AN ILLUSTRATED GUIDE TO

Bornean Orangutan

FOOD PLANTS

JOHN PAYNE & ZAINAL ZAHARI ZAINUDDIN

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BRINGING BACK OUR RARE ANIMALS

WWF

Front cover

Orangutan feeding on fruits of *Ficus parietalis*, a locally common species that grows well on old oil palms.

Charles Ryan / Sticky Rice Travel

Back cover

The amazingly long stolon of the very rare *Ficus minahassae* can sometimes reach a length in excess of two meters. Numerous tight bunches of figs clinch in alternate fashion on the stolon. Each bunch holds about 30 figs.

Zainal Zahari Zainuddin

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An illustrated guide to Bornean orangutan food plants
by John Payne and Zainal Zahari Zainuddin

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Contents

The purpose of this guide

This book has several possible uses. One is to suggest a role for the palm oil industry by showing that an issue for which the industry has been most often criticised—its impact on orangutans—can be addressed. Large regions of pure monoculture always bring risks. Accordingly, both voluntary and government-mandated palm oil sustainability standards incorporate a need for 'set-aside' lands within plantation management units. Set-aside areas include riversides (riparian zones), steep slopes, peat, fragile and marginal soils, rocky sites, undrainable swamps and 'high conservation value' (HCV) areas. We now know that sparse numbers of wild orangutans can persist in mixed oil palm and forest landscapes, with females refuging in forest patches and males moving between the patches through the oil palms. But, in the absence of active policies and interventions, these populations will drift to extinction. The extinction process has been hastened by the often misguided 'rescue' of orangutans from these mixed landscapes, thereby reducing the already sparse population even further.

Large estates and concessions situated within the natural distribution of orangutans can play a role in permanently sustaining these populations, firstly by allowing orangutans to live within plantations and, secondly, by retaining and actively growing food plants most favoured by orangutans on set-aside areas within the plantations.

A purpose of this guide is to show the sorts of plants that can be maintained, fostered, grown and cultivated as a contribution to enriching set-aside lands, and sustaining orangutan populations in a mixed oil palm forest landscape. The guide is based primarily on knowledge and experience gained in Sabah (Malaysian Borneo). But it is also applicable elsewhere because, although there are regional differences, depending on what particular species of wild plants are most prominent in the local ecosystem and forest types, orangutans' favourite food plants are broadly similar throughout Borneo and Sumatra. In addition, for areas where there are no orangutans, most of the plants featured in this guide represent important food sources for a variety of other wildlife species that are benign to humans, such as fruit bats, leaf monkeys, binturongs, deer and many bird species.

Even if none of the above applies to the reader, this guide can perhaps bring new insights, stimulate new ideas and perhaps new habitat creation or restoration programmes.

Global context

'Protected areas' set aside by governments for nature conservation can never be sufficient to prevent the extinctions of all wildlife species. Why? Primarily because forest lands set aside by governments for conservation are just small samples of what existed in the past, usually marginal for wildlife because the best lands are largely taken for human use. And secondly, because governments are primarily responsible for the people. Wildlife tends to come second in priority. In general terms globally, there is an increasing view that large corporate land-owners that grow industrial-scale commodity crops (as well as the businesses involved in the supply chain from 'field to fork', also known as 'palm to plate') should make use of their scale, their management-expertise or—where possible—parts of their land holdings to help prevent species extinctions.

In nature conservation, we are concerned principally with four major threats: climate change and its impacts, loss of natural habitats, pollutants and excessive human 'offtake' of wildlife. In some areas, invasive species are also a major concern. Much of the damage has already happened, and more is to come. One contributory way to help ameliorate those human-generated changes, however, is to restore some of what has been lost. This is not new thinking. There are many initiatives and programmes locally, regionally and globally to restore ecosystems—for example, by planting trees, rehydrating wetlands or removing plastics. While these are all welcome and necessary initiatives, in many cases they are generic. They might be linked to a global aim, such as removing carbon dioxide from the air. Rarely, however, are restoration initiatives targeted for the recovery of a particular endangered wildlife species in a specific ecosystem.

The oil palm and orangutan context

There is a general view that orangutans should stay inside specific forest areas designated by humans. Accordingly, some very useful forest restoration programmes have been conducted in degraded parts of protected areas. In the usual global view, oil palm and orangutans are seen as incompatible. The usual narrative is that one is the enemy of the other. But thinking outside the box (in other words, restructuring ill-defined problems) often leads to new insights, the solving of problems and, sometimes, new programmes.

We are told that orangutans need tropical rainforest. Studies of wild orangutans over the past few decades have proven that this is indeed true. Reproducing populations of wild orangutans occur only in extensive areas of protected rainforest in Borneo and Sumatra. But this cannot be the whole story. Fossilized orangutan teeth and bones show that the species used to live on mainland Asia from hundreds of thousands to a few tens of thousands of years ago, in areas that were not necessarily covered in evergreen rainforest, and before the spread of modern humans in the region. How could that be? We shall never know precisely, but observations in the Kinabatangan region of Sabah in Malaysia and also in the Ketapang District of West Kalimantan, Indonesia, provide some clues. In those areas, research shows that female orangutans can live in quite small patches of forests that have been left behind following the conversion of most of the former forest land to oil palm plantations. Usually, they have one or even two offspring with them. How do these orangutans become pregnant? Although there might also be a male orangutan living in the same patch of forest, in many cases that is not so. Instead, the males move through oil palm plantations, between forest patches, over many kilometres, to mate with the females.

How is it that we do not see these male orangutans? There are three reasons. Firstly, the number of orangutans in the landscape who do travel in the oil palm blocks is extremely small—no more than the total number of plantation managers walking in those same blocks at any one time. Secondly, any orangutan that is alive in a predominantly oil palm landscape knows from experience that humans are bad news. Humans might molest, chase, knock, cut or capture them. Although it has no way of knowing, the humans might then send it to a place far away that they have never

been to before, and might not survive. So, the life of orangutans in mixed oil palm and forest landscapes revolves around not only on seeking food, but equally around trying not to be seen by humans. Those orangutans that are successful at not being seen by humans are the ones that tend to survive and thrive. Thirdly, the humans most likely to spot a wild orangutan or nests, by luck, are workers harvesting fruit bunches, who might not necessarily be believed if they report sighting an orangutan, know what orangutan's nest looks like or might not even know what an orangutan is. In fact, it is true that wild male orangutans do travel through oil palm plantations. But their numbers are extremely small.

These observations provide context to three puzzles. Firstly, there is the zoological mystery of why male orangutans grow to a much larger size than females: on average over 80 kg for males, less than 40 kg for females. Yet in general, their diet is the same. In humans and most other mammals, on average males grow to be only slightly larger than females. Zoologists usually argue that in species where adult males are much larger than adult females, the large size of the former is an evolutionary outcome of physical competition between males for females. While wild mature male orangutans do occasionally fight each other, that is very rare. They prefer to avoid conflict. Instead, their large body size may allow them to travel further, over bigger areas, seeking opportunities to mate with females who are resident in their very much smaller home ranges in forest patches. This leads to the second mystery: why, very rarely, do humans report seeing a wild orangutan in very remote sites where orangutans have not been seen previously. Examples of such cases occur from time to time in the forests of central Borneo, Brunei, northern Sarawak and south-western Sabah. These orangutans are mature males, travelling over great distances, seeking female orangutans—albeit where, unknown to the males, there are none. Thirdly, in the past, rural communities in Borneo spoke of a ghost-like, forest-dwelling ape known as 'batutut', or (in Sumatra) 'orang pendek'. In cases where sightings are not figments of the imagination, these are typically less agile and often under-nourished old orangutans in the last years of their life, usually males, that often walk on the ground. They are usually darker in colour than younger orangutans. They try to stay away from humans but are occasionally glimpsed in the forest gloom.

Until recently, it was fashionable to 'rescue' orangutans found in plantations and to translocate them to an 'orangutan rehabilitation centre' or to extensive forests elsewhere. But we now realise that, if those orang-

utans are not injured, that approach makes little sense. For one thing, the conversion of the former forests to plantations typically happened more than thirty years ago, so the orangutans living there now, some of whom were born only recently, must have adapted to life in a mixed oil palm and forest landscape. For another thing, moving orangutans into a forest where they have never been before might not be in the orangutan's best interest—they might not be able to find enough food for sustenance over the longer term or, if there are already orangutans present in that forest, they may well be stressed or harassed by those existing residents. Worse still is the idea of bringing all orangutans from an oil palm plantation to a rehabilitation centre. Why go to the bother of taming a wild orangutan, then having to feed it on purchased fruits for the rest of its life, for tourists to see, when it might have been able to survive for many years unaided?

Which leads on to another fundamental issue: what foods do wild orangutans need, whether the orangutans be in a vast protected forest or in a scatter of forest patches in an oil palm landscape?

More than 95% of the orangutan's diet consists of plants, and the bulk of their plant food consists of fruits and young leaves. This is not surprising, as fruits tend to be rich in carbohydrates and fats, while young leaves tend to be relatively rich in proteins. Other items such as flowers, stems, cambium (inner bark) of trees, and insects make up only a small proportion of the diet in terms of amounts eaten. However, those latter foods may be critical during periods when there are no edible young leaves or fruits in the forest.

Wild plants, especially species in the equatorial regions, protect themselves from herbivorous animals (whether that be insects or mammals) by synthesizing natural chemicals, known as 'secondary metabolites', that develop in the leaves as the leaves grow, and in young fruits before the fruits are ripe. These chemicals tend to be bitter, spicy or astringent in taste, and are toxic in large quantities. Although orangutans are more tolerant than humans to these natural chemicals, as far as possible, orangutans do avoid feeding on old leaves and on unripe fruits in order to minimise their intake of natural toxins and indigestible fibre. They seek young leaves and ripe fruits whenever possible.

All forests, including tropical rainforests, tend to have annual fruiting seasons lasting a couple of months, interspersed with much longer 'off' times with little or no fruit available. Rainforests also experience 'bad' years, usually the driest and wettest years, when very few fruits are produced, even in the fruiting season. Wild orangutans seek and gorge on

carbohydrate-rich fruits whenever those are available in large quantities. These feasts allow them to store body fat. In lean periods, they survive on those fat reserves along with the cambium of trees and lianas and any other minor food sources that they can find. Most of the time, conditions in the rainforest are intermediate, however, with neither vast amounts of fruits, nor famine.

Any tract of forest as well as any region of mixed oil palm and forest has a 'carrying capacity' for large wild animals such as orangutans. Carrying capacity means the number of individuals that can be sustained alive in a particular defined area. The carrying capacity of orangutans in a landscape is not defined by the number of 'fruit trees' in the landscape. It is crucial to understand that the carrying capacity for orangutan in a region is influenced by the amount of food available at the occasional worst time when there is almost no food available for several months.

Carnivorous animals can always hunt other animals for food, while animals that can fly (bats and birds) can potentially go elsewhere in search of foods. Female orangutans have a problem: in famine times, they stay put and wait until weather conditions promote the growth of young leaves, flowers and fruits. If adverse weather conditions last too long, they or their offspring may succumb and die.

It is not so much a question of the precise plant species that orangutans need, but whether fruits and young leaves in general are available, and in what quantities. Little if anything can be done in extensive rainforests to boost the production of orangutan food plants, so the carrying capacity of orangutans depends on natural conditions (such as soil fertility) and phenomena (such as rainfall patterns). Empirical research shows that the natural carrying capacity of different rainforest areas varies from zero to about four orangutans per square kilometre. Where orangutans do exist, a typical carrying capacity is slightly over 1 individual per square kilometre. That is lower than the least populated parts of the world in human terms, lower even than Mongolia and western Sahara. Even the densest wild orangutan populations, found on forested fertile, moist lowland soils, and on volcanic-derived mountain soils in Sumatra, are similar to human population density of places such as Namibia and Iceland. In other words, the natural population density of wild orangutans is always extremely low even under ideal conditions, and in practical terms can never be increased. Except in very localised cases of some individual orangutans feeding on oil palm meristem when there is no other food nearby, orangutans never

become a pest. They will always be naturally rare, and need human support to ensure that their numbers never drop below a point beyond which sustaining reproduction becomes impossible.

In the lower Kinabatangan region of eastern Sabah, it is estimated that about 800 orangutans now live in 50,000 square kilometres, equivalent to about one orangutan in 6.25 square kilometres. This sort of low population density is what we find naturally in many of the inland hill forests of Borneo, where steep slopes, acidic soils, low nutrient content and high annual rainfall result in very low annual fruit production and frequent long periods with no orangutan foods. The lower Kinabatangan orangutan population is down from about 8,000 orangutans that would have occurred there some fifty years ago. This is not surprising. In terms of vegetation, just 9% of the land in this region is now under some form of forest cover, while 90% is oil palm plantation, and 1% human settlement and infrastructure.

Now, there are three points to be made. Firstly, to be sustainable in the long term, a wild animal population needs to number in many hundreds, at least, and ideally at least a thousand or so. Secondly, even with intensive human help over many years, the orangutan population in a mixed oil palm and forest landscape will remain very small, and without adversely affecting human activities in any major way, whether in terms of palm oil production or economy or safety. Wild orangutans never harm humans. If a particular orangutan causes any damage to oil palms, the damage will be localised and should be amenable to site-specific management. Thirdly, if we want to sustain the Kinabatangan orangutan population, and not allow it to drift to extinction, then humans need to purposefully help. That help must not come in the form of moving orangutans out, an approach that in biological terms is similar to hunting in that it will simply reduce the overall population size even further. Realistically, the help that humans can provide can come only by boosting availability of orangutan food plants throughout the year within oil palm plantations. That would help to lift the regional orangutan carrying capacity, and ensure that some food is available even in the worst drought and very wet years. Is that possible? Yes, because the small parts of an oil palm estate that should not be cultivated with palms—the 'set-asides'—can be enriched with orangutans' favoured food plants.

Introduction to the guide

For whatever purpose this guide is used, whether to provide a general background for embarking on a restoration or habitat enrichment project, or to identify and choose plant species, or simply to gain an idea of what orangutans like to eat, or to ascertain plant names, some practical system of naming is needed. Unfortunately, no ideal system exists.

The equatorial forests in which wild orangutans live contain a very great diversity of plant species. The number of species is so great—even within one locality—that there is no commonly used name in any language for most particular species. Alternatively, names exist in Malay, Indonesian or in local languages and dialects, but those names may be used inconsistently or for more than one plant species. Also, the indigenous names used two generations ago are now almost all lost, as younger generations have moved away from forest regions and are linked instead to the digitally-connected world. In other words, the only reliable naming for any species is the scientific name, something which only a very small number of botanists can tackle. Even that approach can present problems because, in reality, there is not a single professional botanist alive who can go into any patch of forest in Malaysia or Indonesia and identify on the spot more than a few species of trees that are present. In addition, scientific naming, especially of woody plants, can change over time, based on specialist herbarium and DNA-based revisions.

