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An introduction to tropical rain forests

Rain forests have crossed a threshold of perception. No week passes without a new report on television, radio, or in the press of another piece of destruction, or a new message of gloom for the planet.[1] The public is left in no doubt that something nasty is happening down on the Equator. Man's present-day impact on tropical rain forests is, however, just the last stanza of a saga stretching back into the past beyond the beginning of written history.

European knowledge of tropical forests began when Alexander the Great crossed the Khyber Pass in 327 BC, into the Punjab, to establish the eastern limits of his short-lived empire on the banks of the Indus.[2] 'His army saw mangrove swamps (which upset conventional views on trees), jackfruit, mangoes, bananas, cotton, and banyans—which upset everybody's views on what roots are supposed to do'.[3] These bizarre findings were incorporated in the *Enquiry into plants* of Theophrastus, philosopher and pupil of Plato and Aristotle, to become part of the general knowledge of plants, copied, corrupted, and not improved upon for nearly two thousand years until the great voyages of discovery of the sixteenth and seventeenth centuries and the subsequent European colonial expansion.

The word jungle, still often in use, comes from the Hindi jangal, a reference to the dense impenetrable forest and scrub around settlements.

Tall stories percolated back to Europe from the early visitors (Fig. 1.1). For example, in the East poisoned arrows were discovered to be tipped with the sap of the upas tree,[4] accounts of whose identity and preparation mingled fact and fable. Of this the great Dutch naturalist G. E. Rumpf wrote in 1750:

> Under the tree itself no plant, shrub or grass grows—not only within its periphery but, even, not within a stone's throw of it; the soil is sterile, dark and as if burned. Such poisonousness does the tree exhibit that from the infected air birds perching on the branches are stupefied and fall dead, and their feathers strew the soil. So caustic were the branches sent to me in a stout bamboo vessel that when the hand was placed on the vessel, a tingling was produced such as one feels on coming out of the cold into the warmth. Everything perishes which is affected by its exhalation, so that all animals avoid it, and birds seek not to fly over it. No man dare approach it unless his arms, legs and head be protected by clothes.[5]

Osbeck, on a voyage from Sweden to China, stopped in east Java and, on 20 January 1752, saw a tree with flowers on its trunk. Cauliflory is unknown in northern Europe. He believed he had found a leafless parasite, and called it *Melia parasitica* (Fig. 1.2) naively commenting:

> A small herb of barely a finger's length growing on tree trunks. It is so rare that so far as is known no one ever saw it before.[6]

With Colonial penetration scientific specimens began to flood back to the museums of Europe. At first the plants were the weeds of open places, many of which have wide occurrence. Indeed, when Linnaeus made his great synthesis of the world's plants, the *Species plantarum* of 1753, he believed from this evidence that the tropics had a rather species-poor and uniform flora.

The tropics had a powerful influence on the development of biology in the nineteenth century. Biogeography and ecology are both founded on the journeys in South America of the German Alexander von Humboldt, in the Andes (where he recorded how vegetation changes with climate) and in the lowland rain forests of Venezuela. He travelled with the Frenchman Aimé Bonpland. They arrived at Cumana, Venezuela, on 16 July

