A troop of long-tailed macaques near the Park Information Centre.

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Cibodas to Cibeureum

MT. GEDE PANGRANGO NATIONAL PARK

Information Book Series
Vol. 1

A walk in one of the oldest and most famous tropical forest reserves on earth

FOREWORD

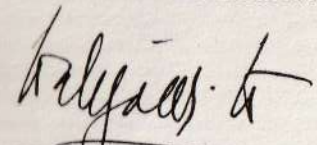
Among its many responsibilities, Mt. Gede Pangrango National Park is charged with providing information and interpretation materials. The aim is to promote appreciation and awareness, both with regard to natural resource conservation and National Park management. Through a public information programme we hope to enhance the park's reputation as an area of global conservation significance, in keeping with Mt. Gede Pangrango National Park's status as a core zone of a World Biosphere Reserve announced by UNESCO.

This book is the first of an information series to be prepared by Mt. Gede Pangrango National Park. The guide provides interpretation material for the well-used path running from the Cibodas Gate to the Cibeureum Waterfalls. The information it contains illustrates the rich biological diversity that visitors can discover. The text is of two types: brief information to be read when walking along, and more detailed information to be read at leisure.

In order to develop the series the park has set up a team headed by Wandojo Siswanto; members include Agus Mulyana, Hidayat Santosa and Memen Suparman. The team actively gathers data based on past vegetation surveys, including research carried out by various universities and supplemented by data coming from park personnel.

I would like to address special thanks to Keith Harris, who, under the British Council/Voluntary Service Overseas programme, wrote the text, provided photographs and made this guide book possible. He was assisted by Sopian whose local knowledge of the park and its wildlife is very much valued. I would also like to gratefully acknowledge the contributions of Jeanine Pfeiffer, Marja Boon, Rosie Ounstead and park personnel who provided technical or practical assistance. Acknowledgment must also go to the staff of the Museum of Zoology, Herbarium Bogoriense and the Cibodas Botanic Gardens for providing additional advice and assistance.

It is intended that other publications, Indonesian and English will be available in the near future.



Wahjudi Wardojo

Head of Gede Pangrango National Park
Directorate General of Forest Protection
and Nature Conservation, Ministry of Forestry

Cibodas to Cibeureum

Dicetak Ulang Oleh
Koperasi Eidelweiss
Taman Nasional Gunung Gede Pangrango

REMEMBER: ALL PLANTS AND ANIMALS
WITHIN THE PARK ARE PROTECTED.

PLEASE DO NOT INJURE, COLLECT,
OR IN ANY OTHER WAY
DISTURB THE WILDLIFE.

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INTRO.

Visitors to the park will notice different things and interpret them in different ways. This guide helps you enrich **your** experience.

Become submerged in the feel of the forest and be aware of all your senses. Climbing to the top of the mountain is a worthwhile challenge, but a slow walk and careful observation will reveal more secrets.

If a wasp chases you off, ask yourself why: is it territorial? Why do many of the fungi glow after dark? What does being hot and sweaty when you walk and cold when you stop tell you about the climate? Why are climbing rattan palms covered with spines? Do the spines point up or down? Why are many young forest leaves red? The Great Puzzle!

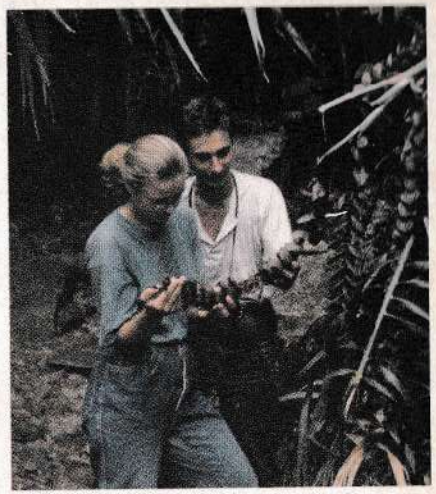
You might not come up with all the answers but you will, literally, be following in the footsteps of Wallace, van Steenis, Jacobs and many other eminent biologists. All were awe-inspired by the wealth and beauty of this area.

ABOUT THE WALK

The trail is on a well-laid stone path to the Cibeureum Waterfalls. Sturdy shoes or trainers are advisable. The uphill walk, 2.7 km, one way, non-stop, takes about an hour, but can take over three hours or more if you pause to look around. It will be dark at six, after which you will be in trouble without a flashlight. Rain is most likely mid- to late afternoon, especially between November and March.

Every 100 m there is a numbered marker stone, 27 in all. The guidebook uses these stones to direct you to particular points of interest.

HOW TO SEE THINGS IN A FOREST



- Keep as quiet as possible;
- Wear dull-coloured clothing;
- Listen carefully;
- Look very carefully;
- Investigate smells;
- Investigate to see where fallen flowers and fruits have come from.

The forest is teeming with insects, reptiles, amphibians, birds and small mammals but they don't usually jump out at you. It is very easy to walk under a tree full of leaf monkeys and not see them. In the still conditions of the forest look at any leaves that move and even at those that don't!

There is no need to be frightened of the animals, but do not annoy wasps or scorpions: their sting is painful. Leeches are common in the forest but very rare on the path. Snakes and wild pigs are generally not a worry but it is best not to interfere with them. Plants are far more dangerous! Many are poisonous, or are covered with stinging hairs, and tree branches can fall in high winds.

With around 350 plant species in one hectare, of which perhaps 80 are tree species, it will not be possible to identify everything, therefore the guide focuses on a few important, common or noticeable plants in order to indicate the area's remarkable botanical diversity.

Plants and trees have not been labelled: labels are intrusive and tend to fall off. Hunt around for yourself: it's more rewarding.

Be prepared to look around; things might not be where they are supposed to be! Also, flowering times vary from species to species, so different plants may be more obvious at different times of the year.

Plant collecting and damaging the forest is clearly not allowed but, where the guide suggests, you may pick and examine small pieces of common vegetation.

HOW TO USE THIS BOOK

For each marker stone 1 there will be an arrow and a box

At the trees. directing you "Where To Look".

Below the "Where To Look" box, we have provided a list of "Things to Look For". These items are in colour-coded boxes which mean the following:

Always present/visible

Usually present/ usually not difficult to find

Occasional/seasonal

REMEMBER: If you can't find the items at the location indicated in the text, search elsewhere !

Unless you are very keen and have a lot of time do not try to read all the information while in the forest.

Text in purple is intended to be read in the forest.

Text below the blue line is intended to be read when you have more time. Space out your stops or choose beforehand — by reading the text or looking at the photographs — things that interest you. This text includes detailed sections relating to the history or medicinal value of plants, or concerning aspects of tropical ecology. As most visitors have only limited time in the forest these additional offerings are intended to be dipped into or left until later.

QUIZ Quiz questions appear in the text and are intended to be fun. Try them out on a friend. Answers can be found at the back, together with a short check list.

NAMES It is quite common for a species to have four names: Indonesian, Sundanese, English and scientific. Names are important: English names are often well known; scientific names promote accuracy; and Indonesian names are often descriptive or relate to traditional or local knowledge. However, learning names should not become an aim in itself but should promote enjoyment of the forest.

BEFORE YOU ENTER THE FOREST

Observe the general view of the area as you walk towards the park entrance.

- Mt Gede, ahead and to your left
- Mt Pangrango, directly ahead
- Mt Mandalawangi: the mountain ridge close-by on the right
- Cikundul river, running from the valley head down to the right of the golf course
- Pancuran Mas Waterfall on the Cibodas River, half way along golf course on left

Gede crater area: a five-hour walk to the summit. Mount Gede has now been quiet for around 40 years! Records suggest that the longer the mountain "sleeps" the greater the chance of a violent eruption.

Past Eruptions

Gede's first recorded eruption was in 1747. The most violent, however, spanned the months November 1840-March 1841. In December of 1840 flames over 200 m high flared out of the crater. Showers of rocks and clouds of ash accompanied the event.

The last eruption was in 1948, with several very small events up to 1957. Fumaroles still give out sulphurous gases whose acidity affects the vegetation. Gede and Pangrango sit on top of much older and larger extinct volcanoes: Pangrango represents a relatively recent eruption point perched on the rim of the vast and ancient Mandalawangi crater. In case of a large eruption it is likely the lava would flow straight towards Cibodas.

Mt Gede and Pangrango are both 'young', Quaternary volcanoes, built up in the last three million years. Mt Gede rises to 2,958 m above sea level (a.s.l.), and in clear conditions the crater wall can be seen. The older and now extinct cone of Mt Pangrango reaches up to a height of 3,019 m a.s.l..

The ridge or saddle connecting the two peaks is at a height of 2,400 m a.s.l.. As you look at the volcanic complex your eye is ranging across three types of forest:

Sub-montane	1,200-1,500 m a.s.l.	Park boundary to Blue Lake
Montane	1,500-2,400 m a.s.l.	Lake up to the saddle
Sub-alpine	2,400-3,019 m a.s.l.	Saddle to summit

Eruptions: good or bad? It's an open case

Past eruptions of Gede have devastated huge areas of vegetation but have enriched the soil by adding minerals. Lowland forests are closed systems, with very little natural input or loss of nutrients. West Java's mountain forests are very different. They are open systems: soil washed away by rain and rivers is replenished by the breaking down of rocks and the weathering of volcanic ash. Soils on lower slopes gain in fertility due to weathering and biological activity. These soils are, therefore, much richer in clays and humus than the soils of higher areas.

Mounts Gede and Pangrango.

1

Look at the forest.

- species richness: a great many different kinds of plants

You are about to enter the best upland forest on Java. The area is species rich and relatively little disturbance has been caused by people.

The walk will take you through the sub-montane zone to the lower edge of the montane forest. Sub-montane forest contains more species than the park's higher, cooler areas. Two families of plants dominate:

- large oaks/chestnuts (FAGACEAE), which make up much of the general canopy;
- laurels (LAURACEAE), which often constitute the majority of medium-sized trees of the sub-storey.

All the forest along the path can be classed as FAGO-LAURACEOUS.

Cibodas: the oldest tropical reserve?

The old Cibodas reserve set up in 1889 is certainly one of the oldest, formally established, tropical forest reserves on earth; botanists have described it as "the pearl in the crown of Java." In the past 'jungles' all over the world were regarded as dark and sinister; today our understanding of the tropical forest is that of a profound and complex ecosystem. In the story that has brought about such a radical change in perception Gede-Pangrango has played a leading role. Open any well-known book on tropical forests and there will be a strong likelihood that within its covers the name Cibodas will appear. Even more than this, among those who have visited or worked here, Cibodas is a name spoken of with special affection.

Park gate: look for the bush over the gate: it is a paper chase plant (see notes Stone 16).

On the left side of the path, 1.5 m beyond a large boulder just as you enter the forest. (Also close to HM2)

1

- a small fig tree overhanging the path
- lots of small twigs without leaves

- hundreds of yellow-brown balls (figs) growing on the small twigs (out of season only a few figs may be visible)
- fallen figs (for structure see notes: Figs and wasps)

Ficus ribes is one of Gede-Pangrango's most common fig trees. Figs are a very important food source for birds such as pigeons as well as for many mammals. (More about figs at HM2)

Forests: Each a unique document

Each forest type represents a 'prehistoric document' with a history it is possible to investigate. Many of the plants of the park, such as rattans, evolved in the S.E. Asia region. Some temperate types, including buttercups, arrived on Java from Europe by mountain hopping; others, such as datura, were brought here by humans. But the forest is not just thrown together - from the confusion of chance occurrence it has developed a unity. The starting points, the species, have now established complex relationships, which are not static but always evolving. The whole has become like a complex city, inhabitants living different life styles, some very specialised and some general opportunists. Out of this apparent 'chaos', a giant organism is formed.

Fig tree, *Ficus ribes*.

1

At the base of trees between HM1 and HM2.

- buttresses: supporting, wing-like structures at the base of trees

Giant buttresses tend to be a feature of flat, lowland rain forests. Many of the trees along this low area of the path are buttressed, but large buttresses become less common as you walk towards Cibeureum. The higher up a mountain you go the smaller the trees tend to be: growth rates are much slower in cooler conditions.

Why do trees have wings?

Buttresses are wing-like roots/stems which reinforce the base of the tree. There are several theories concerning their function. The structures may act like guy ropes on a tent pole. Try knocking very hard on big buttresses; they ring if under tension. Buttresses are believed to occur predominantly on the up-slope, pulling a tree upright. They are very useful if the weight of the tree is not balanced, perhaps due to an unevenly-shaped crown or the unequally distributed weight of other plants growing on the branches. Another theory suggests that the main function of buttresses is to take up ground space so that other trees cannot grow too close.

Oak: *Lithocarpus pseudomoluccus*.

At the large tree next to the marker stone.

2

- *Ficus variegata:* the large fig tree next to the stone
- space under the base of the tree
- small fig tree growing on the large tree
- two types of leaf
- two sizes of fig

16 paces before stone on left-hand side of path

- *Ficus ribes*: small tree, often with small figs

Growing on the large fig tree, *Ficus variegata*, is a smaller fig, *Ficus sinuata*. Both are lowland species. Observe the roots: the large fig tree is hollow underneath. Nutrients from the urine and faeces of animals sheltering in such places may help to increase the tree's supply of minerals.

Fig sap contains a white latex and is used as a medicine for stomach upsets and even tooth-ache. In the past a wax extracted from *F. variegata* was much sought after for batik dyeing.

Fig tree, *Ficus variegata*.

2

Figs and wasps

If any of the small, spherical figs have fallen, carefully break one open. The hollow cup (receptacle) houses many minute flowers. Examine the small entrance hole used by wasps. The very small plates around the hole allow wasps into the fig but prevent escape.

Java alone has over 70 different kinds of Ficus, the park around 15. Every fig species has its very own tiny wasp species to pollinate it - a famous example of plant/insect co-evolution. Biologists are able to work out either the species of wasp or fig by identifying the partner. The wasps' life-cycle, including mating, takes place inside the hollow balls and the insects are actually 'held prisoner' inside unripe figs. Males never emerge but die after mating. Fertilised females, however, burrow their way out and fly to other figs in order to lay their eggs and, in so doing, transport pollen and aid fig pollination. Amazingly, there are even other kinds of wasp which specialise in parasitizing the fig wasps!

Top: the large fig of *Ficus variegata*.
Bottom: the small figs of *Ficus ribes*.

QUIZ NO. 1 Figs have many uses, but which statement do you think is NOT true:

i. The bark of *Ficus ribes* can be chewed with betelnut.
ii. Some species of fig can be used to give a rubber and were the origin of the name india rubber.
iii. Traditionally on Java some fig leaves were smoked with opium.
iv. The bark of *F. variegata* can be beaten into a bark cloth.
v. The very expensive fruits of *F. variegata* were exported to Europe where they were a rare delicacy enjoyed by kings and queens.

On the left side of the path, 45 paces past HM2.

2

- a twisted, rope-like creeper

Like a huge rope, climbers ascend towards the light. Such woody climbers are termed lianas.

Jeepers creepers!

Many lianas possess a twisted structure. The twists look and work like rope, giving both flexibility and strength, allowing the plant to stretch. Some large species of lianas are aptly named monkey-ladders.

