

ADAPTATION TO ARID ENVIRONMENT: A COMPARATIVE STUDY OF HUNTER-GATHERERS AND PASTORALISTS IN AFRICA

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ABSTRACT

The author compares two modes of living in African continent, hunting-gathering and pastoralism, and discusses man's adaptation to arid environment. First, the author deals with the San, hunter-gatherers of the Kalahari, and the Rendille, camel pastoralists of arid area in northern Kenya, describing the characteristics of their environments, livelihood, and societies. Secondly, he compares them with other hunter-gatherers, pastoralists, and agriculturalists inhabiting less arid habitat, and points out that pastoralism is suited to drier environment, agriculture to wetter environment, and that hunting-gathering is widely adaptive to both. Through further examination of the land and resource utilization, material culture, demographic features, and social organizations of the San and the Rendille, he concludes that the extensive land utilization accompanied by frequent migration—common to both peoples—should be interpreted as an adaptation to arid environment, and that their quantitatively limited material culture, elaborate demographic regulation, and flexible social structure are remarkable characteristics of the societies in arid regions.

INTRODUCTION

The African continent comprises various vegetation zones formed according to the degree of humidity, i.e. tropical rain forest or montane forest in wet regions and savanna-woodland or desert in dry regions. There are various types of human lifestyles corresponding to these variations of the natural environment. These include all types of basic human subsistence patterns, hunting-gathering-fishing, agriculture and pastoralism, most of which are organized in close connection with nature.

Most cases of even agriculture or pastoralism which accompany food production methods have an intimate relationship with nature, to say nothing of the case of the hunting-gathering-fishing way of life which uses natural resources directly.

Ecological anthropology aims to understand such diverse human lives related directly and profoundly to nature as a whole, and the group organization which sustains human lives themselves. This study, on one hand, takes a synchronic point of view by describing details of life and society and then by understanding the realities of human adaptations and variations, but, at the same time, it takes a diachronic point of view by analysing the life forms and social organizations of various human groups comparatively to trace human socio-cultural evolution.

The author has conducted field research on the San, hunter-gatherers of the Kalahari Desert, since 1966, and on the Rendille and Pokot, pastoralists of the arid area in northern Kenya, since 1975. In this paper, he attempts to compare the two distinctive lifestyles of hunting-

gathering and pastoralism, and to clarify the characteristics of their adaptations to an arid environment. He deals mainly with the San and Rendille, as examples of each type of lifestyle in the driest regions. An outline of the life and society of the two peoples is described, and the features of these two different lifestyles are discussed from the point of view of the adaptation to aridity.

The ethnographic materials used in this paper are based mainly on the author's own field work but part of the data on the Rendille is borrowed from S. Sato (1978, 1980).

THE SAN

1. Environment of the habitat

The Kalahari in which the San live is located in the ecotone between the Tropic of Capricorn desert and the savanna. Since the Kalahari is situated on an inland plateau some 1,100 m above sea level, it has a continental climate with scant rainfall and great variations in temperature. The summer midday heat tops 40°C even in the shade, while in winter the strong cold winds blow in from the Antarctic Ocean, sending temperature down close to -10°C. Even in a day, the difference in maximum and minimum temperature reaches 15 to 30 degrees. As in most other areas of the continent, a year is divided into two seasons, the long dry season and the short rainy season.

The Kade area of the Central Kalahari in which the author conducted research is divided into the following three vegetation zones:

- (i) The open scrub plain, populated chiefly by grasses of the family Graminae, with a mixture of such shrubs as Grewia, Terminalia, Commiphora.
- (ii) The acacia woodland, mainly composed of the genera Acacia and Albizia, with sparsely scattered tall trees.
- (iii) The Caesalpiniaceae plain, consisting of distinct communities of two species of the genera Bauhinia and Tylosema. They are B. petersiana (a shrub) and T. esculentum (a creeper), the two species of the family Caesalpiniaceae.

These three vegetation zones constitute the Kalahari Desert; the largest area is the open scrub plain.

In certain places in the Kalahari, fissures in limestone outcroppings catch and hold water, or an underground vein of water comes close to the surface, so that natural springs and pools are made available. However, no such permanent sources occur in the author's research area. Water pools are formed for a few days only after heavy downpours during the short rainy season, and people can obtain water for 30 to 60 days in a year. The rest of the time, they obtain necessary moisture mainly from the fruits or roots of wild plants.

