MARING MICROADAPTATION: A STUDY OF DEMOGRAPHIC, NUTRITIONAL, GENETIC AND PHENOTYPIC VARIATION IN A HIGHLAND NEW GUINEA POPULATION

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ABSTRACT

MARING MICROADAPTATION: A STUDY OF DEMOGRAPHIC, NUTRITIONAL, GENETIC AND PHENOTYPIC VARIATION IN A HIGHLAND NEW GUINEA POPULATION

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This thesis reports on a study of the demography, diet, health and genetics of the Simbai Valley Maring of Australian New Guinea. Field research among the Maring was carried out between July 1966 and June 1969. During this period of time the Maring were experiencing a population decline. This decline was due primarily to the effects of introduced diseases such as influenza. However, it was demonstrated that the Maring have extremely low birthrates and are suffering from both protein and iodine malnutrition and from malaria, and it is believed that these factors contributed to the decline.

In addition, a great deal of phenotypic variation was found to exist from place to place within the Simbai Valley. Much of this phenotypic variation was due to local environmental variation, particularly in the availability of protein and iodine. In particular, those Maring living in the more densely populated northwestern part of the valley were shorter, slighter and had lower hemoglobin values than did those Maring living in the southeastern part of the valley.

It was suggested that the various Maring local populations may represent various stages in the adaptation to a highlands fringe environment. These stages include pioneering, population build-up leading to resource depletion, and finally to population decline.

A major conclusion of this thesis is that there is a need to re-evaluate homeostatically regulated equilibrium models of human ecology.

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CHAPTER 1

INTRODUCTION

Anthropologists have long been concerned with the role of the environment in influencing or limiting human behavior and biology. The term ecology appeared in the anthropological literature as far back as the turn of this century (Mason 1895; Wissler 1926). The development of ecological thinking in anthropology has been outlined and reviewed by Helm (1962), Vayda and Rappaport (1968), and Netting (1971). In spite of the long history of ecological thinking in anthropology, it is only fairly recently, within the past twenty years, that anthropologists have begun to study man, his biology and behavior as integral parts of particular ecosystems (Vayda and Rappaport 1968; Rappaport 1968; Vayda 1971; Lee 1968, 1969; Woodburn 1968; Watanabe 1968; Dyson-Hudson 1969; Barth 1956; Sweet 1965; Conklin 1954, 1957, 1961). The importance of this approach has been discussed by Alland (1969), and by Vayda and Rappaport (1968). These authors have emphasized that many other puzzling or seemingly irrational aspects of human behavior, including symbolic activity and religion, may become intelligible and rational when viewed in an ecological framework.

Among the central concerns of ecological anthropology have been the nature and productivity of various subsistance activities (Lee 1968; Rappaport 1968) and the way in which human populations control and distribute their numbers so as to remain within the limits of the carrying capacity of their local environment as determined by their technology

(Vayda and Cook 1964; Kunstadter 1972). Indeed, since Malthus (1798) observed that human populations have the capacity of overrunning their food supply, social scientists (Davis 1963; Davis and Blake 1956; Dorjahn 1958; Lorimer 1954; Benedict 1972; Nag 1962), as well as biologists (Calhoun 1962; Slobodkin 1961; Smith 1963a,1963b) have been concerned with elucidating population control mechanisms in both human and animal populations. Demographers such as Carr-Saunders (1922) have long known that even the most primitive human populations have both direct and indirect means of controlling their rate of increase; the former consisting of abortions and infanticide, the latter consisting of a variety of practices which tend to reduce the risk of conception. The animal ecologists have it clear that a local population, if it is to avoid extinction, ultimately must remain within the limits imposed by carrying capacity (Slobodkin 1961).

Physical anthropologists and human biologists have traditionally been concerned with the study of human evolution and of human variation. They have been particularly concerned with the role of the environment as a selecting agent for certain morphological and genetic traits (Livingstone 1968; Harrison 1961; Hiernaux 1966; Roberts 1953). Weiner (1972: 393) has stated that "Human ecology is a recognizable discipline or approach within human population biology; it involves a number of different kinds of equilibrium relationships, stable and unstable; various forms of 'control' systems are set up in the ecological interrelations; adaptation and selection are expressions of dynamically controlled ecological situations." He had also stated (Ibid.) that in the study of a human ecosystem, a two level approach is desirable; the first level containing background parameters such as rainfall, soil properties, natural vegetation, and disease; the second containing the ecological interaction between population and habitat and their outcome in terms of modes of agriculture, carrying capacity and population distribution and density, and the physiological and medical state of the community and its genetic constitution.

Cultural anthropologists (Rappaport 1968; Brown and Brookfield 1959; Watson 1965) and geographers (Clarke 1971; Brookfield 1964; Waddell 1968) have been using an ecological approach to the study of various indigenous New Guinea populations. They have concentrated mainly on aspects of production and distribution of resources (Clarke and Street 1967; Bulmer 1968) on the role of social organization and exchange systems (Meggitt 1970), religion (Rappaport 1971) and warfare (Vayda 1971) for the maintenance of man-land ratios.

A number of investigations into the anthropometry and genetics of New Guinea populations (Littlewood 1972; Freedman and Macintosh 1965; Giles, Ogan, Walsh, and Bradley 1966) have revealed that a great deal of variation in these characteristics exists from population to population. In some instances the variation appears to be clinal (Littlewood 1972; Freedman and Macintosh 1965), but in many cases, particularly in the case of single gene markers, the variation appears to be random (Giles, Ogan, Walsh, and Bradley 1966; Livingstone 1963). Although environmental variation, particularly variation in altitude, has occasionally been cited as a possible cause of the observed phenotypic and genotypic variation, the more usual explanations given include those of genetic drift or founder effect for the random differences and gene flow for the clinal differences. These models of variation are given validity because of the small size, relative isolation, and linguistic diversity of many New Guinea populations.

Since the end of World War II, a number of studies have been done on the health (Buttfield and Hetzel 1966; Maddocks and Rovin 1965; Schofield, Parkinson, and Kelley 1964; Vines 1967), nutrition (Hipsley and Clements 1947; Coman and Malcolm 1958; Hipsley and Kirk 1965; Venkatachalam 1962; Bailey 1963; and Bailey and Whiteman 1963), demography (Stanhope 1970; Brown and Winefield 1964; Scragg 1957, 1967), and growth and development (Malcolm 1970; Bailey 1964) of various New Guinea peoples. Much of the work on nutrition and health has been summarized by Vines (1972). It indicates that protein-calorie malnutrition is frequently encountered in the highlands and that this malnutrition along with malaria, iodine deficiency and acute and chronic respiratory diseases are the most important medical problems in the highlands. Recently Malcolm (1970a, 1970b) has demonstrated that the late maturation and short adult stature which characterize many New Guinea highlands populations is due to protein deficiency at crucial growth periods in childhood. In spite of these health problems, demographic studies have indicated that highlands populations are either stable or are increasing in numbers (MacArthur 1966).

To date, most of the studies concerned with physical, genetic, health and demographic characteristics of New Guinea populations have focused on only one or a few of these parameters, and little work has been done to relate the various parameters to each other or to local environmental factors. There are a few exceptions to this general statement, notably the work on the Fore peoples of the Eastern Highlands by Glasse (1962, 1963, 1967, 1970); Gajdusek and Alpers (1969); Bennett (1962a, 1962b); MacArthur (1964, 1972); Williams, Fisher and Fischer

(1964) and the ongoing work by Sinnett (1972:4) on a Western Highlands population. In addition, the Institute of Human Biology at Goroka has been sponsoring interdisciplinary research on micro-adaptation in two New Guinea locations, one on the coast, the other in the Eastern Highlands. However, the results of these investigations are just beginning to appear (Booth and Hornabrook 1972; Fox, et al. 1972; Weiner 1972; Cotes, et al. 1972; Norgan, et al. 1972).

The present study deals with interpopulation diversity among the Maring-speaking populations on the south wall of the Simbai Valley in Australian New Guinea. These thirteen local populations which share a common language and culture exhibit a wide range of variation in a number of physical traits, including stature, weight and skinfold thickness. Variation among these populations has also been demonstrated to occur in the hematological parameters of homoglobin and haptoglobin concentration as well as in traits determined by single loci genes such as blood groups, G6PD deficiency, color vision deficiency, transferrins and acid prosphatase. In addition, there is variation between local populations in health and nutritional status, particularly in frequency of malaria and of iodine deficiency, and in population density and demographic characteristics. Other investigators working in this area (Vayda 1966, 1971; C. L. Vayda 1968; J. Street n.d.; W. Clarke 1970) have also noted local variation in certain aspects of social organization, warfare patterns and in the physical environment.

The purpose of this thesis is to show that the observed phenotypic variation in the Simbai Valley is related to micro-variation in the environmental setting of these populations. The environmental parameters which appear to be most significant in producing phenotypic variation are those related to the adequacy of nutrient intake and to exposure to disease. It will be shown that variation in these parameters is also related to intensity of settlement and population density of the local populations, so that those populations which exhibit the most crowding will be shown to have the smallest stature, the lowest rate of population increase, the highest incidence of disease, and the lowest resistance to the introduced stresses of culture contact. Finally, the data contained in this thesis will be used to test a number of hypotheses on the nature of population control and the regulation of ecosystems in primitive societies.

The Simbai Valley Maring were chosen for this study because extensive ethnological and ecological studies had recently been done among them (Rappaport 1968; Clarke 1971) and these studies indicated that the Simbai Maring were in a state of equilibrium with their environment, that is, that they were managing to maintain their population size within the limits of the carrying capacity of their environment. Moreover, the investigators working among the Maring had informed me that there appeared to be appreciable phenotypic and environmental variation from place to place within the valley.

Field research in New Guinea was carried out in two periods: the first between July 1966 and February 1967, and the second between December 1967 and June 1969. Out of this total of 26 months, 20 were spent in residence among the Simbai Valley Maring; 2 were spent in the administrative centers of Port Moresby, Mount Hagen and Madang, and in the Simbai and Tabibuga (Jimi River) Patrol Posts and at the Anglican Mission station at Koinambe (located on Maring territory in the Jimi Valley), studying archival materials (mostly census and health records) related to the Maring; and 2 months were spent at the University of Papua and New Guinea doing a preliminary statistical analysis of my demographic and biomedical data. (I spent the remaining 2 months as a patient in various territorial hospitals.)

Upon my arrival in the field in July 1966, I made an initial survey of the Simbai Valley in the company of Professor A. P. Vayda. At that time I selected two locations, Mondo and Tababi, in which to do intensive research. These locations were selected because the populations censused there showed the highest contrast to be found in the valley in such features as population density, physical stature and access to primary forest. The populations near Tababi bordered on unoccupied primary forest, while the people at Mondo were surrounded by other groups. These two populations were about a day's walk distant from each other--three miles as the crow flies and about 12 to 15 miles on the ground.

While among the Maring, I made my home at Mondo in the territory of the Tuguma clan cluster. I also lived for a month or so at Tababi, on the border of the territories of the Bomagai-Angoing and Fungai clan territories. In addition, I visited each of the other Simbai Maring local populations at least four times during the course of my field work. The duration of these visits ranged from one day to two weeks. Three of the Jimi Valley Maring groups were also visited.

Types of Data Collected

Because I was interested in testing hypotheses concerned with the relationship between nutrition and population dynamics, I concentrated on the collection of data related to these fields. Later during the course of the study, it became apparent that it would also be necessary to obtain information on Maring health and population genetics. An epidemiologist (Dr. John Stanhope) from the Department of Public Health of the Territory of Papua and New Guinea collaborated with me on a Maring health survey which was conducted in June 1968. A genetic study was undertaken in August 1968 with the cooperation and assistance of Dr. P. Clark and Professor R. Walsh, both of the School of Human Genetics of the University of New South Wales.

Genetic data is presented in Chapter 6.

Demographic Data

The Australian Government began taking annual censuses in the Simbai Valley in 1960. These census figures, plus the information contained in village registers formed the basis of my demographic inquires. In addition, a census was conducted in July 1966 by A. P. Vayda, and I censused the Simbai Maring populations in June and in December 1968. This provided almost nine years of census information for the Simbai Valley Maring. Thus, the ages of children born after the first census are known to an accuracy of at least one year. For older persons, the government age estimations were used as a basis for my estimates, which were constantly checked and revised using the criteria of known historical events, life stage, dental evidence and medical opinion. While resident among the Tuguma at Mondo, I maintained a birth and death register and collected genealogies.

In addition, because of the limited time depth provided by census material, and because it was impossible to obtain complete genealogies from all of the 2,000 Simbai Valley Maring, I collected reproductive histories from 418 women above the age of 17. Extensive anecdotal data on Maring beliefs related to sex and reproductive behavior was also collected from both male and female informants.

Demographic data is presented in Chapter 3.

The Maring Diet

To obtain information on the composition of the diet, individual and family daily food intake studies were done at Mondo in the northwest and at Tababi in the southeast. Because of the limitations on sample size imposed by direct intake studies, these were supplemented by survey techniques which covered virtually the entire Simbai Valley Maring population. The survey techniques were specifically designed to obtain data on the availability and intake of animal protein foods.

In addition, samples of staple vegetable foods were obtained from six of the local groups and these were analyzed for their protein content.

Nutritional data is presented in Chapter 4.

Maring Health and Nutritional Status

In order to assess the adequacy of the Maring diet, three basic methods for evaluating nutritional status were employed. The first was a clinical examination of virtually the entire Simbai Maring population. This examination was performed by Dr. J. Stanhope, an epidemiologist in the Department of Public Health of the Territory of Papua and New Guinea. The results of this study are presented in Chapter 5. The second method consisted of an anthropometric survey of the entire population. Heights, weights, skinfold thickness, and arm circumferences were measured for each subject, and head and chest circumferences were measured for children. Heights and weights were obtained on at least two occasions for most subjects. This anthropometric data yielded information on nutritional status and allowed me to construct cross-sectional and semilongitudinal growth curves for the population. Anthropometrical data is presented in Chapter 6 along with data on genetics. The third method used was the consultation of the records of the Anglican Mission's Maternal and Child Health Service.

CHAPTER 2

MEET THE MARING

This chapter will introduce the Simbai Valley Maring and their environmental setting. First, I will locate the Maring in space and briefly describe relevant aspects of their environment, social and political organization, history and subsistence activities; then I will describe regional variation within the Maring area and how it affects anthropometry, clinical signs and demography.

The Location of Maring Territory

The territory occupied by Maring-speaking peoples is located on the northern fringe of the central New Guinea highlands. It lies approximately half-way between the Waghi-Sepik Divide to the south and the Ramu River Valley to the north, straddling the administrative boundary between the Madang and Western Highlands Districts of the Territory of New Guinea, which runs along the top of the Bismarck Mountain range. Specifically, the territory begins at longitude 144° 37' E, latitude 5° 27' S and extends roughly from the Jimi River in the south over the Bismarck Mountains to the Simbai River in the north,[1] and from the

[1]There are also some Maring-speaking peoples located south of the Jimi River in the vicinity of the Wum rest house, and north of the Simbai River near the Bank rest house. These people have generally been ignored by investigators--except A. P. Vadya--who have worked among the Maring and they are also excluded from this study. This exclusion has been partially arbitrary and partially due to the fact that these people are bilinguals and have non-Maring affiliations.

vicinity of the Gunt's and Togban rest houses[1] in the southeast to that of the Bokapai and Kinimbong rest houses in the northwest.[2] It is about seventy miles southwest of Madang and thirty-five miles northeast of Mount Hagen. (see map, Figure 2.1)

Maring territory can be reached on foot from the Simbai Patrol Post airstrip which is located about ten miles to the northwest of Maring territory at the head of the Simbai Valley, or from the Tabibuga Patrol Post airstrip which is located across the Jimi River about three and a half miles south of the southeast corner of Maring territory, or from the Anglican Mission airstrip at Koinambe in the southwest corner of Maring territory.

Those Maring groups living in the Jimi Valley are in the Western Highlands District and are administered from Tabibuga, while those in the Simbai Valley are in the Madang District and are administered from the Simbai Patrol Post.

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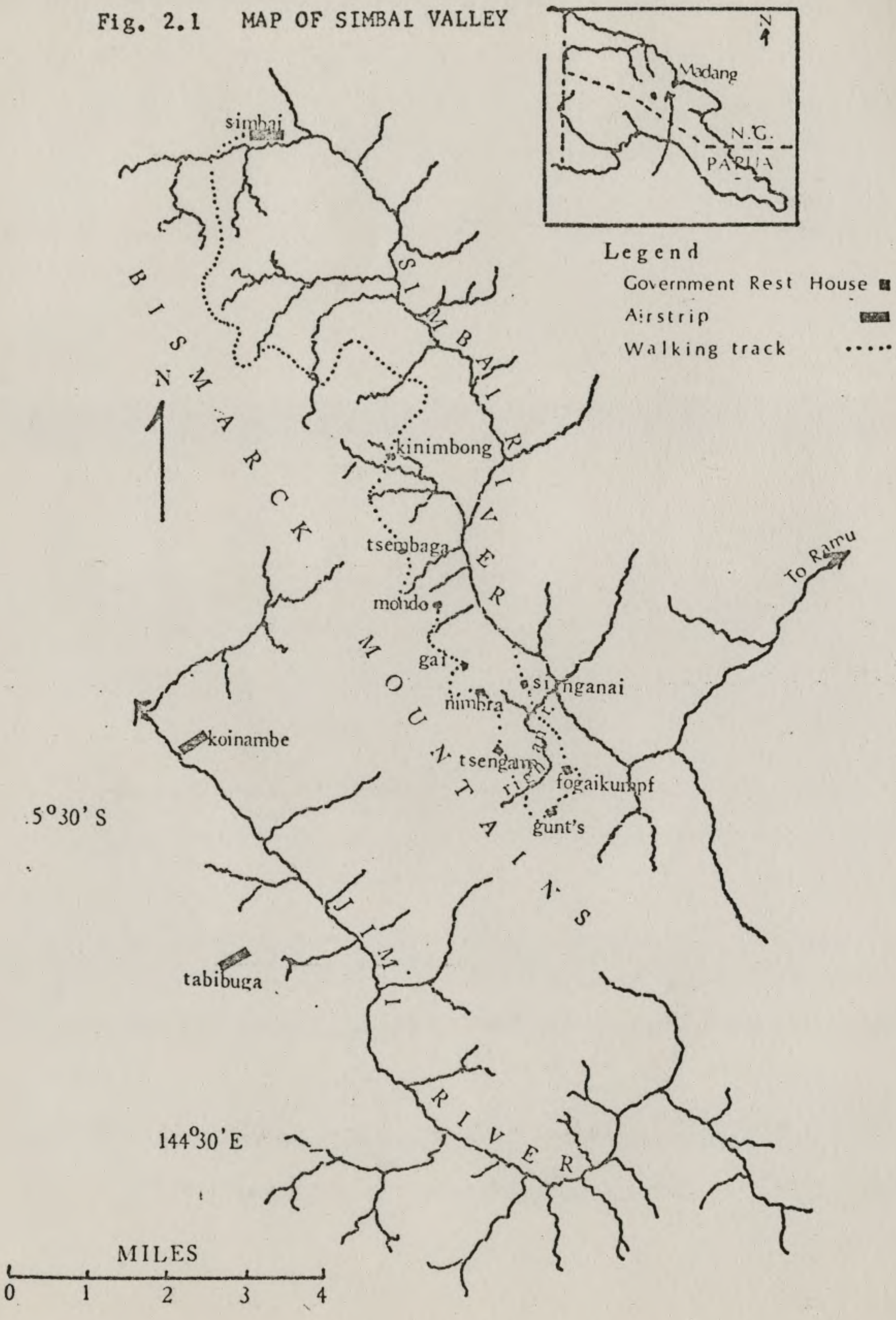
[1]Within the Maring area rest houses are shelters, built at distances of one to three hours walk apart, which temporarily house government officials during their patrols through the area. They are occupied by such visitors for only a day or two a year. The people residing in the vicinity of a rest house are required to keep it in good repair. At various times the Patrol Officers have tried to have people build nucleated villages near the rest house. To date these efforts have met with little success.

[2]The rest house called Gunt's on Australian Government maps and in the Village Directory is actually located on the crest of a ridge called Tababi. Gunt's is the name of the originally proposed site of this rest house, approximately one-half mile to the northwest of Tababi. Such naming errors are common. Names assigned to rest houses and to the groups which are censused at them are sometimes place names and sometimes clan names. In some cases, Maring groups have themselves adopted the name assigned to them (this is likely to be true if the name was originally a clan name) but in the other cases not. In an attempt to avoid adding to the confusion, I will use the names which are listed in the Village Directory, but I will indicate what they refer to and I will also give the alternative names, particularly those which have already appeared in the literature.

Fig. 2.1 MAP OF SIMBAI VALLEY



In all there are about 7,000 Maring speakers. This study is primarily concerned with the slightly more than 2,000 of them who live on the south wall of the Simbai Valley, between the Kinimbong and Gunt's rest houses. The territory of these Simbai Valley Maring is roughly isomorphic with the Department of District Administration's census division 33B MARENG, located in the Simbai area of the Ramu Sub-district of the Madang District (D.D.A. 1968 Village Directory:82, 87). According to this source, the area of the MARENG census division is approximately 75 square miles and its population 2,381, giving an overall population density of 31.7 persons per square mile. However, this census division includes the population censused at the Tembiump rest house to the northwest of Kinimbong, as well as the population censused at the nine rest houses from Kinimbong to Gunt's. The entire population at Tembiump as well as about half of that censused at Kinimbong (ca. 300) are Karam rather than Maring-speaking and are thus excluded from this study.

Physical Environment

The terrain within the Maring area has been characterized as being "difficult and disorderly" (Street n.d.). Relief features are determined both by bedrock formations and by fault systems. The Simbai fault is the major one in the area, and movement along it (mostly vertical, but also horizontal) has created both the Simbai Valley and the Bismarck Mountains. Some local faults, such as the Righan, run perpendicular to the Simbai fault, while others run in varying directions. Movement along these faults is still occurring, as is evidenced by the frequent earth tremors experienced in the Maring area.

Within Maring territory there is a local relief of from four to five thousand feet. The land is intricately dissected with predominantly steep slopes. The crest of the Bismarck Mountains lies at approximately 7,000 feet, while the Simbai River flows from an altitude of approximately 2,500 feet to approximately 1,500 feet through Maring territory, dropping at the rate of about 100 feet per mile.

Near Tsembaga, where the Simbai River flows closest to the crest of the Bismarcks, the average slope from the top to the bottom of the valley is 27° (Ibid.). The transverse profile of the Simbai River Valley is symmetrically stepped: steep (45°) upper slopes, gentle (15°-25°) intermediate slopes, steep (45°) lower slopes, and very steep (50°-60°) inner gorges. The smaller valleys are V-shaped and have slopes of 45° or more. Steeper slopes are common where streams have steep gradients and are rapidly cutting their channels into the bedrock. Street (Ibid.) noted that many of the streams flowing into the Simbai River, particularly those in the northwestern part of Maring territory, have gradients approaching 100% and their inner gorges have slopes of more than 45°.

There are numerous ridges and streams which run more or less perpendicular from the crest of the Bismarcks down to the Simbai River. As indicated above, the streams are fast-flowing and they occur at intervals of approximately one-half mile. Many of the ridge crests are knife-edged. Both streams and ridges, but particularly streams, are used by the Maring to mark the boundaries of land owned by the individual clans and clan clusters. Thus, in general, clan territories consist of adjacent strips of land which run from the crest of the range to the river below. This is particularly true in the northwestern portion of Simbai Maring territory. The main exceptions occur in the vicinity of the Singanai and Fogaikumpf rest houses, both of which are located on low hills, separated from the main north wall of the valley. The clans residing here own no land near the top of the range.

In addition to serving as boundaries between the territories of adjacent clans, ridge crests are frequently the location of foot paths used by the Maring for travel both within and between individual group territories. This is because ridge crests may extend for long distances with only minor breaks, thus providing direct and relatively easy routes from place to place.[1] By contrast, the Australian Government walking track runs parallel to the river and the top of the range, about half-way between them.

As one may infer from the above description, flat land within Maring territory is virtually non-existent and sizable tracts with moderate slope are rare. Most of those which do occur have areas of less than two acres.

The one notable exception is the Duimba Basin, home of the Bomagai and Angoing clans, which is located to the southeast of Gunt's in the southeastern end of the Simbai Valley. According to Street (Ibid.), it is by far the largest continuous area of moderate slope in the valley, being about a mile long by half a mile wide, with an average slope of only 5°. The major streams which traverse the basin are only incised to a depth of twenty-five feet.

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[1]Note that among the Maring, friendly relations tend to occur between groups located across the mountain range or across the major rivers from each other, while adjacent groups on the same valley wall are like to be enemies. Intercourse and trade occur between friendly groups, but are forbidden, by custom, between groups in emnity status.

Climate

In the Simbai Valley, as elsewhere in New Guinea, temperature is more influenced by altitude than it is by season. Seasonal variation in temperature is slight and it has a greater influence on the diurnal temperature range than it does on the mean daily temperature. Thus, in the dry season, it tends to be both warmer during the day and cooler during the night than it does in the wet season. The Maring recognize that high places tend to be cool and low places warm. Although Simbai Maring territory covers an altitudinal range of more than 5,000 feet, the altitudinal range of habitation sites within this territory is much more limited, being only about two and a half thousand feet, from 2,500 to 5,000 feet above sea level. Actually most Maring houses tend to cluster between three and four thousand feet. At these altitudes, temperatures range from a daily low of about 60°F to a high of 80°F in the shade.

In 1962-63 Rappaport (1968:32-33), while working at an altitude of 4,750 feet in Tsembaga territory, recorded a diurnal temperature variation ranging from 7° to 16°F, with daily maxima in the mid- to high 70's and minima in the low 60's. During my residence at Mondo, at an altitude of 3,800 feet in Tuguma territory, I observed a similar diurnal range with slightly higher maxima and minima; the highest temperature I ever recorded in the shade was 78°F, and the lowest 62°F. In 1965 Clarke (1971:46), working in the Duimba Basin at an altitude of 3,500 feet, recorded an average temperature of 70.1% with a daily maxima in the low 80's and a daily minima in the mid 60's.

Rainfall in the Simbai Valley is abundant and falls throughout the year. The average annual rainfall is between 120 and 175 inches. The

Maring recognize a wet and a dry season; however, these are not particularly well-marked and they are subject to some variation in their time of occurrence from year to year. In general, rainfall is heaviest between November and April, and lightest between May and October. In the driest months there may be as little as six inches of rain, and in the wettest months there may be as much as twenty-five inches of rain.

In the Maring occupied portion of the Simbai Valley weather comes from the north or the northeast. Frequently clouds roll in from the northeast, coming up the valley in the late afternoon. Days are generally sunny, rainfall usually occurs in the late afternoon or at night, but it may persist all day during the wet season. During the wet season in 1968, and again in 1969, I experienced several prolonged sunless periods of cloud, fog and rain. These adverse weather conditions could last up to ten days. In the drier months there are similar periods of fine weather with no rain, and only a little cloud and fog. Persistent fog is common at altitudes above 6,000 feet.

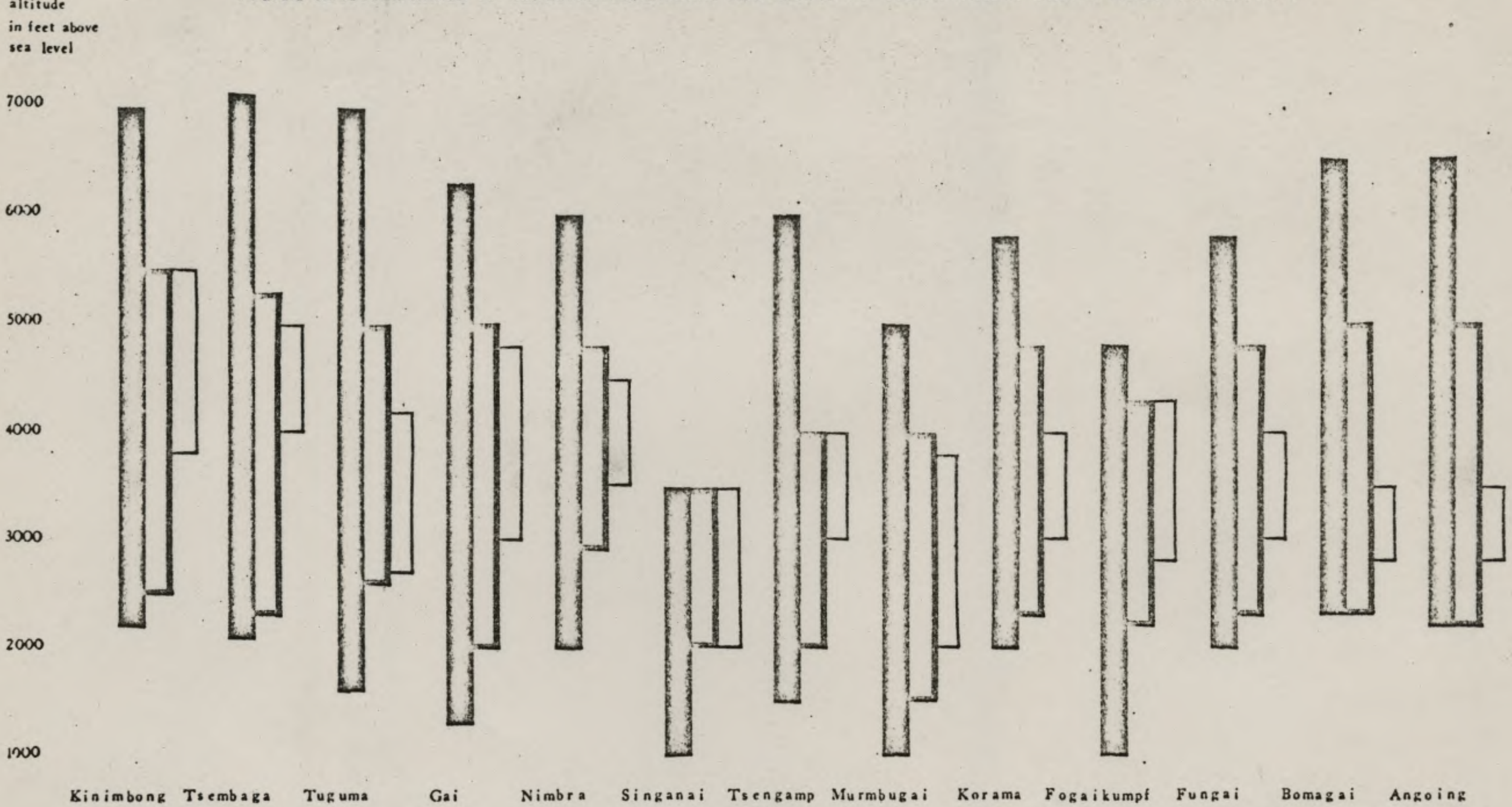
Winds strong enough to damage trees are rare, but they do occur about once a year. I have never heard of houses or gardens being destroyed or damaged by these winds. However, the heavy rainfall, coupled with the frequent earth tremors, is probably responsible for the fairly common landslides which occasionally destroy gardens and endanger house sites.

The Maring are aware of the danger of landslides and avoid building their houses on or under very steep slopes. In 1966 there was a rather half-hearted attempt to build communal houses where they could all go in the event of an earthquake. They said, at that time, that it would be better for all of them to die together rather than to be taken one at a time. This movement appeared to be influenced by cargo cult activities on the Rai coast. It lasted only a few months and none of the houses were ever completed or occupied.

Altitude, relief and rainfall patterns all have an influence on the Maring way of life. Low-lying areas are considered to be unhealthy because they are occupied by spirits and ghosts of ancestors who can cause disease. They are unhealthy because the malaria-bearing mosquitos are more numerous at lower altitudes. The Maring avoid low altitude places, particularly at night. On the other hand, high altitude places are cold, cloudy, damp and windy, and thus unsuited for either gardens or residence sites. Swiddens are cut in the altitude range of from 2,000 to 5,500 feet above sea level. Between the upper limit of gardens and the 7,000 foot top of the Bismarck range the land is covered with an unbroken stand of primary forest. Primary forest is also found at low altitudes. In the northwestern part of Simbai Maring territory, these stands of low altitude forest are rather limited, but they become far more extensive to the southeast. Small remnants of primary forest also remain on slopes which are steeper than 45°; these slopes are too steep for gardens. Forest animals and plants are hunted and gathered by the Maring. (see Appendix 1 for a list of non-domesticated plants and animals utilized by the Maring) (see Figure 2.2, "Altitudinal Range of Local Group Territories, Gardens and Resident Sites")

The land between the minimum and maximum altitudinal limits of horticulture is covered with a mosaic of gardens and of secondary forest in various stages of development. There are also occasional grassy patches, but these are limited in area, and occur mostly in the north-western portion of Simbai Maring territory.

Fig. 2.2 ALTITUDE RANGE OF TERRITORIES, GARDENS AND HOUSES OF SIMBAI VALLEY MARING LOCAL POPULATIONS



While some gardening activities are carried out throughout the year, most new swiddens are cut at the end of the wet season or at the beginning of the dry, so that the undergrowth can dry before it is burned. The appearance of certain marker plants or, in some places, the position of the sun signals the beginning of new garden activity. Thus, new gardens are cut and fenced during the months of March, April, May and June; and burning is done in June, July and August. Some crops are planted before burning; others after.

Drought appears to be unknown in the Simbai Valley; but excess rain, or too much rain at the wrong time of year, does occasionally cause problems by interfering with the burning of swiddens and thus delaying planting time or decreasing the total area planted. These delays and cutbacks are usually not too serious for I have never heard of a famine occurring in the valley.

Subsistence and Technology

The subsistence patterns and activities of two Simbai Maring populations (the Tsembaga in the northwestern part of the territory, and the Bomagai-Angoing in the Duimba Basin on the southeastern frontier) have already been described in great detail (Rappaport 1968 and Clarke 1969). Here I will sketch a picture of these activities.

As I have previously indicated, Maring subsistence is based on classic swiddening in which new gardens are cut each year--mainly in secondary forest. These gardens yield crops for a period of 14 to 26 months, (Rappaport 1968:42) after which they are abandoned to fallows which according to Rappaport (1968:52-53) may last from about 8 to over 40 years. Tuberous staples include taro (both Colocasia and Xanthosoma), sweet potato, yams (Dioscorea alata, Dioscorea nummularia, Dioscorea bulbifera, Dioscorea pentaphylla, and Dioscorea esculenta) and manioc (Manihot dulcis). In the Simbai Valley taro is the most important staple--at least as far as humans are concerned--but the sweet potato is the dominant crop in some of the higher altitude Jimi Valley locations.

Other important crops include sugar cane, bananas, marita pandanus (Pandanus conoideus) and the grasses (Saccharum edule and Setaria palmaefolia) and a large variety of leafy greens (including Rungia klossi, Gnetum gnemon, Hibiscus manihot, etc.). Corn, cucumber, pumpkin and tobacco are also grown and were probably fairly recently introduced into the Simbai Valley. In addition to the above crops, certain inedible plants are also cultivated for ornamental, ritual or utilitarian purposes. Rappaport (1968:44-46) provides an inventory of all cultivated species planted in Tsembaga swiddens.

The Maring raise pigs, chickens and a few hunting dogs. In addition, they keep cassowaries[1] (who do not breed in captivity) and an occasional cockatoo or hornbill; the former for their prized meat as well as plumes, the latter two as pets as well as for their plumage, which is used for adornment.

In addition to gardening and animal husbandry, hunting and gathering also supplement the Maring diet. The forest yields feral pigs, cassowaries, a variety of marsupials, fruit bats and a profusion of birds as well as reptiles and rodents. (see Appendix 1) Frogs are found by the banks of streams, and most of the permanent streams contain eels,

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[1]Among the southeastern Maring groups which border on the forest, cassowaries are kept almost as pets and are allowed to run free through settlement areas. They are much rarer in the northwest and are much more closely guarded. Chicks are sometimes allowed to run free, but older birds are always kept in small fenced enclosures. The northwestern groups acquired them from the southeastern groups in trade.

which were traditionally caught in traps but are now sometimes taken with fish hooks. Catfish occur in the larger rivers. The forest (both primary and secondary) also provides some vegetable foods as well as building materials.

Maring technology is simple. The only tools used in gardening are the digging stick and the recently introduced steel bush knife and axe.[1] Hunting is done with bows and unfletched arrows, and these, together with spears, axes and wooden shields were also used in warfare. Animals are sometimes caught in snare, deadfall or pit traps. A variety of vegetable fibers are twisted into string; this string is used to make net carrying bags, and the netted loin cloths and string aprons which are the main items of clothing for men and women. Small amounts of bark cloth are also made and are worn by women, who may also wear rain capes made of strips of pandanus leaf sewn together. Ornamental arm and waist bands are woven from orchid stems.

Cooking is also simple. Traditionally only two techniques, roasting and steaming, are employed. In the former, food is cooked directly over the fire or is buried in hot ash; in the latter, it is either placed in a bamboo tube with a little water which is then sealed and heated over a fire, or placed in an earth oven with red hot stones and a little water. The oven is sealed with banana leaves and the food is steamed for thirty minutes to an hour. Cooking stones are handled with wooden tongs and there are no eating utensils. Bamboo tubes and gourds are used as containers. In the late 1960's some Maring obtained enamel or

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[1]Steel tools were first introduced into the Simbai Valley in the early 1940's by trade from the upper Jimi Valley. These tools became common in the mid-1950's and by the 1960's they had completely replaced the earlier stone implements.

aluminum pots, and these are now being used for boiling or steaming food.

Before the establishment of the Tabibuga and Simbai Patrol Posts, the Simbai Valley Maring manufactured salt by boiling the water obtained from salt springs located on the north wall of the Simbai Valley. The water was boiled in a basin constructed of stones and lined with clay and banana leaves, and raised high enough off the ground so that a fire could be build under it. Other than as ornamental pigments, this is the only use Maring made of clay. Surplus salt manufactured in the Simbai was traded across the Bismarck Mountains for stone axe blades which were quarried and shaped in the Jimi Valley.

The Maring build their houses, which are constructed with light timber frames tied with vines, directly on the ground in small artificially leveled clearings. Walls and roofs are covered with pandanus leaves. Maring houses last for an average of about five years, but roofs and siding may have to be replaced more often. A house may be completely assembled in a day, but it usually takes several days or even weeks to collect the necessary building materials. Houses, rectangular in shape with curved rear walls, measure about 8 feet wide by 25 feet long by 5 feet high at the ridge pole. They have a single entrance and no windows or chimney. Men and women sleep in separate houses and these have different interior designs. The men's house consists of a single room, while the women's house has two. The front room of the women's house has pig stalls running along one side and is used for food storage and preparation, and the entertainment of visitors; the back room is for sleeping. Small groups of related males above the age of seven or eight sleep together in a men's house; each married or widowed woman has her own house and shares it with her young sons, unmarried daughters and pigs.

A Maring hamlet typically consists of a centrally located men's house, surrounded by the houses of the wives, mothers and widowed sisters of the occupants of the men's house.

Work is divided along sex and age lines, but other than this there is no full-time specialization, that is, every able-bodied person works. A man and a woman, usually husband and wife, but sometimes brother and sister or widowed parent and opposite sexed child, form a gardening team. Men fell trees, build fences and mark out small rectangular plots within the garden. Women are responsible for clearing and burning the undergrowth, planting, weeding and harvesting, although they may be helped by their male partner in these tasks. Some crops, such as sugar cane, bananas and pit pit (Saccharum edule) are the exclusive responsibility of males. Women are responsible for the care and feeding of pigs which live, each in its separate stall, in the front room of the woman's house. The hunting of large animals is a male occupation; women collect small game, such as frogs, rodents and insects, in the course of their gardening activities. These smaller animals are also actively hunted by children and casually captured by men. The making of string and articles manufactured from string is women's work, while the weaving of arm bands and other ornaments, as well as the making of the implements of war is men's work. Women carry burdens in net bags suspended from their heads and supported on their backs. Girls are taught to carry in this fashion from about the age of 5 or 6 when they begin to accompany their mothers to the gardens. Men carry burdens on their shoulders.

Origins and Affiliations, and Contact History

Linguistic[1] and cultural[2] evidence suggests that the Maring are most closely related to peoples living to the south in the Central Highlands. To the north and northwest of Maring territory live the distantly related Gainj and Karam speakers, to the east and southeast, Maring territory borders on a vast tract of uninhabited virgin forest.

Investigations into Maring prehistory have yet to be undertaken and oral traditions are notoriously unreliable, so there is little that can be said with certainty about how they entered the Simbai Valley or about the length of time that they have been resident there. Rappaport (1968:12) has argued that the Maring entered their present territory from the south, occupying first the upper Jimi Valley and later spilling over into the Simbai. Vayda (personal communication), on the other hand, has suggested that it is equally possible that the Maring first crossed the Bismarck Mountains well to the southeast of present Maring territorial boundaries and occupied first the Simbai and only later the Jimi Valley. He bases this possible past migration route on the present day trade route which moves certain goods directly from the Central Highlands into the southeastern Simbai via middlemen who live in a place called Aindem. The exact location of Aindem is unknown to us, as is the nature

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[1]Linguistically, the Maring belong to the Jimi subfamily of the Central Family of the East New Guinea Highlands Stock of the East New Guinea Highlands (Micro) Phylum (Wurm 1964). The Maring are the most northerly located speakers of the Central Family languages. The Karam and Gainj languages, spoken by their neighbors to the north and northwest are only distantly related to the East New Guinea Highlands Stock.

[2]In numerous details of culture and social organization, the Maring exhibit a closer affinity to their neighbors to the south than they do to their northern neighbors.

of the language spoken there. What is known is that Aindem is about a three-day walk from the southeastern end of Maring territory and that some intermarriage takes place between the southeasternmost Maring clans and the Aindem people.

Rappaport (Ibid.) also assumes that the Maring occupation of the Simbai Valley is fairly recent, probably dating back no further than 200 to 250 years. He based this assumption of recent occupancy on floristic evidence (lack of obvious environmental degradation) and ethnohistorical evidence (he noted that four out of five of the Tsembaga clans claimed their origins in the Jimi Valley three or four generations back, and that his older informants stated that there had previously been more extensive tracts of low altitude primary forest than there are now). Vayda (personal communication) again disagrees with this interpretation, saying that there is not sufficient evidence for any estimation of the time depth of the Maring occupation of the Simbai Valley.

The amount of linguistic and genetic (see Chapter 6) diversity which has been found to exist among the various Simbai Valley Maring local populations suggests that Maring occupancy of the Simbai Valley may in fact be much older than Rappaport's estimate. But without comparable studies to determine the amount of variation present in Jimi Valley Maring populations, from whom it is believed the Simbai populations are derived, it is impossible to know whether the variation which exists in the Simbai developed in situ or whether the original colonizing populations were already divergent from each other. If it turns out that the Jimi Maring populations vary as much as the Simbai populations and that the variation in the Jimi parallels that found in the Simbai, then it may not be necessary to postulate any great age of occupancy.

Surface finds of artifacts such as stone mortars and pestles, and ground stone blades of a shape different from that used by the Maring in the recent past also indicate an older occupancy of the Simbai Valley, but it is impossible to know whether the people who made and used these artifacts were the ancestors of the present population. It is also impossible to know without archaeological investigation whether the valley was occupied continuously from the time of the mortar and pestle makers to the present.

In the neighboring Kaironk Valley, inhabited by the linguistically unrelated Karam speakers, a recently discovered stone tool manufacturing site has been dated at 3,500 B.C. (S. Bulmer personal communication). In light of this evidence, as well as that of genetic and linguistic diversification it is likely that our estimates of the length of time the Maring have been in the Simbai will have to be revised upwards. However, this cannot be done accurately until further studies into the archaeology, culture history, linguistics and genetics of the Maring and their neighbors have been made.

My own feeling is that it is possible that the Maring settled the Simbai Valley from the Jimi in several waves, and that the northwestern part of their territory was settled before the southeastern part. Evidence for this assumption is largely presumptive and is based on the following facts: first, population density is greater in the northwestern part of the valley than it is in the southeast; second, the local populations in the northwestern part of the valley have recognized boundaries at or near the top of the range which separate their territories from those of adjacent Jimi Valley groups. This is particularly true of the Tsembaga, the Tuguma, and the Kanamb-Kaul (at Gai). To the southeast of Gai there are no boundaries at the top of the range, and the land there is held in common by adjacent Simbai and Jimi groups. Also, at the far southeastern part of Simbai Maring territory, many members of the Bomagai and Angoing clans are bilocal, claiming residence both in the Simbai and in the Jimi. These bilocal Bomagai may be current representatives of the most recent migratory movement from the Jimi into the Simbai Valley.[1] Again Vayda argues that the differences in boundary behavior might be due to other factors such as the nature of the terrain on the crest of the range or to other environmental factors. Furthermore, differences in population density are not necessarily related to length of occupancy but may be due to differences in the quality of the local environments.

Floristic and other environmental evidence tends to support the notion that the northwestern portion of Simbai Maring territory was settled earlier, or at least has been used more intensively than the southeastern portion. There has been more environmental degradation in the northwest than in the southeast. Land use has been more intense, secondary forest tends to be younger, and deflection towards grassland, while rare, is more common in the northwest than it is in the southeast.

The Maring recognize at least three major ecological zones in the Simbai Valley. The first, extending from the head of the valley to Kinimbong on the border between Karam and Maring territory, is mostly grassland. The second, extending from Kinimbong southeast to Gai, has a mixed floristic component consisting mainly of gardens and young

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[1]Some of the Kundagai at Kinimbong are also bilocal and they are related to the Kundagai at Tswenkai and Bokapai (two Jimi Valley locations) but they claim to be distinct from the Jimi Kundagai, while the Simbai and Jimi Bomagai give the impression of being more closely related to each other.

secondary forest, with some grasslands. The third zone, to the southeast of Gai, is considered to be mostly forest; gardens are cut in older secondary growth and there is little or no grass. Some of my informants claim that there is another ecological boundary at the Righan River and that southeast of the Righan the land cover is mostly primary forest.