Lianas bind trees together, providing added stability in high winds. If, however, in very strong storms one tree topples, the intertwining growth of lianas will tend to bring everything crashing down. This happened here in the mid-1980s creating the large gaps you can still see at intervals along the path.

Liana growing on *Sloanea sigun*: the sore/red-eye tree – the star-shaped fruits break open to reveal a red inside.

Left: *Kadsura scandens*. The juicy fruits of this common liana grow in grape-like clusters and are sharp tasting, with medical properties: around Cibodas the fruits are made into a poultice to reduce fever.

3

On the right-hand side of the path, 3 paces before and 5 paces after the stone; 12 paces beyond the stone on the right-hand side of the path, and 27 and 60 paces up on the right.

- pandan palms: very long, narrow, belt-like leaves
- teeth on leaf-edge and mid-rib
- spiral growth pattern of leaves

- finger-like prop roots

The belt-like leaves of pandan palms (*Pandanus furcatus*) are unmistakable: tough, very dark green, narrow, and reaching 2-5.5 m in length. The name 'pandan' derives from the Malay word meaning 'fragrance' and refers to the scented flowers. The pandan's other name, screw palm, derives from the way the three rows of leaves spiral out from the stem.

The teeth on the leaves provide a defence against browsing animals. Why the teeth on the mid-rib tend to point backwards while those on the leaf edge point forwards is a puzzle. The mid-rib teeth probably help support the weight of the large leaves as they climb over other vegetation.

Pandans: multi-purpose plants

Pandans, relatives of true palms, are distributed throughout the Old World. Their leaves yield a strong fibre and are extensively used for matting; sail cloth was another traditional product. The leaves and flowers of some species are used in cooking or as a source of perfume. One pandan was mixed with milk and drunk as a love potion. (If you wish to explore this possibility further see ref: Burkill!). Our *P. furcatus* is an edible species. Juice extracted from its leaves is used as a flavouring in Sundanese cuisine. Traditionally in Indonesia this pandan was one of a number claimed to have value as an antidote to poison.

A matter of sex!

3

"Henceforth be flourishing as the pandan and waring'en trees."

- Part of an ancient Javanese marriage benediction: recorded by Sir Thomas Stamford Raffles.

A pandan is either male or female. In temperate regions the large majority of flowering plants are bisexual, but in tropical forests a significant minority have separate sexes.

In tropical forests, because there are so many different species, the likelihood is that individuals of any one species will grow far apart. Therefore plants which are both male and female (bisexual) will tend to fertilise themselves (self-pollination), and be less likely to pollinate each other (cross-pollination). In order to prevent self-pollination, and so make sure that only cross-pollination takes place, many species in tropical forests carry the male and female flowers on different plants.

Cross-pollination is especially important in the highly competitive conditions prevailing in the tropics. Crossing quickly mixes up genes, making a species more adaptable and, therefore, quicker to respond in the on-going evolutionary battle against diseases and parasites. It also affords a vital competitive edge in the struggle for light and space.

Pandanus furcatus: a screw palm.

3

Walk on looking around for climbing palms covered with spines.
(Also along the side of the path between HM9 - 10.)

- rattans:vicious palms armed with many spines and long, hook-covered whips
- palm-like leaves
- long spines at base of plant
- claws on leaves

- clawed whips from the tops of some leaves

- snakeskin fruits

Such palms, called rattans, are one of the many types of liana or woody climber. The park has several species including the rhino rattan, the devil's bush and reed rattans.

The rhino rattan

The very large, common, mountain rattan is *Plectocomia elongata*, called in Indonesian *rotan badak*. Badak translates as 'rhino', 'thick-skinned' or 'giant', all of which aptly fit this plant: tough and reaching over 40 m in height. The scientific name *Plectocomia* means plaited hair: the flowers form long, plait-like chains which the Balinese used to wear as skirts. After fruiting the plants die and fall, often becoming major obstacles to visitors using the path.

Plectocomia elongata: a large mountain rattan.

Reed rattans: not pretty flowers!

3

Reed rattans belong to the largest rattan genus (*Calamus*). The park has at least two species but they tend to grow away from the path, deep in the forest. Reed rattans are very successful. The only group to extend beyond S.E. Asia, *Calamus* species reach to Africa and Fiji. Commercially, *Calamus* is the most important group of rattans. The flowers hang away from the stem and the flower stalks can grow into long, clawed whips called flagella.

Daemonorops: two species occur in the park (*D. rubra* and *D. melanochaetes*): both yield resin but *D. rubra* fruits constitute an important supply of dragon's blood

Devil's bushes and Dragon's Blood!

The famous rattan *Daemonorops rubra* is found in the lower areas of the park. The first part of its scientific name means 'devil's bush' and it is not difficult to see why: the plant is heavily armed with sharp spines.

Indonesia and Malaysia share one hundred or so species of 'devil's bushes'. Around eight *Daemonorops* species, including our *D. rubra*, yield the world famous 'Dragon's Blood'. Other non-rattan sources of the 'blood' had been reaching Europe since classical times but 'Sumatran Dragon's Blood' was traded westwards to India and Europe by the Arabs from the 16th century onwards. The main trading centres were Palembang, Jambi, West Java and Kalimantan.

Wild, mystical claims abound, but Dragon's Blood has two practical uses: it produces a very high quality dye for varnishes, and it has medicinal value - for instance in treating stomach complaints. The active compounds are benzoic and benzolactic acids and an alcohol (draco-resinotannol). Dry 'blood' is obtained from the fruits which contain the crystallized resin.

Which rattan is this?

See if you can identify a rattan. All have small claws on their whips.

Rhino rattan (*Plectocomia elongata*)
Often very tall, stem as thick as your arm! End of leaf stalk very long and extended into a whip (cirrus). Spines on stems spirally arranged, and comb-like. Flowers forming long, plaited chains.

Devil's Bush (*Daemonorops species*)
Spines random, not spirally arranged. Whips on some of the leaf stalks, spines light brown, older spines often dark brown.

Reed rattan (*Calamus species*)
Spines random, not spirally arranged, with some of the clawed whips coming from the stems (flagella). Spines usually green. Stems often small and usually not much thicker than your thumb.

Top: *Calamus* flowers grow on long clawed whips.
Middle: *Plectocomia* flowers.
Bottom: *Plectocomia* fruits.

No forest, no rattans

3

The presence of rattans indicates relatively undisturbed or primary forest. The focus for rattan diversity is South East Asia, strongly centred on Indonesia and Malaysia. Indonesia alone is home to over 350 species.

Three-quarters of the world's cane is produced by Indonesia. In the late 1980s the country was earning around US$ 200 million annually from the rattan trade - a figure expected to triple over the next few years. Conservationists are very fond of telling us that without the tropical forests there would be no cane furniture to sit on.

Stop thief! Years ago thieves often broke into peoples' houses wearing very little clothing and covered in oil; they were very difficult to grab hold of. Bent rattan canes, possessing vicious spines, were effectively employed in hooking and restraining the wrong-doers.

Rattans continue to play an important part in Javan and Sundanese village life. Several canes are used in basketry and for matting. Salak (*Salacca edulis*), with brown snake-like skin is an edible rattan fruit commonly sold in markets.

QUIZ NO. 2

Only one of the following statements about rattans is NOT true:

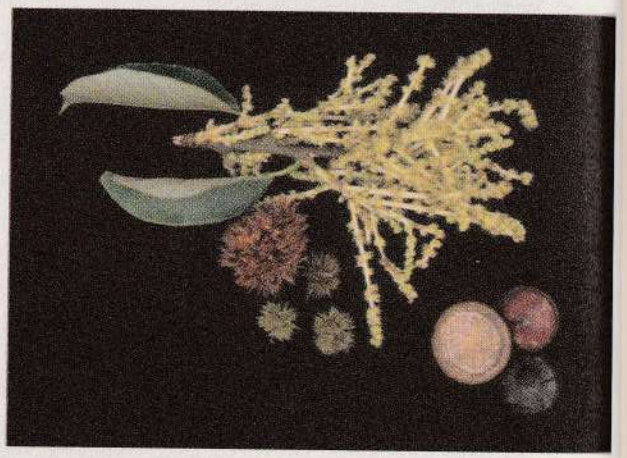
i. Their stems are a good supply of drinking water.
ii. *Plectocomia elongata* can be used to make a noose to catch wild elephants.
iii. Many Europeans thought Dragon's Blood to be the blood lost by dragons when fighting elephants.
iv. Bamboos are giant, thornless species of rattan.
v. Rattans must be prepared by being boiled in oil in order to bring the resins to the surface.

4

Right hand side of the path, 5 paces beyond the stone, 3 m into the forest

- a large, old, silver chestnut tree
- spiny fruits with 2/3 sharp tasting nuts inside
  (If not visible here hunt for fallen fruits all along the path)

The silver chestnut (*Castanopsis argentea*) here, may be around 70 years old. The name refers to the silvery underside of the leaves. Mountain specimens have thicker leaves and more spines on their fruits. The problem for biologists is to know whether there is a reason for this, or is it, as in the words of van Steenis, a mere "caprice of nature"?



Left: The silver underside of the leaves gives the silver chestnut its name

Above: Chestnut flowers and spiny fruits (*Castanopsis*) and oak acorns (*Lithocarpus*): chestnuts and oaks both belong to the same family (FAGACEAE)

Right-hand side of the path, 27 paces beyond the stone.

4

- chestnut tree leaning over the path
- spiny fruits with 1 nut inside (tastes good)

At this location you should find the Javan chestnut (*Castanopsis javanica*) leaning out slightly over path. Generally, individuals are too poorly-shaped to be of value as commercial timber trees but possess a strong, long-lasting timber.

As you walk along the path look out for fallen chestnuts: green/brown and thickly covered with spines. The monkeys and gibbons split them open with their bare hands!

Where chestnuts grow

Chestnuts of the genus *Castanopsis* are found in E./S.E. Asia, and range from N.E India and Japan to New Guinea. Oddly, a small area of the west coast of North America possesses both living and fossil *Castanopsis* species. Chestnuts are common in the lower hills of the Indonesian archipelago, favouring altitudes between 1,000-1,500 m a.s.l.. In the park they form an important part of the sub-montane community, not reaching into the true montane zone. *Castanopsis* species prefer ever-wet forest and hence are more abundant in the west, being absent from Central Java.

The Javan chestnut flowers from September to March and fruits develop from March to December. This pattern of flowering in the wet season and fruiting in the dry is typical of chestnuts. The silver chestnut is an exception. It flowers from August to October, the driest months of the year, and fruits from November to February, the time of highest rainfall. This may be just another "caprice of nature", but the two different flowering cycles may relate to complex biological factors: perhaps the different conditions necessary for seed germination. Often climatic changes or day length will trigger collective flowering.

4

All along the length of the path.

- Four species of primate: one gibbon and three species of monkey (descriptions below)

Three kinds of monkey and one species of gibbon are found along the path. All are commonly observed but you must walk quietly, and look and listen. Try scanning open trees for dark round 'blobs' with tails hanging down! Youngsters are also frequently seen. The striking colour/markings of young leaf monkeys is thought to help maintain parental interest.

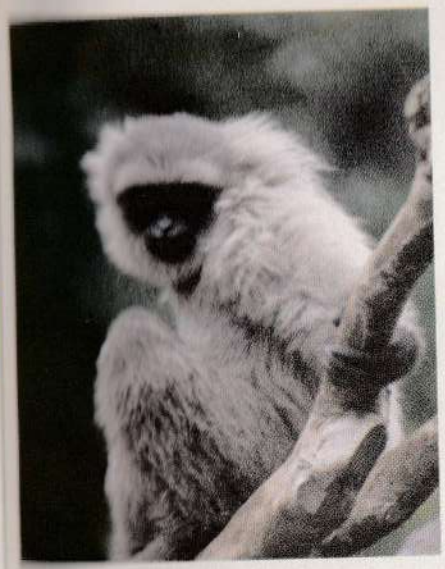
Key to primates

Javan gibbon (*Hylobates moloch*)
Grey body, black face, no tail. A lowland species found only in the lower areas of the park. Endemic to western Java, extremely rare and endangered. Usually seen singularly or in pairs; all the other primates live in groups. The Indonesian name, Owa, accurately describes its call.

Ebony leaf monkey (*Trachypithecus auratus*)
Black, long-tailed, long limbs and slender-looking; youngsters are ginger. Endemic to Indonesia: only occurs on Java and a few associated, smaller islands. Feeds on leaves.

Javan leaf monkey (*Presbytis comata*)
Grey, long-tailed, slender-looking long limbs and with a crest on the head. Youngsters are white with a black stripe from head to tail and another across the shoulders. Endemic to western Java, extremely rare and endangered. Feeds on leaves.

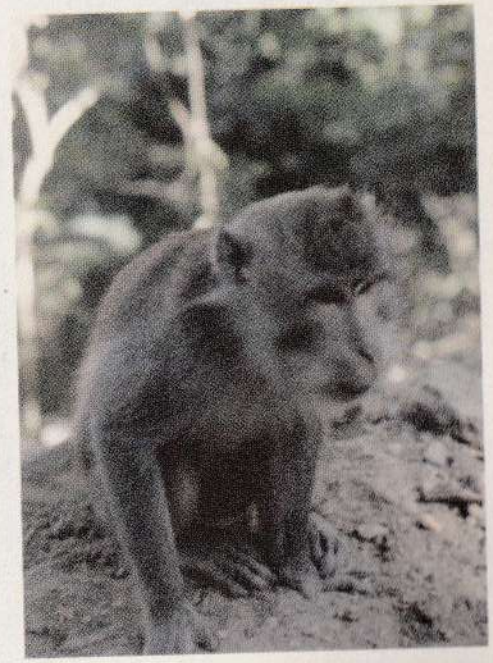
Long-tailed macaque (*Macaca fascicularis*)
Grey, long-tailed, short limbs and stocky looking, the only monkey in the park to be found on the ground. Diet very varied. Ubiquitous: may even live in towns.



Javan Gibbon

Ebony leaf monkey

Javan leaf monkey



Long-tailed macaque

5

On the left-hand side of the path 4 paces beyond the stone.

- *rasamala*: a very tall tree with an orange-white trunk
- several other trees of the same species growing together as a 'family group'
- the way *rasamala* trees tower over other vegetation

The huge species of tree towering over this area is the *rasamala* (*Altingia excelsa*). Called by Junghuhn the 'king of the mountain forest' individuals may reach well-over 60 m in height. The richly coloured trunk is very striking in full sunlight. Rasamala, as here, often grows in so called 'family groups'. There is another fine specimen down the path on the bend, and several more just a few metres up on the left. Trees that rise above the general canopy like rasamala are called emergents.

Big trees and small insects

The tree genus *Altingia* contains only eight species and is to be found from Assam and southern China down as far as Java. Our representative, rasamala, grows best in hilly areas of high rainfall. It is not really a true montane species: scarce after HM9, its upper limit is just above the Cibeureum falls (1,800 m a.s.l.). Ants commonly spread its sweet smelling seeds.

Strengthen your brain!

