



COSMOLOGY AS ECOLOGICAL ANALYSIS: A VIEW FROM THE RAIN FOREST*

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Among the Tukano Indians of the Colombian Northwest Amazon, carrying capacity is defined mainly in terms of the conservation of protein resources such as game, fish and certain wild fruits. In order to maintain an equilibrium and to avoid frequent relocation of settlements, the Indians have developed a set of highly adaptive behavioural rules which control population growth, the exploitation of the natural environment, and interpersonal aggression. The belief that the spirits of game animals cause illness restricts overhunting and, similarly, a large body of beliefs that regulate sex and food habits try to adjust the birth-rate and to counterbalance socially disruptive behaviour. Shamanism thus becomes a powerful force in the control and management of natural resources, and hallucinatory visions induced by native narcotic drugs become an important tool of shamanistic power. In many aspects Tukano concepts of cosmology represent a blueprint for ecological adaptation and the Indians' acute awareness of the need for adaptive norms can be compared with modern systems analysis.

I

Until relatively recent times the cultural image of the Indian tribes of tropical America has been that of a group of rather primitive and hostile peoples whose contribution to human thought had been negligible and whose level of social complexity had remained far below that of most aboriginal societies of the Old World. In fact, only the higher civilisations of America—the ancient Mexicans, Mayas and Peruvians—were occasionally credited with having created fairly elaborate social, political and religious institutions, but even in their case seldom has there been explicit discussion of native philosophical systems, or something approaching an integrated world-view. Sometimes one was almost led to believe that the tropical forest Indians were fossil societies; societies which, in a sense, were incomplete; which had not evolved and had nothing to teach us. They were 'out of the mainstream' some people said, and those of us who made these societies the subject of their studies, struggled against the stigma of working somewhat 'out of the mainstream.'

In the more recent past, however, this image has undergone a notable change. Ethnological research among the surviving tribes of the tropical rain forest has begun to reach a depth and breadth of inquiry that were formerly unthought of, and these newly gained insights are beginning to shed an entirely new light upon the intellectual achievements of the aboriginal peoples of the Amazon Basin, the Orinoco Plains and many other regions of the American Tropics, a vast area covering more than six million square kilometres. It seems that the old stereotypes are disappearing at last; and instead we are presented with a new image: the Indian, not

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only as a highly pragmatic thinker and an individual with a sound sense of reality, but also, the Indian as an abstract philosopher, a builder of intricate cosmic models, and a planner of sweeping moral designs. Also at the same period, in view of current interest in natural resources, many scientists and technologists who have turned their attention to the tropical rain forest areas of the world, have become concerned with the many problems of ecological adaptation which traditional societies have had to solve in these environments. In the case of the Amazon Basin it takes a healthy and energetic society to cope with the rigorous climatic conditions and with the management of easily depleted natural resources, a society that would develop not only a set of highly adaptive behavioural rules for survival—framed within effective institutional bodies—but, more important still, a society with a coherent belief system, with a foundation of strongly motivating values which would make endurable the problems of man's existence in an unpredictable world.

In this lecture it is my purpose to describe and examine some aspects of adaptive behaviour as I have been able to observe it in the course of my contacts with several Indian groups in the Colombian lowlands. I should add here that by 'adaptive' I mean anything that increases the probability of survival of the individual or the group. In the following I shall mainly refer to the Tukano Indians of the Northwest Amazon, especially the Desana (Eastern Tukano), and my chief concern will be to trace some connexions that exist between the cosmological concepts of these Indians, and the realities of adaptation to a given physical environment. In doing so I shall try to demonstrate that aboriginal cosmologies and myth structures, together with the ritual behaviour derived from them, represent in all respects a set of ecological principles and that these formulate a system of social and economic rules that have a highly adaptive value in the continuous endeavour to maintain a viable equilibrium between the resources of the environment and the demands of society.