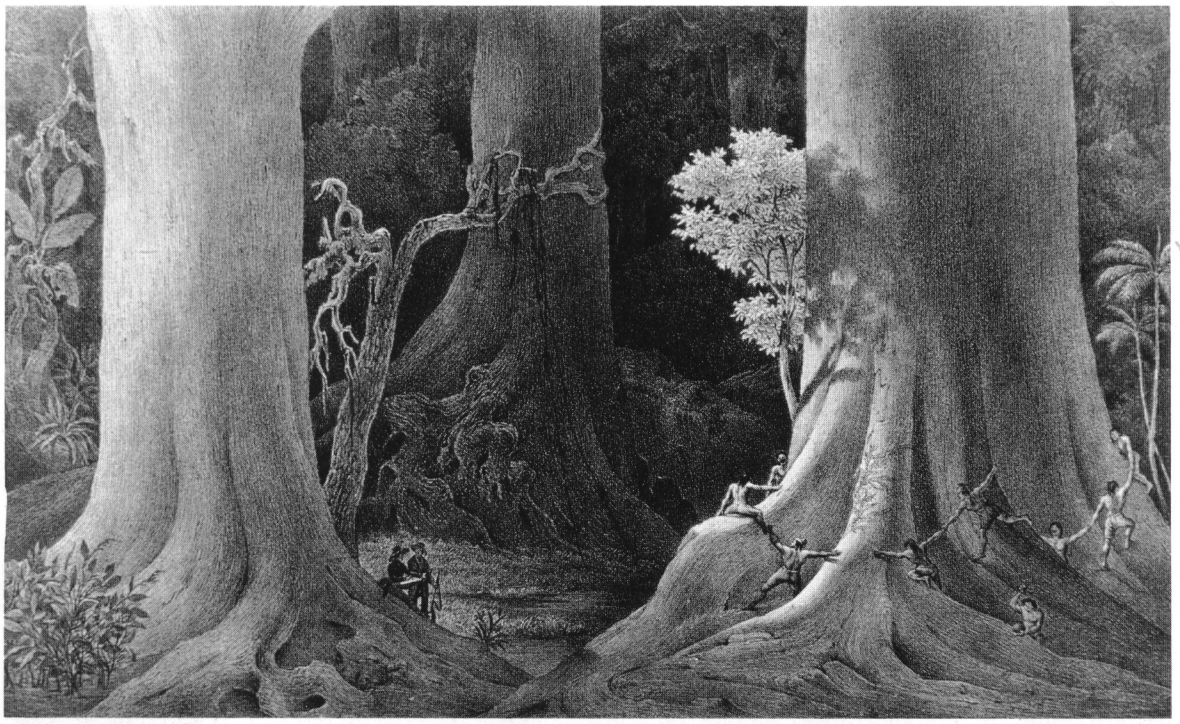

Fig. 1.1.. Early European travellers brought back exaggerated tales about tropical rain forests. This engraving from *Flora Brasiliensis* of von Martius, 1840 (plate IX) is a scene in the Atlantic coast forest of Brazil.

Fig. 1.2. Flowers borne on the trunk of *Dysoxylum parasiticum*, something unknown in northern Europe. When the Swedish botanist Osbeck saw this species in Java he thought the flowers were a leafless parasite. Solomon Islands.

1799 and the effect of the tropical environment led von Humboldt to write home:

What trees! Coconut trees 50–60 feet high; *Poinciana pulcherrima*[7] with a foot high bouquet of magnificent bright red flowers; pisang and a host of trees with enormous leaves and scented flowers, as big as the palm of a hand, of which we knew nothing ... We rush around like the demented; in the first three days we were unable to classify anything; we pick up one object to throw it away for the next. Bonpland keeps telling me he will go mad if the wonders do not cease.

Perhaps even more important for the development of biology was the stimulus the tropical rain forest gave to the minds of Charles Darwin and of

Alfred Russel Wallace in their independent expositions of the theory of evolution by natural selection. Darwin, as a young man 22 years old, went as naturalist on the voyage of the *Beagle*, whose first tropical landfall was Salvador on the Atlantic coast of Brazil (Fig. 10.12). He went ashore on 29 February, Leap day, 1832 and has recorded:

> Delight . . . is a weak term to express the feelings of a naturalist who, for the first time, has wandered by himself in a Brazilian forest. The elegance of the grasses, the novelty of the parasitical plants, the beauty of the flowers, the glossy green of the foliage, but above all the general luxuriance of the vegetation, filled me with admiration. . . . The noise from the insects is so loud, that it may be heard even in a vessel anchored several hundred yards from the shore. . . . To a person fond of natural history, such a day as this brings with it a deeper pleasure than he can ever hope to experience again.

Wallace spent five years travelling in South America (1848–52) and then eight more (1854–62) in the Malay archipelago where he discovered the two distinct faunas of the region, epitomized by the boundary Wallace's Line named after him (Chapter 6). He too was impressed by the richness of the forests:

> If the traveller notices a particular species and wishes to find more like it, he may often turn his eyes in vain in every direction. Trees of varied forms, dimensions and colours are around him, but he rarely sees any one of them repeated. Time after time he goes towards a tree which looks like the one he seeks, but a closer examination proves it to be distinct. He may at length, perhaps, meet with a second specimen half a mile off, or may fail altogether, till on another occasion he stumbles on one by accident.[8]

Richness in species was one of the vivid discoveries of these nineteenth century explorer naturalists. It is now believed that about half the world's species occur in tropical rain forests although they only occupy about seven per cent of the land area. Herbs familiar in Europe have woody relatives which gives a whole new dimension to taxonomy:

> Nearly every natural order of plants has here *trees* among its representatives. Here are grasses (bamboos) of 40, 60, or more feet in height, sometimes growing erect, sometimes tangled in thorny thickets, through which an elephant could not penetrate. Vervains[9] form spreading trees with digitate leaves like the horse-chestnut[10] Milkworts,[11] stout woody twiners ascending to the tops of the highest trees, and ornamenting them with festoons of fragrant flowers not their own. Instead of your periwinkles[12] we have here handsome trees exuding a milk which is sometimes salutiferous, at others a most deadly poison, and bearing fruits of corresponding qualities. Violets[13] of the size of apple trees. Daisies (or what might seem daisies) borne on trees like alders.[14]