5

Resins are used by trees to seal wounds in their bark. There is an old tradition of collecting the impure resin from damar bees' nests (damar being a Malay word for resin). Today *Altingia* resin is still collected for use in drugs and perfumes and can be found as a constituent of Friar's Balsam. Young leaves are edible and chewing them helps ease coughing. One record from 1790 claimed that extracts were a good brain- strengthening tonic. In addition a dye can be extracted from the bark.

What's in a name?

The Indonesian/Javan name *rasamala* means 'excrement' - not exactly appropriate for such a noble tree with a scented resin! Over two thousand years ago Indians were trading tree resin or storax, used by the Egyptians for embalming. Merchants obtained this valuable commodity from around the Mediterranean, exporting it to countries as far away as China. The story went around that the resin was in fact lion's dung. Not surprisingly, the Indian traders gave it the Sanskrit name for dung/ excrement: *rasamala*. It seems likely that *Altingia excelsa* was then discovered and exploited as a new and closer source of resin well before 700 A.D., at the time when Sumatra and Java were ruled by Hindus. Hence, this tree too became known as rasamala, and the name has stuck!

Altingia excelsa: Rasmala tree.

5

To chop or not to chop?

The clear rasasmala resin turns white on drying.

Rasamala is a perfect timber tree possessing a long, straight, uninterrupted trunk, up to 1.5 m in diameter. The very beautiful wood is dense, deep brown and scented. One cubic meter of *Altingia* wood weighs 750 kg – even heavier than teak! No wonder in many places throughout its range in S.E. Asia it has been logged out of existence. If left to mature the tree may live to be 300-500 years old. Only in well-established reserves, such as here, can you see fine examples. Grown outside the forest, in open conditions, rasamala produces a short trunk branching too low down to be commercially valuable. Because large, old trees are now rare the wood is not exported but utilised in Indonesia.

QUIZ NO. 3 Which do you think? Only ONE of the following about rasamala is FALSE:

i. Rasamala wood is used for buildings, bridges, telephone poles and boats.
ii. The rasamala resin is used to make a sweet smelling incense called getah malai.
iii. The scientific name *Altingia* comes from the Indonesian word tinggi, meaning tall.
iv. Rasamala is not a good wood for furniture making because when it dries out it twists and cracks.
v. Rasamala leaves are aromatic and are a favourite ingredient of Sundanese salads.

5

Things you may see fallen on the path:

Top left: red flowers of the family GESNERIACEAE (See notes for marker stone 26)
Top middle: white banana flowers (stone 6)
Top right: orange Rhododendron flowers (stone 15)
Middle right: green leaves of orchids (stone 22)
Bottom left: Figs (stone 2)
Bottom middle: white jasmine flowers, large white flowers of puspa (stone 16),
Bottom right: spiny chestnut fruits (stone 4)

6

All around, especially on the left-hand side of the path directly opposite the stone.

- wild banana plants
- the way the 'stem' is made up of very long leaf stalks

- banana flowers and fruits

Bananas! (Family MUSACEAE). The Indo-Malaysian region is the world's centre for banana diversity: S.E. Asia and the Pacific have many useful varieties unknown to commercial growers. No-one is really sure how today's domestic banana came about. Research suggests that one of its parents is the banana you see here (*Musa acuminata*), called locally *pisang hutan* or the "forest banana". It grows in lowlands and hills, generally occurring in the park up to 1,500 m a.s.l.. Banana plants thrive best in the open conditions of forest gaps.

Bananas don't grow on trees!

The false stem (pseudostem) of a banana plant consists of several long leaf stalks wrapped around each other; internally the structure is not that of a tree trunk or even that of a plant stem. Being large but non-woody creates problems; it is impossible to produce lots of small leaves on twigs. Instead, a few huge leaves emerge from a central 'stalk'. Leaves are 'photosynthetic factories' and must produce enough materials for growth and fruit production. So much energy goes into the making of big banana leaves that they have to function for a long time, even though stalks are weak and leaves tear easily. Because banana fruits are many, and large, it takes many months to amass sufficient energy and materials for their production.

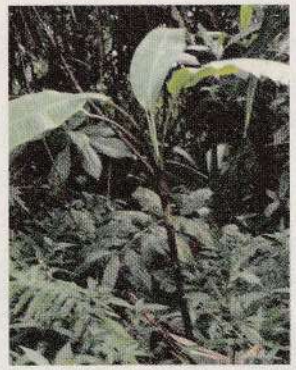
A banana a day keeps the doctor away!

6

Banana plants supply many traditional medicines: young banana leaves have been employed for relief of chest pains and sore or blistered skin; the sap as a cure for gonorrhoea, dysentery and diarrhoea; the root against hair loss and anaemia; the fruit is a laxative and banana flour is used to counter dyspepsia, flatulence and acidity. Here in the park a man was even stopped from bleeding, perhaps to death, by applying young leaves to a deep gash.

Bank your bananas!

Banana pulp is of a very high quality and can be used to make tea bags, sausage skins, disposable nappies and even bank notes. The wild banana, *M. acuminata*, is regarded as an important 'gene bank' for the improvement of the domestic banana.



Bats and bananas

The clusters of long, trumpet-shaped banana flowers hang away from the stem and leaves. Such an arrangement favours pollination by bats. The bats can more easily swoop in and cling onto the exposed flower clusters.

QUIZ NO. 4

Which of the following is FALSE?

i. Bananas need very low levels of nutrients.
ii. Bananas are low in cholesterol, but high in vitamins C and B6.
iii. Park guards use the sap against stings from 'nettle-like' plants.
iv. S.E. Asian bananas are now grown in all areas of the tropics.
v. Traditionally, banana leaves make a very good floor polish.

7

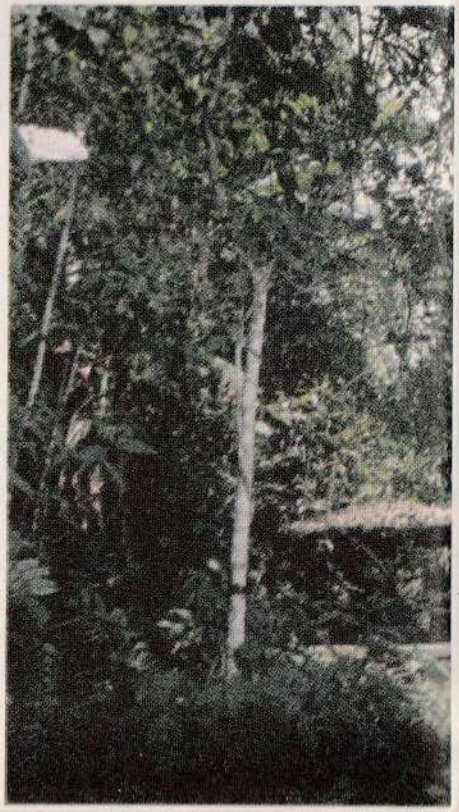
On the right-hand side of the path directly opposite the stone.

- *Selaginella*: small fern-like plant
- leaves growing sideways, on one plane, to obtain maximum sunlight
- small , scale-like leaves covering the stem

The genus *Selaginella* is found all over the world and belongs to a very ancient type of plant. *S. opaca*, the species you see here, however, is only found on Java. The surface layers of the leaves reflect harmful ultraviolet light away from plant tissues, often giving a blue sheen to the surface.

Left: *Selaginella* favours moist shady conditions.

Right: *Dendrocnide stimulans*: the stinging jelatang tree, note the paper-chase plant growing up its white stem.



Where to look: Keep walking until you see a shelter. Stop at the clump of mixed vegetation on the left-hand side of the path about 10 paces before the shelter.

7

- a large chestnut
- a jelatang: a small tree with a very white trunk and large pale leaves. DO NOT TOUCH THE LEAVES.
- a paper-chase plant: a creeper growing on the jelatang tree. Leaves: dark-green, pointed, red-veined

- the white decoy leaves and orange flowers of the paper-chase plant (see notes HM16)

1 meter past the shelter.

- red flowers of a climber (Agalmyla) growing on an old tree (see notes HM25)

he *jelatang* (*Dendrocnide stimulans*) belongs to the same family as the ell-known European stinging nettle (URICACEAE) and its leaves re hairy and poisonous. The itch can be very painful and may last of several days. The group as a whole is mainly tropical and our pecies ranges from Thailand to Java. The jelatang is a lowland plant, aching only into the sub-montane forest, and does not represent a najor hazard to people exploring these mountains. In some lowland orests, however, it can be very troublesome.

QUIZ NO. 5 Guess which of the following statements about the jelatang is NOT true:

i. The plant was traditionally employed on Java to make buffaloes fight.
ii. The sting can make you seriously ill.
iii. A few parts of the plant are sweet and edible.
iv. It was used as a very effective poison, both on darts and in food.
v. The stinging hairs are rich in irritating silica and contain a liquid which acts on nerve-endings.

8

On the right-hand side of the path, 4 paces beyond the stone.

- a *jantri*: a small tree with a white/grey bark

- yellow-white flowers
- large, dark-blue fruits containing seeds

The *jantri*, (*Elaeocarpus sphaericus*) is very attractive, the bark being a mixture of mottled greys, browns and whites. There are around a dozen related species on Java and about 100 shared between the Indo-Malaysian and Australasian regions. The flowers are small but beautiful, with yellowy-white petals often tinged red at the base. The name *Elaeocarpus* means "oil-fruit". The medium-sized, dark-blue fruits provide an important food source for birds and mammals.

A young Jantri tree (*Elaeocarpus sphaericus*).

Eyes, beads and seeds

E. sphaericus is a hill species occurring in north-east India, Java and Sulawesi. The wood is white but is little used as it rots easily. The seeds have a value as beads and, in India, fakirs wear strings of 101 of them: symbolic of the eyes of Shiva. On Java Chinese collectors produce high quality small seeds by cutting a shallow circle around the trees (ring-barking).

On the left of the path 2 paces before the HM8.

8

- *panggang-cucuk*: small trees/shrubs with many short spines on the stem

- leaves coming from a central point (palmate)
- leaves held horizontally to gain maximum sunlight

Trevesia sundaica is covered with short spines. The local name roughly translates as the 'thorn (*cucuk*) skewer (*panggang*)'. If you make a very small scratch with your finger nail you will see a green photosynthetic layer under the bark. The spines stop animals such as deer eating this living tissue. Spines might also be useful in other ways: to increase the surface area of the stem, helping photosynthesis, helping deter plant-eating insects from climbing to the leaves and buds, and in preventing creepers from growing over the tree.

Trevesia: about 12 species are found throughout South East Asia.

Elaeocarpus beads are also used for making Christian rosaries.

8

Walk to the open area just past the next bend (about 35 paces).

- trees blown over by storms
- passion fruit plants: large, heart-shaped leaves covering trees and bushes.

- the very attractive passion flowers
- green/orange passion fruits (markisa)

This area has been badly disturbed by storms. The creeper dominating the vegetation is the passion flower (*Passiflora suberosa*), an introduction from Brazil. Its distinctive purple and white flowers can often be seen lying on the path. Most passion flowers come from America but a few originate in Asia and Australia. The park's other *Passiflora* species, the yellow-flowered *P. edulis*, is also an introduction. Passion flower's profuse, dense growth can frequently kill trees.

A matter of taste?

You may find empty purple, orange or green fruit skins lying on the path, white inside and about the size of oranges. These are the remains of the fruit of the passion flower. Passion fruit is sold in local markets as *markisa* or *konyal*. Another Indonesian name is *buah monyet* (monkey fruit) - odd, since monkeys in the park do not seem to like them! The contents of the empty skins discarded on the path have usually been eaten by treeshrews! Small teeth-marks can be seen where these animals have been nibbling away.

Passion fruits

8

Useful trials or dangerous experimentation?

In the middle of the 19th century 'acclimatisation experiments' were carried out, using potentially economically important, foreign plants. More than 30 species were either introduced into the forest or have escaped from the Botanical Gardens. These 'exotics' are noticeable because they often possess large, colourful flowers and prefer the lighter conditions along the path. Fortunately, none has caused serious problems, and the 'aliens' are insignificant in the functioning of the forest.

Passion flowers have religious significance for Christians.

Passiflora grows fast, smothering native plants in the sunlit conditions of forest gaps.

9

All around, on the ground, on fallen leaves, and on dead wood.

- fungi rotting away dead wood

- bracket fungi
- mushrooms and toadstools

A mushroom, toadstool or bracket fungus is really only a small part, the fruiting body, of a whole organism. The rest of the fungus is busy inside the decaying wood, producing a vast array of enzymes to break down cellulose and other organic materials.

Pick up and smell the soil, look at and feel the leaf litter. Things rot very quickly in tropical forests and the nutrients they contain are soon recycled. Micro-organisms break down leaves, wood and dead animals. In the forest growth and decay are profoundly linked.

Fungi: vital to the well-being of the forest.

What grows up must rot down

Visitors naturally want to see monkeys, sunbirds, leopards and butterflies, and indeed these species all have their own unique roles to play in the well-being of the forest, but spare a thought for the unsung heroes of the system: the decomposers. Without the industry of bacteria, fungi and slime moulds that rot everything away the whole forest would cease to function.

14 paces before stone on left-hand side of path, directly opposite jamuju trees.

10

- *Euonymus javanicus*: a small straight tree (dia. 30cm), shiny leaves in pairs

- fallen red berries containing black seeds

The bright red berries of *Euonymus javanicus* split open lengthways exposing the seeds, which are surrounded by a yellow flesh. It is likely that the red colour attracts birds. The birds act as vectors: they eat the seeds and flesh, fly off and disperse the seeds in their droppings.

Euonymus berries.

A dead white-eye: decomposers will soon get to work recycling the nutrients.

10

14 paces before stone on right-hand side of path.

- two impressive *jamuju* trees

In these higher areas the *jamuju* tree (*Dacrycarpus imbricatus*) starts to replace lowland species as the main emergent. As you continue to climb, these conifers become more frequent, favouring the cooler, cloudy conditions of the montane forest. They are particularly dominant a little higher, at the sub-montane/montane boundary.

The naked seeds of the jamuju grow on a fleshy base and are eaten by birds which then disperse the seeds in their droppings.

The greyish-brown to light-yellow timber, which is very attractive, is traded as Malayan yellow wood. Looking around here at the jamuju's abundance it is difficult to believe that outside the park this much sought-after timber tree is now rare.

Podocarps: giants from Gondwanaland!

Jamuju trees occur from Burma and Southern China through the Australasian Archipelago to the islands beyond New Guinea. Their genus, *Dacrycarpus*, is closely related to that of the podocarps. Podocarp distribution is supportive evidence that the continents have drifted apart.

Podocarps are members of a very ancient group. They are not Eurasian but evolved on the giant southern continent of Gondwanaland, before it broke up into South America, Africa and Australia. Our *Dacrycarpus* species together with a few other podocarps including *Podocarpus neriifolius*, which also occurs in the park, are 'southern invaders' into Eurasia. It seems probable that Sumatra, Burma and Peninsular Malaysia were actually parts of eastern Gondwanaland that collided with Eurasia. On these island fragments plants and animals would have travelled northwards, thus, old Gondwanaland species were able to gain a foot-hold on what was the northern, giant continent of Laurasia.