The Kalahari appears to be barren at first glance, but it supports the distribution of an adequate quantity of plants and animals to sustain people's diet.

2. Life

Of the approximately 60,000 estimated present population of the San, only a few thousand are entirely dependent on hunting-gathering. The division of labor by sex is seen in their subsistence activity; hunting is done by men and gathering by women. Hunting, particularly, is monopolized by the male members.

Over 50 species of animals, primarily mammals and birds, are hunted. Representative hunting methods include shooting large game with bow and arrow, catching small antelopes in a snare, and hunting the springhare

with a hooked pole. The San may also hunt with spears, with the help of dogs, or they may run after small animals and catch them by hand.

The San collect over 80 species of plants. The edible parts include fruits and seeds such as melon, berry and nut, leaf, flower, stalk, root and bulb.

Although the San eat many different kinds of plants and animals, a closer analysis of their diet reveals the fact that they intensively utilize only parts of many items. A comparison of the relative amounts of plant and animal food in their diet reveals that the ratio of plant food is overwhelmingly large, 80 % of the total diet.

Hunting is primarily an unreliable subsistence mode, i.e., the density of game is relatively low, their hunting implements are primitive, and a great deal of practice and labor are necessary. Plant gathering is a far more reliable mode of subsistence because the necessary amounts of food are obtained by comparatively easy work. Thus, vegetable food is the base of their diet.

Moreover, it should be noticed that the San maintain their livelihood by intensive utilization of only about ten species out of eighty edible plants. They will not touch undesirable food unless very hungry. Even the staple food species are so abundant in normal years that most are not touched and rot away by the end of the season. The way of life in which natural resources are used directly by gathering and hunting is thus sustained by a superabundance of staple foods.

Another indispensable condition for the life of hunting-gathering peoples is migration. To live on wild plants, people have to move from place to place in accordance with the seasonal changes and distribution of staple food species. The regional group of about 200 in the study area, #Kade, lives in a range with a radius of 50 km. They move approximately 300 km in total a year, changing campsites every one to six weeks. Migration is one of the basic elements of the hunter-gatherer lifestyle in relation to food obtaining activity, but, on the other hand, it has sociological significance as explained in a later section. Frequent migration is also a factor determining the framework of their material culture. For example, dwellings are simple grass hut made for temporal use, and household possessions are limited to the amount which can be transported on their backs in one trip.

3. Society

The social unit of a hunting and gathering people is generally a nomadic residential group of from ten to twenty families. The author has already pointed out that nomadism is an indispensable feature of the hunting-gathering lifestyle. In addition, however, coupled with a mode of subsistence which relies entirely on limited natural resources, nomadism is a major factor limiting the size of the society itself. The flexible membership of the San residential group consists of a single family to over 100 persons, according to seasonal or other conditions.

San society has no highly developed organizations, such as lineages, clans or tribes, which unite the whole society. Social integration is maintained by the extremely loose ties among kinsmen. Social groupings are not fixed but flexible, with frequent fission and fusion in the process of migration. The family, which is the smallest social unit, is the only permanent unit in their society. With marriage and the age division between providers and dependents, the family is the smallest and most fundamental unit in San society, as well as the unit of self-sufficiency.

A general principle permeating San society is egalitarianism. There is no leader or occupational differentiation and no concept of rank or status. As a rule, each individual can accomplish everything necessary for his or her livelihood. Egalitarianism is realized in the shape of sharing

and cooperating behavior in social life. Although hunting is primarily an individual activity for the San, big game hunting necessitates the close cooperation of several men for pursuit, dismantlement and transportation.

While every item of their limited belongings is shared, food is the most frequently shared and its distribution is the most crucial. Food sharing is one of the important social institutions which mutually ensure existence for those who live from hand to mouth in such a harsh environment as the Kalahari. Because the nomadic lifestyle under such conditions limits the total weight of the material culture, principles of reciprocal exchange such as sharing, lending and borrowing have been established as the basis of society.