II

The Tukano Indians occupy a large area in the central portion of the northwest Amazon, mainly on the Vaupés River, a major affluent of the Rio Negro. Although most of the country is flat and densely forested, a transitional terrain of hilly uplands lies on the western fringe, while towards the north the forest is sometimes broken by stretches of grassy, tree-strewn savanna country. Although this rain forest area has often been described as a rather homogeneous region, many environmental differences exist which have considerable bearing upon the range and success of human adaptive responses. Game animals, amphibians and reptiles, edible fruits, nuts and insects, and suitable horticultural lands are not evenly distributed and considerable resource fluctuation can be said to exist within and among subregions.

The Tukano are bound to their rain forest habitat by a number of circumstances. In the first place, according to myth and tradition, the land inhabited by them at present was originally peopled by their forefathers in ancient, heroic times, and was handed on to their descendants as a solemn investiture in a perpetual trust. These tribal ancestors whose names and deeds are remembered in myths and genealogical recitals had given proper designations to the rivers and the hills, the rocks and the rapids and to all other notable natural features. This, then, continues to be their

country, the homeland of the ancients. It is of interest to observe here that, although the Tukano habitat can, to a large degree, be described as a truly 'natural environment', they themselves perceive it as a man-made environment, transformed and structured in the past not so much by any exploitative activities of their ancestors, but by having been imbued by them with symbolic meaning. There is, then, a time-perspective to their understanding of the environment.

In the second place, Tukano territory is surrounded by lands occupied by other people, be they tribal Indians or be they Colombian or Brazilian settlers, and both these neighbouring groups are quite unwilling to accept immigrants, much less invaders. The Tukano, then, must of necessity exist within the limitations of their given environment and must make the best of it. They have to rely utterly upon their local resources and upon their own traditional skills for exploiting them.

The traditional settlement pattern consists of widely scattered large and well-built communal houses, occupied by extended families whose members derive much of their basic food supply from cultivating manioc gardens. However, seasonal hunting, fishing and gathering play an important part in their economic and social life. Tukano society is divided into more than twenty named exogamic groups; descent is patrilineal and residence is patrilocal, with cross-cousin marriage said to be preferred. Marriage between these different units implies a rigidly structured relationship which is expressed in many forms of reciprocity and exchange. Most of these activities, both social and economic, are closely connected with ceremonies directed by the shaman who also officiates at the rituals of the life cycle and is active as a healer of illness. Warfare is not institutionalised.

Here is a brief summary of how the Tukano imagine the origin and structure of the universe and the elementary forces that animate it. The creator was the Sun-Father, an anthropomorphic god who designed a three-layered cosmos consisting of a flat earth, a celestial vault, and a place of bliss situated under the earth. He then peopled the land and created animals and plants, giving to each species a set of rules according to which they were to live and multiply. However, the Sun-Father created only a limited number of animals and plants, placing both categories under the constant care of specific spirit-beings who were to guard and protect them against eventual abuses. What is more, he assigned to his creation only a restricted, roughly circular, stretch of land, limited on all sides by permanent landmarks. In other words, the creation of the Tukano universe was not conceived as an all-embracing or expanding system, but was a limited, well-defined proposition with finite and restricted resources. Nor was it accomplished as a single act limited in time: it still continues uninterruptedly because, ever since its initiation, the Sun-Father exercises a fertilising action upon it. It is the energy of the sun, imagined by the Tukano in terms of seminal light and heat, that causes plants to grow and fruit to ripen, that makes mankind and animals reproduce, and that is thought to be creative not only in a germinal, biological sense, but also in the sense of spiritual illumination and the attainment of esoteric wisdom. The essence of this force is imagined as a masculine power that fertilises a feminine element that is this world. In Tukano thought, the biosphere has both male and female aspects, but seen in its totality, it has primarily a feminine character over which the sun exercises his power.

