SUSTENANCE, SEASONALITY AND SOCIAL CYCLES ON THE NEMBI PLATEAU, PAPUA NEW GUINEA

By

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Except where otherwise acknowledged in the text, this thesis represents my own original research.

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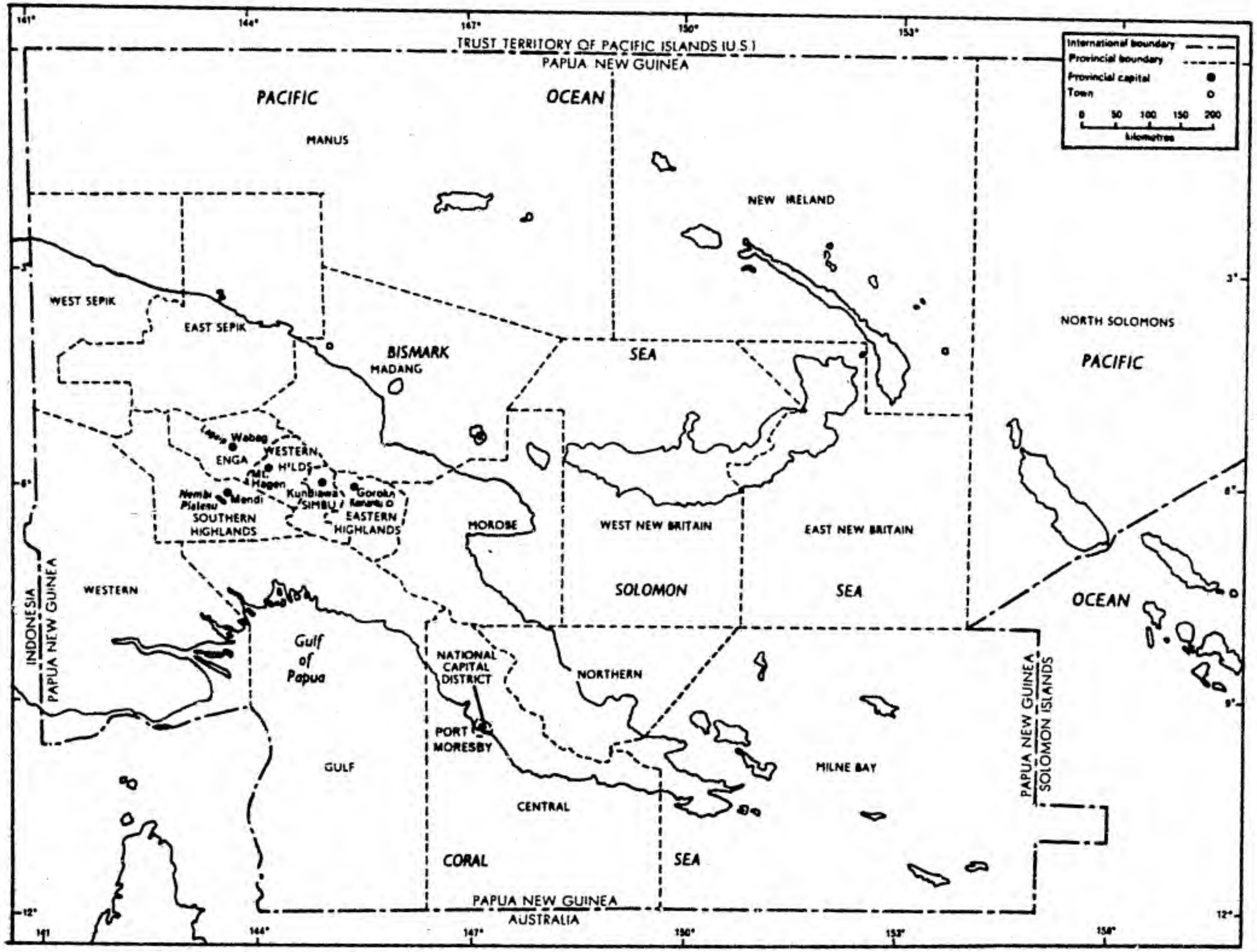
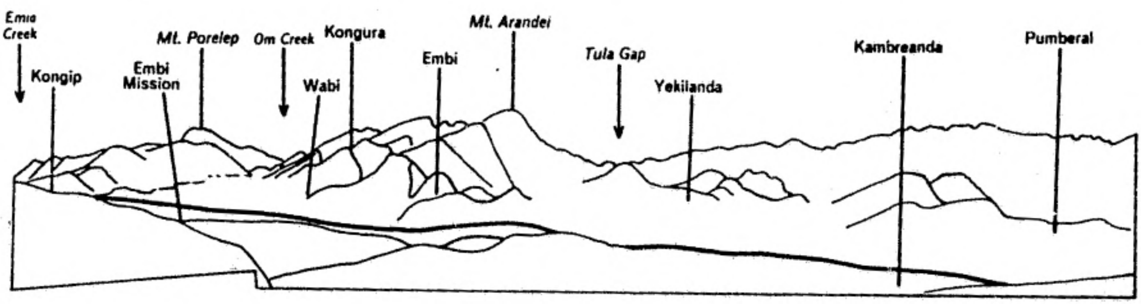
Robert Crittenden



Based on the Papua New Guinea Atlas, The University of Papua New Guinea, 1982

PAPUA NEW GUINEA



A panoramic view of the Lower Pwe Creek basin (September 1980).

ERRATA

Pages 293 and 294 are in wrong order.

Page 366 and 369 are wrongly numbered.

There are no pages numbered 323 through 332.

ABSTRACT

People, pigs, food and land are the main concerns of this thesis. More particularly it is their interconnections and the effect these have on the nutritional status of an especially vulnerable group of people - children. Children are vulnerable because they are dependent upon their mothers for their well-being and it is those children between the age of 0-23 months who are the focus of this study. The susceptibility of children to suffer from malnourishment is examined in a society undergoing rapid changes, changes that have taken place in the last twenty years.