Jamuju: leaves for all seasons

Why should jamuju trees have two types of leaf ? The tree's small needle-like leaves are typical of conifers that must survive long winters. The needles cut down on water loss in the drought conditions that exist when all water has turned to ice. Ancestors of the jamuju would have had to have coped with fluctuating environmental conditions, for instance, those of ice ages and warm spells. Having two types of leaf, broad and needle-like, gives flexibility in changing climatic conditions. The broader type of leaf is efficient in the ever-wet tropics.

10

Jamuju trees (*Dacrycarpus imbricatus*): Sundanese names for the park's other podocarps are ki Bima and ki Putri -Bima was a mighty warrior from Hindu mythology and Putri means princess- names suggesting the strength and beauty of these trees.

11

14 paces before stone and around the stone on right-hand side of path.

- drip tips: leaves with long tips to the leaves (several different examples)

- mosses, algae and fungi growing on old leaves (epiphylls)

- two kinds of jamuju leaf: large tree 7 m before stone on right (see notes stone 10)
  i. needle leaves placed spirallly on twigs
  ii. comb-like teeth, flat and pointed and set in two rows on comb-like twigs

What you can see around you is a scramble for light. Think of the many differently shaped plants as 'designs' for capturing light energy (see notes below).

Do an old, dirty leaf a favour and polish its surface. It is surprising the difference a thin covering film makes to a leaf's efficiency. Mosses, algae and fungi growing on leaves are called **epiphylls**. They reduce the amount of light reaching a leaf, and this lowers the quantity of sugars the plant can produce by photosynthesis.

Leaf shape and colour are perplexing subjects. The function of drip tips, and why young forest leaves are frequently red, generates much lively debate.

Epiphylls can seriously slow the growth of plants.

Drip dry

11

Leaves, including those of many figs, are frequently drawn out to a long point called a drip tip. This is a common 'adaptation' of tropical forest plants, and is a feature looked for by palaeontologists as indicative of a tropical climate. Drip tips speed up the drying of leaves after rain, the theory being that the leaves can then more rapidly resume photosynthetic sugar production. Rapid drying also limits the amount of nutrients that wash out of a leaf.

Heated arguments have occurred between botanists about the usefulness of drip tips. Whitemore says their function 'remains enigmatic'!

By drying the leaf quickly, drip tips may also help prevent the harmful growth of mosses and algae on the leaf (see 'epiphylly' above).

If you are not winning, you're losing

A tropical forest is a highly competitive place and plants will kill each other for light. Plants need sunlight to make food and there are many different strategies for getting light energy, listed below are just a few:

- many small leaves: **rasamala**
- delicate leaves to let light reach all over the plant: **tree ferns**
- a few long-lasting big leaves: **bananas and tjonkok plants**
- growing very tall: *r***asamala and jamuju trees**
- growing on other plants: **bird's nest ferns, passion flowers and rattans**
- producing poisons to stop other plants growing near: **gingers**
- leaves held horizontally: **panggang-cucuk trees**
- very dark green leaves (the green substance chlorophyll captures the light energy) **jantri trees**

Epiphytes: plants which grow on others.

12

Around stone and in trees opposite the stone and shelter.

- *Eupatorium riparium*, small dark green plant with pointed leaves and white, daisy-like flowers
- Large ferns growing in trees (see notes for HM13: Bird nest fern)

Well-lit areas, walk about 25 paces past HM12.

- *Eupatorium sordidum*: large velvet leaves (in pairs)
- how well other plants can grows in the dark conditions under these leaves

- purple daisy-like heads

The path between stones 12/13 is lined with the large, bright-green velvet leaves of *Eupatorium sordidum*. The purple-mauve daisy heads are unmistakable. The white flowers of *E. riparium* are similar, but smaller. Both species of *Eupatorium* are introductions from tropical/Central America.

Harmless introduction or noxious weed?

Eupatorium sordidum is a very noticeable exotic, introduced from Mexico. The plant grows profusely in the lighter areas along the path. It has a narrow altitude range (1,400-1,700 m a.s.l.), and does not thrive in the gloomy conditions of the forest. These two characteristics prevent this weed from becoming a major nuisance, but, over the last few years, the plant has definitely been on the increase. Judge for yourself whether much natural vegetation can grow under the mass of thick foliage. *E. sordidum* may, however, aid soil conservation as its leafy growth quickly covers bare ground susceptible to erosion by heavy rainfall.

50 m past stone 12 where a tree has fallen across the path.

12

- a fallen oak tree which has made an open gap in the forest

- the "rhino" rattan (*Plectocomia elongata*) –> See notes for stone 3

- pale blue, indigo and little pied flycatchers. They often sit in the open watching out for flying insects
- *Rhododendron javanicum*: the orange flowers are in several of the big trees around
- yellow and black beetles: because of the insect's feeding habits its Indonesian name is kubang jamur meaning "fungus beetle"

This is where, in 1993, a large oak fell across the path. The wood is so strong that the tree is called in Indonesian *pasang batu* or stone oak. The area is in the process of regeneration.

Violent storms are a feature of the Gede-Pangrango area. In 1993 several trees were damaged in the Cibodas Botanic Gardens but this was as nothing compared with the strong storms of 1984 and 1985: considerable havoc was wreaked within the National Park, gales toppling many venerable trees. The forest still has not fully repaired itself, but such events are part of a natural cycle.

Tree gaps provide opportunities for quick-growing, light-loving species.

12

Tree death: misfortune or opportunity?

A tall tree is a remarkable balancing act. The weight distribution of its branches is critical to its staying upright. With age, large branches become infected, die and break off, resulting in a lop-sided crown. A strong wind does the rest. When a tree blows over two gaps form:

- one high up in the canopy where the tree stood;
- one gap on the ground where the tree fell.

Such gaps are very important and are technically called a **chablis**. The canopy or crown gap soon fills with young, immature trees, often offspring of the old tree, so species composition is not much altered.

The ground gap, however, is quite different. Light-loving species rush in and a profusion of small herbs and shrubs compete fiercely for space. Gradually the first arrivals are crowded out by light-loving, quick-growing pioneer trees and shrubs. These in turn are shaded out by the establishment of the more typical trees of the mature forest. Such a sequence is an example of **plant succession**.

The rotting tree provides food and shelter for many micro-organisms, invertebrates and other small creatures. The new habitat is a good place to observe birds. Flycatchers are frequently seen hunting around or making short flights to catch insects on the wing. The death of a tree is important in the cycle of the forest. By creating new habitats and new opportunities such occurrences greatly enhance **forest diversity**.

The way the leaves hang from *A. nidus* is reminiscent of someone in prayer: forearms extending away from the body with hands upturned, hence the Bugis name *kembang berdoa*: 'the praying plant'.

On trees.

13

- plants growing wholly on others (epiphytes)
- the bird's nest fern: a large fern with belt-like leaves growing on trees
- thick covering to the leaves of the bird's nest fern
- dead leaves and organic matter building up around the bases of bird's nest ferns

- plantlets of the bird's nest fern (many at the Blue Lake)

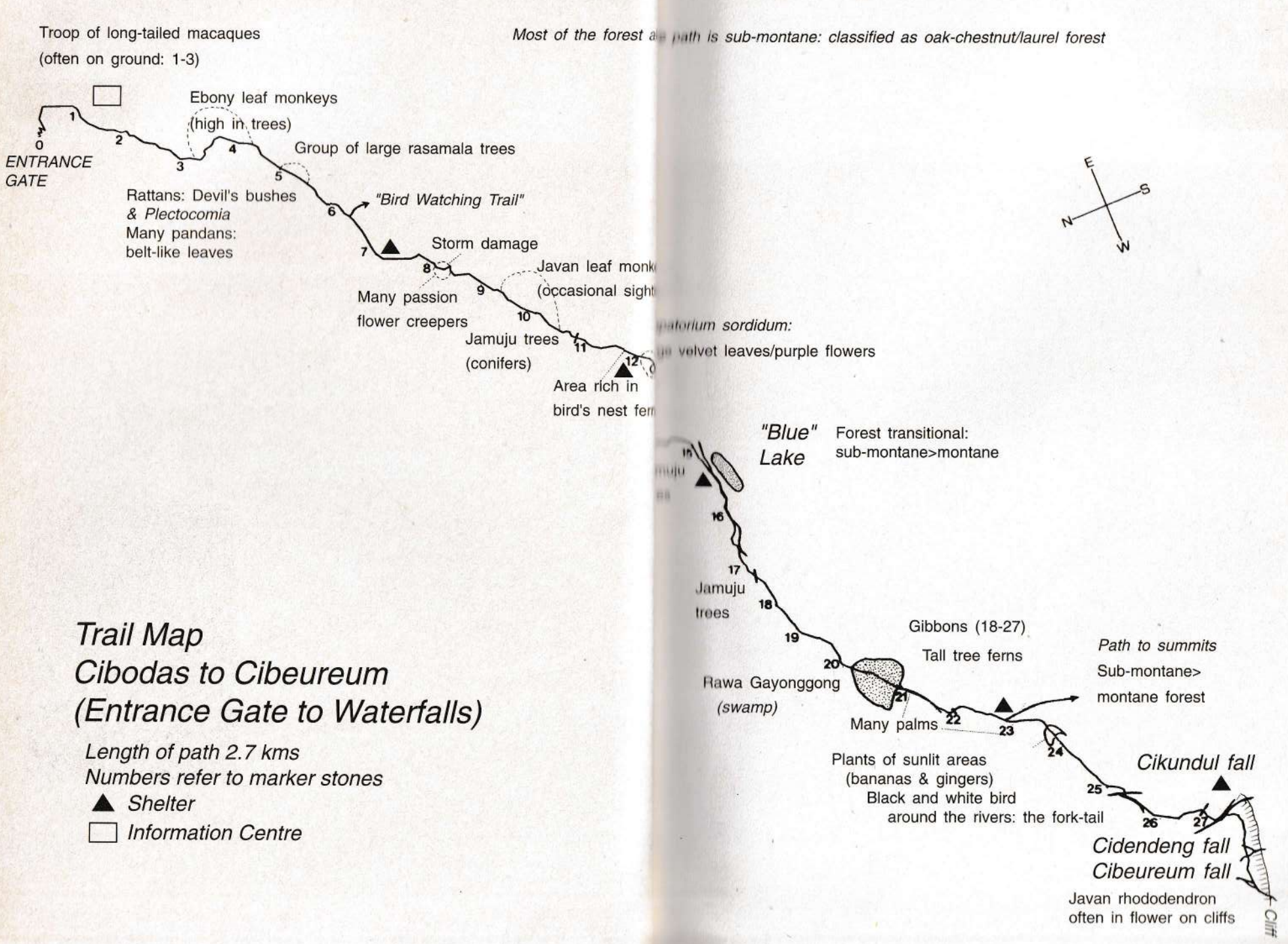
In the forest there is an obvious fight for space and light. One common mode of life is that of the **epiphyte**. These are plants which grow on other plants but are not strongly parasitic. They are particularly abundant in forests where humidity is high. Epiphytes generally face the problems of obtaining sufficient nutrients and water. Common epiphytes include orchids, ferns and mosses. One of the most noticeable is the bird's nest fern, *Asplenium nidus*.

The bird's nest fern

Delicate plantlets establish on trees that have already collected small quantities of nutrients on their bark. As the fern grows, its rosette shape enables it to trap dead leaves, including its own, forming a spongy mass which retains water and prevents the plant from drying out. A diverse community develops. Ants and other communal insects nesting in the fern bring back dead animals and the remains of fungi and plants. Such foraging increases *Asplenium*'s nutrient supply and provides nitrates necessary for growth.

The "singing worm"

With the help of invertebrates and micro-organisms a humus-rich soil is built up. A giant, blue earthworm (*Metaphire longa*) has adapted to living in the bird's nest fern. The worm digests organic matter and releases minerals which the plant utilises. The local name *cacing sonari* means the 'singing worm' and refers to the whistle-like call the animal makes at night. As with many epiphytes the leaves of *A. nidus* are covered with a thick waxy layer (cuticle) which helps to conserve precious water.



Trail Map
Cibodas to Cibeureum
(Entrance Gate to Waterfalls)

Length of path 2.7 kms
Numbers refer to marker stones
▲ *Shelter*
□ *Information Centre*

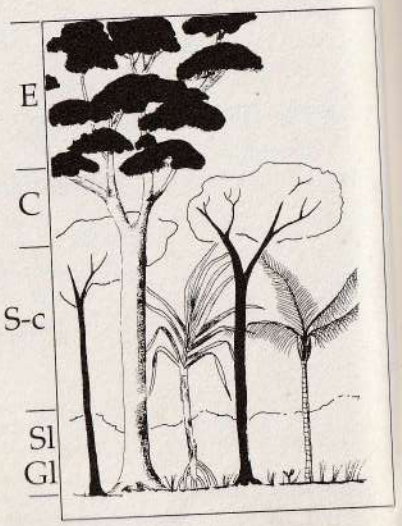
All around at the forest structure.

Emergent trees	giant trees rising above the general forest canopy	*Jamuju trees*
Canopy trees	medium to large trees forming the forest 'roof'	*Puspa*
Sub-canopy	small trees, palms etc. growing in the dark conditions of the forest	*pandans*
Shrub layer	plants up to the height of a person	*Curculigo*
Ground layer	small plants of the forest floor	*ferns, mosses, fungi, grasses*

Layers or patches

Ideally, in a mature, undisturbed forest many plants would grow to their full height, forming layers. In real forest conditions storms blow, trees fall and young, immature plants can be almost any height. To the theoretical biologist using neat computer graphics the real forest may look an untidy mess.

Another way to think about forest structure is as a mosaic, consisting of different aged patches. New forest gaps, formed where trees have fallen, contain 'pioneer species. In full sunlight 'pioneers' out-grow true forest plants. Young forest may be made up of many medium-sized trees which form the canopy. In mature areas that have suffered little disturbance large trees will be more common, and the forest will have a more complicated structure.



•the different types of habitat a tree provides (eg. roots, bark, leaves and holes in the trunk)

Chose a small tree, and think of it in terms of a set of different habitats for living organisms. Look hard and see how many different species (fungi, insects, plants etc.) you can find.

Each species in the forest has its own 'niche' or role in the overall scheme of things. For instance, a hunting beetle of the tree tops plays a very different part in the functioning of the forest from that of a fungus-feeding beetle living in dead wood. Plants and animals form distinct communities within the forest. The fungi, insects, spiders and mammals living in the roots of a tree represent very different species from those living in the sunlit canopy.

Tall trees: living skyscrapers

Let us think about a large tree. Its roots provide protection for a host of invertebrates, amphibians, reptiles and small mammals. The lower part of its trunk is shady and moist, suiting mosses and ferns. Conditions here are often very competitive, with many species of plant fighting for space and light. Higher up, conditions are lighter and less competitive, but much harsher: often the air is damp, but when the clouds clear plants are exposed to strong sunlight and may quickly suffer from heat and water stress. Out above the shade in these equatorial mountains, ultraviolet light is very strong: the equator receives intense sunlight and because the park is at a high altitude there is less ozone than at sea level to protect plants and animals from the harmful effects of UV radiation.