There is also some indirect evidence that soils in the more densely populated northwestern part of Simbai Maring territory are more depleted with respect to nitrogen and to iodine than are those in the sparsely populated southeast. According to a lab report (see Chapter 4) root crops grown in the northwestern part of the territory have lower protein content than those grown in the southeast, and the people living in the northwest show more frequent signs of iodine deficiency than do the people living in the southeast (see Chapter 5).

Maring contact with the outside world has been recent and, at least in the Simbai Valley, to a large degree superficial. Indirect contact dates back to the early 1940's when steel tools first entered the Simbai Valley along trade routes from the southeast. These tools did not, however, become common in the valley until the mid-1950's. In the middle or late 1940's, a territory-wide dysentery epidemic entered the valley and was responsible for the deaths of up to an estimated 25% of the population. There is also evidence (Rappaport 1968:9) that measles entered Maring territory sometime in the 1940's. A wave of cargo cult activity reached the Simbai Valley from the north sometime in the 1940's, but its effects appear to have been mild and transient, except that the experience imparted to the Maring a sense of scepticism about subsequent cargo cult movements (<u>Ibid.</u>).

Direct contact with Europeans began in the middle 1950's when the first Australian Government patrols entered the Simbai Valley, coming both from Aiome on the Ramu and across the Bismarck range from Mount Hagen and later from the newly established Tabibuga Patrol Post. Pacification was completed by 1958.[1] The Simbai Patrol Post was opened in late 1959 and in 1962 the area was declared safe for non-governmental outsiders to enter. The Anglican Church established Mission stations at Simbai and at Koinambe (in the Jimi Valley) in the late 1950's and early 1960's; substations manned by Papuan evangelists, school teachers and medical orderlies were also established at that time at Gai and Kinimbong in the Simbai Valley as well as at several Jimi Valley locations. A government medical aid post was established at Kinimbong in the early 1960's, and the Anglican Mission provided similar medical services at Gai. In 1969 another aid post was opened up at Tababi. In late 1968 and early 1969 Lutheran missionaries attempted to set up stations in the southeastern part of the Simbai Valley at Tsengamp, Tababi and at Kinimbong. Their right to do so was contested by the Anglicans and the matter was unresolved by the time I left the area in May of 1969.

The recruiting of Maring labor for work on coastal plantations began in 1962, and by 1969 a significant number of young Maring men had served or were serving two-year terms on the coast. Recruiting has been heaviest in the middle and northwestern parts of the valley. In 1968 over a third of the able-bodied males at Gai--where the Mission substation was located--were away on plantations, some of them serving second terms. Nowhere else in the Simbai Valley was the percentage of absentee labor so high.

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[1]Prior to contact, intergroup warfare was endemic (see A. P. Vayda 1971).

While it is still too early to fully assess the impact of plantation labor, either on the men who have participated in it or on their home communities, certain acculturative effects are becoming apparent. Returning laborers bring with them a quantity of material goods, trade items such as ornaments, clothing, blankets, cloth, tools and cooking utensils, as well as money. They have also acquired a taste for such exotic foods as rice, bread, tinned meat and fish, and grease (tinned beef drippings), items which they can later purchase at the Trade stores at the Simbai Patrol Post and introduce to their families. They also return with a knowledge of Pidgin English (Neo-Melanesian), and a view, albeit somewhat distorted, of the outside European dominated world. Perhaps, more importantly, their own sense of identity has been altered. No longer, at least vis-a-vis the outside world, are they simply members of their own local clan or clan cluster. They are Maring, and along with fellow Karam and Gainj laborers, they are Simbais; this identification is in opposition to Jimi Valley Maring who are beginning to consider themselves Jimis and identify with Hagens. The political consequences of this enlarged group identity, or of the split between Simbai and Jimi Maring, have not yet been realized, but it is interesting to note that in the 1968 elections for the New Guinea House of Assembly the Simbai Maring voted as a block for Warai Topa, a Maring-speaking candidate for the Middle Ramu Open Seat, and unanimously rejected Jim McKinnon, the first European to enter the valley, first as a prospector and later as a miner and labor recruiter. During the campaign Maring leaders stressed the points that the Maring should express a unified opinion, that they should reject McKinnon because he didn't and because he was white. McKinnon won the election on the strength of Karam, Gainj and Ramu votes.

While serving as plantation workers, Maring men of different and sometimes hostile clans are of necessity forced to live with, talk to and share food with each other, thus breaking traditional taboos on fraternization and dining with the enemy (Rappaport 1968:Chapter 4). When they suffered no ill effects from these actions, some of them began to doubt the relevance of their old customs to the new situation in which war was forbidden. Men returning from the coast must undergo purification rites before they are allowed to resume their life in the community.

Older men, particularly shamans, are somewhat reluctant to transmit their esoteric knowledge to these returned laborers, fearing that because these men have eaten promiscuously, the magic will not work, or will work against the impure practitioner. There is a tendency for the more traditional of the elder men to reject--and perhaps to fear because of contamination--the younger ones who wear cloth and who can speak the white man's language. On the other hand, the younger men have lost a certain amount of respect for their elders and the traditions and practices which they represent. Repatriated laborers go through a period of readjustment which may take several months, but eventually most of them settle down to the traditional way of life and become at least to an outside observer indistinguishable from men who have not had plantation experience. The long term effects of an ever increasing number of returned laborers are not known, but in other parts of New Guinea, these men have been highly instrumental in effecting culture change.

In the 1960's culture contact, particularly for the Jimi Valley Maring, meant involvement, at least to some degree, in the larger emerging New Guinea society. Both the administration and the Mission were active in promoting change, and political and economic development. The

Anglican Mission at Koinambe has been active in its educational and medical programs as well as in its evangelical work. By the late 1960's there had been a number of mass conversions to Christianity among many of the Jimi Maring groups, and the Christian ritual cycle had begun to replace the indigenous one. Primary schools, usually going up to Standard Two, had been established in many places as well as a boarding school going up to Standard Six, at Koinambe. A few Maring children had completed their primary education and were attending secondary school at Goroka. School attendance was reported to be good by Mission teachers and particularly at Koinambe but also at Kompiai and Bokapai it was not uncommon to hear Maring school boys conversing with each other in English at these Jimi places. In addition, nursing sisters specializing in infant and maternal health, patrolled the area regularly visiting each Jimi Maring place on a monthly and sometimes a biweekly basis. Attendance at these clinics was good and some Maring women were beginning to come to the hospital at Koinambe for assistance at childbirth. In 1966 a local Government Council was established in the Jimi Valley and all of the Jimi Maring groups were included in it. Some economic development had also taken place. Returning plantation workers brought cash into the area; additional money could be earned by selling produce to the Mission, by carrying cargo for Government and Mission patrols, and by working on roads or other construction projects at the Tabibuga Patrol Post. Late in 1968 a locally and cooperatively owned and managed trade store was opened at Kompiai, and there was talk of opening others in other Jimi places. Jimi Valley Maring were encouraged by the Mission to manufacture traditional ceremonial axes and other artifacts for sale to tourists in Mount Hagen. The Department of Agriculture, Stock and

Fisheries introduced coffee as a cash crop into the Jimi in the mid-1960's. The Maring enthusiastically welcomed this introduction. Now they could have a "business" of their own--a way of making money. In May of 1969 the first shipment of Maring grown coffee was flown out of Koinambe to be sold in Mount Hagen.

The Western Highlands District Administration has long had a policy of road building to link the various outstations to the major towns in order to provide a more economical means of transportation and communication with these areas than the costly and inefficient light aircraft which are so commonly used in the Highlands and elsewhere in the Territory. This road building policy has extended into the Jimi and a network of roads linking local communities with the Patrol Post have been built or are under construction. In addition, a major artery is being constructed, and when completed, it will provide a link between Tabibuga and the town of Banz. When I left the field at the end of May 1969 only a mile of this road was yet to be completed. Road building takes men away from their traditional gardening activities, but it also brings cash into the area, and once the link to the Highlands is completed, economic impact in the Jimi should become more rapid. During my brief visits to Jimi Maring groups, I often had the impression of excitement and involvement with the changes which had taken place since contact. The younger men, in particular, talked eagerly about "business" and their coffee plantations, and the Local Government Council and the road. This was particularly true during my later visits in 1969. They had made a start, however small, on the road to economic and political development and they seemed eager to continue in this direction.

While the above outlined changes which occurred in the Jimi Valley may appear to be relatively minor, they loom large when compared to the changes which had occurred in the Simbai Valley during the same time period. The Maring were aware of these differences in the rate of change, Jimi siders gloating over their more favored position, Simbai siders feeling that they had somehow been neglected.

For the Simbai Valley Maring, contact with the outside world meant mainly the enforced cessation of warfare and the voluntary cessation of much of their ritual life which was so closely associated with warfare (Rappaport 1968:Chapter 5). True, returning plantation workers brought with them money and goods and a knowledge of the outside world, and possibly carried with them the seeds of change; but little or no effort was made in the decade after initial contact by the Administration or by the Mission to implement social change or political or economic development. This was due partially to a difference in the attitudes and policies of the Administration of the Madang and Western Highlands Districts, and partially to the great distance and isolation of Simbai from Madang.

I have since been informed that a Simbai Local Government Council was opened in late 1970 and that road links are planned and under construction to link the Simbai Valley with the Highlands. On the northwestern border of Maring territory a road is planned to cross the Bismarcks at the Kinimbong pass. These recent developments should help to speed up the economic and political development of the Simbai Maring and at least put them on a par with their Jimi relatives.

A Note on the Number and Composition of Simbai Maring Populations

Defining local population units and the boundaries of these units has always been a problem for anthropologists. This is partially due to two facts: (1) several sets of criteria have been used to define the boundaries of local groups; and (2) the groups so defined are not necessarily congruent. For example, local groups may be defined by genetic, ecological, or socio-political criteria. Genetic criteria would be based on a shared gene pool, its calculation would demand fixed though arbitrary level of endogamy (e.g., 70%). Ecological criteria might demand only that a local population exclusively exploit a common territory, and satisfy all, or most of their trophic needs with products produced on that territory. Socio-political units could be defined as corporate groups which own and defend territory against other similar groups.

As every biologist knows, the genetic definition of a population below the species level is difficult because there is always some degree of gene flow throughout the species and so boundaries between contiguous populations are difficult to draw (for a discussion of the population concept, see Harrison and Boyce 1972:3-5). With humans the situation is further complicated because marriage and mating occur within a socio-cultural framework. The rules of the game may change or fluctuate with time, that is, one may select a mate from clan A today because clan A is now on friendly terms with your clan, but this type of marriage might have been impossible in the past generation because of hostile relations with clan A. Thus, political alliances can and do affect the direction and rate of gene flow.

Socio-political boundaries may be precise at any single point in time, but they are also subject to change primarily as a result of population pressure and as a result of the instigation or termination of warfare or other hostilities.

Ecological boundaries, being at least partially based on environmental factors, may be more permanent. But there is no necessity for the population contained within the ecological boundaries to remain constant through time, and indeed, changes in population composition through migration or replacement are common enough phenomena.

Throughout the course of my field investigations, it had been assumed that there were nine distinct local Maring groups on the south wall of the Simbai Valley.[1] This assumption was based on the fact that the Australian Government attempts to set up census subdivisions which correspond to real population subdivisions. Further, I followed A. P. Vayda's usage in his 1963 Pan Maring survey (n.d.) in which he assumed that clan clusters or local populations were, in fact, congruent with populations censused at rest houses. The data on which this thesis is based has been collected and analyzed with reference to these nine local groups.

It was my impression also that the nine Simbai Valley Maring populations included in this study, that is, those censused at the nine rest house sites on the south wall of the Simbai Valley, were in the 1960's de facto socio-political units. Many of them were also traditional political, ecological, and genetic populations. These have a history of corporate identity, have exploited and defended common territory and have selected more of their mates from within the group than from any other group.

However, Vayda (1971 and personal communication) on the basis of his research into the political organizations and warfare patterns of all

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[1]The D.D.A. Village Directory (Ibid.) lists nine Maring villages on the south wall of the Simbai Valley. These nine so called villages correspond to the populations censused at the nine rest houses.

Maring-speaking groups came to the conclusion that in the more densely populated northwestern portion of Maring territory the largest political unit is the clan cluster. These units are isomorphic with rest house populations. However, in the more sparsely populated southeast, because of the fluidity of alliances, individual clans form the largest autonomous units. This finding on the relationship between population density and social cohesion is similar to that which Meggitt (1965) found among the Mae Enga of the Western Highlands.

In light of the above, I have made every attempt to group the individuals on which my data was collected into units which conform to actual socio-political units. This is not possible in the case of populations censused at Singanai and Fogaikumpf. This is because there are numerous clans of extremely small size which were censused in the area. These clans appear to be remnants of a much larger population which is dying out, or else, they may be refuge populations from other areas. Since they are too small to be subjected to statistical treatment, and since they live in such similar environments, I am considering them to be two large groups rather than sixteen small ones.

The genetic studies were undertaken and their results analyzed before it was realized that the rest house populations might not be congruent with real socio-political units. Thus, in these studies the Murmbugai and Tsengamp clans censused at the Tsengamp rest house were lumped together and called Tsengamp, and the Fungai and Korama clans censused at the Gunt's rest house were similarly lumped and referred to as Gunt's.

Social and Political Organization

The approximately 7,000 Maring speakers are divided into more than twenty autonomous local populations.[1] For the purposes of this study, we will say that there are thirteen populations located on the south wall of the Simbai Valley. These Simbai populations range in size from about 40 to about 350 persons. In the Jimi Valley some populations attain a much larger size (ca. 600-800). Each of these local populations is comprised of one or more named and putatively patrilineal clans. These clans may be further divided into named subunits. Fission and fusion of clans and subclans is common and depends on, among other things, the demographic fate of the group. Functioning independent clans or subclans rarely contain more than 100 or fewer than 20 members. When membership rises above 100, fissions into smaller subunits is likely. Conversely, when memberships drops below the lower limit, the group ceases to be viable and will fuse with another.

Because of depopulation, the fusion of clans was a common occurrence during my field work. Thus, the seven clans censused at the Mondo rest house were in the process of fusing into three: the Dinakai with the Dumbugai-Yimiekai, the Wendakai with the Raweng and the Rliklikai, and the Kongakai with Ambogai. The process of fussion had perhaps gone furthest with the Wendakai-Raweng who were no longer intermarrying and who were using the combined name to designate themselves. The Rliklikai clan, whose numbers had been so seriously depleted that by late 1969 there were only two adult males left, were joining the Wendakai-Raweng because, as they put it, there was no longer any point in maintaining a separate identity. The Kongagai-Ambogai had also stopped intermarrying,

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[1]For a more detailed description of Maring social and political organization, see Rappaport 1968, 1969; Vayda and Cook 1964; C. Lowman-Vayda 1968.

but their use of the combined name was new and not yet universal. These clans all considered themselves to be the original members of the Tuguma local population. The Dinakai had formerly been a separate population and had consisted of four subclans, but these had once again merged. The Dumbugai-Yimiekai, also formerly separate clans, were dispersed and their numbers depleted; those who remained on the land northwest of the Dinakai were merging with the Dinakai (Rappaport 1968:116).

Rappaport (Ibid.) has described the process of clan fission and fusion in detail for the Tsembaga, and has hypothesized that an important factor in fusion is the amount of intermingling of clans lands that has occurred. The intermingling of clan lands is more likely if these lands are contiguous. This may explain why fusion of the Wendakai with the Raweng, whose territories are contiguous, has gone farther than the fusion of the Kongagai with the Ambogai whose territories are separated by the territory of the Wendakai-Raweng.

Each of the named local populations forms a single territorial unit. Members of its constituent clans, and they alone, have rights to the non-domesticated resources found anywhere on the territory. They are also responsible for the defense of the territory against other local populations, and they participate jointly in major rituals and ceremonies expressing group solidarity (Rappaport 1968:Chapter 5).

The territory of each local population is divided into what Rappaport calls "subterritories" and the division is usually along clan or subclan lines. Garden land is usually owned by individual clans or subclans, but it is possible for two or more closely related clans or subclans to own their land in common. In the Simbai Valley the territories of the local populations, as well as their subterritories, run in vertical strips from the top of the range to the river below. Thus, each group has access to land and resources occurring at all altitudes.

The subterritories are further subdivided into smaller plots of land, each owned by a smaller patrilineal unit. Each of these units owns a number of these plots, which are usually noncontiguous and are scattered over the full altitudinal range of the territory. These plots are divided into small garden sites, usually with an area of less than one acre, and the ownership of these sites is claimed by individual men.

Individuals claim land ownership by virtue of having originally cleared the land of virgin forest or through patrilineal inheritance. However, membership in a clan or subclan bestows rights to all the garden land of that group. If an individual is short of land he simply asks another member of his subclan for land and a permanent transfer of title to a tract is made.

A subclan which is short of land may receive additional land either as grants to individual members or it may be granted an entire tract by a subclan with surplus land. Grants in land may also be made by members of one subterritorial unit to members of another within the same local population. These land transfers are usually between affines, most commonly by a man to his daughter's or sister's husband. The ease of transfer of title to garden land within the territory of local population, assures the equal distribution of such land to all members of the local population. Exchanges between local populations are much more difficult and rarely occur peacefully. Indeed, conflict over the ownership of garden land by various local populations may have led to warfare in the past (see Rappaport 1968:115; and Vayda 1971).

Maring marriage rules (see Rappaport 1969) stipulate clan exogamy, but these rules may be broken when a clan becomes large and is beginning to fission. Conversely, members of fusing clans come to consider themselves as brothers and cease intermarrying. In addition, a man may not take a wife from his mother's clan nor from the clans of any of the wives of his clan brothers. He is, however, expected to return a daughter to his mother's clan. Thus, affinal connections are dispersed, but may be renewed in alternating generations.

Marriage within the local population is not prohibited and indeed it is a preferred form of marriage. One of the advantages of local endogamy is that some rights to a woman's labor may be retained by her natal group if she does not move too far away. If she remains within the local population, it is no great hardship for her to continue to make gardens with her widowed father or unmarried brothers. Thus, between twenty-five and forty-five per cent of all recorded Simbai Maring marriages occurred between members of the same local population. (In this context local populations refers to rest house groups.)

Residence is normally patri-viri-local, after marriage a woman takes up residence with her husband's clan. Since territories are small, residence sites are not necessarily adjacent to garden sites. Rappaport (1968:21) has described Maring settlement patterns as pulsating between dispersed hamlets and larger more nucleated settlements. The populations are linked to the conflicting requirements of the ritual cycle and of gardening and pig raising activities.

The local population may be considered to be the largest Maring political unit. Military alliances between local populations do occur, but they are based primarily on individual affinal ties and they are unstable. Leadership within the local population is diffuse and amorphous. There are no explicit political offices, either inherited or achieved. Yet, certain men have a limited amount of authority in certain situations. This authority is based on a combination of personality, ability (particularly in fighting), and the possession of esoteric knowledge. These are the Yu Maiwai described by Rappaport (1968:28) and discussed in detail by Lowman-Vayda (1969). Their authority is, however, limited to their ability to attract and influence followers. They have no powers of coercion.

Environmental Variation in the Simbai Valley and Some of Its Consequences

In previous section I have alluded to the fact that there are micro-environmental differences in the territories of the various Simbai Maring local populations and that these differences affect the amount of protein available for each of these populations. Further, I have suggested that these differences in the amount of available protein are reflected in differences in the clinical, demographic and anthropometric characteristics of the different populations. These differences will now be outlined.

As one moves from northwest to southeast down the Simbai Valley, the mean altitude of both settlements and gardens drops by about 1,000 feet. The amount of rainfall increases by up to 55 inches from 120 to 175 inches per year. The result is that the territories of the southeastern groups are both warmer and wetter than those of the northwestern groups. Therefore, it is more likely that both crops and secondary forest mature more rapidly in the southeast. Indeed, forest cover is heavier in the southeast, due mainly to the larger size of the secondary forest and the higher ratio of secondary forest to gardens. The greater amount of forest and the greater maturity of this forest might indicate that fallows are more adequate in the southeast and that soils are less depleted there.

The territories of the local populations are larger in the southeast, and a greater proportion of the land is, or has been, under cultivation (Table 2.1). In the southeast slopes are relatively less steep and there are larger tracts of flat or relatively flat land. Because it is less subject to erosion, flat land may be more suitable for cultivation.

Game is more plentiful in the southeast and more time is spent in its pursuit. Interestingly, informants state (and Bulmer, personal communication, concurs) that many kinds of game, particularly the larger bush fowl, prefer flat to steep land. More Marita Pandanus which is a rich source of both fat and protein is planted in the southeast, particularly on land owned by the groups censused at the Tsengamp, Gunt's and Fogaikumpf rest houses, as it grows better at lower altitudes. The protein content of staple crops appears to be higher in the southeast, possibly reflecting richer soils, more adequate fallows, more recent occupancy, or a combination of all of these factors. Thus, the average protein content of samples of taro grown at Gunt's was almost twice as much as of those grown at Mondo. The values for the Gunt's samples was 1.14%, those for the Mondo samples 0.59%. In addition to the apparently greater resources on their own territory, the southeasternmost Maring populations have access to the resources of the vast and unoccupied tract of primary forest to the southeast of their borders.

In spite of what appears to be a less favorable environment, the population density in the northwest is much higher than it is in the southeast. The overall density based on 1963 census figures ranges from

TABLE 2.1

SIZE OF SIMBAI VALLEY MARING LOCAL POPULATION TERRITORIES

Population	Total land area sq. mi.	Area in gardens and secondary forest sq. mi.	Area in primary forest sq. mi.	Area in grass sq. mi.
Tsembaga	3.29	1.28	1.93	0.06
Tuguma	3.01	0.75	2.26	0.00
Gai	4.08	2.37	1.70	0.00
Nimbra	4.48	2.57	1.68	0.22
Tsengamp-Murmbugai	3.18	1.00	2.18	0.00
Fungai-Korama	6.51	4.43	2.07	0.00
Bomagai-Angoing	3.46	3.11	0.34	0.01

a high of eighty-five persons per square mile at Mondo to a low of twenty-eight persons per square mile at Gunt's.[1] (Table 2.2)

All of the above would seem to indicate that the food supply, and particularly the protein supply, is greater in the southeast than it is in the northwest. Food intake studies, diet histories, and clinical evaluations of nutritional status, all tend to confirm this impression (see Chapters 4 and 5 for details). Thus, we find that the diet in the southeastern part of Maring territory is richer in both proteins and calories than it is in the northwestern part of the territory. This is due primarily to the greater amount of meat (both wild and domesticated) and Marita consumed in the southeast and to the higher protein content of vegetables grown there.

Probably because of their more adequate diet, the people in the southeast were found to be consistently taller, heavier, fatter, and more muscular than those in the northwest, and their hemoglobin values were significantly higher despite the fact that they were living at lower altitudes and probably at greater exposure to malaria (see Chapter 5). Clinical signs of protein malnutrition were much less frequent in the southeast, and the incidence of enlarged livers and parotid glands (conditions frequently associated with protein malnutrition) was less. In addition to showing fewer clinical signs of protein malnutrition these populations also exhibited fewer signs of iodine deficiency. This was

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[1] These density figures, as well as territory size figures on which they are based are of questionable accuracy. This is because they were calculated from aerial photographs in which boundaries between the territories of local populations were difficult to determine. Nonetheless, they will be used here because they are the best estimates available.

TABLE 2.2

POPULATION DENSITY OF SIMBAI MARING LOCAL POPULATIONS.*

Population	numbers	Overall Population Density persons per sq. mi.	Population density per sq. mi. of gardens and secondary forest
Tsembaga	203	61.7	158.6
Tuguma	255	84.7	340.0
Gai	342	83.8	144.3
Nimbra	324	72.3	126.1
Singanai	200	44.8	160.0
Tsengamp-Murmbugai	160	50.3	160.0
Fungai-Korama	155	23.8	35.0
Bomagai-Angoing	130	37.6	41.8

* Computed from 1963 census figures by H. Manor, Department of Geography, University of Hawaii.

evidenced by lower goiter rates (see Chapter 5). As a result of more adequate intakes of both protein and iodine, children grew more rapidly in the southeast and few, if any, of them were affected by cretinism, a condition commonly encountered in the northwest, particularly among the Tuguma local population.

Gradients similar to those found in the nutritional status of local Maring populations are also encountered in the demography of these populations and are possibly related to protein availability. These gradients have been alluded to previously and they will be spelled out in detail in the next chapter. They indicate that both higher fertility and lower mortality is characteristic of the southeastern populations. This is true in spite of the fact that the density in these areas is less and indicates that at the time of the study these southeastern populations had a greater growth potential than those located in the northwest. However, because of their high population densities it is likely that at sometime in the past the northwestern populations were also characterized by higher growth rates.

CHAPTER 3

DEMOGRAPHY

Demographic studies were undertaken to determine the composition of the Simbai Maring population and to try and assess whether this was a stationary population, or if not stationary to determine the direction and rate of change. Moreover, the studies attempted to detect whether there were regional demographic differences which might reflect the existing environmental variation. In order to achieve this objective, a series of censuses were taken, reproductive histories were collected and a birth and death register was maintained.

In July and August of 1966, A. P. Vayda conducted a census of all Maring-speaking peoples between the Simbai and Jimi Rivers. I accompanied him on the Simbai part of the trip and the results of this census forms the backbone of my analysis. In addition, earlier Australian Government census records dating back to 1958 or 1960,[1] depending on the

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[1]The Government censuses at least in early years are highly unreliable. It is not until about 1963 or 1964 that Government census data is even relatively complete. In other words, up until that time new names were being added to the rosters as more and more people came out of the bush and made themselves known to the Government. By the time of my field work (1966-1969), there was probably only a residuum of about 2-3% of the total population who remained uncensused. This figure is based on my personal, intensive knowledge of the Tuguma population censused at Mondo. In 1966 the Tuguma numbered about 250. Of these, there were six individuals who were hiding in the bush and who were not and probably never will be censused by the Government. They include one adult man, his wife, and two children (a boy and a girl), and two elderly people, one male and one female. I have no information as to how many individuals may have been hiding in other areas, but I suspect that the situation at Mondo is not atypical.

location, were consulted. I then recensused the Simbai Valley Maring population in June and December of 1968. The time interval between our censuses was two years in the first case and six months in the second. The two and a half year interval between the 1966 and 1968 censuses was used to compute what are believed to be reasonably accurate vital statistics.

Reproductive histories were obtained from 418 Simbai Maring women. This number represents almost a total sample of all Simbai Valley women who were ever married. These women were questioned about each pregnancy which they had experienced and the outcome of that pregnancy. They were also questioned about: onset of menses after childbirth, duration of lactation, and resumption of sexual intercourse after pregnancy. This information was used to compute birthrates, infant mortality and pregnancy wastage; and to act as a cross-check on the information provided by census.

In August 1966, the total population of Maring speakers on the south wall of the Simbai was 2,071, of these 1,070 were males and 1,001 were females, yielding a sex ratio of 107 males per 100 females. Thirty-four per cent of the total population was under the age of 15, leaving 64 per cent aged 15 and over. Women between the ages of 15 and 44, that is, those of reproductive age, accounted for 24 per cent of the total population, while 50 per cent of all women were in the 15-44 age category. Using these figures and the census totals in February 1963, plus all birth, deaths and migrations recorded during that time interval, the following vital statistics can be computed: a crude birthrate of 23 births per 1,000, a crude death rate of 27 deaths per 1,000, and a crude rate of natural increase of -4 per cent. These birth and death rates are both remarkably low, and are most probably due to the artifact of the incomplete reporting of infants who died in their first year of life or between censuses. This, however, still leaves an excess of deaths over births, a fact which will be discussed more fully below.

The overall population change between June 1963 and August 1966 has been calculated at -0.8 per cent per annum, and includes an excess of out-migrations as well as an excess of deaths over births. During this time period a group of Gainj-speaking clans who had previously been censused at Singanai, returned to their ancestral home because of the alleged unhealthiness of Singanai. This group accounts for most of the outmigration.

In addition to the above, the three indices of fertility used by Brown and Winefield (1965) for the Chimbu were computed. This was done in order to compare Maring fertility with that of the Chimbu. Thus, fertility, or births per 1,000 females aged 15-44, was 97; reproduction, or female births per 1,000 females between the ages of 15 and 44, was 45; and the replacement rate, or the ratio of children aged 0-4 to women aged 15-44, was 0.400.

Computing the sex or masculinity ratios (males per 100 females) for the various age groups, we find a sex ratio of recorded births of 92, a sex ratio for children aged 0-14 of 110, and a sex ratio for adults aged 15 and over of 104. The high sex ratio for the 0-14 age group might indicate a relatively high death rate for young females. The lower sex ratio for those aged 15 and over may be due to a relatively higher mortality for adult males possibly due to warfare which was practiced until 1958. Figure 3.1 shows the age-sex distribution of the total Simbai Valley Maring population. Figure 3.2 compares the age-sex distribution

Fig. 3.1 TOTAL SIMBAI VALLEY MARING POPULATION AUGUST 1966

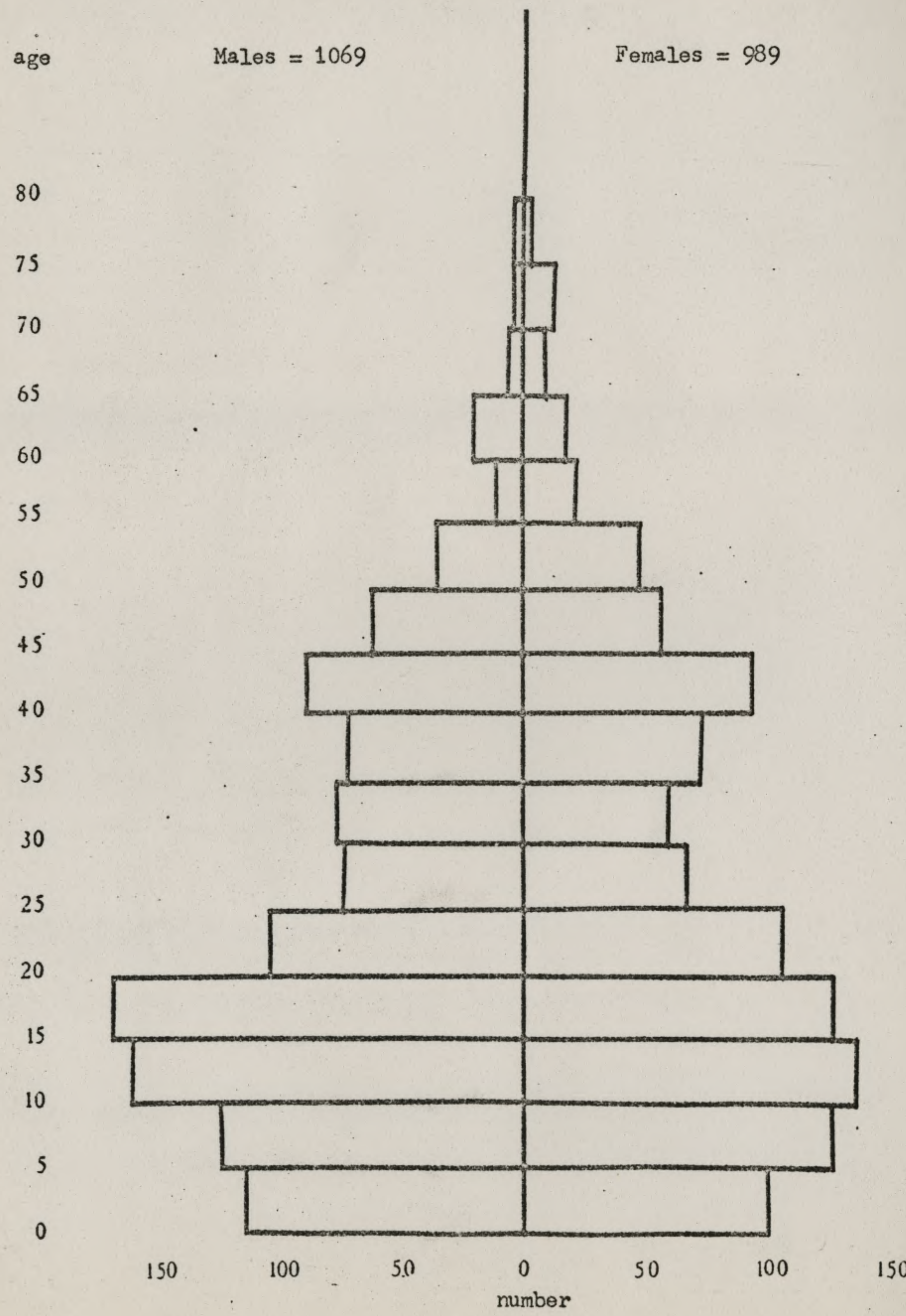
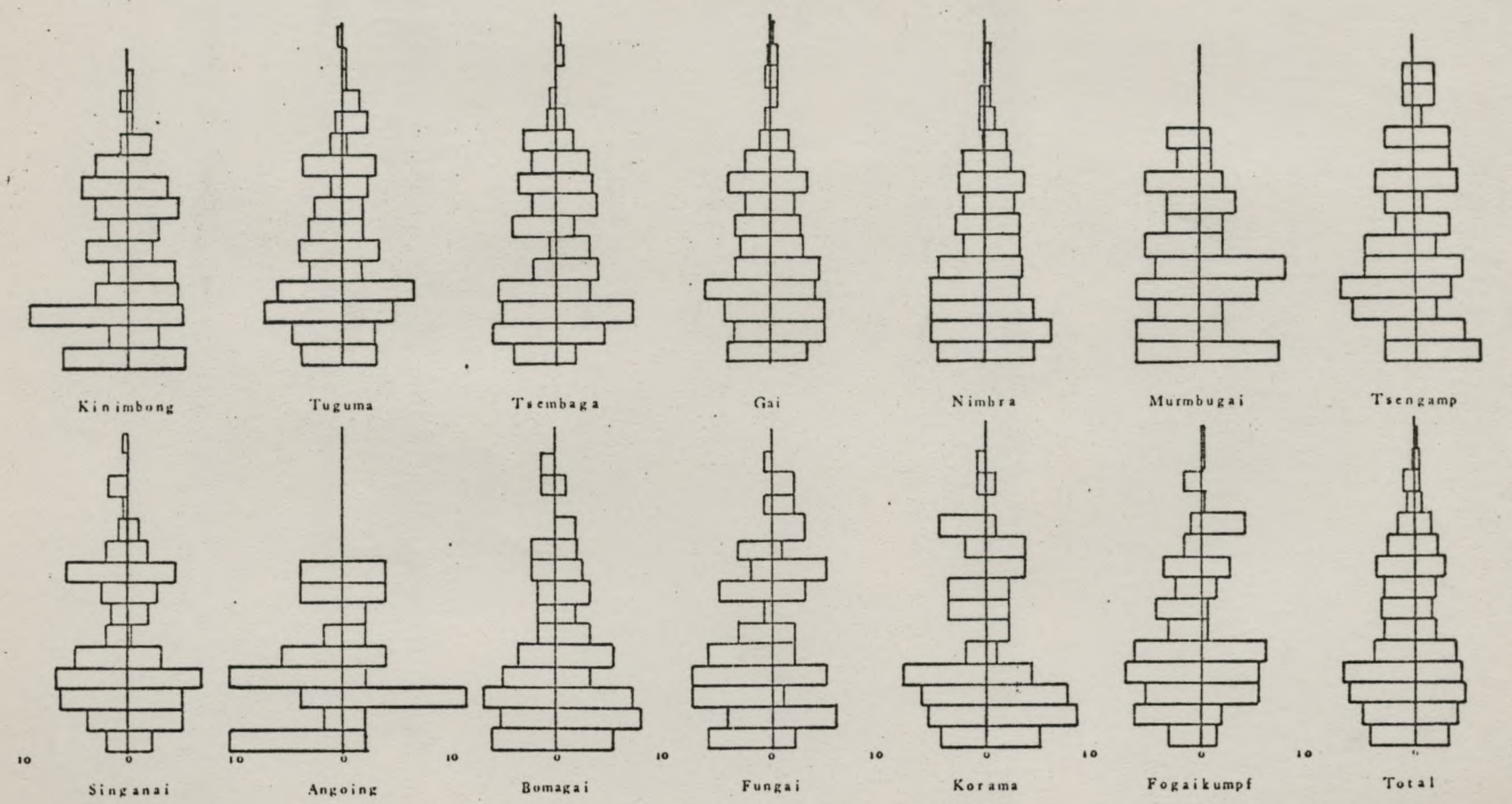


Fig.3.2 PERCENT AGE SEX COMPOSITION OF SIMBAI MARING LOCAL POPULATIONS AUGUST 1966



of each of the component local populations with each other and with the total. In this figure all groups are drawn to the same scale (per cent of total) in order to facilitate comparison. All of the above data is presented in Table 3.1, "Some Vital Statistics for Simbai Valley Maring Populations (August 1966)". This table also contains all of the above data and computations for each of the component populations.

Two years later in December 1968, the Simbai Valley Maring numbered 2,027 of whom 1,095 were males and 922 were females giving a sex ratio of 109 males per 100 females. Thirty-five per cent of the population was under the age of 15 years. Women between the ages of 15 and 44 accounted for 23 per cent of the total population and for 49 per cent of the total female population.

Vital statistics were computed from recorded births and deaths which occurred in the interval between August 1966 and December 1968. During this period the crude birthrate was 33 births per 1,000 and the crude death rate was 41 deaths per 1,000. The difference between these two rates gives a crude rate of natural increase of -8 per 1,000 per year. The overall population change between August 1966 and December 1968 was -0.9 per cent per annum. Again, a small percentage of this decrease was due to out-migration, but this time it was scattered individuals rather than whole clans who moved out of the area. In this later time period both the birth and death rates are higher than those computed for the 1963-1966 time period. This is due to better reporting of infant deaths; however, there is still reason to believe that these figures may still be too low because babies who die within a few hours or even within days of birth tend not to be reported.

The fertility indices computed for this time period are: fertility

TABLE 3.1

SOME VITAL STATISTICS FOR SIMBAI VALLEY MARING POPULATIONS
(August 1966)

	Kinimbong	*Tsembaga*	*Tuguma*	*Gai*	*Nimbra*	*Singanai*	*Tsengamp*	*Murmbugai*	*Korama*	*Fungai*	*Bomagai*	*Angoing*	*Fogaikumpf*	*Total Simbai*
Total Population	133	206	253	342	321	220	90	82	77	78	99	39	121	2071
% under 15	38	33	36	34	38	32	30	32	46	34	49	38	31	34
% over 15	62	67	64	66	62	68	70	68	54	66	66	62	69	66
% of women 15-44 in total population	29	23	23	23	23	28	20	27	18	22	24	23	26	24
% of women 15-44 in female population	57	49	40	49	47	55	42	63	46	50	45	50	53	50
Crude birth rate (births per 1000)	30	23	21	26	20	14	32	33	27	26	20	22	21	23
Crude death rate (deaths per 1000)	26	30	23	25	18	48	29	7	27	0	20	7	43	27
Crude rate of natural increase per 1000	+4	-7	-2	+1	+2	-34	+3	+25	0	+26	0	+ 15	-22	-4
Population change since 1963 Percent/per annum	+2.5	-0.6	-0.8	0.0	-0.3	-5.4	+.86	+1.4	0	+1.1	+ .28	+.86	-2.0	-0.8
Fertility: Births per 1000 women 15-44	103	103	93	112	90	51	158	168	162	117	84	94	83	97
Reproduction: female births per 1000 women 15-44	59	42	39	51	50	33	110	92	104	32	48	29	55	45
Replacement Children 0-4/women 15-44	.487	.362	.328	.405	.506	.213	.555	.540	.572	.411	.291	.333	.226	.400
Masculinity ratio: males/100 females														
Recorded births	75	143	137	114	77	57	43	86	60	250	118	200	50	92
Children 0-14	122	152	117	96	105	84	93	145	77	191	91	115	131	110
Adults 15+	78	103	110	120	106	108	113	129	121	108	90	118	100	104
Total	93	117	112	111	106	100	109	134	98	130	90	117	109	107

equals 140 births per 1,000 women aged 15-44, reproduction equals 69 female children per 1,000 women aged 15-44, and the replacement ratio equals 0.485 children 0-4 per wowan aged 15-44. Again, the fact that the fertility and reproduction rates have increased probably reflects the more accurate reporting of births, regardless of outcome, in this time period. The increase in the replacement rate does reflect an increase in the number of young children in the population (cf. Figure 3.1 and Figure 3.3). In 1968 the sex ratio of recorded births was 103; for children 0-14, 108; and for adults over 15, 110. This may possibly reflect relatively lower mortality for adult males in the absence of warfare, or higher relative female mortality during the recurrent influenza epidemics which were characteristic of the 1960's. The age-sex structure of the entire Simbai Valley Maring population as it existed in December 1968 is depicted in Figure 3.3 and that of the component populations in Figure 3.4. All of the above data are presented in Table 3.2, "Some Vital Statistics for Simbai Valley Maring Populations (December 1968)". This table also contains comparative information for the component local populations.

Figure 3.5 shows the age-sex distribution of the 1968 population by one-year rather than by five-year cohorts. It is included to show that although the ages of people over 10 are based on estimations (as discussed in Chapter 1), there is no systematic bias in these estimates, that is, there is no clustering of individuals at either five-or ten-year intervals. The fact that my age estimates do not show this bias does not necessarily mean that they are accurate, but at least they are free from the most common source of error in age estimation.