Based on these points, this guide adopts the following format for arranging and naming orangutan food plants: genus, family, examples of species in that genus that occur commonly in Sabah, and local names used for that genus. In botany and zoology, 'family' represents a grouping that a specialist can see that makes good sense. In plants, the grouping is based on the structure of reproductive parts and, nowadays, also similarities in DNA. Genus (plural genera) is the level in the hierarchy of biological classification below family and above species. Often, identifying the genus of a plant is not too difficult, while identifying to species level can be difficult or impossible in the absence of flowers and herbarium.

Local names are used sparingly in this guide. This is because of a combination of inconsistency in use in published texts, the fact that many species have no local name, the fact that some names found in published literature are simply repetitions of old and unverified references, and because many of the local names published in old texts (such as Henry Burkill's 1935, A Dictionary of the Economic Products of the Malay Peninsula) have fallen out of use. Also, plant species which are widespread in Asia, distinctive in appearance and used in traditional medicines have numerous local names. In this guide, local names—where provided—include names which are in current common use in Malaysia and Indonesia or in Sabah only, and some names introduced in recent years by the staff of the Sabah Ficus Germplasm Centre in Tabin Wildlife Reserve. Illustrations form the core of this guide, but with the naming as an essential complement.

The guide is not a complete guide to orangutan food plants. Such a guide cannot possibly be produced. An unpublished list of all recorded wild orangutan food plants compiled in year 2007 (Orangutan Foods, compiled by A.E. Russon, S.A. Wich, M. Ancrenaz, T. Kanamori, C.D. Knott, N. Kuze, H.C. Morrogh-Bernard, P. Pratje, H. Ramlee, P. Rodman, A. Sawang, K. Sidiyasa, I. Singleton, C.P. van Schaik) already contained over one thousand species, and more have been added at the local scale since then. Secondly, different plant species occur naturally in different parts of Borneo and Sumatra islands. Thirdly, while a few plant genera are consumed commonly by wild orangutans (either because they are very nutritious and actively sought, or less nutritious but locally common), most plant species in the orangutan diet are eaten only rarely. This guide illustrates plant genera and species that form a significant component of the diet of wild orangutans in a minimum of two study areas.

Criteria for choosing the types of plants illustrated

Fruits are important to orangutans in providing their main carbohydrate source. Leaves are important in providing proteins. Cambium, although eaten in much smaller quantities, is equally important in tiding orangutans over during critical periods when there are no fruit or leaf food sources in the forest. This guide prioritises plants that are known through field studies to provide at least two out of these three resources (fruit, leaves, cambium) to orangutans. More specifically, five criteria (TABLE 1) are used to select the plants presented in this guide.

In planting out seedlings, wildings, cuttings or marcots as food plants, one issue with which to contend is whether the species is monoecious or dioecious. Monoecious plant species have female and male flowers on one plant, or flowers that contain both female and male parts. Species that are dioecious have separate female plants and male plants. With dioecious plants, therefore, there is a risk of planting seedlings which can never bear any fruit.

TABLE 1 · Criteria used to select the plants presented in this guide

CRITERION	EXPLANATION
Orangutan preference	The most important criterion; the plant, at the genus or species level, has to be recorded as a frequently-eaten type of food of orangutans by at least two professional researchers in different regions
Ease of identification	Most rainforest plants cannot be identified readily by non-specialists; to make it practical, this guide emphasises ones which are relatively easily-identifiable; for many plants, this means listing by genus, rather than by species
Potential availability	Orangutan food plant types that are selected for restoration projects need to be accessible in the wild, or produced relatively easily in a nursery; plants that can be found easily as wild seedlings (wildings) and transplanted to nurseries or planting sites in estates, or grown vegetatively (by cuttings or marcots) are favoured over those where rarely-available seeds are required for propagation; only a few plants which are particular orangutan favourites but which are naturally rare are included
Growth rate potential	The parts of the plant that are eaten by wild orangutans must ideally start to become available within a few years after planting the seedling or cutting; many of the plant species that provide food favoured by wild orangutans (for example, merbau, sepetir and keranji, all trees in the legume family which grow to large size) need many years before they bear fruits, and so are not included here
Robustness	Plant species that tend to have demanding conditions or, based on past experience, high mortality after planting, are not included; species that can grow in both open and shaded sites are favoured

An iconic *Ficus crassiramea* tree retained in Abedon oil palm estate in support of biodiversity conservation. When fruiting, this giant fig is visited by rhinoceros hornbills, all the way from Ulu Segama Forest Reserve some 10 kilometres away.

FICUS
(family Moraceae)

Ficus is a genus containing trees, shrubs, climbers, epiphytes and (most famously) hemi-epiphytes, the latter commonly known as strangling figs or stranglers. The genus is collectively known in English as fig, and in Malay and Indonesian as ara. The term fig and ara refer to the genus Ficus and to its fruit. The 'fruit' is actually an inflorescence in an enclosed receptacle, known technically as a syconium. In this guide, for simplicity, the word 'fruit' is used to refer to the Ficus syconium. About 35% of all Ficus species are monoecious (every 'fruit' contains female and male flowers), while the others are dioecious (there are separate female and male plants). Many of the former (but not all) are stranglers and trees, while many of the latter tend to be other forms of plants. The male fruits of dioecious species are rarely eaten by birds and mammals. These fruits do not contain any obvious toxic or bitter substance; the reason for the apparent avoidance of male fig fruits by animals is unknown.

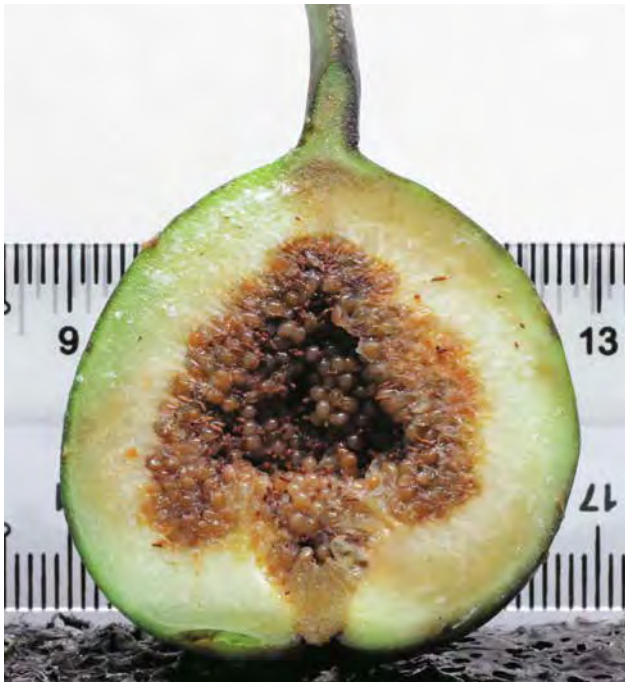
All Ficus species have a white or watery-whiteish latex (FIGURE 1), from the site of plucked leaves as well as in stems and trunks. All Ficus fruits have an ostiole (FIGURE 2), and contain numerous closely-packed small ovaries or flowers (FIGURE 3), a feature immediately obvious when the fruits are cut open.

Overall, Ficus is the most significant genus amongst orangutan food plants. This is clear because orangutans eat Ficus in all areas where orangutans have been studied, because Ficus is eaten frequently or in large amounts over any one-year period, because there are very many species

FIGURE 1 · *Ficus xylophylla* stem oozing white sap

FIGURE 2 · Ostiole in a *Ficus trichocarpa* fruit

FIGURE 3 · Cross section of *Ficus variegata* showing the ovaries and ostiole



in the genus and because most Ficus plants tend to fruit outside the main overall forest fruiting season. Generally, orangutans eat the ripe or near-ripe fruits (FIGURE 4), and also the leaves in a few species (FIGURE 5). Figs tend to be less nutritious than other fruits when compared weight for weight, but also tend to have few natural toxic metabolites compared to other rainforest fruits.

Apart from a few prominent, distinctive and common species, many Ficus are not easy to identify at the species level. There are five main reasons for this. Firstly, there are very many species. Secondly, there is within-species variation in the appearance of some species. Some species can grow in different forms, depending on the local site—for example, some which can climb or strangle may also grow as free-standing trees, while some species can appear to be either a climber or a strangler. Thirdly, the classification and naming of the genus has been quite complex, with different names given to the same species. Fourthly, some herbarium specimens are misidentified. Fifthly, some closely-related species hybridise.

To provide some order to the great variety of figs that might be eaten by orangutans, the following categorisation is used: common stranglers with small leaves, other stranglers, tangkol, and miscellaneous others.

1 Strangling figs—general

Strangling figs are usually obvious. There are woody roots or a single thick stem above the ground, with typically pale-coloured and rather smooth bark, that encloses or runs parallel to the 'host' tree trunk, and woody strangling fig material continues to grow, downwards (like roots) (FIGURE 6), upwards or outwards (as branches). Some of the woody growth is not easily definable as a trunk or branch or root. Some strangling figs manage to grow large without a host tree. Some strangling fig species grow very large, with a tree-like crown of their own (FIGURE 7), whereas some tend to remain small and resemble climbing plants (FIGURE 8). All strangling figs, however, grow naturally from seeds dispersed and dropped by birds or mammals on to tree branches or crevices in the trunk, including on oil palms (FIGURE 9). In some localities, the seeds are deposited and grow on rocky outcrops. On brick or cement buildings built by humans, strangling fig seeds germinate in cracks, and continue to grow unless removed (FIGURE 10).

FIGURE 4 · Orangutan eating *Ficus sundaica* fruits near Sukau, Kinabatangan

FIGURE 5 · Orangutan eating *Ficus microcarpa* leaves

FIGURE 6 · *Ficus microcarpa* showing massive roots in Sandakan

FIGURE 7 · *Ficus microcarpa* growing on an old oil palm, about 20 years old

FIGURE 8 · Small strangling fig (species unknown)

FIGURE 9 · *Ficus dubia* seedling growing naturally on an oil palm

FIGURE 10 · *Ficus caulocarpa* growing on an adandoned cinema in Lahad Datu

2 Common strangling figs with small leaves

There are two common monoecious strangling fig species which occur throughout Southeast Asia, as well as India and northern Australia: *Ficus microcarpa* and *Ficus benjamina.* Compared to other strangling fig species, the leaves of these two species are relatively small and soft. Orangutans eat the fruits and leaves (FIGURE 5). Mature leaves of both species average approximately 6–10 cm long. (Another species similar to *Ficus benjamina, Ficus stricta,* has leaves averaging 10–14 cm long). Individuals of both species can produce several crops of fruits and several 'flushes' of new leaves every year. Both species tend to be robust: they can grow within 10 years to large size, whether naturally dispersed or planted on to old oil palms, or in the ground, and both species can be grown from cuttings, marcots (FIGURES 11 AND 12) or seeds.

TABLE 2 · Differences between two common strangling figs

SCIENTIFIC NAME	LOCAL NAMES	DIFFERENCES BETWEEN THE TWO
Ficus microcarpa	Jejawi Banyan Nunuk	Thin reddish roots hanging from the spreading branches, which may grow into large pillar supports; main branches tend to grow upwards; leaves with no prominent 'drip tip'; there are usually several leaf 'flushes' (growth of multiple new leaves) per year, and leaves of different colours are usually visible on one plant (FIGURE 13); figs ripen from green to white (FIGURE 14) to pink to purple to black; robust and fast-growing on all substrates, including hill slopes and old oil palms, and more tolerant of wet and swampy sites than most other Ficus species
Ficus benjamina	Beringin Waringin	Few or no hanging roots; main branches tend to grow downwards, and all small branches and twigs hang downwards; leaves have a prominent long 'drip tip' that tends to point to the ground (FIGURE 15); figs ripen from green to yellow to orange to red to black; less robust than *F. microcarpa* and usually slower-growing, but more tolerant of dry sites

FIGURE 11 · *Ficus microcarpa* marcot growing with an empty oil palm fruit bunch as mulch

FIGURE 12 · The same marcots, one year later

FIGURE 13 · Young leaf flush on *Ficus microcarpa*

FIGURE 14 · Unripe fruits of *Ficus microcarpa*

FIGURE 15 · *Ficus benjamina* leaves

3 Other stranglers

There are more than 30 additional species of strangling figs in Borneo, of which at least half can grow to large size. The most prominent species are listed in Table 3, with brief notes on some of their most obvious features. All are monoecious. Their commonness or rarity varies from region to region. Some are widespread throughout Southeast Asia and tend to prefer open conditions and lower rainfall, while others have a limited natural distribution as high-rainfall equatorial rainforest specialists.

