained later) by which they can be immediately recognised. As might be expected, also in the arrangement of flowers there is a huge variation (image on the right).

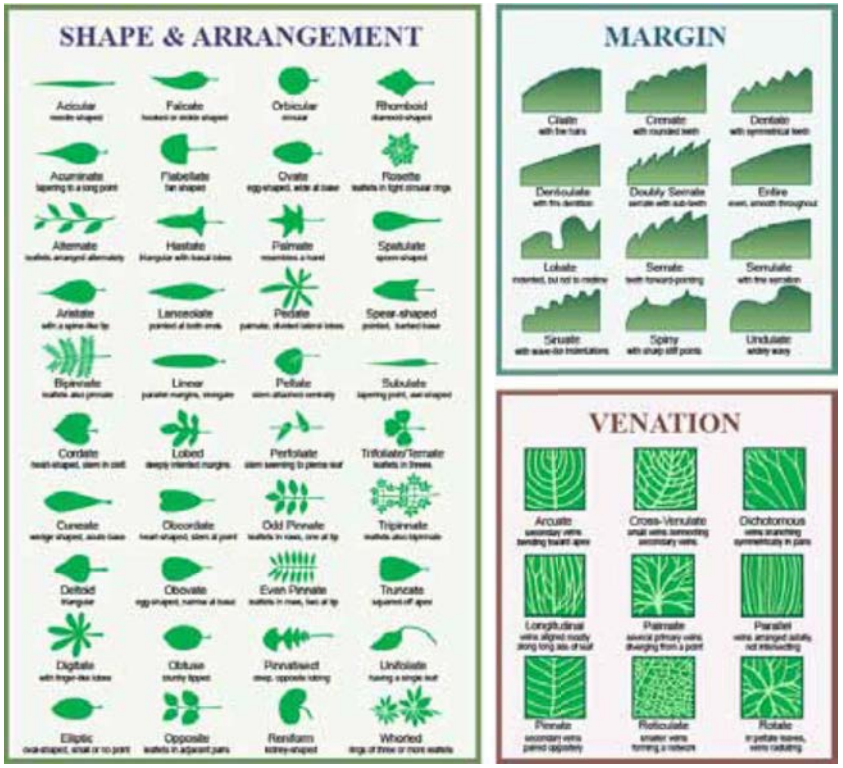


Different types of flower arrangements. These clusters of flowers are called inflorescences.

some background: how does taxonomy work?

Unfortunately most plants do not continuously bear flowers. Therefore botanists also have to look for other characteristics. Leaf shape and arrangement is often the first thing that is looked at when flowers are not present.

There are not nearly as many variations in leaf shapes and arrangements as there are in flower morphology (image below). However if a botanist knows what possible variations can be encountered in a certain area, these do give a very good lead to identifying the species.



The variation in leaf shape, arrangement, venation and margins. Leaf colouration is only sometimes seen as an important characteristic as this is often highly variable within species. Colouration is only taken into account when leaf colour or colour change is very particular.

Aside from these most obvious of characteristics there is a wide range of other ones that are important, and the smallest details count. Examples are hairs, glands, stipules, sap, resin, bark, aromatic compounds, stomata, and associated animals and fungi.

Just all these details that can be looked for already give a good hint about how awesome the natural environment we live in actually is.

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