



# Dayaks and Forests of Interior Borneo

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**B**orneo, largest of the Greater Sunda Islands in the Indonesian archipelago (Fig. 2a,b) and the third largest island in the world (after Greenland and New Guinea), is home not only to the richest rainforests on earth but also to a fascinating diversity of peoples. We will be concerned mainly with this area and with the varied social and land-use practices of the Dayak peoples who live there.

Although the area is remote, the lives that people lead there are by no means static or unchanging and their cultures are not tidy bundles of traditions handed down intact from generation to generation. On the contrary, their long history of mobility, intergroup contacts, intercourse with outside traders, as well as changes in group affiliation and group boundaries have resulted in a wide but irregular distribution of traits and customs commingled with other items peculiar to each small community.

People have lived in and used the resources of Borneo's forests for at least 40,000 years, that is, since the last Ice Age, when the Greater Sundas were connected by a land bridge to the Asian mainland. Borneo then

was, in the words of Tom Harrisson, "at the far fringe of the fully walkable world" (1972:385). Compared to the history and prehistory of mainland Southeast Asia, there is frustratingly little known about the people of Borneo before the 19th century. From the great Niah Cave in Sarawak and a few other sites comes archaeological evidence of past human activities; however, most of

what we know about the island's history in all but the most recent times comes from travelers' accounts and indirect evidence from China and elsewhere.

Borneo is sometimes portrayed as a historical backwater, but that is not, of course, the perspective of its inhabitants. Creation myths of the interior peoples place the origin of humanity in the forests at the heart



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Dayak farmers spend a good deal of time hunting, fishing, and collecting forest products far from home. Even deep in the forest, a meal is not complete without a big pot of rice.*