TABLE 3 · Strangling fig species of Borneo

SPECIES	FRUITS	OTHER FEATURES
*Ficus annulata** (FIGURE 16)	Fruits 3–4 cm, egg-shaped, paired, ripen green to greenish yellow with numerous pale spots	Large, long leathery leaves, variable in size, but averaging 20 x 9 cm
*Ficus binnendijkii**	Fruits 0.5 cm, round, paired, ripen green to orange	Stiff, smooth, leathery leaves, long and narrow in young plants; mainly western Borneo
Ficus borneensis	Fruits 1–2 cm, oblong, ripen green to reddish	Small, leathery leaves with indistinct veins; hills, mainly western Borneo
*Ficus caulocarpa** (FIGURE 10)	Fruits very small (0.3–0.5 cm), growing in dense crowds along smaller branches and twigs, ripen white with pink spots, then turning dull purple	Distinctive oblong leaves with a 'hinge' at the junction of the blade and stalk, rare but widespread in lowlands
*Ficus crassiramea** (FIGURE 17)	Fruits 1.5–2 cm, round, ripen bright orange-red, in a 'cup' of green bracts	Large, long leaves with clear V-shape veins at base; common in coastal alluvial floodplains, peat and sandy wetlands, especially eastern Sabah lowlands
*Ficus cucurbitina**	Fruits 2 x 5 cm, oblong, ripen orange-red, the only species whose fruits bear numerous small sharp hairs	Rare
Ficus delosyce	Fruits 0.5 cm, round, paired, ripen green to white to pale yellow	Scattered, locally common western Borneo, mostly on infertile soils such as sands, peat and ultramafic

*Ficus drupacea** (FIGURE 18)	Fruits 2–3 cm, oblong, paired, ripen orange to dark red	Underside of young leaves and stalks may be hairy; mainly in coastal areas
*Ficus dubia** (now known as *F. lindsayana*) (FIGURE 9)	Fruits 2–5 cm, round or egg-shaped, with a stalk, paired, ripen yellowish-orange to bright crimson	Leaf with long petiole; scattered
*Ficus kerkhovenii**	Fruits 1 cm, round, no stalk, paired, ripen yellow to orange to red to purple	Mainly in high rainfall primary forests, low hills; grows to very large size; some grow as free-standing trees
Ficus pellucidopunctata	Fruits 1–1.8 cm, oblong, some paired some not, ripen green to pale yellow	Widespread, common
Ficus pisocarpa	Fruits 1–1.5 cm, round, paired, ripen green to yellow to dark orange	Widespread, often near rivers
*Ficus stricta** (FIGURE 19)	Fruits 1.5–3 cm, ripen green to yellow to red to black	Lowlands and hills; some grow on rocks
*Ficus stupenda**	Fruits 3–5 cm, conical, paired, ripen green-yellow to dull red, in a 'cup' of green bracts	Leaves large and rounded, often with waxy white latex on underside; lowlands and hills
*Ficus subcordata**	Fruits 1.8–4 cm, oblong, ripen green to yellow to orange or black	Leaves large; rare in Borneo, common in low rainfall areas
*Ficus subgelderi**	Fruits 1 cm, round, ripen green to orange to red	Dried leaves are shiny gold on the upper surface; scattered, mainly western Borneo;
*Ficus sumatrana**	Fruits less than 1 cm, round, paired, ripen green to dark orange	Widespread, common
*Ficus sundaica** (FIGURE 4)	Fruits 1–1.5 cm, round or oblong, some paired, ripen green to yellow to orange-yellow to red	Leaves with distinct basal veins that reach to nearly half the length of the leaf; scattered
*Ficus virens**	Fruits 1 cm, round, white to purple with black spots	Rare; coastal lowlands
*Ficus xylophylla** (FIGURE 1)	Fruits 3–5 cm, large, paired, oblong, ripen green to orange to bright red	Leaves large, thick, with rounded apex; on infertile sandy and peat soils

* Records exist of wild orangutans feeding on these species; the fruits of all the other species listed would surely also be eaten by orangutans

FIGURE 16 · *Ficus annulata,* grown from a marcot planted on a steep slope
FIGURE 17 · *Ficus crassiramea* in a freshwater alluvial swamp

FIGURE 18 · *Ficus drupacea* leaves and fruits, one ripe, most semi-ripe

FIGURE 19 · *Ficus stricta,* a strangler growing on a rocky cliff face

4 Tangkol or red river fig

This species—*Ficus racemosa*—is known as tangkol or nunuk ragang in Sabah, loa in Indonesia and red river fig in English (FIGURE 20). It is a monoecious tree that occurs wild in India, throughout Southeast Asia and northern Australia. The fruits are born in numerous clusters, from the tree trunk and branches, ripening from green to orange-yellow to red (FIGURE 21). The leaves contain many bio-active chemicals and have been used in traditional medicines, especially in India. In contrast to the fruits, mammals other than the colugo seems to avoid feeding on the leaves. Tangkol is singled out here because it is prominent in several features: (1) a tree that can grow to large size, (2) the trunk and branches are smooth and very pale in colour, with the main branches growing away from the trunk in an irregular pattern, (3) tends to grow on river banks, with major branches overhanging the river (although not always), (4) often in clusters of several or many trees at one site, (5) the fruiting pattern varies greatly from tree to tree, but typically most trees bear fruits several times each year, (6) apart from orangutans, all wild animal species that eat fruits (from fish to elephants) feed on tangkol fruits. Tangkol makes an ideal species for restoration in riparian zones, but it does not thrive on swampy sites. Vegetative propagation seems to be more difficult with tangkol than with most other Ficus species, so growing seedlings in a nursery, from seeds, is the best approach (FIGURES 22 AND 23).

5 Miscellaneous other Ficus

Some Ficus grow exclusively as either climbers, or small trees, or large trees, or shrubs or epiphytes. Some species, however, may adopt different forms, depending on where the seed is deposited and the surroundings, especially the prevailing amount of light and the available substrate or space through which to spread.

FIGURE 20 · A *Ficus racemosa* tree

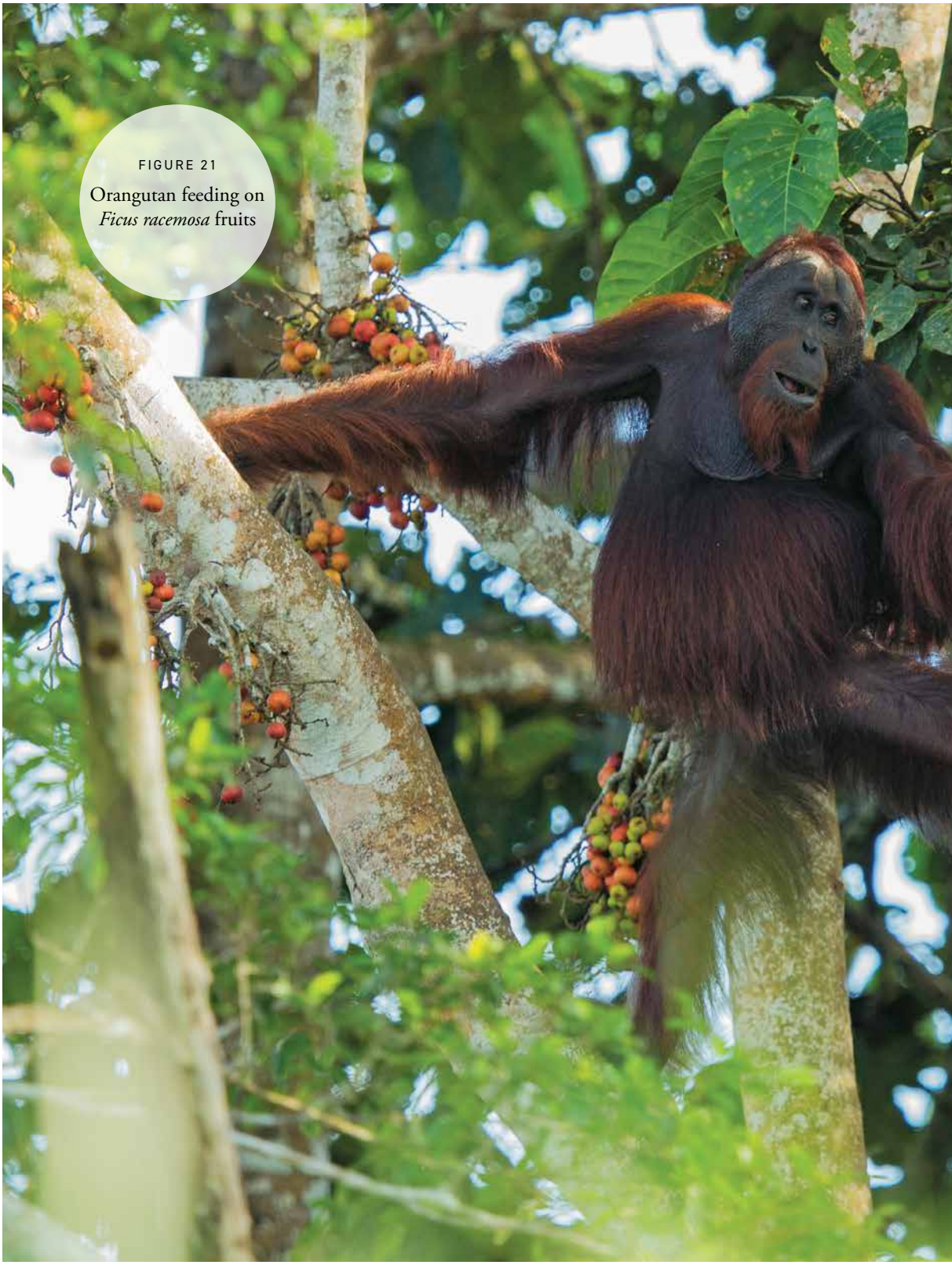


FIGURE 21

Orangutan feeding on *Ficus racemosa* fruits

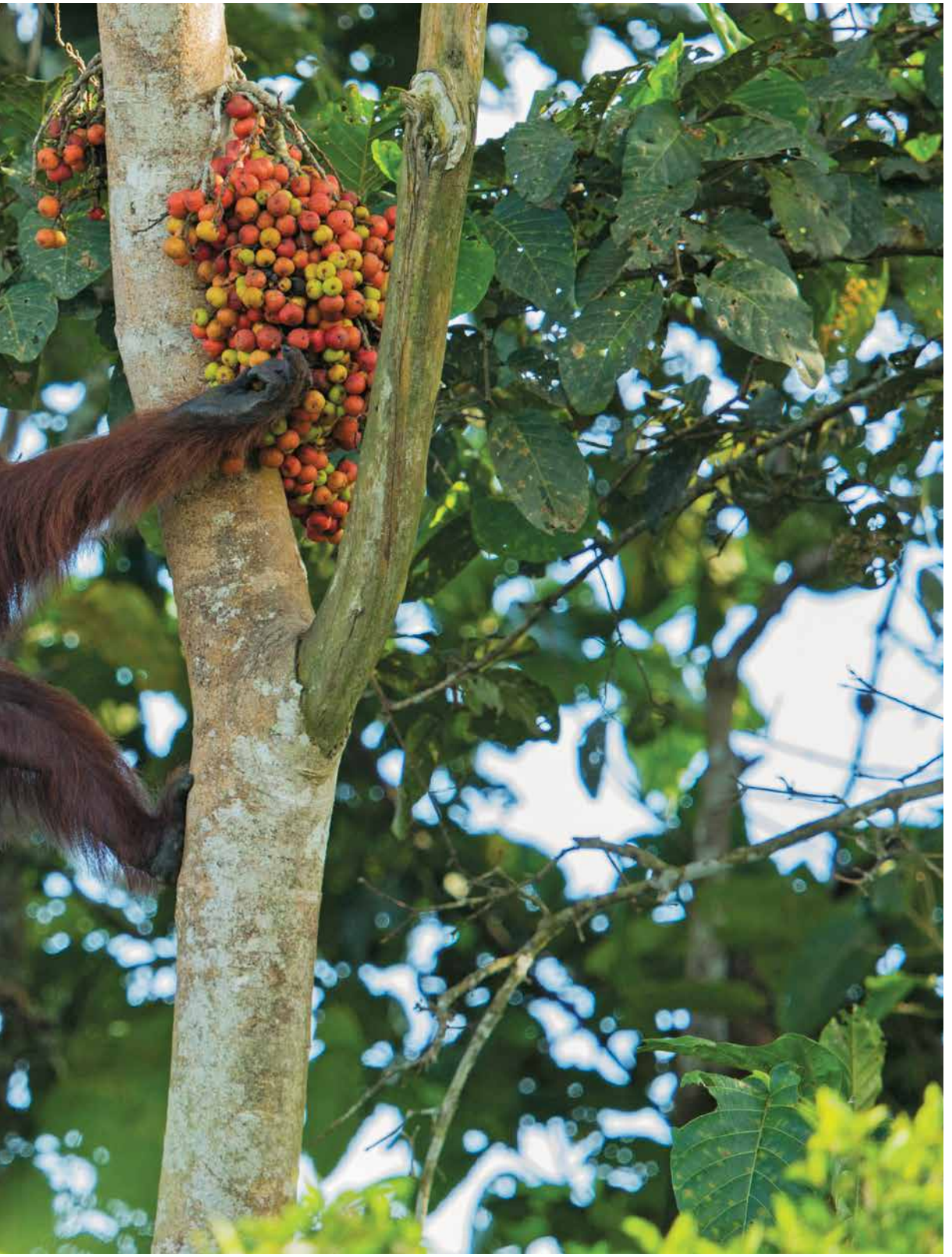


FIGURE 22 · Newly-germinated tangkol seedlings

FIGURE 23 · *Ficus racemosa* seedlings in the Sabah Ficus Germplasm Centre nursery

There are several species of Ficus which always grow to be trees from seeds dropped by birds or mammals on to the ground. Two species reach heights of 40 metres or more: with its smooth, whiteish bark, *Ficus albipila* (monoecious) (FIGURE 24) very rarely fruits and is used by wild honey bees *Apis dorsata* as a nesting tree, while *Ficus variegata* (dioecious), known locally as tandiran (Sabah) or nyawai (Indonesia) is deciduous and typically bears fruits (FIGURE 3) several times annually. Tandiran is variable in details of the leaves and fruits, but the fruits always grow in clusters on stalks directly from the trunk and branches (FIGURE 25). In some trees, the fruits ripen to red, in others they remain green. Tandiran grows straight and rapidly on fertile soils, but can also grow to large size on poor soils. It holds potential as a native plantation tree species for wood production, as well as being a good candidate for planting as a wildlife food source on a wide variety of soil types including peat and on steep hillsides.