Tropical rain forest is certainly very different from the vegetation of northern Europe familiar to these naturalists, and few were able to resist recording their impressions in lyrical prose, or to exaggerate (Fig. 1.3). In perhumid climates, on normal tropical soils and at its grandest, as in the western Malay archipelago, it is, to use von Humboldt's phrase, forest piled upon forest, the topmost trees 45 m or occasionally even taller (Figs. 1.4, 1.5, 1.6), often as solitary emergents which stand head and shoulders above a billowing continuous canopy, many shades of green. Within the canopy[15] there are trees of all different heights, which sometimes locally occur in layers or strata (pp. 25–6), with crowns of many shapes. Trunks are mostly slender with only a minority exceeding a metre in girth. The trunks may be buttressed (p. 50), and the bark variously sculptured and coloured (p. 50). But the forest is more than just a collection of trees, as has been vividly described by E. J. H. Corner:

> On its canopy birds and butterflies sip nectar. On its branches orchids, aroids and parasitic mistletoes offer flowers to other birds and insects. Among them ferns creep, lichens encrust, and centipedes and scorpions lurk. In the rubble that falls among the epiphytic roots and stems, ants build nests and even earthworms and snails find homes. There is a minute munching of caterpillars and the silent sucking of plant bugs. On any of these things, plant or animal, a fungus may be growing. Through the branches spread spiders' webs. Frogs wait for insects, and a snake glides. There are nests of birds, bees and wasps. Along a limb pass wary monkeys, a halting squirrel, or a bear in search of honey; the shadow of an eagle startles them. Through dead snags fungus and beetle have attacked the wood. There are fungus brackets nibbled round the edge and bored by other beetles. A woodpecker taps. In a hole a hornbill broods. Where the main branches diverge, a strangling fig finds grip, a bushy epiphyte has temporary root, and hidden

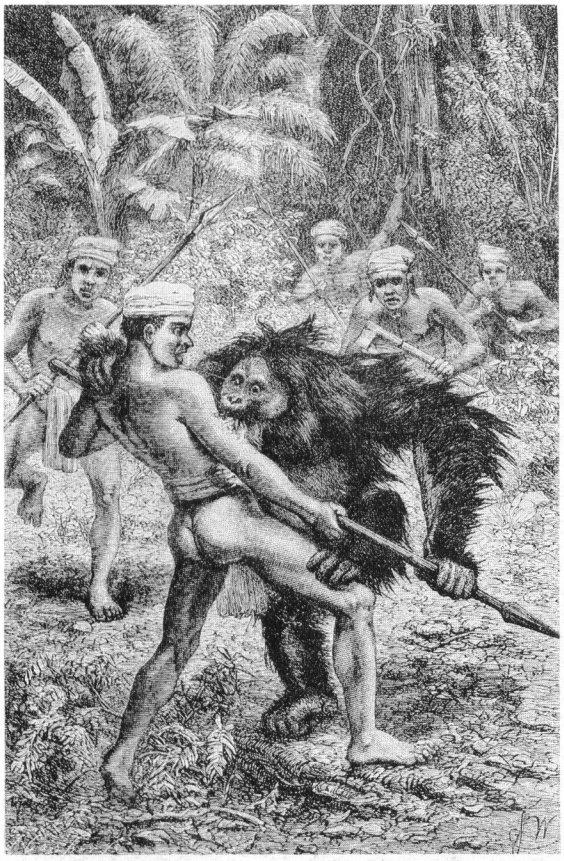

Fig. 1.3. The orang-utan of Sumatra and Borneo is in fact docile and shy and even if provoked is more likely to flee than to attack. This, the frontispiece to A. R. Wallace's *Malaya Archipelago*, gave the European reader the thrill he was expecting.

sleeps a leopard. In deeper shade black termites have built earthy turrets and smothered the tips of a young creeper. Hanging from the limbs are cables of lianes which have hoisted themselves through the undergrowth and are suspended by their grapnels. On their swinging stems grows an epiphytic ginger whose red seeds a bird is pecking. Where rain trickles down the trunk filmy ferns, mosses and slender green algae maintain their delicate lives. Round the base are fragments of bark and coils of old lianes, on which other ferns are growing. Between the buttress-roots a tortoise is eating toadstools. An elephant has rubbed the bark and, in its deepened footmarks tadpoles, mosquito larvae and threadworms swim. Pigs squeal and drum in search of fallen fruit, seeds and truffles. In the humus and undersoil, insects, fungi and bacteria and all sorts of animalculae participate with the tree roots in decomposing everything that dies.[16]