On the basis of data collected between August 1966 and December 1968

TABLE 3.2

SOME VITAL STATISTICS FOR SIMBAI VALLEY MARING POPULATIONS
(December 1968)

	Kinimbong	Tsembaga	Tuguma	Gai	Nimbra	Singanai	Tsengamp	Murmbugai	Korama	Fungai	Domagai	Angoing	Fogaikumpf	Total Simbai
Total Population	*148*	*209*	*232*	*354*	*319*	*198*	*91*	*89*	*75*	*76*	*91*	*55*	*113*	*2027*
% under 15	38	33	36	33	39	33	30	38	44	37	46	33	32	35
% over 15	62	67	64	67	61	67	70	62	56	63	54	67	68	65
% of women 15-44 in total population	28	23	22	22	23	26	18	24	21	21	25	26	24	23
% of women 15-44 in female population	53	50	47	48	48	54	40	53	45	43	50	58	49	49
Crude birth rate (births per 1000)	40	48	19	25	32	37	19	41	28	39	19	45	55	33
Crude death rate (deaths per 1000)	18	43	64	42	20	68	47	31	34	39	38	30	44	41
Crude rate of natural increase per 1000	+22	+5	-43	-17	+12	-31	-28	+10	-6	0	-19	+15	+11	-0.8
Population change since 8/66 Percent/per annum	+4.4	+0.4	-3.6	+1.0	-0.2	-4.2	0.0	+4.9	-1.6	+1.1	0.0	-2.2	-2.8	-0.9
Fertility: Births per 1000 women 15-44	141	210	90	110	139	142	107	163	134	188	75	184	233	140
Reproduction: female births per 1000 women 15-44	87	100	57	66	52	55	85	102	53	112	19	92	109	69
Replacement: Children 0-4/women 15-44	.359	.512	.699	.272	.552	.507	.875	.810	.625	.750	.435	.725	.595	.485
Masculinity ratio: males/100 females														
recorded births	63	109	57	67	167	157	33	60	150	75	300	100	114	103
children 0-14	95	142	115	87	113	78	80	120	120	155	121	125	121	108
adults 15+	84	108	118	129	105	122	156	124	100	85	82	131	100	110
Total	88	118	117	113	108	105	127	122	109	106	98	129	106	109

Fig. 3.3 TOTAL SIMBAI VALLEY MARING POPULATION DECEMBER 1968

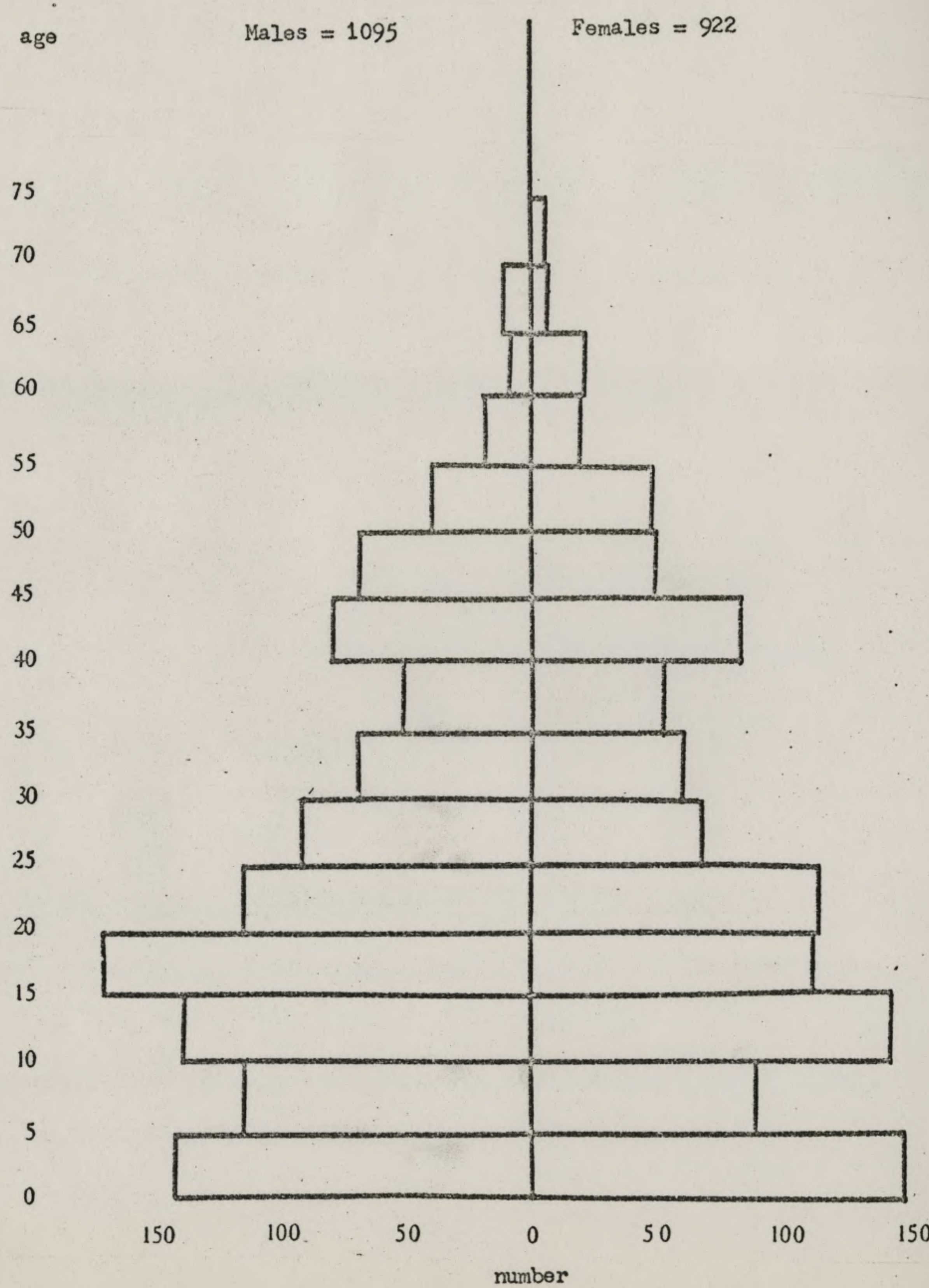


Fig. 3.4 TOTAL SIMBAI VALLEY MARING POPULATION DECEMBER 1968 by 1 year age cohorts

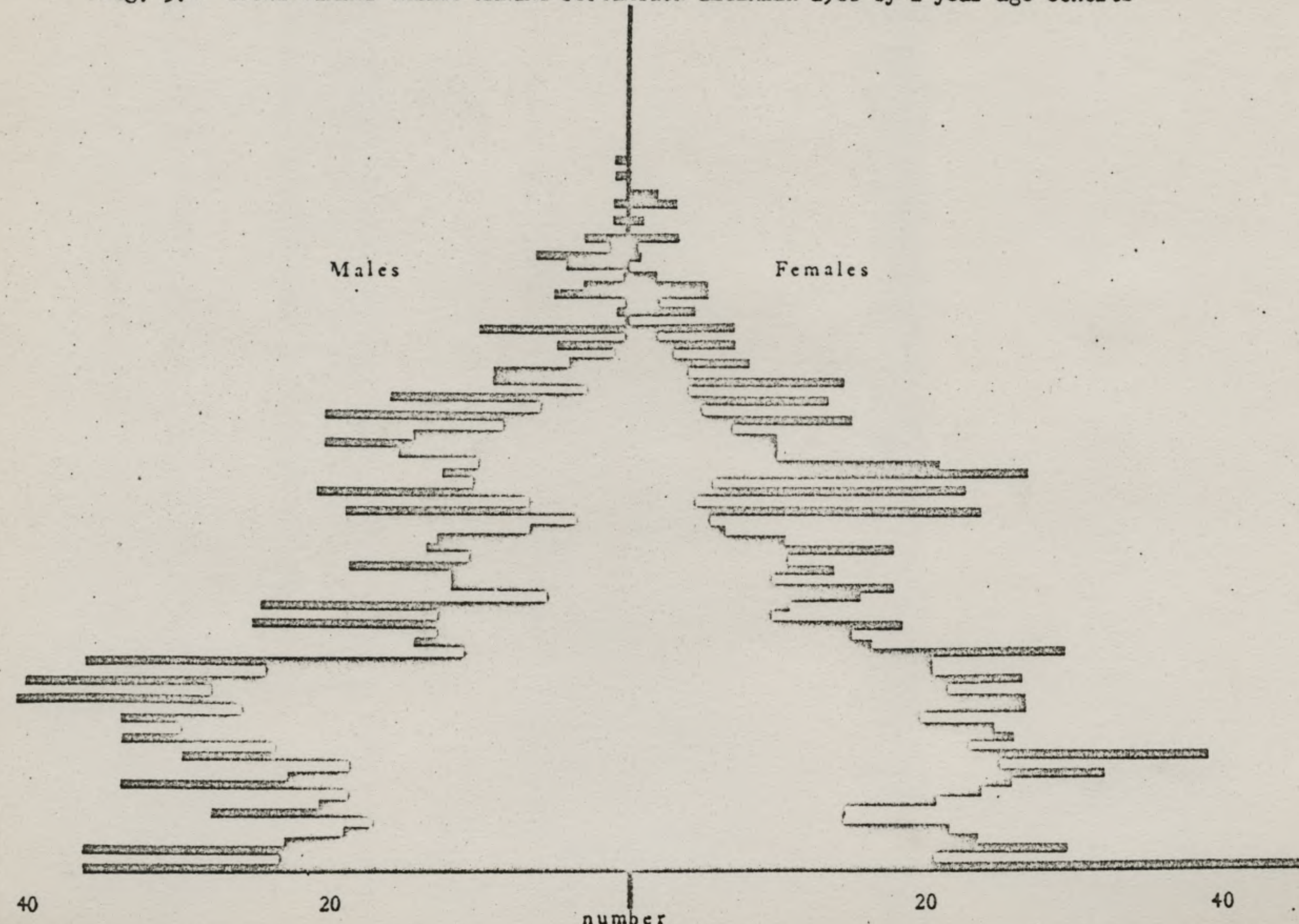
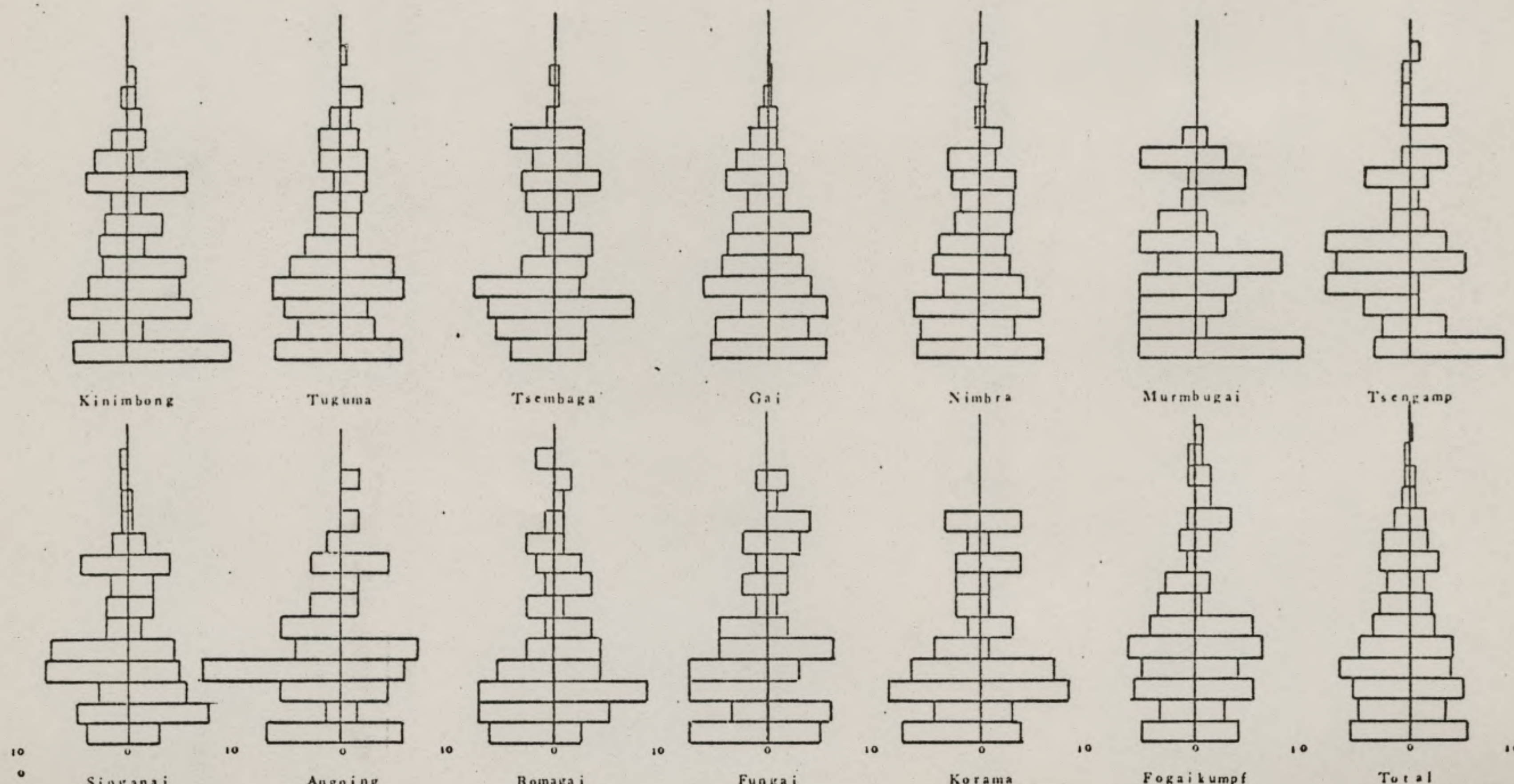


Fig. 3.5 PERCENT AGE SEX COMPOSITION OF SIMBAI MARING LOCAL POPULATIONS DECEMBER 1968

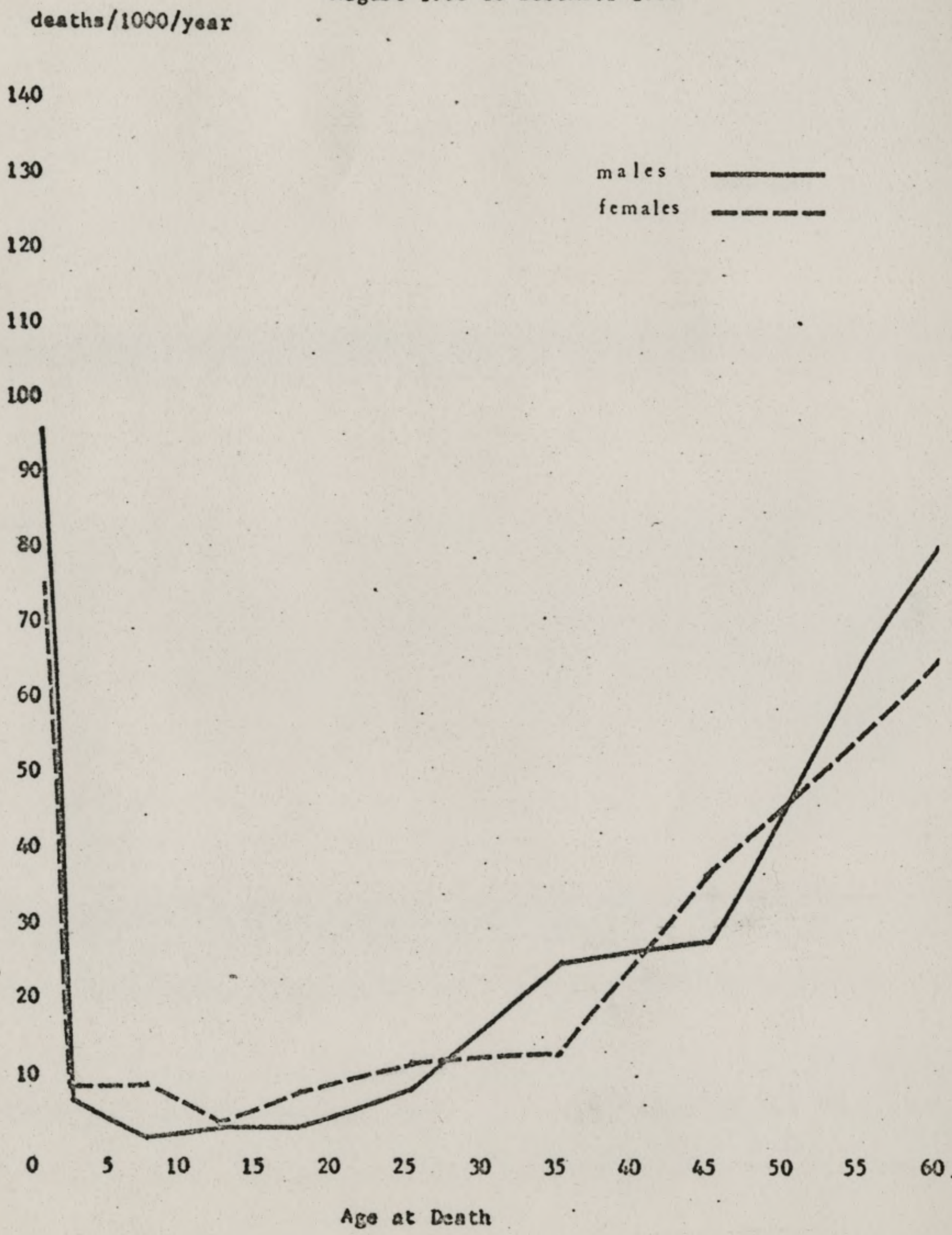


an attempt was made to compute age-specific death rates for the Simbai Valley Maring. These are presented in Figure 3.6. According to Nancy Howell Lee, the anthropological demographer, (personal communication), these indicate a lower than expected infant mortality and a higher than expected mortality for individuals up to the age of 25. They also show that females between the ages of 3 and 27 have higher rates of mortality than do males of the same age and that this is also true of women between the ages of 40 and 50. This differential mortality and its causes will be explained later in this chapter. No attempt was made to compute age-specific death rates for the earlier time period because of the inaccuracy and incompleteness of the data. Also, no attempt was made to compute these rates for the individual local populations because of their small size.

Given the above census data and the derived indices, what if anything can be said about the demographic characteristics of the Simbai Maring? The most important fact which emerges is that this is a declining population. This is evident both from the fact that between February 1963 and December 1968 deaths outnumbered births, and that the population declined at a rate of between -0.8 and -0.9 per cent per annum during that time period. If this rate of decline were constant, the population would have a half-life of about eighty-five years. But this decline appears to be recent, possibly dating back no further than the late 1950's or early 1960's. This may be deduced by examination of the age-sex pyramids which show a marked deficiency in the number of individuals under the age of ten. This deficiency is particularly marked for the number of individuals under the age of five in the pyramids constructed for the population as it existed in August 1966, but it is also present

Fig. 3.6 AGE SPECIFIC DEATH RATES FOR SIMBAI VALLEY MARING

August 1966 to December 1969



in the December 1968 population pyramids--although in the latter case the number of individuals under the age of five has begun to increase. A further examination of the population pyramids reveals another deficiency, this time in the cohort of individuals between the age of twenty-five and forty.

There are two known historical facts which can help to account for the deficiency of individuals in the 0-10 and in the 25-40 age-cohorts. First, throughout the 1960's, the Simbai Valley Maring experienced a series of epidemics, including influenza, meningitis and possibly measles. These were new diseases for the Maring and thus carried with them a high mortality, particularly for young children although persons of all ages were affected. Second, the deficiency in the size of the 25-40 cohort may be the result of the territory-wide dysentery epidemic which occurred in the 1940's. This epidemic had a high mortality everywhere, and it has been estimated that up to 30 per cent of the Maring population may have died then (Rappaport 1968:9; Vayda 1971). According to my Maring informants this epidemic was most severe in its effects on children and adolescents. A number of women told me that they had lost several older children and that they were so grieved by this loss, that they voluntarily abstained from having more children. Also, because there is a deficiency in the size of the 25-40 year cohort, and since these individuals are the parents of the 0-10 year cohort, it may be possible to attribute some of the small size of the latter cohort to the small size of the former cohort.

The crude birthrate for the interval between 1966 and 1968 was as previously noted, 33 births per 1,000. This is still a low birthrate by New Guinean standards (see Table 3.3 for comparative data). While it

TABLE 3.3

MARING VITAL STATISTICS COMPARED WITH THOSE OF OTHER NEW GUINEA POPULATIONS

INDICES	MARING	KIRIWINA*	ORO BAY*	BRERI*	ANGUGANAK*	WAM*	BAIYER*	MINTIMA (CHIMBU)**
Crude birthrate	33	33	40	51	36	43	27	27
Crude death rate	41	13	12	24	18	23	8	15
Natural Increase % per annum	0.1	2.0	2.8	2.7	1.8	2.0	1.9	1.2
Fertility	140	158	169	230	166	195	105	105

* Stanhope (1970)
** Brown and Winefield (1965)

may reflect the under-reporting of children who die soon after birth, there are other indications that this low birthrate may indeed be characteristic of the Maring. These indications include: the age distribution of the population, the results of the reproductive histories, and the knowledge of certain Maring cultural practices which tend to limit fertility. Further, by New Guinean standards, as well as those for most of the pre-industrial world, the Maring are an old population. By this I mean that only 35 per cent are under the age of 15 years (cf. Sinnett 1972, who for a New Guinea Highland population reports that 43.6 per cent are under the age of 15; and Bowers 1970, who for a population in the Kaugel Valley of the Western Highlands reports that 40 per cent are under the age of 15). This fact would indicate that the birthrate is really low and that even without the epidemics of the 1940's and 1960's the Maring were a stationary, or at best, only a very slowly growing population. Vayda (1971) has come to similar conclusions. These impressions about the low birthrate and the static nature of the population seem to be confirmed by the reproductive histories which also point to very low birthrates. These will be discussed in the following section of this chapter.

Reproductive Histories

The data collected by reproductive history is presented in Tables 3.4 and 3.5. On examination of these tables we are once more left with the impression of very low fertility which again may be due in part to under-reporting. In particular, we note that women aged 50 and over report fewer pregnancies than women aged 40-49. The older cohort averages only 2.93 pregnancies per woman, the younger 3.76. Also the number of survivors appears to be too high even for the younger cohorts. However, the biostatistician Howard Levine (personal communication) noted that there is good agreement between the per cent of survivors derived from the reproductive histories and the shape of the age-specific death curve.

The fact that the number and percentage of reported infant deaths consistently decreases from one age-cohort to the next requires some comment. Ignoring the youngest cohort because it is so small, we note that in the 20-29 cohort 22.9 per cent of all pregnancies resulted in offspring who died as infants, in the 30-39 cohort the number of infant deaths drops to 13.9 per cent, in the 40-49 cohort it is 9.0 per cent, and in the 50 and over cohort only 8.3 per cent of pregnancies resulted in offspring who died as infants. This is obviously related to the fact that older women have had more pregnancies and so those offspring who died in infancy represent a smaller percentage of the total (see Tables 3.4 and 3.5).

Another factor may be older women forgetting their children who died in infancy. The forgetting of pregnancies (particularly of those which resulted in abortions, stillbirths and infant deaths) by older women would be facilitated by the Maring practice of not naming children until they are at least six weeks old. In addition, there may have been some under-reporting of infanticides. While I believe that this practice is fairly common, the Maring have learned that it is prohibited by the Australian administration. Thus, some women might have feared that I would report them to the authorities, particularly since this had been done by missionaries who had discovered cases of infanticide.

Nevertheless, despite the above qualifications Maring fertility levels still appear to be low, although probably not quite as low as the data indicates. If we assume that the age of menarche for Maring

TABLE 3.4

REPRODUCTIVE HISTORIES--OUTCOME OF PREGNANCIES BY NUMBER

Group	Age	No. of Women	No. of Preg.	Aver. Preg. per Woman	ABORTED		STILLBIRTH		DEATHS: INFANT		DEATHS: TODDLER		DEATHS: CHILD		DEATHS: ADOLESCENT		DEATHS: ADULT		ALIVE		OTHER		TOTAL	
					M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Fogaikumpf	0-19	3	1	.33				1											0	0				1
	20-29	15	29	1.93					7	5									8	7			15	13
	30-39	3	14	4.67					3	2									4	5			7	7
	40-49	3	10	3.33						1									5	4			5	5
	50+	9	31	3.44					4	2	1		1	1					12	10			18	13
Total		33	85	2.58				1	14	10	1		1	1					29	28			45	38
Angoing	0-19	1	0	0															0	0			0	0
	20-29	3	4	1.3					1										2	1			3	1
	30-39	1	3	3.0															2	1			2	1
	40-49	1	2	2.0															2	0			2	0
	50+	1	2	2.0															2	0			2	0
Total		7	11	1.6					1										8	2			9	2
Bomagai	0-19	0	0	0																			0	0
	20-29	7	10	1.43					1										4	4			5	4
	30-39	6	29	4.8						1		2							14	12			14	15
	40-49	2	9	4.5		1				1		1							3	3			3	6
	50+	2	8	4.0		1									1	1			2	3			3	5
Total		17	56	3.3		2			1	2		3			1	1			23	22			25	30
Fungai	0-19	0	0	0																			0	0
	20-29	5	7	1.55																3	3		1	3
	30-39	3	8	2.70					1	1									3	2	1		4	3
	40-49	4	19	4.75								1	3			1		1	8	5			11	8
	50+	5	20	4.00						1				1	1		2	3	8	4.			11	9
Total		17	54	3.20					1	2		1	3	1	1	1	2	4	20	14			27	23
Korama	0-19	1	3	3.00						2										1			0	3
	20-29	1	1	1.00															1				1	0
	30-39	2	5	2.50										1					1	2	1		1	3
	40-49	4	20	5.00						1			1	1					11	6			12	8
	50+	1	2	2.00															1	1			1	1
Total		9	31	3.44						3			1	2					14	10	1		15	15

TABLE 3.4--Continued

Group	Age	No. of Women	No. of Preg.	Aver. Preg. per woman	Aborted		Stillbirth		Deaths: Infant		Deaths: Toddler		Deaths: Child		Deaths: Adolescent		Deaths: Adult		Alive		Other		Total	
					M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Murmbugai	0-19	0	0	0.00															0	0			0	0
	20-29	10	17	1.70	1				1	3									3	8			5	11
	30-39	2	7	3.50															5	2			5	2
	40-49	7	34	4.90					2	2				2					15	13			17	17
	50+	1	2	2.00															1	1			1	1
Total		20	60	3.00	1				3	5				2					24	24			28	31
Tsengamp	0-19	0	0	0.00															0	0			0	0
	20-29	6	11	1.80					1	2									3	4	1		4	6
	30-39	3	13	4.33					2	1		1							4	5			7	6
	40-49	6	23	3.80					1	1	1	1							7	10			10	13
	50+	4	13	3.25								1	4	1			1		2	4			7	6
Total		19	60	3.15					4	4	1	3	5	2			1		16	23	1		28	31
Singanai	0-19	3	0	0.00															0	0			0	0
	20-29	11	11	1.00	1	1	1		1	1									2	4			5	6
	30-39	10	26	2.60			2	1	3		1	1							5	11			11	13
	40-49	10	42	4.20	1				4	2	3	1		1					13	18			21	22
	50+	1	3	3.00									2						1	0			3	0
Total		35	82	2.34	2	1	3	1	8	3	4	2	2	1					22	23			40	41
Nimbra	0-19	2	0	0.00															0	0			0	0
	20-29	18	21	1.17					1	4	1								7	8			9	12
	30-39	20	73	3.65		1			6	4	2	1	2	1					27	29			37	36
	40-49	19	66	3.47	1				1	1	1	1	2	3	1		1		29	24			36	30
	50+	10	28	2.80					1	1				2					11	13			12	16
Total		69	188	2.72	1	1			9	10	4	2	4	6	1		1		74	74			94	94
Gai	0-19	0	0	0.00															0	0			0	0
	20-29	21	31	1.48		1			4		1	2							12	12			17	14
	30-39	20	68	3.40					3	7	3	1	2	1					29	21			37	31
	40-49	11	46	4.18					4	2		3	2			1			19	15			25	21
	50+	12	32	2.67				1		2							1	1	17	10			18	14
Total		64	177	2.77		1		1	11	11	4	6	4	1		1	1	1	77	56			97	80

TABLE 3.4--Continued

Group	Age	No. of Women	No. of Preg.	Aver. Preg. per Woman	Aborted		Stillbirth		Deaths: Infant		Deaths: Toddler		Deaths: Child		Deaths: Adolescent		Deaths: Adult		Alive		Other		Total	
					M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Tuguma	0-19	1	1	1.00			1												0	0			1	0
	20-29	14	25	1.79			6	5		3									5	6			11	4
	30-39	8	17	2.13					3		1	1							6	6			10	7
	40-49	16	56	3.50			2		1	4	3					1			20	25			26	30
	50+	9	21	2.33									1	1		1		1	8	9			9	12
Total		48	120	2.50			9	5	4	7	4	1	1	1		2		1	30	46			57	63
Tsembaga	0-19	7	0	0.00															0	0			0	0
	20-29	16	24	1.50				2	3	2	1								7	9			11	13
	30-39	8	28	3.50			1		2	1	2				1				10	11			16	12
	40-49	10	32	3.20		1			3			1			1				14	12			18	14
	50+	7	23	3.29					3		1			1	1		1	1	7	8			13	10
Total		48	107	2.23		1	1	2	11	3	4	1		1	3		1	1	38	40			58	49
Kinimbong	0-19	1	0	0.00															0	0			0	0
	20-29	7	8	1.14					2										2	4			4	4
	30-39	5	9	1.80									1	1					4	3			4	4
	40-49	8	7	3.38					1	1	1								8	16			10	17
	50+	6	5	2.50						1			1				1		7	5			9	6
Total		27	59	2.19					3	2	1		2	1			1		21	23			27	31
TOTAL	0-19	22	5	0.23			1			3									0	1			1	4
	20-29	137	196	1.43	1	1	7	7	23	22	3	2							61	71			96	104
	30-39	88	286	3.25		2	3	1	25	17	9	7	5	5	1				107	106			150	138
	40-49	101	380	3.76	2	2	2	1	17	17	10	7	8	7	2	4	1		153	148			195	185
	50+	70	205	2.93					8	9	5	2	7	6	3	4	5	4	82	69			110	95
Total		418	1072	2.56	3	5	13	9	71	69	26	18	20	18	6	8	6	4	402	395			552	526

TABLE 3.5

REPRODUCTIVE HISTORIES--OUTCOME OF PREGNANCIES BY PERCENT

Group	Age	No. of Women	No. of Preg.	Aver. Preg. per woman	ABORTED		STILLBIRTH		DEATHS: INFANT		DEATHS: TODDLER		DEATHS: CHILD		DEATHS: ADOLESCENT		DEATHS: ADULT		ALIVE		OTHER	TOTAL	
					M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F		M	F
Fogaikumpf	0-19	3	1	.33						100													100.0
	20-29	15	29	1.93					24	17									35	24		58.6	41.4
	30-39	3	14	4.63					21	14									29	36		50.0	50.0
	40-49	3	10	3.33						10									50	40		50.0	50.0
	50+	9	31	3.44					13	7	3	3	3						39	32		58.1	41.9
Total		33	85	2.85					17	13	1	1	1						37	31		55.3	44.7
Angoing	0-19	1	0																0	0		0	0
	20-29	3	4	1.30																			
	30-39	1	3	3.00					25										50	25		75.0	25.0
	40-49	1	2	2.00															100			100.0	
	50+	1	2	2.00															100			100.0	
Total		7	11	1.60					9										74	18		82.0	18.0
Bomagai	0-19																				10		
	20-29	7	10	1.43					10										40	40		50.0	40.0
	30-39	6	29	4.80						3		7							48	42		48.0	52.0
	40-49	2	9	4.50		11				11		11							33	33		33.0	66.0
	50+	2	8	4.00		13									13	13			25	38		38.0	62.0
Total		17	56	3.30		4			2	4		5			2	2			41	39	2	45.0	55.0
Fungai	0-19	0	0	0																		0	0
	20-29	5	7	1.55															14	43	4	14.0	43.0
	30-39	3	8	2.70					13	13									38	25	1	50.0	38.0
	40-49	4	19	4.75								5	2		5			5	42	26		68.0	42.0
	50+	5	20	4.00						5				5		5	10	15	40	20		55.0	45.0
Total		17	54	3.20					2	4		2	6	2	2	2	4	7	37	26		57.0	43.0
Korama	0-19	1	3	3.00						66										33			100.0
	20-29	1	1	1.00															100			100.0	
	30-39	2	5	2.50										20					40	20	2	25.0	75.0
	40-49	4	20	5.00						5			5	5					55	30		60.0	40.0
	50+	1	2	2.00															50	50		50.0	50.0
Total		9	31	3.44						10			3	6					45	32	3	50.0	50.0

TABLE 3.5--Continued

Group	Age	No. of Women	No. of Preg.	Aver. Preg. per woman	ABORTED		STILLBIRTH		DEATHS										ALIVE		OTHER	TOTAL	
									INFANT		TODDLER		CHILD		ADOLESCENT		ADULT						
					M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F		M	F
Murmbugai	0-19	0	0	0																		0	0
	20-29	10	17	1.70	6				6	18									18	52		30.0	70.0
	30-39	2	7	3.50															71	29		71.0	29.0
	40-49	7	34	4.90					8	8				6					41	36		50.0	50.0
	50+	1	2	2.00															50	50		50.0	50.0
Total		20	60	3.00	2					8				3					36	36		46.0	54.0
Tsengamp	0-19	0	0	0																		0	0
	20-29	6	11	1.80					10	19									29	37	10	37.0	63.0
	30-39	3	13	4.33					16	8		8							31	38		54.0	46.0
	40-49	6	23	3.80					5	5	5	5	5	5					29	44		44.0	56.0
	50+	4	13	3.25								8	3	8				8	16	31		54.0	46.0
Total		19	60	3.15					4	4	2	5	8	3				2	27	38	2	47.0	53.0
Singanai	0-19	3	0	0.00																		0	0
	20-29	11	11	1.00	9	9	9		9	9									18	36		45.5	54.5
	30-39	10	26	2.60			8	4	12		4	4		4					23	42		46.2	53.8
	40-49	10	42	4.20	2				10	5	7	2							31	43		50.0	50.0
	50+	1	3	3.00									67						33			100.0	
Total		35	82	2.34	2	1	4	1	10	4	5	2	2	1					27	40		50.0	50.0
Nimbra	0-19	2	0	0.00																		0	0
	20-29	18	21	1.17					5	19	5								33	38		42.9	57.1
	30-39	20	73	3.65		1			8	6	3	1	3	1					37	40		50.7	49.3
	40-49	19	66	3.47	2				2	2	2	2	3	5	2	2	2		44	36		54.5	45.5
	50+	10	28	2.80					4	4				7					39	46		42.9	57.1
Total		69	188	2.72	1	1			5	5	2	1	2	3	1	1	1		39	39		50.0	50.0
Gai	0-19																						
	20-29	21	31	1.48					13		3	7							39	39		54.8	45.2
	30-39	20	68	3.40		2			4	10	4	2	3	2					43	31		54.4	45.6
	40-49	11	46	4.18					9	4		7	4			2			41	33		54.3	45.7
	50+	12	32	2.67				3		6							3	3	53	31		56.3	43.8
Total		64	177	2.77		1		1	6	6	2	3	2	1		1	1	1	44	33		54.8	45.2

TABLE 3.5--Continued

					ABORTED		STILLBIRTH		DEATHS: INFANT		DEATHS: TODDLER		DEATHS: CHILD		DEATHS: ADOLESCENT		DEATHS: ADULT		ALIVE		OTHER	TOTAL	
Group	Age	No. of Women	No. of Preg.	Aver. Preg. per woman	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F		M	F
Tuguma	0–19	1	1	1.00			100															100.0	
	20–29	14	25	1.79			24	20		12									20	24		44.0	56.0
	30–39	8	17	2.13					18		6	6							35	35		58.8	41.2
	40–49	16	56	3.50			4		2	7	5					2			38	45		46.4	53.6
	50+	9	21	2.33									5	5		5		5	38	43		42.9	57.1
Total		48	120	2.50			8	4	3	6	3	1	1	1		2		1	33	38		47.5	52.5
Tsembaga	0–19	7	0	0																		0	0
	20–29	16	24	1.50				8	13	8	4								29	38		45.8	54.2
	30–39	8	28	3.50			4		7	4	7				4				36	39		57.1	42.9
	40–49	10	32	3.20		3			9			3			3				44	38		56.3	43.8
	50+	7	23	3.29					13		4			4	4		4	4	30	35		56.5	43.5
Total		48	107	2.23		1	1	2	10	3	4	1		1	3		1	1	36	37		54.2	45.8
Kinimbong	0–19	1	0	0																		0	0
	20–29	7	8	1.14					25										25	50		50.0	50.0
	30–39	5	9	1.80									11	11					44	33		55.6	44.4
	40–49	8	27	3.38					3	4	4								30	59		37.0	63.0
	50+	6	15	2.50						7			7				7		47	33		60.0	40.0
Total		27	59	2.19					5	3	2		3	2			2		36	48		47.5	52.5
TOTAL	0–19	22	5	0.23			20			6										20		20.0	80.0
	20–29	137	196	1.43	1	1	4	4	12	11	2	1							31	36		48.0	52.0
	30–39	88	286	3.25		1	1		8	6	3	2	2	2					37	37		51.7	48.3
	40–49	101	380	3.76	1	1	1		5	5	3	2	2	2	1	1			40	39		51.3	48.7
	50+	70	205	2.93				1	4	4	2	1	3	3	2	2	2	2	40	34		53.7	46.3
Total		418	1072	2.56		1	1	1	7	6	3	2	2	2	1	1	1		38	37		51.1	48.9

women is about 18.5 years[1] and the age of menopause is about 40,[2] and that the average interval between pregnancies is about three years, then the maximum number of pregnancies which a Maring woman can experience is, in fact, seven--provided that each pregnancy is carried to term, and that each child is born alive and manages to survive for at least two years. This may explain the fact that the maximum number of pregnancies reported by any woman was seven and that this number occurred in only three cases out of 418. Among the Tuguma clan cluster for whom I collected complete genealogies, the single largest sibling group encountered was also seven.

Cultural Practices and Biological Factors Affecting Fertility

In common with many New Guinea societies, the Maring exhibit a number of cultural traits which tend to limit their fertility. These include their late age at marriage (ca. 20 for women and from 25 to 35 for men) and the instability of marriages in their first year. Both Maring men and women express a desire to postpone marriage at least for a while; the women to avoid the heavy work of gardening and the pain of childbearing, and the men to avoid the increased responsibility and heavier work loads associated with marriage. In the early months of a marriage, particularly of an arranged marriage, husband and wife tend to avoid each other, both out of feelings of shame. In addition, young men fear the debilitating effects of sexual pollution.

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[1] Based on application of a regression formula derived by Malcolm (1968, 1969) relating age of menarche to average adult size.

[2] The actual average age of menopause in the Territory of Papua and New Guinea is unknown because there are very few middle-aged women whose birthdates have been recorded, but the age of 40 is the one most frequently used by public health workers in the area.

It is considered to be improper for a woman to conceive too soon after her first marriage. This appears to be related to the fact that marriages are extremely brittle in their first months, and that the Maring tolerate no illegitimate children, whether they are the result of pre- or extramarital liaisons. Chastity and fidelity are supposed to prevent illegitimate conceptions, but if such conceptions do occur, or if there is any hint that a woman's husband is not the father of her child, then the infant is destroyed at birth. Two such cases occurred while I was at Mondo. Infanticide is also practiced in the case of malformed infants; I know of one case occurring among the Tuguma. Women who wish to avoid the responsibility of child rearing, either because they consider themselves to be too young, in the case of a first pregnancy, or too old, in the case of a last pregnancy, also practice infanticide. No such cases occurred while I was with the Tuguma; however, adolescent Jimi Maring girls have told me that they have seen their mothers destroy a last baby. In the case of twins, the Maring say that they kill both babies because they believe that only animals give birth to more than one offspring at a time. It may also be resorted to if the interval between births is too short, and this also occurred in two cases among the Tuguma. The Maring believe that a child should be walking, talking, and reasonably independent before the next one is born. This interval of from two and one half to four years is supposed to be maintained by postpartum and lactation taboos on sexual intercourse.

In the course of collecting reproductive histories, some informants told me that their husbands, before going off to work on coastal plantations, had asked them to dispose of their unborn infants. The reasons given for this request were that it would be too hard for a woman to raise a child in her husband's absence, and that the child would not know his father on his return.

Normally, the fate of an unborn child is decided by the community, in particular by the mother's female relatives. It is the mother, however, who is responsible for disposing of the child, although on rare occasion she may be aided in this act by her husband.

The Maring claim no knowledge of abortion, and their contraceptive technology is limited and probably ineffectual. Some informants claim that they practice coitus interruptus to avoid pregnancy, and it is believed that certain individuals possess magical spells which will prevent conception and/or menstruation. A woman's inability to conceive, or to carry a pregnancy to term, or to bear a viable child is often attributed to a curse from her father or brother for failing to marry a man of their choice, or from a rejected suiter.

Sterility does occur among Maring women. However, in some cases it is difficult to tell whether childlessness is due to absolute sterility or to the inability of a woman to carry a fetus to term. Of a total of 396 women above the age of 20, 26 or 6.5 per cent were childless. Breaking this down by 10 year age-cohorts, the percentage of childless cohorts were as follows: in the 20-29 group, 9.5 per cent; in the 30-39 group, 6.8 per cent; in the 40-49 group, 2 per cent; and in the 50+ group, 2.8 per cent.

Again there is regional variation in the number of childless women. Thus, the highest percentage of childless women were found in Singanai, 16 per cent; in Nimbra, 14 per cent; Tuguma, 8 per cent; Tsembaga, 7 per cent; Fogaikumpf, 6 per cent; and Fungai, 6 per cent. Three per cent of the women at Gai were childless. There were no childless women in

Angoing, Bomagai-Korama, Tsengamp and Kinimbong. The distribution of childlessness seems to parallel that of goiters in women and may indicate that iodine deficiency is interfering with fertility.

The Maring share a common New Guinea Highlands belief that women are unclean and polluting and that men may suffer premature aging or worse from too much contact with women (Meggitt 1964). While I have no direct evidence on the frequency of sexual contact, it is likely that this belief would tend to keep it low. This is a conclusion reached by Heider (1972) for the Dani and Meggitt (personal communication) for the central Mae Enga (cf. Bulmer 1971:155).

Several young men of my acquaintance have confided to me that they have maintained their fine physiques and smooth skins by scrupulously avoiding women. It is now a common practice for young men to sign up for two years of plantation labor shortly after their marriage. The men say that they do this because of their fear of the debilitating effects of sexual intercourse. Maring men do not engage in homosexuality. Some of them learned of the existence of these practices while working on coastal plantations and were horrified and disgusted by what they saw. There are taboos on sexual intercourse during certain times in their ritual and warfare cycles (Rappaport 1968; and C. Lowman Vayda 1969) and these taboos undoubtedly have an effect on fertility level, although the magnitude of this effect is not likely to be large.

Polygyny is practiced among the Maring but only to a limited extent.[1] Most men have one wife at a time, although a few have two;

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[1]While the extent of polygyny has not been calculated, it is probably low. A. P. Vayda (personal communication) estimates that no more than 10% of all marriages are polygynous.

fewer still have three, and only one man in the Simbai Valley had as many as four. The practice of polygyny may help to reduce fertility by making it easier for a man to observe the prolonged lactation taboos. But, because of its limited distribution, it is not likely that this practice has any great effect on the fertility levels of the population. Indeed there have been cases of Maring polygynists getting one or more of their wives pregnant too soon after the birth of a previous child. Such behavior is, of course, greatly disapproved of by the community. Women in particular are quick to point out that such a man is like a dog, having no self-control. Again these pregnancies do not result in live offspring, for such infants are frequently killed at birth. The Maring do not adopt young infants, those who are still dependent on mother's milk, because they have no means of artifically feeding them; however, they do adopt older orphan children, those who are capable of eating solid food.

Maring mortuary practices may also help to limit fertility. A man's chief mourner is his widow, and for a period of time, often lasting two years or more after his death, she is required to remain secluded and is prohibited from remarrying. Some widows, particularly older ones, are slow to remarry even after they have gone through the required purification and coming-out ceremony, and are free to do so.

Finally, many Maring women consider it to be improper to become pregnant again once their eldest children are fully grown, and they will thus avoid sexual intercourse and voluntarily terminate their reproductive span. Women may also do this as an expression of grief for their older children who have died, or out of anger with their husbands.

One can see that the practices outlined above would have the combined effect of limiting fertility, by limiting the amount of time that a woman is exposed to the risk of conception, and by limiting the frequency of that risk, even at times when conception would be culturally approved. Effective fertility is further lowered by the practice of infanticide in the event of an unwanted pregnancy. As far as I have been able to determine, most of the above mentioned beliefs and practices have a uniform distribution among the various Simbai Maring populations and thus cannot explain regional differences in fertility.

In addition to these cultural factors which affect fertility levels, there are also biological factors acting to lower fertility among the Simbai Valley Maring. These include nutrition and infectious disease (see Chapters 5 and 6). The most important nutritional factors affecting fertility are protein and iodine deficiencies. These deficiencies have a parallel distribution in the valley and their effects on fertility are similar. Both may cause amenorrhea, and may interfere with a woman's ability to conceive and to carry a fetus to term (see Chapter 5 for more detailed discussion of the effects of iodine deficiency on fertility). They also tend to cause women to give birth to premature infants and such infants have a very low viability.

Furthermore, because adequate amounts of both protein and iodine are necessary for normal growth and development of children, deficiencies in these nutrients may also indirectly reduce fertility by slowing down growth rates and delaying sexual maturation (Hipsley and Kirk 1965: 12-14). These deficiencies may also cause early or premature menopause in affected women. Delayed development would tend to lengthen generation length and lower the birthrate. It would also, particularly if coupled with early menopause, reduce the number of years in which a woman is capable of reproducing and thus limit her maximum number of offspring.

Malcolm (1968 and 1969) has noted that slow growth and late maturation are characteristic of many inland New Guinea populations. This he believes to be the result of chronic protein deficiency. He has also demonstrated that at least for New Guinea populations, the age of puberty is inversely proportional to adult height, and that for females, this relationship can be expressed by the formula: Age of Menarche = 62.71 - 0.303 x adult height (cms.). When this formula is applied to height measurements of Simbai Maring women, it yields an average age of menarche of 18.8 ± 1.7 years, which, while high by Western standards, is within the range encountered among the various inland New Guinea populations studied by Malcolm.[1] More interesting for us than the overall late age of puberty among Simbai Maring girls is the fact that this age varies from one local population to another. In general, girls living in the southeastern portion of Maring territory experience menarche two years earlier than girls living in the northwestern part of Maring territory. In particular girls of the Angoing clan experience it at age 17.8 ± 1.75 years and those of the Tsembaga clan do not experience it until age 19.7 ± 1.5 years (this is the highest age of menarche yet encountered in New Guinea). This difference of 1.9 years may be related to variations in the nutritional statuses of the various populations (see Chapter 4) which in turn may be related to population density.

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[1]Peter Sinnett in a recent (1971) publication noted that the growth of Tukisenta women in the New Guinea Highlands was not completed until the age of 18 and that of men not until 24. While the precise relationship between the age of menarche and the age of cessation of growth is not known, Tanner (1964) has noted that menarche invariably occurs after the peak of the adolescent growth spurt. Thus, his findings tend to confirm mine.

This difference in the age of menarche may also be at least partially responsible for observed differences in fertility which will be discussed later in this chapter.

Cultural Practices Related to Differential Female Mortality

Throughout the Simbai Valley Maring population there is an overall deficit of females. The total sex ratio is 109 males for every 100 females, but this sexual imbalance is not due to an imbalanced sex ratio at birth,[1] nor does it appear to be due to differential female infanticide. Girls are desired as much as boys. Instead, it is due to a higher differential female mortality. This is evidenced by the age-specific death rates (Figure 3.6) which show higher mortality for females between the ages of 3 and 27, and between the ages of 40 and 50. While these differences do not appear to be large, they are reflected in the age-specific sex ratios (Figure 3.7) which also show a large excess of males up to the age of 50 and a higher percentage of females over the age of 50. The reproductive history data does not shed any light on the problem of imbalanced sex ratios because the percentage of survivors is 79 for both males and females. Women at all ages were exposed to a greater risk of infection than were men, and it is possible that because of their lower nutritional status, their resistance to disease is also lower than that of men.

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[1]The Maring sex ratio at birth is 103:100 for births recorded between August 1966 and December 1969, or 105:100 as calculated from reproductive histories. The sex ratio at birth is 106:100 for white Americans and 103:100 for black Americans. Among Americans, sex ratios decreases with age because of higher male mortality. Among the Maring, the excess of males increases until the age of 15 and then drops so that by the age of 50 the females outnumber the males. An overall excess of males is a characteristic of many New Guinea populations.

As we have noted, the Maring practice residential segregation of the sexes. Men and boys over the age of about seven reside together in the men's house, while a woman shares her house with her small children, unmarried daughters and pigs. Most raw and cooked food is stored in the woman's house, and it is likely that the presence of food and of pigs attracts more disease-bearing vermin to a woman's house than to a men's house. Small boys would be exposed to the same risk of infection as their mothers and sisters, but because of their higher intake of protein (see Chapter 4) their resistance would be higher.

Cultural patterns related to the care of sick expose women to a greater risk of infection than the men. This is because it is primarily a woman's job to tend to the physical needs of the sick and the dying. She will bring the sick person food, coax him to eat, sit with him in his house, tend the fire, etc. Men are most likely to practice curing, at least for adults, but most curing magic is performed outside in house yards, and the curer rarely directly touches or handles his subject.