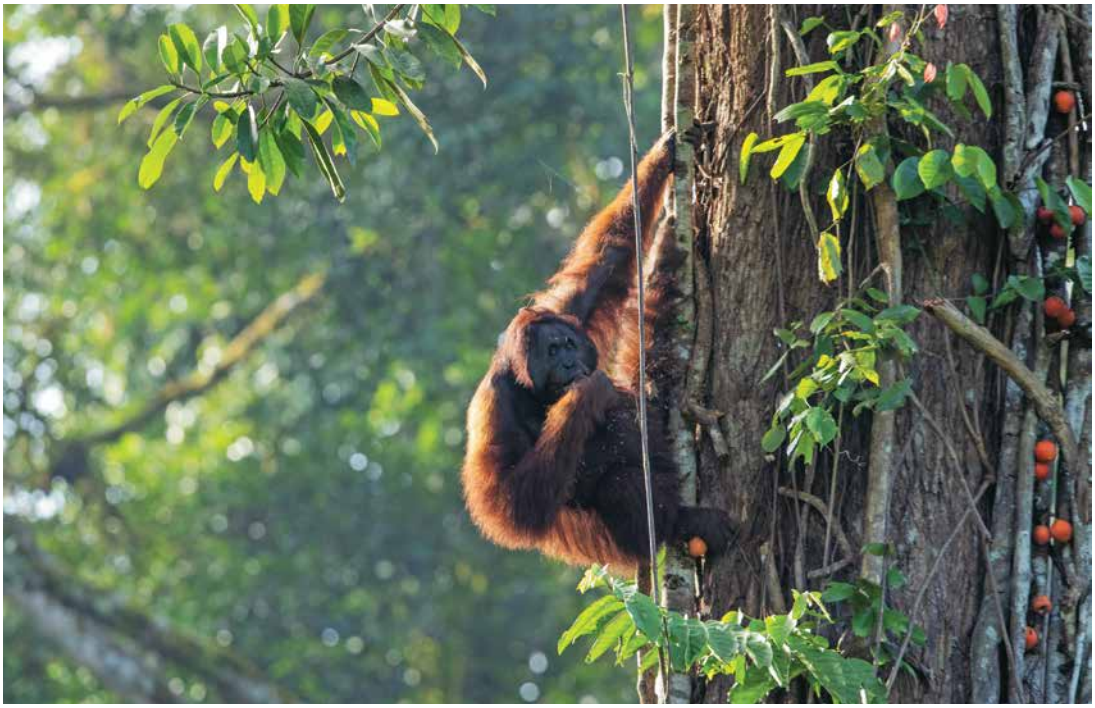
Some Ficus species need the support of trees on which to grow but, unlike stranglers, start life as seeds dropped on to the ground. Most species of climbing figs in Borneo are root-climbers, meaning that they grow upwards by means of adventitious roots that grow and grip on to the trunks of trees, rather than by tendrils or hooks. Of the various climber Ficus, some are widespread and with fruits recorded as eaten by wild orangutans, some are naturally rare and localised, some are confined to mountain ranges and some have very small fruits. Two species of root-climbers which bear large fruits eaten by orangutans are *Ficus barbajovis* and *Ficus punctata* (FIGURE 26). As with most dioecious Ficus species, only the female fruits are consumed by wildlife, but not male fruits. In these root-climber species, when the climber reaches the host tree canopy, it grows branches out sideways and the original root detaches from the tree trunk, thickens and starts producing figs. The fruits are either spherical or pear-shaped and, in the case of *punctata* when ripe, about 10 cm in diameter and weighing about 300 grams each. *Ficus punctata* produces several crops of figs per year, with only one or two figs ripening every day. Thus, one liana can produce a small but steady supply of food for animals, such as orangutans, for around half the days in the year (FIGURE 27).

FIGURE 24 · *Ficus albipila*

FIGURE 25 · Orangutan feeding on tandiran fruits, which are borne only on the trunk, branches and larger twigs

FIGURE 26 · *Ficus punctata*

FIGURE 27 · Orangutan feeding on *Ficus punctata* fruits



Ficus trichocarpa usually grows as a root-climber, but can also grow downwards as an epiphyte from tall trees. Root climbers represent a suitable form of plant to help enrich sites with abandoned old oil palms, as they can grip on to the otherwise broad, smooth trunks, and tolerate shady conditions (FIGURE 28). The mature plant presents a very different appearance, with a thick canopy and abundant fruits (FIGURES 29 AND 2).

Ficus parietalis (ara kertas) (FIGURE 30) grows as a slender climber, or as a small tree, or as a scrambling plant on rocks, or as an epiphyte. In mature oil palm plantations near to forest, this species can sometimes be found commonly as a climber or epiphyte, with almost every palm bearing a plant two or three metres from the ground. The leaves and the red-coloured fruits of female plants are eaten by orangutans. *Ficus parietalis* has large leaves, with only four or five side veins, and which feel rough to the touch on the underside.

Ficus subulata (ara mata ikan) grows either as a small tree or as a climber (FIGURE 31). The fruits and leaves are eaten by orangutans. Immature climbers of this species send roots round a host tree trunk, which clasp it in position and then it produces long flimsy branches which grow to enter the crowns of nearby trees. These branches attach themselves to the other trees with encircling roots and a series of *subulata* crowns develop within the tree tops. Each *subulata* crown grows roots downwards to the ground. *Ficus subulata* can be identified by its very long, pointed reddish-green stipule; an 'ear' or 'auricle' on one side of the leaf base; no hairs on any part of the plant; large leaves each with up to 16 pairs of side veins; and by the veins being slightly sunken into the leaf surface.

One of the most common species of Ficus in Borneo, *Ficus villosa* (ara lipan), is a slender climber with all parts other than the fruits and the upper side of the leaves covered in dense, soft, reddish hairs (FIGURE 32). *Ficus heteropleura* (FIGURE 33) may grow as a climber, small tree, epiphyte or strangler, while *Ficus obscura* (also known as *Ficus scaberrima*) is usually a bush but may grow as an epiphyte (FIGURE 34). *Ficus aurata* (kumpan, tempan, gatal piring) is a common shrub or small tree in open areas, with fruits that have tiny sharp hairs both inside and outside (FIGURES 35 AND 36). *Ficus deltoidea* (mas cotek) is a slow-growing specialist of nutrient-poor substrates, usually found on as an epiphyte growing on the branches of large, old trees and also abandoned oil palms and rocks or as a bush on degraded lands (FIGURE 37). The fruits of all the species mentioned above are reported to be eaten by orangutans.

FIGURE 28 · *Ficus trichocarpa* seedling planted at the base of an abandoned old oil palm tree

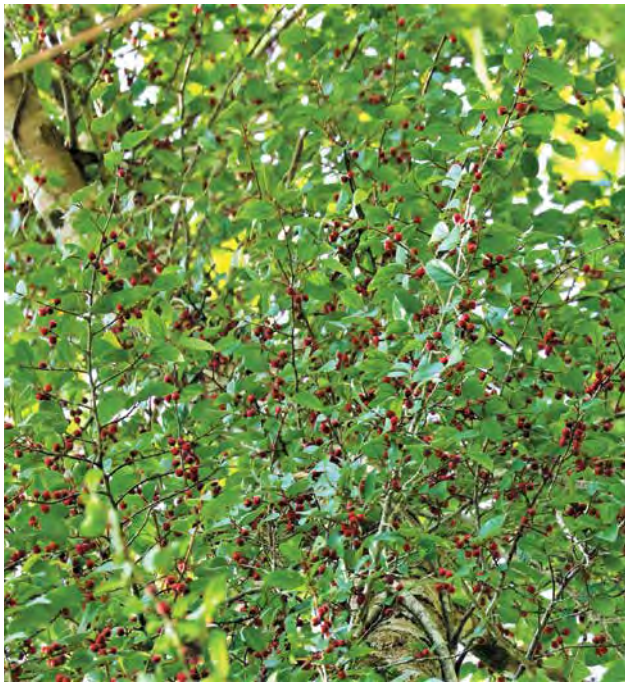


FIGURE 29 · Mature *Ficus trichocarpa*

FIGURE 30 · Collecting *Ficus parietalis* fruits for nursery propagations

FIGURE 31 · *Ficus subulata*

FIGURE 32 · *Ficus villosa* fruits growing under the leaves

FIGURE 33 · *Ficus heteropleura,* growing here as a strangler

FIGURE 34 · *Ficus obscura (scaberrima)* growing here as a bush
FIGURE 35 · *Ficus aurata* tree with fruits

FIGURE 36 · Cut *Ficus aurata* fruits

FIGURE 37 · *Ficus deltoidea* growing on an oil palm tree

It is safe to say that the fruits of most species of Ficus will be eaten by wild orangutans, and the leaves of some, but there are a few Ficus species which are probably rarely or never eaten by orangutans. One group consists of about six species that grow as small trees (up to about 18 metres maximum tall), often in damp, shaded sites with low light intensity, dioecious and with clusters of fruits born on stalks on the tree trunk (FIGURE 38). The unripe female figs of these species are sometimes consumed by people in Borneo as salad, but none have been reported as orangutan foods. This may be because the trees tend to be off the usual forest travel routes of orangutans or the fruits are borne on bare trunks or because the species are rare in the sites where wild orangutans have been studied. However, due to their natural habitat preference, these tree Ficus might be suitable for planting in riparian zones next to small rivers, under old retained oil palms. Another group is the earth figs, about ten species known in Borneo, in which the plant is a bush or small tree and the fruits are borne on slender horizontal roots that grow from the base of the trunk on the soil surface. The fruits thus are usually mixed with leaf litter, and eaten by mammals which habitually walk on the ground (FIGURE 39). The fruits of female earth figs are sweet and consumed by people. However, they ripen consecutively, in small numbers, over many weeks, so would be only a minor and occasional part of any orangutan's diet.

Finally, the peculiar *Ficus septica* (Lintotobau), a shrub or small tree (FIGURE 40), is the only currently-known native Ficus species which should not be planted for orangutans. This is partly because the species is locally very abundant, and takes up space that other tree species could more usefully fill if the aim is to enrich a site with food plants for wildlife. The yellowish-white sap is corrosive to animal skin, and the leaves and roots contain metabolites that have cytotoxic effects. The leaves are rather soft compared to most other Ficus and the leaf veins are distinctively white. Where it occurs naturally, this Ficus often becomes invasive, especially on poor and degraded soils, with thousands of plants clustered along roadsides and in untended parts of oil palm plantations. Dispersal is by fruits bats and probably civets, but the location of the fruits (on the stems and branches of shrubs growing in open sites) is not normal orangutan habitat, and primates would probably avoid the species due to the corrosive sap.

FIGURE 38 · Male *Ficus nota* tree, showing numerous fruits which have fallen to the ground uneaten

FIGURE 39 · Fruits of an earth fig

FIGURE 40 · *Ficus septica* invading a riparian zone

6 Exotic Ficus species

Due largely to their attractive appearance and tendency to be cultivated by cuttings, there are several species of Ficus that are not native to the range of wild orangutans, that have been introduced to Borneo or Sumatra, either as ornamentals or for their edible fruits. These should not be planted in restoration or enrichment projects. The most common ones are listed in Table 4. In addition, there are varieties of some native Ficus (notably *benjamina* and *macrocarpa*) cultivated for ornamental purposes, such as coloured leaves or as bonsai, and these should also not be planted out as orangutan food plants.

TABLE 4 · Exotic fig species found in Malaysia and unsuitable for restoration purposes

SPECIES / COMMON NAME	PLANT FORM	ORIGIN	HUMAN USE
Ficus auriculata Roxburgh fig	Small tree	Mainland South and Southeast Asia	Ornamental (very large, dark 'hearted-shaped' leaves) and large, juicy edible fruits
Ficus carica Common fig	Tree	West Asia and Mediterranean	The common globally-traded edible fig
Ficus elastica Indian rubber tree	Tree	Mainland South and Southeast Asia, Sumatra and Java	Formerly cultivated for latex used to make rubber; now ornamental
Ficus erecta Inu biwa	Shrub	Northern Asia	Ornamental with edible purple fruits
Ficus lyrata Fiddle-leaf fig	Small tree	West Africa	Ornamental with large, glossy, thick, violin-shaped leaves
Ficus maclellandii Banana leaf fig	Small tree	Mainland Southeast Asia	Ornamental
Ficus natalensis Natal fig, Mutuba	Shrub (originally a strangler)	Southern and central Africa	Ornamental with small, thick, triangular leaves; very similar to the native species *Ficus deltoidea*
Ficus obpyramidata Ara lempong	Tree	Mainland Southeast Asia	Fruits are eaten raw as salad. Introduced in Sarawak, and sometimes misidentified as tangkol
Ficus pumila Creeping fig (FIGURE 41)	Root climber	Northern Asia	Ornamental; fruits used to make 'ice jelly' or aiyu
Ficus religiosa Bodhi tree, Sacred fig, Pipul	Tree	India and mainland Southeast Asia	Religious and medicinal

FIGURE 41 · Ornamental exotic *Ficus pumila*

CLIMBING PLANTS

Climbing plants include lianas (woody-stemmed plants that start life as seeds in soil, and use trees as support for upward growth); scrambling plants (that also start as seeds in the soil, but are more like bushes that grow stems horizontally and vertically, all woody except in the case of climbing bamboo); and epiphytes (that start as seeds deposited on to trees, and grow woody stems downwards and upwards). Climbing plant species eaten by orangutans come in all the above forms, from many families. They tend to be under-reported and even overlooked in studies of wild orangutans. This is because they are small in size in comparison to many of the Ficus species and to trees, so small amounts are eaten at any one time, and because they tend to be hidden from the view of human observers on the ground, and (not least) because they are difficult to identify. Unlike the case of trees, there are no published books for identification of climbing plants. Specialist taxonomic papers are of no help to ordinary readers, and herbarium specimens tend to be sparse. The authors are not aware of any nursery anywhere that grows lianas for habitat restoration purposes, nor of any literature on propagation methods.

But there are advantages in climbing plants for enriching habitat for orangutans in oil palm plantations. The advantages include: (1) they can be planted under old oil palms, and the old palms become the support trees, (2) they can be planted near the base of any small trees, whether those are under old oil palms or not, and grow up with the growing trees, (3) they tend to produce edible parts for orangutans sooner after planting than do trees, (4) some can be grown from wildings (but there is a risk of misidentification of species) and (5) there are many climbing plant species that provide foods in the form of leaves, stems and fruits taken by orangutans when few or no trees are fruiting.

In the following descriptions of genera and species, the plant name is followed by which plant parts are known to be eaten by orangutans.

Bridelia stipularis

Leaves, fruits, also flowers are eaten by orangutans

Bridelia is a genus of woody monoecious plants that occur in Asia, Africa and Australia, used in the past as a source of tannin from the bark, for tanning leather and ropes. The various species include trees and lianas. The species *Bridelia stipularis* (FIGURE 42) is a shrub with long, thin, straggling branches up to 20 metres long, that is locally abundant as a pioneer plant on some roadsides, riversides and other sites exposed to sunlight. It can be identified by a combination of its growth form, its prominence in exposed sites and—most crucially—by a pair of prominent, heart-shaped stipules, and distinctive leaves. Propagation methods unknown, probably by seed, or silviculture to manage it in existing set-aside sites.

Bridelia stipularis and other *Bridelia* species are known in Sabah as balatotan, and as kelidai or kernam in Peninsular Malaysia. The leaves and stems have antioxidant properties.

Dinochloa (climbing bamboo)

Soft stems and growing shoots are eaten by orangutans

Dinochloa is the only bamboo genus that grows as a climbing plant. Unlike other bamboos, which have straight stems, the stems of *Dinochloa* have a 'zigzag' shape (FIGURE 43). About 10 species occur in Borneo. The softest stems and shoots are eaten by orangutans (FIGURE 44) when other foods are scarce. Due to its potentially invasive nature, it should not be planted deliberately, but could be retained if already present in set-aside zones in plantations. To avoid it spreading unduly and to provide new shoots as orangutan food, the existing stems can be cut periodically. The usual local name in Sabah is wadan, also pering-pering elsewhere.