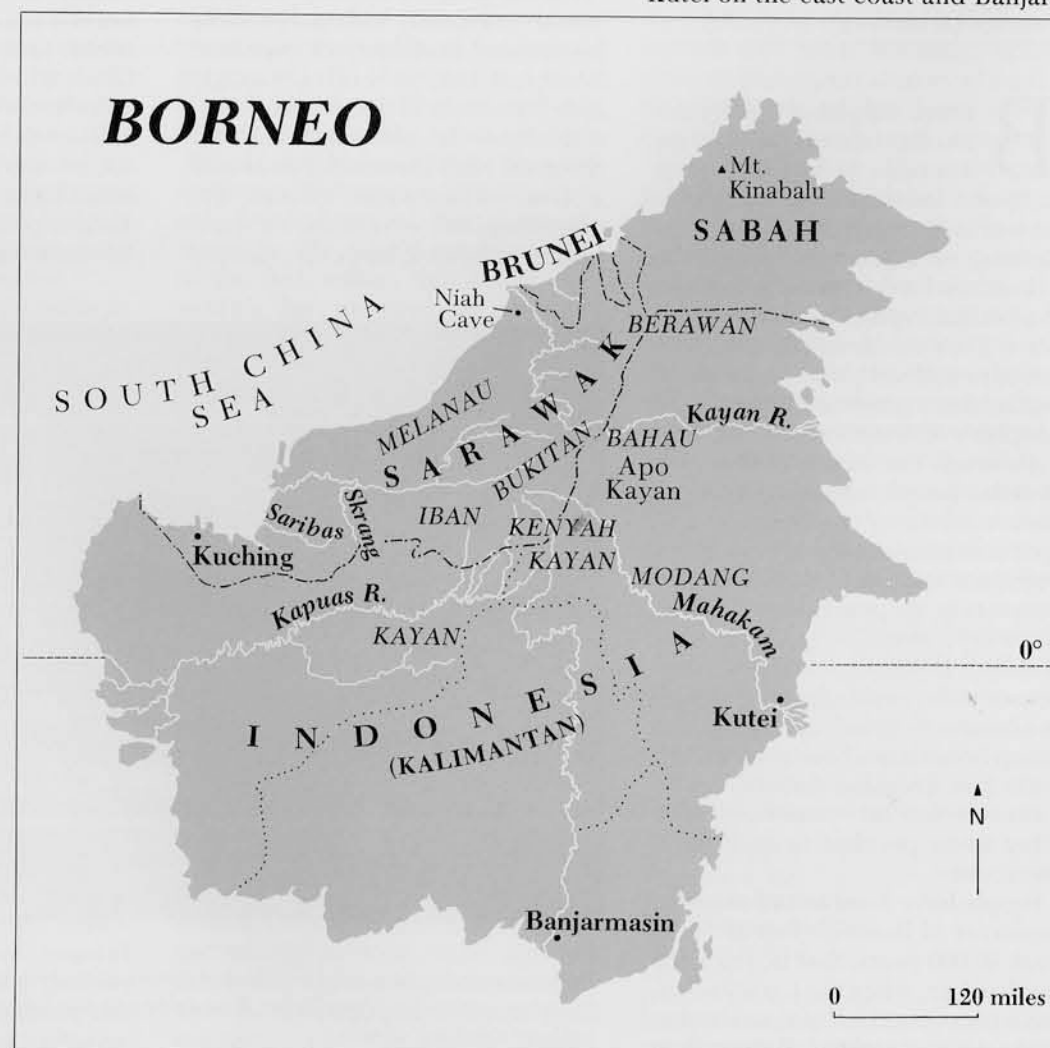


of the island. To highland peoples such as the Kenyahs, we “downriver” folk are all foreigners (*alok*). As such, we begin our account here, at the island’s periphery, as did the early Indonesian, Chinese, and European voyagers.

## A Turbulent History

Since the 1st millennium A.D. political and economic influences from outside powers such as China and Java have ebbed and flowed across Borneo's coastal regions. The effects of these outside contacts have seeped into the interior by means of trade, migration, warfare, and colonial hegemony. Principalities situated near the coast by navigable rivers have from time to time risen to local prominence, flourished for awhile, and then, for the most part, lapsed into obscurity or fallen into ruin. A few, such as Kutei on the east coast and Banjar-

**2a,b**  
The island of Borneo is centrally located in insular Southeast Asia. The trade routes that connected China, the Philippines, the Malay Peninsula, Siam (Thailand), Java, and Sumatra with mainland Southeast Asia and India all passed the shores of Borneo.



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The interior of Borneo is rugged and mountainous. An airstrip in the remote Apo Kayan provides a link with the outside world.

masin in the south, were absorbed during the colonial period into the Dutch East Indies. Since its early history in the 7th century A.D., only the Sultanate of Brunei has managed to survive intact the vicissitudes of trade, war, piracy, and colonial domination (see Brown, this issue).

The coastal kingdoms and sultanates depended for their survival on overseas trade and alliances beyond the island. The *raison d'être* of the cities and smaller trading towns located at the mouths of Borneo's rivers, however, was the flow of valuable forest products, collected by people in the hinterland. These heterogeneous interior peoples, commonly known as Dayaks, are the focus of this article.

## Human Geography

According to a recent estimate (Ave and King 1986:8,13), Borneo has roughly 3 million people who can be classified as Dayak. This is somewhat less than a third of the island's population. The remaining two-thirds are mostly Muslim peoples dwelling near the coast

(Malays, Banjars, Kuteis, Bugis, Javanese and others) and a significant number of Chinese. We include as Dayaks the nomadic and semi-nomadic peoples of the forests, such as the Punans and Bukitans, who probably comprise less than one percent of the Dayak

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population. The majority of Dayaks are farming people inhabiting the middle and upper reaches of Borneo's many rivers. Most practice the shifting cultivation of rice. Hunting and gathering and the collection of forest products for trade are also important economic pursuits, even among cultivators, especially in large forested areas of low population density (Fig. 1).

Numerous linguistic and ethnic groupings exist within the broad category of Dayaks. These are geographically distributed with little regard to the political boundaries that divide Borneo into the Malaysian states of Sarawak and Sabah; the Indonesian provinces of East, South, Central, and West Kalimantan; and the independent nation of Brunei Darussalam. Even the natural barrier formed by the rugged central spine of mountains has not stopped the migration of peoples between highlands and lowlands and from one side of the island to the other.

Five great rivers flowing out of the central highlands—the Barito, Kapuas, Rejang, Kayan, and Mahakam—serve as highways for migration and trade, although the upper reaches are fraught with dangerous rapids which must be circumvented by overland portages. Transverse movements between the different river systems are blocked in the interior by densely forested ridges or, in the southern part of the island, by vast swamp forests. In the very center of Borneo, however, trails link the headwaters of the several rivers. In the past these were

the routes for headhunters, as well as for collectors of forest products and occasional peddlers who were bold enough to venture into the highlands.