The seminal energy of the sun is thought to constitute a huge circuit in which the

entire cosmos participates. This circuit is imagined as having a limited quantity of procreative energy that flows continuously between man and animal, between society and nature. Since the quantity of energy is restricted, man may remove what he needs only under certain conditions and must convert his quantum of 'borrowed' energy into an essence that can be reincorporated into the circuit. For example, when an animal is killed or when a crop is harvested the energy of the local fauna and flora are thought to be diminished; however, as soon as the game or fruit are converted into nourishment, the energy is conserved, now on the level of society, because the consumers of the food have now acquired a reproductive life force that previously belonged to an animal or plant.

III

The striking point about these ideas is that this bears a remarkable resemblance to modern systems analysis. In terms of ecological theory, the Tukano thus conceive the world as a system in which the amount of energy output is directly related to the amount of input the system receives. According to the Tukano, the system handles these inputs in two ways: sexual energy which has been repressed in the individual, returns directly to the capital of total energy in which the biotic components of the system participates; mere health and well-being, resulting from controlled food consumption, represent an input which energises also the abiotic components of the system, for example, the movements of the stars or meteorological phenomena. The individual should never cause a disturbance in this general equilibrium, that is, he should never use energy without restoring it as soon as possible. The entire system is largely derived from the model of sexual physiology. The Tukano concept of solar energy includes a large number of things to which a seminal symbolism is attributed because of their colour, shape, texture or other characteristics; while a number of other things are associated with a female concept of fecundity and gestation. The associations of images and symbols are interpreted by the Tukano on various levels of abstraction and eventually dissociate themselves farther and farther from natural and physiological facts until, at a higher cognitive level, they come to constitute a systems theory of balanced, finite energy flow.

This cosmological model of a system which constantly requires rebalancing in the form of inputs of energy retrieved by individual effort, constitutes a religious proposition which is intimately connected with the social and economic organisation of the group. In this way, the general balance of energy flow becomes a religious objective in which native ecological concepts play a dominant organisational role. To understand the structure and functioning of the ecosystem becomes therefore a vital task to the Tukano. It follows that the Indian's ethnobiological knowledge of the natural environment is not casual and is not something he assimilates through gradually increasing familiarity and repeated sense experience; it is a structured, disciplined knowledge which is based upon a long tradition of enquiry and which is acquired of necessity as part of his intellectual equipment for biological and cultural survival.

Among the Indians there is usually little interest in new knowledge that might be used for exploiting the environment more effectively and there is little concern for

maximising short-term gains or for obtaining more food or raw-materials than are usually needed. But there is always a great deal of interest in accumulating more practical knowledge about biological reality and, above all, about what the physical world requires from man. This knowledge, the Indians believe, is essential for survival because man must bring himself into conformity with nature if he wishes to exist as part of nature's unity, and must fit his demands to nature's availabilities.

Animal behaviour is of greatest interest to the Indians because it often constitutes a model for what is possible in terms of successful adaptation. On the one hand, the Indians have a detailed knowledge of such aspects as seasonal variation and microdistributions of the animal and plant species of their habitat. They have a good understanding of ecological communities, of the behaviour of social insects, of bird flocks, the organisation of fish schools, the patterns of fish runs, and other forms of collective behaviour. Such phenomena as parasitism, symbiosis, commensalism and other relationships between co-occurring species have been well observed by them and are pointed out as possible models of adaptation. On the other hand, myths and legends abound with accounts of visits to the animal world, of people turning into animals in order to learn more about their habits, or of animals teaching men how to make use of certain resources. Shamanistic wisdom often contains detailed descriptions of such contacts and exchanges, and many shamans claim to have acquired part of their specific knowledge from animals which revealed to them some unexpected food resource, a cure for an illness, or a practical procedure in solving some everyday problem. Some of this wisdom may then be considered esoteric and secret, remaining the private property of a shaman, but often enough this specialised knowledge of animal behaviour becomes part of prescribed patterns of human action and interaction because of its obvious adaptive value. Moreover, mythology emphatically tells of animal species which have become extinct or which were punished or degraded for not obeying certain prescribed rules of adaptive significance. Thus, gluttony, improvidence, aggressiveness and all forms of overindulgence are punished by the superior forces, to serve as examples not only to the animal community, but also to human society. Animals, then, are metaphors for survival. By analysing animal behaviour the Indians try to discover an order in the physical world, a world-order to which human activities can then be adjusted.