Against a broad background of culture contact the man-land relationship of the Nembi Plateau is examined and points of weakness highlighted. Factors, other than purely agronomic, or simply part of the equation that pits population size and density against resources, are shown to be contributing to the poor nutritional status of young children and a high rate of child mortality. Elements of weakness in the socio-cultural and agro-economic system of the Nembi are pin-pointed and have their roots in pre-contact times, but they have only become critical as the Nembi have been incorporated into the wider national economy as a deprived periphery.

The ability of the Nembi socio-economy to sustain a satisfactory level of welfare is threatened. The effects of continued contact have been to increase the rate of population growth. The death rate has dropped and the fertility rate has increased. At the same time access to favourable areas of land has become limited, length of fallows have become shorter, soil fertility has declined and

yields have become lower as people have struggled to locate closer to the road that connects them with the wider economy.

Within this broad picture particular children have been identified as being more at risk than others. The agriculture of the Nembi and their socio-cultural system has a weak though important seasonal aspect to it, and it is those children born at a particular time of year who are more prone to dying. A combination of the pressure of work that women have to bear, the poor environmental situations, the pattern of disease prevalence and their seasonal aspects, affect the health and well-being of young children variably throughout the year and according to a child's age.

Understanding the complex interaction between the various facets of the Nembi way of life is seen as the key to revitalize the Nembi and to help them to cope with the results of the upheaval they have experienced.

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In the Department of Geography, Gennesse Beadman typed this thesis, while Val Lyons drew the maps and figures. Their experience smoothed my path considerably. Others provided comments on drafts of the various chapters and I am indebted to Gary Simpson, Wayne Warry, Jimmy Weiner, Stephanie Fahey and Keith Thomas. Robert Drake was an able teacher and a much needed help in the use of the computer.

I am also indebted to many individuals in Papua New Guinea, particularly to Mary Hermiz of the Christian Union Mission at Embi on the Nembi Plateau and to Euclid d'Souza, the agricultural officer stationed at Ol on the Nembi Plateau. Mary allowed me free access to her Health Centre records and Euclid gave freely of his ideas. Dr Lyn Clarke and the Department of Health provided support whilst in Mendi as did Merle and Kathy Anders. The District Manager at Nipa, Paul Fearman and his wife Liese were most hospitable hosts and provided friendship and a haven from the pressures of work. Andrew Wood and Margaret Trantor were good friends in Port Moresby.

My greatest debt is to the people of Kongip and to Janis Baines. The people of Kongip were generous of their time and Kin Kurop especially made our time in his village a pleasant one. Without the support and help of Janis Baines this thesis would probably have not been written. Her presence in the village with me allayed any fears the men had of my intentions in talking to their wives, and her friendship with the women enabled her to collect for me much useful information. At all times her encouragement and support was most reassuring. Her help in analyzing the data was welcome and valuable. This thesis is dedicated to her and the people of Kongip.

CONVENTIONS

ARM	- Assistant Resident Magistrate
CSIRO	- Commonwealth Scientific and Industrial Research Organisation
IBRD	- International Bank for Reconstruction and Development
NPEP	- National Public Expenditure Plan
PR	- Patrol Report
SHP	- Southern Highlands Project
VC	- Village Constable

Currency

The monetary unit in Papua New Guinea is the Kina. One Kina equals 100 toea. During the time of fieldwork 1 Kina was equal to A$1.33.

CHAPTER ONE

THE SILENT FOOD PROBLEM OF THE POOR

The Southern Highlands Province is one of the poorest and remotest provinces in Papua New Guinea. Furthermore, it is probably one of the most backward areas of the world.

Papua New Guinea Rural Development Project Staff Appraisal Report June 22 1978b: The World Bank

We are the last men of Papua. Now we are the cargo-boys (labourers) for the men of Pangia, Ialibu, Kagua and Mendi. Behind us is the forest, our ground is sick, our sweet potato is small and our children die.

Kin of Kongip on the Nembi Plateau, Southern Highlands Province 1980

The Nembi Plateau : The Problem

Two seemingly contradictory statements have been made about the socio-economy of the Nembi Plateau. Both encompass attitudes which have emerged from the broader framework of Papua New Guinea development policy. On the one hand the Nembi Plateau has been described as a 'region of difficult terrain and little potential for economic development and therefore it is likely that the people will have to rely on their traditional forms of subsistence agriculture for their livelihood' (IBRD 1978c:40). With no or very few opportunities to generate cash through profitable enterprises it has been assumed that the Nembi will have to depend upon their own efforts, encapsulated within their traditional subsistence economy.

On the other hand it is also recognised that the socio-economy of the Nembi Plateau has reached a crisis point: the delicate balance between physical resources and population is reaching its limit. The occurrence of child malnutrition and the extremely low yields of sweet potato are seen as symptoms of high population densities, the result of a combination of long gradual increases in numbers of people and an environment capable of supporting higher than usual densities (Allen et al 1980:130). Thus not only was the future of the Nembi to be left in the hands of the people themselves, but it was also to depend upon a productive system labelled inherently inadequate. The Nembi Plateau thus epitomises those poorer, out-of-the-way areas of the Papua New Guinea Highlands that are rapidly becoming marginalised. What has not been recognised is that the process of marginalisation is the result of development policy. For even if Nembi are not helped to change they will not stay as they are. They will accrue all the disadvantages of exposure to the developed economy.

Shaw (1980) has highlighted the negative impact that macro-economic policies have had on rural areas, including those policies formulated at the provincial level and therefore supposedly more in tune with the needs, wants and aspirations of the rural people. His comments are relevant here as my interest in the Nembi Plateau socio-economy stems directly from provincial policies. Part and parcel of national planning rhetoric in Papua New Guinea is the aim to reduce the gap in living standards between rural and urban areas and between provinces. Emphasis has been placed however upon inter-provincial inequalities (the responsibility of National Government) rather than differences that exist within the provinces (the responsibility of Provincial Government). Shaw stressed that such emphasis will have little impact on the living standards of the bulk of rural people in comparison to the more advantaged within the provinces (1980:5).