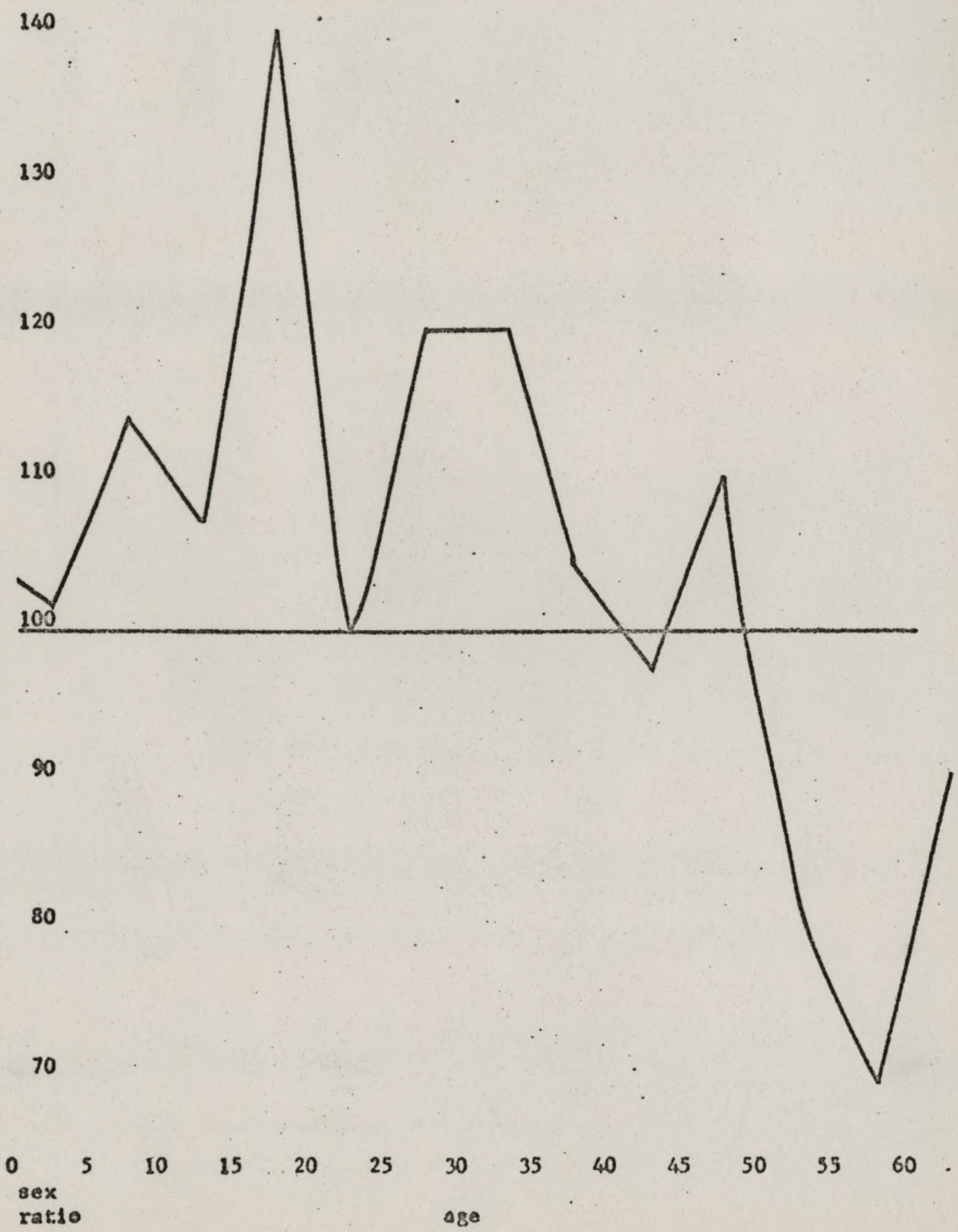
Many chronic and some acute illnesses are thought to be caused by ancestral spirits who are hungry for pig meat or its essence. When a shaman makes this diagnosis, it is customary to kill a pig and to dedicate it to the offending spirit. The flesh is consumed by the victim and his close kinsmen. Rappaport (1968) noted that this practice would benefit both the sick person and his kinsmen because it would provide them with a large dose of protein, from which antibodies could manufactured, enabling them to better combat infection. However, my observations were that the diagnosis of hungry ancestral spirits requiring a pig killing occurs more often in the case of a sick man, than it does for a woman or a child. During the time I was resident at Mondo this diagnosis was made only once in the case of a woman and since she was only a woman, a chicken instead of a pig was sacrificed--pigs were killed for men on at least twelve occasions. Out of a total of 47 pigs killed by all Simbai Valley Maring in 1967-68 for reasons of illness, only 16 or 35 per cent were killed for women. Consequently, pigs are more often killed for adult males, and it would seem that women and children are frequently denied the benefit of additional protein during disease stress.

Women are also assigned the task of caring for the dead. They are the most demonstrative mourners, crowding into the deceased's house to wail and to fondle the corpse. Men maintain a rather quiet vigil outside the house. Later, after the body has been exposed for several weeks, it is a woman's job to remove the bones from the platform and to clean them of rotted flesh. The bones are then kept in a woman's house or, in the case of a married man, worn around his widow's neck. The women keep the bones until these are finally buried, about two years after death has occurred. While a woman is engaged in these mortuary tasks, she is considered to be unclean. She may not harvest or prepare food for men, nor may she eat food cooked over the same fire with men; this may help to prevent the spread of contagion to men.

The above practices all tend to expose women to greater risk of infection leading to sickness and death than men, thus helping to explain the overall deficit of women in the population. This shortage of women also tends to limit the rate of population growth by removing child-bearers from the population.

From this it emerges that the most important causes of mortality among females is their high exposure to infectious disease. Deaths in

Fig. 3.7 SIMBAI VALLEY MARING SEX RATIOS BY AGE



childbirth also occur, but as far as I could tell, this was not a major cause of mortality. On the other hand, men are differentially exposed to risks of injury and death by engaging in the somewhat dangerous activities of warfare, hunting, tree felling and construction. Cultural practices affecting mortality as well as those affecting fertility appear to occur with equal frequency throughout the entire Simbai Maring area.[1] The presence of these practices, many of which are shared with other highland New Guinea populations, indicates that prior to contact the Simbai Maring population as a whole must have been essentially a static or only a very slowly growing population. The decline which occurred in the 1960's prior to and during the course of this study is believed to be due to the added stress of newly introduced infectious diseases coupled with the possible further reduction in fertility due to the temporary absence of young men who were away working on coastal plantations. There was, in effect, a cultural lag--so that traditional fertility limiting practices continued to operate during a period of increased mortality.

It is also possible that mortuary practices amplified the effects of the epidemics because, as previously noted, the women bear the burden of these rites and are thus more exposed to contagion. Thus, it is possible that a positive feedback situation arose in which introduced infectious disease caused, because of mortuary rites differentially increased mortality among women, thus eliminating child-bearers from the population and causing the population to decline even more rapidly because

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[1]An exception to this statement may be the fact that, at least in the late 1960's, there appeared to be less emphasis on residential segregation of the sexes in the northwestern end of the valley than in the southeastern part. This was particularly true at Mondo where many men were residing with their wives on a permanent basis.

birthrates declined while mortality rates increased.

Regional Variation

It has been noted above that in 1966 there was a deficiency in the number of children in the 0-4 and the 5-9 cohorts in the total population. While this deficiency was present in all groups, it was more severe in some than in others. The greatest deficiencies occurred in Tsembaga, Tuguma, Singanai and Fogaikumpf, while Nimbra, Gai, Kinimbong, Bomagai and Murmbugai show less of a deficiency.

In 1968 the 0-4 cohort has increased in size, but again there is regional variation. The biggest increases are in Kinimbong, Tsembaga, Gai, Nimbra, Murmbugai, Angoing, Fungai and Korama. The Tuguma, Singanai, and Bomagai still have depleted 0-4 cohorts.

The vital statistics also demonstrate variation from group to group. Since the statistics computed for the 1963-1966 interval are suspect for reasons of incomplete reporting on infant deaths, let us note merely the differences which occur in the rate of natural increase. This rate varied from a low of -34 at Singanai to a high of +26 for the Fungai. Decreases were exhibited by the Tsembaga, Tuguma, Singanai, and Fogaikumpf populations, while the Kinimbong, Gai, Nimbra, Tsengamp, Murmbugai, Fungai and Angoing showed an increase.

In 1968 better statistics were available and these indicated variation in the rate of natural increase, fertility, and the death rate. The rate of natural increase ranged from -43 at Tuguma to +22 at Kinimbong. Among the losers were the Tuguma, Gai, Singanai, Bomagai, Korama and Tsengamp. The gainers were the Kinimbong, Tsembaga, Nimbra, Fogaikumpf, Angoing and Murmbugai. Fertility or births per 1,000 women aged 15-44

TABLE 3.6

AVERAGE NUMBER OF PREGNANCIES OF WOMEN AGED 40-49 AND % OF OFFSPRING STILL ALIVE

Location	N	Average Pregnancies	Percent Alive		
			Male	Female	Total
Fogaikumpf	3	3.3	65	70	90
Angoing	1	2.0	89	100	100
Bomagai	2	4.5	92	73	67
Fungai	4	4.75	74	52	72
Korama	4	5.0	93	67	85
Murmbugai	7	4.9	86	78	83
Tsengamp	6	4.0	57	74	75
Singanai	10	4.2	52	84	74
Nimbra	19	3.47	80	80	80
Gai	11	4.18	79	72	74
Tuguma	16	3.50	69	93	80
Tsembaga	10	3.20	67	81	81
Kinimbong	8	3.38	75	90	89
	101	3.76	79	79	79

ranged from a high of 233 at Fogaikumpf to a low of 75 at Bomagai. Tuguma also had a low level of fertility while that of the Tsembaga women was high. Crude death rates varied from highs of 68 at Singanai and 64 at Tuguma to lows of 18 at Kinimbong and 20 at Nimbra.

The reproductive histories also indicate variation in the average number of pregnancies experienced by women from different groups. The highest average is reported by the 40-49 cohort at Bomagai, Fungai, Korama, and Murmbugai while the lowest number are reported at Fogaikumpf, Tuguma, Tsembaga and Kinimbong (see Table 3.6, "Average Number of Pregnancies Experienced by Women Aged 40-49 and Percentage of Offspring Still Alive").

Is it possible to draw any conclusions from this high degree of demographic variation? Before we try, we should note that some of this variation may be due in part to random forces acting on small populations. In spite of this possibility, it does appear that two generalizations may be made. The first is that the Tuguma population located in the northwest and residing at low altitudes, within their territory, and the Singanai population located on a low hill to the northeast of the main valley wall are undergoing the most rapid decline. This is the result of a combination of high mortality and low fertility. As we shall see in Chapter 5, these populations also exhibit high rates of iodine deficiency and malaria. In addition, it will be shown in Chapter 4 that the Tuguma population suffers most from a lack of protein. So it is likely that the combination of malaria, iodine deficiency and protein deficiency are responsible for the observed high rates of decline of these populations. The second generalization which can be made is that those populations who have access to aid posts, namely Kinimbong, Tsembaga, Gai and Nimbra are showing higher fertility, lower mortality, and a larger percentage of children in their populations.

CHAPTER 4

DIET

Studies of the diet within the various Simbai Maring local groups were undertaken in order to answer questions about the availability and distribution of food, particularly protein-rich food. This was necessary because it was thought that the differences recorded in demographic, anthropometric and clinical parameters might be related to local differences in diet, particularly to differences in protein consumption. Also investigated was Rappaport's (1968) hypothesis that a positive relationship exists between an individual's biological status and his need for protein, and the amount of protein which is, in fact, allocated to him.

Methods Used in the Collection of Nutritional Data

In order to determine the composition of the Simbai Maring diet and to detect individual and regional variations, two basic types of strategy were employed. The first consisted of a direct measurement of food intake, both on a household and on an individual basis. The second strategy consisted of the use of survey techniques which were designed to detect regional differences in the ownership and killing of pigs, and in the consumption of wild protein foods. In addition, samples of the major root crops (taro, yam, and sweet potato) from six local Maring groups were analyzed for their protein content to test whether the protein content of vegetables grown varies from territory to territory since these differences would be significant as vegetables comprise the bulk of the Maring diet.

Direct food consumption studies were conducted on nine Maring households. Seven of these were located at Mondo and two at Tababi (see Table 4.1 for the composition of these households). Each household was under observation for a period of time ranging from one to two weeks, and two of the Mondo households were restudied after an interval of approximately six months.

Because willingness to cooperate and accessibility were overriding considerations, no attempt was made to randomize the sample of households. However, an effort was made to include as many age-sex categories as possible. The original plan called for each household to be studied at three-month intervals, but this plan had to be abandoned because some households were unwilling to cooperate. In addition, the results obtained from one of the households was questionable because of a lack of cooperation of some of its male members.

While a household was under observation, all food brought home was weighed raw, by named variety. Note was made of quantities of food which was intended for pigs, or guests, or for planting material, and these quantities were omitted from the final analysis. Attendance at meals was checked so that individual intakes could be computed in the manner described by Rappaport (1968:278-284).

In addition to household consumption studies outlined above, individual consumption studies were simultaneously undertaken, that is, each individual portion of cooked food eaten by each household member was weighed on a portion scale. This tedious and time-consuming task was done in order to determine exactly how food is apportioned within a household. Because of the difficulty involved in this data collecting

TABLE 4.1

COMPOSITION OF HOUSEHOLDS

members	age	sex	height in cms	weight in kgs	skinfold thickness in mms	arm circumference in cms
Location: MONDO					Clan:	Kongagai
Arowkwai	35	M	162	52	5	25
Kumbun	26	F	137	35.5	5	19
Aiome	7	F	94	14	7	14
Ding	45	M	152	41	3	21
Aina	40	F	144	38.5	4	20
Krikai	35	M	149	44.5	4	23
Pun	15	F	131	35	5	18
Lam	8	M	103	16.5	5	15
Tinga	5	M	86	12	6	13.5
					Clan:	Rlikrlikai
Meina	50	M	156	48	4	23
Gebia	18	M	137	32.5	5	20
Nuke	13	F	118	25	7	19.5
Korup	4	M	75	10	7	14
Apai	44	F	138	36.5	8.5	20
Kumar	50	M	146	40.5	3	20
Ti	29	F	141	36.5	6	19
Dire	10	F	108	16.5	4	14.5
					Clan:	Wendakai
Karap	31	M	155	46	4	22.5
Tukunemp	36	F	146	38.5	3	22
Terum	25	F	140	45	10	22
Boning	1	F	64	5.5	5	10
Dyeng	28	M	153	46.5	6	25
Dimgi	23	F	135	36	8	19
Mema	18	M	148	45.5	8	23
Rumbeo	42	M	143	41.5	4	22.5
Kiap	19	M	147	46	10	24
Angro	14	F	126	32.5	13	20.5
Kopal	11	M	111	20	6	16

TABLE 4.1--continued

members	age	sex	height in cms	weight in kgs	skinfold thickness in mms	arm circumference in cms
Location: MONDO					Clan:	Raweng
Gamai	53	F	144	41	6	21
Takai	21	F	140	38.5	7	17.5
Kum	19	M	152	39	4	18
Koimp	14	M	127	26	4	17
Goe	17	M	152	41	5	20
Location: TABABI					Clan:	Bomagai
Wut's	47	M	156	51	5	24
Gimda	19	M	163	51	4.5	22.5
Yuamang	17	M	161	59	4	21
Bari	15	M	146	42	5	21.5
Kum	12	M	120	22.5	4	16
Geven	28	F	140	37	7	18
Wandama	25	F	145	40	13	19
Yombari	19	F	147	42.5	18.5	21
Kumba	11	F	113	22.5	6	16
					Clan:	Angoing
Pero	42	F	142	42	4.5	21
Yamba	18	M	159	45.5	-	-
Waia (A)	15	F	137	30.5	6	18
Tango	13	M	123	23	5	18
Tui	12	M	127	23.5	6	16
Waia (W)	15	F	139	36.5	7.5	20

method, the size of the sample and its spatial distribution was limited to seven households and two locations. The results of these individual studies are believed to be more accurate than the household studies and this data is presented in the next section.

In order to partially correct for this small sample size and limited distribution, surveys were undertaken to determine the availability and consumption of protein-rich foods throughout the entire Simbai Maring territory. The accuracy of the results of these surveys is judged to be less than that of the food consumption studies, but the results are still interesting and usable. These surveys consisted of a recent protein consumption history, and a census of pigs owned and of pigs killed in the previous year.

The protein consumption history consisted of a series of questions about the animal foods consumed by the individuals in the previous week. Each individual in the survey was asked whether he had eaten meat, what kind it was, how large a portion, and how it was obtained. Members of all clans, except those censused at Gai and at Mondo, were questioned. Maring attitudes about meat consumption have probably led to an under-reporting of the game consumed. Small animals (such as insects, frogs, lizards, etc.) might not be reported either because they are considered to be unimportant child's food, or because there is a certain amount of shame attached to their consumption by adults. Larger animals (such as eels, marsupials, feral pigs, etc.) might also be under-reported because these should be shared, possibly even with the investigator. Nevertheless, the results of the survey have been tabulated and are presented in the last section of the chapter.

Pig ownership and pig-killing data were obtained from members of all

Simbai Maring clans. Each person was asked to name and describe, with regard to sex and size, each pig owned and each pig killed within the previous year. In addition, information was obtained on the origins of each pig, the reasons for each pig killing and on the distribution of the pork. Questioning was done in public, and answers were frequently verified or corrected by others present. For this reason it is believed that the pig census results are reasonably accurate.

In addition to quantitative data, anecdotal material on hunting behavior and success was collected, as well as information on the relative ease of pig raising in different locations.

Results

The composition of the Simbai Maring diet

The per cent composition of the diet of each household in the study has been computed and is presented in Table 4.2, "Composition of the Diet by Per Cent Weight of Foods," and is compared to other New Guinea diets in Table 4.3. Since different households were studied at different times of the year, and since none of the households covered were considered to be atypical in terms of what they were eating, the variation in the per cent composition of the diet from household to household may be seen as representing seasonal differences in the availability of foods as well as purely individual preferences.

One of the most obvious and important facts to be noted from Table 4.2 is that the Maring are essentially vegetarians. Animal food, of any kind, appears in only three of the eleven studies, and in these it forms only a very minor constituent of the diet, from 0.03 to 0.2 per cent.

As for all highland New Guineans, root crops form the major element

TABLE 4.2

COMPOSITION OF THE DIET BY PERCENT WEIGHT OF FOODS

	1968											
	MONDO									TABABI		
	Feb.	March		June		July		Oct.	Nov.	Dec.		Overall Average
Sweet Potato	3.4	2.6	1.3	3.3	15.0	5.6	29.4	33.1	23.3	21.6	15.4	14.0
Taro (Xanthosoma)	11.1	5.1	2.2		3.1	0.7	1.3	0.5		11.0	17.1	4.7
Taro (Colacasia)	27.9	37.4	23.0	47.2	37.4	50.9	15.6	8.2	15.1	0.7	2.2	24.1
Manioc	1.3			1.9	9.6	0.7	4.1	0.5	4.4			2.0
Yams	12.8	19.8	12.1	24.7	9.9	7.4	11.9	3.0	7.0	0.6	0.5	10.0
TOTAL ROOTS	56.5	64.9	38.6	77.1	75.0	65.3	62.3	45.3	49.8	33.9	35.2	54.9
Banana	0.3		1.2	1.0	6.4		5.0	5.7	13.8	5.5	0.6	3.6
Other fruit	0.9				0.8	7.0	12.6	1.9		4.4		2.5
Misc. Vegetables	5.2	1.4	0.8	0.6	0.5	6.0	1.4	14.5	10.2	5.5	5.2	4.7
Marita Pandanus	14.3	3.2				2.0		5.8	4.9	15.1	28.4	6.7
Leaves	7.6	13.0	6.3	11.7	9.9	14.8	10.7	14.1	2.3	12.8	15.0	10.7
Grasses	8.5	13.6	22.3	7.6	4.0	3.2	3.6	3.6	7.7	13.8	8.0	8.7
Sugar Cane	6.6	3.8	30.8	2.2	3.4	1.7	3.8	9.3	11.2	9.9	8.0	8.2
Animal Food		0.03					0.01				0.2	0.022

TABLE 4.3

COMPOSITION OF THE DIET OF OTHER NEW GUINEA POPULATIONS BY PERCENT WEIGHT

	Busama[1]	Kaiapit[1]	Patep[1]	Kavataria[1]	Chimbu[2]	Kambuaja[3]
Taro	65.0	7.3	45.9	8.6	-	77.0
Yams	1.4	9.5	0.2	55.2	5.0	-
Sweet potato	-	25.7	37.6	15.0	77.0	3.0
Manioc	-	2.0	0.2	1.4	-	-
Sago	6.8	0.3	-	-	-	-
Banana	1.1	31.6	0.4	5.5	-	-
Fruits and stems	6.1	-	2.6	2.3	13.0	-
Leaves	14.0	9.2	8.0	-	2.5	-
Coconut	2.2	9.5	-	2.8	-	-
Marita pandanus	-	-	?	-	?	-
Grain	0.4	-	3.0	-	1.5	-
Leafy greens	-	-	-	-	-	5.0
Peanuts	-	-	-	-	-	10.0
Misc. veg.	-	3.4	1.8	1.4	-	-
Animal and fish	2.9	1.7	0.2	9.7	1.0	5.0

1. Hipsley and Clements (1947:135-138)

2. Venkatachalam (1962:9)

3. Oomen and Malcolm (1958:fig. 21 opp pg. 37)

TABLE 4.3 -- Continued

	Pari[4]	Kaporaka[4]	Jabakogl[3]	Nubuai[3]	Tambanum[3]	Sowek[3]
Taro	6.0	-	1.0	1.0	5.0	1.0
Yams	-	63.5	-	-	27.0	-
Sweet potato	72.4	4.0	92.0	-	-	-
Manioc	-	6.5	-	-	3.0	-
Sago	-	-	-	93.0	38.0	72.0
Banana	5.5	11.2	-	-	9.0	-
Fruits and stems	5.0	0.8	-	-	-	8.0
Leaves	11.0	-	-	-	-	-
Coconut	-	10.0	-	1.0	8.0	12.0
Marita pandanus	-	-	-	-	-	-
Grain	-	-	-	-	-	-
Leafy greens	-	-	4.0	-	8.0	2.0
Peanuts	-	-	-	-	-	-
Misc. veg.	3.0	-	2.0	-	-	-
Animal and fish	0.5	4.0	-	3.0	2.0	5.0

3. Oomen and Malcolm (1958:fig.21 opp. pg.37)

4. Hipsley and Kirk (1965:80)

of the diet, amounting to an overall average of 54.9 per cent. This figure is much lower than that reported for Chimbu and other highland groups (Hipsley and Kirk 1965:80; Venkatachalam 1962:9), but is in line with figures reported by Rappaport (1968:73) and Clarke (1971:179) for other Maring groups. The actual per cent of tubers in individual family diets ranged from 33.9 per cent to 77.1 per cent. There is a rough inverse proportion of the per cent of tubers in the diet to that of Marita pandanus and of sugar cane, both of which are good sources of calories. Marita which is rich in both fat and protein is only available during part of the year. Although a few fruits may ripen earlier, marita does not really come into season until September. It is most abundant during the wet months of November, December, January and February, while the last fruits ripen early in March. The marita season begins earlier, and may last longer in the warmer, wetter, lower southeastern territories, than it does in the northwest. It also tends to be more abundant in these areas. This is evident not only from the larger per cent of marita eaten in Tababi, but also from observations of more extensive marita groves in the southeast and from informants' accounts to the effect that it grows better at lower altitudes. Clarke (1971) notes that marita is available throughout the year in the Dwimba Basin, southeast of Tababi, but is more abundant in the wet season.

The major root crops consumed by the Maring are: taro, sweet potato, yams and manioc. Of these taro is the most important comprising 28 per cent of the diet. Sweet potato is next in importance comprising 14 per cent of the diet. Yams constitute another 10.7 per cent, while manioc appears to be a relatively minor food, forming only 2.0 per cent.

The proportion of the various root crops appears to vary from season to season, as well as possibly from place to place. Everywhere, the Maring state a marked preference for taro and yams over sweet potatoes and manioc. The former are considered to be ceremonial foods, the latter more fit for pigs. This is a very common New Guinea belief; it may be related to the fact that taro and yams are indigenous crops, while sweet potato and manioc are relatively recent introductions.

There appears to be an inverse proportion in the per cent of taro and sweet potato consumed in the individual studies. Thus, sweet potato is more important in the months of July to September when taro is relatively scarce. Another point of interest is that while the major type of taro consumed at Mondo was Colacasia, Xanthosoma was dominant at Tababi. This finding is confirmed by Clarke (1971:179). This, again, may reflect environmental differences between the two locations.

Yams form a much larger per cent of the diet at Mondo than they do at Tababi. It is not certain whether this is a reflection of seasonal or of regional variation. At Mondo yams were most abundant in February and March, dropping off in June and July and becoming relatively scarce in October and November. Since the observations at Tababi were made in December, the scarcity of yams there then may simply be a reflection of a continuing cyclical trend. Clarke (1971:182) notes that there is a relative scarcity of yams in the vicinity of Tababi during the period between July and November.

Other important constituents of the Maring diet are leaves and grasses; together they comprise 19.4 per cent by weight of the average total diet. Although the amount of these foods eaten by the individual families in the study varies, the variation is relatively small. Nonetheless, it appears that more of these vegetables are eaten when marita is available. This is not surprising since the two are often eaten together; greens mixed with marita sauce are a favorite Maring dish. Both Rappaport (1968:72) and Clarke (1971:181) have commented on the importance of greens in the Maring diet. These foods are particularly good sources of vitamins and minerals, as well as protein, and this latter fact is important for people who are essentially vegetarians.

If we can take the eleven individual family studies to represent typical diets throughout the course of a year, then an interesting fact emerges; during the wetter months the diet appears to be richer in protein, or at least in vegetable protein, than it is during the drier months. This is due not only to the increased consumption of greens and marita, but also to the fact that during these months more taro is consumed than sweet potato, and that the protein content of the former is considerably higher than that of the latter (see Table 4.4).

Since respiratory disease is more prevalent during the wet season, the additional protein in the diet might afford some protection against its adverse effects. However, it may also be that the additional vegetable protein available during the wet season merely compensates for a greater scarcity of animal foods at this time. Although I have no quantitative evidence on this point, it did appear, at least at Mondo, that more game was captured during the drier months. For example, eels are only taken in the dry months when the streams are lower and less turbulent, and many rodents and some marsupials are captured in the course of garden clearing and burning, which are essentially dry season activities. Also, hunting for marsupials occurs on clear moonlit nights which are more common during the dry season.

TABLE 4.4

PROTEIN CONTENT OF ROOT CROPS GROWN IN VARIOUS SIMBAI MARING LOCATIONS

	Taro		Yams		Sweet Potato	
Location	Number of Samples	% Protein	Number of Samples	% Protein	Number of Samples	% Protein
Tsembaga	11	0.975	5	2.04	5	0.75
Mondo	5	0.59	2	2.66	6	0.705
Gai	4	1.24	2	2.62		
Nimbra	15	0.90	5	2.18	1	0.96
Tsengamp	6	1.03	2	2.75	2	0.89
Fungai-Korama	6	1.05	6	1.90	8	0.875
Overall Average	47	0.95	22	2.32	22	0.80
Range of Published Values		1.4-1.9		1.9-2.0		0.9-1.7

Protein Content of Root Crops

Because the Maring are essentially vegetarians, it is important to know the protein content of the vegetables in their diets in order to assess the adequacy of these diets. Ideally, one would want a chemical analysis of all foods grown and eaten by the Maring, as it is well known that the chemical composition of food crops can vary tremendously depending upon such things as soils, growing conditions, state of maturity at harvest, etc. However, the cost of such a complete analysis of local foods is prohibitive. Thus, the nutritive values of most of the foods consumed by Maring in this study are derived from published values of the same or similar foods grown in other areas.

However, because of a generous offer by Dr. Lawrence Malcolm of the Department of Public Health, I was able to have eighty-six samples of root crops (taro, yam, and sweet potato) grown at the same altitude on the territories of six Maring local groups (Simbaga, Tuguma, Gai, Nimbra, Tsengamp, Fogaikumpf-Korama), analyzed for their protein content. The results of this analysis are presented in Table 4.4. and these values have been used alongside the published ones in the subsequent calculations of the nutritive values of individual Maring diets.

While the sample size for each food from each location is probably too small to draw anything but tentative conclusions, some interesting facts emerge from these analyses which require some comment. First, the average protein content of both taro and sweet potato falls well below the published values, while Maring-grown yams have a higher protein content. In particular, Maring-grown taro (the most important staple) has an average protein value of only 0.95 per cent by weight, as compared to the published range of values of from 1.4 per cent to 1.9 per cent protein by weight. This lower protein value of the most important food might be enough to make the difference between an adequate diet and one that is deficient in protein. A second fact which emerges is that there is considerable variation in the protein content of taro grown in different Maring territories. Of particular interest here are the exceptionally low values for taro grown on Tuguma and Tsembaga territories. This alone could be responsible for the small stature and higher incidence of protein malnutrition encountered among these populations.

Results of the Food Intake Studies

The composition and location of the households included in the food intake study are detailed in Table 4.1. Data collected from two of these households (the first studied at Mondo and the last studied at Tababi) were largely omitted from subsequent analysis, although they were included in the previous section on Percent Composition of the Diet. In the first case, the data was collected on a household rather than an individual basis, and so the actual apportionment of food within the household is not known. In the second case, it was evident that most of the household members were not cooperating with the investigator and were, in fact, consuming large quantities of food away from home. This intake could not be measured. It is believed that the results obtained with the other households in the study are accurate and do reflect the true intake of foods, with one other possible exception, that of the class of adolescent males. Adolescent males are largely unattached to any single household and may, in fact, receive food from several sources: their mothers, married sisters, brothers' wives, etc. It is thus likely that the intake figures for this class is on the low side. However, it is to be noted that the intake of adolescent boys is in good agreement with that of girls, and there is no reason at all to believe that there is under-reporting here as the girls eat at home with their mothers.

The results of the individual intake studies are presented in Table 4.5, and are summarized in Table 4.6 which compares the nutritive values of the diets of various age-sex categories with two sets of standards--those of Langley (1947:134) for New Guinea, and those of FAO/WHO (1955, 1957). The corrections applied to these standards by Rappaport (1968:75) have also been used in this study, both for the sake of comparability and because the Tuguma and Tsembaga populations are almost identical in height and weight.

In Table 4.7 the diets of the Tuguma, Tsembaga, and Bomagai-Angoing Maring are compared. In this table, the Tsembaga data is derived from Rappaport (1968:75) while that for Bomagai-Angoing adult males comes from Clarke (1971:179).

Examination of the individual intake figures reveals a high degree of variation in the intake of protein and calories within each category. The variation is most marked for the adults and adolescents of both sexes and this variation needs to be commented upon. For adults it appears that intake is related to activity levels; the highest intake are those of a single family, that of Karap, a man in his prime with a lot of ambition, a tutul (government appointed head man), a man very much involved in expanding his influence and his wealth. Both he and his two wives were extremely active in gardening and pig rearing, and their extraordinary high food intake may reflect all this activity.

Of the adult males, the lowest intakes were by Kumar and Kurui. Kumar was a man of about fifty years old, who seemed to be well past his physical prime. He was a shaman (a kunda yu) and as such was under

TABLE 4.5

AVERAGE DAILY INTAKE OF NUTRIENTS FOR
MALES ABOVE 18 YEARS OLD AT MONDO

Name	Age	Ht.	Wt.	Skf.	Arm Cir.	Calories	Protein* min.	Protein* max.	Protein* loc.	Fat*	Ca++	Month	# of days
Karap	31	155	46	4	25	3097	68.4	75.0	64.9	28.9	2398	March	7
Kiap	19	147	46	10	24	2392	39.6	46.8	36.3	7.8	1498	July	8
Rumbeo	42	143	41.5	4	22.5	2227	25.4	32.3	27.1	7.8	1262	July	8
Krikai	35	149	44.5	4	23	1828	30.8	37.7	26.7	20.3	1131	Oct.	6
Ding	45	152	41	3	21	2536	46.4	54.8	41.8	17.0	1932	Oct.	6
Meina	50	156	48	4	23	2585	40.3	47.1	26.5	4.5	1967	June	7
Arowkwai	33	162	52	5	25	2571	40.6	46.5	42.3	24.5	1187	Nov.	7
Kumar	50	146	40.5	3	20	2183	41.0	46.9	29.0	6.4	2220	July	7
Ding	45	152	41	3	21	2627	42.2	50.7	37.8	6.2	1343	March	7
Krikai	35	149	44.5	4	23	2216	34.6	35.9	31.6	2.7	1786	March	7
Arowkwai	33	162	52	5	25	2844	57.6	63.5	49.9	14.7	2503	March	10

* - calculated in grams

Ca^{++} - calculated in milligrams

TABLE 4.5--Continued

AVERAGE DAILY INTAKE OF NUTRIENTS FOR
FEMALES ABOVE 18 YEARS OLD AT MONDO

Name	Age	Ht.	Wt.	Skf.	Arm Cir.	Calories	Protein*			Fat*	Ca++	Month	# of days
							min.	max.	loc.				
Aina	40	144	38.5	4	20	2310	47.8	54.0	43.0	12.2	2297	March	7
Tukunemp	35	146	38.5	3	22	3017	79.9	85.6	79.2	8.1	2794	March	7
Kumbun	26	137	35.5	5	19	2376	46.7	52.9	42.3	14.6	1381	Nov.	7
Terum	25	140	45	10	22	3011	67.3	72.9	60.6	31.1	2635	March	7
Dingi	23	135	36	8	19	2007	42.0	44.2	37.0	26.2	1850	March	7
Gemai	53	144	41	6	21	1463	28.6	33.5	25.3	5.1	1474	July	8
Aina	40	144	38.5	4	20	2565	43.7	54.0	40.2	31.9	1661	Oct.	7
Takai	21	140	35.8	7	17.5	1455	22.8	27.5	20.8	5.3	2865	July	8
Ti	29	141	36.5	6	19	1652	36.3	40.6	30.2	10.0	1889	July	7
Kumbun	29	137	35.5	5	19	2737	50.9	50.9	34.2	8.5	1806	March	10

* - expressed in grams
Ca^{++} - expressed in milligrams

TABLE 4.5--Continued

AVERAGE DAILY INTAKE FOR MALES
10-18 AT MONDO

Name	Age	Ht.	Wt.	Skf.	Arm Cir.	Calories	Protein* min.	Protein* max.	Protein* loc.	Fat*	Ca++	Month	# of days
Gebia	18	137	32.5	3.5	19	1691	26.7	31.8	21.5	3.2	1188	June	7
Woruka	14	134	31.5	5	19	1824	42.1	46.5	40.2	2.7	1790	March	2
Moma	18	148	45.5	8	23	1708	28.3	31.3	26.9	3.0	871	March	7
Kopul	11	111	20.0	6	16	1781	17.1	22.6	14.7	5.4	761	July	4
Koimp	14	127	26.0	4	17	1754	19.4	28.1	13.7	6.1	391	July	8
Goe	17	152	41.0	5	20	1440	29.6	36.9	29.2	6.4	775	July	6
Kumb	19	152	39.0	4	18	1689	20.0	23.2	18.7	4.0	924	July	8

* - expressed in grams
Ca++ - expressed in milligrams

TABLE 4.5--Continued

AVERAGE DAILY INTAKE OF NUTRIENTS
FOR FEMALES 10-18 YEARS AT KONDO

Name	Age	Ht.	Wt.	Skf.	Arm Cir.	Calories	Protein* min.	Protein* max.	Protein* loc.	Fat*	Ca^{++}	Month	# of days
Dire	10	108	16.5	4	14.5	1011	20.2	23.1	15.6	5.1	1218	July	7
Pun	15	129	28.0	7	19.5	2291	49.9	55.3	39.6	11.5	1964	March	7
Angro	14	126	32.5	3	20.5	1704	30.4	35.5	27.3	4.7	1471	July	8
Pun	15	131	35.0	7	19.5	1895	36.8	41.5	33.5	27.6	1404	Oct.	7
Nuke	13	118	25.0	7	19.5	1311	24.6	27.9	20.9	3.0	1161	June	7

* - expressed in grams
Ca^{++} - expressed in milligrams

TABLE 4.5--Continued

AVERAGE DAILY INTAKE OF NUTRIENTS
FOR CHILDREN 5-9 YEARS AT MONDO

Name	Age	Ht.	Wt.	Skf.	Arm Cir.	Calories	Protein* min.	Protein* max.	Protein* loc.	Fat*	Ca^{++}	Month	# of days
						Males							
Lam	8	103	16.5	3.5	14.5	2006	45.4	51.3	43.2	30.8	1534	Oct.	7
Tinga	5	86	12.0	6	13.5	1565	24.6	28.0	23.5	18.3	740	Oct.	7
Lam	8	101	16.0	5	15.0	1744	32.4	37.3	27.5	17.9	1356	March	7
Tinga	5	84	11.5	3.5	13.5	1094	22.7	25.1	20.6	7.7	559	March	7
						Females							
Aiome	7	94	14.0	7	14	1485	27.6	30.9	25.4	14.5	887	Nov.	7
Aiome	7	91	14.5	7	15	1317	27.4	29.2	26.9	8.1	1055	March	10

* - expressed in grams
Ca^{++} - expressed in milligrams

TABLE 4.5--Continued

AVERAGE DAILY INTAKE OF NUTRIENTS
FOR MALES AND FEMALES AT TABABI

Name	Age	Ht.	Wt.	Skf.	Arm Cir.	Calories	Protein* min.	Protein* max.	Protein* loc.	Fat*	Ca++	Month	# of days
Males													
Tui	12	127	23.5	6	16	1959	37.9	41.9	35.2	45.0	1683	Dec.	7
Tango	13	123	23.0	5	18	1479	29.9	34.0	29.1	33.3	1410	Dec.	7
Yamba	18	159	45.5	-	--	2520	44.8	53.7	43.3	11.2	3127	Dec.	7
Females													
Waia (W)	15	139	36.5	7.5	20	2431	40.9	46.7	40.8	6.1	3038	Dec.	7
Waia (A)	15	137	30.5	6	18	2029	40.1	48.8	43,5	5.9	2040	Dec.	7
Kiap	11	113	22.4	6	16	1114	35.9	38.9	35.2	24.3	1729	Dec.	7
Pero	42	142	42.0	4.5	21	2860	66.1	73.4	66.7	3.6	2940	Dec.	7

* - expressed in grams
Ca++ - expressed in milligrams

TABLE 4.6

NUTRITIVE VALUE OF THE TUGUMA DIET COMPARED WITH FAO/WHO AND NEW GUINEA STANDARDS

Consumers			Calories		Protein					Calcium	
category	N	avg. wt. (kgm)	rec. daily intake Langley, corrected [a]	est. actual daily intake	rec. daily intake Langley, corrected	rec. daily intake FAO/WHO corrected [b]	est. daily intake (grams) [c] min.	max.	act.	daily intake Langley corr. (mgms)	est. daily intake (mgms)
adult males	10	45.25	2,130	2,528	32	37	43.6	49.9	39.2	640	1809
adult female	9	37.7	1,735	2.344	32	33	47.9	53.6	43.4	640	2131
adolescent male	7	33.6	2,471	1,698	80	44	26.1	31.4	23.5	1120	954
adolescent female	5	27.4	1,540	1,642	56	27	32.3	36.6	27.3	750	1443
male 5-9	4	14.0	1,157	1,602	44-53	21	31.3	35.4	28.7	890	1047
female 5-9	2	14.25	1,157	1,401	44-53	21	27.5	30.0	26.1	890	971
children 3-5	1	10.0	1,000	944	42	15	15.9	17.7	14.4	840	518

a) Langley's (1947:134) recommendations were made for people larger in stature than Tuguma. Rappaport (1968) has calculated correction factors for the Tsembaga which are the same size as the Tuguma.

b) FAO, World Food Problems, #5, 1964, corrected for the biological value of vegetable protein, taken for the vegetable diet as a whole to be 70 (out of a possible 100).

c) Minimum and maximum intakes are presented because of ranges in protein content attributed to various authorities.

TABLE 4.7

COMPARISON OF THE NUTRITIVE VALUES OF TUGUMA, TSEMBAGA, AND BOMAGAI-ANGOING DIETS

Category	TUGUMA					TSEMBAGA				BOMAGAI-ANGOING				
	No.	Calories	Protein			No.	Calories	Protein		No.	Calories	Protein		
			Min.	Max.	Local			Min.	Max.			Min.	Max.	Local
Adult Male	10	2,528	43.6	49.9	39.2	6	2,575	43.2	58.2	?[2]	2,650[2]		52[2]	
Adult Female	9	2,344	47.9	53.6	43.4	4	2,163	36.3	48.9	1	2,860	66.1	73.4	66.7
Male 10–18	7	1,698	26.1	31.4	23.5	0				3	1,986	37.5	43.2	35.8
Female 10–18	5	1,642	32.2	36.6	27.3	1	2.112	35.4	47.3	3	1,858	40.3	44.8	39.8
Male 5–9	4	1,602	31.3	35.4	28.7	2	1,334	22.5	30.0					
Female 5–9	2	1,401	27.5	30.0	26.1									
Child 3–5	1	944	15.9	17.7	14.4	2	1,236	20.7	28.0					
Child 1–3	0					1	875	14.7	19.8					

1. from Rappaport (1967)

2. from Clarke (1971)

several dietary restrictions (taboos or at'ek). His wife, whose intake was also low, spent a good deal of time with her brothers in Tsembaga and did not appear to be doing a lot of gardening in Mondo; she was also somewhat burdened by the care of an infant son who appeared to be a cretin. Their daughter also appeared to be on the thin side. While it is impossible to say whether it was a cause or an effect of his low food intake, Kumar did not appear to be a healthy man, and in fact, he died, probably of pneumonia, a few months after his household's diet was studied. Karui was an elderly man, probably in his sixties; his activity level was very low, as he spent most of his time in his house yard, and rarely participated in gardening or other activities. It is thus possible that his extraordinarily low intake is accurate, reflecting his low level of activity. But there is also the possibility that he was receiving some additional foods.

In addition, the intakes of Gogo and Krikai are also suspiciously low. Both of these men were unmarried at the time of the study, and thus, unattached to any household. It is, therefore, possible that they were also receiving food from other sources.

The intakes of the women vary as much as do those of the men. Karap's wives have the highest intake of the Tuguma women, while the lowest intakes are those of Ti (Kumar's wife); Dimgi (Karap's brother's wife), Takai, and her mother Gamai. Ti's low food intake has already been commented on. Dimgi was in her last month of pregnancy and was very inactive, remaining close to home most of the time. She was cautioned by her sisters-in-law not to eat too much; to do so might harm her unborn child. It is difficult to explain Takai's low intake, except that since she was not married, she may have been doing less gardening than married women of her age. In other words, her activity level, and thus her food requirements, may have been more comparable with those of adolescent girls rather than those of adult women. Gamai complained of minor illness during the course of the study and she spent a good deal of time resting in her house.

The intake of adolescents varies less than that of adults, and the variation which does occur, appears to be related to the size and age of the individual, rather than to activity levels, as with adults.

Now let us examine Table 4.7 and compare the nutritive value of the diets of the Tuguma Maring with those of the Tsembaga and the Bomagai-Angoing Maring. The nutritive value of the Bomagai-Angoing adult male diet was computed by Clarke (1971:179) from his 1965 field data. Rappaport obtained his results by weighing food brought into the household, and then assigning intake ratios (he calls them trophic units) based on requirements calculated by Langley (1947:134) to the individual household members. He did not do actual apportionment studies. Clarke does not specify his methodology.

Thus, differences in methodology may explain the differences in the diets of the Tuguma and the Tsembaga Maring. Because these groups occupy adjacent and very similar territories, are highly intermarried and display similar anthropometric characteristics, it is assumed that their diets would be similar. In fact, in terms of calories, the agreement for adult males is almost perfect: 2,528 calories per day for Tuguma males, 2,575 for Tsembaga males. The values for adult females are higher in Tuguma (2,344 calories) than in Tsembaga (2,163 calories). Adolescent Tuguma girls consume fewer calories (1,642) than do Tsembaga girls (2,112). The older Tuguma male children consume more calories than do their Tsembaga counterparts (1,602 vs. 1,334), while the younger ones consume less (944 vs. 1,236). There are few children in either study and variation here may not be significant.

Because of the fact that actual apportionment studies were done at Mondo, it can safely be assumed that the Tuguma values are more accurate than the Tsembaga ones, and are, in fact, probably typical of both Tuguma and Tsembaga caloric intakes.

Although the data on the Bomagai-Angoing diet is limited, it does appear that the caloric intake of all categories of people is higher here than at Tuguma or Tsembaga.

More important than the differences in caloric intake are those in protein intake. The Tuguma minimum values for adult males agree perfectly with those for Tsembaga males and both are below the value for Bomagai-Angoing (43 grams protein for Tuguma and Tsembaga vs. 52 grams protein for Bomagai-Angoing). The Tuguma women had more protein (48 grams) than the Tsembaga women (36.3 grams), and indeed more than the men. The values for the one Bomagai-Angoing woman are 66.1 grams protein per day, again higher than for males. The protein intake values for adolescent girls are the same at Tuguma and Tsembaga; they are higher at Tuguma for older children, and lower for younger ones. In all cases, the values for the Bomagai-Angoing are higher than for the Tuguma-Tsembaga.

Minimum rather than maximum values are compared as they are more in agreement with the protein values obtained in the analysis of locally-grown crops. In fact, the local values for Tuguma and Tsembaga root crops are lower than the minimum reported values, while those from the Bomagai-Angoing are only slightly above the minimum.