In Tukano culture, the individual person is conscious that he forms part of a complex network of interactions which include not only society but the entire universe. Within this context of an essential interrelatedness of all things, a person has a manifold many functions that go far beyond his or her social roles and that are extra-social extensions of a set of adaptive norms. These rules or norms, then, guide a person's relationships not only with other people—past or present, kin or ally—but also with animals, plants, as a matter of fact with all biotic and non-biotic components of the environment. The rules the individual has to follow refer, above all, to cooperative behaviour aimed at the conservation of ecological balance as the ultimately desirable quality. Thus the relationship between man and his environment is being formulated not only on a cognitive level, but clearly it also constitutes an affective personal relationship in which individual animals and plants are treated with respect and caution.

The Tukano are quite aware of the fact that, in order to maintain a stable balance

of input and output, a number of regulatory mechanisms have to be instituted and, what is more, have to be fully respected by all members of the society. These social controls of necessity possess marked adaptive implications and must be enforced primarily in those aspects of existence which, to a large degree, determine survival. I shall mention here: population growth, the exploitation of the physical environment, and aggression in interpersonal relations. It is quite clear to the Tukano that, in order to ensure individual and collective survival and well-being, adaptive rules have to be established to adjust the birth-rate, the harvest-rate, and to counter-balance all socially disruptive behaviour.

IV

I shall first turn to the problem of population growth and regulations. Two mechanisms are used by the Indians to control the birth-rate: oral contraceptive and sexual continence. Tukano women use herbal concoctions which, in varying concentrations, cause temporary sterility, and by this means they manage to space their offspring over several years in such a way that when a woman has her second child the first is already sufficiently independent not to be a bother. The number of children is kept low and couples with many children are criticised quite openly as socially irresponsible. It may be added here that the old and infirm, as soon as they cease to collaborate in the food quest of their household group, are eliminated by being abandoned in the forest or on an island in the river.

The second mechanism is abstention. Sexual abstinence and sexual repression are practised on many occasions and are among the most important prerequisites to many ritual activities. It is important to point out here that, in Tukano thought, food and sex are closely related and are symbolically equivalent. This idea of relationship between caloric and sexual appetite is expressed in many ways; on a metaphorical level sexual intercourse and eating are equated, and in ritual exchange certain foodstuffs come to represent the exchange of women. Since strict exogamic rules constitute the main organising principle in Tukano society, the consumption or avoidance of certain foods are geared to the concept of exogamy in such a way that dietary restrictions come to stand for sexual restrictions. The selective use of certain foods may thus be said to be subject to the laws of *exophagy*, which determine the permissibility of certain foods under diverse circumstances. There are 'male' and 'female' foods and food preparations, and these rules refer not only to animal-derived foods, but also to vegetable foods.

These aspects are best illustrated by the ideas that guide the activities of the hunter. All game animals are subject to the Master of Animals, a dwarf-like spirit-being with marked phallic attributes. This supernatural gamekeeper jealously guards his flock consisting of deer, tapir, peccary, agouti, paca, monkeys and all other animal species that are a common food resource of the Indians. The Master of Animals is directly their protector and procreator and they all live inside steep rocky hills or in deep pools in the river, both dwelling-places being imagined as large store-houses teeming with game and fish. In order to obtain the supernatural Master's permission to kill a game animal, the prospective hunter must undergo a rigorous preparation which consists of sexual continence, food restrictions, and purification rites ensuring cleansing the body by bathing and emetics. For some days before

going on a hunting excursion, the man should refrain from all sexual relations and, what is more, he should not have had any dreams with an erotic content. Moreover, it is necessary that none of the women who live in his household is menstruating. Another mechanism that restricts overhunting is this: According to cosmological myths all game animals are associated with certain constellations, as defined by the Tukano. However, a species can only be hunted after its constellation has risen over the horizon, and it is said that the animals cry and weep with fear when they realise that their time is approaching. It may be mentioned here also that the hunt itself is more than a mere food quest in that it is imagined as a courtship in which the prey has to be seduced to submit to the hunter.