Tall trees provide many habitats.

15

Where to look: Walk on 60 paces until you come to the Blue Lake, on the left-hand side of the path. Look at the far side of the lake.

- the change in vegetation from the lake-edge to the top of the ridge
- the colour of the lake: blue, green or brown

- algal growth

Here we can see the start of the transition from sub-montane to montane vegetation. The mass and diversity of the sub-montane forest near the edge of the lake gives way to the twisted podocarp conifers of the ridge top. The area is rich in the bird's nest fern *Asplenium nidus*, and many epiphytic orchids grow on the trees around.

The medium, green-grey tree at the water's edge, directly opposite on the further shore, is yet another species of fig, *Ficus alba*. Brown-throated barbets and treeshrews can often be seen taking its fruits. After producing figs the tree appears to die and then, after resting, sprouts new leaves.

Slimy-green or magical-blue?

Depending on algal growth, sometimes *Telaga Biru* is a slimy, green-brown, at other times a magical deep blue. The lake's water is rich in nutrients (**eutrophic**). The area's volcanic rocks and soils are sources of many soluble minerals. Nitrates, which strongly influence the growth of algae, are derived mainly from the rich supply of decomposing leaves and other organic matter.

The colour of the lake undergoes dramatic changes which appear to relate to the wet and dry seasons and to nutrient supply - both factors affect algal cycles.

At the far end of the lake on your right.

15

- medium-sized orange flowers near the lake's edge

The beautiful orange-flowered *Rhododendron javanicum* often blooms, flame-like, high up on the branches of host trees. It occurs all around the lake, but a fine specimen is growing right down at the water's edge. Look for it also at the clearing between HM12-13, on the cliffs at the waterfalls and investigate wherever you see its fallen flowers.

Rhododendrons

Rhododendrons are mainly a sub-tropical/tropical group. A few species have even reached California and Siberia but the great centre for rhododendron diversification is S.E. Asia, particularly the temperate mountains of the region. From the Himalayas through Indonesia to New Guinea, rhododendrons form an important constituent of sub-montane, montane and sub-alpine communities.

R. javanicum occurs from the park boundary right to the top of Gede and is one of a few plants able to withstand the sulphur-rich gases of the crater. While *R. javanicum* represents the common, large-flowered species, three additional rhododendrons also ornament the forest. The other frequently encountered member of the genus is *R. retusum*, which possesses rather smaller, deep-orange, trumpet-shaped flowers.

15

Medium–large birds to look out for near the lake:

Brown-throated barbet: Green bird, brown head.

Black eagle: Black, very large, high up on open branches.

Crested serpent-eagle: Small crest on head and white tail-bar.

White-crowned forktail: Long tailed, black and white bird of streams and lake margins. If brown on head: lesser fork-tail.

Blue-tailed trogon; A very beautiful, long-tailed bird; blue-green back, yellow under-parts and red bill.

Racket-tailed drongo: Blue-black birds, tails having two long bare trailing 'wires' with feathery ends. Two species:

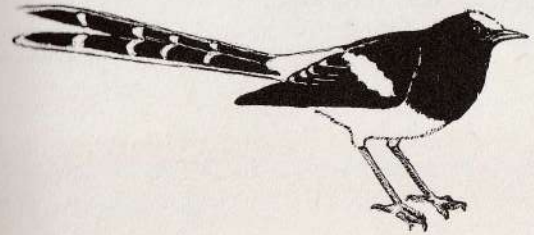
Greater racket-tail: lowland species, forked tail;
Lesser racket-tail: mountain species, tail not forked.

Sunda whistling-thrush: A medium-sized, plump, cheeky and rather inquisitive bird. The male is black and dark blue and the female rather brownish. The loud whistle and constant tail-flicking are very diagnostic.

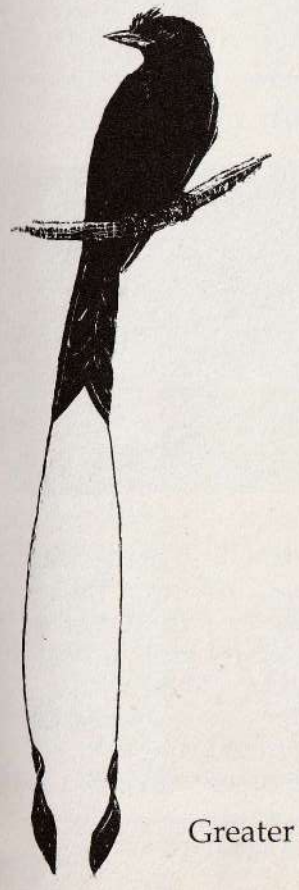
Sunda and scarlet minivets: Flocks of striking red and black birds. Female scarlet minivets are black and yellow.

The lesser spiderhunter. These birds not only hunt insects but are ofen seen drinking nectar, hence the Indonesian name *burung madu*: honey bird.

15



White-crowned forktail



Greater racket-tailed drongo

Black eagle

16

On the right-hand side of the path 1 m beyond the stone.

- Puspa: a tall tree (diameter 75 cm) often with white flowers
- a small tree, *Saurauia pendula*, 20 cm from the stone also with white flowers, (see notes for HM22)

- young, red-coloured leaves

This old puspa (*Schima wallichii*) belongs to the tea family (THEACEAE). You may have seen the fleshy, white flowers with orange centres lying on the path (see photograph stone 5).

The perplexing problem of puspa

Young leaves of puspa trees are reddish and new growth *en masse* produces a distinctive colourful bloom to the forest. Why so many species of rain forest plant produce red leaves is one of the most widely pondered questions in tropical ecology. One suggestion is that the colour protects the delicate shoots from ultraviolet light.

Puspa is one of the common species of both lowland areas and mountains, occurring between 300-2,600 m a.s.l.. Within the park it ranges from the boundary up through the sub-montane and montane zones. The species does particularly well, often becoming dominant, in the lower half of the montane forest. Though not a particularly good quality timber tree it is used in reforestation, repairing damaged areas by contributing to fairly rapid re-establishment of tree cover. Basically an east and southeast Asian species, in Indonesia it occurs naturally in Kalimantan, Sumatra and West Java, and has been introduced to the drier eastern half of Java.

On the ground about 2 m past this stone.

16

- fallen paper-chase plant flowers: yellow, trumpet-shaped
- white 'decoy-leaves'

You should find the small, orange, trumpet-shaped flowers belonging to the paper-chase plant (*Mussaenda frodosa*). Their shape is typical of butterfly-pollinated flowers, the long thin tube being designed for the long tongues of these insects.

If not in flower at this site, *M. frodosa* can be encountered all along the lower half of the path: 9 paces before the shelter (HM7) and on the far shore of the Blue Lake. A large specimen can be seen just before you cross the bridge as you leave the park.

The behind–before plant

M. frodosa is a lowland species; it meets its upper limit in the park at around 1,500 m a.s.l., roughly the altitude at the Blue Lake. The plant occurs in secondary forest and open places such as the forest edge and at the Blue Lake. Related species are found in Africa and are grown as ornamentals. The Javanese name *walek adep* means behind-before, and refers to the white 'decoy leaves' These are actually formed from part of the flower base (the sepals) and may serve to attract insects.

17

Both sides of the path, 15 paces past the stone.

- Datura plants: large pale green leaves
- Spiral scars on stems where leaves have fallen off
- large, white, trumpet-shaped flowers
- A small colourful sunbird (look where-ever you see datura flowers)

The large shrub with sizeable white, trumpet-shaped flowers is originally from Central/South America and is a species of datura. *Brugmansia suaveolens* is fast growing and slightly poisonous. Control measures include cutting back but, as yet, no means have been found to eradicate the weed completely. On the positive side it attracts Kuhl's sunbird. Look out for a small, colourful bird with a long bill investigating the flowers (description occurs later).

Medicine, poison or drug?

The old name for *Brugmansia suaveolens* is datura, which is derived from Sanskrit. There are several datura species; as a result of their high medicinal value they have been introduced to many countries. Only one species appears native to Asia but most derive from South/Central America.

Daturas belong to the SOLANACEAE. The family, well-known for many medicinal and poisonous plants, is a source of a variety of well-known alkaloids. Daturas are rich in the drugs scopolamine atropine and hyoscyamine. Traditionally in S.E. Asia these plants have been employed as a treatment for nervous complaints and as a pain killer. They are said to be effective in getting rid of parasites (e.g. ringworm) and as a cure for boils. The unopened flower buds contain a liquid which many local people use to bathe and refresh tired eyes. This practice also occurs in Latin America. Interestingly, doctors use the drug atropine to dilate the eye.

Datura also have a more sinister value: as a source of alkaloids for use as poisons. Our species (*B. suaveolens*) is quite low in toxins and the leaves are sometimes used as fodder. The flowers, however, are considered poisonous.

17

Angel's trumpets: in Colombia *Brugmansia* are called evil eagle trees. The bird's spirit is believed to cause the unpleasant hallucinations – biochemists claim scopolamine as the cause.

Javan sunbird and South American flowers

Kuhl's sunbird is only found on the mountains of Java (a Javan mountain endemic). *B. suaveolens* , as we have seen, is from Brazil. Its flowers open wide at night and are white, factors which when taken together indicate night pollination. The flower's shape suggests pollination by moths or bats; the long petal tube contains a nectar which can be reached only by long tongues. Here we find, therefore, that a Javan endemic sunbird, along with some other nectar feeding birds, has formed a relationship with a South American species. Normally, pollination by sunbirds is suggested by small, red/orange, trumpet-shaped flowers like those of *Agalmyla parasitica* (see notes for stone 25). What we are seeing here, therefore, could be the start of an evolutionary partnership.

QUIZ NO. 6 Strange but true, only one of the following statements is false:

i. In Malaysia criminals used datura to stupefy their victims.
ii. The Oracle at Delphi probably employed a datura to assist with predictions.
iii. In India and Indonesia datura plants were used in the treatment of cholera.
iv. An oil, obtained by soaking the leaves, is claimed to be an effective cure for ear and skin complaints.
v. A 'datura overdose' causes death by over-stimulation of the brain.

18

On the left-hand side of the path, directly opposite the stone; also all along the path in damp conditions.

- *Impatiens platypetala*: pink flowers
- large green pods (see Pop a pod)

Frequently seen between HM18 and HM23

- Javan gibbons (see primate notess, HM4)

All along the path you will certainly have noticed *Impatiens platypetala*: a pink/purple flower with five large petals and a long, tail-like spur. *Impatiens* species are commonly grown in gardens all over the world. *I. platypetala* does not compete well in the dark conditions of the forest, preferring the lighter conditions of the path. It occurs all over the Malesia region.

QUIZ NO. 7

From what you have seen, how do you think the seeds are usually dispersed? By:

i. being caught in the fur of animals?
ii. floating away on the wind?
iii. being hurled/catapulted away from the plant?
iv. being eaten by birds?
v. floating away in rivers?

18

Pop a pod

Seed dispersal is very important: plants need to travel to places suitable for growth.

Search for the seed pods of *Impatiens platypetala* and carefully pick a very large one. What do you notice about the colour of the pod?. Now squeeze very gently .

Key to *Impatiens* species:

I. radicans
Pale flower, only species with spots on petals, also with strongly saw-like edge to leaves (Don't pick – only found in a very few places in West Java).

I. javensis
White to pink flower, always with darker centre; spur on back of flower curved. Leaf edge slightly saw-like, leaf may be hairy.

I. platypetala
Large pink flowers (2-3.5 cm), leaves have strong veins edged with small teeth. Very common.

I. chonoceras
Small trumpet-shaped flowers, very hairy leaves small teeth. Flower spur red-veined.

Impatiens javenesis

18

On the left-hand side of the path 67 paces beyond HM18, 37 paces to HM19.

- an old tree with strangler/creeper a growing up its trunk.

- yellow magnolia flowers
- yellow flowers/ large green fruits of the creeper

The tree is *Manglietia glauca*, a relative of the magnolias (MAGNOLIACEAE), and, therefore, a member of perhaps the most ancient family of living flowering plants. The round green fruits of the climber *Fagraea blumei* are eaten by monkeys and gibbons.

Manglietia fruit

Manglietia glauca: High but not dry

The small genus of *Manglietia* is confined to S.E. Asia, with *M. glauca* growing throughout Indo-China and as far east as Flores. The tree is suited to high-rainfall areas and, hence, on Java is most common in the west of the island. It is a true highland species, thriving in both the sub-montane and montane zones (900-2,400 m a.s.l.). The strong, fine-grained wood is sought both for carving and for use in buildings. If you are fortunate you may see the attractive, rather primitive, fragrant yellow flowers.

Manglietia strangled by *Fagraea*

18

Fagraea blumei: Low and hot up to high and cool

Fagraea blumei is one of 60 related species which occur in S.E.Asia. The specimen here is growing as a climber but other examples take the form of small trees. In the park they seem to thrive best in the transitional area between the sub-montane and the montane zone. Generally, however, throughout Java, the species can be found from the hot lowland forests right through to the cold conditions of the montane zone. The flowers are yellow, often dark, and, in some species at least, pollination is said to be by night-flying moths. The monkeys and gibbons can sometimes be seen feeding in fruiting trees.

Going up or coming down?

Fagraea blumei has variously been described as both a climber and a strangler:

F. blumei can start life by creeping up other plants and then, when its lower parts die, becoming epiphytic, growing wholly on another tree. Such plants are called hemi-epiphytes.

Doing just the opposite are the stranglers, including some figs and some *Fagraea* species. Their seeds, transported by birds, start life high in the branches of host trees as epiphytes. They then grow long roots to the ground which form a thick enveloping network and strangle the host tree.

19

The low vegetation next to the stone, in particular 3 paces before the stone on the right-hand side of the path.

- *Curculigo*: large, corrugated leaves
- the long V-shaped leaf stalks

- small yellow flowers at the base of the leaves
- pinky-white fruits

Curculigo capitulata does not attract much attention but a little searching at the base of the plant may reveal a clustered mass of attractive, bright-yellow flowers and pale, pinky-white berries.

Curculigo: many names, many uses

The botanist van Steenis records the Dutch name *rusteloze zieltje*, ("restless soul"): the long V-shaped leaf stalks cause the large leaves to tremble with the slightest air disturbance. The Sundanese name is *daun tjonkok*, which is thought to derive from daun (leaf) and bonkok (to bow). *C. capitulata* is a medicinal plant -but please do not pick it. In some parts of Asia the leaves are sprinkled over elephants to cure them of fever. It ranges from Australia to China, and is at home in low areas through to montane forests (50-2,200 m a.s.l.).

Curculigo species grow throughout the tropics. They are small in number, but are an important source of traditional fibre, string and wrapping. Dayaks of Borneo use *Curculigo* fibre to make fishing nets. There is a local story that if you cut the plant you may be attacked by a leopard cat.

On the left-hand side of the path, directly opposite the stone.

20

- wild sugar-cane: a tall grass

- a white central line (mid-rib) running from the base of the leaf towards the tip

The tall grass here is a wild relative of the cultivated sugar cane (*Saccharum*). This one, however, is not very sweet. Java has perhaps four species belonging to the genus *Saccharum*. They are valuable to the cane grower as a source of disease resistant genes.