Rappaport (1968:72-78) has discussed the adequacy of the Tsembaga diet. He has noted that the diet provides ample calories for all age categories, but that it is only marginal with respect to providing enough protein and calcium for the younger age groups. Present findings on the Tuguma and the Bomagai-Angoing diets tend to confirm his findings, but there are some differences which should be noted. The protein intake of adult Tuguma males is only barely above the WHO/FAO recommendations (Table 4.6), while that of adult females is about ten grams above the recommended value. This wider margin of safety is probably necessary for these women who are almost always pregnant or lactating, and who are, by custom, more frequently exposed to infectious disease than are men. Adolescent males and females are consuming exactly the WHO/FAO recommended protein allowance, and it should be noted that this is considerably below the Langley (1948:134) recommendations. Children from five to nine are receiving more protein than the WHO/FAO recommended allowances, but less than the amount recommended by Langley, while children less than five are receiving less than the amount recommended by WHO/FAO.

The protein intake of all categories of Bomagai-Angoing for whom we have information is considerably higher than that of the Tuguma and Tsembaga. For adults, it is on the order of 20 grams a day higher, for adolescents it is about 10 grams a day more. This higher protein intake may be responsible for the greater stature of the Bomagai-Angoing. In fact, it is quite possible that there is an even greater differential in the amount of protein consumed by these two groups; because while these diet studies cover mainly vegetable foods, it is known that the Bomagai-Angoing consume far more meat, both domestic and wild, than do the Tuguma and Tsembaga. More will be said on this fact later.

As has been noted by Rappaport (1968:76) the very low protein intake of young children is related to the high starch content of the diet and the fact that children simply cannot consume enough of these bulky foods to satisfy their protein requirements. However, observations on the actual apportionment of food indicates that the protein in children's diets is most likely of higher biological value than that in the adult diet. This is so because the diet of children is far more varied than that of adults. Children tend to eat small quantities of a number of different foods, frequently as many as twenty different kinds at a single meal, while adults satisfy themselves with larger portions of fewer different foods. This greater variety in children's diets would tend to increase the biological value of its protein content, because it is likely that amino acids missing from one type of vegetable will be found in another. In addition, children frequently consume small insects and other creatures, and while these were frequently too small to weigh, it is believed that they do contribute a few grams of complete animal protein to the daily diet.

Nonetheless, it is evident that the protein content of children's diets is, at best, only marginally adequate. Signs of protein malnutrition are common in the three to five age group, and at least four cases of frank Kwashiorkor were encountered. Also the growth and maturation rate of these children are very low when compared to that of American or Australian children. While delayed growth may be due to a number of factors, including iodine deficiency, many workers (Jelliffe 1966) consider it to be an early and significant sign of protein malnutrition.

As will be demonstrated in Chapter 6 the Tuguma and Tsembaga populations are characterized as having the smallest stature of any of the Simbai Maring populations. In view of the fact that these populations also appear to have the lowest protein intake of any of the Simbai Maring populations, it is tempting to speculate that their small stature may be due, at least in part, to the low protein content of their diets, particularly of the diets of children and adolescents. However, I must stress that this is only speculation because the number of individuals in the child and adolescent categories for whom we have dietary information is small (see Table 4.7). It is also possible that the short stature of the Tuguma and Tsembaga populations may be related to low iodine intake or to a combination of the effects of reduced iodine and protein intake. The prevalence and effects of iodine deficiency will be discussed at greater length in the following chapter.

There are two known cases of Maring children who consumed Western-type diets during critical growth periods; one, an adolescent boy from Tuguma, and the other an infant girl from Kompiai in the Jimi Valley, just over the mountain from Tuguma. The Tuguma boy spent much of his adolescence at the Aiome and, later, the Simbai Patrol Posts and later worked for two years as a laborer at a coastal plantation. He returned to Mondo in 1968, at the age of about twenty. At this time he was several inches taller than any other Tuguma male. The girl was adopted by an Australian couple a few hours after birth. At the age of two years, her size and degree of maturation was much closer to the Australian norm than that of any other Maring child.

One might also be tempted to speculate that the smaller size of the Tuguma and Tsembaga Maring may be the result of a genotypic or phenotypic adaptation to the low level of protein in their diets, since it seems obvious that smaller individuals would require less protein than larger ones. If small size were the result of a genetic adaptation than one would expect to find, as Frisancho et al. (1973) did in southern Peru, that the fertility of short women would be greater than that of tall women. This is not the case among the Maring. Here as we have seen in Chapter 3 low fertility is associated with short stature.

The notion that the short stature of the Tuguma and Tsembaga is a phenotypic adaptation also has to be rejected because recent work by Lee and Chow (1968) and Chow, et al. (1968) indicates that nutritional stunting may impair the efficiency of protein metabolism. They particularly noted that the progeny of protein deprived rats made poor utilization of protein in the diet and that this defect was particularly marked when the young rats were fed "low" quality rather than "high" quality proteins. They postulated that the defect was one of metabolism as uptake of nitrogen was normal. They also noted that among eleven-year-old children in Formosa, those who were from adequately fed families required a much lower dietary intake to permit normal weight gain than did those from poorly fed families. The children from poorly fed families also showed consistently higher urinary nitrogen excretion.

Results of the Pig-Killing Survey

The results of the pig-killing survey are presented in Table 4.8. These results indicate, as did those of the food-intake studies, that meat and particularly domestic pork, form only a minor part of the Simbai Maring diet. However, before turning to a discussion of the results of the survey, it is necessary to point out some possible sources of error both in the collection of pig-killing data and in its analysis. First, there is the problem of under-reporting. This could occur either because the people interviewed forgot a particular killing or were reluctant to discuss it with the investigator. (This appears to be unlikely because pig-killing is a public event, and the pig-killing interviews were conducted in public. This is believed to minimize this possible source of error.) Under-reporting may present greater problems in the live pig census. It is believed that a more important source of error may be in the estimation of the weight of pigs killed, and therefore, in the estimation of the amount of pork available for consumption. No live pigs or pig carcasses were actually weighed during this study. But Rappaport (1968:57) who did weigh pigs, reported that those killed by the Tsembaga Maring during the course of his study weighed on an average between 120 and 160 pounds. For the purpose of this analysis, the mean value of 140 pounds was used. This corresponds to the Maring designation of a large (yondoi) pig, and this was the size pig most frequently reported in the pig-killing histories. Very large (yondoi mai) pigs were also killed, and while these probably weighed more, there was also a fair number of smaller pigs killed. Thus, it is assumed that the estimated average weight of 140 pounds may be slightly on the high side.

No Simbai Maring clan was holding a kaiko or pig festival during the course of the current study. Thus, all pigs were killed for purposes of affinal payments or to placate the ancestors of persons who were seriously ill. Moreover, particularly at Singanai and Fogaikumpf, pigs were killed just because people were hungry for pork. Occasionally, some were killed for a local domestic celebration, such as the return of plantation laborers. It seems reasonable to assume that 1968 was a fairly typical year with respect to pig killing.

The total number of pigs killed by all the Simbai Maring clans included in this study in 1968 was 184. This yielded an average of 6.3 pounds of pork per capita per year, or an average of 7.887 calories and 478 grams of protein per person per year. Actually, the amount of pork available per person varies from one local group to another throughout the valley, with a high of 12.0 pounds per person at Gunt's and a low of 2.74 pounds at Gai. More pork per person was available in the southeastern areas of Gunt's and Tsengamp than anywhere else. Mondo comes in next with 7.2 pounds per person, and is followed by Kinimbong 6.6, Fogaikumpf 6.2, and Singanai 6.0, with the lowest per capita amounts of pork available at Tsembaga 5.3, Nimbra 3.3, and Gai 2.74 (Table 4.8). The pattern which emerges seems to be one of high pork consumption on the edges of Simbai Maring territory and low consumption in the middle. The one exception to this pattern occurs at Mondo, where the amount of pork is higher than expected. There are several possible explanations for this high figure. Firstly, my presence at Mondo may have influence pig-killing behavior, as I would purchase fresh pork when it was available. Secondly, Mondo was hit most severely by the influenza epidemic in 1968 and a number of pigs were killed in an attempt to appease the angry spirits. Thirdly, because I spent most of my time at Mondo, and

TABLE 4.8

RESULTS OF PIG KILLING SURVEY

Location	Population	No. Pigs Killed	Total Amt. Pork lbs.*	Pork per Person-gram	Calories**	Protein** gram	Fat** gram	Calcium** mgm
Fogaikumpf	113	10	700	6.2	7,762.4	469.96	633.6	279
Gunt's	297	51	3570	12.0	15,024.0	909.6	1,203.0	540
Tsengamp	180	23	1610	8.93	11,180.0	676.89	919.79	402
Singanai	197	17	1190	6.0	7,512.0	454.8	618.0	270
Nimbra	319	14	980	3.3	3,756.0	250.14	339.9	149
Gai	354	15	1050	2.74	3,430.5	207.69	282.2	123
Mondo	232	24	1680	7.2	9,014.4	545.76	741.6	324.0
Tsembaga	209	16	1120	5.3	6,635.6	401.74	545.9	239
Kinimbong	148	14	980	6.6	8,263.2	500.28	679.8	297.0
TOTAL	2,049	184	12,800	6.3	7,887.6	477.54	648.9	284

* All calculated values based on average weight of pigs = 140 lbs., and edible portion = ½ total weight of pig

** U.S.D.A.

1687b—Composit of trimmed lean cuts, thin class, without bone and skin—81% lean, 19% fat thus knew the Tuguma better than any other local group, my information on them may be more accurate than that for other groups.

Results of the "Recent Protein Consumption Survey"

Due to the unreliability of the results of this survey, I will not attempt to present these results in a quantitative fashion, but will merely discuss them to give an indication of the amount of variation which was encountered. In general, the people who were surveyed at Kinimbong, Tsembaga, Tuguma, and Gai indicated that little or no meat had been eaten in the week prior to the survey. Moreover, those who did respond positively, said that they had only eaten small game, such as insects, birds, lizards and marsupials. Individual portions could not have been greater than an ounce at a time. At Kinimbong I was informed that because of the scarcity of game in the area, men had almost ceased to hunt. Indeed, several men there had discarded their weapons entirely. The people surveyed at Gai, responded that they had been kept too busy with mission work to hunt, and that besides, there was little or no game available anyway.

At Nimbra, Tsengamp, Gunt's, Fogaikumpf and Singanai, the response was quite different. All of the clans censused at these places reported a fairly consistent consumption of at least some animal foods in the week prior to the survey. At Nimbra and at Tsengamp, people reported eating mostly small game, but this seemed to be fairly abundant. At Fogaikumpf, Singanai and at Gunt's reports were given of having eaten quantities of large game, namely, cassowaries and feral pigs. People in these areas, particularly members of the Kono (Fogaikumpf) and Bomagai and Angoing clans, were very involved with hunting and found it to be a rewarding activity. Remember that these clans have access to an almost unlimited tract of primary forest which stretches out to the southeast of their territory. This impression of abundant game is confirmed by Clarke's study. He (1971:90) noted that an average of three or four feral pigs were killed and eaten by the people in the Dwimba Basin during each month of his residence there, while four of five cassowaries were killed and eaten during one year of his residence there. He noted that the pigs were small, averaging only about 50 pounds, but this would yield over one pound of undressed pig per person per month. Cassowaries are about the same size as feral pigs and would provide a similar amount of meat. Clarke also estimated an additional consumption of about 10 ounces of animal flesh (bird and marsupial) per person per month.

Thus, the total amount of edible animal flesh consumed by the forest-edge people would amount to about 12 ounces per person per month. This is equivalent to 1,753 calories and 106.1 grams of protein.

In contrast, during my twenty-two months at Tuguma, only three feral pigs were captured; Rappaport (1968:78) reported a similar number during his stay with the Tsembaga. In this area there are no wild cassowaries. Marsupials, eels and birds were occasionally captured in these areas but the numbers were small and probably yielded no more than one ounce of animal flesh per person per month. The individual food consumption studies confirm this impression that these Maring groups are essentially vegetarian.

Thus, one is left with the impression that among the Simbai Maring clans whose territory borders on the forest, game provides an average of about three grams of protein per person per day; for those clans without access to large tracts of forest, the amount of protein per person per day is indeed negligible.

It is evident from the above that the Maring are primarily vegetarians, and, at best, animal food forms only an extremely small portion of their diet. Not only is the overall intake of protein low, but it appears to vary from place to place so that the Maring populations in the southeastern portion of the territory on the forest edge have diets richer in both animal and vegetable protein than do the groups in the northwest.

CHAPTER 5

HEALTH

In order to assess the affects of the low protein intake and the apparent regional variation in the availability of protein as well as to obtain a picture of the overall health and nutritional status of the Simbai Valley Maring population, I invited Dr. John Stanhope, an epidemiologist working for the Public Health Department of the Territory of Papua and New Guinea, to examine the population. He kindly agreed and spent two weeks with me in the Simbai Valley in June 1968. During this time we visited each of the Simbai Valley Maring populations; Dr. Stanhope examined all of the cooperative individuals in these populations, paying particular attention to features related to nutritional state. The methodology he used was that described by Jelliffe (1966:10-105) for the assessment of the nutritional status of a community. Examination results were recorded on individual punch cards which also contained anthropometric, hematological, genetic and genealogical data.

In addition to these physical examinations, I kept records of the growth and development of Tuguma children and consulted the personnel and records of the Anglican Mission's Maternal and Child Welfare services. The Department of Public Health also provided information on infectious diseases affecting the area.

Results

The results of these investigations indicated that the most important chronic medical problems which affect the Simbai Valley Maring are dietary deficiencies in both iodine and protein, and a high incidence of malaria. In addition, this population had been subject to epidemics of influenza during the wet season (November to May) of 1966-67, 1967-68 and 1968-69. During the summer of 1967, the Simbai Valley was quarantined by the Public Health Department because of an outbreak of suspected meningitis. First, I will discuss the incidence and distribution of the deficiency diseases and then of malaria. Following this, I will show how these chronic endemic diseases may interact with each other, how their presence may affect the outcome of acute infectious diseases, and how they may help to explain the regional variation in demography and phenotypes.

A number of previous investigations (Buttfield, et al. 1966; Buttfield and Hetzel 1967, 1969; Hetzel 1970; Pharoah, Buttfield, and Hetzel 1971) have demonstrated that the condition known as endemic goiter is commonly found in the mountainous regions of New Guinea. Areas of high endemicity are now known to exist in the Huon Peninsula, and in the Central Highlands and in the Jimi Valley. Stanhope (n.d.) and I discovered that this condition was also prevalent among the Simbai Valley Maring.

Endemic goiter is believed to be caused by a deficiency of available iodine in the diet. The condition is characterized by enlargement of the thyroid gland in a large proportion of the affected population and is associated with a condition known as endemic cretinism which is also believed to be caused by iodine deficiency (Green 1973). The enlargement of the thyroid gland is believed to be a compensatory attempt of the gland to increase its iodine trapping capacity so as to maximize the use of whatever iodine is available, and thus maintain the production of thyroid hormones within normal levels. An adequate supply of these hormones is necessary for the regulation of body temperature and metabolism, and for normal physical and neurological growth and development as well as for muscle contraction and nerve conduction (Means, De Groot, and Stanbury 1963).

The size and activity of the thyroid gland is controlled by a negative feedback mechanism involving both pituitary and hypothalmic hormones as well as thyroid hormones. The amount of circulating thyroid hormone is dependent on both the dietary intake of iodine and upon the ability of the thyroid gland to trap iodine and to synthesize its hormones. The concentration of thyroid hormone circulating in the blood stream has an inverse effect on the amount of thyrotrophic hormone releasing factor (TRF) released by the hypothalmus and on the amount of thyroid stimulating hormone (TSH) released by the adenohypothesis. Low levels of iodine intake are paralleled by low levels of circulating thyroid hormones which in turn stimulate an increase in the secretion of TSH by the adenohypothesis. The increased secretion of TSH stimulates the hyperplastic growth of the thyroid gland and a concomitant increase in the secretion and release of thyroid hormones, in an attempt to maintain the normal euthyroid state (Dumont, Neve, and Otten 1969).

Thus, a deficiency in the dietary intake of iodine is the major etiological factor in endemic goiter. The ingestion of adequate amounts of iodine will cause an involution of almost any enlarged thyroid gland (Green 1973:121). Workers in New Guinea have achieved involution of goiters and prophylaxis against their return for periods of at least five years with a single intramuscular injection of iodized oil (Pharoah, Buttfield and Hetzel 1971; Buttfield, et al. 1966; Buttfield and Hetzel 1967). This treatment proved effective in reducing the size of the goiters in a few Simbai Valley Maring who were treated in the Madang Hospital. Stanhope recommended that this treatment be afforded to all Simbai Maring women of child-bearing age. This treatment was carried out by a public health worker in August 1968.

The observed incidence and distribution of enlarged thyroid glands detected by Stanhope in June 1968 is summarized in Tables 5.1, 5.2, 5.3 and 5.4. The overall goiter rate (that is, the per cent of individuals with enlarged glands as detected by palpation as well as by visual inspection alone) was 17.9 per cent. This rate is as high as that reported by Buttfield and Hetzel (1967) for the inhabitants of the Huon Peninsula of Eastern New Guinea; an area which is known to have a high goiter endemicity. By contrast the Chimbu people in the Eastern Highlands have a much lower incidence of goiters. Venkatachalam (1962) noted that only 4.2 per cent of Chimbu adults had enlarged thyroid glands and that no Chimbu children were so affected.

The demand for iodine is greatest during periods of rapid growth and high metabolic activity particularly during adolescence for both sexes and during the reporductive years for women. These categories of people tend to have a higher incidence of goiters than do adult males in the same population. Stanhope (n.d.) calculated that the overall thyroid rate for Maring males between the ages of 10 and 19 was 34 per cent, for females of the same age the rate was 59 per cent, and for women over 20 the rate was 44 per cent.

We also noted that there was some variation in the goiter rate from place to place within the Simbai Valley. Thus, the people censused at

TABLE 5.1

GOITER RATES TOTAL POPULATION

Group	Males			Females			Combined		
	number examined	number positive	%	number examined	number positive	%	number examined	number positive	%
Fogaikumpf	53	6	11.3	56	14	40.0	109	20	18.4
Angoing	20	5	25.0	14	4	28.6	34	9	26.5
Bomagai	37	13	28.5	39	13	33.3	76	26	29.2
Fungai	32	9	28.1	29	9	31.0	61	18	29.5
Korama	26	4	15.4	25	7	28.0	51	11	21.6
Murmbugai	37	10	27.0	40	10	25.0	77	20	26.0
Tsengamp	37	4	10.8	32	10	31.2	69	14	20.3
Singanai	62	10	16.2	74	23	31.1	136	33	24.2
Nimbra	108	16	14.8	133	41	30.8	241	57	23.6
Gai	118	14	12.0	132	54	41.0	250	68	27.2
Tuguma	105	6	5.7	91	37	40.7	196	43	23.0
Tsembaga	98	24	25.5	82	47	57.3	180	71	39.5
Kinimbong	35	0	0.0	56	5	8.9	91	5	5.5
Total	768	121	15.8	803	274	34.2	1571	395	25.1

TABLE 5.2

NUMBER OF ENLARGED THYROIDS AND GOITER SIZE-TOTAL POPULATION

AGE	GRADE 1		GRADE 2		GRADE 3	
	M	F	M	F	M	F
0-9	6	11	5	3	0	0
10-19	36	36	32	66	4	12
20+	28	64	11	88	3	6

TABLE 5.3

SELECTED THYROID RATES

	Males 10-19	Females 10-19	Females 20+
Rate	34%	59%	44%
Mean size all glands	0.53	1.05	0.72
Mean size enlarged glands	1.56	1.79	1.63

TABLE 5.4

GOITER RATES OF MALES AND FEMALES AGED 10-19 AND OF FEMALES AGED 20 AND OVER BY LOCAL GROUP

LOCAL GROUP	GOITERS: males 10-19	GOITERS: females 10-19	GOITERS: females 20 & over
KINIMBONG	0%	8%	12%
TSEMBAGA	50%	95%	60%
TUGUMA	6%	73%	42%
GAI	17%	78%	45%
NIMBRA	42%	32%	93%
SINGANAI	36%	100%	46%
TSENGAMP	50%	57%	33%
GUNT'S	50%	47%	32%
FOGAIKUMPF	47%	33%	38%

Kinimbong at the northwestern extreme of Maring territory had the lowest overall rate which was only 5.5 per cent. However, the highest rate of goiters 39.5 per cent was found among the Tsembaga people who live immediately to the southeast of Kinimbong. All of the other local populations had goiter rates ranging from 18.4 per cent to 29.5 per cent. The age-specific goiter rates also varied. Thus, all adolescent girls at Singanai had enlarged thyroid glands, as did 95 per cent of those at Tsembaga, 78 per cent of those at Gai and 73 per cent of those at Tuguma, while only 8 per cent of those at Kinimbong were affected. At the other locations the percentage of girls with goiters ranged from 32 per cent to 57 per cent. Since girls of this age are still living on the territory in which they were born, the goiter rate in this group may possibly reflect local variation in the availability of iodine.

In addition to the enlarged thyroid glands, iodine deficiency may result in the production of children who are known as endemic cretins. These children are characterized by having multiple neurological defects, including deaf mutism, lack of muscular coordination, spasticity, crossed eyes and various degrees of mental and physical retardation (Querido 1969:85; Dumont, Delange, and Ermans 1969:91-96). There were at least twelve typical cretins in Tuguma, at least one at Tsembaga and one at Nimbra. Twelve of the thirty-eight children under the age of ten were diagnosed as cretins. No adult cretins were diagnosed, but the intellectual capacity of a few adults were suspect. The Anglican Mission's health workers in the area indicated that endemic cretinism was also fairly common among the Jimi Valley Maring children. They also indicated that this condition was much less frequent among the Karam speakers who live to the northwest of Kinimbong.

The prevailing opinion (Dumont, Delange, and Ermans 1969) is that endemic cretinism is caused by hypothyroidism in the mother due to her deficient intake of iodine, or by the insufficient intake of iodine by the infant in its first six months of life. However, Pharoah, Buttfield, and Hetzel (1971:310) suggest that "it is possible that elemental iodine is necessary for the embryological development of the nervous system, quite apart from its role in the synthesis of the thyroid hormones." They make this suggestion because in their study of the Jimi Valley population no clinical evidence of maternal hypothyroidism was found and they note that the fertility of these women precluded maternal hypothyroidism of any severity. They consider it to be rare for conception to occur in such women; and should conception occur, they believe it is unlikely that the fetus would be carried to term. However, it is difficult to evaluate these statements about fertility for the authors do not provide us with fertility rates nor with enough data to calculate these rates.

As we have noted in Chapter 4, the fertility rates of the Simbai Valley Maring are low and that this is also the case in many other parts of New Guinea. This low fertility may be due at least in part to the effects of hypothyroidism on the women in an iodine deficient population.

At least two Tuguma women showed clinical signs of hypothyroidism, one was a girl of at least fifteen or sixteen years of age who had an unusually enlarged thyroid gland. She was extremely short (120 centimeters) and showed no signs of pubescence. In addition, her body was infected with scabies and open sores. She seemed to be very dull and lethargic and had a depressed nasal bridge and presented a typical picture of myxedema. She was considered to be defective by the local population. After treatment with iodized oil, her thyroid gland became smaller and her personality changed (she became active, bright and inquisitive). She begun to grow (her height increased 3 centimeters in 6 months) and to show signs of puberty.

The other Tuguma woman who gave the appearance of being hypothyroid also had a large goiter and appeared to be dull and sluggish. She was in her middle twenties, had been married and widowed twice and had borne no children.

Moreover, Stanhope in his 1968 report commented on the high degree of pregnancy wastage (fetal and infant deaths) among the Simbai Valley Maring; noting that of the 54 pregnancies occurring between 1964 and 1968, 11 resulted in stillbirths, 22 in infant deaths, and 18 in infants still alive at the end of one year. In three cases the fate of the pregnancy was unknown. This yields a stillbirth rate of 20.4 per cent and an infant mortality rate of 40.8 per cent or a combined fetal and infant wastage of 61.0 per cent of all recorded pregnancies. This is higher than for any New Guinea population discussed by Stanhope (1970:37).

Table 5.5 shows pregnancy wastage for each of the rest house populations per 100 recorded births between July 1966 and December 1969 and pregnancy wastage per 100 births as derived from the reproductive histories. With some exceptions, notably at Fogaikumpf, the amount of pregnancy wastage parallels the incidence of goiters in the population. Thus, it appears likely that iodine deficiency in this population may be an important contributing factor to the high rate of pregnancy wastage.

Moreover, the high incidence of cretinism due to iodine deficiency may contribute to the high infant and child mortality encountered among the Maring, as these cretinous children seldom survive much past the age

TABLE 5.5

PREGNANCY WASTAGE BY LOCAL GROUP

	Fogaikumpf	Gunt's	Tsengamp	Singanai	Nimbra	Gai	Mondo	Tsembaga	Kinimbong
A.	400.0	83.3	100.0	444.4	83.3	250.0	273.0	173.0	230.0
B.	285.7	99.3	168.1	219.5	111.7	137.4	206.6	189.1	84.7

A. Fetal and infant deaths per 1000 births recorded during the period between 7/66 and 12/69.

B. Fetal and infant deaths per 1000 births derived from 418 reproductive histories.

of five. Because the Maring are unable to make a diagnosis of cretinism until a child is at least six months old, these children escape infanticide only to die later of natural causes. Although the Maring do not consider severely affected cretins to be human, they treat them well. I was surprised at how long even some of the most severely retarded cretins did manage to survive. One Tuguma child was so badly retarded that at the age of six or seven he weighed no more than 20 pounds and was unable to lift his head. He finally died of a respiratory disease, probably pneumonia. Marginally retarded children do exist in the population and it is possible that they do survive to adulthood, but we were unable to detect them without physiological and psychological testing (see Green 1973 for a discussion of cretinism in Equador).

The Maring consider cretins to be spirit children who were exchanged for human babies who were left unwatched while their mothers were working in their gardens. The Maring also believe that children who are conceived in gardens or in the bush are likely to be cretins, as the wood spirits or minjuwa are capable of entering a woman's vagina during copulation and placing their children in her womb.

The presence of iodine deficiency may also affect fertility in another culturally mediated fashion. Cretins were always the youngest child in their families. Their mothers stated that they would have no more children until the affected child either recovered or died.

In the previous chapter, I demonstrated that the amount of protein in the Maring diet was extremely low, so it is not surprising that signs and symptoms of protein malnutrition should be found to occur within this population. These symptoms included hepatomegly and enlarged parotid glands in all segments of the population as well as hair signs, pigment changes, edema, muscle wasting and growth retardation in children.

Enlargement of the liver has been noted in many New Guinea populations and has been studied by a number of investigators since 1957 when Peters noted an association between liver enlargement and spleen enlargement in people of the very malarious Fly River and Milne Bay areas of Papua. However, about 4 per cent of the teenagers in the malaria-free Wabag region were found to have enlarged livers, suggesting that malaria was not the only factor. Scholfield, et al. (1964) working in the Sepik noted that older women tended to have both liver and spleen enlargement associated with anemia. Vines (1967) emphasized that the highest prevalence of enlarged livers is found in women living in malarious areas, where over 60 per cent of the women over 45 are affected.

In the highlands, enlarged livers are frequently diagnosed as cirrhosis and are attributed to chronic protein deficiency. The problem is discussed by Venkatachalem (1962). He notes that nearly one-third of all of the subjects in his survey had palpable livers and that this frequency was nearly twice as high as the spleen rate.

Hepatomegly was also found among the Simbai Valley Maring (see Table 5.6), but the overall rate was only 6.4 per cent. More palpable livers were found in women than in men and they occurred in all age groups. At least one older woman was diagnosed by Stanhope to have hepatic carcinoma. She was a member of the Tuguma group. In two of the local populations, the Fungai and the Kinimbong, the incidence of hepatomegly was zero, while among the Tsengamp and Murmbugai the incidence was over 10 per cent. The significance of enlarged livers among the Maring is not known, but it is likely that they are associated with both malaria and protein deficiency.

TABLE 5.6

ENLARGED LIVER RATES

Group	Males			Females			Combined		
	number examined	number positive	%	number examined	number positive	%	number examined	number positive	%
Fogaikumpf	53	3	5.7	56	7	12.5	109	10	9.2
Angoing	20	0	0.0	14	3	21.4	34	3	8.8
Bomagai	37	0	0.0	39	3	7.7	76	3	4.0
Fungai	32	0	0.0	29	0	0.0	61	0	0.0
Korama	26	1	3.8	25	1	4.0	51	2	3.9
Murmbugai	37	4	10.8	40	6	15.0	77	10	13.0
Tsengamp	37	3	8.1	32	5	15.6	69	8	11.6
Singanai	62	0	0.0	74	3	4.1	136	3	2.2
Nimbra	108	8	7.4	133	8	6.0	241	16	6.6
Gai	118	12	10.2	132	12	9.1	250	24	9.6
Tuguma	105	7	6.7	91	5	5.5	196	12	6.1
Tsembaga	98	4	4.1	82	6	7.3	180	10	5.6
Kinimbong	35	0	0.0	56	0	0.0	91	0	0.0
Total	768	42	5.5	803	59	7.3	1517	101	6.4

Parotid gland enlargement has been considered by many workers (Jelliffe 1966:32; Venkatachalem 1962; Oomen and Malcolm 1958) to be a symptom of chronic protein malnutrition, although other workers consider it to be a physiological adaptation to a diet largely composed of unrefined starches (Vines 1972). As in many Highland New Guinea populations, enlarged parotid glands were observed to occur among the Maring. The parotid gland rate for the various Maring local groups are shown in Table 5.7. The overall rate of parotid enlargement was 5.6 per cent of the population. This is quite low in comparison to the rate of 23.6 per cent observed by Venkatachalem (1962) for the Chimbu. As among other groups, Maring males and females appear to be about equally affected. There was variation in the frequency of occurrence of enlarged parotids from place to place. The highest frequencies occurred among the Tuguma and the Korama, the lowest among the groups located to the southeast of the Righan River, and among the Tsengamp and the Murmbugai. This finding may possibly reflect the greater amount of protein available to the members of these southeastern groups (see Chapter 4).

Children displaying signs of protein malnutrition, including hair signs, depigmentation, edema, muscle wasting, and personality changes were seen in all of the Simbai Maring groups. Three hundred and ninety-eight children under the age of ten were examined and fifty-seven or 14.3 per cent exhibited some signs of protein malnutrition. Here again there was regional variation. The highest frequency of children with these symptoms was found among the Murmbugai, Tuguma and Kinimbong groups. The lowest incidence occurred among the Tsembaga, Singanai, Bomagai, Angoing and Korama populations. During my field work, I observed five cases of frank kwashiorkor. Two of these occurred at Tuguma, two at Gai

TABLE 5.7

ENLARGED PAROTID GLAND RATES

Group	Males			Females			Combined		
	number examined	number positive	%	number examined	number positive	%	number examined	number positive	%
Fogaikumpf	53	2	3.8	56	1	1.8	109	3	2.75
Angoing	20	0	0.0	14	1	7.1	34	1	2.94
Bomagai	37	0	0.0	39	2	5.1	76	2	2.63
Fungai	32	1	3.1	29	0	0.0	61	1	1.64
Korama	26	2	7.7	25	3	12.0	51	5	9.80
Murmbugai	37	3	8.1	40	0	0.0	77	3	3.9
Tsengamp	37	0	0.0	32	2	6.3	69	2	2.9
Singanai	62	2	3.2	74	5	6.8	136	7	5.15
Nimbra	108	9	8.3	133	5	3.8	241	14	5.8
Cai	118	5	4.2	132	10	7.6	250	15	6.0
Tuguma	105	10	9.5	91	9	9.9	196	19	9.7
Tsembaga	98	9	9.2	82	2	2.4	180	11	6.1
Kinimbong	35	2	5.7	56	3	5.4	91	5	5.5
Total	768	45	5.9	803	43	5.4	1571	88	5.6

and one at Tsembaga. In all the cases the mother had become pregnant too soon. Both of the affected Tuguma cases recovered, those at Gai and Tsembaga died.

Growth retardation, considered by Jelliffe (1968) to be the first sign of protein-calorie malnutrition, appeared to be common among Maring children. This impression was borne out by an examination of the Maternal and Child Welfare clinic records, which showed little or no weight gain in most children between the ages of about six months and two to two-and-a-half years. Unfortunately, the clinic visited only the northwesternmost Maring groups, those between Kinimbong and Nimbra. Clinic visits were sporadic and attendance was spotty, so no attempt was made to quantify their findings (Figures 5.1 and 5.2 show growth curves for the entire Maring population constructed from cross-sectional data). Because of the small number of individuals in each age category, it was not possible to construct such growth curves for each of the local populations. From the limited information which is available, it does appear that growth retardation is common among the Maring. This is not surprising in view of their small adult stature. It is also likely that growth retardation is more frequent and more severe in those places, namely Tuguma and Tsembaga, where the adults are smallest.

Cross-sectional data on head and chest circumference on children from age 0-10 is presented in Figures 5.3 and 5.4; and in Table 5.8. These measurements were collected because as Jelliffe (1966:70) notes a chest/head circumference ratio of less than 1 may be due to developmental failure, or to the wasting of muscle and fat tissue on the chest wall and can be used as an indicator of protein-calorie malnutrition of early childhood. In adequately nourished children the circumference of the

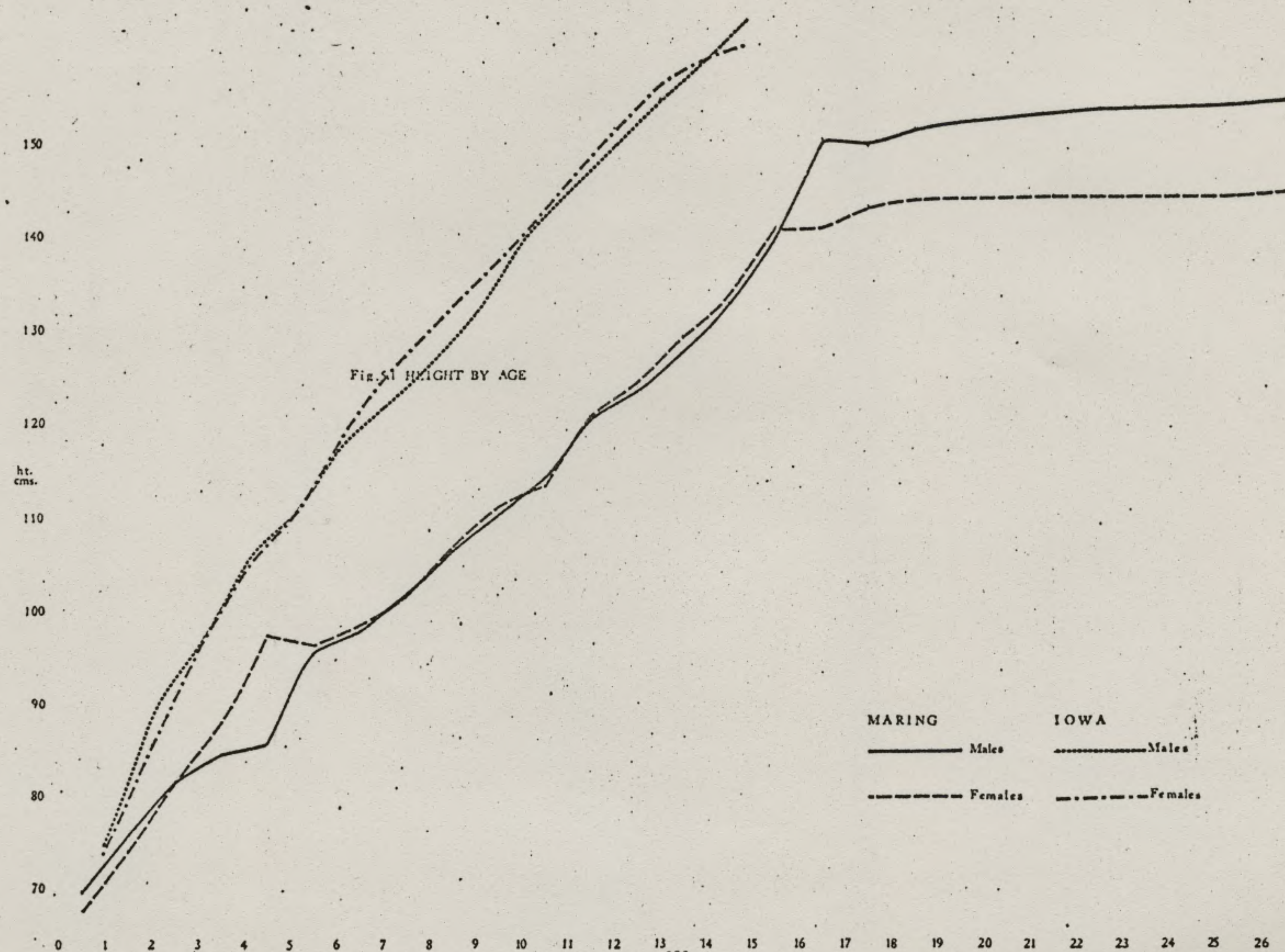


Fig.51 HEIGHT BY AGE

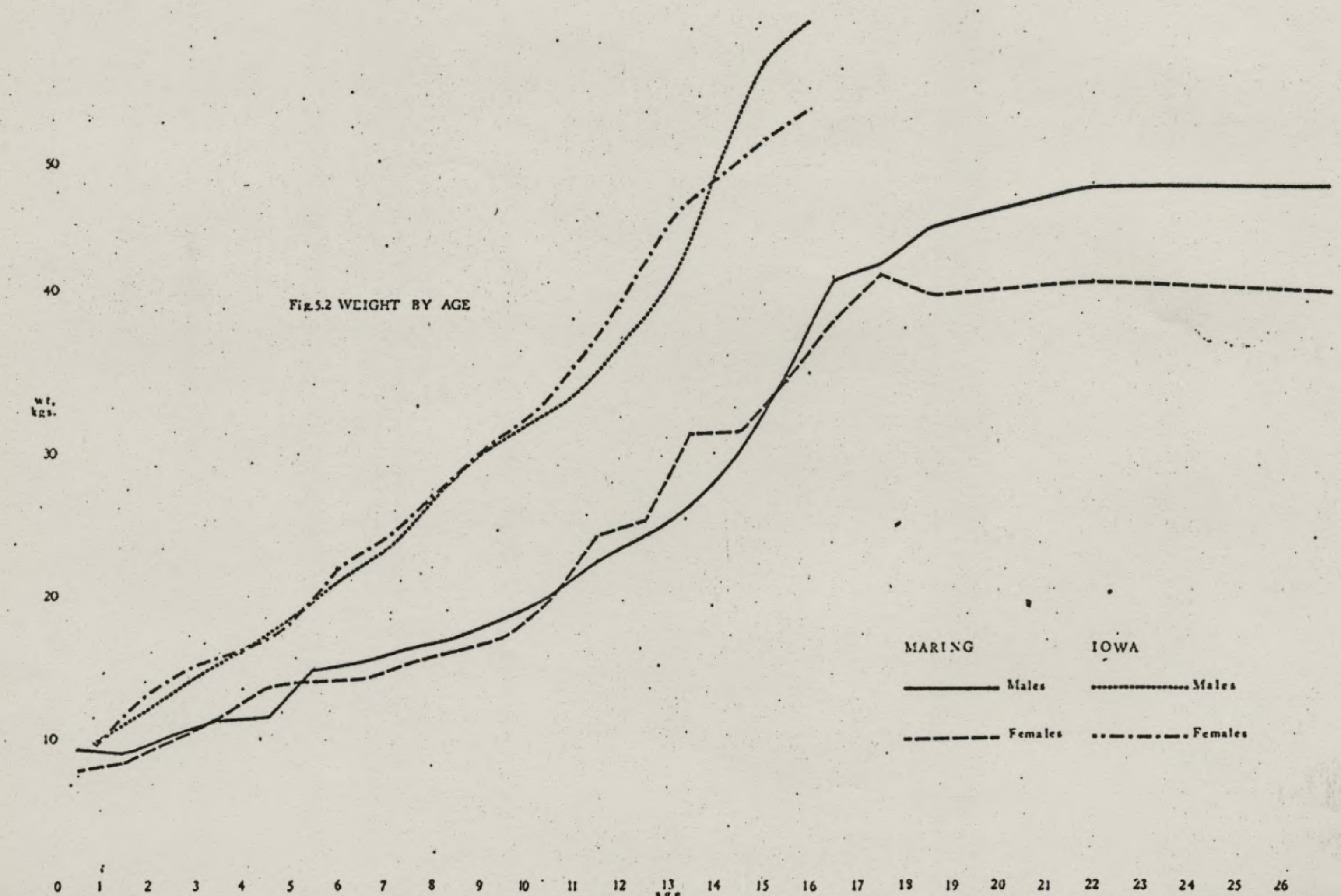


Fig.5.2 WEIGHT BY AGE

Fig. 5.3 HEAD AND CHEST CIRCUMFERENCE OF MARING BOYS AGE 0 - 10

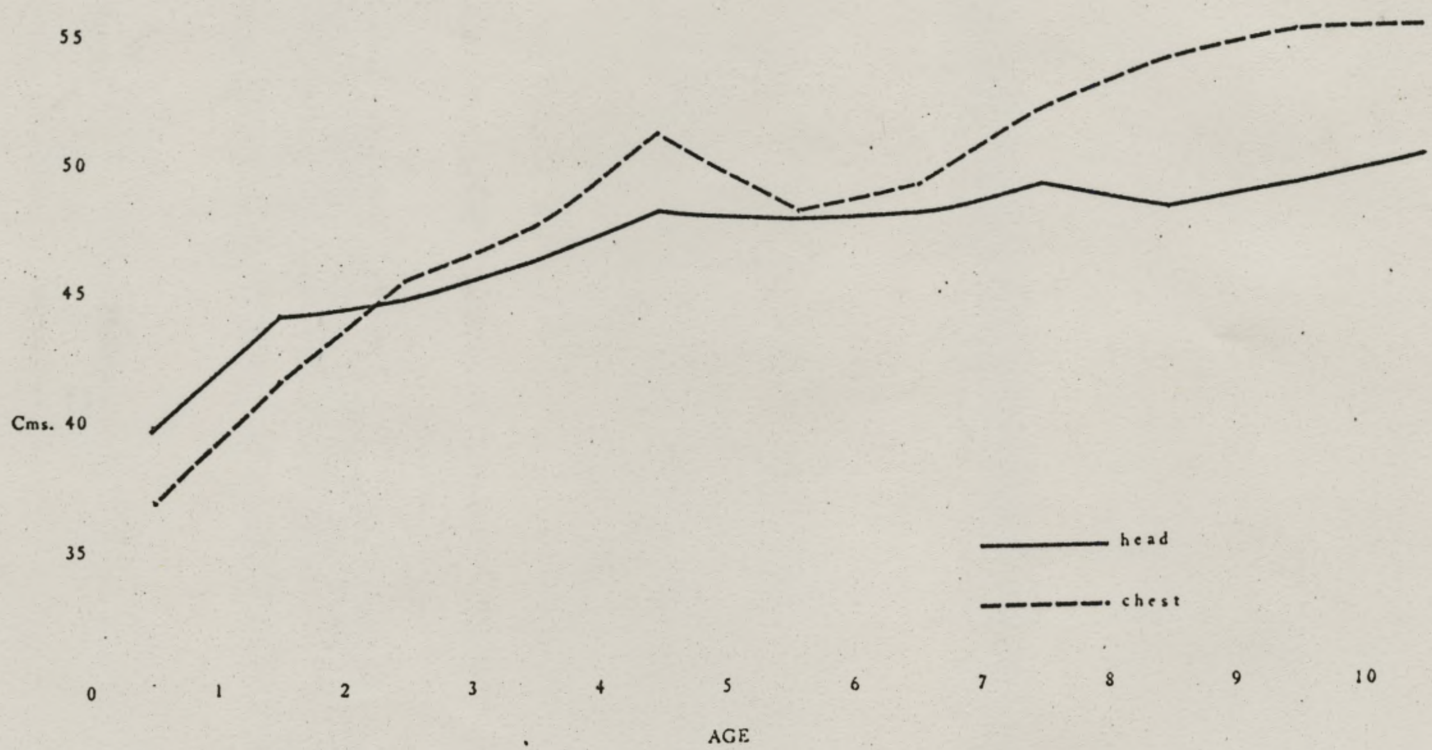


Fig. 5.4 HEAD AND CHEST CIRCUMFERENCE OF MARING GIRLS AGE 0-10

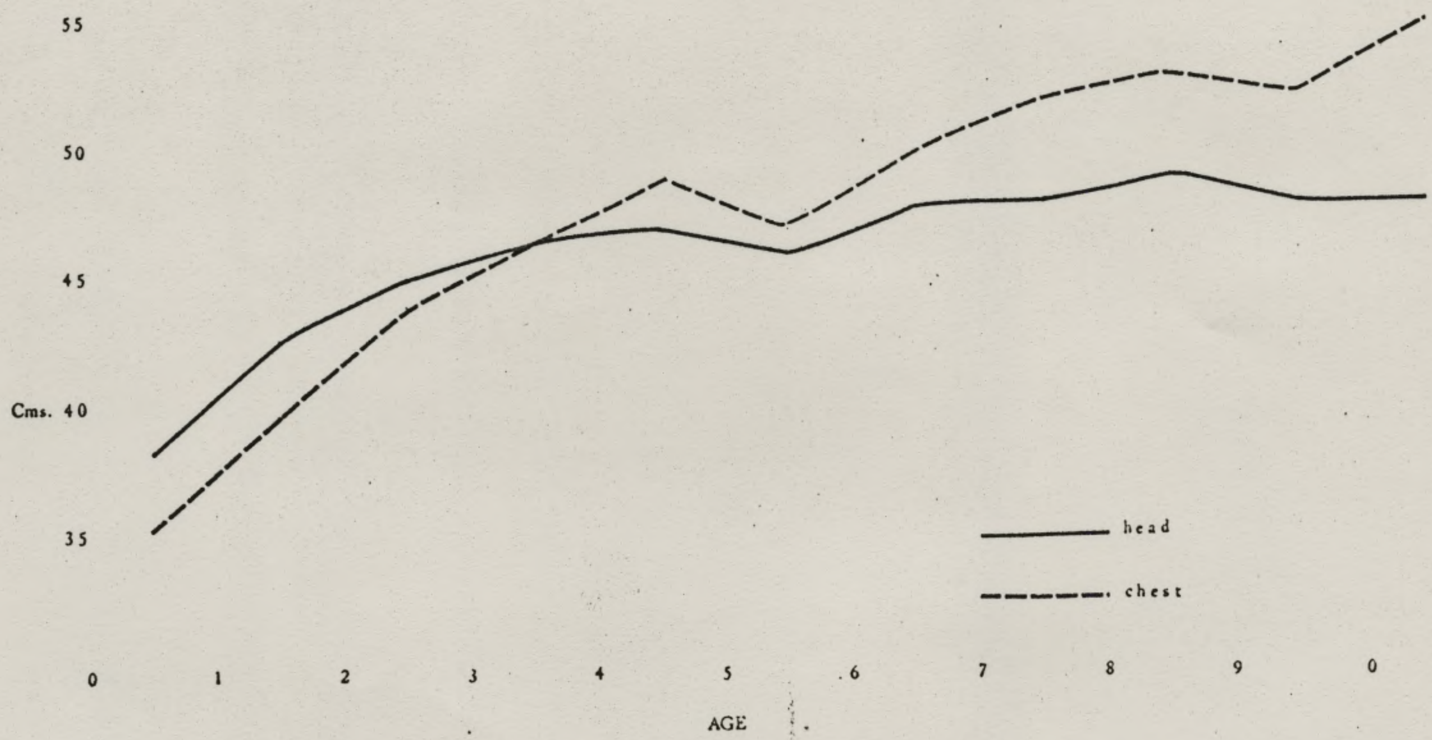


TABLE 5.8

HEAD AND CHEST CIRCUMFERENCE OF MARING CHILDREN
COMPARED WITH STANDARD MEASUREMENTS

	MARING						STANDARDS*	
	Males			Females				
Age in months	N.	Head Circum.	Chest Circum.	N.	Head Circum.	Chest Circum.	Head Circum.	Chest Circum.
6	15	40.0 ± 3.5	37.0 ± 5.7	16	38.5 ± 3.7	35.4 ± 4.6	43.4	44.0
18	19	44.3 ± 1.3	41.7 ± 1.5	20	42.7 ± 1.1	39.8 ± 1.4	47.4	48.0
30	28	44.9 ± 1.5	45.6 ± 2.5	17	45.1 ± 1.5	44.0 ± 2.9	49.5	51.0
42	19	46.6 ± 1.2	47.5 ± 6.7	18	44.4 ± 1.5	46.4 ± 2.7	50.3	52.5
54	7	48.3 ± 1.1	51.3 ± 4.0	11	47.0 ± 1.9	48.8 ± 2.8	50.6	54.0
66	15	47.8 ± 1.7	48.0 ± 2.6	3	46.0 ± 2.1	46.0 ± 0.6	50.7	56.0

* Adapted from Jelliffe (1966:71)

A further indication that growth and developmental retardation is common among the Maring is the fact that the mean age of tooth eruption for Maring children as determined by Stanhope (personal communication) is late, even as compared to New Guinean standards. Thus, the mean age of eruption of the first tooth is 8.27 months and it is not unusual to see children even past the age of one year with no teeth (see Tables 5.9 and 5.10).