For the financial year of 1980, 9.5 percent of the total National Public Expenditure Plan budget was directed to assist the less developed areas, as identified by a working group in the National Planning Office. The objective was to recommend the steps the Government should take to redress the problems of provincial inequality (Simpson 1980:2). In an effort to further redress provincial inequalities, funds were sought from outside agencies (see Simpson 1980, Shaw 1980). Provinces (previously districts) formulated their own plans in order to attract both NPEP and external funds. The

East Sepik Rural Development Project was appraised for Asian Development Bank funding in 1976 and the Southern Highlands for funding by World Bank in 1978. Enga Province is in process of appraisal.

Lagging some thirty years behind the rest of the highlands in development, the Southern Highlands was the first highland province to submit a comprehensive rural development plan for outside funding. The initiative came from within the province. Three-quarters of the approximately K18 million loan (excluding management costs) is being spent on developing an economic infrastructure based on roads, tea and coffee planting, with ancilliary services. The remainder is distributed between health, formal and nonformal education and the subsistence sector. Although the project aims to improve the welfare of the Southern Highlands people, the majority of spending, even in health and nonformal education, is on infrastructure and will have limited impact for the majority of rural people (see Simpson 1978a for a more thorough critique of the Southern Highlands Project). Although the initiative for the project has its origins before Provincial Government status was given to the districts, the project begs Shaw's question as to whether rural development programmes are contributing to the welfare of all groups in the province, or whether they are a device for the buying off of the provinces by the central government (1980:10). At first glance the composition of the Southern Highlands Province rural development project would suggest already advantaged groups in the province are further advantaged to catch up with those in the other provinces (see Simpson 1978a). An important component however, of the Southern Highlands Project is the setting up of a research team to investigate the subsistence component of the provincial economy. Approximately 9 percent of the project's fund are allocated for this purpose.

The research effort is directed at those areas of the province not able to benefit immediately from the project. Recognising the limited agricultural potential of most of the Southern Highlands the project has a major objective to establish nucleus estates owned by local government councils. Instead of promoting private interests by allocating funds to small-holder development throughout the province, the aim is to promote small-holder development in areas surrounding the council estates. The marginal areas however, are to be heavily researched in an effort to promote ways in which they can catch up with the more favourable agricultural zones. The objective is to counteract the impact of large amounts of capital and expertise in particular areas creating substantial rural inequalities.

The Nembi Plateau is but one of five areas initially selected for research into the socio-economy of marginal regions. These regions cover the three main agro-climatological zones (varying principally with altitude) in the province and are representative of problems throughout the rest of the highlands (IBRD 1978c). As such, research results from the Southern Highlands will have a wider impact as other provinces initiate their own programmes. Greater understanding of the dynamic nature of rural economies and the interaction of the old with the new will enable plans of management to be more effective. Strategies may also be more closely related to the existing socio-economic structures and more in accord with the aspiration of the people.

This thesis seeks to address the problem of describing the Nembi condition in a manner that will contribute to the province's stated aim of wishing to understand the socio-economies of the rural areas. In particular I am interested in demonstrating that the nutritional status of children on the Nembi Plateau is the result of far more than a simple correlation between population densities and physical resources. A preliminary report (Allen et al 1978, 1980), on the Nembi situation, emphasised the internal ecologic factors* and the stress placed upon them by a growing population. Socio-cultural factors were correspondingly neglected. Whilst not following an ecosystem approach I want to demonstrate the inter-dependent nature of the many facets of the Nembi socio-economy. At the same time I consider that the most significant factor contributing to the pressures upon the Nembi is that a once autarkic system (inasmuch as individual clans are the important structures of social organisation), is being subjugated to a more powerful and initially alien force (see Rowley 1965). The psychological damage inflicted by such a process has not often been considered (see Haswell 1975:207 who makes this observation in The Gambia (West Africa) but also see Berndt 1953, Worsley 1957, Lawrence 1964 and Allen 1976 for examples of studies of reactions by Papua New Guineans to European contact).

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* Lea (1973:71-72) writing of the Wosera people of the East Sepik Province called internal ecologic stresses '...those objects in a system which affect diet, garden habitat, land availability, labour and yields..'. He also said they were the easiest to recognise and measure.

Whilst concentrating upon the internal ecologic stresses, the preliminary reports (Allen et al 1978, 1980) also glossed over some aspects of the physical environment. It seemed to me at the time of first visiting the Nembi Plateau and after preliminary reading upon the rest of the highlands of Papua New Guinea that seasonality is an important aspect of the socio-economy that had received scant attention (Chambers et al 1981). In view of the well known occurrences of periodic food shortages at particular times of the year throughout the highlands (see for example Shannon's description of seasonal food shortages in the district around Goroka in the Eastern Highlands: 1970), and because it appeared that the Nembi Plateau experienced the same phenomenen (Allen et al 1978), it seemed appropriate that my research should explore some of the seasonal aspects of the Nembi way of life. Shannon's report assumed that climatic factors were contributing to seasonal food shortages around Goroka, but Allen el al (1978, 1980) reported for the Nembi that seasonal food shortages were unlikely to have an environmental cause. The CSIRO report (1965) on a land-use and land capability survey in the Waga-Tari region including the Nembi Plateau, also stated that seasonal fluctuation in all the climatic elements were negligible. However, whatever the root cause, I was interested to see whether within the periodic and cyclical nature of the agricultural systems of the highlands, revolving around the accumulation and slaughtering of pigs (see Brookfield 1973, for example), there was any rhyme or reason to the apparent seasonal cycle of food supply. Within the broad framework of culture contact I was interested to see whether aspects of seasonality permeated the socio-cultural activities of the people.

The effect of these two phenomena, culture-contact and seasonality, upon the nutritional status of children is the major concern of this thesis.

