

Kayapo Indians: experts in synergy

It is fundamental to the preservation of the tropical forests to show that standing, living forests are more valuable than cut and burned ones. The sad truth is that currently the forest is economically valuable through cattle, lumber and gold, all of which are attained only through the destruction of tropical forests and savannahs. Indigenous peoples can teach us how to attach greater value to the living tropical forest, they can teach us new models for sustained natural resource use and management.

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Indians are thought of as merely exploiters of their environments -not as conservers, manipulators, and managers of natural resources. Researchers find however, that presumed "natural" ecological systems in Amazonia are, in fact, products of human manipulation. Old agricultural fallows are extensive and reflect human-engineered genetic diversity. In the formation of "islands of forest" (Apete) in the "campo-cerrado" in Brazil, for example, the Kayapo were found to have concentrated plant varieties collected from an area the size of Western Europe into a 10-ha plot.

The Kayapo, a case study

The knowledge of the Kayapo Indians is an integrated system of beliefs and practices. In addition to the information shared generally, there is specialised knowledge held by a few. Each village has its specialists in soils, plants, animals, crops, medicines, and rituals. A complete Kayapo view of nature is difficult to convey because of its underlying cultural complexity. It is possible, however, to identify categories of indigenous knowledge that indicate new research directions, even shortcuts, for Western science, as well as alternatives to the destruction of Amazonia.

Ethno-ecology

The Kayapo identify specific plants and animals as occurring within particular ecological zones. They have a well-developed knowledge of animal behaviour and also know which plants are associated with particular animals. Plant types in turn are associated with soil types. Each ecological zone represents a system of interactions among plants, animals, soils and, of course, the Kayapo themselves. The Kayapo recognise ecosystems that lie on a continuum between the poles of forest and savannah. They have names, for example, for as many as nine different types of savannah -savannah with few trees, savannah with many forest patches, savannah with shrub, and so on. But the Kayapo concentrate less on the differences between zones than on the similarities that cut across them. Marginal or open spots within the forest, for example, can have micro-environmental conditions similar to those in the savannah. The Kayapo take advantage of these similarities to exchange and spread useful species between zones, through transplanting seeds, cuttings, tubers and saplings. Thus there is much interchange between what we tend to see as distinctly different ecological systems. Kayapo agriculture focuses upon the zones intermediate between forest and savannah types, because it is in these that maximal biological diversity occurs. Villages too are often sited in these transition zones. The Kayapo not only recognise the richness of these zones, but they actually create them. They exploit secondary forest areas and create special concentrations of plants in forest fields, rocks outcroppings, trial sites, and elsewhere.

Forest islands

The creation of forest islands, or Apete, demonstrates to what extent the Kayapo can alter and manage ecosystems to increase biological diversity. Apete begin as small mounds of vegetation, about one to two meters round, created by ant nests in open areas in the field. Slight depressions are usually picked out because they are more likely to retain moisture. Seeds or seedlings are planted in these piles of organic material. The Apete are usually formed in August and September, during the first rains of the wet season, and then nurtured by the Indians as they pass along the savannah trails. As Apete grow, they begin to look like up-turned hats, with higher vegetation in the centre and lower herbs growing in the shaded borders. The Indians usually cut down the highest trees in the centre to create a donut-hole centre that allows the light into older Apete. Thus a full-grown Apete has an architecture that creates zones that vary in shade, light and humidity. These islands become important sources of medicinal and edible plants, as well as places of rest. Palms, which have a variety of uses, prominently figure in Apete, as do shade trees. Even vines that produce drinkable water are transplanted here. Apete look so "natural", however, that until recently scientists in fact did not recognise them as human artefacts. According to informants, of a total of 120 species inventoried in ten Apete, about 75 percent could have been planted. Such ecological engineering requires detailed knowledge of soil fertility, micro-climatic variations, and species niches, as well as the interrelationships among species that are introduced into these human-made communities.

Plants that are good friends

The Kayapo are aware that some species develop more vigorously when planted together. They frequently speak of plants that are "good friends" or "good neighbours". One of the first of these "neighbour complexes" I was able to discover was the "tyrutiombiqua", or "banana neighbours". Among the two dozen varieties of edible tubers and numerous medicinal plants that thrive near bananas are some of the mekraketdja ("child want not") plants, which are very important in regulating fertility among the Kayapo. Other managed plant communities are concentrated around e.g. papaya, genipapo (*Genipa americana* L.) and urucu (*Bixa orellana* L.) which produce their own unique microzones for planting. The Kayapo characterise such synergistic plant groups in terms of "plant energy". These groups can include dozens of species and require complex patterns of cultivation. Thus a Kayapo garden is created by carefully combining different "plant energies" just as an artist blends colours to produce a work of art. Indian fields thrive on diversity within the plots. This diversity is quite ordered to the Indian eye, with careful matchings between plant varieties and micro-environmental conditions. What appears to us to be random field plantings turns out to have five more or less concentric zones, each with preferred varieties of cultivars and different cultivation strategies. The Kayapo exploit the properties of fields in transition between new and old but also shows how micro-environmental planting zones are created to modify effects of secondary forest growth. Equally significant is the indigenous conceptualisation of plant communities, rather than individual species, as the basis for ecological management.