THE RENDILLE

1. Environment of the Habitat

Most of northern Kenya, located between the Equator and 4°N, is situated on the lowland plain from 400 m to 600 m above sea level and is semi-desert. Annual rainfall is below 250 mm. The Rendille are the camel herders living in the semi-desert plain extending south-eastward of Lake Turkana. Their habitat is adjacent to the lowland semi-desert areas of the Turkana to the west, the Gabra to the north, the Boran and Somali to the east, and the hill ranges which the Samburu inhabit to the south.

Annual rainfall reaches approximately 500 mm in hill ranges, but less than 100 mm in the lowlands. Temperatures in the lowlands where the Rendille spend the most time are high, 22°C - 39°C. Humidity is extremely low.

The vegetation is very poor; trees and shrubs adaptive to dry climates, such as genera Acacia, Commiphora, Sericomopsis, Duosperma, Blepharis, Indigofera, etc., are sparse, and the grasses of Graminae and the like are extremely rare.

The population density of wild animals is so low under these harsh environmental conditions that the inhabitants can not live by hunting. Because of climatic conditions and infertile soil, agriculture is, of course, impossible. Scarce grasses and thorn bushes, which man can not consume directly, are fed to livestock and transformed into foods suitable for human consumption. This way of life based on animal husbandry is the only means of subsistence for peoples living in such a dry area.

2. Livestock

The Rendille with a population of 20,000, lead a nomadic life by herding camels, goats, sheep and cattle in a vast semi-desert area of 50,000 km². The camel is the most important animal they keep, and the management of camel herding plays a central part in their economic and social life. The milk and meat of the camel form the bulk of their diet, and the use of the camel as a means of transportation enables them to move far from water place possible. The camel is surprisingly well adapted to the arid environment. It can live on a simple diet of thorn bush and rough grass, components of poor desert vegetation, and, moreover, it can tolerate the lack of moisture and high temperatures with its specific physiological mechanisms. Consequently, while cattle must be watered at least once every 2 - 3 days and even goats and sheep, which tolerate aridity comparatively well, every 4 - 5 days, watering every ten days is sufficient for the camel.

The Rendille keep goats, sheep and cattle in addition to camels. The Rendille herd only a small number of cattle, in the surrounding hills, because they require water and good pasture and can barely survive in the dry lowland plains.

The Rendille depend chiefly on herding camels, as well as goats and sheep. While camels are taken care of mainly by young men, goats and sheep are cared for collectively by unmarried women. According to Sato (1980), each Rendille family owns 15 camels and 46 small stock on the average.

Camels are far less efficient than cattle as domesticated animals, if one considers the balance between the amount of work invested on herding management and the production of milk and meat. Since cattle become sexually mature faster and start to reproduce earlier, and have a shorter gestation period than camels, their reproduction rate is twice as fast. Again, cattle are rather easily managed because they are, in general, resistant to diseases, obedient and less mobile.

The Rendille make a livelihood chiefly by herding camels because their habitat is so dry and access to water is so difficult. Only the camel, an animal surprisingly well adapted to dryness, is able to exist in such a barren land. Man is also able to survive in this environment by utilizing and even depending entirely on the camel.

Camels can be herded in wide ranges over fifty kilometers from a waterhole, because they are mobile and need infrequent watering. In comparison, goats and sheep must be herded comparatively close to the water place. These animals have different food habits according to species; camels are browsers, sheep are grazers, and the goat lies between the two. The Rendille maximally exploit the limited resources of the poorly vegetated land, by keeping several animal species that vary in mobility, tolerance to aridity, and food habits.

The Rendille diet is mainly dependent upon animal products such as milk, meat and blood. Milk is the most important item, supplied primarily by camels and secondarily by small stock. Camels are not usually slaughtered for meat, but for ritual purposes or because of fatal wounds or sickness. Goats and sheep, which have a reproduction rate four times higher than camels, and grow fast, are the chief sources of meat.

3. Life and Society

Unlike San society, Rendille society has lineage and clan systems and tribal integration. The society also has age-set and age-grade systems. Class differentiation is established according to age-set groups, for example, elders, unmarried youths and boys have distinctly different social statuses.

The main subsistence activities, including herding camels, are left to young men. Elders, on the other hand, play an important role in social aspects, such as maintaining settlements, determining the timing and place of migration, governing social events or ritual ceremonies, etc.. The elders are responsible for the management of stock raising.