Gnetum

Fruits, leaves and cambium are eaten by orangutans

Gnetum is a woody dioecious liana, with 8 species known in the forests of Borneo. There is also one cultivated tree species. *Gnetum* stems, flower stalks and fruits are all distinctive (FIGURE 45). *Gnetum* is an ancient type of

FIGURE 42 · Fruiting *Bridelia stipularis* and *Bridelia stipularis* leaf undersides

FIGURE 43 · *Dinochloa* species, showing 'zigzag' stem growth at top right

FIGURE 44 · Juvenile orangutan feeding on a growing shoot of *Dinochloa trichogona*

FIGURE 45 · *Gnetum leptostachyum* fruits

FIGURE 46 · Planting *Gnetum* seedlings on the edge of a forest set-aside

plant, slow-growing, and with tasty, nutritious seeds that germinate many months (in the Sabah Ficus Germplasm Centre nursery, about one year) after being ripe on the liana. The majority of seeds produced are eaten by small beetles or mammals, and few get to germinate. In the wild, *Gnetum* lianas are always rare and never clumped at one site. The branches and leafy twigs are sparse and, usually, they are noticed only when fruiting. The fruits of most species are pink when fully ripe. Attempts at producing marcots failed. Propagation by seed is possible, but less than 10% survival can be expected. Seedlings may be planted at the base of small trees in secondary forest (FIGURE 46). Local names include baluhu, tinjau, meninjau, melindjo and belinjau.

Lophopyxis maingayi

Leaves, stems, shoots and fruits are eaten by orangutans

This woody climber with leafy, coiled tendrils is absent from most areas but has a wide distribution in Southeast Asia (including Borneo but not Sumatra), Melanesia and Micronesia, and may be locally common. The margins of the leaves are usually serrate (saw-like) and are said to smell of mustard when crushed. The fruits have five wings and one seed. Photos may be viewed at *https://v3.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxid=444868*. Local names include simpuru, taburuh and tali sasawi.

Merremia (now known as Decalobanthus)

Leaves and cambium are eaten by orangutans

This is a light-demanding native creeping plant with about 9 species in Borneo. Three species *(Merremia peltata, Merremia borneensis* and *Merremia gracilis)* (FIGURES 47 AND 48) are common and extremely invasive, and represent significant fast-growing weeds that can cause death by smothering of other species of planted orangutan food plants. It has been reported that stems can grow at a rate of 10 cm per day. Where *M. peltata* occurs, weeding of planted tree seedlings needs to be done twice monthly. *Merremia* should not be planted deliberately, but could be retained if already present, and managed in set-aside zones in plantations. Local names include tali, belaran, kekangkung and ulan.

FIGURE 47 · *Merremia peltata* leaves and flowers
FIGURE 48 · *Merremia gracilis*

Poikilospermum

Leaves, stems, cambium, flowers and fruits are eaten by orangutans

Poikilospermum is an epiphyte, with a soft woody stem and distinctive large leaves, that grows to become a climber on its host plant (FIGURE 49). There are about 12 species in Borneo, some endemic. The commonest is *Poikilospermum suaveolens.* The flowers are pink (FIGURE 50). Plants can be produced by seed or cuttings. For habitat enrichment purposes, seedlings and cuttings can be affixed to tree trunks about two metres above ground level in small bamboo stem containers with soil, and watered during dry periods. Local names include seringkalang, pulus and mentawan.

Spatholobus

Leaves, stems, cambium, flowers and fruits are eaten by orangutans

Spatholobus are woody lianas of the legume family (Fabaceae). All species have trifoliate leaves and distinctive fruits consisting of one seed and one wing (FIGURES 51 AND 52). In some regions, including Sabah, *Spatholobus* represents the most significant food plant genus after Ficus in the diet of orangutans. This may be because of the high protein content of the leaves, also because they are fast-growing and, in some areas, locally abundant. *Spatholobus* leaves are eaten by many species of animals other than orangutans, both mammals and insects. Availability of *Spatholobus* fruits is limited by season, and in most years no fruiting of this genus is seen. Probably the leaves of some species are preferred over others, but there are not enough reliable records to be sure. *Spatholobus* plants occur in most types of forest within the range of orangutans, but the genus appears to be absent from peat soils.

Fourteen species are known in Borneo, with 12 recorded in Sabah. The shape, size and characteristics of the leaves and fruits are variable. Usually, definitive determination of a species can be made only with flowers. Herbarium records (specimens collected over more than a century in many regions) suggest that two species (*ferrugineus* and *macropterus*) are by far the most common, and they are the only species of the genus known in Sumatra. Table 5 may help to provide a tentative identification of species when there is no flowering or fruiting.

FIGURE 49 · *Poikilospermum suaveolens* liana growing on an oil palm tree

FIGURE 50 · *Poikilospermum* flowers are pink

FIGURE 51 · *Spatholobus* species, showing trifoliate leaves and unripe fruits

TABLE 5 · Main features of five *Spatholobus* species in the diet of Bornean orangutans

SPECIES	FEATURES
ferrugineus	The leaflet shape is variable, but tends to be oval and rounded compared to all the other species, and not sharply-pointed. All leaflets are distinctively asymmetric. The 5–8 pairs of secondary veins terminate at the leaf margin (unlike other species, where the secondary veins terminate diffusely). Stipules are as broad as they are long, curved, inwards-pointing and tend to drop off when the leaflets mature.
macropterus	All leaflets are slender with a pointed tip. The lateral leaflets are symmetric or slightly asymmetric. The 4–8 pairs of secondary veins are curved and terminate diffusely. The tertiary veins are reticulate (i.e. very few of the many fine veins between the secondary veins are in straight lines).
gyrocarpus (= *sanguineus*) (FIGURE 53)	Leaf shape is very variable, but each leaflet has 8–11 pairs of secondary veins (most other species have 5–8 pairs). Leaflets are slightly asymmetric, with fine venation.
hirsutus	All leaflets have a distinct, long, narrow, pointed 'drip tip' at the apex. The lateral leaflets are almost symmetric, with a rounded base. Leaflets are similar in form to latistipulus, but each has only 5–9 pairs of secondary veins. The tertiary veins are scalariform (i.e. most of the fine veins between the secondary veins join the secondary veins in straight lines). 'hirsutus' refers to the flowers, not the leaves.
latistipulus (FIGURE 54)	Leaflets are similar in form to hirsutus, but each has 10–12 pairs of secondary veins. The only Spatholobus species with large, broad (1 x 1 cm), asymmetric, curved, inwards-pointing stipules that persist long after the leaflets unfold.

A possible way to secure *Spatholobus* for planting is to collect wildings. However, not only are the different *Spatholobus* species difficult or impossible to distinguish at seedling stage, but seedlings of other genera may be taken in mistake. There are at least two *Spatholobus*-leaf 'look-alike' genera of lianas: the curiously-named *Mastersia bakeri* (family Fabaceae) (FIGURE 55) and *Agelaea* species (family Connaraceae) (FIGURE 56). There are no records in the orangutan literature relating to the former, but leaves and cambium of *Agelaea* are eaten by wild orangutans in Sabah. Local names for *Spatholobus* include ramus or remus and lipoi.

FIGURE 52 · Ripe fruits and seeds of several *Spatholobus* species

FIGURE 53 · *Spatholobus gyrocarpus*

FIGURE 54 · *Spatholobus latistipulus* planted in a riparian zone

FIGURE 55 · Young leaves of *Mastersia bakeri*
FIGURE 56 · Young leaves of *Agelaea cf. trinervis*

Uvaria

Fruits and leaves are eaten by orangutans

Uvaria is a genus of woody climber in the Annonaceae, a pan-tropical family that contains trees, lianas and shrubs. *Uvaria* has about 19 species in Borneo, that all bear clusters of fruits, each fruit containing a few or many seeds in two rows. At a quick glance, the ripe fruits appear to be bunches of small, unripe bananas. Most common is *Uvaria grandiflora* (FIGURE 57), a widespread wild species of Southeast Asia, grown as an ornamental for its large, red flowers. There are other Annonaceae climber genera in Borneo and Sumatra, notably *Artabotrys, Desmos, Fissistigma, Friesodielsia* and *Mitrella*, with similar fruits and leaves which are known to be or likely to be eaten by orangutans. Local names for these various climbers include akar pisang-pisang, akar mempisang, potudung, kenang and larak.

Willughbeia

Fruits, leaves and cambium are eaten by orangutans

Willughbeia is a genus of woody climbers in the family Apocynaceae, with white latex in the stem and fruits. Before the introduction of the Brazilian rubber tree into Southeast Asia in the late nineteenth century, the latex of *Willughbeia* was tapped for rubber production. The fruits of all species are spherical, externally yellowish or brownish when ripe, containing several to many seeds, each covered in a tasty sweet or slightly acidic, juicy, edible sarcotesta. Depending on the species (FIGURES 58 AND 59), the sarcotesta may be orange, reddish or white in colour. Although the stem and branches of the plant may be tens of metres long, the fruits are often low-hanging. Local names include serapit, akar getah, gegerit, senggerip, gitan, jitan, kubal, pitabu.

FIGURE 57 · *Uvaria grandifolia*

FIGURE 58 · Cut ripe fruit of *Willughbeia angustifolia*

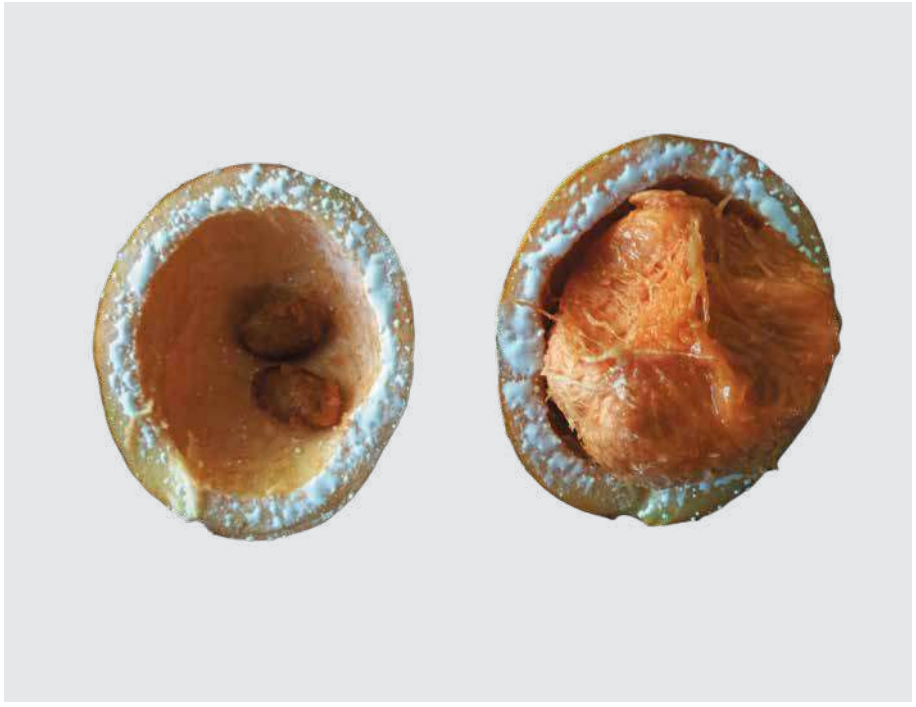


FIGURE 59 · Fruiting *Willughbeia* species liana

TREES

There are so many kinds of trees whose fruits and, to a lesser extent, leaves and bark (cambium) (FIGURE 60), are eaten by orangutans, that choosing a representative array for an illustrated guide is a challenge. Within any one genus of trees where at least one species has been recorded to be an orangutan food species, we do not know if all species are orangutan food plants—but the chances are high that most or all are. Here, we outline some of the most common genera of orangutan food trees.

Until a few decades ago, the vegetation over most of Borneo and Sumatra was dipterocarp forests, in which a large proportion of the tall canopy trees belong to the family Dipterocarpaceae. For several reasons, no members of this family are included in this guide. The trees take decades to grow to mature size. They bear fruit infrequently—some species only every twelve years or so in Borneo. They tend to fruit simultaneously, at times when orangutan's most preferred fruits are also abundant in the forest. In some areas where wild orangutans have been studied, the apes rarely or never feed on any part of dipterocarp trees. Even in areas where orangutans are recorded as feeding on dipterocarp fruits, these trees are not significant food sources.

The fruits of durians (about 20 wild species exist in Borneo) are relished by orangutans (FIGURE 61). Indeed, durian fruits possibly represent the only significant source of conflict between humans and orangutans for that reason. Where wild orangutans live near to rural human communities, there is competition for the fruits, whether those fruits are wild or planted in an orchard. As with humans, durian fruits represent a very strong and occasional favourite but not a staple part of the diet. Similar comments apply to wild mangoes and rambutans.

In the following descriptions of genera and species, the plant name is followed by which plant parts are known to be eaten by orangutans.

Alangium javanicum

Fruits and leaves are eaten by orangutans

Several species of the monoecious *Alangium* occur within the distribution of orangutans, with each preferring different soil types. *Alangium javanicum* (FIGURE 62) is the most common and widespread. Local names include kondolon, wangerin and satu inchi.

Annonaceae

Fruits are eaten by orangutans, occasional records of leaves and cambium

This is the soursop family. Most species are monoecious. As in *Uvaria* (page 67) most Annonaceae trees bear clusters of fruits, each fruit containing few or many seeds in two rows. At a quick glance, the ripe fruits of some species remind one of bunches of short, unripe bananas (FIGURE 63). The tree genera in this family which have been recorded as orangutan food plants include *Alphonsea, Cananga, Cyathocalyx, Enicosanthum, Goniothalamus, Mezzettia, Monocarpia, Polyalthia* (FIGURE 64), *Popowia, Pseuduvaria* and *Xylopia*. Local names include pisang-pisang, mempisang, mahawai, banitan, karai.

Artocarpus

Fruits are eaten by orangutans, also leaves and cambium in some species

Artocarpus is in the same plant family (Moraceae) as *Ficus*. Twenty-four species of *Artocarpus* are known in Borneo, all trees, all monoecious, and all bearing fruits that are edible to orangutans and humans (FIGURES 65–67). Both the flesh (botanically, perianth or syncarp) of the fruits and the seeds are edible. Although growing best on fertile soils, most *Artocarpus* species can tolerate poor soils, including hill slopes. A plethora of local names exist, some confined to a particular species, some to several species and some with inconsistency. Table 6 provides some guidance. The other ten species are extremely rare or localised in distribution. Breadfruit (*Artocarpus communis*; kamansi) and jackfruit (*Artocarpus heterophyllus*; nangka) are both introduced species, grown for human consumption of their fruits.