Present attitudes of planners to the Nembi have historical precedent and they must therefore be placed in their historical context. Many aspects of Papua New Guinea's economic policies mirror those of other developing countries. Present interest in the relationship between population, malnutrition and food supply in subsistence and peasant agricultural systems in Papua New Guinea stems directly from such a broader world-wide interest. In the same way that the Nembi cannot be understood without considering the trauma of culture-contact which they have experienced, so is it necessary to also understand as far as possible the policies which shaped the form of that contact and subsequent interaction. The Nembi now find themselves in a situation not of their own making, and facing a future that will become increasingly beyond their control as they are drawn into the wider and more powerful national (and international) economy. The Nembi's place in that economy is as much the responsibility of people in the stronger engulfing economy as it is the Nembi's.

Nutrition and Economic Development

Recent estimates suggest that in less developed countries, two thirds of pre-school children suffer from malnutrition. A further 1 to 7 percent of children under five years of age are so severely malnourished as to display symptoms of the classical syndromes of kwashiorkor and marasmus (Schofield 1979:11). These two conditions have focussed attention upon the inadequacy of the diet of most of the people in the world. Yet it is only recently that malnutrition has been recognised as a continuing condition of much wider proportions and with far deeper implications than suggested by the incidence of famine. More than a simple problem of shortfalls in food supply that at times reach such levels as to evoke terms like starvation and mass hunger, malnutrition is now appreciated as the 'silent' condition of the world's poor (Joy 1973, Reutlinger 1977).

Poverty, as displayed by poor housing, poor sanitation, unclean water supplies, inadequate (and inappropriate) education and lack of cash earning opportunities, is a condition into which most of the rural population of Papua New Guinea are locked. Under these conditions the incidence of infectious disease related to poor environmental sanitation is high and infection and malnutrition combine synergistically to produce high death rates among children (Schrimshaw et al 1968, Scrimshaw 1979:vii, Gordon 1976), and adults are prevented from achieving their productive potential. Thus people live in a 'vicious circle of poverty' (Bauer 1965, Myrdal* 1968:184). The clinically defined 'syndromes of kwashiorkor and marasmus, together with the mixed forms, are only the visible, above the waterline, part of the iceberg of malnutrition in the young' (Brock 1966). This iceberg is both a consequence of economic conditions in less developed countries and a contributory factor (Schofield 1979:11).

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* Footnote No.3 of page 1844 and 1845 gives the background to the introduction and use of this phrase in the literature. Myrdal 1968 Vol.III:1844-1845).

Haswell sums up the manner in which concern with malnutrition has merged with that for poverty. 'The nature of poverty' she writes 'defies such neat definition as being that point at which there occurs an imbalance between man and land as soon as men can no longer rely upon the natural fertility of the land for their survival' (1975:211). The root causes and interaction of poverty and malnutrition are far more complex than solely inadequacies of food supply. Nevertheless past development theory assumed that shortfalls in food supply lay at the heart of the problem of promoting economic growth and development. This assumption still lingers on. Indeed it remains axiomatic to expect increasing food supplies to prompt social and economic changes and to lead not only to better health but also to later marriage, lower fertility, lower birth rates and thus slower rates of population increase. Surpluses from the agricultural sector invested in other sectors are expected to prompt the development of a balanced and prospering economy. The results of such development policies, however, have been far from balanced.

Thornton (1979 pers.comm.) has suggested that in many cases what would have been relatively self-sufficient societies have been brought to the stage where new pressures have compounded the old. In this he echoes the trenchant statements of the underdevelopment theorists. The poverty of the less developed countries and the impoverishment of their rural areas are a result of an active process of their being underdeveloped by the western developed economies (see for example Frank 1966, 1969, Szentes 1971, and Amarshi, Good and Mortimer 1979). Unlike Papua New Guinea, in Africa the process of underdevelopment began very early, with the depradations of Portuguese and English traders in the 16th and 17th centures. In Papua New Guinea the process of underdevelopment began in the late 19th century on the coastal areas of the mainland and the islands but only after the Second World War in the highlands. Since then the pace of change has been dramatic. A combination of stresses (new values, production for cash, recruitment of labour) combined to weaken and destroy the essence of pre-contact societies and began to render them dependent upon the western economic system. Subsistence populations were encouraged to turn to cash cropping and the pursuit of other cash earning opportunities. The expectation of large returns for small efforts compared with expanding production at the labour intensive margin of the subsistence economy was beguiling. It has turned out to be an illusion.

Total net wealth and stability of pre-contact subsistence economies has very often declined (see Curtain 1980 for example for the effect of outmigration of adult men looking for work upon the economies of the villages of the Sepik). The result has been, more often than not, a change in socio-economic circumstances so rapid as to amount to rupture (I thank D.S. Thornton for this phrase; pers. comm:1979).

Fifteen years ago, after a colonial history going back as far as the 1880s for some parts of coastal Papua New Guinea, Brookfield wrote: '... what we see at present in New Guinea is a society in the early stages of a rather painful readjustment to the conditions of its natural environment, in response to new wants, new means of achieving them, and the acquisition of a new range of skills' (Brookfield

1966:77). Nevertheless, it has proved impossible, even if it were deemed desirable in some cases, to influence the rate of that readjustment and to make it less traumatic. The pace of change in all the variables, for example population growth, education, institutional change, aspirations and rewards as well as productivity, has either not been at a sufficient pace, or more importantly, with sufficient balance, to maintain a smooth development path.

Failure to promote a satisfactory development path has been the result of policies more concerned with growth indicators at the national scale than with the welfare of the rural people (see Lipton 1977, Chenery et al 1974, George 1979). It was assumed that investment in particular sectors of an economy would, through the multiplier effect and linkages, 'trickle-down' and permeate all sectors of the economy and raise the standard of living of all (Rao 1958). Gross National Product (GNP) and per capita income are still the most common measures of economic growth and their continued use is because they are still capable of showing further advance. Welfare improvements were supposed to be a natural concomitant of economic growth and many rural areas consequently suffered from benign neglect.