Now the trails and rivers of the interior are traveled in peace by itinerant traders and parties of Dayaks on their way to and from the lowlands where they work as loggers and plantation laborers, and by others who collect forest products to exchange in downriver markets for salt, steel, cloth, tobacco, and other goods. Such trade expeditions can be long and arduous, lasting for more than a year and requiring months of travel. It is therefore not surprising that most necessities of life for the interior peoples probably have been obtained from local sources. Even salt and iron were produced and exchanged by people in the remote highlands, where trade with the coast was unreliable until well into the 20th century. People in these areas still depend on nearby forests for food, building materials, and a variety of other products. Before discussing the ways in which forests are used, we will briefly describe some aspects of Dayak societies.

### Social Organization

Kinship is the basis for much of Dayak social and political organization. Members of a community acknowledge a common descent, or

affinity through marriage, relationships which not only unite the community as a people but also serve to define its limits. Generally speaking, kinship is reckoned bilaterally through male and female lines. Affinities and differences between ethnic groups are cast in terms of kinship, with genealogies purporting to show the common descent of groups, such as the various Kenyah communities. Slaves captured in war in former times were for the most part prohibited from marriage with their captors and so remained genealogically "outside" those societies. But the occasional adoption of captive children was an exception to this rule.

In many Dayak societies, especially in the central highlands and surrounding areas, people belong to different social strata or classes, although such differentiation is by no means universal. Nomadic Penan (or Punan) in Sarawak have no social classes of their own but are considered an inferior class by some neighboring cultivators with whom they trade forest products. Among the farming peoples, Ibans are noted for their egalitarian ideology, although individuals can attain positions of prestige through travel (*bejalai*, including expeditions to collect forest products), the accumulation of wealth, and in former times success in headhunting.

Social stratification is most pronounced among the Kayans and

neighboring peoples such as the Kenyahs. The leadership exercised by aristocratic (*maren*) chiefs in these societies can be quite strong, especially in the past when chiefs commanded the labor of slaves (*dipen*) and, for a certain number of days each year, of "commoners" (*panyin* and *hipuy*). Aristocrats still command a large measure of respect, as well as some of their hereditary political privileges.

Although money is increasingly important in the interior of Borneo, wealth among Dayaks has long taken the form of heirlooms (porcelain jars, bronze gongs, old beads, and swords; see article by Chin) and rights to cultivate land and harvest valuable forest products.

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Heirlooms (Fig. 7) and special rights are inherited by children and sometimes given between families as bridewealth or dowries. Heirlooms tend to circulate within more-or-less endogamous groups, which in some longhouse communities are the "house-owners," in others "aristocrats." Property and social rank are the privileges of women as well as men. This is exemplified by the "fabulously expensive" beads worn by a 19th century Kayan aristocrat and bought with a great quantity of fine birds' nests from caves she owned (St. John 1862, I:119).

Marriages between aristocrats of different villages, even between distinct ethnic groups, were important in pre-colonial days as a means of extending or cementing political and military alliances, creating in effect a common aristocracy for ethnically diverse communities in any particular area. Aristocratic marriages are still counted as important ties of kinship between communities in central Borneo.



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Rivers are the highways of interior Borneo. A Kenyah husband and wife pole their canoe up a shallow stream.

### Headhunting and Warfare

Warfare, including headhunting, slave capture, plunder, and conquest, was practiced by Dayaks in various parts of Borneo until the early part of the 20th century. Especially notorious as headhunters were the Ibans and Kenyahs (Fig. 17), but headhunting and the capture of slaves were widespread through the end of the 19th century except in the southern part of the island. Successful headhunters enhanced their own prestige, in part because their actions were perceived to contribute to the prosperity of kin and community through the performance of certain important rituals. These rituals, such as the Iban *kenyalang* and the Kenyah *mamat*, required fresh human heads for their performance.

Usually the heads were taken from members of neighboring groups, but at times there were opportunities to range further afield. This was most dramatically so for the Ibans who had settled in the lower reaches of the Saribas and Skrang rivers of Sarawak in the late 18th and early 19th centuries. Because of disorder along Borneo's western coast, they were able for several decades to paddle down the rivers in their war canoes and, with virtual impunity, make headhunting raids upon Malay and Chinese coastal settlements and small parties at sea. The disorder was partly a result of the fact that the Dutch, who had been policing the coast, had withdrawn during the Napoleonic and immediately post-Napoleonic period because of wars elsewhere (Vayda 1976:54-63).