FIGURE 60 · Orangutan feeding on the bark of a *Sterculia* tree

FIGURE 61 · Orangutan feeding on fruits of *Durio graveolens*

FIGURE 62 · *Alangium javanicum*

FIGURE 63 · *Goniothalamus* fruits
FIGURE 64 · Flowers of *Polyalthia cauliflora*

TABLE 6 · Fourteen Bornean *Artocarpus* species and some of their local names

SCIENTIFIC NAME	LOCAL NAMES	NOTES
anisophyllus (FIGURE 65)	mentawa, bintawak, bintau, entawak, terap ikal, bakil, puan, pupuan	Probably the commonest wild *Artocarpus* tree in Borneo, with distinctive leaflets, alternating large and small
brevipedunculatus (previously known as *melinoxylus*) (FIGURE 66)	temponek, pala tupai	Borneo endemic; small (<5cm) fruits with bulging lobes; orange, sweet pulp
dadah	dadah, beruni, tampang, selangking, betu, biluli	Rare; small (5–7cm), lobed fruits with pink, sour pulp
elasticus	terap, togop, talun, pedali, tekalong, pekalong, benda, kapua, kumut	Widespread; leaves large; hairy fruits, about 12x6cm; flesh yellowish white, oddly smelling
integer	chempedak, jackfruit, temedak, pulutan, nakan, tibadak, tundak	Widespread; fruits large (about 30x12cm), long, rounded, bulbous; flesh orange-yellow
kemando	pudu, pudau, kudu, pupud, puroh, bontorong, kasai, kian, purau	Common; fruits about 4x3cm, short hairs; no flesh
lanceifolius	timakon, keledang, kaliput, bangsal, binturong, bunon, em-putu, sedah, kakian, tempunang	Uncommon; fruits about 10x8cm, green-brown; sweet, juicy flesh—dark orange coloured in northern Borneo, white elsewhere
limpato	kesusu, tampang susu, empatak	Odd compound fruits, pale green with 8–20 orange-coloured fruits projecting from the core; flesh sweet, orange-coloured
nitidus	dadak, beruni, betoh, tampang selangking, empaka, karon, sinojoh, taburakin	Widespread and variable in appearance of leaves and fruits; fruits approximately 6x3cm; in Borneo, seeds with a bright pink coat
odoratissimus	terap, tarap, timadang, binturong, munturong, marang, pingan, kian, keiran, tekalong, beluli	The original 'terap', endemic to Borneo, commonly cultivated; large (about 15cm), more-or-less spherical fruits, with a distinctive pungent-sweet odour; flesh dirty white
rigidus	peruput, puju, pujan, perian, periam, pudau, mantibungan, pala munsoh, pudau, temponek, tempun, kondang, kulidong, pekalong, temputu, bakil	Fruits more-or-less spherical, about 8cm diameter; hard, dull yellow-orange; flesh yellow-orange, sweet or slightly acidic
sericicarpus	togop, pedalai, terap bulu	Widespread; similar to elasticus, but leaves very large (about 50x25cm); 'hairy' fruits about 12x5cm; flesh white, sweet
tamaran (FIGURE 67)	timbangan, tamaran, kakang, kalong, entawa, tembaran, kihan, marawayan	Borneo endemic; leaves about 30x14cm; 'hairy' fruits about 12x6cm; flesh white, sweet
teysmannii	cempedak air, nangka air, tuwadak, tilap	Rare; leaves about 25x10cm; fruits about 10x6cm; flesh white, sweet; the only *Artocarpus* species recorded in swamp forests

Baccaurea

Fruits are eaten by orangutans, leaves in some species

Baccaurea is a genus of small, dioecious trees in the family Euphorbiaceae, with 26 known species in Borneo. The fruits of all species grow in abundant clusters on long stalks, with one to six seeds in each fruit, each seed covered in a juicy, sour aril (FIGURES 68–71). According to species, the aril may be white, yellow, orange, red, blue or purple. It is safe to say that all species of *Baccaurea* can provide food for orangutans.

Given that all species are dioecious, and the leaves of only some species have been recorded as orangutan food, this would not be a high priority genus for habitat restoration for orangutans. However, the fruits of all species are conspicuous and low-hanging, so seeds can be readily collected.

TABLE 7 · Bornean *Baccaurea* species and some of their local names

SCIENTIFIC NAME	LOCAL NAMES	NOTES
angulata (FIGURE 68)	embaling, belimbing hutan	Fruits star-shaped in cross-section, about 2.5 cm wide, red; 2–3 seeds; aril white
bracteata	rambai tikus, kapul pugi, nentalon, pugi, tampoi paya, puak, kelibon, jemating, selantikan	Fruits about 1.5 cm wide, dark brownish red; 3–6 seeds; aril yellow
brevipes	rambai hutan	Fruits about 1.8 cm wide, pinkish-white; 1–3 seeds; aril purple
costulata	kampul	Fruits about 5 cm wide, pinkish-orange; 3–4 seeds; aril red
deflexa	encia, jentihan, keliwan, lubi, mata tingan, tampoi merah	Fruits about 1.5 cm wide, reddish; 1–2 seeds; aril red or orange
dolichobotrys	jelentik	Fruits about 1 cm wide, yellow-brown; 1–2 seeds; aril red or orange
edulis	tampoi paya, kapul, kulibon, puak	Fruits about 6 cm wide, yellow-brown; 2–4 seeds; aril yellowish
javanica	mata plantok, sarakat	Fruits about 1 cm wide, yellow-orange; 1–2 seeds; aril purple
lanceolata (FIGURE 69)	limpasu, rambai hutan, lampong	Fruits about 5 cm wide, pale green, yellow or orange; 1–4 seeds; aril translucent white; common, often fruiting

macrocarpa	tampoi, puak, kapul	Fruits about 7.5 cm wide, pale yellow or reddish brown; 3–6 seeds; aril translucent white
macrophylla	jelenteh	Fruits about 1.5 cm wide, pale yellow brown; 2–3 seeds; aril translucent off-white
maingayi	kapul, setai belabou, tampoi	Fruits about 2 cm wide, orange-green; 1–2 seeds; aril dull orange
minor		Fruits about 1.3 cm wide, pale dull orange; 3 seeds; aril yellow-orange
mollis		Fruits about 3.8 cm wide, light yellow-brown; 1–4 seeds; dark red
moteleyana (FIGURE 70)	rambai	Fruits about 2.5 cm wide, cream-coloured; 3 seeds; aril translucent white
odoratissima	kunau-kunau, mata kunau, enkuni	Fruits about 1 cm wide, red; 1–2 seeds; aril blue
parviflora	setambun, engkuni, konkuni, mata pelanduk	Fruits 3 cm long, about 1.5 cm wide, maroon-black; 1–3 seeds; aril purple-red or white
polyneura (= *kunstleri*)	rambai kuning, jentik-jentik, jelintik	Fruits about 2 cm wide, pale yellow-orange; 1–3 seeds; aril orange-red
pubera	puak	Fruits pear-shaped about 3.5 cm wide, yellow-brown; 5–6 seeds; aril yellow-orange
pyriformis		Fruits about 3.5 cm wide, yellow-brown; 2–3 seeds; aril cream-orange
racemosa	kokonau, engkuni, longkuno, menteng	Fruits about 2.5 cm wide, pink-yellow-orange; 1–3 seeds; aril purple
reticulata	tampoi	Fruits about 5 cm wide, green-orange-brown; 3–6 seeds; aril translucent white-yellow
sarawakensis	mata kunau	Fruits triangular, about 3 cm wide, yellow-red-pink; 1–3 seeds; aril pinkish blue
sumatrana	sangkurat	Fruits ellipsoid-flattened, yellow-orange-red, about 1 cm wide; 1 seed; aril orange
tetrandra (= *stipulata*) (FIGURE 71)	kunau, enkuni, mata pelandok	Fruits about 1.5 cm wide, pinkish; 1–4 seeds; aril blue or purple
trigonocarpa		Fruits angular, about 1.5 cm wide, yellow-orange-purple; 1–2 seeds; aril orange-red-purple

Diospyros

Fruits are eaten by orangutans, also leaves and cambium in several species

Diospyros is a genus of trees in the family Ebenaceae, with about 75 species in Borneo. The outer bark on most species is black, thin, brittle and fissured. Hence the common local names for all *Diospyros* species, kayu malam or kayu arang. The inner bark is usually cream-coloured or yellowish, and the fresh wood is very pale, almost white. The tree trunk is monopodial—a single growing point at the top of tree, with 'wagon wheel' array of branches when viewed from the ground. Leaf shape varies with species but tends to be long and slender. There are tiny black (or yellow) glands (specks < 1 mm) visible on the leaves of most species. The form of the fruit is that of a persimmon, although details including fruit size and palatability vary between species (FIGURES 72 AND 73). There may be 1–16 seeds in each fruit, depending on species, and usually 4–8. Advantages for an orangutan food plant restoration programme include, usually, the presence of at least one species in any forest patch, fruiting typically occurs over long periods, or with more than one season per year, and out of the main forest fruiting peak. Wildings can often be recognised by the black flecks on the leaves. Disadvantages are that almost all species are dioecious and slow-growing.

Dracontomelon

Fruits are eaten by orangutans, also leaves and cambium

One or both of the monoecious species *Dracontomelon dao* and *Dracontomelon costatum* (family Anacardiaceae) may be locally common in lowland forests, and periodically provide large quantities of fruits, with the sour-sweet white pulp around the single seed being the target of orangutans. The former grows wild mainly along river valleys and has spherical fruits about 3 cm diameter (FIGURE 74) while the latter has smaller, slightly elongate fruits. The fruits are unique in that there are five tiny, equidistant bumps ('stylar remains') arranged around the circumference of each fruit, barely visible but obvious to the touch of fingertips. Both species are widely known locally as sengkuang.

FIGURE 65 · Orangutan feeding on fruits of *Artocarpus anisophyllus*

FIGURE 66 · *Artocarpus brevipedunculatus*

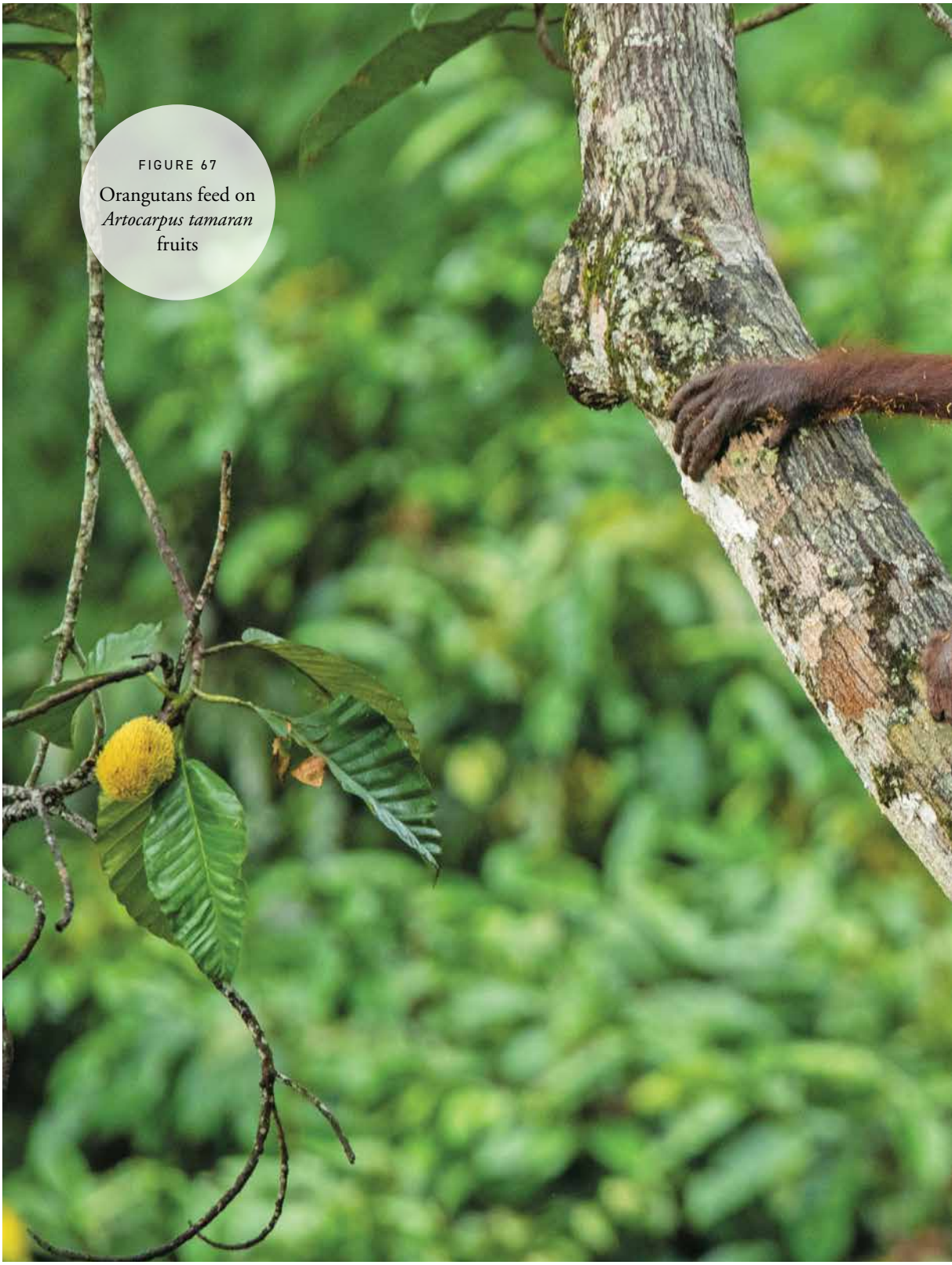
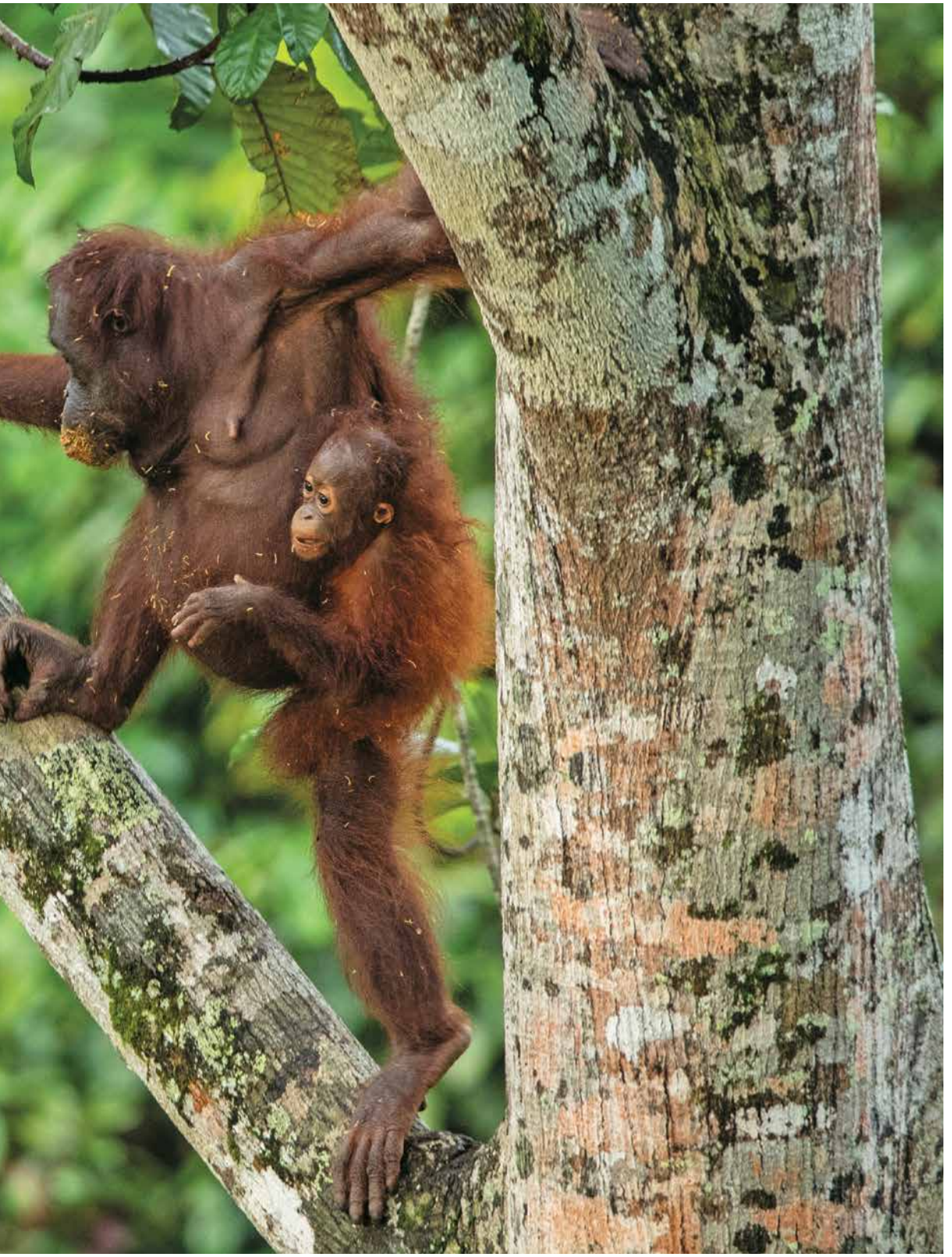