A very sweet toothbrush

There is strong evidence that sugar cane derives from the island of New Guinea, where it has been eaten for at least 8,000 years, perhaps much longer. It started to spread up through the Indonesian archipelago about 7,000 years ago. The cultivated *Saccharum officinarum* developed from S.E. Asian canes, which then crossed with wild Chinese and Indian species. In Irian Jaya sugar cane fibre is chewed to keep teeth clean!

Sugar cane: note the white line running down the leaf.

21

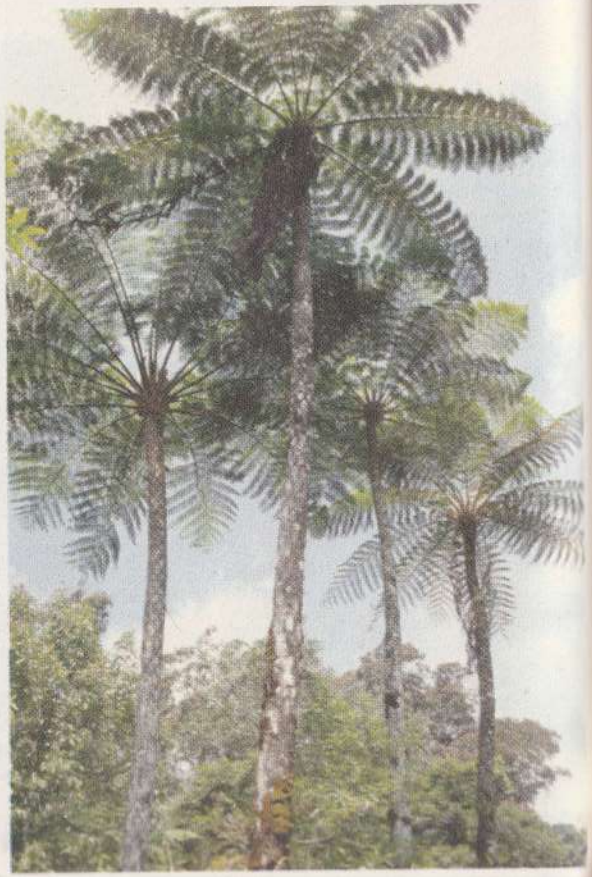
15 paces before the stone on the left.

- tree ferns (about 15 large specimens)
- patterns on the stems indicating leaf scars where old leaves have fallen off
- colour of the hairy leaf buds

- worm-like threads showing the inside structure of the trunk

- orchid flowers growing on the tree ferns stems

Before modern flowering plants evolved, vast forests of tree ferns covered much of the earth. Much of the coal we now burn comes from the remains of tree ferns buried in swamps of the Carboniferous period, some 350-270 million years ago. Modern tree ferns, rather smaller than many of the giant species of the past, thrive in the cooler, damp conditions of mountain forests. The park has four species, three of which grow along the path.



Tree ferns buds can be eaten! Those of *Cyathea latebrosa* (left) taste good but the buds of *C. contaminans* are rather sharp.

21

Key to tree ferns:

Cyathea latebrosa
Small species; curled-up leaf buds covered with black/dark brownish-purple hairs; usually with shoots growing from the base of the trunk.

C. contaminans
Often tall and elegant, curled-up leaf buds covered with straw-coloured hairs.

C. tomentosa
High altitude species; tall and elegant; bud hairs dark browny-purple. Similar to *C. latebrosa* but taller and not readily producing shoots from the base.

Dicksonia blumei
High altitude tree fern. Bud hairs are a rich orange-brown colour. Not along Cibeureum path but can be encountered higher up.

Try to see if you can identify the tree ferns you see at this and other locations.

Dicksonia blumei

QUIZ NO. 8 Which species are the tree ferns around HM 21 (in photograph to the left) ?

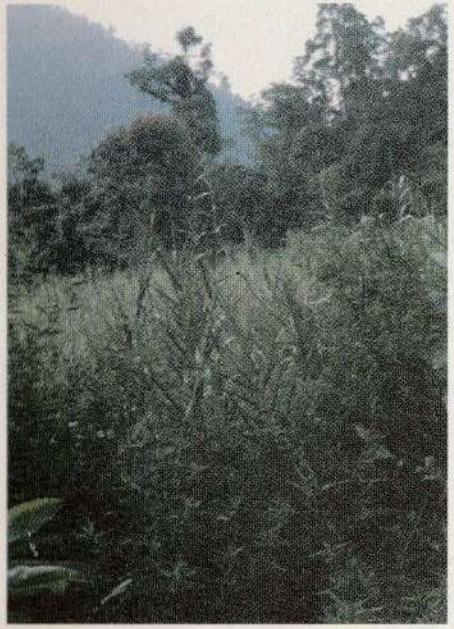
21

At the flat swampy area on the same side as the stone, looking back down the path.

- a tall grass growing in the swamp

This small swamp, *Rawa Gayonggong*, takes its name from the large grass growing here: called in the Sundanese language *Jukut gayonggong* (*Phragmites karka*). The plant may well be a form of the common reed (*P. communis*) found all over the temperate world. The leaves make excellent paper and matting.

Rawa Gayonggong may not be wholly natural, but the change from forest to swamp vegetation enriches the biological diversity of the area.



Rawa Gayonggong

Pinanga coronata

All around: 0.5 m behind, 3 paces before on the right, and 4 paces before the marker stone on the left.

22

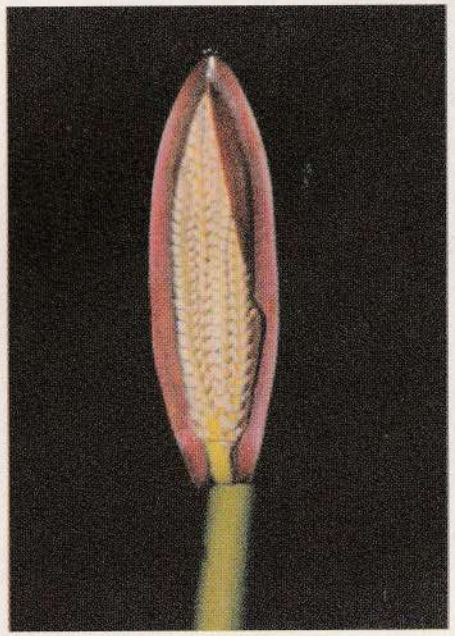
- palms (*Pinanga coronata*): looking like small trees
- circular scars where the old leaves have dropped off
- large, red leaf bases surrounding the stems

- clumps of petal-less flowers (see flower structure below)

About 115 *Pinanga* species are distributed throughout S.E. Asia but, curiously, only one, *P. coronata*, occurs naturally on Java. The genus as a whole favours chestnut/oak-laurel forests such as that along the Cibeureum path.

Tree palms

There are two kinds of large palm in the park: rattans and tree palms. *Pinanga coronata* is the tree palm you will discover along the path. Whereas rattans are commercially important, tree palms fulfil an ornamental role. What is remarkable about them is their flower structure. The flower of *P. coronata* grows in a red, leaf-like sheath called a spathe. Eventually this falls off and the creamy-coloured flower spikes are left spread out and bare on the stem, just under the crown of leaves. If you discover one in bloom look carefully: one female flower is placed between two male flowers (*ménage à trois*). It is thought that bees and beetles are the main pollinators.



Pinanga coronata: palm flowers

22

7 steps beyond stone across the path.

- *ki leho canting*: a tree can be seen arching over the path.
- epiphytes growing on the trunk: orchids and ferns

- flowers growing out of the bark (cauliflory)

The pinky-white petals of ki leho canting (*Saurauia pendula*) are thick and waxy. Flowers grow directly from the woody trunk and branches. This common feature of many lowland rain forest trees is uncommon in the true montane zone. *S. pendula* is another example of a lowland rain forest species living near its upper altitudinal limit.

Orchids

Growing on the tree is a species of small, orange-flowered orchid. DO NOT PICK IT. Orchids are very sensitive to climatic conditions and will frequently not grow if transplanted to a different altitude.

Gede-Pangrango is particularly rich in orchids: there are around 200 species, four of which occur within the National Park and nowhere else. Like many rare gems orchids are often very small and difficult to find but well-worth the effort of careful looking.

Bulbophyllum cernuum

Paphiopedilum javanicum

Ki leho canting: Yuk! What a horrid name

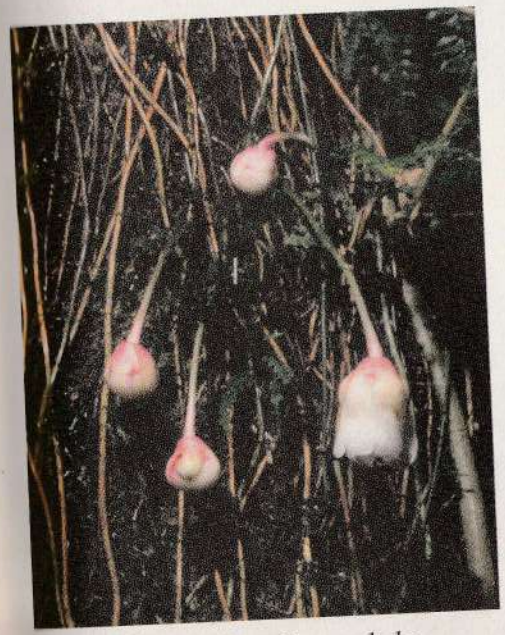
In the Sundanese language *ki* means tree, *leho* is mucus -as in running nose- and *canting* scoop. The name 'mucus scoop tree' derives from the thick liquid in the fruit.

Globe trotters

Saurauia is one of 89 genera which appear on the both sides of the Pacific ocean. Around three million years ago the climate was much warmer and some members of these groups were able to spread northwards, up and around the Pacific rim. Later, when the climate changed, they were not able to survive the harsh frosts of N. Asia and N. America. In consequence, these genera now exist in two separate regions: S.E. Asia and tropical America.

Nothing to do with cauliflowers

The first European to see flowers growing directly out of tree trunks thought he had discovered a parasite!



cauliflory : *S. pendula*

Why flowers on trunks (**cauliflory**) and flowers on old branches (**ramiflory**) occur only in tropical conditions is not really understood. They allow fruits to be bigger and heavier, as with durian, and give easier access to animals such as treeshrews which eat the fruit and then disperse the seeds in their droppings. Cauliflory and ramiflory are absent in temperate conditions, such as exist higher up these mountains. One explanation relates to the bark, which tends to be thicker in cool areas, making flower production from trunks and branches very difficult.

23

Upwards along the path into the montane forest and downwards into the Cikundul river valley.

- a change in vegetation

Near shelter.

- a lesser gymnure: a small shrew-like mammal with a short tail (see animal notes)

This spot marks what scientists call an **ecotone** or transitional boundary between two ecosystems: **sub-montane** and **montane**.

Cloud often hangs over the cool, dim, montane forest. Growth of plants is consequently much slower, resulting in much smaller trees. Such conditions favour mosses, which grow profusely over stones and vegetation alike.

Place of peaceful tranquility or battle ground?

An ecotone is not just where two communities meet but can be thought of as a confrontational zone. If environmental conditions are stable a balance is likely to be achieved, however, should conditions change, favouring either one vegetation type or the other, then one community will advance and the other retreat. In the past when a drop in temperature occurred, such as at the time of an ice age, the montane vegetation moved downwards. If the present build-up in carbon dioxide warms up the planet - the 'Greenhouse Effect' - then it is likely, over a couple of centuries, that the sub-montane forest will extend higher up the montains.

2 paces before the stone on the right-hand side of the path, 3 m into the forest, and 14 steps past HM23 on the right-hand side of the path, 4 m into the forest.

23

- *Pandan areuy*: a climber with long, dark green leaves growing on trees
- spiral growth pattern of the leaves

- large pink 'flowers' containing club-like structures

Freycinetia insignis is termed a bole climber. The plant is frequent in hill and sub-montane forest. The Sundanese name *pandan areuy* translates as the climbing pandan. On Java the tough roots were used to make rope (see photograph, stone 11 – epiphytes).

A feast of flowers

The flower heads of the climbing pandan, *F. insignis*, are large, club-like and usually three in number. The pink structures at the base are not true petals but coloured leaves called bracts. When in bud the bracts protect the developing flower heads. The actual flowers are tiny and cover the clubs. Climbing pandans in any one area tend to flower at the same time. Flowering plants are raided by hungry small mammals, though the flowers are very bitter-tasting. Bitten off pink and green leaves, sometimes found scattered at the base of the plants, often indicate that leaf monkeys have been feeding on flower stalks.

If you see any flower clubs look for damage caused by hungry bats. The plants are thought to produce a 'bat-attracting odour'. There is speculation, therefore, that they are **bat-pollinated**. This is an important form of pollination within rain forests and a decrease in bat numbers can dramatically affect forest composition.

23

In the damp places along the edge of the path

- *Lobelia angulata*: a small, creeping plant
- heart-shaped leaves with a toothed (serrated) edge.
- small mauve flowers
- very large purple fruits

With careful searching you should find the tiny *Lobelia angulata* creeping over the stones. Remarkably, the plant ranges over South America, Australia, through Indonesia and southern China right up to the Himalayas, but, curiously, is missing from Borneo and the Moluccas. It is generally a plant of hills and mountains, ranging from 600-2,300 m a.s.l..

Arisaema filiforme: found in Malaysia, Sumatra and Java.

Where have all the flowers gone?

There are many flowers in the forest but they are designed to be seen or smelled by insects, birds or bats, not humans.

Many visitors from temperate regions are surprised that there are not more flowers to be seen in tropical forests. One function of flowers is to produce seeds to help plants survive difficult conditions: drought or excessive heat or cold. In tropical forests plants are usually able to grow throughout most of the year. Vegetative reproduction - parts breaking off plants and rooting - is very common.

Open areas along both sides of path

24

- Gingers: tall plants with two rows of leaves
- the way the 'stem' is made up (see notes)

- ginger flowers

In this area we can see gingers. They belong to a family (ZINGIBERACEAE) closely related to the bananas. Both groups are light-loving, not growing well in deep forest. The species at this location is *Nicolaia solaris* (see photograph next page).

Gingers, gingers, gingers

The park's nine species of ginger have overlapping altitude ranges. One of the most common species of lower areas is *Amomum coccineum*. Search the soil for 'earth flames': the plant's bright red and yellow flowers. The flesh surrounding the seeds is sweet-tasting. The juice from the leaves is used externally in some parts of S.E. Asia to treat fevers.

Amomum coccineum

Similar and also very common is *Nicolaia solaris*; its orange flowers, growing from a ball of the same colour on the ground, occur all along the path. *N. solaris* is also edible: the leaves are used as a flavouring. The sap from the stem is an analgesic and is applied to ease *jelatang* stings (see notes stone 7).

The white and purple-flowered gingers, *Zingiber inflexum* and *Z. ordoriferum*, are frequently encountered. Their flowers hang out of a green club-like structure which stands a few centimetres off the ground. Later on, when containing fruits, the club may turn red. The most noticeable ginger flowers are those of *Hedychium roxburghii*. They look like a mass of cream and white ribbons. This last ginger is a true mountain species, growing from 1,000 - 2,200 m a.s.l..