Wars of conquest were waged by Kayans, Modangs, and others migrating from the Apo Kayan in the 18th and early 19th centuries. These fierce highlanders took heads, slaves, and agricultural lands from less numerous or less warlike peoples. Of those who were not killed, captured, or driven off, some retained their original ethnic identities under the sway of conquering chiefs. Others either forged links to the invaders through marriage and ethnic "conversion" or else resisted the invaders by forming loose alli-



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Elongation of the earlobes was formerly a common practice. The results of it, once considered a mark of beauty, can still be seen in older Dayaks.

ances on the basis of apparently invented ethnic affinities, such as those among Kajang communities in Sarawak (Rousseau 1975:38-40).

These migrations brought the warlike Dayaks of the interior into direct conflict with coastal sultanates such as Kutai and Brunei, whose rulers claimed sovereignty over the lowland peoples and ownership of valuable birds' nests, rattan, bees-

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wax, and other forest products brought down the rivers to their trading ports. Some of the highland peoples, specifically the Kayans in the northwest and the Segais in the northeast, wrested control of valuable bird nest caves from the sultans and maritime traders. A Kayan "army" of some 3,000 warriors actually besieged the city of Brunei until the Sultan capitulated to their demand for booty (St. John 1862, I:86ff. and II:56).

Dayak warfare, together with headhunting and "piracy," as the British and Dutch called the maritime raiding that threatened their economic and political interests, was largely suppressed during the 19th century. This was accomplished through the joint efforts of the colonial powers—including a small force led by James Brooke, most successful of the English merchant adventurers and self-styled "White Rajah of Sarawak" (see Brown, this issue)—and some of the sultanates in Borneo and Java (Pringle 1970).

### Diversity of Forest Resources and Their Use

Between the coastal belt of mangroves and the timberline high on Mount Kinabalu, the natural vegetation over almost all of Borneo is tropical rainforest. No part of the island is more than eight degrees of latitude from the equator, so temperature and day length show little seasonal variation (Robequain 1958:219). The average temperature at sea level ranges around 27 degrees C, or 80 degrees F. Mean annual rainfall is high: at least 2,500 mm (100 inches) in most areas and around 4,500 mm (175 inches) in the mountainous interior. In contrast to the strong seasonal pattern of wet and dry monsoons that occurs in mainland Southeast Asia and parts of eastern Indonesia, rainfall in Borneo is fairly evenly distributed throughout the year, except in some areas near the coast. Nevertheless, droughts do occasionally occur. In 1982 and 1983 a climatic anomaly associated with the El Niño phenomenon affected the world's

weather, causing severe drought throughout Indonesia. This, together with a spate of land-clearing and intensive logging, led to widespread forest fires in East Kalimantan and Sabah (Malingreau 1987). Such rare climatic events, estimated to occur once in a century or so in the case of the drought in East Kalimantan, may have profound effects on the evolution and distribution of rainforest species. There are, however, few long-term or even medium-term studies by which to assess the consequences of aberrant natural disturbances for forests and their use by humans.

Borneo's forests are extremely diverse in number of species and in the variety of forest environments. In a recent study of lowland forest trees

in East Kalimantan, nearly 250 species were found on less than 2 hectares (about 5 acres), even excluding the smaller trees (Whitmore 1984:5-6). While no thorough survey of economically useful plants and animals has been made for Borneo, the number for the nearby Malay Peninsula has been calculated to be about 2,400 (Jacobs 1982:3773, based on Burkill 1935).

Two major sources of variation in tropical forests are differences in altitude and drainage. Forests in the lowlands, below about 750 m (2,400 feet), can be broadly divided into wetland or swamp forests and dryland forests. The dryland forests are dominated by dipterocarps, a large and abundant family of big trees economically important for

their timber, resin, and oil-bearing nuts. These products are harvested or collected by Dayaks for their own use and for commercial trade, although the advent of mechanized logging since the early 1970s has led to the replacement in the timber industry of expert Dayak woodsmen by non-Dayaks skilled in the operation of heavy machinery.