Delayed tooth eruption is also a common observation in children with hypothyroidism (Andersen 1966). In cretinism not only is tooth eruption delayed but tooth formation is also impaired. According to Andersen (Ibid.) approximately 80 per cent of cretins have enamel hypoplasia. The time of enamel growth disturbance is roughly related to the time of onset of thyroid deficiency, and the occurrence of enamel hypoplasia in cretinism is regarded as another sign of interuterine hypothyroidism. Enamel hypoplasia was a common finding in Maring children and was especially prevalent in those who were diagnosed as being cretins.

While it is undoubtedly true that protein deficiency is responsible for much of the growth retardation and consequent short stature encountered among the Maring, it is likely that iodine dificiency is also a contributing factor. In his study of a Guatemalan highlands community characterized by high rates of endemic goiters, Greene (1973) noted that the residents were shorter in stature than those of genetically similar populations not suffering from iodine deficiency. He also noted that the adult cretins in his population were shorter than normal adults. As previously mentioned growth retardation and dwarfing are characteristic features of the hypothyroidism which may result from iodine deficiency.

Another feature which is relevant to an assessment of Maring nutri-

TABLE 5.9

ERUPTION TIMES OF DECIDIOUS TEETH *

Tooth	Age in months	
	Upper	Lower
Medial Incisor	9.72 ± 0.62	8.27 ± 0.80
Lateral Incisor	12.78 ± 0.78	13.15 ± 0.81
Canine	18.73 ± 0.58	19.68 ± 0.57
First Molar	16.06 ± 1.07	16.04 ± 0.96
Second Molar	24.66 ± 3.74	24.00 ± 1.16

* Stanhope (personal communication)

TABLE 5.10

MEAN AGE OF ERUPTION OF PERMANENT DENTITION *
COMPARED WITH NEW GUINEA MEAN
(Barker n.d.)

	TOOTH	MEAN	S.D.	NEW GUINEA MEAN
MALES UPPER	1	7.20	0.45	6.66
	2	8.23	0.50	7.82
	3	10.04	0.57	10.14
	4	10.46	0.62	9.57
	5	11.22	0.57	10.69
	6	5.85	0.45	5.57
	7	11.50	0.61	11.08
	8	18.59	1.22	
MALES LOWER	1	6.57	0.46	6.15
	2	7.48	0.56	6.98
	3	10.01	0.55	9.64
	4	10.22	0.54	9.80
	5	11.17	0.65	10.79
	6	6.12	0.48	5.47
	7	11.45	0.61	10.77
	8	18.58	1.29	
FEMALES UPPER	1	6.74	0.46	6.48
	2	7.52	0.62	7.37
	3	9.81	0.63	9.34
	4	9.86	0.67	9.25
	5	10.28	0.71	10.31
	6	5.50	0.55	5.46
	7	11.02	0.54	10.94
	8	18.57	1.17	
FEMALES LOWER	1	6.44	0.48	6.05
	2	7.04	0.53	6.82
	3	9.96	0.63	8.94
	4	9.94	0.70	9.37
	5	10.51	0.69	10.39
	6	5.53	0.52	5.36
	7	10.93	0.54	10.16
	8	17.50	0.96	

* Stanhope (personal communication)

tional status is the fact that Maring adults tend to lose weight with advancing age. This weight loss is due mainly to a loss of subcutaneous fat as indicated by declining skinfold thickness measurements, and indicates that throughout adulthood the Maring suffer from an energy imbalance, that is, they tend to expend more energy than they consume.

Malaria is a major public health problem throughout most of New Guinea. This disease is known to be endemic at altitudes of up to 6,000 feet (Black 1972) and since most of Maring territory lies below this altitude, it is important for us to know the degree of endemicity of malaria among the Maring.

In 1962 a mass blood survey was undertaken by the Malaria Service of the Public Health Department in order to determine the degree of parasitemia among the Maring. The results of this survey were never published, but according to the Territory Malariologist, Dr. Saave (personal communication) the results expressed in per cent of the population with parasitemia, for the nine rest house populations in the Simbai Valley were as follows: Kinimbong 10.43 per cent, Tsembaga 6.21 per cent, Tuguma 4.66 per cent, Gai 8.06 per cent, Nimbra 0.0 per cent, Singanai 6.08 per cent, Tsengamp 33.02 per cent, Gunt's 19.52 per cent, and Fogaikumpf 19.56 per cent. The infections were caused by both Plasmodium falciparum and by Plasmodium vivax. From this blood survey there appears to be little relationship between parasitemia and altitude of settlement. However, it is well known that the collection and examination of blood films alone has the disadvantage of indicating only the presence or absence of parasitemia at a given point in time (Black 1968:29). Parasite rates show seasonal variation, and in mild infections it may not be possible to detect parasites in a single blood film.

It has been suggested by Black (Ibid.) that the spleen rate (per cent of individuals in a population with enlarged spleens) may be a better indicator of the amount of malaria in a population, as it is not so liable to rapid seasonal change. It is for this reason that in practice, spleen rates are the criteria used to describe the various rates of malaria endemicity. The spleen becomes enlarged after a single infection and clinical attack of malaria. It remains enlarged under conditions of persisting untreated attacks. In African populations spleen rates are lower in adults than they are in children, presumably because adults have an acquired immunity to malaria. But, according to Black (Ibid.), in New Guinea populations exposed to malaria, the enlargement of the spleen persists throughout adulthood. Thus, in order to determine the incidence and distribution of malaria among the Maring, spleens were palpated by Dr. Stanhope during the course of the physical examinations which he conducted in June of 1968. We were unable at that time to obtain blood smears.

The childhood spleen rates, that is, the per cent of children between the ages of two and nine with enlarged spleens as computed by Stanhope (n.d.) ranged from a low of 11 per cent at Nimbra, to 47 per cent at Tuguma and 54 per cent at Singanai. Seventy-three of the total of 304 children between the ages of two and nine examined had palpable spleens, giving an overall childhood spleen rate of 24 per cent which would classify the degree of malaria endemicity as meso-endemic according to Black (1968:36). The overall Maring childhood spleen rate is thus higher than that of 17.7 per cent reported by Venkatachalam (1962) for the Chimbu, although he noted that there was a lot of regional variation in that area. Hipsley and Kirk (1965) reported that only two of the twenty-eight chil-

TABLE 5.11

SPLEEN RATES

Group	Males			Females			Combined		
	number examined	number positive	%	number examined	number positive	%	number examined	number positive	%
Fogaikumpf	53	20	37.7	56	22	39.3	109	42	38.5
Angoing	20	1	5.0	14	6	42.8	34	7	20.6
Bomagai	37	8	21.6	39	15	38.5	76	23	30.3
Fungai	32	0	0.0	29	1	3.5	61	1	1.6
Korama	26	2	7.7	25	1	4.0	51	3	5.9
Murmbugai	37	15	40.5	40	12	30.0	77	27	35.5
Tsengamp	37	3	8.1	32	3	9.4	69	6	8.7
Singanai	62	25	40.3	74	26	35.2	136	51	37.5
Nimbra	108	9	8.3	133	8	6.0	241	17	7.1
Gai	118	32	27.4	132	32	24.2	250	64	25.6
Tuguma	105	30	28.6	91	35	38.5	196	65	33.2
Tsembaga	98	24	24.5	82	18	22.0	180	42	23.3
Kinimbong	35	4	11.4	56	2	3.6	91	6	6.3
Total	768	173	22.5	803	181	22.5	1571	354	22.5

dren whom they examined in the Chimbu village of Pari had palpable spleens.

The overall spleen rates for the Simbai Valley Maring are shown in Table 5.11. From this table it can be seen that the overall spleen rate (including children and adults) for the entire population was 22.5 per cent and that the rate was identical for males and females. The close agreement between childhood and total spleen rates indicates that there is little immunity developed by adults in this population. There was also a great deal of variability in spleen rates from place to place. The population at Kinimbong had a rate of only 6.3 per cent while that at Fogaikumpf had a rate of 38.5 per cent. The highest spleen rates (those above 30 per cent) were found among the peoples of Fogaikumpf, Singanai, Murmbugai and Tuguma. It should be noted that the members of the first three of these groups do not have access to land above 3,500 feet. However, the high spleen rate found among the Tuguma cannot be related to the altitude of their territory which extends up to the top of the range at about 7,000 feet, but may be related to the fact that most Tuguma houses occur in the lower portion of their territory, between the altitudes of 2,800 and 4,200 feet. In addition, it is possible that the high incidence of malaria among the Tuguma is related to the fact that they were the only Simbai Maring population examined in which no G6PD deficiency was found. G6PD deficiency has been postulated to give some resistance to malaria (Livingstone 1967). A report published in 1966 by Kruatrachue, et al., demonstrated that in individuals with G6PD deficiency, the concentration of parasites is greatest in those erythrocytes which are most deficient in the enzyme. More recent studies (WHO 1969:39) indicate that the enzyme G6PD is utilized by both the red blood cell and the malaria parasite in energy metabolism so that the parasite is unable to reproduce in enzyme deficient cells.

The lowest spleen rates found among the Simbai Valley Maring (under 10 per cent) were among the Fungai, Korama, Kinimbong, Nimbra and Tsengamp populations, all of which live at relatively high altitudes in which malarial transmission is known to be less intense.

From the above we can see that protein and iodine deficiencies as well as malaria are the most important health problems among the Maring and that the distribution of these disorders varies from place to place within the valley. Some populations appear to be clearly healthier than others. In particular, the population at Kinimbong seemed to be relatively free of malaria and from the symptoms of iodine deficiency, although some indications of protein deficiency were encountered. This population had the lowest death rate and the highest rate of natural increase of any of the Simbai Valley Maring local populations. The environmental factors which may contribute to the relative health of this population include the high altitude of its territory which would inhibit malaria transmission and the fact that there is an aid post there which dispenses anti-malarial drugs.

The Tsembaga and the Tuguma both had high incidences of malaria, iodine deficiency and protein deficiency. Protein deficiency among these populations was shown to be caused by both the scarcity of animal foods and the low protein content of the vegetable foods grown in these territories. If the low protein content of the vegetable foods is caused by nitrogen depletion of the soils, it is possible that whatever caused the nitrogen depletion, might also have caused iodine depletion. In Chapter 3, I noted that the population density of the Tuguma and the

Tsembaga was the highest encountered among the Simbai Valley Maring, and that there was evidence that their land had been subject to more intense cultivation than that of other groups. This intense cultivation may have exhausted the soil of both nitrogen and iodine. The death rates for both of these groups was high and the Tuguma had the highest rate of natural decrease and the lowest birthrate of any of the Simbai Valley Maring populations.

The population at Singanai had a high incidence of iodine deficiency and of malaria, but not of protein deficiency. The incidence of malaria here is related to the low altitude of Singanai territory which does not extend above 3,500 feet. The protein intake of this population is enhanced by game which is hunted in the abundant low altitude forest which is located within its territory. The death rate at Singanai was higher than that of any other Simbai Valley location, and the rate of natural decrease was second only to that of the Tuguma.

The populations located further to the southeast generally had lower incidences of both iodine and protein deficiency. Altitude appeared to be a factor in the incidence of malaria as those groups at lower altitudes, particularly the Murmbugai and the Fogaikumpf, had higher incidences of malaria. However, these two populations had high birthrates and both showed a natural increase of about 10 to 11 per 1,000 or 1 per cent per annum in the interval between August 1966 and December 1968.

Malaria incidence was low among the Nimbra, Fungai and Korama populations and it is believed that the protein intake of these populations is relatively high. The population at Nimbra was increasing, but that of the Fungai was stable and that of the Korama showed a slight decrease.

All three of these populations had relatively low birth and death rates.

As I have indicated earlier, recent episodes of acute infectious disease, particularly influenza and meningitis, have taken their toll among the Maring. Vines (1972) has noted that in New Guinea, influenza is associated with an increased prevalence of acute bronchitis and pneumonia, and it causes increased mortality in the community. In the New Guinea Highlands, adult males seem to be the group which suffers the highest mortality from influenza.

Thus, it appears that demographic features are related to the health status of each of the local populations. In particular those populations who suffer from a combination of two or more of the major health problems are also the populations showing the greatest rate of decline.

The various diseases which affect the Maring may be related to each other in the following ways:

Protein deficiency is most severe in its effects on young children (infants and toddlers). Not only does it cause delayed growth and permanent physical stunting and possible mental retardation, but it also greatly impares its victim's ability to resist disease, particularly infectious disease. Indeed, the relationship between protein malnutrition and infectious disease can be called synergistic. That is to say that the simultaneous presence of both conditions results in an interaction which is more serious for the host than would be expected if their combined effects were merely additive. Also, an infection which may precipitate clinical malnutrition can result in further synergism, as the infection then becomes more severe in the malnourished host. Thus, there is the danger that the mutual interaction of malnutrition and infectious disease can create a vicious circle which frequently results in the death of the host (Scrimshaw, Taylor, and Gordon 1968). For example it has been demonstrated that acute bacterial, viral or protozoan infection commonly precipitates kwashiorkor in children suffering from chronic, subclinical protein malnutrition.

Protein deficiency lowers the ability to resist infection and it has been reported that the most frequent cause of death in kwashiorkor and marasmus is bronchopneumonia. There is also evidence that even less severe forms of protein malnutrition can aggravate bronchopneumonia (Ibid.). In a series of influenza epidemics which occurred in the Simbai Valley during the late 1960's, it appeared that the number of fatalities probably due to secondary pneumonia was far greater among all age groups in the northwestern part of Maring territory where protein is scarce.

There is no clear-cut evidence that protein malnutrition affects the course of malaria. But it has been demonstrated that malaria can contribute to protein malnutrition by interfering with the absorption of dietary protein (Ibid.) and by destroying the protein content of red blood cells. Two per cent of the host's red blood cells may be destroyed each day (Jelliffe 1968). In addition, malaria is more severe during pregnancy (WHO 1968:46) and may thus contribute differentially to the mortality of women.

Iodine deficiency can also cause delayed growth and permanent physical and mental retardation. The effect of iodine deficiency on mortality is unclear, except that cretinous children among the Maring have low viability. Those who are severely retarded rarely survive past the age of five years. Iodine deficiency which results in hypothyroidism can lower fertility by interfering with conception and with the ability to carry a fetus to term. It has also been suggested (WHO 1965:315) that a reduction in metabolic activity, such as caused by iodine deficiency, slows the rate of growth of malaric parasites within the red blood cells and thus delays the antigen-antibody interaction which occurs when the blood cells rupture. Because of this delay there would be a corresponding prolongation of parasite circulation in the blood and a delay in the development of immunity to malaria.

CHAPTER 6

PHYSICAL AND GENETIC VARIATION

In Chapter 3 we examined Maring demography and discovered that the overall population was declining, but that regional variation existed. In Chapter 4 the Maring diet was investigated and was found to be only marginally adequate in terms of protein consumption and also that there was regional variation. In Chapter 5 we discovered that the most important health problems for the Maring were protein deficiency, iodine deficiency, malaria and recently influenza. However, since we are dealing with very small populations, and with disease factors which may be ephemeral, it was decided to investigate phenotypic and genotypic characteristics of these populations as it was thought that they might reflect more long standing regional environmental variation and adaption to this environmental variation.

Much of the material included in this chapter has been published elsewhere (Buchbinder and Clark 1971). However, the earlier report covered a smaller sample of Simbai Maring local groups than this report does. This was because lack of time and funds prevented us from doing hematological and genetic studies on all of the groups included in the rest of the study. Thus, these studies have not been done on the people censused at Kinimbong, Singanai and Fogaikumpf, nor on the members of the Bomagai and Angoing clans censused at Gunt's. Moreover, for the purpose of these genetic and hematological studies the Murmbugai and Tsengamp clans censused at Tsengamp were lumped together and called Tsengamp, and the

Fungai and Korama clans censused at Gunt's were similarly lumped and referred to as Gunt's. This was done because these clans were judged to be sufficiently similar in the characteristics under investigation, and in order to have groups of comparable size for statistical analysis. It is not possible at this time for me to separate the groups called Tsengamp and Gunt's into their component clans as has been done for the anthropometric, demographic, and health parts of the present study.

Methods

Anthropometric studies were performed on members of all the Simbai Maring groups; the size of the sample was almost equal to that of the total population. Blood samples were drawn from ca. 600 adult members of the Tsembaga, Tuguma, Gai, Nimbra, Tsengamp (Tsengamp and Murmbugai clans) and Gunt's (Fungai and Korama clans) populations and color vision testing was performed on 308 adult males from the same populations.

Weights were measured by means of a hanging spring balance fitted with a sling on which the subject was seated. Small children were weighed in their mother's arms. The balance had a capacity of 100 kilograms and was calibrated in tenths of a kilogram. Weights were recorded as the nearest tenth of a kilogram. The balance had a zeroing device, and its accuracy was repeatedly checked in the field against objects of known weight. No attempt was made to apply a correction factor for the weight of clothing since all subjects wore approximately the same minimal attire.

Heights were measured by having the subject stand on a flat surface to which a vertical upright had been fixed. A steel tape-measure calibrated in millimeters was attached to the upright and a ruler was placed on the subject's head at right angles to the tape-measure and height was measured to the nearest millimeter.

Triceps skinfold thickness was measured on the subject's left arm which was hanging relaxed at his side. The measurement was taken at a point halfway between the acromial process of the scapula and the tip of the olecranon process of the ulna. The Lange skinfold calipers were used. Arm circumference measurements were made at the same point that skinfold thicknesses were taken using a steel tape calibrated in centimeters.

Blood was collected from the subject's left cubital vein into containers (leeches) containing heparin. An aliquot was used on the day it was collected to determine the ABO blood group, hemoglobin concentration and the level of glucose-6-phosphate dehydrogenase (G6PD) activity. G6PD screening tests were performed with a "Sigma" kit designed for that purpose. Hemoglobin was measured with a portable Spencer hemoglobinometer using oxyhemoglobin. The instrument was calibrated against the International Standard.

As we had no centrifuge, the remainder of the blood was allowed to settle overnight, and the plasma was decanted early the next morning. The red cells and plasma were then packed in polystyrene boxes and carried to the Simbai Patrol Post and thence by light aircraft to Madang where they were packed in ice and forwarded to the School of Human Genetics, University of New South Wales, Australia for further blood group and serum tests. On their arrival in Sydney, some of the samples were found to have spoiled because of bacterial contamination and delays in transit and were thus unsuitable for further testing.

Color vision tests were carried out on male subjects by means of Ishihara Charts (1942 edition). Under my supervision, the test was explained to each subject by a member of the Tsembaga clan who was bilingual in Maring and Neo-Melanesian. The charts for non-literate persons were used, and color vision deficiency was scored only if it was certain that the subject understood the requirements of the exercise and carried out the first test without hesitation. Subjects were then considered to have color vision deficiency if they had difficulty with any of the charts.

Tests for the ABO MNs and Rh blood groups were performed for us by the staff of the School of Human Genetics, University of New South Wales, using techniques described by Macintosh, Walsh, and Kooptzoff (1958). The results of ABO testing in the field agreed perfectly with the results obtained in the laboratory.

Haptoglobin and transferrin phenotypes were determined by P. Clark using starch gels with a discontinuous buffer system (Poulik 1957). All suspected CD1 transferrin types were confirmed by autoradiography with Fe^{59}.

Dr. L. Y. C. Lai, of the School of Human Genetics, University of New South Wales, determined the acid phosphatase types by electrophoresis, using a modified form of the method of Hopkinson, Spencer, and Harris (1963) (Lai 1968)

All gene frequencies were determined by P. Clark and the staff of the School of Human Genetics, University of New South Wales. For the ABO system Fisher's method (Dobson and Ikin, cited by Macintosh, et al. 1958) was used. The Rh gene frequencies were calculated as described in Hainline, et al. (1969). Direct gene counting was used to determine MNs, haptoglobin, transferrin and acid phosphatase gene frequencies. All blood genetic markers were tested by the Hardy-Weinberg equation and found to be in equilibrium.

Marriage frequencies were computed from data collected by A. P. Vayda in 1962 and supplemented by data I collected in 1968. Included in these calculations are all existing marriages contracted by living Simbai Valley Maring as well as the remembered marriages of their parents and grandparents.

Results

Anthropometric data are presented in Tables 6.1 and 6.2. Table 6.1 shows heights, weights and ponderal indices for males and females in each of the thirteen Simbai Maring groups. Table 6.2 shows skinfolds, arm circumference and muscle circumference data. The average height of Maring men is 154.06 centimeters with a range of from 151.10 centimeters for Tsembaga men to 159.17 centimeters for Angoing men. These differences were found to be statistically significant ($P < 0.001$). In addition, an inspection of the data reveals a general increase in height from north-west to southeast (see Figure 6.1).

The average height of Maring women was 144.89 centimeters with a variation of between 141.99 centimeters for Tsembaga women and 148.17 for the Angoing women. The same general trend in height is apparent for women (see Figure 6.1). The differences in the extreme mean values are as significant as those for the men.

The average Maring man weighs 47.41 kilograms and the average woman weighs 39.94 kilograms. The average range for males is between 45.82 kilograms for the Tuguma to 53.29 kilograms for the Fungai. The average range for females is from 37.85 kilograms at Tuguma to 43.07 kilograms for the Korama. The difference in the extreme values is significant ($0.17 > P > 0.05$) for males, and more so for females ($P < 0.001$). There

TABLE 6.1

ANTHROPOMETRIC DATA: HEIGHTS, WEIGHTS, AND PONDERAL INDICES

Populations: Clan or clan cluster		No.	Height		Weight		Ponderal Indices		
			Mean	S.D.	Mean	S.D.	wt/ht.	wt/ht^3	100 log wt/ht
Kinimbong:	Males	26	153.31	5.98	46.08	5.11	0.301	0.013	1.085
	Females	38	145.16	5.89	38.84	4.24	0.268	0.013	1.094
Tsembaga:	Males	52	151.10	4.76	46.10	4.68	0.304	0.013	1.099
	Females	46	141.93	4.88	38.91	4.49	0.274	0.014	1.188
Tuguma:	Males	60	151.65	4.95	45.82	7.54	0.302	0.013	1.093
	Females	53	141.96	5.00	37.85	3.89	0.266	0.013	1.111
Gai:	Males	94	153.77	4.92	47.10	5.28	0.306	0.013	1.086
	Females	78	144.72	6.03	40.95	6.43	0.283	0.013	1.112
Nimbra:	Males	83	155.08	5.71	48.86	5.94	0.314	0.013	1.087
	Females	80	145.70	4.75	40.21	5.79	0.276	0.013	1.099
Tsengamp:	Males	26	152.96	5.07	44.81	4.63	0.293	0.013	1.079
	Females	20	146.70	5.78	37.35	4.92	0.254	0.012	1.070
Murmbugai:	Males	24	156.58	5.13	48.67	5.66	0.310	0.013	1.076
	Females	22	144.77	4.48	38.55	4.23	0.266	0.013	1.094
Singanai:	Males	52	153.88	5.44	45.25	5.43	0.294	0.013	1.074
	Females	40	144.15	6.86	38.33	5.25	0.266	0.013	1.097
Korama	Males	16	155.81	4.16	49.69	5.05	0.318	0.013	1.087
	Females	15	146.00	3.89	43.09	3.62	0.295	0.014	1.119
Fogaikumpf:	Males	31	155.29	4.58	49.16	5.38	0.316	0.013	1.088
	Females	27	146.41	5.55	42.11	4.92	0.287	0.013	1.108
Fungai:	Males	17	158.47	6.14	53.29	6.85	0.338	0.013	1.088
	Females	23	147.78	4.71	42.74	4.46	0.289	0.013	1.102
Bomagai:	Males	18	156.11	3.68	48.89	4.50	0.313	0.013	1.081
	Females	24	147.38	5.41	42.21	4.07	0.286	0.013	1.102

TABLE 6.1--Continued

ANTHROPOMETRIC DATA: HEIGHTS, WEIGHTS, AND PONDERAL INDICES

Populations: Clan or clan cluster		No.	Height		Weight		Ponderal Indices		
			Mean	S.D.	Mean	S.D.	wt/ht.	wt/ht^3	100 log wt/ht
Angoing:	Males	12	159.17	4.88	50.92	4.97	0.319	0.013	1.071
	Females	12	148.17	5.80	41.67	4.38	0.281	0.013	1.092
Total	Males	511	154.06	5.49	47.41	5.97	0.307	0.013	1.086
	Females	478	144.89	5.71	39.94	5.31	0.275	0.013	1.104

TABLE 6.2

ANTHROPOMETRIC DATA: SKINFOLD THICKNESS, ARM CIRCUMFERENCE AND MUSCLE CIRCUMFERENCE

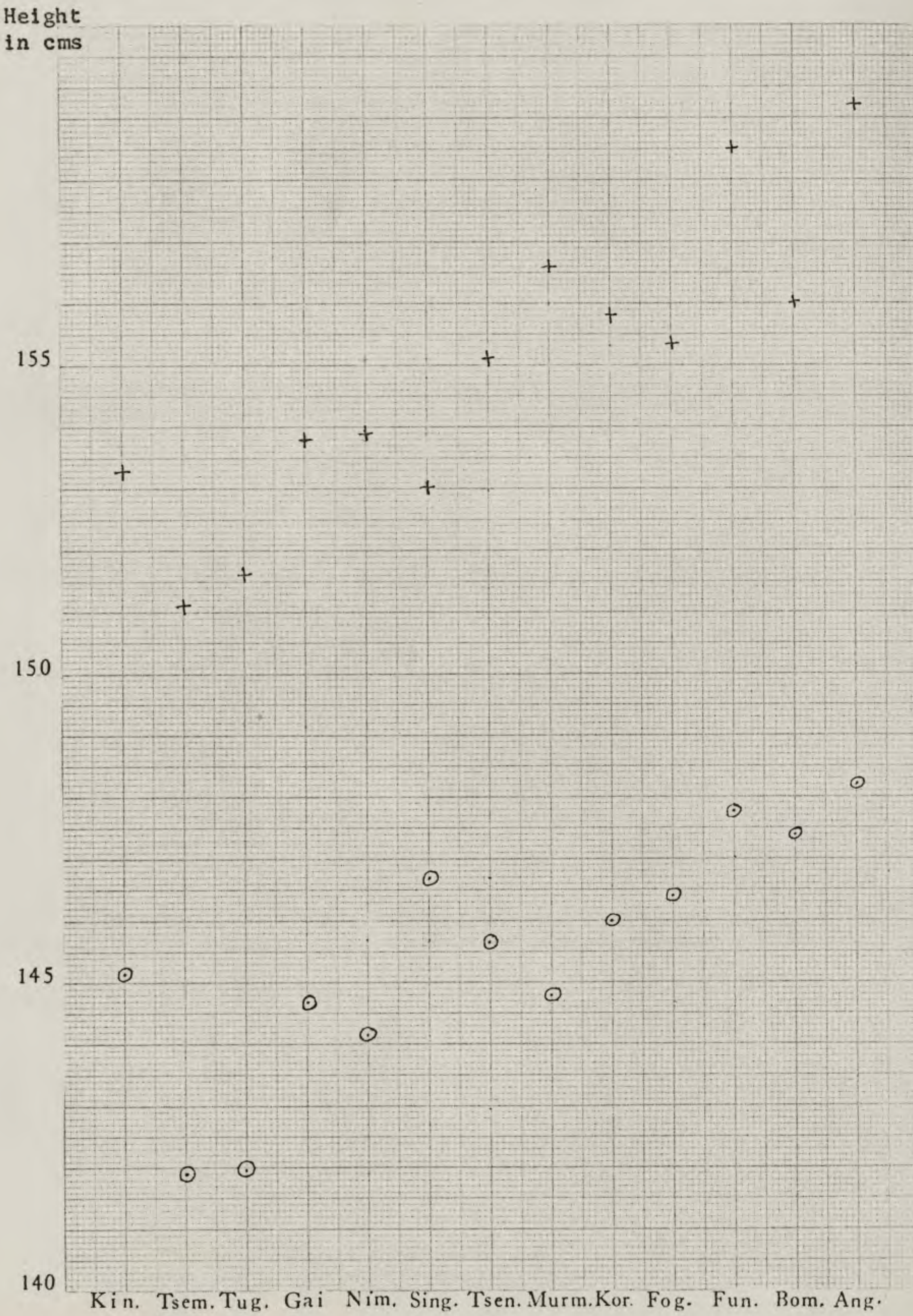
Population: Clan or clan cluster		No.	Skinfold Thickness (mm)		Arm Circumference (cm)		Muscle Circumference = Arm Circumference minus Pi times skinfold thickness
			Mean	S.D.	Mean	S.D.	
Kinimbong:	Males	26	3.96	0.94	23.27	2.10	22.03
	Females	38	5.42	2.89	20.47	2.01	18.77
Tsembaga:	Males	53	4.11	1.14	23.49	1.99	22.20
	Females	46	5.52	1.95	20.46	1.56	18.73
Tuguma:	Males	59	3.97	0.92	22.93	1.94	21.68
	Females	60	5.24	1.84	19.89	1.59	18.24
Gai:	Males	90	4.32	1.31	23.36	1.94	22.00
	Females	77	6.09	3.08	20.65	1.63	18.75
Nimbra:	Males	73	5.59	2.81	23.53	2.64	21.78
	Females	79	7.05	3.38	20.52	1.68	18.31
Tsengamp:	Males	23	4.48	1.02	23.30	1.33	21.89
	Females	20	5.75	2.95	19.95	1.32	18.01
Murmbugai:	Males	21	4.48	1.01	23.81	1.65	22.40
	Females	22	4.86	1.60	20.27	1.35	18.74
Singanai:	Males	28	4.29	1.19	23.00	1.91	21.65
	Females	26	5.35	3.38	19.69	1.81	18.03
Korama:	Males	13	4.46	0.84	24.00	1.88	22.60
	Females	14	7.43	4.08	21.21	1.21	18.88
Fogaikumpf:	Males	30	4.23	0.99	23.10	2.06	21.77
	Females	27	5.37	2.18	20.63	1.70	18.95
Fungai:	Males	14	6.71	4.04	25.5	1.30	23.39
	Females	21	7.62	3.61	20.99	1.74	18.55
Bomagai:	Males	14	5.14	0.99	23.86	1.51	22.25
	Females	21	8.28	4.41	20.62	1.94	18.02

TABLE 6.2--Continued

ANTHROPOMETRIC DATA: SKINFOLD THICKNESS, ARM CIRCUMFERENCE AND MUSCLE CIRCUMFERENCE

Population: Clan or clan cluster		No.	Skinfold Thickness (mm)		Arm Circumference (cm)		Muscle Circumference = Arm Circumference minus Pi times skinfold thickness
			Mean	S.D.	Mean	S.D.	
Angoing:	Males	10	5.80	2.48	24.50	1.20	22.68
	Females	11	8.73	2.93	21.45	1.30	18.71
Total:	Males	454	4.58	1.82	23.74	2.07	22.31
	Females	452	6.17	3.12	20.44	1.70	18.50

Fig. 6.1 ADULT HEIGHT BY LOCATION



is also a tendency for weight to increase from northwest to southeast. The ponderal indices also show a northwest to southeast trend but the differences are slight (see Figure 6.2).

When we compare weight for height of the Maring with the standards used by Jelliffe (1966:238-241), we find that the mean weight for height of most Simbai Maring males falls within 80-84 per cent of standard. The mean values for the males at Fogaikumpf and for the Korama, Fungai, Bomagai and Angoing males are exceptional and these fall in the 85-89 per cent of standard category. It should be mentioned that all of these groups are on the edge of the forest, and it is believed that their diet is more adequate in terms of protein consumption (see Chapter 4). Most Maring females also fall in the 80-84 per cent of standard category, with the exception of those at Gai and the members of the four clans censused at Gunt's. These are in the 85-89 per cent of standard category.

The average skinfold thickness for all Maring men is 4.58 millimeters and for women 6.17 millimeters. There are highly significant differences between the extreme mean values, but all fall below 60 per cent of the standard values (Jelliffe 1966:Ibid.). There is also a tendency for skinfolds to be thicker in the southeastern groups (see Figure 6.3 and Table 6.2).

Arm circumferences averaged 23.74 centimeters for males and 20.44 for females. This puts the males in the 80 per cent of standard category and the females in the 70 per cent of standard category (Jelliffe 1966: 242). Muscle circumference, computed by subtracting Pi times the skinfold thickness from the arm circumference, for males averaged 22.31 centimeters and for females averaged 18.50 centimeters. This puts the males in the 90 per cent of standard category, and the females in the

Fig. 6.2 ADULT WEIGHTS BY LOCATION

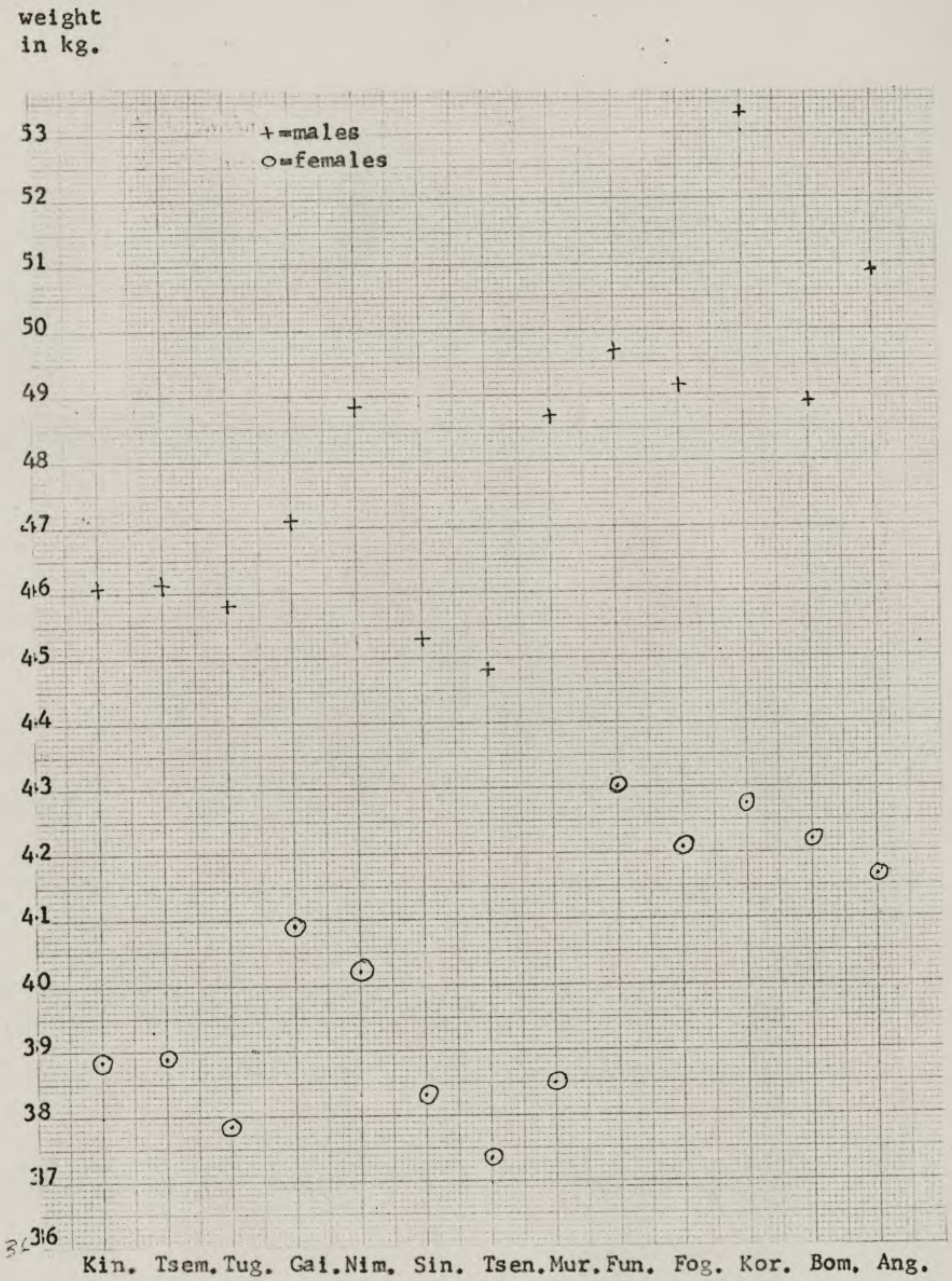
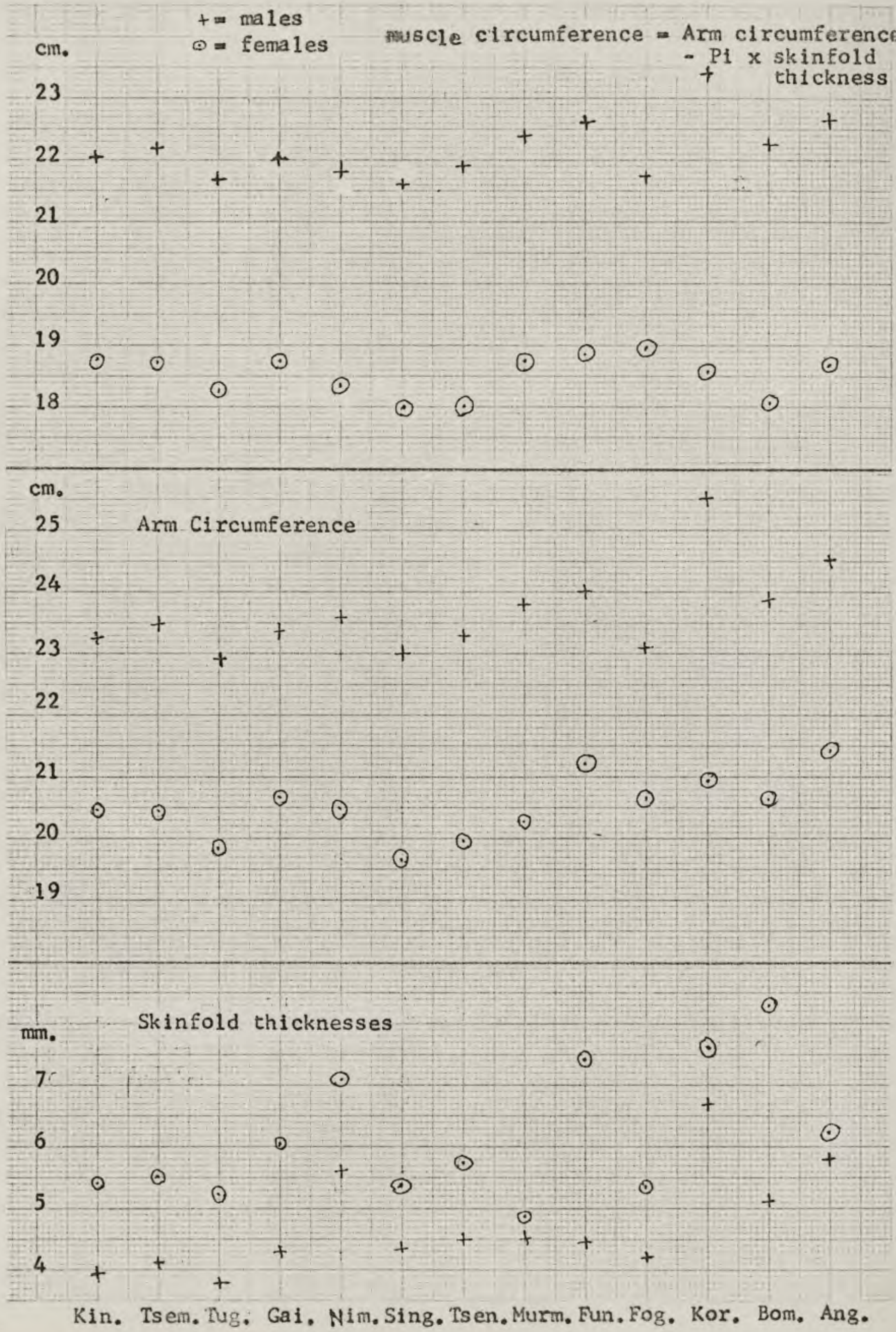


Fig. 6.3 ADULT SKINFOLD THICKNESSES, ARM CIRCUMFERENCES, AND MUSCLE CIRCUMFERENCES



80 per cent of standard category (Ibid.). There is little difference in muscle circumference from group to group, but again there is a slight tendency for people in the southeast to be more muscular.

Hematological data are presented in Table 6.3. The mean hemoglobin values of adult males vary from 12.79 grams per cent in Tuguma to 15.60 grams per cent at Gunt's. The corresponding mean values for adult females are 12.01 grams per cent and 14.03 grams per cent. These differences are statistically significant ($P < .001$) and are contrary to those which would be expected on the grounds of altitude of residence, as there is an average drop in altitude of about 1,000 feet moving from northwest to southeast down the valley. They do reflect the better nutritional status of the people living in the southeast.

G6PD deficient male subjects were found in all groups tested with the exception of the Tuguma. The per cent of deficient males ranged from 1.9 in Nimbra to 15.4 in the adjacent group censused at Gai. Females were not tested. The relationship between G6PD deficiency and malaria was discussed in Chapter 5.

A somewhat surprising outcome of the genetic study was that a total of 21 of the 308 male subjects tested for color vision had some type of defect as determined by the Ishihara Charts. This compares with a rate of 7.4 per cent for Europeans and 5 per cent for Asians (Adam 1969). No color blind subjects were found in Tuguma and percentages ranged from 3.2 in Nimbra to 13.8 at Tsengamp (see Table 6.4). It is of interest that in a horticultural group such as the Maring, who still rely somewhat on hunting, that the overall frequency of color vision defect should be as high as 6.8 per cent of the male population because color blindness is considered by some workers to be selectively disadvantageous in

TABLE 6.3

HEMATOLOGICAL DATA *

Group	Hemoglobin (g./100 ml.)			Hypohaptoglobinemia			G6PD Def. Males Only		
	No.	Mean	S.D.	Total	Def.	%	Total	Def.	%
Gunt's (3):									
Males	28	15.60	1.49	28	3	10.7	26	2	7.7
Females	12	14.03	0.86	12	0	0.0	--	-	--
Tsengamp (4):									
Males	59	14.22	1.51	59	7	11.9	47	1	2.1
Females	40	13.50	1.11	45	4	8.9	--	-	--
Nimbra (6):									
Males	55	14.48	1.27	63	4	6.3	53	1	1.9
Females	53	13.54	1.27	55	0	0.0	--	-	--
Gai (7):									
Males	46	13.22	2.54	50	10	20.0	39	6	15.4
Females	67	12.99	1.34	71	8	11.2	--	-	--
Tuguma (9):									
Males	52	12.79	1.54	49	8	16.3	19	0	0.0
Females	46	12.01	1.26	51	11	21.6	--	-	--
Tsembaga (10):									
Males	49	13.59	1.28	48	14	29.6	39	3	7.7
Females	52	12.86	1.19	53	8	15.1	--	-	--
TOTAL:									
Males	--	--	--	297	46	15.5	223	13	5.8
Females	--	--	--	286	31	10.8	--	--	--

* from Buchbinder and Clark 1971

TABLE 6.4

COLOR VISION DEFICIENCY

LOCAL POPULATION	NUMBER TESTED	PERCENT DEFICIENT
Tsembaga	49	11.11
Tuguma	58	0.00
Gai	52	5.96
Nimbra	63	3.17
Tsengamp	58	13.79
Gunt's	28	10.72
Total	308	6.82

a primitive community (Post 1962; Neal and Post 1963).