During the twentieth century knowledge of tropical rain forests developed in two streams.[17] On the one hand academic scientists continued to collect and identify the plants and animals, and to describe forest structure. Many of these studies were made on short visits of a few months' duration. They tried to comprehend the nature of forest variation from place to place. This was in accord with the preoccupation of ecologists in temperate countries at that time with the nature of climax communities and with succession. This phase of study culminated with the publication of a masterly synthesis by P. W. Richards of the whole field up to about 1940.[18] Independently, colonial foresters began to delimit blocks of forest to be preserved from felling for agriculture, to control the utilization of forests for timber production, and to develop silviculture. This last involved the application of the centuries old European knowledge about what is today sometimes called 'gap-phase dynamics', namely the ability of different species to regenerate after different degrees of canopy disturbance.

In recent decades the two separate streams have merged to lead to the new synthesis which is a major part of the present book.

Apart from the growing knowledge of tropical rain forests in the Western scientific tradition it must not be forgotten that within the tropics man has lived close to Nature and in intimate contact with tropical forests for millenia. The forests yielded all the products needed for his life, and he learned how to grow crops on inherently infertile rain forest soils, by shifting agriculture, moving the fields every 2 or 3 years and allowing forest regrowth to restore site fertility. This discovery was made independently in all parts of the tropical zone. His numbers were never large.

The era of European exploration of the world followed by the Industrial Revolution led to increasing human impact, which has increased continually till the present day (Figs. 1.7, 1.8). The evolution of medical knowledge in the West, plus the development of powerful drugs, has this century removed most of the health hazards of the humid tropics so that death rates have diminished and life expectancy increased, both dramatically. This has added the new pressure on tropical forests of much higher and rapidly increasing