Within the schema of national economic development, the agricultural and the industrial sector, at different times, were assigned the role of leading sector in which capital injections were meant to act as catalysts. Lipton summarises the arguments against industry as a leading sector. He highlights the syndrome of urban bias as a feature of developing economies (1977) and the failure of the benefits of 'growth' to reach rural areas. Investment directly in the rural areas has also had little beneficial effect, either in prompting a balanced development or in improving rural welfare. To some extent lack of understanding of the nature of rural socio-economies has been to blame. Controversy, centred upon interpreting the structure and function of pre-contact and indeed post-contact agro-economies, polarised into two schools of thought. As a consequence two forms of rural development policy evolved. On the one hand were the transformation theorists and on the other the improvement theorists (see Thornton 1973 and Hyami and Ruttan 1971 for reviews).

Africa and India have been the proving ground for most development theory with Papua New Guinea and the rest of the Pacific region lagging behind (see Evans 1977), compounding the difficulty of understanding the multi-faceted nature of Papua New Guinea society. Transformation theory considered pre-colonial rural socio-economies as backward and stagnant (Schultz 1953, 1964, 1968, Lewis 1955) with little to contribute to their own modernization except surplus labour. It was assumed that increased productivity could take place only after the introduction of expensive new technology, cash crops, husbandry, machinery and land reform. In essence, capital inputs would transform a passive and inefficient system into one that was highly productive and capable of supporting a modern economy.

Hill's plea in 1966 for a reappraisal of the nature of West African rural socio-economies emphasised that they were not stagnant. She argued that simple technology did not necessarily imply simple socio-economic organization or inefficiency. Improvement theory thus proposed that for development objectives to be attained they must be compatible with the structure and location of the socio-economies to be developed. The fundamental assumption of transformation theory, that rural socio-economies were 'tradition-bound', and could contribute nothing to their own improvement was questioned. The work of economists (Lipton 1968a, Ortiz 1967, Verhaegen 1967, Clayton 1968 for example) demonstrated that 'traditional' rural economies could contribute positively to their future growth and development. It was still argued however that forcing complex social structures and economies into the western development mould had been harmful, both creating new problems as well as exacerbating the old (Chenery et al 1974, Clay 1978, Dasgupta 1978, Lipton 1968b, 1977, 1978). Existing inequalities had become more pronounced and rural-urban migration, unequal distribution of income and increases in the number of landless families and lack of opportunities for cash earning had become imponderables.

Out of the theories of improvement evolved strategies that began to address the imponderables and to move away from growth via industry or agriculture as the principal criterion. Undue emphasis upon macro-economic indicators showed that the ultimate purpose of development policies had been lost sight of: to eradicate physical poverty and to provide all human beings with the opportunities to develop their full potential (Streeten and Burki 1978:412, Streeten 1980, Burki and Haq 1981). The issue of 'basic needs' firmly replaced at the centre of development theory the objective of providing for man and his needs through the eradication of poverty. Raising productivity was seen as necessary but not sufficient on its own to meet the objective. Thus the aim was now to provide for the needs of the impoverished without necessarily first raising their productivity: to redistribute the benefits of growth accruing from other sectors and areas via the provision of basic goods and services as an end in itself rather than as an unplanned spin-off from increases in GNP.

An ugly fact of life is that the manner in which basic needs are defined is largely determined by what a country can afford, tempered by the expediencies of politics. Streeten and Burki (1978:413) have identified a core of basic needs: food (calories and proteins), clothing, safe drinking water and shelter. In addition they have suggested a hierarchy in which basic needs are met. Minimum basic needs are those that must be met for bare survival. Protection from fatal diseases and provision of adequate housing provide the conditions for continued survival with a minimum of food and water, whilst protection from debilitating diseases, provision of more food and a modicum of education ensures continued productive survival. Sustenance and good health are central to the basic needs approach, but whilst laudable objectives they carry within them dangers of over-simplification. The debate about transformation versus improvement is not resolved and the intricate nature of rural socio-economies and the way in which they interact with the modern western economy remains largely unknown. Indeed lack of understanding of the processes taking place as the rural socio-economies were inevitably drawn into the monetized economy meant that intervention programmes, designed to raise rural productivity or maintain and improve rural equality, have had limited success (see Lipton 1977 for a general overview and Howlett et al 1976 for the Chimbu Province of Papua New

Guinea). A broad conclusion would be that many development plans despite attempts to the contrary have had results which have been largely uncontrolled, unplanned for and misunderstood.

The Process of Development in Papua New Guinea

It is against this changing background of opinion that economic planning policies in Papua New Guinea have been shaped. In the last five or six years real attempts have been made to incorporate a basic needs strategy (see for example Lynch and Simpson NPO 1978, Simpson 1978b, Jackson 1981) into the Post-Independence National Development Strategy (Central Planning Office 1976, National Public Expenditure Plan 1981-84). Health and nutrition of the rural people, especially of those who remain essentially in the subsistence sector of the economy, have become important issues. National Nutrition Surveys were conducted in 1975 and 1978 and prompted initiation of research programmes into the relationship between population, agricultural systems, food supply and nutritional status and health (Southern Highlands Rural Development Project IBRD 1978, Enga Rural Development Project, Simbu Land Use Project, CSIRO Agricultural Resource Potential of Papua New Guinea 1980). The legacies of past theory and policy nevertheless remain and provide a back-cloth for the present. Although emphasis has been given to investigating the health and nutrition of the rural population, studies are in danger of remaining couched in the essentially Malthusian model that has dominated agricultural development policies since the Second World War.