However, there is some data available which suggest that in Sardinia there is an association between the distribution of G6PD deficiency and color blindness of the deutan type (both traits appear on the x chromosome). Siniscalco, et al. (1966) has suggested that the neutral or slightly detrimental gene which is responsible for the defect in color vision has enjoyed protection in a malarial environment because of its close linkage with the highly adaptive gene for G6PD deficiency. Adam (1963) has also found an association between the distribution of G6PD deficiency and color blindness in Israel. The distribution of color blindness parallels the distribution of G6PD (rho = .71) deficiency in the Simbai Valley and thus supports this hypothesis.

The blood group findings for the Simbai Valley Maring tested are shown in Table 6.5. Expected numbers from gene frequencies have been calculated in all instances, but no significant differences between the observed and expected numbers were found (Buchbinder and Clark 1971). The Simbai Maring gene frequencies are compared to those of three other Western Highlands populations previously reported (Reickmann, et al. 1961; Walsh, et al. 1966; MacLennon, et al. 1967) in Table 6.6. From this table it can be seen that in the ABO system, the frequency of the O gene is lowest and that of the A is highest among the Maring. In the MNs system the gene combination Ms was not reported in the other highland populations, but among the Maring it is present in two subjects, one from Gai and the other from Nimbra. Remember that these two locations are adjacent. Only three Rh chromosome combinations have been found in the area, and the Simbai Maring have the highest value of the R2 combination and the lowest of Ro. Ro was found in two subjects, both from Tuguma.

TABLE 6.5

BLOOD GROUP PHENOTYPES AND GENE FREQUENCIES

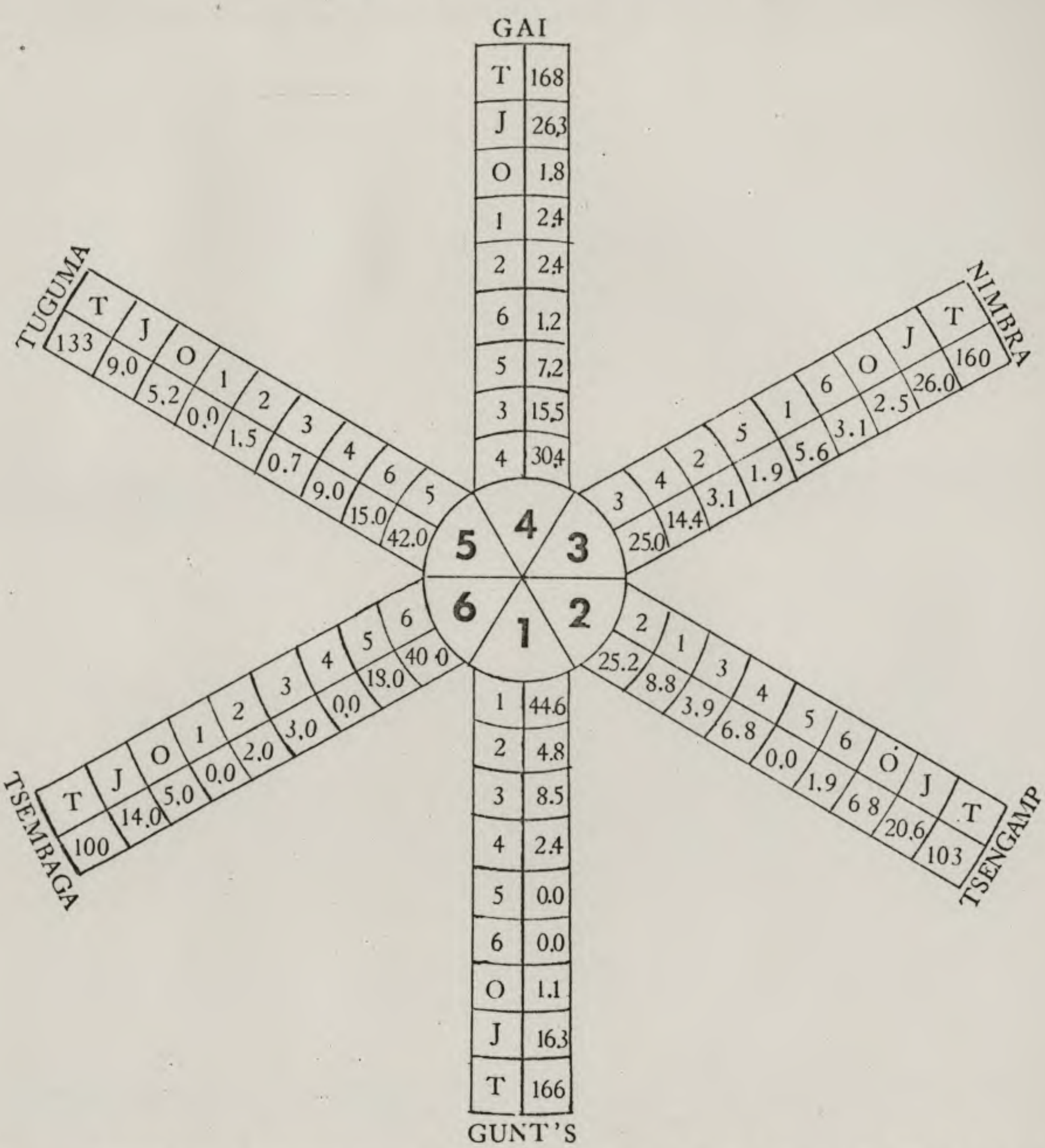
System	Location	No.	Phenotypes O	A	B	AB	Gene Frequencies $\overline{O}$	$\overline{A}$	$\overline{B}$
ABO	Gunt's	41	12	15	8	6	0·5583	0·2792	0·1615
	Tsengamp	101	40	37	16	8	0·6366	0·2467	0·1166
	Nimbra	117	32	36	31	18	0·5355	0·2474	0·2171
	Gai	120	38	33	35	14	0·2093	0·2202	0·5705
	Tuguma	101	38	40	16	7	0·6155	0·2663	0·1832
	Tsembaga	104	46	33	18	7	0·6711	0·2084	0·1205
	Total	584	206	194	124	60	0·6027	0·2371	0·1601

System	Location	No.	R_1R_1	R_1R_2	R_1R_0	$\overline{R_1}$	$\overline{R_2}$	$\overline{R_0}$
Rh	Gunt's	25	19	6	0	0·8800	0·1200	0·0000
	Tsengamp	89	48	41	0	0·7697	0·2303	0·0000
	Nimbra	49	38	11	0	0·8878	0·1122	0·0000
	Gai	104	67	37	0	0·8221	0·1779	0·0000
	Tuguma	52	47	3	2	0·9519	0·0288	0·0192
	Tsembaga	90	79	11	0	0·9389	0·0611	0·0000
	Total	409	298	109	2	0·8643	0·1333	0·0024

System	Location	No.	MN SS	MN $S\overline{s}$	MN $\overline{ss}$	NN SS	NN $S\overline{s}$	NN $\overline{ss}$	MM $S\overline{s}$	MM $\overline{ss}$	$\overline{MS}$	$\overline{Ms}$	$\overline{NS}$	$\overline{Ns}$
MNS	Gunt's	26	0	0	1	0	11	14	0	0	0·0000	0·0192	0·2117	0·7691
	Tsengamp	89	0	2	2	1	33	50	0	1	0·0000	0·0337	0·2079	0·7584
	Nimbra	51	1	1	2	2	14	31	0	0	0·0208	0·0184	0·1812	0·7796
	Gai	99	0	3	1	0	29	65	1	0	0·0023	0·0280	0·1593	0·8103
	Tuguma	52	0	1	3	0	1	47	0	0	0·0000	0·0385	0·0192	0·9423
	Tsembaga	90	0	0	3	0	12	75	0	0	0·0000	0·0167	0·0666	0·9167
	Total	407	1	7	12	3	100	282	1	1	0·0044	0·0251	0·1381	0·8324

From Buchbinder and Clark (1971)

Fig. 6.4 MARRIAGE FREQUENCIES



Location of spouses natal group for the local populations included in the genetic study. Figures in the center circle represent the local populations mentioned at the head of each column. Percentage endogamy is shown in the innermost boxes of the column; for example 30.4 percent of Gai wives come from Gai (4 x 4). Successive boxes represent local populations arranged roughly by distance from the population represented by the number in the center.

O = percentage of marriages to non-Maring speaking peoples of the Simbai.

J = percentages of marriages to people from the Jimi Valley.

T = total number of marriages included in this study.

N.B. Columns do not add up to 100 percent because marriages to people in populations not included in the genetic study have been omitted.

TABLE 6.6

TRANSFERRIN, HAPTOGLOBIN AND ACID PHOSPHATASE

Village	Transferrin						Haptoglobin						Acid Phosphatase					
	Phenotypes				Gene Frequencies		Phenotypes				Gene Frequencies		Phenotypes				Gene Frequencies	
	No.	CC	CD_1	D_1D_1	Tf^C	Tf^{D_1}	No.	1–1	2–1	2–2	$\overline{Hp^1}$	$\overline{Hp^2}$	No.	A	B	AB	$\overline{A}$	$\overline{B}$
Gunt's	40	35	4	1	0·9250	0·2750	37	27	8	2	0·8378	0·1622	19	2	12	5	0·2368	0·7632
Tsengamp ..	104	93	11	0	0·9471	0·0529	92	62	27	3	0·8207	0·1793	97	4	60	33	0·2113	0·7887
Nimbra	118	109	9	0	0·9619	0·0381	114	80	21	3	0·8377	0·1623	50	0	39	11	0·1100	0·8900
Gai ..	121	115	6	0	0·9752	0·0248	103	65	35	3	0·8010	0·1990	86	9	35	42	0·3571	0·6429
Tuguma	104	100	4	0	0·9808	0·0192	84	47	32	5	0·7500	0·2500	54	5	33	16	0·2407	0·7592
Tsembaga ..	101	99	2	0	0·9901	0·0099	79	47	29	3	0·7785	0·2215	82	4	49	29	0·2055	0·7944
Total	588	551	36	1	0·9677	0·0323	509	328	162	19	0·8035	0·1965	388	24	228	136	0·2431	0·7569

From Buchbinder and Clark (1971)

Within the groups tested there was an appreciable variation in the distribution of ABO phenotypes, but this variation was not statistically significant ($0.10 > P > 0.05$). There was no variation in the distribution of MN ($0.80 > P > 0.70$), but there was a significant difference in the distribution of the s blood groups ($0.001 > P$). The lowest incidence of s is found at Tuguma and the highest at Tsengamp.

Approximately half of the blood samples were tested for Fya and Kell antigens. All samples were positive for Fya and negative for Kell which agrees with Kariks and Walsh's (1968) findings for the Bainings of New Britain.

Data on transferrins, haptoglobins and acid phosphatase are presented in Table 6.7. For the transferrins the differences in the number of CD_1 phenotypes are not significant ($0.10 > P > 0.05$), but there is a statistical trend indicating that the D gene occurs most frequently in the vicinity of the Gunt's rest house in the southeast and decreases along the valley with the least frequent at Tsembaga in the northwest. One DD phenotype was found at Gunt's and one abnormally slow transferrin at Tsengamp. We have not yet established if this abnormal transferrin is a genetic variant, a storage artifact or the result of infection of the sample. Blood could not be obtained from relatives of the propositus.

There are two aspects of the haptoglobin results. The first is the distribution of phenotypes determined by the genes Hp^1 and Hp^2 (see Table 6.5). There are no significant differences within the area or between the values for the Simbai Valley Maring and those reported for Mt. Hagen in the Western Highlands by Blackburn and Hornabrook (1969). The second aspect is the frequency of the so-called Hp o-o types. A similar apparent absence of haptoglobin has been reported in New Guinea

TABLE 6.7

BLOOD GROUP GENE FREQUENCIES IN NEW GUINEA HIGHLAND POPULATIONS

System	Location	Gene Frequencies				Source
		$\overline{O}$	$\overline{A}$		$\overline{B}$	
ABO	Simbai	0·6027	0·2371		0·1601	Buchbinder and Clark
	Western Highlands:					
	Oksapmin ..	0·8395	0·0596		0·1009	MacLennan *et al.*
	Telefolmin ..	0·7027	0·2015		0·0958	Reickmann *et al.*
	Lake Kopiago ..	0·6371	0·1465		0·2164	Walsh *et al.*
		$\overline{R}_1$	$\overline{R}_2$		$\overline{R}_0$	
Rh	Simbai	0·8643	0·1333		0·0024	Buchbinder and Clark
	Western Highlands:					
	Oksapmin ..	0·7824	0·1174		0·1002	MacLennan *et al.*
	Telefolmin ..	0·8670	0·0575		0·0755	Reickmann *et al.*
	Lake Kopiago ..	0·8962	0·0534		0·0504	Walsh *et al.*
		MS	Ms	NS	Ns	
MNS	Simbai	0·0044	0·0251	0·1381	0·8324	Buchbinder and Clark
	Western Highlands:					
	Oksapmin ..	0·0000	0·0612	0·0068	0·9319	MacLennan *et al.*
	Telefolmin ..	0·0000	0·0403	0·0133	0·9463	Reickmann *et al.*
	Lake Kopiago ..	0·0000	0·0798	0·0242	0·8960	Walsh *et al.*

From Buchbinder and Clark (1971)

populations by several authors (Booth and Vines 1968; Curtain et al. 1965). These subjects have been typed as Hp o-o, but Blackburn and Hornabrook (1969) produced evidence that, in Hp o-o samples, the haptoglobin concentration is too low for the proteins to be stained on starch gels. These authors claim that such subjects are hypohaptoglobinemic. They state that, on concentration, most hypohaptoglobinemic sera can be typed and that they are likely to be Hp^{2-2}. The condition of hypohaptoglobinemia has been associated with hemolysis in malarial infection and with protein deficiency. The findings for the Simbai Valley Maring are presented in Table 6.3. There are significant differences from village to village, but there is no correlation between the incidence of hypohaptoglobinemia and any of the other genetic characteristics studied. However, it is of interest to note that the highest incidence of hypohaptoglobinemia is found in the northwestern part of the region, notably at Gai, Tuguma and Tsembaga, where the people are smaller, thinner and have lower hemoglobin values, indicating a possibly higher degree of nutritional stress in these areas (cf. Tables 6.1, 6.2, and 6.3).

The frequency of the A gene for acid phosphatase varies from 0.1100 at Nimbra to 0.3571 at Gai immediately to the northwest. The differences in gene frequency are statistically significant ($0.01 > P > 0.001$). There is an absence of acid phosphatase phenotype A in the Nimbra population.

From the marriage data for the groups on which the genetic studies were done (see Figure 6.4), it is evident that more spouses are selected from within the group than from any other single group in the Simbai Valley. For these groups the percentages of endogamous marriages ranges from 25 per cent of all marriages at Nimbra to 44.6 per cent of all marriages at Gunt's. The mean percentage of endogamy for the six groups is 34.5. Marriages with non-Maring speakers are rare, ranging from 1.2 per cent in Gunt's to 6.8 per cent in Tsengamp. However, marriage with Jimi Valley Maring speakers is fairly common, ranging from 9 per cent of all marriages at Tuguma to 26.3 per cent of all marriages at Gai. The mean per cent of Jimi Valley marriages for the six groups is 18.7.

In this chapter I have reported on a study of some physical and genetic characteristics of the Simbai Valley Maring, as well as on the marriage patterns of those groups for which genetic data was collected. It was shown that heights, weights, skinfold thickness and arm circumference vary significantly from one end of the valley to the other. It was also shown that these characteristics are interrelated so that the tallest people tend also to be the heaviest, fattest and most muscular. This is not surprising as these characteristics are also wholly dependent on environmental factors, especially those concerned with nutrition. It has been shown in Chapters 4 and 5 that the nutritional status of all the Simbai Maring groups is suboptimal, particularly with regard to protein, and that the groups in the northwest tend to suffer more from this dietary inadequacy. The hemoglobin values were seen not to be related to the altitude of residence, which varies from 3,000 to 5,000 feet above sea level. The higher values were found among those groups living at low altitudes in the southeastern end of Simbai Maring territory and it is believed that these values may reflect the greater amount of protein available there. Hypohaptoglobinemia was most prevalent in those areas which exhibited low hemoglobin and low heights and weights, and again, may reflect protein deficiency in these areas.

While a clinal distribution or gradient was found from northwest to southeast for the anthropometric and hematological traits, no such cline was observed among the genetic traits with the exception of the D gene of the transferrin system. However, the differences in the frequencies of this gene between groups are not statistically significant. Where there are significant differences between the frequencies of other genes, these frequencies do not show a regular pattern along the valley.

Thus, it has not been possible to correlate the gene pattern with the anthropomorphic and hematological data. The pattern of phenotypic difference attributable to single gene factors supports the concept of random distribution of genes as a result of the operation of the founder principal and the perpetuation of gene differences in the absence of widespread interbreeding between members of different local groups. The phenotypic variation in the multifactorial anthropometric traits suggests a regular environmental variation.

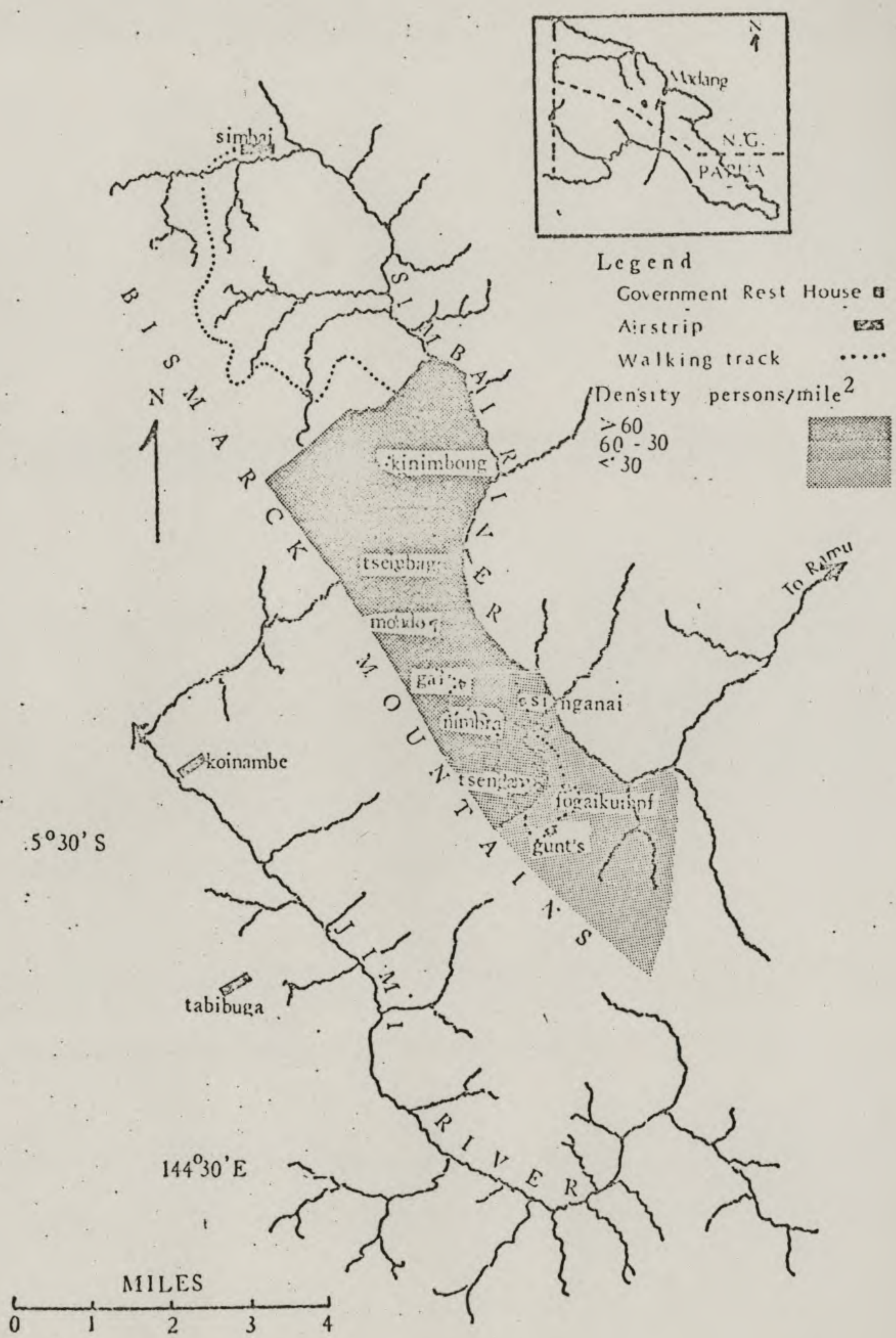
CHAPTER 7

SUMMARY AND CONCLUSIONS

The last four chapters have presented data on Simbai Maring demography, diet, health and nutritional status, and physical and genetic characteristics. What has energed from this study is that the thirteen Simbai Maring populations exhibit much variation in each of the characteristics under investigation. This variation found in a number of the biological characteristics is interrelated, and I have suggested that this biological variation may ultimately be related to variation in local environmental conditions--primarily population density, availability of protein, availability of iodine and presence of malaria.

Going from northwest to southeast down the Maring-occupied portion of the Simbai Valley, one encounters a drop in local population density. The highest population densities of over 60 persons per square mile occur in the northwest among the groups censused at Kinimbong, Tsembaga, Tuguma, Gai and Nimbra. Intermediate densities of between 30 and 60 persons per square mile are found among the populations at Singanai and at Tsengamp. Low densities of less than 30 persons per square mile are found among the populations censused at Gunt's and at Fogaikumpf (see Figure 7.1). The clans at Fogaikumpf and the Bomagai and Angoing clans of Gunt's border on and have access to vast amounts of unoccupied primary forest which they use for hunting. If this primary forest area were included in the density calculations, the resulting population density would have been much lower. The clans censused at Singanai also have

Fig. 7.1 MAP SHOWING POPULATION DENSITIES



access to large amounts of unoccupied forest, but all of their forest is at low altitude (below 3,500 feet).

Not only does population density decrease from northwest to southeast, but there is also a decline in altitude; there is a highly significant positive correlation between density of settlement and the mean altitude of settlement, $r = .97$, $P < .001$. Consequently, the highest population densities, those over 60 persons per square mile, are found among those groups whose mean altitude of settlement is over 3,750 feet. However, the relationship between density of settlement and altitude is not strictly linear, so that the Tuguma population whose mean altitude of settlement is 3,500 feet have a density of over 75 persons per square mile, and the clans at Gunt's and Fogaikumpf have lower densities than would be expected solely on the basis of their mean altitude of settlement (see Figure 7.2).

Malaria appears to be the obvious explanation for decreasing population density at low altitudes, and indeed there is a tendency for spleen rates to increase as the settlement altitude drops, $r = -.49$, $.10 > P > .05$. Although the correlation between altitude of settlement and incidence of malaria is marginally significant, the relationship appears to be influenced by other factors because very low spleen rates were found among the Fungai, Korama and Tsengamp clans whose mean altitude of settlement is 3,500 feet, while the highest spleen rate of all was found among the Fogaikumpf population who live at the same mean altitude (see Figure 7.3). The association between altitude and spleen rate for the other populations is fairly constant. The Maring themselves recognize the relationship between altitude and malaria and are reluctant to spend the night at low elevations. In order to fully assess the

Fig. 7.2 POPULATION DENSITY BY MEAN ALTITUDE OF SETTLEMENT

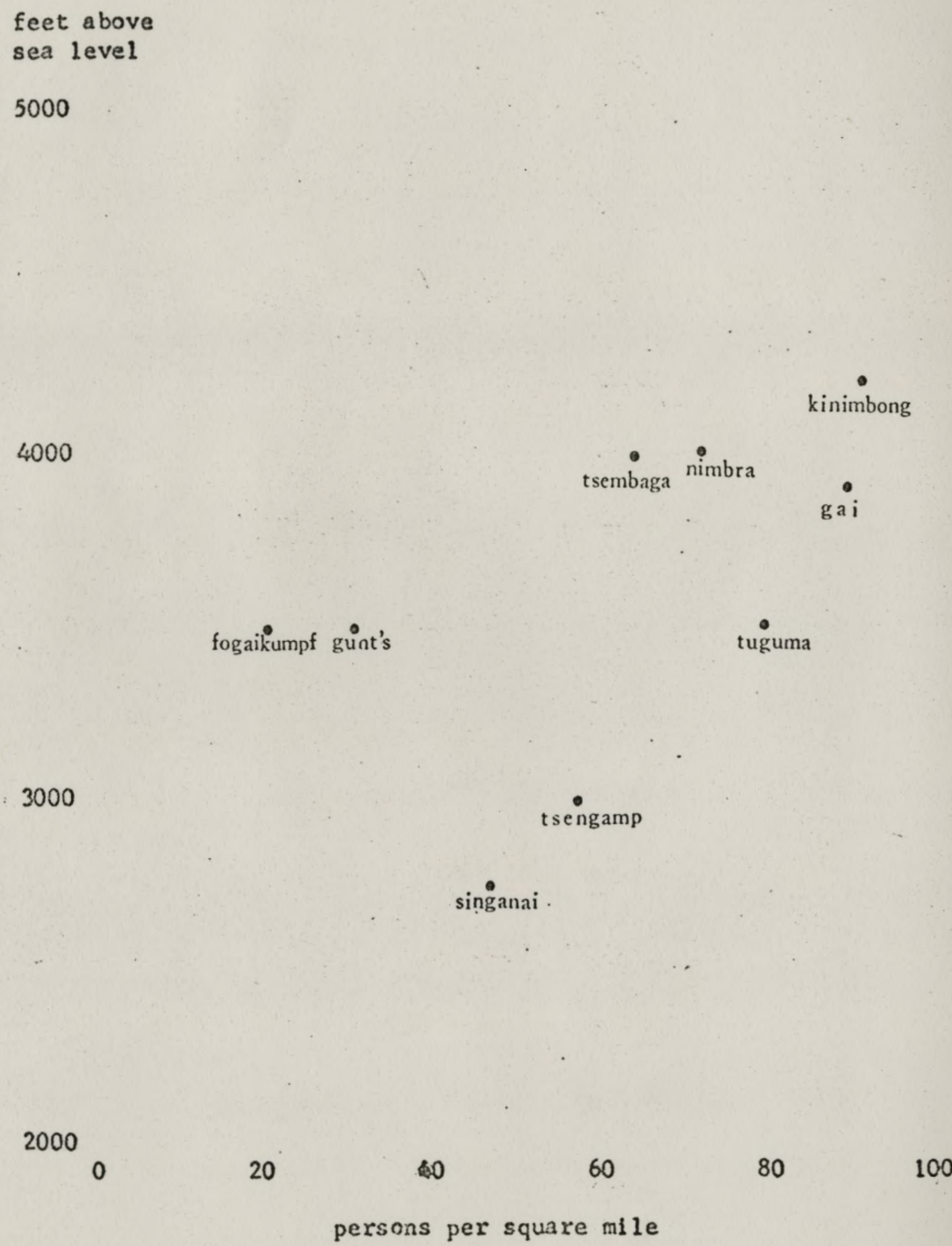
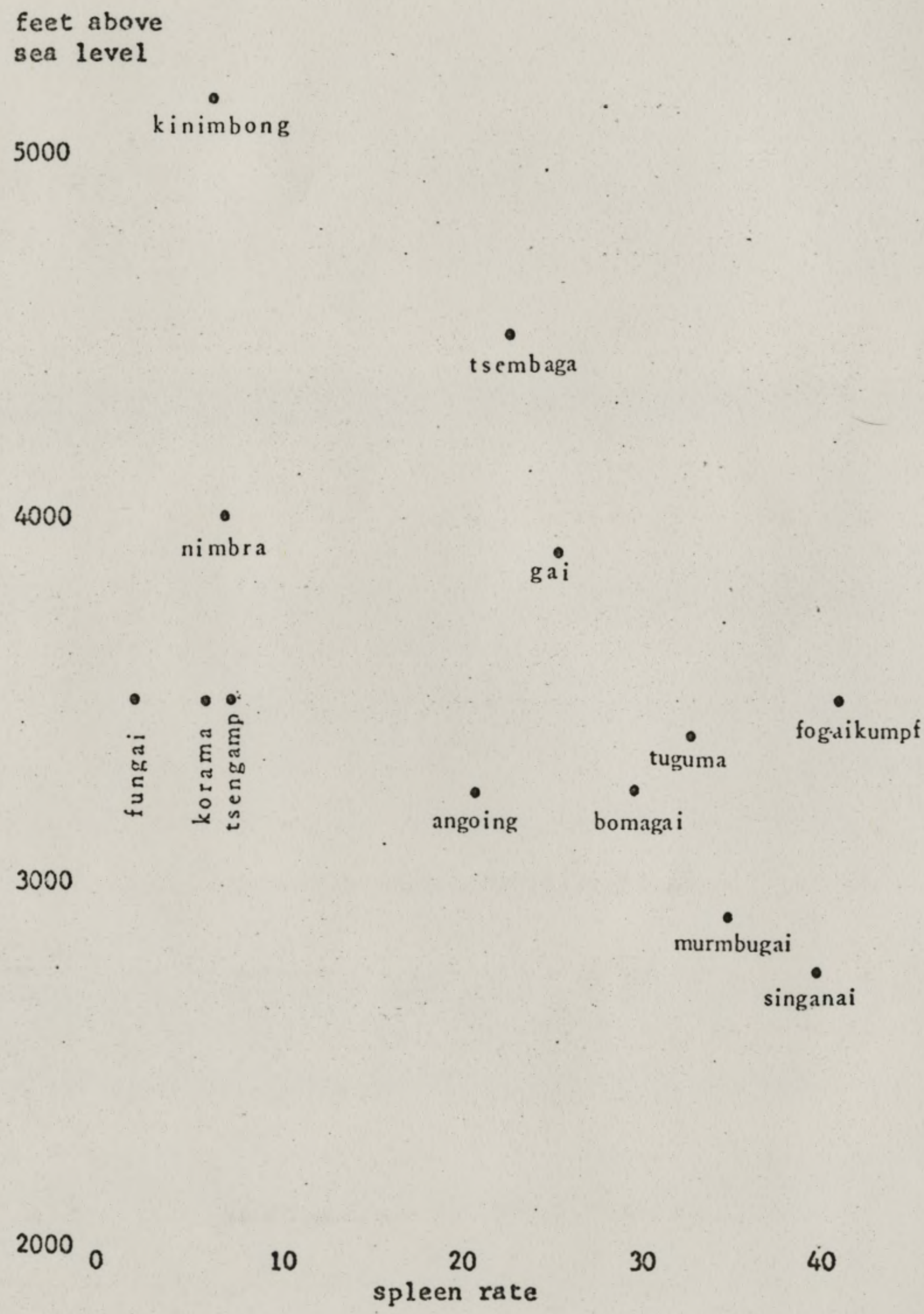


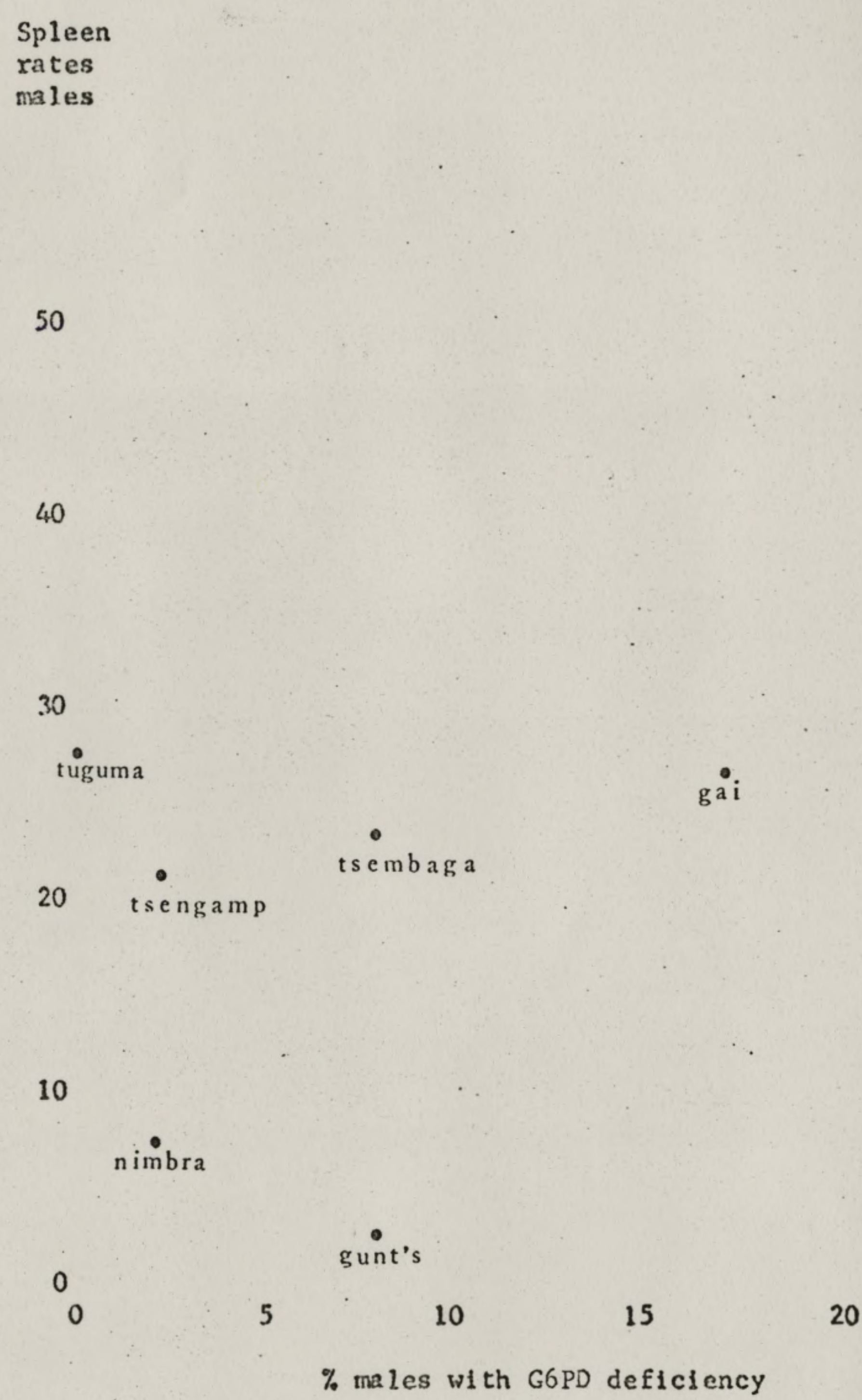
Fig. 7.3 SPLEEN RATES BY MEAN ALTITUDE OF SETTLEMENT



relationship between altitude and malaria in the Simbai Valley, it would be necessary to know the exact movements of the people and the location of their major economic activities in relationship to the movement and biting habits of the anopheles mosquito. While, I do not have this information, it is known that the people at Singanai and at Fogaikumpf, that is, the people with the highest spleen rates, do tend to spend appreciable amounts of time hunting in low altitude primary forest; it is possible that they contracted malaria while hunting rather than at home. If this were the case, it might be assumed that the spleen rates of the men would be higher than the spleen rates of the women, for men hunt and women usually work in their homes and gardens. This is true for the Singanai population where the spleen rate for males is 40.3 per cent and that for females is only 35.2 per cent; it is not true for the population at Fogaikumpf where the spleen rate for males is 35.7 per cent and that for females is 39.3 per cent. Among the Bomagai and Angoing who also do a considerable amount of hunting in primary forest, the spleen rates are also higher in women than they are in men (spleen rate for Bomagai males is 21.6 per cent, for females it is 38.5 per cent; for Angoing males it is 5.0 per cent, and for females it is 42.8 per cent). This suggests conversely that it may be the altitude of gardens which are more crucial, and indeed all of these groups do make gardens at low altitudes.

I have previously indicated that the relatively high spleen rates found among the Tuguma may be explained by the absence of G6PD deficiency in this population. But the amount of G6PD deficiency does not correlate with the spleen rate for any of the other groups, $r = .15$ (not significant) (see Figure 7.4) so that it is not possible to attribute variation in the rate of malaria solely to the variation in the amount of genetic resist-

Fig. 7.4 G6PD DEFICIENCY BY SPLEEN RATE



ance in the local populations.

For those populations for whom we have information on hemoglobin concentration, we find a significant inverse relationship between hemoglobin concentration and spleen rate, for males $r = -.91$, $.01 > P > .001$; for females $r = -.88$, $.01 > P > .001$ (see Figure 7.5), so that the lower the spleen rate, the higher the hemoglobin concentration. Biologically this seems reasonable because malaria destroys red blood cells thus causing anemia. However, the mean hemoglobin values of the various populations are also strongly related to the settlement density; hence, those populations with high density tend to have low hemoglobin values. This may be related to protein intake which appears to be higher among the low density groups. It is also possible that there are local differences in the amount of iron available in soils, but this would have to be tested.

The incidence of hypohaptoglobinemia is also positively and significantly correlated with the incidence of malaria; for males $r = .72$, $.05 > P > .02$; for females $r = .94$, $P < .001$; consequently, those groups with high spleen rates also have a high incidence of hypohaptoglobinemia (see Table 7.6).

Overall goiter rates are not significantly correlated with either settlement altitude or population density. However, the goiter rates in women over the age of twenty do seem to be related to density (see Figure 7.7); with the exception of the people at Kinimbong who had the lowest goiter rate of all, the highest goiter rates are found among the high density groups where between 45 and 93 per cent of the women were affected. At the mid-density locations of Tsengamp and Singanai, 33 to 46 per cent of the women were affected, while the overall average of goiter rate for the women at Fogaikumpf and at Gunt's was under 33 per cent. It is likely

Fig. 7.5 HEMOGLOBIN VALUES BY SPLEEN RATE

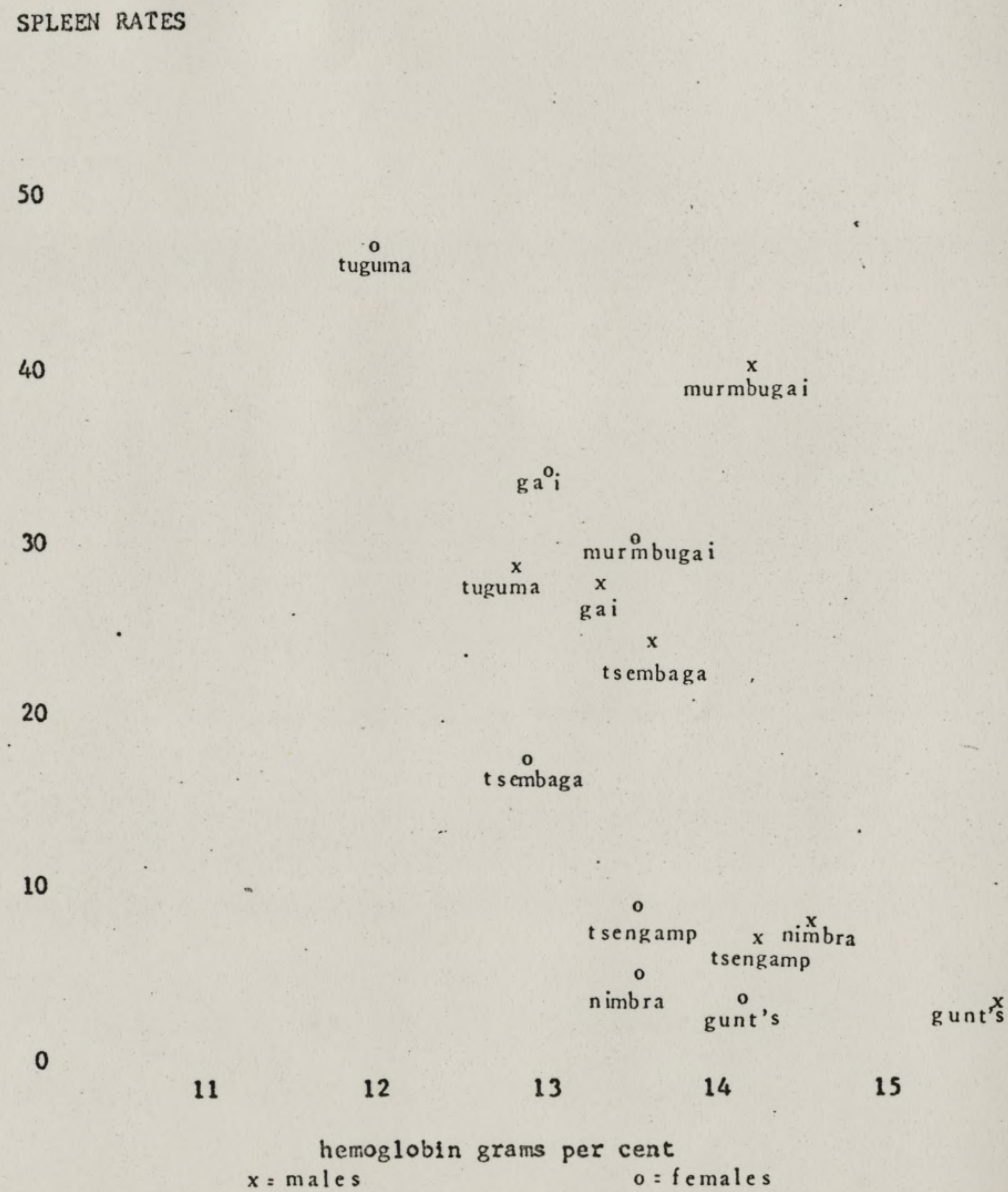


Fig. 7.6 INCIDENCE OF HYPOHAPTOGLOBINEMIA BY SPLEEN RATE

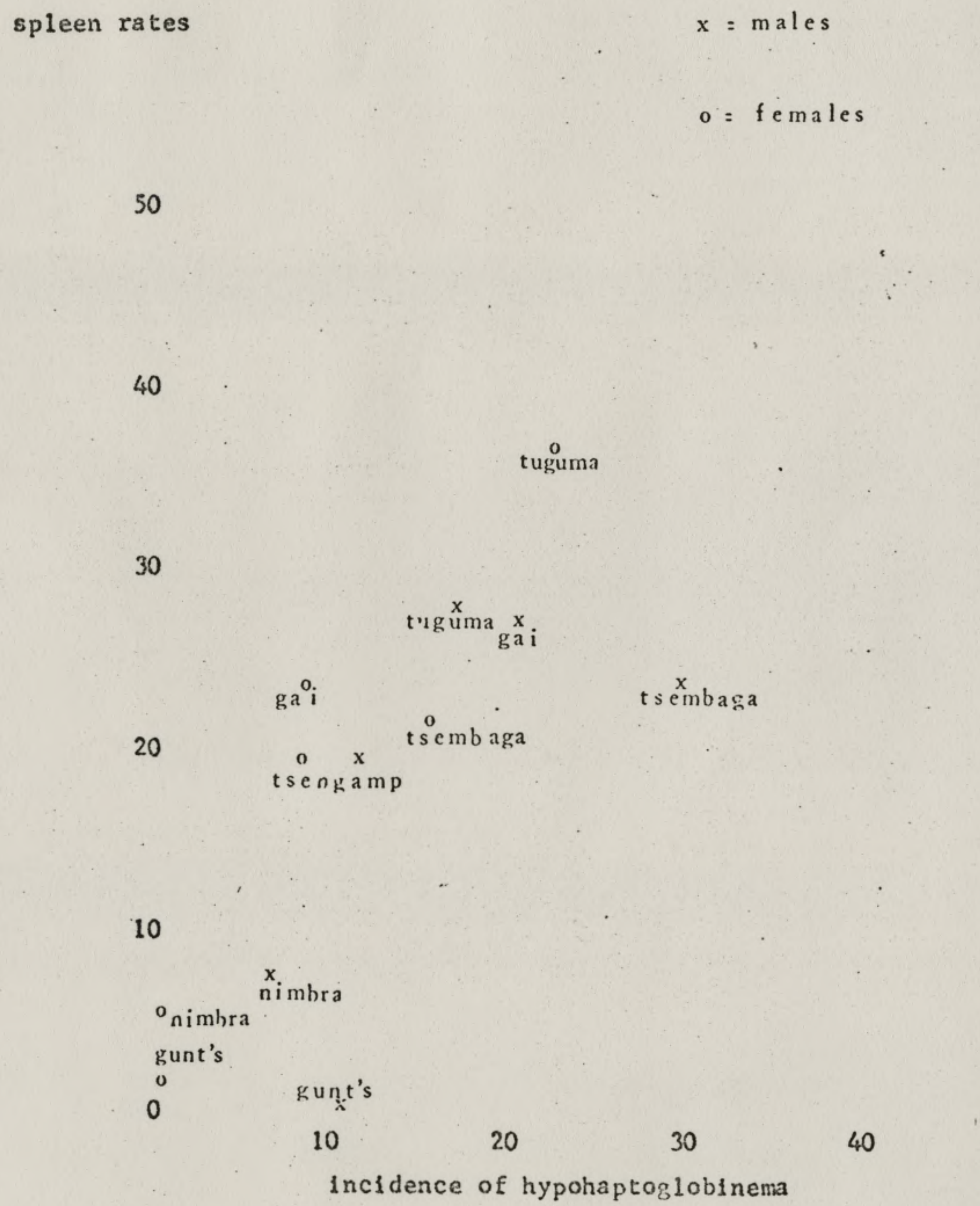
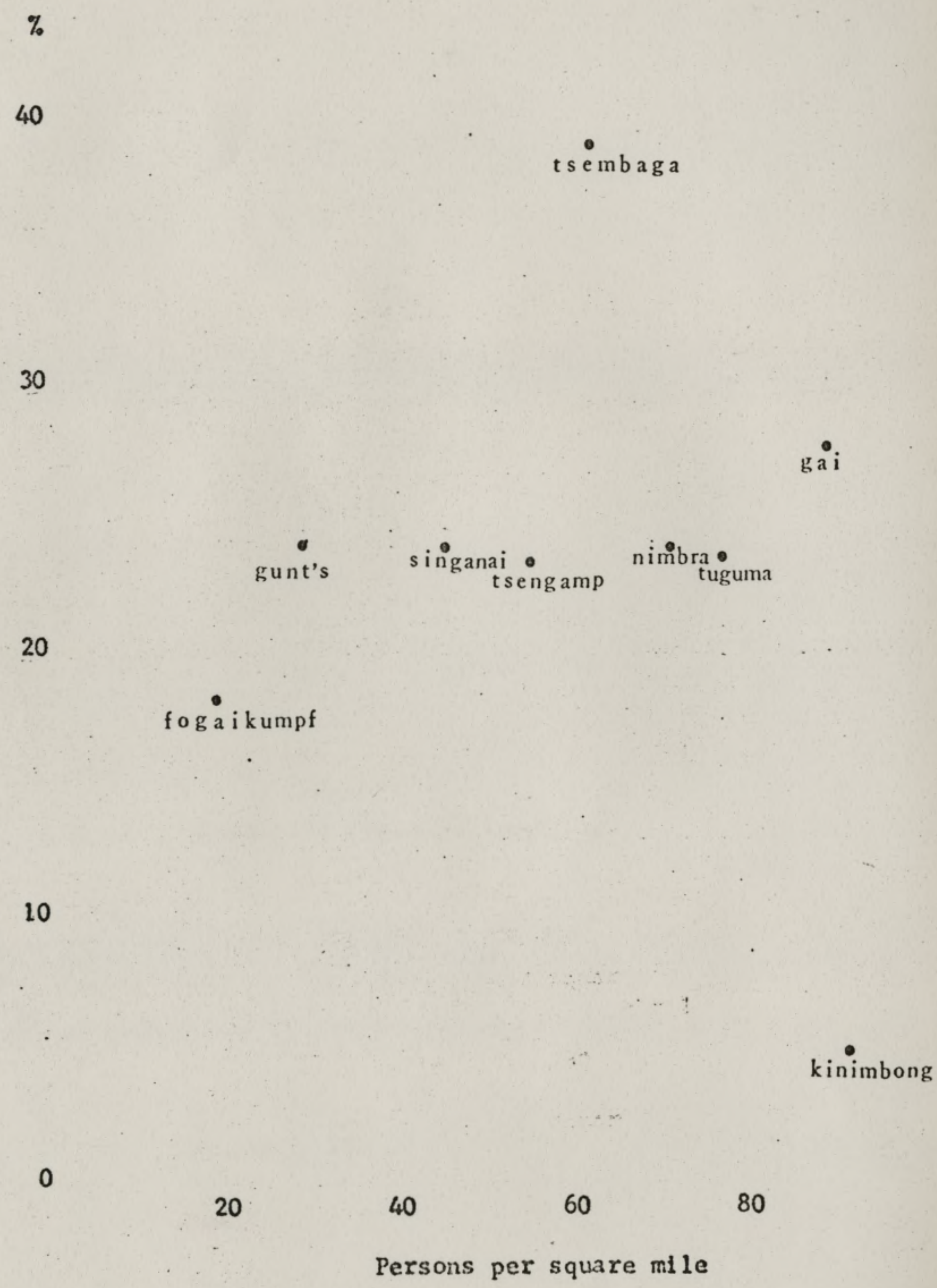