FIGURE 67
Orangutans feed on *Artocarpus tamaran* fruits



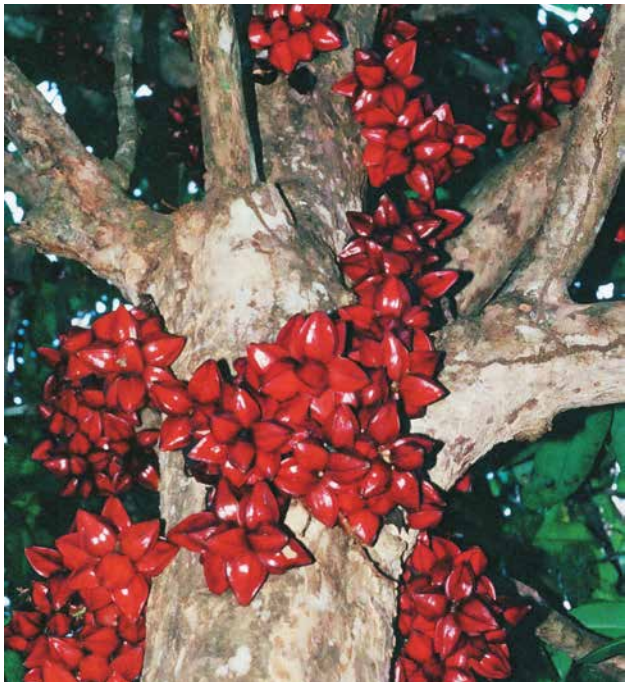


FIGURE 68 · *Baccaurea angulata*
FIGURE 69 · *Baccaurea lanceolata*

FIGURE 70 · *Baccaurea motleyana*

FIGURE 71 · *Baccaurea stipulata*

FIGURE 72 · Orangutan feeding on *Diopsyros* fruits

FIGURE 73 · Fallen fruits of *Diospyros*

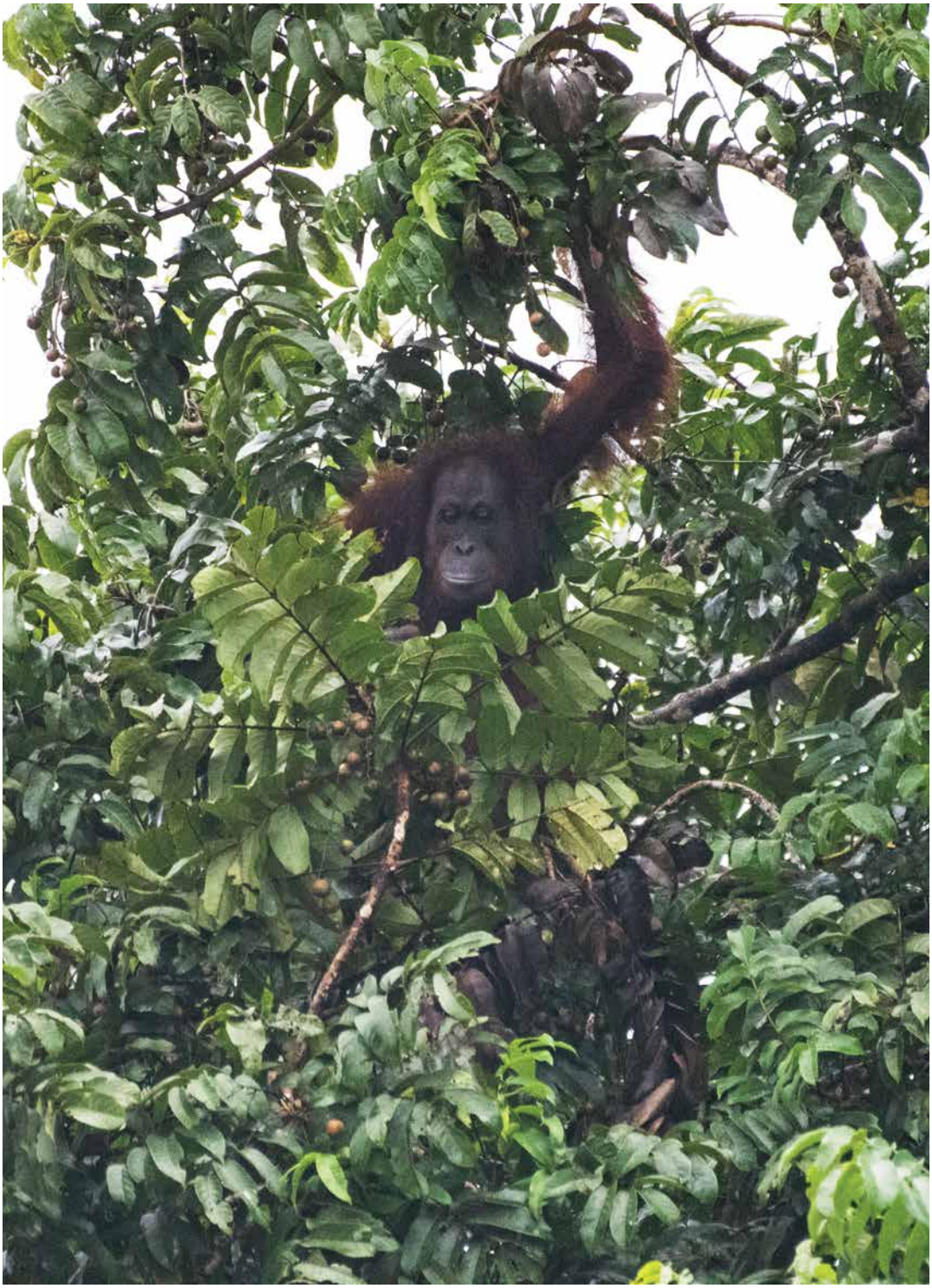


FIGURE 74 · Orangutan feeding on *Dracontomelon dao* fruits

Elaeocarpus

Fruits and leaves are eaten by orangutans

Elaeocarpus is a genus of trees in the family Elaeocarpaceae. Over 100 species occur in Borneo, mostly small sized trees, often in gaps in natural forests, with about 30 species common. Some species are monoecious, others dioecious. *Elaeocarpus stipularis* is probably the commonest of all. Leaves vary greatly between species, but the fruits of all species resemble small olives (FIGURE 75), an oily pericarp covering a single hard seed (more than one seed in a few species), and a blueish or blue-green colour when ripe. Local names for the genus include kungkurad and medang musang.

Endospermum

Fruits and leaves are eaten by orangutans

One or both of the dioecious species *Endospermum diadenum* or *Endospermum peltatum* (family Euphorbiaceae) may be locally common in heavily logged or damaged lowland forests, and periodically provide large quantities of 1 cm wide fruits, usually just before a general peak of ripe fruiting in the forest (FIGURES 76 AND 77). The trees can often be identified from a distance because the crown is usually noticeably asymmetric and sparse, with the upper trunk curving and the main branches concentrated on one side of the crown. Both species are widely known locally as sesendok.

Garcinia

Fruits and leaves are eaten by orangutans

Garcinia is a genus of trees in the family Clusiaceae (formerly, Guttiferae). Over 60 species occur in Borneo, mostly small sized trees of the understorey in closed-canopy forests, many in the hills and mountains, and mostly dioecious. If the bark is cut, a yellow or creamy-white exudate is seen. In shape and structure, the fruits of all species resemble small mangosteens (FIGURE 78), with prominent calyx and stigma, 1–8 seeds, all covered in a juicy pulp. Size and colour of the fruits and pulp varies with species. The usual local name for the genus is kandis hutan.

FIGURE 75 · *Elaeocarpus* species

FIGURE 76 · Young orangutan in an *Endospermum peltatum* tree

FIGURE 77 · Leaves and fruits of *Endosperumum peltatum*

FIGURE 78 · *Garcinia dulcis*

Gironniera

Fruits, leaves and cambium are eaten by orangutans

Gironniera is a genus of trees in the family Cannabaceae (formerly Ulmaceae). Four species (*hirta, nervosa, parvifolia* and *subaequalis*) occur commonly in the lowlands of Borneo, all small or medium sized trees, and all usually dioecious (some herbarium specimens are monoecious). The first two names are regarded as a single species by recent taxonomists. The distinctive fruits have 'subtended persistent perianth lobes', or in simple language have two spindly beaks at the far end (FIGURE 79). Flowers and fruits are produced frequently by saplings and immature trees as well as old trees. Local names for the genus include medang kasap, entabuloh, hampas tebu, hugot-hugot, kiga, kuayon, luazon, rozan, ruwayon and sosopon bonging.

Hydnocarpus

Fruits, leaves and cambium

Hydnocarpus is a genus of trees and woody shrubs in the family Achariaceae (formerly Flacourtaceae) with 17 species in Borneo, all usually dioecious (some herbarium specimens are monoecious) and usually growing on hill sides. The leaves tend to be long, leathery with an asymmetric base and a thick 'knee' where they join the short petiole (FIGURE 80). The fruit is a large (4–12 cm) berry, with a thick rind, yellowish, brownish, greenish or blackish according to species, hairy in some species, and with several to many seeds in the middle, all embedded in a pulp (FIGURE 81). The usual local name for the genus is karpus, taganiob or setumpol.

Fagaceae

Fruits are eaten by orangutans, occasional records of leaves and cambium

Lithocarpus and *Castanopsis* are genera of trees in the family Fagaceae, with about 60 species of the former and 25 species of the latter found in Borneo, all monoecious. The fruit of *Lithocarpus* is known as an acorn, varying according to species from 1.5 to 5 cm diameter (FIGURE 82). Local names for the genus include mempening, berangan, saled and tikalod.

FIGURE 79 · *Gironierra parvifolia*
FIGURE 80 · Leaves of *Hydnocarpus*

FIGURE 81 · A ripe *Hydnocarpus* fruit

FIGURE 82 · *Lithocarpus* species

Fruits of many Castanopsis species, also known locally as berangan, have distinctive bristles (FIGURE 83). Most—but not all—species in both genera occur primarily in hill and mountain forests, where their fruits represent important seasonal foods for the sparse orangutan populations found in these regions (FIGURE 84).

Meliacaee

Fruits are eaten by orangutans, leaves in some species

Meliaceae (the langsat family) contains 12 genera of trees in Borneo. Most numerous is *Aglaia*, a genus of dioecious trees with about 60 species in Borneo (FIGURE 85). In many species, the wood and fruits have a faint odour similar to that of langsat fruits. The leaves of many species have bioactive compounds. *Aglaia* fruits grow as bunches of berries, each with one or a few seeds, each seed covered in a sugar or lipid-rich aril that is edible for humans as well as orangutans. Depending on species, the ripe fruits may be almost any colour except green, blue or black, while the aril may be white, orange or red. The genus is included in this guide because there are so many species and, although the genus may be rare in any one site, there will usually be several species in any one area. Local names for the genus *Aglaia* include lantupak, langsat-langsat, lelangsat, buno, koping-koping, palunau and segera. Also in the family Meliaceae are *Chisocheton,* with about 20 species in Borneo (FIGURE 86), and three species of monoecious tree in the genus *Sandoricum* (local name sentul or ketjapi), which have fruits that are edible to humans as well as orangutans.

Microcos

Fruits are eaten by orangutans, occasional records of leaves and cambium

Microcos (sometimes known as *Grewia*) is a genus of small monoecious trees and bushes in the family Malvaceae (formerly Tiliaceae) with about 26 species described for Borneo. The trees are rather fast-growing and produce fruits when still small (FIGURE 87). Local names for the genus include kerodong, chenderai, bunsi, damak-damak, pimping damek and indollubah.