Rendille society is organized by a patrilineal clan system, and residential groups are composed on the basis of this system. The inheritance of property, including livestock, is made along the male line, from father to son or from elder brother to younger brother. Many aspects of daily life are conspicuously male oriented. The Residential pattern of the Rendille comprises a kind of dual organization in which the living spaces of people and livestock are separated. Settlements are usually established in the vicinity of a waterhole. The group is composed of a comparatively stable membership of married men and women, and small children, and plays a central part in the Rendille social life. Migration is repeated every two or three months. Except for a short period in the rainy season when there are enough plants, only a small number of animals for milking and transportation are kept in the settlement.

The greater part of their livestock are herded in places remote from the settlement because the area in the vicinity of the waterhole can not

support a large number of livestock. Each livestock species is classified into groups according to species, age, developmental stage, physiological condition, locomotion pattern, or the purpose of human usage, and is herded by the group of unmarried men and women. Camels are herded as a large group far from the settlement, taking advantage of their physiological features mentioned earlier. According to Sato (1980), camels are herded sometimes at distances of 100 km or 200 km from the settlement, averaging 70 km. Goats and sheep are herded mainly by girls comparatively close to the waterhole because they need water every 3-4 days and their mobility is low. Rendille pasturage, regardless of camels or goats and sheep, consists of a day trip herding from the temporary camp which is shifted every three or four days.

Compared to the settlement, which functions as a center for the elders' socio-political activities, the livestock camp is the field of subsistence activity that supports the economic basis of Rendille society. To sustain a settlement, a constant number of milking animals is necessary, so people must continually exchange animals between the settlement and the camp; e.g. send an animal that has ceased milking to the camp, and bring a milch one instead. Thus, people frequently travel between the two residences to exchange animals and to communicate. Furthermore, camp members repeat fission and fusion in the process of frequent migration in a wide range, particularly when both people and animals concentrate at the waterhole. Sato (1980) reported that such fission and fusion of the camp is determined by sociological factors based on human relations in and between camps, as well as by ecological factors such as the distribution of food for the animals.

It can be said that Rendille society is primarily regulated by the camel and its management, on which they base their economy. Physiological and ecological characteristics peculiar to the camel lead to a large scale nomadic lifestyle accompanying a dual structure of residence. Moreover, the low reproduction rate of the animal affects profoundly various aspects of Rendille society. For example, population control by a late marriage system, which is unique in this society, and the strict inheritance system of animals by the eldest son.

HUNTING-GATHERING, AGRICULTURE AND PASTORALISM

In the preceding two sections, the author outlined examples of hunter-gatherers and pastoralists living in the driest regions of Africa. In the following sections, he intends to clarify the features of their adaptation to aridity in comparison with other African peoples, especially hunter-gatherers and pastoralists in less dry regions. He will also consider the significance of the development of social organization after the acquisition of means of food production by clarifying the difference between the socio-ecological adaptations of hunter-gatherers and pastoralists.

As mentioned in the beginning of the paper, Africa contains various natural environments from dry to wet, and various human lifestyles corresponding to the respective environments. The biggest area in the African continent is the savanna-woodland zone, which has little rain. Therefore, the most common way of life in Africa is agriculture accompanied by animal husbandry, utilizing the nature of the vast savanna-woodland zone as a resource. The savanna-woodland zone changes gradually into rain forest zone and into desert zone and according to these transitions of vegetation, lifestyles also change gradually. Wetter climates favor agriculture, while, drier climates are better for pastoralism.

Pastoralism is not suitable in the forest where there are many diseases, such as trypanosomiasis, affecting livestock. Since nomadic pastoralism based on wild plants resistant to dryness is possible even in very dry desert zones, it is an extremely adaptive mode of subsistence in arid land. Agriculture, on the other hand, is not feasible in areas not receiving more than a certain amount of rainfall, because moisture is necessary for the growth of cultivated plants.