Transformation policies have had their day in Papua New Guinea's development plans. Great variation exists between remote corners of the Southern Highlands belonging to the Nembi, Hewa, Kaluli, Etoro, Foi and Fasu and the landscape of the Eastern Highlands where the creation of a peasantry is well advanced (under the belief that a modern industrial society will emerge from the ruins of a peasant society, Wolf 1966:vii). The Southern Highlands has had prolonged contact with the western economy only comparatively recently. The painful process of readjustment is just beginning. In other areas change has occurred rapidly since the early 1950s. Indeed the pace with which 'traditional' systems responded to the monetized economy and the alacrity with which rural dwellers expressed their desire for 'goods' of the Europeans has been misleading (see Berndt 1954 for the Kainantu people, and Nilles 1954 for response of Eastern Highlands and Chimbu). The desire for cash and pre-occupation with accumulation and exchange of wealth by rural Papua New Guineans prompted the erroneous belief that rural society was little less ordered by the same economic laws as western market economies (Lingenfelter 1977 gives an overview for Oceania, but see R.S. Finney 1971, B.R. Finney 1973, Moulik 1973, Shand and Straatmans 1974, and discussions by Brookfield 1968, 1973, and Howlett 1973, 1980). The rate of increase in small-holder coffee blocks during the early 1950s in the Eastern Highlands and late 1950s in the Western Highlands is a case in point.

Somewhat paradoxically the same conditions suggested that the agricultural economies of rural Papua New Guinea were 'primitive'; they were poorer reflections of modern capital intensive systems. As such, rural economies were unchanging and needed capital injections to get them moving. As passive recipients however, they possessed no qualities to positively contribute to the process of development which was viewed as a one-sided action rather than an interaction. Investment was planned to transform 'traditional'agriculture to a modern profitable mix of subsistence and cash cropping i.e. peasant farming. Such a condition of 'primitiveness', thought to characterize the Papua New Guinean rural economy, had other connotations which justified policies of transformation. Not only were they regarded as simple but also as 'arcadian' in which the traditional agriculturalist had limited wants amidst plenty, or what Fisk called 'primitive affluence' (1962, 1964, but see also 1972:37). In such arcady people were underemployed, or were deemed to be so in comparison to those shackled to the working week of the market economy. Tapping the surplus labour of the rural economies was then a legitimate method of promoting more efficient rural productivity. To this end agricultural development policy was centred upon expatriate plantation production. Encouragement of small-holder production was the natural concomitant and did not imply a greater or growing appreciation of the necessity to understand more fully the nature of 'traditional' society, and the way in which it was changing (de Souza and Porter 1974:14). A bouyant world market for coffee and continued increases in 'small-holder' production lent credence to the supposition that all was progressing well in the rural areas of Papua New Guinea. This optimism was bolstered by favourable trends in GNP and <u>per capita</u> income (see Colebatch 1979).

The failure of such innovations as the introduction of a major cash crop like coffee to effectively transform the socio-economies of parts of highland Papua New Guinea has been analysed by Brookfield (1968, 1973). A slightly different but not necessarily conflicting interpretation has been given by Howlett for the Eastern Highlands (1973, 1980) and for the Chimbu Province (1976).

Brookfield drew upon fifteen years experience in the Chimbu Province to demonstrate that the well integrated internal system of Chimbu society had considerable powers of absorbing innovation. Indeed Finney also pointed out that in the Eastern Highlands whilst groups were eager to embrace new types of economic activity they remained in many respects thoroughly traditional (1973:x). Finney's major point was that Gorokan society, and by implication the rest of the highlands, '...was pre-adapted for economic change...' and '...traditional values and institutions were positive assets rather than liabilities in the adoption of cash cropping and commerce' (1973:x-xi). But whereas Finney made a favourable prognosis for the future of Gorokan society, Brookfield's analysis was pessimistic and Howlett's decidedly so.

Brookfield argued that the introduction of coffee to the Chimbu, whilst not effecting any structural transformation seriously weakened the foundations of the Chimbu socio-economy. Changing patterns of land-use, consumption and perception of the total environment had the effect of partially integrating the Chimbu economy into the national Papua New Guinea economy in the role of deprived periphery (Brookfield 1973:127). Clarke made a similar diagnosis for the Maring, and concluded that 'people living in what have come to be remote peripheries find themselves in an ambiguous relationship _vis-a-vis_ the more developed centres; they are both tied to them and separated from them' (1980:189).

The rural Papua New Guinean thus appears to fall between two stools. Contact with the modern market economy has presented him with a choice between two forms of socio-political economy. Where the choice has been made to adopt the new ways of life the stress of the transition, according to Howlett, has been compounded rather than eased. Unsurmountable constraints have served to shackle the ambitions of most of the rural people. For the Chimbu it was shown that there were (and still are) limited opportunities for the overwhelming majority (Howlett _et al_ 1976). As a consequence stratification of the rural society is taking place and a rural elite is emerging which has an effective monopoly on scarce resources and more importantly of scarce opportunities (Howlett _et al_ 1976, Standish 1981). Potential for further improvement is thus severely curtailed and Howlett suggests that the peasantry created in the highlands of Papua New Guinea is a terminal stage rather than the pre-conditions for involving people more deeply in the development process (1973, 1980).

The acquisitiveness of the highlander has therefore been more the cause of his downfall than of his salvation, for it has been misinterpreted as a worldly wisdom. The crux of the problem is therefore, as viewed by Howlett _et al_ (1976) a lack of 'niches of opportunity'. Rowley termed those niches the 'interstices of cultural frontiers' (1965:190), a concept which emphasises the meshing of two different ways of life and cultural values. According to Brookfield the dissillusionment of the Chimbu caused them to return to traditional values with renewed vigour. A similar process of 'involution' was described by Geertz (1963) for parts of rural Indonesia. Alternatively Howlett argued that because the demand for cash has been 'traditionalised', the need for it has become inescapable (Howlett 1980:194). The disadvantaged majority can thus neither go back or go forward and remain in limbo as a rural poor (see also Rowley 1965:90-127).

It could have been expected that as change had started later in the Southern Highlands and at a slower pace, lessons would have been learnt from the experiences of the other highland provinces. Although the National Government échoed the sentiments of Howlett (1973, et al 1976) and expressed the fear that national planning policy was perhaps 'creating a system of peasants who will remain permanently at the bottom of the economic ladder' (Chan 1978:6), the essential elements of development planning have not changed. The creation of a peasantry has become some form of tertium quid, the first step to involving people in the development process (Chodak 1973:296). Sinha (1978:242-244), commenting upon Lipton's analysis of urban bias in development policies throws some light on the way in which that process is viewed. He states that the developed countries, '...in their development process,... simply annihilated the rural areas by urbanising them and their values of life'. Policy in Papua New Guinea appears to assume that such a process of annihilation was tranquil and can be repeated.