At higher elevations, dipterocarps become progressively less important and are replaced by species of the beech, laurel, myrtle, and heath (rhododendron) families, together with scattered stands of conifers. Human utilization extends regularly into the lower montane zone, from 750 to about 1,500 m (5,000 feet) but rarely to higher elevations. (In Borneo there are few areas above 2,000 m in any case.) The most valuable rattans (*Calamus* species) occur in lowland and lower montane forests. Sago palms (*Metroxylon sagu* and other species) are most abundant in the lowlands, both in swamp forests and cultivated stands. The Melanau Dayaks in Sarawak formerly relied on these carbohydrate-filled palms for their subsistence; now they grow them as cash crops. Sago palms in the highlands are the staple of nomadic Punans.

In the sparsely populated interior, hunting and fishing provide most of the animal protein eaten by settled as well as nomadic peoples (Figs. 8-10). Domestic pigs and chickens are raised mainly for ceremonial occasions. Dogs are kept and are specially bred for hunting by some Dayaks. The principal game animals are the bearded pig (*Sus barbatus*) and sambar deer (*Cervus unicolor*); a variety of other mammals, birds (Fig. 13), reptiles, fish, insects, crustaceans, and mollusks are also hunted for food and other products. Dayak hunters use spears, blowpipes, shotguns, traps, and snares. Their fishing techniques include the use of lines, throw nets, weirs, traps, dams, and plant-derived poisons.

Because of the large quantities of fat they carry, wild pigs are the favorite prey of Dayak hunters (Fig. 8). Fossil remains of the bearded pig have been found in the caves at Niah, Sarawak, where they are more abundant than any other game animal since the earliest period rep-



6 Rituals mark various points in the agricultural calendar and other important events in people's lives. This old woman is cutting a lock from the man's hair before beginning the ceremonial meal at the end of mourning by an Iban community. (Photo by C. Padoch)

resented there, the late Pleistocene between 20,000 and 40,000 years ago (Majid 1982:134-138). Although a few pigs can usually be found in any area throughout the year, they are most abundant during mass migrations which are made across the central mountains and coincide with the irregular fruiting periods of oaks and dipterocarps (Caldecott and Caldecott 1985).

### Minor Forest Products

For more than 1,000 years the principal exports from the forests of Southeast Asia were such products as gums and resins, rattan, nuts and fruit, sago, aromatic woods, beeswax, animal skins, teeth, claws and horns, bezoars from monkeys and porcupines, the bile of bears, and edible birds' nests. Historical records indicate that some of these have been traded to China since at least the 5th century (Dunn 1975:111-112). Since then, the trade routes have been extended to India, the Middle East, Europe, and America.

The plant and animal products mentioned above are now called "minor forest products" in contrast to timber, which in this century has surpassed them in volume and value. Nevertheless, non-timber products are still more significant as a source of livelihood for people in the interior

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of Borneo and other forested areas of Southeast Asia, both as articles of trade and for subsistence (Fig. 11). Rattan is now the most important commercial minor forest product in the total value of its exports, but pound for pound few if any exceed in value the edible nests of certain cave-dwelling swiftlets (*Aerodramus* species). These nests are so avidly sought by gourmets in



7 Porcelain jars and glass beads serve as items of wealth throughout interior Borneo and show the historical importance of trade with the outside world. The beaded cap and belt worn by this Lun Dayeh woman are equal in value to several water buffalo. (Photo by C. Padoch)

China and Southeast Asia that they fetch remarkably high prices on the world market. For example, high quality nests sold for \$200 to \$400 a kilogram (about 100 nests) on the Upper Mahakam River in East Kalimantan and for around \$1,000 a kilogram in Singapore in 1979 and 1980 (Jessup and Peluso 1986:510). Caves are guarded day and night during the birds' breeding season. Collection and sale of the nests are controlled by government regulations, although in some areas these are circumvented.

The collectors of these products in Bornean forests are mostly Dayaks, both farmers who collect intermittently and nomads who spend a great deal of their time collecting. Some specialize, at least temporarily, in a particular product, and some claim proprietary rights to certain resources. Generally, however, Dayak collectors range widely and collect a variety of forest products in accord with changes in their availability and the prices offered for them.

### Longhouse Construction

The building of longhouses illustrates the skill with which Dayak artisans use materials from the



8 Wild pigs are the favorite prey of Dayak hunters. These men have killed a pig which their dogs brought to bay in a stream.