Fig. 7.7 Goiter Rates by Population Density

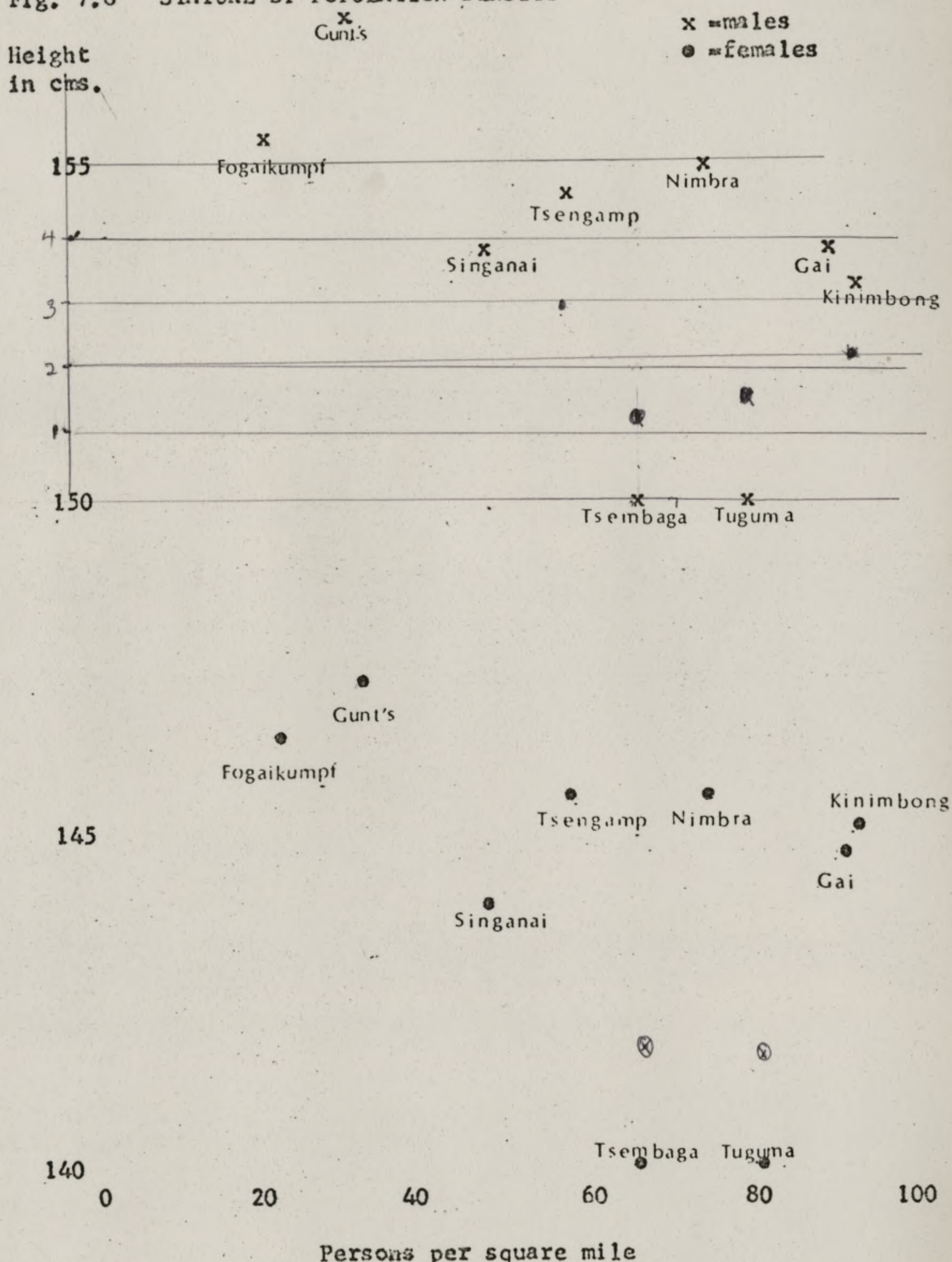


that the soils in the high density areas have become more iodine depleted than have those in the low density areas. Another possible explanation may be that the populations in the low density areas, who are eating more meat, may be getting some additional iodine from animal sources which tend to be relatively rich in iodine. All of the above hypotheses related to the distribution of iodine deficiency and of malaria can only be tested by further research designed to detect micro-environmental differences.

In addition to the association between disease rates and population density, there is also a weak inverse correlation between stature and density, for males $r = -.45$ and for females $r = -.17$; thus, the shortest Maring tend to be found in the most densely populated areas (see Figure 7.8), the middle-sized in moderately dense areas, and the tallest in the lowest density areas. The populations at Kinimbong and at Nimbra are slightly taller than are those at the other high density places, but both the Nimbra and the Kinimbong populations are relatively free of the stress of malaria. Moreover, the Kinimbong population also seems to be relatively free of the stress of iodine deficiency.

While direct dietary intake data is not available for each of the Simbai Maring populations, it is evident that the protein intake among the low density populations at Gunt's and Fogaikumpf is greater than that of the high density groups at Tuguma and Tsembaga; the difference is due to the intake of more animal protein and to the higher protein content of vegetable foods grown on the territory of the low density groups. Not only did the southeastern low density groups consume more wild protein, but they also consumed more domestic pork than did the low density groups. Also it was my distinct impression, an impression borne out by informants' statements while I was in the field, that it was much easier

Fig. 7.8 STATURE BY POPULATION DENSITY



to raise pigs in the low density areas than in the high density areas. Pigs in the low density areas were said to grow faster, be more fertile, and to be less subject to disease than pigs in the high density areas. Actually, the fertility levels of all Simbai Maring pigs seemed to be very low, and their mortality levels were all quite high. In Kinimbong and Tsembaga almost half of the local pig herd had been obtained through trade, mostly from Jimi Valley Maring locations; but two of the Tsembaga pigs came from Tsengamp. At Tuguma a third of the pigs were imported: half of these were obtained from the Jimi, the other half from southeastern Simbai Maring groups. My data on the place of origin of pigs is less complete for Gai, Nimbra, Singanai and Tsengamp, but it does appear that many of these pigs were home grown, and Tsengamp and Singanai were supplying pigs to other groups. At Gunt's and Fogaikumpf, from where I have good data on the origins of pigs, almost two-thirds of the pigs were imported, and most of these were obtained from upper Jimi Valley, non-Maring-speaking peoples, in exchange for either ornamental bird plumes or for cassowaries. In the northwestern part of the Simbai, people obtained their pigs mostly with the payment of money, reflecting their greater acculturation and thus greater amounts of cash, held either by returned plantation workers or obtained through occasional work for the government, missions, and anthropologists. Prior to the introduction of cash, it is probable that these groups were using locally manufactured salt to obtain pigs. Rappaport (1968:70-71) has commented on the low fertility and low survival rate of the Tsembaga pigs. He attributes this low fertility to what he believes to have been an abnormally nucleated settlement pattern which prevailed among the Tsembaga in 1962-63, and which had the effect of preventing domestic sows from meeting feral boars (domestic boars are castrated). In 1963, at the end of the last Tsembaga kaiko or pig festival, the Tsembaga pig herd numbered only 60 animals. In 1968, the Tsembaga had 109 pigs, but of these only 60 were Tsembaga born. The other 49 were imported. However, I believe that this low pig fertility is much more general in the Simbai; it is related to the fact that in the high density areas the feral pig population is probably fairly small, either because of the limited amount of low altitude forest left in these areas, or the fact that the pigs in this forest have been over-hunted, or to a combination of both factors. I base this statement not only on the low fertility of the domestic sows, but on the fact that while I was there, very few feral pigs were captured or for that matter even sighted in these areas.

Demographic data indicated that the Maring population as a whole has been declining at a rate of slightly less than 1 per cent per annum since at least 1963. This is true of the Jimi Valley Maring as well as the Simbai Valley Maring with whom we are concerned. While much of this decline may be due to the effects of recently introduced diseases, such as influenza, it is important to remember that the population structure is one of a declining or, at best, stationary population; it is likely that this population has been stationary or perhaps even declining for some time even prior to direct European contact. Cultural evidence suggests this as more clans are in the process of fusing than are in the process of fissioning. Indeed, during the time of my field work, not a single Maring clan in the Simbai Valley showed any evidence of splitting. Between July 1966 and May 1968 (when I left the field) clan fusion was occurring at Tuguma, Gai, Singanai and Fogaikumpf as well as at Tsembaga; there was evidence that it had occurred at the other places as well.

Rappaport (1968:17-28) reported that prior to 1963 the Tsembaga population density had been much higher and that even in 1963 the clans there were in the process of fusing. Part of the decrease in density which he noted, he attributed to the fact that the Tsembaga were defeated and driven from their territory in 1953 and that many of them had not yet returned in 1963. He also stated that a substantial portion of the population had been killed in the dysentery epidemic which occurred in the valley in the 1940's.

It will be recalled that the variation in the vital statistics of each of the local populations did not seem to show any regular pattern. This is likely to be due to the small size of the individual populations. The highest rate of natural decline was experienced by the Tuguma, Singanai, Tsengamp and Gai populations, while substantial gains were made by the Kinimbong, Nimbra and Fogaikumpf populations. The Tsembaga showed a slight increase, and the clans censused at Gunt's showed a very slight increase, and the clans censused at Gunt's showed a very slight decrease.

Thus, even in spite of the random processes which affect small populations during short periods of time, it is still fairly evident that the high density populations are decreasing, while the low density ones are probably increasing. The population at Nimbra was remarkably free of malaria, and the one at Kinimbong was both free of malaria and of iodine deficiency; these factors undoubtedly had something to do with the fact that they were increasing. In addition, the weights and skinfold thicknesses of the Nimbra population were among the highest encountered among the Simbai Maring, and in particular, skinfold thicknesses were significantly higher than those of most of the other groups. This is a further indication that the nutritional status of this group was higher than that of the others, particularly of the other high density groups. Unfortunately, the reason for this difference is not known. It might be due to the fact that the Nimbra dietary intake was higher or to the fact that in the absence of malaria their diet was more adequate.

Reproductive histories confirmed the impression gained from census data that fertility among the Simbai Maring is quite low. In addition, they revealed that the number of pregnancies per woman was higher in the low density areas around Gunt's than it was among the high density Tuguma and Tsembaga. It is believed that because the reproductive histories cover a greater time period, they reflect more accurately what may be considered to be more permanent variations in the demographic characteristics of the different local populations than do census data.

It has been postulated that the low fertility in the more densely populated northwestern groups may be related to the relatively later age of maturation of women there and that this late maturation is due to the relatively greater amount of protein and iodine deficiency from which these groups suffer. Protein and iodine deficiency also contribute to the high infant mortality in these areas.

Having summarized the data presented in this thesis, an overall picture of Simbai Maring population dynamics will be presented. Data gaps which prevent us from having a complete understanding of the processes at work in the Simbai will be pointed out. Finally, I will compare my findings with those of Rappaport and Clarke and will attempt to construct a model of the ecology and population dynamics of the Simbai Valley Maring.

Let us begin by noting that the Simbai Valley is located on the northernmost fringe of the densely populated central highlands and is very close to the vast and underpopulated Ramu River flats. Looking at the distribution of population in New Guinea as a whole, we note that population densities are high in the central highlands which are relatively malaria-free and where the people practice an intensive, largely mono crop sweet potato cultivation along with large scale pig production. Population densities tend to be lower on the fringes at intermediate altitudes where malaria is both endemic and epidemic and where cool night temperatures may increase the risk of respiratory infection. These areas are characterized by extensive and very mixed swidden cultivation and by rather casual pig raising. Pigs in these regions are neither penned nor herded, but are allowed to roam free and to forage a great deal of their own food from abandoned gardens and from the secondary forest which replaces the gardens. It is possible that the steep slopes that characterize much of the fringe area are unsuited to intensive cultivation because of erosion and loss of nutrients. Terracing is not practiced. Further away from the central highlands, population densities are extremely low being on the order of one person per square mile (Dornstreich, personal communication). Mixed swidden cultivation is practiced, and some pigs are kept, but substantial amounts of animal protein are obtained from the hunting of feral pig, marsupials, cassowaries and other smaller game (Morren and Dornstreich, personal communication). In coastal and swampy areas, population densities tend to increase again in spite of malaria. In these regions malaria is holoendemic, and it is likely that the peoples living in these regions have developed some immunity to malaria. Fish and other sea foods contribute substantial amounts of protein to the diet of these coastal and riverine populations.

As previously noted, the Simbai Valley is extremely steep-sided; not even in the areas of highest population density within the Maring area has there been any attempt to practice intensive or permanent field cultivation, although this form of cultivation is sometimes practiced by the Karam speakers who live at higher altitudes to the northwest of the Maring in the Simbai. Judging from the results of the analysis of soils by Rappaport (1968) and by Clarke (1971), the quality of the soil in the Simbai is poor and long periods of fallow are necessary to restore fertility after cropping and to prevent deterioration. Clarke states (1971: 71) that the average lengths of fallows in the Dwimba basin are forty years; Rappaport (1968:52-53) notes that in Tsembaga the average length of fallows is on the order of fifteen years in lower altitudes and twenty-five years in the higher areas. The shorter fallows practiced by the Tsembaga may be a response to the higher population densities; the result may very well be reduced nutrient content of soils, reflected in reduced nutrient content of crops, which in turn is reflected in the nutritional stunting, anemia, high goiter rates and low resistance to disease which characterize the high density Simbai Maring populations.

Not only are the soils in the Simbai of poor quality, but judging by Maring capture rates, game is also very scarce, particularly in the more densely populated part of the valley; hence, game does not add appreciable amounts of protein to the diet, neither does the meat obtained from the other domestic animals pigs and a few chickens. Thus, the Maring are essentially vegetarians. The amount of vegetable protein in the Maring diet is not low by New Guinean standards largely because of the great amount of greens consumed. This fact has already been commented on by Clarke (1971:181) and by Rappaport (1968:72). However, having discovered that the protein content of sweet potato and taro grown on Maring soils is well below published values, I ask whether the protein content of other crops, particularly of greens, might not also be low. If this were so, it might explain why the Maring appear to be suffering more from protein malnutrition than are some of the highlands populations, like the Chimbu and the Enga, who have diets lower in protein than those of the Maring. The protein content of crops grown in the more densely populated areas is lower than those grown in the low density areas; if this low protein content is due to relatively poorer or more depleted soils, it is likely that other vegetables grown in these areas also have lower protein content. If this is true, it goes a long way towards explaining why the people living in these areas are smaller and more susceptible to disease.

It becomes obvious that, for the kind of micro study which was attempted here, traditional diet intake studies are not sufficient because local variation is so great. It is necessary to have all locally grown foods analyzed for their nutrient content. Reliance on published values only obscures local differences.

Again, let me note that the Maring are very small and slightly built people, and that those living in the more densely populated northwestern regions are shorter and slighter than are those living in the more sparsely settled southeast. They also appear to be extremely slow growing and late maturing; although in the absence of accurate information on birth dates and of long term longitudinal growth studies, it is impossible to determine just how slow their growth and how late their maturation really are. If we may extrapolate from Malcolm's study of the Bundi people who live in a similar highlands fringe environment not far away to the southeast, it is likely that the Simbai Maring, and particularly those living in the northwest are among the most slowly growing people in the world. There is enough evidence to suggest that at least a large component of their short stature is due to nutritional stunting as a result of both protein and iodine deficiency. Without long term experimental food supplement studies, it is difficult to tell whether or not there is also a genetic component involved. One might, perhaps, argue that small body size evolves in response to diets low in protein; but, if this were true, one would expect to find that the populations containing the smallest people would also be the healthiest, and the most fertile, and in the Simbai Valley this is not the case.

In addition to being small, the Maring are likely to be suffering from anemia, again particularly in the more densely populated regions. They frequently suffer from malaria, and iodine deficiency. Their resistance to infectious disease appears to be very low, judging by their extremely high mortality in the influenza epidemics which occurred in the late 1960's. Almost one-fifth of the Tuguma population died between 1966 and 1969, and the death rate here might have been even higher if I had not been there to administer penicillin or to take people to aid posts. During this period, it was not uncommon for a person, who had previously appeared to be well, to sicken and die within 24-48 hours after the first onset of symptoms.

In the late 1960's, the entire Maring population was decreasing, and although an appreciable amount of this decrease was due to the effects of recently introduced disease, there is no evidence that the population was increasing prior to contact. Indeed, although contact introduced new causes of mortality into the Simbai Valley, it also eliminated some of the traditional causes of death, namely warfare and homicides which might follow accusations of sorcery and witchcraft. It is difficult to determine just how much mortality was increased after contact.

A number of questions remain to be answered about Maring population dynamics and biology as a whole and about the local variation which exists in the valley. In the first place, why do the Simbai Maring peoples appear to be so unhealthy, and why is the population as a whole doing so poorly. I have argued that the reason is that they suffer from protein deficiency, iodine deficiency, and malaria. However, there are other New Guinea populations which suffer more from one or another of these conditions and yet do not appear to be living such a precarious existence. For example, malaria is a greater problem in the Sepik River area and along parts of the coast, and protein deficiency may be more prevalent in some highland populations (Stanhope 1970). What makes the Maring situation unique is that they suffer from a combination of all three, and the effects of all of these conditions are synergistic.

Another and more difficult question is why is there a greater build up of population density in the northwestern part of the Simbai Valley, where both protein and iodine are relatively scarce. Is it because these areas are potentially less malarial than the areas to the southeast, or is it because they have been inhabited longer and have thus had more time for population growth to occur. I believe that the latter explanation is more probable, but it is impossible to verify without archaeological evidence. Clarke has noted that there is more environmental degradation in the northwestern part of the Simbai Valley, but although this degradation is associated with high population density, it does not prove long occupancy. Another possibility to be considered is that these high densities are being artifically maintained by the Pax Australiensis. Rappaport tells us that the Tsembaga were defeated and fled from their territory in 1953, and resettled it only under the protection of the Australian Government in 1958. Had the government not interfered, the Tsembaga would not have returned, and their territory would only have been annexed by the groups adjacent to it after sufficient time had elapsed to complete the ceremonial cycle. This delay would have allowed Tsembaga territory to recover some of its fertility and would have alleviated crowding on adjacent territories. Vayda (1971) reports that rout was a frequent outcome of Maring warfare occurring in nineteen of the twenty-nine cases which he was able to record. He suggests that one of the functions of Maring warfare was to adjust man-land ratios when an imbalance did occur. The practice of postponing the takeover of conquered lands until the completion of ceremonies, ten years or more after conflict, might have allowed these lands to recuperate from the effects of overcrowding. It is also possible that those peoples whose territories were the most depleted would be the ones who were most physically stunted and most physiologically stressed and thus, also the ones most likely to be defeated in war. This might have been a contributing factor in the defeat of the Tsembaga; although the main factor seems to have been the failure of their major allies, the Tuguma, to show up on the day they were routed. The Tuguma are just as small as the Tsembaga and seem to be even more stressed with disease. The reason that they did not show up for the fight may have been that they were physically unable to maintain fighting for any length of time. Tempting as this explanation may be, it must be remembered that the Tuguma were successful in their last fight with the Kanamb-Kaul clans immediately to their southeast at Gai. Although living under crowded conditions, the Kanamb-Kaul are still somewhat taller and healthier than are the Tuguma. The fact that all adult

Tuguma and Tsembaga are small probably indicates that the conditions which caused their stunting are probably of fairly long standing in their part of the valley.

Stanhope (1970) commenting on the demographic situation in the Simbai Valley has proposed for the central highlands a model of continual population growth in which people constantly spill over into the fringes and low altitude areas where they die. If this was the case, then one might speculate that the upper part of the Simbai was populated earlier than the lower part and that the numbers there were constantly being replenished by migration from the Jimi. In fact, some population movement does take place in both directions across the Bismarck Mountains and in both directions along the Simbai Valley. But it is not possible at this time to determine if there is a net flow in any direction. Perhaps when Vayda completes his analysis of all Maring marriages, it will be possible to determine if more women enter than leave the Simbai Valley or vice versa. Because of the lack of historical evidence, this may be the only way to test this model.

Recent work by Bateson (1963) and by Slobodkin (1968) suggests a model of biological adaptation which may be useful in understanding the processes at work among the Simbai Valley Maring. Bateson (1963) noted that organisms respond to environmental stress by means of hierarchically ordered series of adaptive response mechanisms. The more superficial physiological adaptations are rapid and easily reversible, but costly in terms of reduced flexibility of response to additional stresses. Panting as a response to low oxygen pressure at high altitudes would be an example of a superficial response. The deeper physiological responses (adaptations or acclimations) are slower acting and not so easily reversible;

however, once operative, they function to restore flexibility to the shallow responses. The gradual increase in circulating red blood cells and the increase in the vital capacity of the lungs which occurs after a person has been living at high altitudes for a while would be examples of deep responses. Once these are established, the panting response would again be available for use in temporary oxygen shortage, such as that which occurs during and after violent physical exertion. Because of the possibility of the reversibility of an environmental change, Bateson notes that it is important that deeper changes lag behind the more superficial ones. Finally, he points out that genetic change may affirm somatic change. Thus, in the above example, selection would favor those individuals who make the most rapid and complete adjustment to high altitude living. Once this selection has occurred organisms will have restored flexibility in their deep physiological response systems. Presumably they could now cope with still lower oxygen pressures.

Slobodkin (1968) amplifies the above model of adaptive response by applying it to populations of organisms in their ecological setting. He thus postulates four levels of response to environmental perturbation: behavioral, physiological, ecological and genetical. He notes that the physiological responses of individuals in a population undergoing stress may reduce their viability and fertility, thus causing the population to decline. He argues, however, that reduced population density is almost universally beneficial to the surviving organisms, thus, restoring their flexibility in the face of further environmental perturbations.

A further assumption of his model, which may be of particular relevance to this study, is that small body size may evolve in response to catastrophic perturbations (those which without regard for genotype cause a high mortality rate) in the environment. This, he states, is because small animals tend to reproduce more rapidly than large ones. (As we have seen small Maring do not reproduce more rapidly than large ones.)

However, he goes on to state that "It is also the case that smaller animals tend to have lower overall flexibility to many kinds of perturbations than do large ones, and that smaller animals can maintain a numerically greater population than large ones on a given resource supply. These effects in turn, increase the susceptibility of populations of small animals to perturbations and tend to enhance the catastrophic aspects of whatever large perturbations may occur." (Ibid.:201) Eventually, the physiological flexibility of the population will be so reduced that even a minor disturbance will cause relatively major responses, including a high mortality rate. One supposes that such a population increasingly faces the possibility of extinction, unless it is capable of evolving some sort of flexibility restoring adaptive mechanism. Otherwise it becomes a population of small unhealthy animals whose numbers fluctuate widely and rapidly in response to relatively minor environmental disturbances.

Following the above model, let us see if it is possible to view the different Simbai Maring local populations as occupying different positions in an "adaptation cycle." In this context I do not equate adaptation with positive evolutionary changes leading to long range survival. Perhaps the term acclimation is closer in meaning to the concept I am proposing. One of the basic premises of Slobodkin's model is that there is an inverse ratio between a population's size and its growth rate and between the population's size and the well-being of its members. Thus, when pioneering populations enter a new environment they expand rapidly to fill it. These populations are characterized by having robust and fertile members (Smith 1963). Among the Simbai Maring the populations in the southeast have the above characteristics and hence, may represent this developmental stage. Later, as the population expands to fill the environment, and as resources become relatively scarce, members of the population respond to these worsening environmental conditions by means of behavioral and somatic changes; of which the former might include warfare or the development of cultural behaviors which limit fertility or increase the probability of mortality and the latter which might include reduced body size. The Maring populations in the northwestern part of the Simbai may represent this stage for they exhibit high population density and small body size. However, as Slobodkin (Ibid.) has pointed out, this kind of adaptation is only a makeshift one and carries with it the burden of reduced somatic flexibility and thus reduced ability to withstand further stress, such as introduced infectious disease or the psychological effects of culture contact. The smaller, more crowded Simbai Maring populations in the northwestern part of the valley are also those which have the highest mortality due to introduced disease. As a consequence of reduced somatic flexibility, viability and fertility decrease and the rate of population growth declines and may become negative. This is also occurring in the densely populated Maring regions. If there are no further environmental perturbations, the population may reach an equilibrium and no further somatic change or environmental degradation may occur. If this situation lasts long enough, it is possible that genetic mechanisms may come into play to reinforce the intermediate somatic changes. There is no evidence to suggest that any of the Simbai Maring populations have ever reached this equilibrium stage.

As Bateson (1963) has noted, it would be difficult to test for genetic adaptation except in a situation in which the population is placed under double stress. In which case the genetically adapted individuals would be better able to withstand the stress than the somatically adapted ones. The Simbai Maring in the 1960's were in a situation of double stress, the first being the traditional stress of malnutrition and malaria, the second being the various effects of contact. According to the model, if the people in the northwestern part of the valley were small because of genetic changes, they should be better able to withstand the new stresses than if they were small because of nutritional deprivation. However, as we now know, they did not respond well to the second stress presumably because they had no reserve somatic flexibility. Thus, according to the model, if additional environmental stresses are encountered by a population before any genetic adjustment has been made, the population by virtue of its previous somatic adaptations will have little reserve somatic flexibility left to cope with the new stressors and will be in danger of a population crash which may ultimately lead to local extinction. If this does occur, then the environment may have a chance to recuperate and the pioneering process may begin again. Possibly, this will be the fate of the densely populated Simbai Maring regions. To summarize, we may argue that because of recent occupancy, the populations in the southeast are in a pioneering stage characterized by robustity, high fertility and low population density. In the mid-density areas, the size of the individuals and their fertility have declined to a certain extent. In the high density regions both body size and fertility have declined to the point that in the face of introduced stresses, these populations are now declining. The fact that individual Maring populations do not fit the model exactly is due to the local environmental differences previously discussed. Moreover, there is at least one respect in which the Maring, in general, do not fit this model, and that concerns the statement by Slobodkin that in the face of catastrophic changes in the environment small body size may evolve because small animals are able to reproduce more rapidly than large ones. We have already noted that, in fact, small Maring do not reproduce as rapidly as large ones, but that is because their small body size is a somatic response to nutritional stress rather than a genetic response.

It seems likely that the Maring population is not, and probably never was, in a state of equilibrium with its environment, unless one wants to think of equilibrium in terms of very long term cyclical changes. But it would be difficult, if not impossible, to determine whether the processes outlined above are cyclical or unidirectional.

Kunstadter (1971) takes exception to the traditional model of the demographic transition, particularly its assumption that pre-modern populations were characterized by balanced high birth and death rates. He believes that these populations were generally characterized by moderate birthrates and moderate to low death rates, resulting in population growth in most years. However, he notes that such populations are occasionally subject to disasters that severely deplete their numbers. The operation of such factors might explain the build-up of population density in the northwestern part of the Simbai, and what I observed might simply be the last in a series of what formerly were recurrent disasters. I say last because due to the effects of contact, the Maring are becoming a demographically transitional population. In fact, if Kunstadter's argument is correct, and the cycles of population build-up and decline take approximately 100 years, then the various Maring populations may represent different stages in this model. Their physiological status would be the same as suggested in the Bateson-Slobodkin model, and in fact, Kunstadter's model could be seen as a variant of the previous one.

In light of the above discussion, it is necessary to evaluate the equilibrium model proposed by Rappaport (1968) for the Tsembaga Maring. He has "argued that the regulatory function of ritual among the Tsembaga and other Maring helps to maintain an undegraded environment, limits fighting to frequencies that do not endanger the existence of the regional population, adjusts man-land ratios, facilitates trade, distributes local surpluses of pig in the form of pork throughout the regional population, and assures people of high-quality protein when they most need it." (1968:224) I will not comment on the frequency of warfare or on trade among the Maring because these subjects are beyond the scope of this thesis; but it is necessary to examine the notions of undegraded environments, adjustment of man-land ratios, surplus pork, and the amount of high grade protein being made available to people when they most need it.

Although my field research was concerned primarily with the physical and demographic characteristics of the Maring people rather than with their environment, it became clear that there was variation in the amount of environmental degradation which had occurred in the territories of the various Simbai Maring local populations and also that the territories of the more densely populated groups, namely the Tuguma and the Tsembaga, were more degraded than the territories of the less densely populated groups. Environmental degradation manifested itself in the lower protein content of the crops grown on these territories, in the lesser amount of game available in the forest, and in the stunting and poor health of the people living on a reduced protein intake. We have already noted that the length of garden fallows in the territory of the Tsembaga were shorter (by a factor of 1/2) than the fallows in the territory of the Bomagai-Angoing. Moreover, as Clarke (1971:190) has pointed out, the trees in the secondary forest were younger and the forests were less complex, that is, they contained fewer species, than the secondary forest in Bomagai-Angoing territory. Clarke notes that the lack of complexity is an indication of environmental degradation (Ibid.); Margalef (1963) has also noted that young or degraded ecological systems tend to be simple (contain few species) whereas mature and stable systems tend to be complex. Given the uneven distribution of population in the Simbai Valley, and the uneven distribution of the effects of crowding on the landscape, it does not appear that the Maring means of adjusting man-land ratios through ritual and warfare have been very effective. Although, in fairness to Rappaport, we must again note that the Tsembaga were on their territory in 1963 and thereafter only because of the intervention of the Australian Government. Presumably, without this intervention, the Tsembaga population would have remained dispersed and their land would eventually have been appropriated by the adjacent groups, thus perhaps relieving some of the crowding and possibly restoring some of the fertility to the land.

The fact that the Maring ritual cycle distributes pork throughout the whole population (that is, among all the Maring-speaking populations) cannot be questioned, but it is necessary to ask whether the pork so distributed could really be considered as surplus. I have no desire to get involved in a discussion of the economic concept of surplus, but it is apparent to me that, from a strictly biological or nutritional point of view, there is no surplus pork among the Maring. This raises questions concerning the economic and ecological wisdom of the Maring mode of pig rearing, particularly the practice of allowing pig herds to become large enough to pre-empt human food resources and then of slaughtering all the pigs at once for ceremonial purposes. It would be more efficient to slaughter pigs one at a time as they became fully grown, and it is significant that this is, in fact, the practice of the sparsely settled Singanai and Fogaikumpf populations. Rappaport himself has commented on the energy wastefulness or expense of Maring pig raising practices, noting that among other things the energy return per pig is greatly reduced by the practice of maintaining fully grown pigs in the herd for a period of two years or more before killing them. From a nutritional, as well as from an ecological point of view, it would make better sense for the Maring to kill and eat their pigs as they became mature rather than to wait for ceremonial occasions to occur. This would tend to distribute pork consumption more evenly throughout the population.

Rappaport has asserted, based on informant's statements, that Maring practices with regard to pig killing in non-festival years tend to assure people of high quality protein when they most need it, that is, in times of stress, such as just before they fight or when they are sick. There was no fighting in the Simbai when I was there, but there was much sickness. In the non-festival year of 1967-68, 184 pigs were consumed by all of the Simbai Maring population. Of these only forty-seven (or 25.6 per cent) were killed in response to human illness and of these forty-seven, only sixteen (or 35 per cent) were killed in the case of a sick female. Fifteen pigs were killed because they had been damaging gardens or appeared likely to do so. Twenty-four were killed to celebrate the return of men who had been away working on plantations, eighteen were used in affinal payments, and another eighteen for funeral rites which took place on the average of two years after the death had occurred. The remaining sixty-two pigs were used for a variety of non-stress related purposes; this number included pigs who died of illness or accident. Pigs that die of natural causes may be consumed, usually by women and children.

Although some pigs are indeed killed in times of illness, these are few, and it is doubtful that they provide much protein to the sick person or for close of kin. Frequently, in the case of an acute illness, by the time pigs are killed, butchered and cooked, the patient has already died. The situation which I experienced may have been anomalous because of the influenza epidemics, but certainly during that period not every individual who became ill had a pig killed for him.

Rappaport argues that the Maring ritual cycle functions to maintain the population of people and pigs well below the carrying capacity of the local territory, thus, preventing environmental degradation and allowing the ecological system to continue in perpetuity. His study did indicate that the Tsembaga population was below carrying capacity. However, there are many problems inherent in the concept of carrying capacity, some of which have been discussed by Street (1969). Most of the points raised by him have to do with difficulties in determining the carrying capacity of a particular system. These difficulties arise not only because of crude measuring techniques, but also because ecosystems and the means used to exploit them are constantly changing, and the rate of change or degradation may be smaller than the errors inherent in the techniques of measurement. Clarke (1971:192) thinks that carrying capacity should be thought of as a gradient rather than a critical limit. I would add that it may be more useful to look at limiting factors than to try to determine overall carrying capacity in the study of human adaptation. Thus, it may be true that the Tsembaga population, for example, is below the carrying capacity of the Tsembaga territory, but it is likely that any increase in the population size without compensating change in the technology or economics, such as adding fertilizer to the soil, or obtaining cash to buy protein foods from outside, would only result in a more poorly nourished and perhaps more stunted and sickly people. The limits of this system are not to be expressed as the amount of energy which may be extracted in perpetuity from the environment with the Tsembaga technology, but rather as the amounts of protein and iodine which are currently available to the people, as well as the amount of malaria to which they are subjected.

Rappaport (1968) proposed a brilliant equilibrium model of Maring ecology and its regulation on the basis of a very careful study among one population, the Tsembaga, for a period of about fifteen months. Further studies among other Maring local populations over longer periods of time by the Vaydas, Clarke and myself have yielded data which suggests that Rappaport's model is not wholly adequate for an understanding of Maring ecology in the Simbai Valley. Rather I have proposed that a more accurate model is a dynamic one involving pioneering, population build-up, subsequent nutritional and disease stress resulting from environmental degradation due to "crowding", leading to malnutrition and to stunting and low resistance to disease. This stage may then be followed by a population crash when new stresses are added to the system. On the basis of present evidence it is impossible to determine whether the processes here outlined are cyclical or unidirectional.

APPENDIX

NON-DOMESTICATED RESOURCES UTILIZED BY THE MARING

A. PLANTS--Identifications are provided by Rappaport (1968) and Clark (1971)

1. Food

Life Form	Scientific Name	Native Name	Parts Eaten	Other Uses
Tree	*? Pentaspadon* or *Rhus sp.*	*karinanc*	nut	tech.
	Macaranga sp.	*konjenpai*	leaf	
	Breilschmiedia sp.	*kom*	leaf	ritual
	Ficus dammaropsis	*timnai*	fruit	
	?	*kumur*	stem	tech.
	Pandanus sp.	*pima*	fruit	tech.
	Pandanus sp.	*taba*	fruit	
	?	*konjup*	leaf	ritual
	?	*rama*	leaf	
	Mangifera sp.	*wowi*	fruit	
	Aleurites moluccana	*kaba*	nut	
	Erythrina sp.	*yaur*	leaf	
	Cyathea angiensis	*yimunt*	leaf	
	Cyathea,new species	*kangup*	leaf	
	Missiessya sp.	*yamo*	leaf	medical
	Chisocheton sp.	*birpi*	nut	
	Ficus puncens	*kobenum*	leaf, fruit	
	Ficus wassa	*beka*	leaf, fruit	fiber
	Unidentified	*dukumpna*	leaf, fruit	
Shrubs, Herbs and Bushes	*Cyrtandra sp.*	*welence*	leaf	ritual
	Chloranthus sp.	*korap*	leaf	ritual
	Microcos sp.	*nimkmai*	leaf	
	Unidentified	*pingo*	leaf	
	"	*kopenga*	leaf	fiber
	"	*gonbi*	leaf	
	"	*nink amp*	leaf	ritual
	Rungia klossi	*tok ami*	leaf	
	Commelina sp.	*komerik*	leaf	
	Cyathea rubiginosa	*kaban bep*	leaf	
	Setaria palmaefolia	*korami*	stem	
	Dennstaedtia sp.	*terai*	leaf	
	Cyclosorus sp.	*aruk*	leaf	
	Diplazium sp.	*rangilopa*	leaf	
	Unidentified	*ruma rena*	leaf	

Life Form	Scientific Name	Native Name	Parts Eaten	Other Uses
	Ficus andenoperma	*anjai*	leaf	
	Laportea sp.	*cenan*	leaf	
Vines	Unidentified	*yibona*	leaf	tech.
	Palmeria sp.	*kip ndim*	leaf	
	Piper sp.	*morameka*	leaf	ritual
	? Trichosanthes sp.	*jen*	fruit	
Epi-phytes	*Polypodius sp.*	*kwiop*	leaf	

2. Technological

Life Form	Scientific Name	Native Name	How Used	Other Uses
Tree	*? Pentaspadon* or *Rhus sp.*	*karinanc*	tools	food
	Caldcluvia sp.	*bokanc*	building	
	Quercus sp.	*non*	building	
	Garcinia sp.	*tandapa*	tools	
	Cryptocarya sp.	*kawit*	dress	ritual
	?	*krim*	dress and tools	
	Albizzia sp.	*kanam*	tools	
	Ficus trachypison	*ringanc*	building	
	Eugenia sp.	*nomomba*	dress	ritual
	Eugenia sp.	*apen*	tools, dress	
	Descaspermum sp.	*dam nene*	building	
	Calsmus sp.	*kumbaka*	tools	
	?	*kumur*	building	food
	Freycinetia sp.	*korainga*	tools	
	Pandanus sp.	*buk*	tools	
	Pandanus sp.	*pima*	building	food
	Pandanus sp.	*tumbama*	building, tools	
	Ternstroemia sp.	*tondomane*	building	
	?	*dima*	tools	
	Bubbia sp.	*ruimam*	dress	
	Unidentified	*aimenga*	dress	medical
	"	*amengi*	tools	
	"	*air*	tools	
	"	*koro*	building	
	"	*gambo*	tools	medical
	"	*tingia*	tools	
	"	*nunr*	dress	ritual

Life Form	Scientific Name	Native Name	How Used	Other Uses
Tree	Unidentified	*yent*	building	
	"	*rangan*	tools	
	"	*mar mar*	building	
	Araucaria hunsteinii	*juk*	tools	
	Casuarina papuana	*jimi*	building	agronomic
	Casuarina sp.	*kipir*	building	agronomic
	Pandanus sp.	*miyon*	building	
	Leea sp.	*bebon*	building	
	Phyllanthus sp.	*dikambo*	building	
	Ficus sp.	*danje*	tools	
	Licuala sp.	*moropmai*	tools	
	Alphitonia iacona	*pokai*	building	medical
	Dondonaea viscosa	*gra*	building	
	Mischocdon sp.	*birpi*	building	
	Saurauia sp.	*rokunt*	building	
	Gironniera sp.	*penta*	building	
	Boerlagiodendron sp.	*aimam*	building	
	Dillenia sp.	*munduka*	building	
	Oreocnida sp.	*rumem*	building	
	Unidentified	*membra*	building	
	"	*pia*	building	
	"	*punt*	building	
	Ficus sp.	*gimbondum*	fibers	
	Melastoma malabothricum	*wop kai*	fibers	
	Homolanthus sp.	*tup kalom*	fibers	
	Phalerium nisidai	*pukna*	fibers	
	Maoutia sp.	*nongamba*	fibers	
	Fagraca racemosa	*burumoi*	supplies	
	Astronia sp.	*kukair*	supplies	ritual
Shrubs, Herbs and Bushes	*Cyathea sp.*	*nongam*	dress	
	Bambusa sp.	*kow*	tools, dress	
	Phrynium sp.	*mingin*	building	
	?	*namdinga*	building	
	Alpinia sp.	*puplaka*	building	
	Crinum sp.	*yimane*	tools	
	Agiaonema sp.	*mocam*	dress	ritual
	Bambusa forbesii	*kingen*	building	
	Imperata cylindrica	*korndo*	building	
	Miscanthus floridulus	*ripa*	tools	
	Piper sp.	*yikun*	dress	ritual
	Costus sp.	*monomp*	building	
	Bambusa sp.	*waia*	building, tools	
	Alpinia sp.	*banangoi*	dress	ritual
	?	*Kopenga*	fibers	food
	Slocasia sp.	*gump*	supplies	

Life Form	Scientific Name	Native Name	How Used	Other Uses
	? Calanthe sp.	*koronda*	supplies	ritual
	Spathoglottis	*korndo*	supplies	ritual
Vines	?	*Gambrongin*	tools	
	Dimorphanthera sp.	*ayuk*	building	
	?	*yibona*	tools	food
	Aeschynanthus	*koramp*	building	ornamental
	Hoya sp.	*kowundo*	building	
	Aeschynanthus sp.	*yimbunk*	building	
	Smilax sp.	*gum biogun*	tools	
	Medinella sp.	*aikumbindi*	building	
	Ficus sp.	*mopakai*	building	
	Adenis sp.	*adar*	building	
	Lepistemon urceolatum	*apop*	building	
	Flagessaria indica	*gon*	building	
	Dicranopteris pinearis	*mombo*	building	
	?Alpinia sp.	*cawaka*	building	
	Unidentified	*mundunt*	building	
	Freycinetia sp.	*krina*	fibers	

B. ANIMALS

Birds (*kapang*)--at least 69 native taxa, most of which are used for food and to a lesser extent ornaments, trading, and wealth objects.

Marsupials (*ma*)--at least 28 native taxa used primarily for food and also fur, hides, fibers, ornaments, and in trade.

Rats (*koi*)--at least 8 native taxa all of which are used for food by women and children.

Insect larva (*tuma*)--one native taxa found in tree stumps--a highly prized food.

Snakes (*noma*)--at least 8 native taxa used for food and one for hide.

Lizards (*tum*)--at least 1 native taxa used for food.

Insects (*bang*)--at least 8 native taxa, 7 of which are used for food, 1 is used for medicinal purposes and 1 for ornaments.

Frogs (*anp*)--many taxa used for food by women and children.

Crabs (*korapa*)--one native taxa used for food.

Fish (2 native taxa, *kobe* (eel), and *tuoi* (catfish)--both of which are eaten.

Wild Pigs (*konj*)--1 taxa used as food.

Fruit Bats (*mandang*)--1 native taxa used as food.

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