Whenever game is scarce, the shaman must visit the Master of Animals in a narcotic trance and try to obtain from him the release of some of his charges. He will not ask for individual animals but rather for herds or for a good hunting season and in return he promises to send to the Master's abode the souls of persons who, at their death, must return to this great store-house to replenish the energy of those animals the supernatural gamekeeper gives to the hunters. The Master of Animals and his numerous personifications are thus conceived as administrators of usufruct rights; since game resources are limited, restrictive rights to their use are instituted by these spirit-beings, and it falls to the shaman to become the mediator.

From the examples I have mentioned it is obvious that the combination of all these prerequisites represents in itself a body of highly adaptive rules which notably restrict the activities of any hunter or fisherman. A person cannot go hunting or fishing simply any time he needs food, but only after having undergone a more or less anxiety-charged period of preparation, the purpose of which is to avoid overhunting. Illness or misfortune in hunting are almost always attributed to neglect of any of the numerous rules a hunter has to observe.

Food restrictions are not only observed in connexion with economic activities, but are a standard practice on most ritual occasions and in many other everyday circumstances. For example, a man whose wife is expecting a child should eat neither tapir, peccary nor monkey meat because this might affect the good health of his yet unborn offspring. A man whose hunting or fishing gear has become polluted from being casually touched by a woman, must observe a liquid diet for several days. When fish run to spawn, those present in one's stretch of the river should not be eaten, nor are birds' eggs ever collected for food, and the flesh of some reptiles is avoided during their breeding season. All these interdictions are verbalised by the Indians in terms of dangers to the consumer's health. Especially strict prohibitions keep people from eating normally while engaged in the acquisition of esoteric knowledge and, similarly, all rituals of the individual life cycle involve temporary dietary restrictions. In summary, during pregnancy, childbirth and menstruation; during mourning periods, or while gathering medicinal herbs; during the couvade or while engaged upon the preparation of poisons, narcotics or love potions, people carefully control their food intake and, as a general rule, refrain from eating the meat of game animals.

Similar prohibitions restrict the gathering of wild fruits and nuts, of honey and of edible insects. Even the extraction of raw-materials used in technological manufactures is controlled by ritual restrictions. The gathering of thatch for a roof, of clay for pottery making, or of scarce woods or fibres for a number of specific end

products, are subject to permits which have to be obtained from the spirit-owners of the respective resources.

This complex of dietary and sexual restrictions is closely related to the control of aggressive attitudes. The principal mechanism which checks socially disruptive behaviour is the organisation into exogamic groups which are linked by alliances and stand in a relationship of reciprocal exchange. Besides exchanging women, these complementary units will give and receive foods, raw-materials or manufactured goods, and on these periodic occasions which constitute highly formalised rituals, the dances, songs and ceremonial dialogues emphasise over and over again the paired linkages that unite Tukano society.

It appears from the foregoing that the Tukano definition of what constitutes carrying capacity, refers mainly to a certain balance of protein-rich food resources such as game, fish and wild fruits. Environmental degradation is interpreted *not* in terms of soil exhaustion, but in terms of the eventual depletion of game and of increased walking time. Because of the relative scarcity of protein resources restrictive rights to their use have to be established in order to avoid frequent relocation of settlements. Propitious conditions for horticultural activities are perhaps not plentiful, but land for productive garden plots *is* available. However, the nutrient content of practically all vegetable foods of the rain forest is very low and carrying capacity is therefore determined by the existence of protein resources, and population size and density are functions thereof.