24

Tough guys

Gingers are typical of disturbed areas. They 'get in quick' after storm damage, or grow at the forest edge and along paths. Their leaves are very effective at shading out tree seedlings and neighbouring vegetation. In such highly competitive conditions many plants produce poisons to inhibit the growth of other species. Gingers are thought to use this ploy.

The leaves of gingers often appear as two rows along a 'stem'. This pseudo- or false stem is made up of leaf stalks (petioles) concentrically wrapped around each other, rather like a cross-section of an onion. The leaves that emerge from the top, therefore, have stalks several metres long!

Clockwise from top: Zingiber inflexum seed pod, Zingiber odoriferum, Hedychium roxburghii, Ginger leaves, Nicolaia solaris

2 paces before the stone on the right-hand side of the path.

25

- horse-tails: round leaf-less stems about 1 m in height
- small, brown, spore producing clubs

Behind stone growing on tree 7 m into forest

- *Pandan areuy* (see notes for stone 23)

Horse-tails (*Equisetum*) are well known in most countries of the world, often as troublesome weeds. They represent one of the oldest groups of land plants on earth. Closely related to the ferns, they produce spores, not seeds. You should be able to find the dark, club-shaped structures which contain the spores. These plants were around long before modern tropical forests developed. Our species is *Equisetum debile*.

Horse-tails: many uses, but do they cure arthritis?

In some countries horse-tails were used for polishing silver, because of their high silica content. In Irian Jaya and Papua New Guinea they have a very old use as hair decoration.

If you examine the stem you will see that it is jointed, but the joints are not swollen. This has led to the *Equisetum* being used in some parts of S.E. Asia as a cure for swollen joints. Please do not try this remedy, as the plants are poisonous.

26

Where to look: On the trunks of many of the trees: tree fern next to stone, 5/11 paces before stone on left, 6 paces beyond stone on right and 40-50 paces beyond stone on both sides of path.

- *Agalmyla parasitica*: a climber with large green leaves with small teeth on leaf-edge
- tree ferns: identify species from key (see stone 21)

- long, tube or trumpet-shaped, red flowers climbing up trees (usually in flower somewhere along path)

On many of the trees you should find a climber with large leaves. *Agalmyla parasitica* is very noticeable when in bloom: the bright red, upright flowers are 3.5-5.5 cm long. Their particular shape and colour suggest pollination by small, nectar-seeking birds.

The plant is an important indicator of primary forest and is rare in logged or degraded secondary forest. Do not worry if the specimens here are not in flower: the species has a long flowering season and examples can usually be found all along the path.

Harmless epiphyte or nasty parasite?

The stem of *A. parasitica* possesses short, clinging roots. Even though the name suggests a parasitic mode of life, the plant is usually described as epiphytic (growing on others). Research carried out at Cibodas by Went, just before the war, was the first to show that many epiphytes, like parasites, are quite choosy as to what they grow on (host specific). Some epiphytes even tend to extract nutrients from their host plants. Such findings have led many botanists to the conclusion that there is no clear-cut division between parasites and epiphytes.

Agalmyla parasitica

Which one is this?
A guide to red-flowered creepers

26

There are several similar species belonging to the family GESNERIACEAE, *Agalmyla parasitica* is the one you will most frequently encounter along the path to Cibeureum. A related genus is *Aeschynanthus*, comprising 170 or so species occurring from India to S. China. Members of the genus *Aeschynanthus* are relatives of African violets, and in Europe are popularly grown in hanging baskets.

But which?

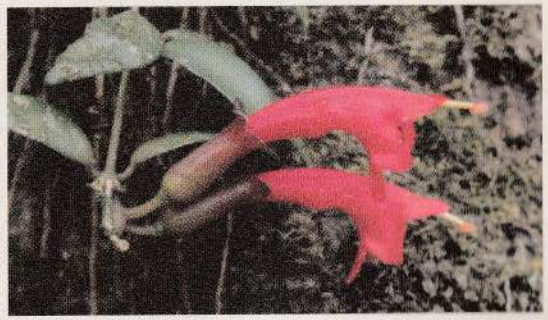
Agalmyla parasitica
Leaves in unequally-sized pairs: one of the pair is very large,(15-20 cm long), slightly hairy with a long stalk, the other leaf is stalk-less and so small you may not notice it. The large flowers always grow from the junction of the stem and a large leaf, and are not found at the end of the plant.

Aeschynanthus
Flowers at the end of the plant (not all need be), paired leaves the same size (5 cm approx.) :

Aeschynanthus longiflorus
Leaves long and pointed, dark above, paler below. Large red flowers (7-9 cm) but with a black line around the opening of the flower tube and with perhaps a little yellow; calyx at base of petals small, needle-like and dark red.

Aeschynanthis angustifolius
Long leaves with very short stalks. Calyx small and made up of a ring of small 'needles'; small flowers (1-2 cm), tube green with purple edge.

Aeschynanthus horsfieldii
Leaves egg-shaped or long but very pointed. Plant often free-standing. Petals red; the calyx at the base of the petals is needle-like, green and light red or red. This species is rather similar to *A. longiflorus* but the flowers are smaller, measuring up to 4 cm.



Aeschynanthus radicans
Stems often hanging down, leaves egg-shaped and slightly pointed, leaf edge with a few small teeth. Clusters of about 5 flowers (4.5-7.5 cm) on end of stems, or pairs of flowers where leaf stalk joins the stem; petal tube in a big green/dark-purple cup (calyx). Calyx length about half that of the flower.

27

All around.

- The different types of rock:
  - — fine grained rocks from inside lava flows
  - — rough textured (gritty) rocks from the outside of lava flows (seen at far end of the cliffs between the 2nd/3rd waterfalls)
- Many textures and colours of rocks in the stream bed (see fire broken rocks below)

The falls, from left to right, are named the Cikundul, Cidendeng and Cibeureum. The open arena in which you are now standing is formed where several tracts of lava meet. To your right are the volcanic rocks of Pangrango and to your left are the lava flows of the more recent Gede eruptions. It is worth looking around for pyroclastic or 'fire broken' rocks. These were rocks hurled through the air in past eruptions; pumice stone is a well-known example. Many of the large slabs of lava lying around fell in 1985 when a rock-slide destroyed all the trees at the base of the Cidendeng waterfall.

Forests and water

The three rivers unite lower down to form the Cikundul River. The park is a vital water catchment which supplies West Java. The slow and continuous release of water by the forest prevents both floods and water shortages.

High up on the cliffs.

27

- a red moss
- an orange-flowered *Rhododendron* (see note for HM15-16)

The red moss (*Sphagnum gedeanum*) gives the area its name: *Cibeureum* meaning Red (Moss) River. The moss is named after Mt. Gede and has very limited distribution.

In the air.

- fast-flying birds

Most of the birds flying around here are glossy swiftlets but you may be fortunate enough to see giant swiftlets: length 16 cm, dark brown/black, with slightly forked tails. They are very rare, restricted to mountainous areas of Malaysia and Western Indonesia. On Java they are confined to just a few forested mountains in the west. Gede-Pangrango is one of the last strongholds of this endangered species but in recent years giant swiftlet numbers have declined. They nest in damp conditions behind waterfalls. Natural landslides have destroyed the birds' nesting places. Look also for black eagles soaring over the falls.

27

Between the two furthest waterfalls, to the right of the path.

- very large, heart-shaped leaves of wild taro (*talas*)

In the open areas at the base of the falls grows wild taro, called on Java *talas*. S.E. Asia is the plant's original home. The giant, heart-shaped leaves arise from an edible underground stem. Domestic varieties of taro are very well-known, and are commonly offered for sale in markets. The wild plants you see at Cibeureum may have established entirely naturally, or may have been planted many years ago.

Taro: the oldest cultivated plant on earth?

In many tropical countries of Africa and the Caribbean taro has been introduced as a new and important source of starch, but few people realise just how long the plant has sustained humans. It seems likely that taro was cultivated even before rice. In the highlands of Papua New Guinea excavations have revealed ditches, dug for taro cultivation, dating back 9,000 years. Taro is therefore a contender for the title 'oldest cultivated plant on earth.'

Wild taro.

Raw taro is poisonous, which deters animals, including people from eating the plant. Among other toxic chemicals, calcium oxalate crystals cause irritation to the digestive system. Hunter-gatherers would have included wild taro in their diets when it was discovered that cooking rendered the plant edible.

Plant types	No. of species
Epiphytes	100
Trees	78
Low herbs	39
Shrubs	31
Woody climbers	20
Terrestrial ferns	20
Herbaceous climbers	9
Tall herbs	8
Treelets	6
Woody creepers	5
Herbaceous creepers	5
Stranglers	3
Tree ferns	2
Palms	2
Pandans	1
Bananas	1
Mistletoes	1
Total number of plant species in only 1 ha	331

Why are rain forests so rich in species?

Biologists are still arguing, but the answer has something to do with the tropical forest's tall, three-dimensional nature and the fact it meets two conditions which allow life to proliferate: it is constantly wet and warm.

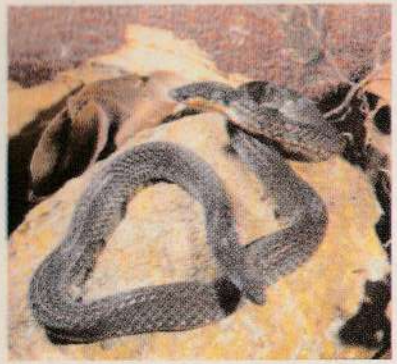
Not seeing the forest for the trees

NOTES

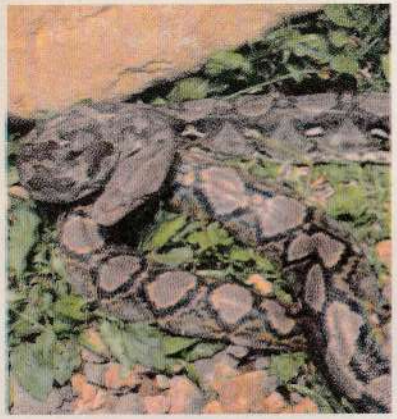
In 1959 one of the first-ever attempts to count the number of species in a tropical rain forest was conducted here at Cibodas. The table lists what Meijer found in just one hectare of this forest:

Complex relationships: the fungus beetle *Episcapha glabra*, sports warning colouration, suggesting it is poisonous to eat.
The beetle on the left is different: it is mimicking the first more common species.

The high level of competition and predation made possible by such conditions also seems to 'drive' the creation of new species. For instance a species of beetle might attack five species of tree. So each tree species develops a means of protection against the insects: poison, thick leaves, masses of hairs etc.. Some beetles then develop resistance to the poison, while some develop strong mouth parts to attack thick leaves. This specialisation may lead to five new species of beetle, each of which attacks only one species of tree. Each tree species then develops a new way to avoid being eaten and the beetles evolve to meet the new challenge. This is called an 'arms race'; there are no real winners but the specialisation in life-styles generates new species of beetle and tree.



Calomaria linnaei: a harmless "reed" snake which lives under stones



Reticulated pythons (*Python reticulatus*) are very rarely encountered. Even though non-poisonous they will sometimes eat monkeys.

Megophrys monticola: the Horned frog

A note on the animals you may see, together with a few lines on some you won't!

The park has around 19 species of frog. You might come across a tiny brown one, just over 1 cm long: it is likely to be *Microhyla palmipes*, a true highland species. If you see a dark-coloured frog with red spots on its back we would like to know about it: *Cacophryne cruentata* occurs only in Gede-Pangrango National Park and is becoming more difficult to locate. Under no circumstances try to catch it, but note its location.

The medium-sized 'horned' frog (*Megophrys monticola*) is common, but is a master of disguise: light brown in colour with a pair of horns over its eyes it looks like a leaf or a small piece dead wood. Why it takes so much trouble to hide when it is reputed to be poisonous is a mystery.

The Green Crested Lizard (*Calotes cystalatus*) is a very handsome reptile. Often mistaken for a chameleon it can change colour from lime green to brown/black. If disturbed it tends to stay very still, so you should be able to get a good look and, if you move very slowly, a close-up photograph. The males can sometimes be seen 'head bobbing' to attract the interest of females. Do not try to catch these lizards: their bite can draw blood.

The brown, smooth-skinned, small-headed lizards are common skinks. Frequently seen in sunny places, they are very fast moving.

Animal spotting is very much a matter of luck but an early start and keeping quiet increases your chances. A pair of binoculars is particularly useful.

NOTES

You are very unlikely to see leopards, and even less likely to be eaten by them! Their footprints are occasionally found around the Cibeureum falls where, hidden by the night, these secretive predators hunt wild pig and deer. Rather more common are the leopard cats. A little larger than their domestic cousins, they are difficult to see but you might be in luck. Wild dogs also live in the park but these are extremely shy and scarce.

Rather more noticeable by its smell than by its good looks is the stink badger. Black with white on the head and back, individuals can be seen frequently by the side of the path (see photos next page). If disturbed they have a habit of sitting very still by tree roots or rocks. Dr. Dammerman, who visited here in 1929, records that "sensitive people have fainted from the dreadful stench".

If you come across a stink badger you may well be able to get very close in order to take a photograph, but be careful: it can eject a foul-smelling liquid from its anal glands. This spray is so nauseating that it can cause vomiting. As with many animals that specialise in digging for worms and insects, the stink badger possesses a robust snout and powerfully-clawed fore-limbs.

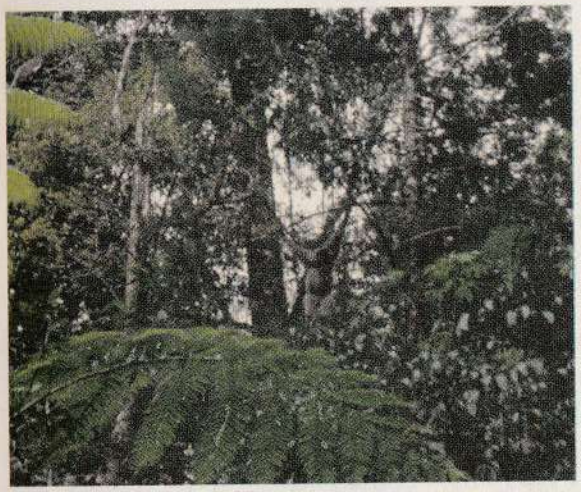
Conocephalus chamaeleontinus: the Indonesian name is bunglon

A calotes lizard

NOTES

Found only in western Java, the Javan gibbon is the world's rarest gibbon. It has suffered very badly over the last couple of hundred years: lowland forest clearance for agriculture, hunting, the pet trade and urbanisation have all played a part. Before the National Park was established individuals were often seen for sale along the Bogor-Sukabumi road. Now the provision afforded by the three West Javan National Parks offers solid grounds for hope.

Gede Pangrango is home to about 100 gibbons, which may represent 10% of the total population. The gibbon can be encountered all along the walk to Cibeureum but is most frequently observed between marker stones 17-23. Listen out for its loud, booming call: "Owa." Gibbons are monogamous and youngsters have to fend for themselves after the age of three. Family groups are small and usually consist of two adults and one offspring. (A descriptive key is given for gibbon and monkey species in the text - see notes for Stone 4).