Present hunting and gathering peoples in Africa are the San of the Kalahari, the Pygmies of the Ituri Forest, the Hadza of Tanzanian savanna, the Ndorobo of Kenya and the Bambote of Zaire. While the San and Pygmies still have considerably large populations, the rest remain in small numbers. Although these peoples are limited in number, detailed examination of their habitat environment reveals that they are distributed over diverse vegetation zones, from wet tropical rain forest and montane forest to dry woodland, savanna and even semi-desert.

The fact that the hunting-gathering mode of life, supported the whole human race until 10,000 years ago, still can be seen in many places in Africa indicates its high adaptiveness. Again, this mode of life was so adaptive that it could have supported the lives of 90 % of the estimated 80,000 million people who have been born on the earth till today (Itani, 1977).

There are many cases in which hunting-gathering plays an important role as a subsidiary subsistence activity among agriculturalists or pastoralists living in the African savanna-woodland where the rainy season is short and rainfall varies greatly from year to year. People suffer from famine in a drought year. The agrico-pastoral Kgalagadi and the pastoral Herero, Bantu neighbors of the San, engage in gathering wild plants intensively in drought years. Although the Tongwe of Tanzania and the Mongo of Zaire forest are agriculturalists, they hunt wild animals and fish in rivers or lakes as part of their daily subsistence activities (Kakeya, 1976; Takeda, 1979; Sato, 1980; Kano, personal communication).

In summary, while agriculture is suited to wetter environments and pastoralism to drier environments, hunting-gathering is widely adaptive in both environments.

MIGRATION AND MATERIAL CULTURE

A characteristic of the lifestyles of both the San and Rendille is frequent migration. While the San hunter-gatherers shift their campsites in accordance with the seasonal transition of natural food resources, the Rendille pastoralists migrate according to the distribution of food plants of the livestock on which they depend. Among both peoples, migration is primarily necessary in subsistence activities, but, at the same time, it functions as a mechanism that maintains society by releasing social tensions and conflicts, caused by the complicated human relations in a residential group. Migration has a common feature in structure and function in both societies, in that their residential groups repeat frequent fission and fusion, and exchange their members in the process of migration. In an extremely small San regional group of only several hundred people, fission and fusion of the group takes place in the whole society. In Rendille society, on the other hand, it is seen among segmentary units; membership changes take place among the residential groups organized by the clan system. In Rendille social organization, which has developed with livestock management, the settlement composed of the patrilineal descent group is rather semi-sedentary and stable in its membership. The livestock camp, however, is a homogeneous and small scale group free from the restraint of the rigid organization of the

settlement, and very similar to San society in structure and function. Rendille livestock camps exchange their membership freely through an extensive nomadism, especially at the time of periodic aggregations at waterholes.

Frequent migration works as a factor limiting the total amount of material culture. Hunting-gathering societies confront nature directly. They are completely controlled by nature and at the same time depend entirely on it.

They have absolute faith that the bounty of nature will provide them with necessities, and attempt to work artificially upon nature to a minimum extent. This lifestyle does not require too much material culture. The crude and hastily made hut of the San is well adapted to nomadic life in the Kalahari: even though it is built in a short time with materials ready at hand, it gives protection from the burning sun and is well ventilated. Clothes and hunting-gathering utensils, their possessions, are few and simple. The author earlier reported in detail (Tanaka, 1979) on the San's material culture; the total number reaches only 79 items, and most of them are made on the spot with what they have ready.

Though the material culture of nomadic pastoralists is more complex than that of hunter-gatherers, it is not very developed. The nomadic pastoralists who raise and manage livestock are also living in close relationship with nature. The lifestyle of extensive herding and repeated migration limits the amount of material culture, as is the case with the hunter-gatherers. They ordinarily use pack animals for transportation. In the case of the Rendille, some camels are chosen and brought up for that purpose, so the amount that can be carried in the move increases greatly. Since grasses and timbers for building huts are scarce in the semi-desert area of northern Kenya, the Rendille devise a very unique type of fabricated hut which they use over generations. They carry the disjointed materials whenever they move. A hemispheric frame is made by combining scores of slender trunks of a certain bush which has an extremely limited distribution along riverine forests in Rendille land. The frame is covered with about thirty mats woven of the fibers of wild sisal. The hut is light and handy, and has an excellent structure from the standpoint of architecture (Grumm, 1976). The dwelling is well adapted to the hot-dry semi-desert area; it prevents the strong sunshine and is as well ventilated as that of the San.