The three aspects I have mentioned—population growth, the exploitation of the physical environment and the control of aggression—can be reduced to one single problem, that is, the maintenance of a balanced ecosystem. The Indians know that their daily existence depends upon the proper functioning of these adaptive interactions. The question arises, how can a people be made to follow these prescriptions and regulations which impose such severe restrictions upon their social behaviour and their biological needs?

V

The mechanisms which, in the native groups I am concerned with here, enforce the rules are closely related to the aboriginal theory of disease. To begin with, the specific bodily or mental conditions which, according to the Tukano, constitute illness and which manifest themselves through a large number of signs and symptoms, are always thought to be caused by an agent external to the body. The possible pathogenic agencies fall into three categories (1) the revenge of game animals; (2) the ill-will of other people, and (3) the malevolence of supernatural beings such as the Master of Animals or other spirit-beings.

This malevolence of people and animals is not an arbitrary force that blindly strikes its unsuspecting victim. On the contrary, illness is always interpreted as a quite natural consequence of a person's breach or neglect of cultural norms. Apart from its being socially and emotionally disturbing, illness is, in the Tukano view, nothing but a reaction to the ecologically inadequate behaviour of the patient, to his maladaptive performance. It is the patient who causes the disease, by making himself vulnerable to it. The diagnosis the shaman establishes has, therefore, two different aspects: One refers to the patient's complaints, to the symptoms he has developed; the other aspect refers to the question *why* the person became a victim of

the disease. And here we can recognise another important aspect of the shaman's function, an aspect that is closely related to the problem of ecological adaptation.

In shamanistic practice illness is taken to be the consequence of a person's upsetting a certain aspect of the ecological balance. Overhunting is a common cause and so are harvesting activities in which some relatively scarce natural resource has been wasted. The delicate balance existing within the natural environment, between nature and society, and within society itself, constitutes a series of systems in which any disturbance, however slight, is bound to affect the whole. For example, meddling with certain women who should be avoided is the same kind of affront as eating certain fish that should not be eaten; while killing too many animals of a certain species must always be avoided. These are offences the consequence of which is likely to be an illness. In the diagnostic process, which is often accompanied by divinatory practices, the shaman is interested in the patient's illness not so much as a function of biology, but rather as a symptom of a disorder in the energy flow. His main concern is about the relationship between society and the supernatural Masters of game, fish and wild fruits, on whom depend success in harvesting and who command many pathogenic agents. To the shaman it is therefore of the essence to diagnose correctly the causes of the illness, to identify the exact quality of the inadequate relationship (be it adultery, overhunting, or any other over-indulgence or waste), and then to redress the balance by communicating with the spirits and by establishing reconciliatory contacts with the game animals. To mention just one example of how a diagnosis is established: A man who has killed too many animals of a certain species, will appear in the shaman's dream or trance states in the shape of that animal and the image will be accompanied by a certain luminosity, a certain degree of light. It is quite remarkable that differences in high or low light intensity are recognised to be very important in the flow of solar energy, as understood by the Tukano, and that shamans will mention in their spells and incantations up to seven shades of 'yellow light' that energise the biosphere.

In summarising this aspect I want to emphasise that the shaman as a healer of illness does not so much interfere on the individual level, but operates on the level of those supra-individual structures that have been disturbed by the person. To be effective, he has to apply his treatment to the disturbed part of the ecosystem. It might be said then that a Tukano shaman does not have individual patients; his task is to cure a social malfunctioning. The diseased organism of the patient is secondary in importance and will be treated eventually, both empirically and ritually, but what really counts is the re-establishment of the rules that will avoid overhunting, the depletion of certain plant resources, and unchecked population increase. The shaman becomes thus a truly powerful force in the control and management of resources.