Population, food and malnutrition

Four main elements have dominated policies for the rural areas of Papua New Guinea from 1950 to the present, within the broad framework of encouraging the growth of a modern agriculturally based economy. Firstly, concern for the pace of population growth and the relatively rapid increase in urban dwellers has been a constant reminder of the pressures upon an inadequate supply of services. Consequently villagers have been encouraged to grow cash crops, cocoa, coffee and copra to counterbalance the attraction of the growing urban centres. Thus problems of food supply, especially the cost of food imports to feed the growing urban centres has been high on the list of priorities. To a much lesser degree the poor nutritional status of the rural dweller as demonstrated by the New Guinea Nutrition Survey Expendition (1947), were also matters for concern.

These concerns were, and still are a part of the conflict between equity and efficiency (Brookfield 1972a:99). The conflict was as strong in the 1950s as it is in present policies (Downs 1980:273-329). Hasluck (Minister for Territories in the 1950s) proposed that it would not be wise '...to concentrate on economic advancement to the neglect of social advancement or to create imbalance between economic change and social change [and] all economic advancement should be of such a kind that the participation of the indigenous people [is] not excluded' (1976:290). In contrast, the International Bank for Reconstruction and Development (IBRD), when it published the results of its 1962 Mission to Papua New Guinea (then called the Territory of Papua and New Guinea), made it quite clear it supported economic efficiency; 'To obtain the maximum benefit from the development effort, expenditure and manpower should be concentrated in areas and on activities where the prospective return is highest' (IBRD 1965:35). Earlier avoidance of rapid economic growth because precipitate action could endanger social stability (Downs 1980:276) was therefore in direct opposition to the sense of urgency accompanying the proposal that economic development should take place, to ensure self-sufficiency before self-government (see Brookfield with Hart, 1971:243-286).

After independence, further IBRD Missions visited Papua New Guinea in July 1976 and October 1977. Their reports were published in 1978 (1978b). It was noted that Papua New Guinea had an unusually clear set of development policies as outlined in the Eight Point Plan of 1972, "policies...remarkable for their attempt to reconcile objectives of growth and quality of life" (IBRD 1978b:xii). The most important aims of the Eight Point Plan were; 'More equal distribution of economic benefits, including movement toward equalisation of services among different areas of the country; decentralisation of economic activity, planning and government spending, with emphasis on agricultural development, village industry, internal trade, and the channelling of more spending through local and area bodies; self reliance, an economy less dependent for its needs on imported goods and services and better able to meet the needs of its people through local production' (Central Planning Office 1974). On the face of it, it appeared that an independent Papua New Guinea had opted for equality, as had been urged by Hasluck in the 1950s (1976:128-155) and indeed by Murray before the Second World War in Papua (West 1968:122-174).

Independence in 1975 ensured that the needs of the indigenous people were not to be neglected by a distant colonial government. The development of Bougainville copper and of plantation crops, especially coffee, contributed substantially to the viability of the Papua New Guinea economy by the time of independence. The establishment of Provincial Governments by the Organic Law of 1977 served to give regions some sort of political autonomy in deciding their own development priorities and strategies. Nevertheless the pattern of regional growth and spatial inequalities that developed under the Australian Administration persisted. Although the uneven spread in cash income and the distribution of government services between different parts of the countries was in part due to variations in physical accessibility, agricultural potential and exploitation of natural resources such as copper and forestry, investment in the more attractive areas, contributed to the process of what Myrdal called "cumulative and circular causation" (1957, 1968:1843-1847, 1857, and 1870-71). Those areas of Papua New Guinea which by virtue of favourable location or mix of resources were the first to attract investment, accelerated in terms of their social and economic development (see Hinchliffe 1980:824 for a fuller discussion). Less fortunate areas were left further behind and in the case of the Southern Highlands, development may have been further retarded as result of a formal migration scheme, supervised by government (see Harris 1972, 1978).

Before independence two studies had been commissioned to report on those partsof the country which were believed to be economically disadvantaged (The Economist Intelligence Unit 1972, Faber et al 1973). The Eight Aims of The Strategies for Nationhood

(1974) sprang directly from the latter report (Hinchliffe 1980:826). Decentralisation of some measure of political power to the provinces has only served to highlight the inequalities between them (Hinchliffe 1980:820).

The Organic Law (1977) provided for each province to receive an amount of money equal to the cost of maintaining government services at the level which existed in the 1976/77 fiscal year (Simpson 1980:1). To all intents and purposes the result has been to perpetuate the status quo. In the North Solomons Province total transferred revenue from Central Government to the Province in 1978 was equal to K105.6 per capita. The Southern Highlands received only K34.7 per capita (Simpson 1980, Table 1). There is thus a rather hollow ring to the objective of a more equitable distribution of national income with special attention being paid to the needs of the less developed areas. Colebatch (1979) has pointed out that other measures designed to alleviate regional, especially rural inequalities have also had limited success. He calculated that the Rural Improvement Programme (that had its origins in the Rural Development Programme of the 1967/68 budget as an item in the Works Programme), accounted for only 1.4 percent of total Government spending in 1977 (1979:1). When held against the stated aims of national policy in the Eight Aims the proportion spent on rural projects seems very small indeed.