ADAPTATION TO ARIDITY IN HUNTER-GATHERERS AND PASTORALISTS

The author has already compared African hunter-gatherers, especially the San of the dry grasslands and the Pygmies of the humid forest, in former papers (Tanaka, 1979; 1980). Because the animals hunted and the conditions of their locations differ completely, the hunting methods employed by each people vary greatly. In the forest, collective methods are indispensable for catching forest-living duikers hiding in the bush by using either net or bow-and-arrow, while in open land, solitary bow-and-arrow hunting by stalking is chiefly performed.

Hunting utensils are inevitably different among these two peoples, as reflected in the respective hunting methods. Generally speaking, people make the best use of a specific character of the habitat; utilizing plant materials which are abundant and easy to obtain in dense forests, and animal materials which are preservable and durable in dry grassland.

Differences in the details of subsistence, including hunting, cause great disparity in every aspect of their life from the size of nomadic range, the frequency of movement, etc., to social organization. The common characteristics of hunting-gathering societies that they have flexibly

organized nomadic groups of small scale and lack social differentiation or developed social organization are true of San and Pygmy societies, and both societies show a strikingly homologous pattern. Hunter-gatherers of arid zones, however, normally have larger nomadic ranges and higher mobility than those of humid zones because differences in fauna and flora, and mode of subsistence reflect on their social structure. In contrast with the comparatively stable residential group of Pygmies having a definite hunting territory, the San living in open land repeat frequent fission and fusion so that territoriality becomes vague.

Hunting-gathering peoples in the ecotone area between forest and savanna are a good example of the difference in living structures of dry land and wet land. Terashima (1980) pointed out that the Mbote living in the woodland zone of eastern Zaire are an intermediate type between the San and Pygmies in every aspect of subsistence mode, nomadic range and social structure.

Among San societies, the life structure varies slightly according to small regional variations in humidity. The Dobe area !Kung of the northern Kalahari, which Lee (1965, 1979) studied in detail, live in a somewhat more humid environment than the !Kade area of the central Kalahari. There are permanent waterholes and a staple of single species which is favorable and reliable throughout the year. Consequently, people can live a nomadic life around the place where food and water concentrate; their nomadic range is only half that of the !Kade people.

The biggest factor of adaptation in hunter-gatherers is the distribution and quantity of wild animals and plants they primarily live on. Adaptation to arid environments with poor fauna and flora is, therefore, characterized by a wide nomadic range, frequent migration and various social institutions which accompany them.

East African pastoralists are distributed mainly in the dry lowland area such as Masai land, northern Kenya, northern Uganda, Somalia, south-western Ethiopia and Sudan. The habitat of the Rendille outlined in the second section is one of the driest parts of their distribution. Here we will discuss the matter of adaptation to aridity in pastoralism by comparing the lives of pastoral and agrico-pastoral peoples living in less arid areas from western Kenya to eastern Uganda.

On the escarpment hills in western Kenya and eastern Uganda live the Pokot, Karimojong, Jie and Dodoth. With a few exceptions, including the Pokot on whom the author conducted field research, most of the tribes live by herding livestock and although they depend considerably on agriculture, their chief economic base is pastoralism. The area is occupied mostly by acacia woodland, and cultivation of sorghum, finger millet, bulrush millet, maize and bean, etc. is seen along the riverine forest. The main subsistence base of the people is cattle herding. Cattle is chiefly used for milk but not for meat. Meat is obtained from small stock like goat and sheep. While the Rendille give social and ritual as well as economic value to the camel, these Nilotic peoples, living in the hills with more rain, give corresponding value to cattle. The social and ritual importance of cattle to Nilotic pastoralists has been repeatedly stressed by many researchers (Evans-Pritchard, 1940; Gulliver, 1955; Dyson-Hudson, 1966; Deshler, 1965; Fukui, 1979).