The shaman then interferes quite directly with hunting, fishing, gathering and most other harvesting activities. For example, a shaman will personally control the quantity and concentration of fish-poison to be used on a certain stretch of river; he will determine the number of animals to be killed when a herd of peccary is reported, and he will decide on a suitable harvesting strategy for the gathering of wild fruits. He will determine *which* fish have to be thrown back into the water after a haul has been made, and occasionally he even might completely prohibit the killing of certain animals in a restricted area of the forest. He will also control such techno-

logical activities as the construction of a communal house, the manufacture of a canoe, or the opening of a trail. All these activities obviously affect the natural environment since trees have to be felled and many plants have to be destroyed or used in the process, and the shaman's role as a protector of game and plant-life explains why animals and plants figure so prominently as his spirit-helpers. All this, I should like to point out here, is not speculation; the Indians are quite explicit in these matters and explain that the spirit-owners of nature must not be angered and that it is the shaman's task to reconcile them.

The very large denotative vocabulary of a shaman expresses his great concern with establishing the complete inventory of the ecosystem. In order to be able to administer this great store-house, he has to know, name and categorise all its contents. This knowledge eventually provides him with the criteria for ecological planning and this, of course, is problem-solving by anticipation. The fact that many daily activities such as hunting, fishing, gathering, the clearing of a new field or the curing of a disease are subject to divinatory practices in order to locate the most propitious spot or time, or to find the most effective procedure in coping with this or that predicament, gives the shaman ample opportunity to protect wild-life by random scheduling of hunting excursions whenever he thinks that a certain species is endangered, or to channel any other exploitative activity in directions he believes to be best. I know of several cases where shamans initiated limited migratory movements by asking people to abandon their homes in order to avoid an approaching epidemic or the presence of evil spirits, both calamities being revealed in divinatory trance. The true reason, however, seems to have been the advanced depletion of protein resources. In view of the observation of a number of related cases, it seems not unlikely that shamanistic divinatory practices operate with models and that, in this manner, many adaptive changes are being introduced by shamans.

One might ask here: how far is a shaman actually conscious of his role as an ecological broker? Does he always act quite rationally and with an adequate understanding of ecological principles?

There exist, of course, differences. Some shamans, notably the younger and less experienced ones, tend to verbalise their conceptions in quite simplistic terms by saying that overhunting and overharvesting are bound to annoy both the spirits and the game animals, and that illness will be the punishment. They will readily point out changes in prey abundance and will attribute the biotic impoverishment of certain restricted areas to the action of vengeful spirits. Others however will not make use of these mystical interpretations but will blame greed and ignorance for the depletion of protein resources. They will attribute some (if not all) diseases to nutritional deficiencies and will state quite plainly that protein resources are scarce and have to be protected.

To be sure, the fact that most economic activities are accompanied by rituals does not mean that the shaman simply asks the supernatural forces for abundance, for plenty, for a maximum amount of what the environment can produce, but rather that occasions are being provided for stock-taking, for weighing costs and benefits, and for the eventual re-distribution of resources. At these moments the shaman's book-keeping shows the general system inputs and outputs. In point of fact, most shamanistic activities such as curing rituals, rain-making, the periodic reaffirmation of alliances or food exchange between exogamic groups might be

viewed as rituals concerned with resource management and ecological balance. This fact has sometimes been obscured by a tendency to describe native shamans in terms of mere witchdoctors or religious fanatics.

VI

The Tukano and many other Colombian tribes believe that the entire universe is steadily deteriorating. Thus it is thought that formerly people were healthier, stronger and more intelligent than they are at present; that animals and fruits were larger and that they were more abundant than now. The Indians will point out stretches of forest, rivers or lagoons saying that in former times animal life was plentiful there. It is true that, at present, this feeling of impending doom is partly justified; in many parts the world of the rain forest Indians is on the wane. But the Indian's sense of entropy, of the tendency toward disorder and chaos, does not seem to be a consequence of his present plight, but rather represents an existential anxiety that forms part of native cosmology and philosophy, and that is based upon the close and daily observation of the biological cycles of growth and decline. The important point is that this idea of increasing disorder is always followed by the institutionalised resolution to *recreate* the world and to re-establish its order and purpose as stated in cosmological tradition. This continuous cycle of ritual creation, destruction and re-creation can be found in many tropical forest societies and is indeed an important mechanism of cultural and biological survival.