Ethnopedology

A survey of Kayapo soil taxonomy shows sophisticated horizontal and vertical distinctions based on texture, colour, drainage qualities, friability, and stratification. Soil qualities are frequently related to indicator plant species that allow Indians to predict floral and faunal components associated with specific soil types, each of which is managed differently

according to individual characteristics. Sweet potatoes, for instance, like the hotter soil and thrive in the centre of fields where shade from the margins rarely penetrates. The plants must be well aerated, however, or soil compaction will smother the root system. The Kayapo use various types of ground cover such as vegetation, logs, leaves, straw, and bark to affect moisture, shade, and temperature of local soils. Holes are sometimes filled with organic matter, refuse, and ash to produce highly concentrated pockets of rich soil. Old banana leaves, stalks, rice straw and other organic matter are piled and sometimes burned in selected parts of fields to create additional local variations. The Kayapo have dozens of types of plant ash, each said to have certain qualities preferred by specific cultivars. The ash is usually prepared from the vines, shucks, stalks, and leaves of plants that have been cut or uprooted during harvesting or weeding. Sometimes piles of organic matter are made, with the different varieties carefully separated and allowed to dry in the sun until they will give a complete burn. The ashes are then distributed to the appropriate part of the field.

Ethnozoology

Like other indigenous groups, the Kayapo conscientiously study animal anatomy, paying special attention to stomach contents of game animals. They are also astute observers of many aspects of animal behaviour. The Kayapo encourage their children to learn the behaviour patterns and feeding habits of different animal species, which are considered to have their own "personalities". Part of this knowledge is gained through pet rearing. In a survey we found over sixty species of birds, reptiles, snakes, amphibians, mammals and even spiders being raised in the village. Kayapo use a precise knowledge of insect behaviour to control agricultural pests. For example nests of "smelly ants" (genus *Azteca*) are deliberately placed in gardens and on fruit trees that are infested with leaf-cutting ants (*Atta* spp.). The pheromones of the "smelly ants" repel the leaf-cutters. These protective ants are also highly praised for their medicinal properties and are frequently crushed and their highly aromatic scents inhaled to open up the sinuses. The Indians cultivate several plants containing extrafloral nectars, often on the leaves or stems, which attract predatory ants to serve as "bodyguards" for the plant, and plant banana trees to form a living wall around their fields, because predatory wasps nest preferentially under the leaves.

Ethno-agriculture and agroforestry

Indigenous agriculture begins with a forest opening, into which useful species are introduced and ends with a mature forest of concentrated resources, including game animals. The cycle is repeated when the "old-field" forests develop canopies too high and dense for efficient production and are cleared again. Agricultural plots are designed to be productive throughout this reforestation cycle. Contrary to persistent beliefs about indigenous slash-and-burn agriculture, fields are not abandoned after a few years from initial clearing and planting. On the contrary, old fields offer an important concentration of diverse resources long after primary cultivars have disappeared. Kayapo "new fields" for example, peak in production of principal domesticated crops in two or three years but continue to bear produce for many years: sweet potatoes for four to five years, yams and taro for five to six years, papaya and banana for five or more years. The Kayapo consistently revisit old fields seeking these lingering riches. Fields take on new life as plants in the natural reforestation sequence begin to appear. These plants soon constitute a type of forest for which the Kayapo have a special name that means mature old fields. Such fields provide a wide range of useful products, and are especially valuable for their concentrations of medicinal plants. Old fields also attract wildlife to their abundant, low and leafy plants. Intentional dispersal of old fields and

systematic hunting extends human influence over the forest by providing, in effect, large "game farms" near human population centres. The Kayapo do not make a clear distinction between fields and forest, nor between wild and domesticated species. Gathered plants are transplanted into concentrated spots near trails and campsites to produce "forest fields". The sides of trails themselves are planting zones. It is not uncommon to find trails composed of four-meter wide cleared strips of forest.

Rainforest harvest for whom?

Industry and business discovered many years ago that indigenous knowledge means money. In the earliest forms of colonialism, extractive products were the basis for colonial wealth. More recently, pharmaceutical industries have become the major exploiters of traditional medicinal knowledge for major products and profits. The annual world market value for medicines derived from medicinal plants discovered from indigenous peoples is US\$ 43 billion. Although no comparable figures are published for natural insecticides, insect repellents, and plant genetic materials acquired from native peoples, the annual potential for such products is easily that of medicinal plants. Likewise, natural fragrances, dyes, body and hair products are coming to account for major world markets. Growing interest and catapulting markets in "natural" food, medicinal, agricultural, and body products signals increased research activities into traditional knowledge systems. Now, more than ever, the Intellectual Property Rights of native peoples must be protected and just compensation for knowledge guaranteed.

Too much success

Ecologists are justifiably concerned with the ecological impact of production of "natural products" that become too successful. The tendency is always toward monocultures of cash crops. Many worry that international demands may spell the end of biodiversity, rather than encourage conservation of natural resources as initially desired. Provocations of cultural changes can be equally disconcerting. By establishing mechanisms for "just compensation" of native peoples, are we not also establishing mechanisms for destruction of their societies through the subversion of materialism and consumerism? Given current realities, such concerns are reduced to romantic notions. The fact is that indigenous societies and their natural environments are being destroyed by the dramatic expansion of industrialised society now. Native peoples must have the right to choose their own futures. Without economic and cultural independence, such a choice is not possible. The current devastation of native peoples and the ecological systems that they have conserved, managed and intimately known for millennia, require that new and drastic steps be taken to reorient world priorities. All channels and organisations -governmental, non-governmental, professional, commercial- must work together to reverse the current momentum in loss of cultural, ecological and biological diversity of this planet.

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