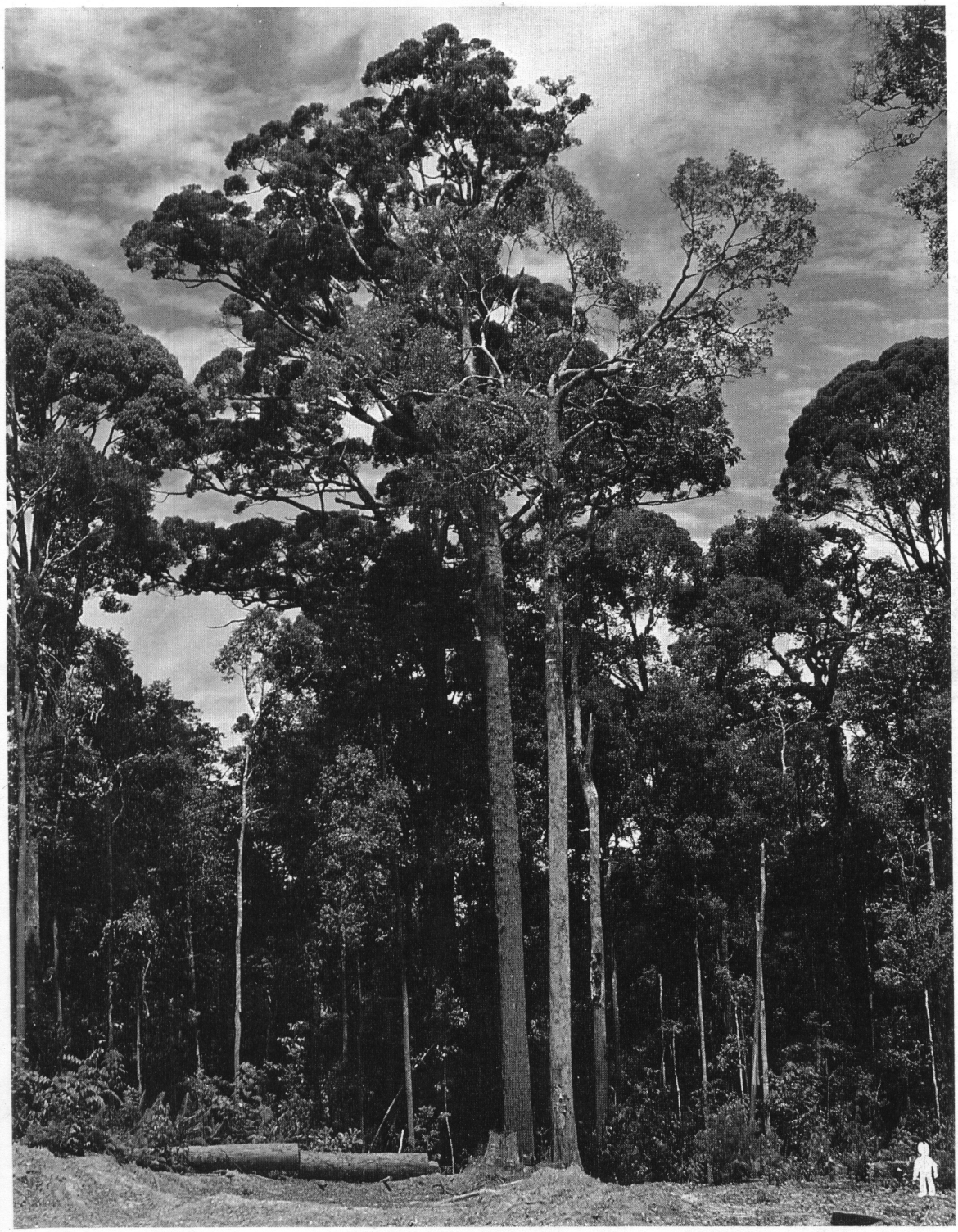

Fig. 1.4. Lowland evergreen dipterocarp rain forest in profile (Brunei), with *Dipterocarpus crinitus* right centre and *Shorea curtisii* to its left. Without the scale object the reader would not realize the huge size of these trees.

Fig. 1.5. Profile diagram of lowland evergreen dipterocarp rain forest, Brunei. Ridge crest plot 60 × 7.5 m, all trees over 4.5 m tall shown. Mature phase forest except for extreme right hand end. (From Ashton 1965, in Whitmore 1984*a*, Fig. 1.6; see latter for species' identification.)

human populations (Fig. 10.1). The technological development of reliable machines for road building and log hauling, of chain saws for tree felling, and of bulldozers for land-clearance since World War 2 have made it possible to remove tropical rain forests on a scale and at a rate that was previously impossible. The forest frontiers have been rolled back. What seemed limitless forests a few decades ago are now seen as finite and vulnerable. Even only a third of a century ago, when my own Odyssey began, tropical rain forests seemed boundless. I descended the Amazonian flank of the Andes in Ecuador on muleback to investigate montane forest zonation, a journey which now takes an hour by bus. Then I travelled widely through the Solomons in the western Pacific by schooner, and collected plants never seen by science on sparsely inhabited islands where the rain forest came down to the wild coconuts leaning over the sandy beach. Later I explored the eastern part of the Malay peninsula, poling up rivers by prahu to the head of navigation before walking for several days to the peaks cresting the watershed.[19] Now one flies to those lands from London in only a day or so and can next day be in the patches of jungle which remain, arriving by dump truck along a muddy logging road. There is more general and scientific interest in tropical rain forests than ever before and this new ease of access is part of the reason. So let us now turn in Chapter 2 to a close examination of the tropical forest zone and then continue with analysis of its plants, animals, dynamics, and present status.

Fig. 1.6. Emergent kapok, *Ceiba pentandra* var. *caribaea*; riverine forest near Iquitos, Peru. Subsequently all felled to supply a short-lived plywood industry.

This species is one of the biggest and commonest emergents of the Amazonian rain forests (Gentry and Vasquez 1988) and occurs also in Africa (Fig. 3.30).

Fig. 1.7. Lowland semi-evergreen rain forest penetrated by logging road. Lower Amazon, Jari, Brazil.

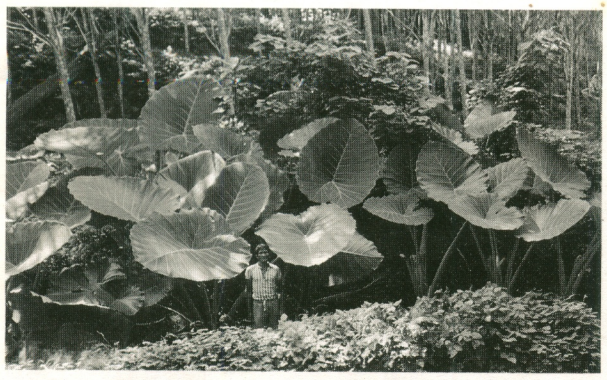

Fig. 1.8. Giant herbs, here the aroid *Colocasia gigantea* at Langkawi, Malaya, are a distinctive feature of the lowland humid tropics.

Fig. 1.9. Lowland evergreen dipterocarp rain forest in profile, beside a newly built telecommunications tower access-track, Malaya. Emergent *Canarium* and *Shorea* but no other distinct strata. Note man.