9,10 Dayak children contribute to their families' subsistence. These Kenyah girls and boys are equipped for fishing. The girls catch small fish with their nets and put them in the gourds tied to their heads. The boys have a homemade spear-gun powered by a rubber band cut from an old inner tube.



forest. Not all Dayaks live or did live in longhouses, and even among long-house dwellers there is considerable variation in building materials and techniques, architectural styles, and technical skills. The most impressive houses, which we will take for our example, are those made by Kayans, Bahaus, Kenyahs, and other peoples of the central highlands and surrounding areas (Hose and McDougall 1912, I:55ff, 203-210; Kelbling 1983). Some of these great dwellings were 1,000 feet long and housed 100 or more families in a single structure (Fig. 14). In the 19th century, when warfare and

11 Forest products provide materials for manufactured items such as this rice basket of split bamboo.

headhunting were endemic, houses were built on fortified hilltops or raised as much as 12 m (40 feet) above the ground on massive hardwood piles.

Houses are now more easily accessible, though heavy piles, beams, and boards are still used in their construction. Until quite recently, wooden house parts were all made by hand with steel axes and adzes, themselves the products of skilled village blacksmiths. Now mechanical saws are sometimes used.

Different species of timber trees, palms (whose leaves are sometimes used as roofing material), and rattan (used to fasten the other parts) are selected to make the various parts of a house. Borneo ironwood (*Eusideroxylon zwagerii*)



12 Elaborately decorated baby carriers are used by some Dayaks (see article by Whittiers). The beadwork and animal teeth indicate the child's social rank.

is prized where durability is important, as in shingles and piles, while lighter wood with a clear, straight grain (such as that of dipterocarps and of the coniferous *Podocarpus* species and *Agathis* species) is preferred for making floor boards. Altogether, a great many species are used for building materials. For example, more than 40 were identified among plants collected in the vicinity of just one village in the Apo Kayan (Soedjito 1982:table 5).

Each family is responsible for preparing the parts of their section of a longhouse, and all must contribute to the chief's central section, which is the largest and most elaborate. These preparations include selecting various kinds of timber and other materials for different house parts, felling and dressing the timber, and transporting the finished pieces to the house site. All this can take several years, as the work is done intermittently between the agricultural seasons and may be delayed by various distractions, misfortunes, or bad omens. On the other hand, unless the builders are pioneering far from their previous home or their old house was destroyed by fire, some parts of an old house can usually be used again in the new



13 Snares and traps are used to catch animals such as the argus pheasant shown here.

structure. Even heavy timbers and piles can be lashed to canoes and floated downriver to be erected again at a new site. During the 19th century, when village migrations were more frequent than now, Kayans in Sarawak generally moved gradually downstream, taking their houses with them from one site to the next.

Once all the parts of the house have been assembled at the building site, the actual erection of the structure is remarkably swift. The heavy piles and beams are raised into position by gangs of men, then

fitted by means of mortised joints, and lashed together with rattan. After the framework of the house is in place, each family, working on its own section, lays down the large floor boards and ties the lighter wall boards and shingles in place with rattan. Each section consists of a walled cooking and sleeping area in the rear, leading to a covered veranda in front, divided by a partition beneath the ridge of the roof. Neighboring sections adjoin to form a series of closed apartments on one side of the house and an extended veranda or gallery on the other. The



14 A longhouse may appear to be a communal dwelling, but in fact it is a series of individual family apartments. This Iban house, like most longhouses, is built close to a river. (Reproduced courtesy of the Sarawak Museum)

gallery is a place for all manner of work and play. It is used for meetings, rituals, and story-telling (Fig. 15); it is also a sleeping place for visitors, bachelors, and the ubiquitous hunting dogs.

### Farming in the Forest

Agriculture, the cultivation of fruit trees, and other forms of resource management are practiced in the lowlands and up to the altitudinal limits of permanent human habitation. Rice is the staple crop of virtually all Dayak farmers, although there are significant variations, as discussed by Padoch in this issue. Shifting cultivation of dry (unirrigated) rice predominates in the interior of Borneo and is the form of agriculture with the most extensive and direct effects on forests.

Areas of forest are cleared and burned to make fields, or swiddens as they are called by anthropologists (Fig. 16). Shifting cultivators, as the term implies, move from one farm site to another every one to three years or so, generally returning to previously cultivated sites after a fallow period of variable length. Parts of an old field may be planted with perennial crops such as fruit trees, which are either harvested or protected when the site is cleared

again for open-field crops. This rotation does not necessarily entail a change in residence on the part of the farmers, although some shifting cultivators do move their houses or villages fairly often. Properly speaking, they are not nomadic, however.