Neolamarckia cadamba

Fruits and cambium are eaten by orangutans

Neolamarckia cadamba, formerly named *Anthocephalus chinensis* (family Rubiacae) is of relatively minor significance to orangutans as a tree that supplies food (FIGURES 88 AND 89), but for a combination of four reasons it is of disproportionate significance as a species for restoration of orangutan habitat. Firstly, it grows straight upwards and quickly, even through smothering *Merremia* climbers, so positive results of planting are quickly obvious. Secondly, it is locally common wild in degraded forests, especially in the turned-over soils of roadsides, so seeds are readily available. Thirdly, it fruits outside the main forest fruiting season, including during the main rainy season. Fourthly, due to its monopodial crown it is favoured by orangutans as a nesting tree, and after a few weeks, the dark brown dead leaves of the nest contrasting with the bright green living leaves can be seen clearly from a distance. There is a fifth point of interest. It can be interplanted amongst oil palms, with little detriment to oil palm fruit yields and can be harvested for sale as timber on a cycle of about ten years. In the meantime, it can provide multiple nesting sites and some orangutan food within an oil palm landscape. Having a very straight trunk and small crown, harvesting of the trees can potentially be done with no significant damage to the oil palms. Local names are laran, kelampayan, jabon and kadam.

Sapindaceae

Fruits are eaten by orangutans, occasional records of leaves and cambium

This is the rambutan family. Most species are small monoecious trees, and most produce copious fruits in which the single seed has an edible aril. The genera of trees that produce fruits eaten by orangutans include *Nephelium* (the rambutans and pulasan or maritam), *Arytera littoralis* (local names include ampungit, anging manuk, nunuk-nunuk and petinag) (FIGURE 90), *Dimocarpus* species (local names include mata kuching, mambu, marakiang, membuakat, buku, longan, etc) (FIGURE 91), *Lepisanthes* (local names include sintatanod, enkelili, indulus, tamud tamud, etc), *Paranephelium* (local names include ambuakat, ampungot, bambakat and tombuakat), *Pometia pinnata* (local name kasai) (FIGURE 92) and *Xerospermum* (rambutan pacet, resat, kalas, etc), but probably the fruits of all genera in this family would be consumed by orangutans.

FIGURE 83 · Fruits of *Castanopsis hypophoenicea*

FIGURE 84 · Orangutan testing *Castanopsis* fruits

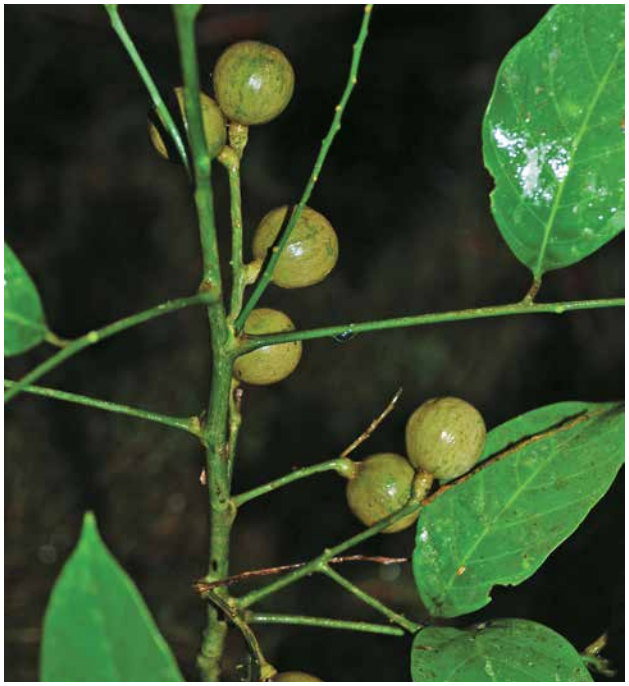


FIGURE 85 · Unripe fruits of *Aglaia oligophylla*
FIGURE 86 · Orangutan feeding on fruits of *Chisocheton*

FIGURE 87 · *Microcos* fruits and leaf

FIGURE 88 · Orangutan feeding on fruits in a *Neolamarckia cadamba* tree

FIGURE 89 · Fruits of *Neolamarckia cadamba*

FIGURE 90 · *Arytera littoralis*

FIGURE 91 · *Dimocarpus longan* ssp. *malesianus*

FIGURE 92 · *Pometia pinnata*

Sapotaceae

Fruits are eaten by orangutans, occasional records of leaves and cambium

This is a family of tropical plants in which, together with the families Moraceae and Apocynaceae, all species have a copious white latex in the trunk and all the stems. Most trees are monoecious. The seeds (only one per fruit in most species, up to six in some) of all species have a characteristic longitudinal scar, paler than the glossy brown or black seed coat. There are ten genera native in Borneo *(Aulandra, Chrysophyllum, Diploknema, Eberhardtia, Isonandra, Madhuca, Palaquium, Payena, Pouteria* and *Sarcosperma),* all trees (FIGURE 93). All trees in this family are known as nyatoh in Malaysia and Indonesia. The wood of larger trees is popular for fine furniture making. Two exotic members of this family are cultivated in Borneo: *Manilkara zapota,* from America, known locally as chiku or sauh, for its sweet edible fruits; and *Mimusops elengi,* from mainland Asia, known locally as bunga tanjong, as a popular ornamental roadside tree whose flowers open at dusk and emit a fragrance through the night. The fruits of all native Sapotaceae species are similar in form to the fruits of these introduced species.

Symplocos

Fruits, leaves, flowers and shoots are eaten by orangutans

Symplocos (family Symplococaceae) is a genus of small trees, containing about twenty species in Borneo (FIGURE 94). The ripe fruits of most species are blue or dark-bluish. It is one of a very few favoured orangutan food trees that can grow in seasonally swampy and flooded areas. Local names include jiak, jirak, giak and loboh.

FIGURE 93 · *Payena gigas*, a species confined to mountain forests in north-western Sabah

FIGURE 94 · *Symplocos celastrifolia*

Syzygium

Fruits, occasional records of leaves and cambium

All *Syzygium* species are monoecious trees in the family Myrtaceae, with up to 200 species in Borneo, formerly referred to as *Eugenia* (which is an American genus of trees in the same family). Although the form of the tree, the leaves and fruits vary greatly with species, the genus can often be recognised by the fruits of all species having the persistent remains of the calyx tube and the leaves, in most species, with an intramarginal vein (FIGURE 95). Each fruit is a berry, with one (occasionally two) seed. The pulpy or pithy outer layer of the fruit is the part eaten. Local names for the genus include obah, ubar and kelat. The classification and accepted scientific names for many forms of *Syzygium* have yet to be resolved. In Kinabatangan, there is a seasonally swamp-tolerant tree known as *Syzygium cerasiforme,* also spelled as *Syzygium cerasiformis,* which is possibly the same species referred to elsewhere as *Syzygium jamboloides, Syzygium javanicum* and *Syzygium racemosum.*

Xanthophyllum

Fruits, leaves and cambium are eaten by orangutans

This genus is the only one in the family Polygalaceae which grow as monoecious trees (about 42 species in Borneo) within the range of orangutans. The fruits are spherical, pear-shaped or elongate, consisting of an outer rind enclosing 1 to 20 seeds in an edible pulp. Depending on species, the diameter of ripe fruits may be between 1 and 14 cm, and green, yellow, brown or orange in colour (FIGURE 96). The leaves of some species are eaten frequently by orangutans (FIGURE 97). Local names include minyak berok, nyalin, langgir and rangil.

FIGURE 95 · *Syzygium* species, showing the characteristic intramarginal vein on the leaves and the remains of the calyx tube on the fruits

FIGURE 96 · *Xanthophyllum* species fruits

FIGURE 97

Orangutan feeding on leaves of *Xanthophyllum ecarinatum*

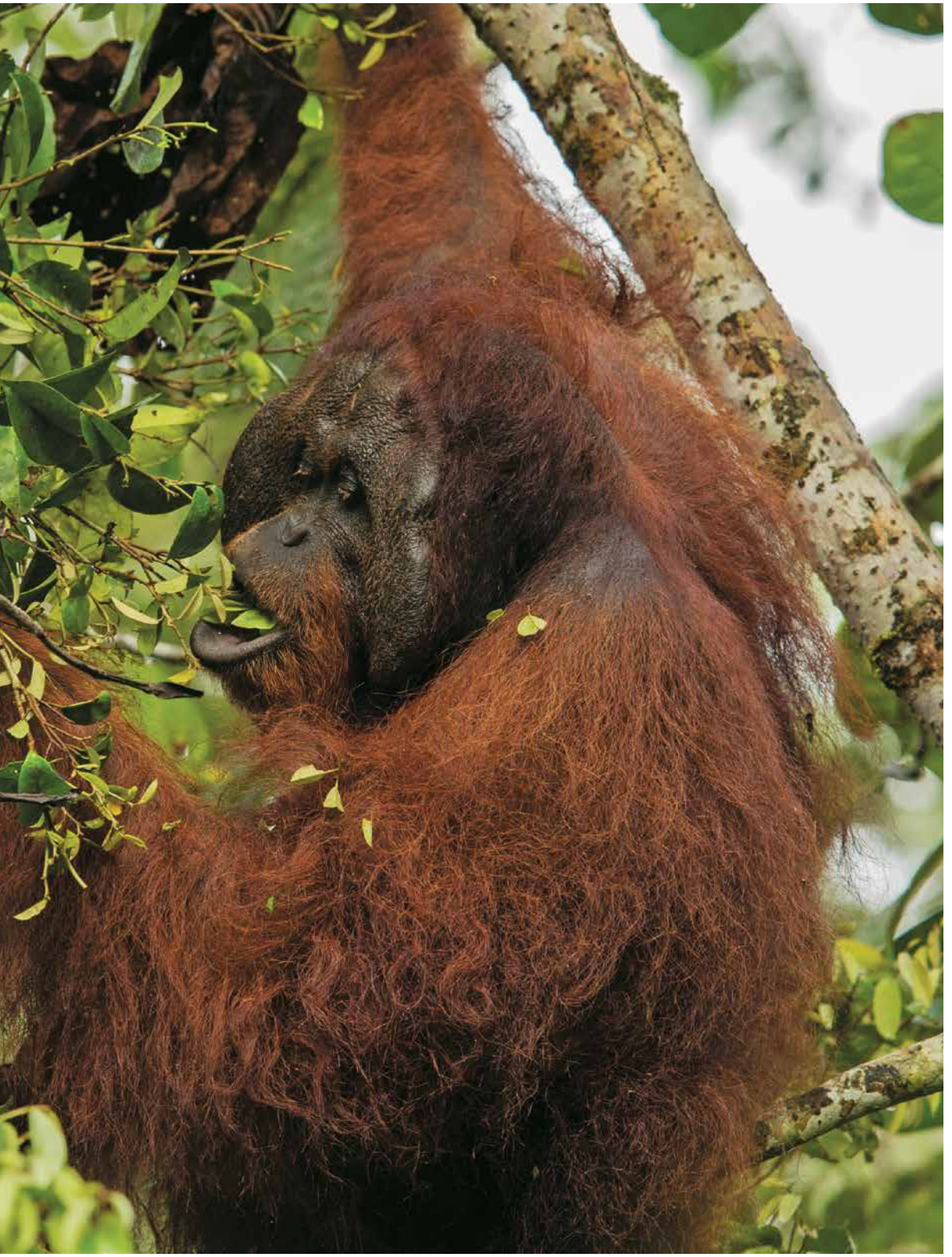


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Figure 92

Glossary

Adventitious root	Roots that are above ground level, usually growing from a stem
Aril	A fleshy outgrowth from a particular point of a seed, which grows to enclose much of the seed, and has evolved as a means to attract birds or mammals to feed on it and disperse the seed
Deciduous	Plants that shed all their leaves together, annually
Dioecious	Species which have separate female and male plants
Epiphyte	A plant that lives on another plant
Hemi-epiphyte	A plant that starts life as an epiphyte, but grow downwards into soil
Marcot	Vegetative propagation by cutting the entire bark from a section of a living leafy slender branch, covering the wound with a small handful of soil, and wrapping and tying the soil in place with a piece of transparent plastic sheet; adventitious roots form and grow over a period of a few weeks into the soil; the slender branch is then cut off, just below the adventitious roots, and planted into soil in pots or bags in the nursery
Metabolite	A natural chemical produced in plants, that has a specific function; tens of thousands are known; secondary metabolites are those that have an ecological function such being toxic to insects
Monoecious	Plant species that have female and male flowers on one plant, in this book including hermaphrodite plants, where each flower has both female and male parts

Ostiole	A very small, single, natural opening in every Ficus syconium, that allows tiny female wasps to enter to lay their eggs and pollinate the tiny flowers inside
Sarcotesta	A fleshy modification of the outer cell layers of a seed coat, which grows to enclose the seed, and has evolved as a means to attract birds or mammals to feed on it and disperse the seed
Secondary vein	The veins on a leaf that emerge on both sides from the mid-rib
Stipule	A very small, natural outgrowth at the base of a leafstalk (the petiole), usually as a pair, in some species single and in some species absent
Syconium	The unique type of inflorescence borne by all Ficus plants, consisting of a fleshy, hollow receptacle with multiple flowers on the inside surface; it is not a true fruit, but regarded as a fruit in non-scientific literature (plural: syconia)
Trifoliate	A compound leaf that has three leaflets
Vegetative propagation	Growing new plants from cuttings taken from old plants, and not from seed
Wilding	A wild seedling that is removed from the wild, instead of from germination of seeds in a nursery

Resources

This text provides an overview of the geographic variation in wild orangutan diets:
https://cherylknott.files.wordpress.com/2011/06/russon-et-al-2009-chapter-9-geographic-variation-in-orangutan-diets.pdf

The NGO 'HUTAN' has over 25 years experience with orangutans in the Kinabatangan landscape. Useful literature can be found here:
https://www.hutan.org.my/resources/hutan-reports-and-publications/

These reports provide insights into restoration in very degraded sites, but are geared more to forest structure restoration than to provision of important orangutan food plants:
https://elti.yale.edu/sites/default/files/rsource_files/iucn_book_0.pdf
https://www.wwf.or.jp/activities/data/20160328WWF-Japan_Malaysia_orangreport.pdf

This blog is a unique and extraordinarily useful source for Ficus:
https://borneoficus.info/

Orangutans can persist in mixed oil palm and forest landscapes, with females refuging in forest patches and males moving periodically between the patches through the oil palms. Large oil palm estates and concessions situated within the natural distribution of orangutans can play a role in permanently sustaining these populations, firstly by allowing orangutans to live within plantations and, secondly, by retaining and growing food plants most favoured by orangutans on the set-aside areas. But which plants are the most favoured, and how to recognise them? This guide outlines more than 100 kinds of native Bornean plant types whose fruits, leaves or bark are commonly eaten by wild orangutans. One third are of the remarkable 'keystone' genus, *Ficus,* which provides the single most important food source for orangutans in most areas where the species has been studied. The guide is illustrated with over 90 photos.

www.bringingbackourrareanimals.org

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