In the course of these ceremonial occasions, when the universe and all its components are being renewed, one goal becomes of central importance: the reaffirmation of links with past and future generations, together with the expression of concern about the future well-being of society. The emphasis of the ritual is upon unifying the social group, upon continuity, upon the close bonds of identity that unite society with the past and make it the foundation of the future. It seems that this sense of union provides deeply motivating values and strong incentives for ecological responsibility. The lengthy genealogical recitals and the ritual dialogues have a powerful cohesive function, and in many of these rituals animal and plant-spirits are thought to participate, expressing by their presence their interrelatedness and interdependency. It must be pointed out here that the ritual re-creation of the universe is generally accompanied by the collective use of narcotics of plant origin. During these drug-induced trance states, or other forms of dissociate phenomena, the participants establish contact with the mythical past, in fact, they see themselves return to the time of divine Creation and thus take part in it. It is clear that, here again, the officiating shaman can adaptively orient the interpretations of the visions people project upon the vivid background of their hallucinations.

During most or all of these rituals which can be said to be essentially concerned with ecological balance, the recital of myths and genealogies is of great importance. These myths explain man's nature and trace man's destiny from birth and infancy through maturity to decline and death; from the sin of incest to chaos and near-destruction, and hence to a new order and the establishment of law. These myths and tales, I should like to emphasise here, are not mere 'literature'; they represent a truly remarkable effort at intellectual interpretation, at providing a cognitive matrix for life. They are a guide for survival because they establish rules of conduct.

not only for ritual occasions but for everyday life; a fact which sometimes goes unnoticed as long as one has not discovered the metaphorical code in which the myths are transmitted.

The cosmological myths which express the Tukano world-view do not describe Man's Place in Nature in terms of dominion, of mastery over a subordinate environment, nor do they in any way express the notion of what some of us might call a sense of 'harmony with nature.' Nature, in their view, is not a physical entity apart from man and, therefore, he cannot confront it or oppose it or harmonise with it as a separate entity. Occasionally man can unbalance it by his personal malfunctioning as a component, but he never stands apart from it. Man is taken to be a part of a set of supra-individual systems which—be they biological or cultural—transcend our individual lives and within which survival and the maintenance of a certain quality of life are possible only if all other life forms too are allowed to evolve according to their specific needs, as stated in cosmological myths and traditions.

In closing, I should like to note the following. Until quite recently ethnologists and archaeologists have attempted to explain cultural evolution and change in terms of linear cause-and-effect models and this approach is still used by most specialists in these fields. Gregory Bateson was the first ethnographer to sense the need for a systems theory model to account for his ethnographical data, although his now classic monograph on New Guinea was written long before the formal aspects of systems theory had been developed.

Archaeologists have been particularly prone to dependence on cause-and-effect explanations and models constructed on the principles of linear causality, and these trends have been emphasised in the intellectual movement called 'New Archaeology'. It is only recently that Flannery has noted that two very different kinds of explanatory models are used by the 'New Archaeology.' One of these schools is explicit in its adherence to linear causality. Flannery has applied the term 'law-and-order' archaeology to this school. The other less popular trend has been an application of systems theory to account for cultural change, attributing its dynamics to very slow deviations which originate in a part of the system and then develop into major modifications. It seems that this approach is far more likely to produce significant models than is 'law-and-order' archaeology.

It is striking then that in the last decade ethnographers and archaeologists are coming to accept as the only kind of explanatory model which can be used to handle ecological relationships the kind of overall systems model which was adopted by 'primitive' Indians a very long time ago.

NOTES

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