Shifting cultivators have too often been cast in a stereotypical role as unchanging traditionalists, whether their agricultural practices are seen as destroying forests (a view widespread until the 1950s and still current among some foresters and government planners) or as adapted to maintain a kind of harmony or stability within forest ecosystems (a view that gained popularity among anthropologists during the 1960s). Evidence can be found in support of either view, as shifting cultivation includes a tremendous diversity of peoples and practices in a wide range of environments. Advocates of both views, however, have tended to dichotomize unduly, depicting human activities as either destructive or conservative and neglecting the possibility of neutral or contradictory effects. Similarly, with the emphasis on typological uniformity and the persistence of some traditional practices, there has been a tendency to overlook variability and responsiveness to changing circumstances among pre-industrial peoples. Some Bornean examples will serve to illustrate these points.



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The gallery of a longhouse is where people gather for public activities. Here, a Catholic religious service is in progress in a Kenyah longhouse.

Against the views that shifting cultivation either destroys or maintains forests, we refer to a study in the Apo Kayan. From this the conclusion was drawn that, while there is no evidence of permanent forest destruction by the activities of Kenyah farmers in that area, the repeated use of farm sites over a period of generations may have led to a change in the species composition of secondary forests, specifically toward a greater proportion of trees well adapted to fire, cutting, and other disturbances associated with shifting cultivation (Mackie et al. 1987:510). Shifting cultivators can and do, however, take deliberate action either to conserve resources or to exploit them more fully. Thus Padoch found that the Ibans of Sarawak were able to "use resources more sparingly and conservatively when altered circumstances made a change in behavior desirable" (Padoch and Vayda 1983:309).

Variability within particular ethnic groups of shifting cultivators has been shown by Rousseau, who has posed the question, "Is there a Kayan system of land tenure?" (1987:51). A common assumption is that particular groups (Kayan, Iban, and so forth) have broadly defined systems of agricultural land-use that are uniform for each group and across localities. Rousseau argues the contrary position and notes that in the Baluy region of Sarawak certain principles of tenure are shared by different groups in the same geographic areas but differ between areas. He also observes that some commonly acknowledged rules can nevertheless yield different practical results in different circumstances, a point also made by Jessup with regard to Kenyah land tenure rules in the Apo Kayan (1981:21).

### The Historical Context of Forest Exploitation

Lest the contemporary examples we cite suggest to readers that human activities have only recently had significant effects on forests, we conclude with a brief review of archaeological and historical evidence

of human activities in Southeast Asian forests. The hunting of pigs since the Pleistocene and the importance of forest products in trade from early historical times have already been mentioned. Here we focus on forest clearing and technologies of forest exploitation.

One line of evidence comes from the study of fossil pollens (reviewed by Flenley 1979). In Sumatra, these show an increase in plants associated with forest clearing (such as grasses and secondary forest species) from about 4,000 to 6,000 years ago. Major forest clearing evidently was underway by 2,500 years ago (Maloney 1985). Human disturbance of the forests in earlier times, such as may have been associated with the use of fire, is likely to have been obscured in the fossil record by major climatic changes. (It is worth noting that a quartz pebble from Niah in Borneo, presumed to be a firestriker, was found in the stratum laid down between 20,000 and 40,000 years ago [Majid 1982:124].)

The dates derived from pollen cores roughly agree with archaeological evidence of Neolithic agriculture in the Indonesian archipelago. Finely made stone tools, including axes and adzes indicative of skilled craftsmanship in wood, were brought with rice cultivation from mainland Southeast Asia apparently more than 5,000 years ago (Glover 1979). Neolithic burials at Niah have been carbon dated to between 3,000 and 4,000 years ago and later (Solheim 1983:44). Some of the burials contain "beautifully polished" stone tools as well as fine pottery and various other artifacts (Cheng 1969:8).