People live a sedentary life for a certain period of the year for cultivation, and practice daily herding from the semi-sedentary settlement. When the crops are harvested at the height of the dry season and pasture around the settlement becomes scanty, they move the settlement to a new pasture. Moving distance and nomadic range are, however, far smaller than those of semi-desert nomads like the Turkana and Rendille, who have ranges of several hundred kilometers in radius. The contrast between the agricultural adaptation in wet regions and the pastoral adaptation in dry

regions described briefly in the fourth section is clearly seen among these pastoralists. Where it becomes drier, agriculture is less suitable, and in extremely dry areas such as the places the Rendille, Gabra, Somali or Turkana live, pastoralism is the only form of existence for human life. In the arid area of Africa where rainfall varies from year to year, drought threatens agricultural economies by spoiling crops, but does not threaten so much pastoral economies. Overall dependence on livestock and nomadic pastoralism in wide ranges as seen in the Rendille can be concluded to be the best form of human adaptation to aridity.

GROUP STRUCTURE AND SOCIAL ORGANIZATION

Flexible group structure in hunter-gatherers and pastoralists is related particularly to the lifestyles of frequent migration. Through the process of movement San residential groups or Rendille livestock camps exchange their membership continuously. According to Sato (1980), both young men and women composing Rendille livestock camps re-organize their herds and at the same time exchange group members. Sato also suggested that the flexibility of their group organization plays a very important sociological role in releasing social tensions and discords caused by frictions and conflicts among group members as seen in San society.

Hunter-gatherer society is, in general, of small scale and not differentiated socially except for the division of labor by sex in hunting-gathering activities. In comparison, pastoral society is of much larger scale, has complex social organizations such as age-set and age-grade systems or segmentary lineage systems, and is well integrated as a tribe. Such tribal societies of pastoralists, however, are basically united by kinship ties, and social differentiations, beyond economic or political differentiations by sex and age such as occupational or class differentiations, are not seen. This society can also be said to be based on egalitarianism as well as hunter-gatherer society.

The striking difference between pastoral society and hunting-gathering society is that the former uses natural resources indirectly, through intermediate animals, while the latter makes direct use of them. Most of the differences in their social structures are caused by the discrepancy of subsistence modes of both societies.

There are two marked features in Rendille society: one is the functional differentiation between the political function shouldered by elders and the economic function of youth, and the other is the dual organization of residence; semi-sedentary settlement and nomadic stock camp. These subjects were already discussed in previous chapters but they should be understood as the expression of the pastoral adaptation to dry and harsh environment.

For human life depending entirely on natural resources in arid areas where both fauna and flora are poor, demography is an especially important problem. A population above the minimum requirement for the continuation of society should, of course, be maintained, but unnecessary increases in the population must be avoided. There should be an optimum population density balancing the supply of natural resources and the demand of human consumption in any society. Each society must maintain a population density with flexibility and wide range on the basis of such a standard density. It is very difficult, probably almost impossible, to compute the optimum density of each society with different conditions.

At the end of the paper, the author discusses the mechanisms of population control which are another aspect of adaptations to extreme aridity, with reference to the cases of the San and Rendille. The average age of marriage in the San and Rendille is rather high compared with the

other African peoples; 25 in San men and 18 in San women, and 32 in Rendille men and 25 in Rendille women. The Rendille marry latest of any pastoral people (Sato, 1978). Since the factor influencing the population growth rate is the number of births per woman, the Rendille control the population growth by delaying the age of marriage.

The San believe that if a new baby is born before the last child is 2 or 3 years old and weaned, the first one will become ill and die, so, they allow intervals of more than two years between births. Birth control is attained simply by abstention in San society. In many cases, men often visit the other camp and live there for sometime apart from their wives. They may live with a girl friend or marry a second wife. Such form of polygamy as seen in San society dissolves unbalanced numbers of men and women and at the same time, functions significantly to prolong the interval between childbirths and to control the population. In fact, in the nomadic hunting and gathering life, it is not physically possible for a mother to bring up more than two nursing infants who are completely attached to her. Infanticide in San society was reported in earlier literature (Schapera, 1930) though it might be rare.

In Rendille society, Sato (1978) reported that a twin in the first birth or a child of an unmarried mother are killed soon after birth, and that the age of marriage of a girl whose father belongs to the specific age-set in their age system is delayed. There can be seen such strict regulation mechanisms in their social institutions, corresponding to the harshness of nature in Rendille land and to the characteristics of the camel, which takes many years before sexual maturity and has low reproductive rate.

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