Left: Spot the gibbon
Right: A young ebony leaf monkey: look for "black blobs" with tails hanging down. Monkey spotting requires good powers of observation.

The two species of leaf monkey (ebony and Javan) are smartly attired and their long limbs and head crests give them a rather aristocratic air compared with the literally more down-to-earth macaques. Monkeys show acute awareness of everything that is going on, and you will be more likely to get good views of them if you are quiet. A troop on the move is very noisy as its members leap and crash through trees. However, spotting monkeys lazing in the midday sun offers a much greater challenge.

Right: The most dangerous view of a stink badger.

NOTES

Left: The very brave stink badger can eject a foul smelling liquid from glands near its tail.

As always in the tropics the best time to see animals, including birds and primates, is early in the morning when territorial displays are made and food is sought. At this time monkeys often travel in family groups, moving from the safety of roosting trees to trees supplying breakfast. All the primates, however, are also frequently seen throughout the day.

The Javan leaf monkey, like the gibbon, gets its Indonesian name from its call: a high pitched "surili". Seeing them sitting nonchalantly in trees it is easy to forget that you are looking at a particularly rare and endangered species confined to western Java.

The all-black ebony leaf monkey, or Javan *lutung*, ranges over the whole of Java and is quite adaptable. It is still quite common in many places but concern is increasing as hunting pressure and forest loss continue to take a toll.

Paradoxically, the very common long-tailed macaque, or *kera*, is the most difficult of our monkeys to watch. This species tends to prefer lowland plantations to mountain forest. Though groups are often heard searching the forest floor, low vegetation makes observation difficult.

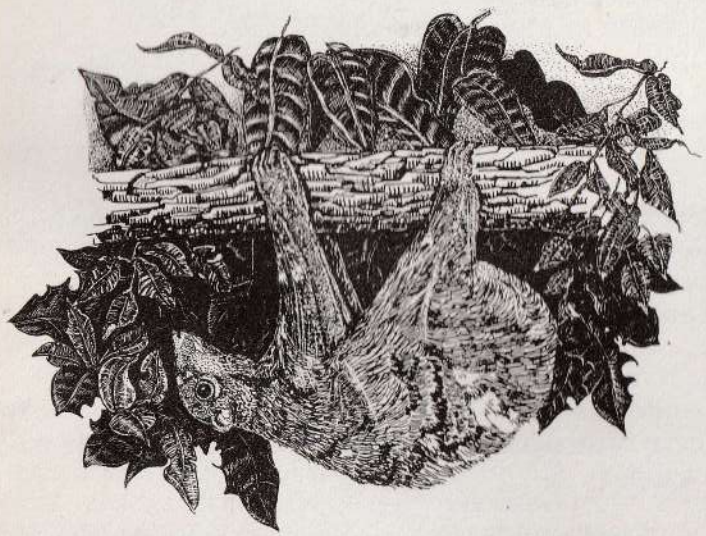
NOTES

A rustle in the undergrowth may indicate the presence of wild pig; though shy they can sometimes be surprised by the quiet visitor. Wild pigs have a reputation for being very dangerous but those in the park just disappear into the forest at the first sign of people. In fact the park boasts two species: the Eurasian wild pig, ancestor of the domestic breeds, and the much rarer Javan warty pig.

Both the park's two species of deer are specialist forest dwellers. The lesser mouse-deer, being nocturnal, is usually encountered either at dawn or dusk and is not really a true deer at all. Lesser mouse-deer are found from Burma to Java, with related species in India, S.E. Asia and Tropical Africa. Around 30-40 million years ago their ancestors were found all over the northern hemisphere. In Indonesia mouse-deer are renowned for being smart, and often feature in folk-tales.

The muntjak represents the park's only species of true deer. Difficult to see - but if you hear the call you won't be surprised by the animal's alternative name: barking deer. (For descriptions of the two deer species see check list.)

The flying squirrel, noted for the richness of its chestnut-coloured fur, emerges at dusk. Flaps of skin stretched between the front and hind legs allow the flying squirrel to glide several metres from tree to tree.



Using the same technique to get around but belonging to a very much more ancient group of mammals is the *colugo* (left), often mistakenly called a flying lemur. Hanging 'sloth-like' beneath tree branches, with a small rat-like head and a large sac-like body, the animal is a vision of ungainliness with an eerie voice to match.

When launched into the air, however, the colugo displays superb skills as an accomplished glider. Individuals frequently hug trees, and are so well camouflaged that they seem to disappear on landing.

Many of the animals are nocturnal and it is well worth exploring the forest path by torchlight.

NOTES

A little better known is the *pangolin*. Common but difficult to find, it is a specialist feeder, climbing trees to dispose of ants and termites which, together with the fact that its body hairs form overlapping scales, gives rise to its other name: the scaly ant-eater.

Often mistaken for a smallish squirrel in appearance and a bird in its raucous call is the treeshrew (*Tupaia glis*). Treeshrews are easy to watch as they leap about in small trees chasing birds and each other, hunting insects and eating figs.

Despite the squirrel-like bushy tail and a shrew-like head, they are not closely related to either rodents or insectivores but belong to a group of their own (SCANDENTIA). Treeshrews are very characteristic and unique to the forests of S.E. Asia.

Smaller mammals such as bats and rats abound but are difficult to identify. One cheeky little creature which often comes right up to the feet of people sitting quietly in the shelters is the lesser gymnure (*Hylomys suillus*), a true mountain dweller. Called in Indonesian *tikus babi*, or the pig mouse, it is a member of the class INSECTIVORA. This effective hunter searches the forest floor for small invertebrates. In appearance the lesser gymnure resembles a large shrew, having a pointed snout and short tail, but is thought to be more closely related to the hedgehogs.

NOTES

With around half the bird species found on Java occurring here, the park is internationally known by bird watchers and professional ornithologists.

The very rare Javan hawk-eagle

All but one of the twenty species of bird found only on Java - the 'Javan Endemics'- have been recorded in the Park. The main text has covered some of the birds you are likely to see but a few of the others are well worth looking out for. All along the path, but particularly near the start, listen carefully for the rustle of leaves caused by small family groups of the chestnut-bellied partridge. This commonly-sighted bird occurs only in West and Central Java.

One of the most fairy-tale sights to be experienced is when a mixed flock of scarlet and Sunda minivets suddenly descends around you, particularly if the bright sunlight catches their striking red and black wings. Should you see yellow and black birds as well, they will be scarlet minivet females.

The small, olive-green birds with white rings around their eyes are, not surprisingly, called white-eyes. They never seem to stay still, or indeed stop chattering, as they hunt around for insects and berries. White-eyes often form mixed flocks with other forest birds. To the bird watcher this can bring on an apoplexy: not a sighting for half an hour then suddenly unidentified small birds flitting everywhere and two minutes later a return to stillness.

Sunda blue robin (female): a shy and uncommon resident of the mountains of Java and Sumatra

NOTES

You may happen across a small group of medium-sized, brownish birds with white and black markings, usually jumping around a metre or so off the ground and too busy arguing with each other to take much notice of you. If so the chances are you will have come across either white-bibbed babblers, only found in Java, or chestnut-backed scimitar-babblers, which possess a long curved beak and a long white stripe above the eye. If, however, tails keep nervously fanning in and out then there is a very good chance you will have seen rufous-tailed fantails.

The bird list continues: Java's smallest bird, the endemic pygmy tit, which may hop over to get a good look at you, would barely provide a mouthful for the magnificent black eagles gliding high above the canopy; the very handsome orange-breasted trogon, bedecked like a medieval herald in greens, yellows, blues and reds calls "turrr turrr", almost non-stop, while flicking its long iridescent tail; the park even boasts the ancestor of the domestic chicken, the red jungle fowl.

Two of Java's rarest birds can be seen in these mountains: the giant swiftlet, once common at Cibeureum falls but now rather rare, and the Javan hawk-eagle, a large bird with a long crest on its head. All these forest species need the refuge provided by the National Park.

One the way back you might like to see if you can spot some of the following:

Animals commonly seen

Chestnut-bellied partridge (*Arborophilia javanica*) Brown bird, short tail, often in family groups searching the forest floor.

Sunda whistling-thrush (*Myiophoneus glaucinus*) A dark blue-black, medium-sized, plump thrush with a strange, haunting call.

Kulh's sunbird (*Aethopyga eximia*) Often found around large white trumpet-shaped flowers (for more information see notes stone 17).

Male: (Very attractive) olive green back; white wing patch; very striking, iridescent purple-blue crown; throat and breast bright red; rump yellow and tail blue.

Female: Olive green with white wing patch.

Monkeys & gibbons See text (stone 4) for descriptions.

Squirrels Plenty around if you are observant! Some are very good gliders.

Treeshrews (*Tupaia* spp) Bushy tail, like a squirrel, but with a pointed head. Noisy; calls bird-like.

Lesser gymnure (*Hylomys suillus*) Looks like a large shrew. Pointed nose, very short tail.

Lizards Green Crested Lizard (*Calotes cystalatus*). Not a chameleon but can change colour to brown/black.

Skinks These are smooth, fat lizards with small heads; often brown in colour.

Animals infrequently seen:

Tree frogs Many around but difficult to find.

Wild pig Two species Eurasian wild pig (*Sus scrofa*), Javan warty pig (*S. verrucosus*). Pigs are common but shy and often heard moving around in the undergrowth.

Leopard cat (*Felis bengalensis*) A little larger than the domestic cat, with a mottled coat.

Leopard (*Panthera pardus*) Unmistakable, rare and shy. If you see one, tell us!

Asian wild dog (*Cuon alpinus*) Very rare but call occasionally heard.

Small clawed otter (*Aonyx cinerea*) Lives by rivers but commonly travels through the forest.

Stink badger (*Mydaus javanensis*) black with a white stripe down its back.

Pangolin (*Manis javanica*) Long and scaly-coated; quite common but difficult to see.

Deer Two species:

Lesser mouse-deer (*Tragulus javanicus*): small, about the size of a small dog (40 cm in length); reddy-brown, no antlers, three white stripes on the neck.

Barking-deer (*Muntiacus muntjak*): larger (60 cm in height, 1 m in length); males may have antlers, underside of body white.

Colugo (*Cynocephalus variegatus*) Grey, small head, large body, often hangs upside down. Flaps of skin along sides of body used for gliding.

QUIZ

Answers to the questions in the text:

1 v. False: It is recorded that the figs of *Ficus variegata* were stored for times of need but Rumpf records that no European could bear to eat them!

2 iv. False: Bamboos are not closely related to rattans and palms but are actually giant grasses.

3 iii. False: even though *Altingia* is tinggi (tall) the name derives from an early colonial administrator of the region: W. A. Alting, an 18th century governor of the Dutch East Indies.

4 i. False: Bananas require high levels of nutrients.

5 iv. False: Records exist of the *Jelatang* being tried as a poison but it does not seem to work very well.

6 v. *Datura* poisoning is only rarely fatal but when it occurs death is due to respiratory paralysis.

7 iii. True: the pod splits, throwing the seeds out.

8 The species of tree fern just before stone 21 is *Cyathea contaminans* (see photo).

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GLOSSARY

alkaloids: a large group of organic, carbon compounds containing nitrogen, frequently poisonous and often investigated for medicinal properties
batik: method of printing pattens on cloth by waxing areas not to be dyed
Bole: trunk of a tree
Bugis: name of a people living in South Sulawesi, famous for their fine ships and sailing skills
calyx: an outer layer (envelope) which surrounds the petals, often leaf-like or sometimes forms a tube
canopy: a layer in the forest made up of tall trees forming the leafy 'roof' to the forest
cellulose: large organic compound made up of many small sugars
cirrus: (pl.**cirri**) a whip like-structure, possessing claws, growing from the end of a leaf tip (cf.**flagellum**)
co-evolution: when two organisms/structures show complementary development - eg the shape of small trumpet shaped flowers and the long tongues of butterflies
continental drift: established theory that a super continent, Pangaea, split into Laurasia and Gondwanaland, which in turn separated into the continents as we see them today
crown: part of the tree above the trunk, made up of branches, twigs, leaves, etc
decomposers: organisms such as bacteria fungi which get their energy from breaking down dead matter. They release minerals/nutrients which can then be used by living organisms for growth
emergent: tall tree that has a crown that reaches well above the forest canopy
epiphyte: plant or animal growing on others but not taking nutrients from the host
Eurasia: collective term for the land mass consisting of Europe and Asia
eutrophic: water containing high levels of nutrients which causes growth of algae and other micro-organisms, which often use up all the oxygen
exotic: a plant from another country or area
flagellum (pl. **flagella**): long whip-like structure possessing spines or claws used by rattans for climbing. Often has flowers growing from it. The base joins onto a stem (cf. **cirrus**). Only found in reed rattans (*Calamus*)
Friar's balsam: an old type of oily medicine made of resins, spices, etc.
fumarole: steam vent on a volcano often around which is deposited sulphur
genus (pl. **genera**): a taxonomic group that is made up of closely related species
Gondwanaland: Ancient giant continent which broke up into Africa, Australia and South America India and Antarctica. The break up occurred before 65 million years ago
host: animal or plant on which an epiphyte or parasite lives

GLOSSARY

insectivores: Animals specialising in eating insects (and small invertebrates). Also refers to members of the class INSECTIVORA: shrews, moonrats and hedgehogs
Jungle: originally an Indian word for an area of scrub-land, not really tropical forest at all
Laurasia: Ancient giant continent which broke up into Eurasia and North America
lianas: Woody climbers
Malesia: bio-geographical region, includes Indonesia, Malaysia, the Philippines, Singapore, Brunei and Papua New Guinea
niche: the role played by an organism within the functioning of the biological community
Old World: Area covering Africa, Europe and Asia
palaeontologists: Scientists who study life in the geological past
parasite: a plant or animal that lives on or in another and taking nutrients from it, hence doing the host harm
photosynthesis: a process by which green plants use light energy to produce sugars from carbon dioxide and water, a bi-product being oxygen
pollination: transfer of pollen from the male parts of a flower (anthers) to the female parts of a flower (stigma)
primate: Member of the taxonomic group which includes man, apes (includes gibbons) and monkeys
pumice stone: very light volcanic stone containing many holes, which formed from gas bubbles at the time when the rock was molten
Quaternary: Most recent geological era
resin: semi-liquid substance which bleeds from certain trees and plants when injured. It often hardens sealing the wound
rodents: members of the taxonomic group RODENTIA: squirrels, rats, mice and porcupines
ring-barking: making a circular cut around the circumference of a tree
Sanskrit: a very ancient language from which the classical Indo-European languages developed
spur: long, narrow, tube-like structure
sub-storey: a layer made up of medium-sized trees growing in dark conditions created under the canopy
Sundanese: Language and culture of West Java and quite distinct from that of East and Central Java
temperate: cool climatic conditions, not very hot or very cold
toxins: poisons
transitional area: area of gradual change
urbanisation: growth of towns and cities, or the change from rural to urban
waring'en: species of fig tree