A technological revolution in agriculture, woodworking, and many other aspects of human life occurred with the development of metallurgy. In mainland Southeast Asia, the manufacture of bronze was fully developed by 4,000 years ago, and ironworking appeared by around 2,500 years ago (Bayard 1984). These technologies presumably reached the islands somewhat later. As noted by Freeman (1970:174-175), iron tools are a great boon to forest-dwelling shifting cultivators. They are far superior to stone axes for land-clearing, especially the felling of large trees in primary forest. It

is uncertain when metallurgy or metal tools first reached Borneo, but iron had arrived by the T'ang dynasty in the 7th century A.D. (Cheng 1969:19), and extensive iron works existed near Santubong on the western coast by the 10th century (Solheim 1983:36-38). Cheng describes Santubong as it must have been at its height, in the 12th and 13th centuries, as "a great seaport" in a landscape "enveloped by the smoke puffing out from hundreds of foundries." Its exports to China and elsewhere included not only iron but also spices and forest products: rhinoceros horns, elephant tusks, and birds' nests (Cheng 1969:18-19).

In the interior of Borneo, village smiths using locally obtained ore and charcoal practice skills that may be a continuation of early Southeast Asian ironworking traditions. Remarkably, swords produced by Kayan craftsmen and others in the remote highlands are of hard steel that in the 19th century surpassed in quality even that imported from Europe. These blades, were believed to possess magical powers and were prized as trade goods throughout central Borneo. Until the early part of this century, when imported axes and trade steel became available to people in the highlands, Dayak smiths forged tools for farming, house building, and boat making, as well as weapons for hunting and warfare.

### "World demand for Borneo's forest products...has risen together with the revolution in technologies of exploitation."

Another revolution in the technology of forest exploitation, one much more recent than the advent of the Iron Age, has come to Bornean forests with the introduction of mechanized timber-cutting and transport (Kartawinata et al. 1984:90; Kartawinata and Vayda



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Dayak woodsmen built platforms to fell trees above their widely spreading buttresses. Here, a tree is being cut for timber.

1984). In lowland forests and rivers this has taken the form of logging with bulldozers and trucks and of motorized riverboats carrying passengers and cargo. Farther in the interior, motorized canoes can now reach remote headwater districts more quickly and reliably than was possible when boats were paddled. Thus traders are better able to bring in supplies for parties of Dayak collectors and to bring out shipments of rattan and other forest products. Air transport is even used for some of the more valuable products, such as aloes wood, bezoars, and gold.

World demand for Borneo's forest products, particularly timber and rattan, has risen together with the revolution in technologies of exploitation. It is feared that some species are suffering severe depletion and may be in danger of extinction (Jacobs 1982; Jessup and Peluso 1986:523-524). The threats to tropical forests now are more serious than in the past, but in keeping with our theme of variability and change we cite two examples of past episodes of "boom and bust" in Borneo's forest products trade.

The first is that of aloes wood, or

*gaharu*, a medicinal product of *Aguilaria malaccensis* and other Southeast Asian trees. It is among the products traded to China since early in the 1st millennium A.D. Since ancient times, "there seems to have been extended periods when little or no trade was possible and the collectors of the wood in Southeast Asia must have had to pursue other endeavors" (Gianno 1986:5). By contrast, during collecting booms (the most recent of which in Borneo and Malaya began in the late 1970s after a hiatus of a generation or so) the exploitation of the trees may have been intense. Burkill suggests that the scarcity of *A. malaccensis* in many parts of its range is a consequence of such

heavy exploitation in the past (1935, 1:203).

Our second example of a forest product that suffered in the past from a destructive boom in cutting is gutta percha (*Palaquium gutta*), a kind of wild rubber occurring in Malaya, Sumatra, Java, and the interior of Borneo, where Dayaks use it for caulking and sealing. During the 19th century, gutta was found to have excellent insulating properties. It came to be in great demand for use in submarine telegraph cables, and the relatively high prices paid for it in Singapore led to a collecting boom in Borneo and Malaya. Consequently, the trees were practically exterminated in many areas (Foxworthy 1916:50-51).

We mention these examples to show, once again, that instability and irregular changes in people's use of forests are not simply phenomena of our own time, but rather are characteristic of a world in Heraclitean flux. There are, however, reasons for special concern about the present destruction of tropical forests, in Borneo and elsewhere. One is the rapid rate and wide reach of forest exploitation now that the industrial revolution has penetrated to the remotest parts of the world. Another is the particular combination of mechanized commercial logging, land-clearing, and colonization schemes with migrant farming that contributes to deforestation in Borneo and Southeast Asia generally.

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17  
Headhunting and warfare were prevalent in central Borneo until the present century. Here, a Kenyah chief from the Apo Kayan, dressed in his old fighting garb, entertains the photographer.

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