Clarke in reviewing the effect of rural development policies and socio-economic change amongst the Bomagai-Angoiang sums up the present dilemma in government policy (1980:173-192). He believes it is ironic that the pressure toward marginalisation (Brookfield's deprived periphery) exists within a framework of a national development strategy which strongly favours rural development, the reduction of inequality and the maintenance and improvement of subsistence agriculture (1980:189). The irony may well be misplaced. The common denominator of pre-and post-independence policies is to be found in those directed to the agricultural sector of the economy, as distinct from those directed to the rural sector of the population. There is still a persistent neglect of the proposal made to Hasluck by the Spate, Swan and Belshaw report that 'a prosperous New Guinea economy can be built on the foundations of native society...particularly in the direction of promoting native agriculture' (cited in Hasluck 1976:141). Even though concern with the rural areas and the agricultural sector are now couched in terms of rural welfare and seen as a direct reaction to colonial policies of rural neglect (Faber et al 1973, The Economist Intelligence Unit 1972, Simpson 1978, Shaw 1980), reaction to macro-economic growth indicators and neglect of rural welfare has not been accompanied by greater understanding of the rural economy of Papua New Guinea. Spending, to reverse the present pattern of national growth, would have to be of mammoth proportions (Hinchliffe 1980:824) to encourage in the disadvantaged areas self-supporting productive activities able to produce a surplus over subsistence production. Indeed present concern for the interaction between cash-cropping, subsistence farming, population growth, food supplies and levels of malnutrition, despite the rhetoric to the contrary remains dominated by policies of efficiency rather than equity.

The apparent failure of the pre-colonial and the monetized economy to mesh into a harmonious whole has therefore attracted analysis other than that of Brookfield and Howlett. While they accepted that pre-colonial society had and was changing, and that the solutions lay in looking forward and analysing the interface between two forms of socio-economy, others have not only looked solely to the subsistence sector but also backward to the past. The misconception that traditional agriculture was arcadian and unchanging persists. Lambert (1975, 1976, 1978, 1979a, 1979b, 1980 and n.d.) maintained that malnutrition amongst rural children under five in Chimbu province is a direct result of decreases in subsistence production in the face of competition from coffee production. Stress within rural socio-economies, he contended, is demonstrated by the degree of malnutrition. He thus advocated maintenance of the subsistence system to ensure nutritional adequacy of people's diets.

Argument over whether cash cropping alone is indeed adversely affecting rural diets (see Hide 1980) nevertheless still neglects the fundamental problem of how to enable subsistence systems, that are irrevocably changing, to change for the better. Traditional systems have changed according to people's perception of their needs and environment, and new aspirations and wants have been introduced. Lambert (1975 et seq) implied that a return to 'pure' subsistence economies, to the arcady of 'primitive affluence', was not only desirable but also possible. Lambert wrote that 'agriculture in Papua New Guinea is the mainstay of existence for the great majority of the population who live in the rural areas. Prior to the advent of colonialism, this agriculture consisted almost exclusively, of subsistence food production...and Papua New Guinea was almost self-sufficient in food' (1979a:1). Apart from his belief in an idyllic existence in pre-colonial Papua New Guinea, Lambert neglected to account for the complexity of highland and lowland social structures and organisation that depended upon production of a surplus for their existence.

Misinterpretation of the response of pre-colonial socio-economies to the monetized economy has therefore masked the effects of culture-contact. Lack of tolerance by the monetized economy has introduced new elements of stress, but provided limited opportunities for readjustment. Areas such as the Eastern Highlands Province, with longer histories of contact with the monetized economy in Papua New Guinea, have adjusted to some degree. They have not, however, progressed as predicted and evolved into modern agricultural socio-economies but remain, in the same way that Marcus describes for Tonga, as "compromise cultures" (1980, 1981).

Interest in a 'basic needs approach' in Papua New Guinea rural development policy has also unfortunately tended to follow a similar approach. Even where problems of malnutrition and poverty are seen as due to lack of cash earning opportunities (eg. Bourke and Allen 1979) the difficult subject of the interface between cash and subsistence is glossed over. The two systems, despite the work of Brookfield (1973), Howlett (1973, 1976, 1980) and Clarke (1973, 1980) amongst others, have been viewed as existing alongside each other and in a state of conflict to the disadvantage of the subsistence sector. Undoubtedly some of the stresses imposed by the monetized economy have provided stimuli to change and adaptation, but others have been harmful, leading to poverty, social distress, ill-health and even death (Lea 1973:56). Solutions will not lie in the resurrection of a mythical arcadian subsistence system, or a return to the pre-contact status quo.

For the Nembi the problem is becoming acute. For the Nembi the rate of change in other more advantaged areas has been too fast for them to keep pace and it seems that even the consolation of the partial satisfaction of a compromise culture may pass them by.

The Framework of Analysis

My approach has a distinctly historical flavour. I present no apology for this. Inasmuch as I am concerned with the processes associated with the present condition of the Nembi it is necessary to delve into the past and to discover their antecedents. At the same time the present will not continue unchanged into the future. A fuller understanding of past man-land relationships on the Nembi Plateau, will foster an increased sensitivity to the present Nembi way of life. My analytical approach to the problems of the Nembi Plateau has been influenced not only by the preliminary investigations of Allen et al (1978, 1980), but also by my previous experience in The Gambia (West Africa). The report of Allen et al prompted my interest in the Nembi Plateau as a place to focus my research. Their recommendations for further investigation into the Nembi socio-economy provided the broad framework for my surveys as well as points of contention which needed clarification. As an example of a rapid rural appraisal (Chambers et al 1979) the report of Allen et al demonstrates the advantages to be gained from an initial survey carried out by a team of 'experts' to identify fruitful avenues of further investigation. By making such recommendations the report did not attempt to make prescriptions and thus emphasises, albeit by default, that such rapid rural appraisal cannot provide answers. It has often been the case that such short term intensive investigations have been interpreted as providing solutions to the problems of many areas (see Chambers et al 1979).

In The Gambia, research by the Medical Research Council of the United Kingdom, the Dunn Nutrition Unit of the University of Cambridge, and the Land Resources Division of the Overseas Development Ministry of the United Kingdom (Dunsmore et al 1976), as well as by individual researchers (Haswell 1953, 1963, 1975, Gamble 1955, 1958 for example) enabled information to be collated on the socio-economic and ecological environment and the medical condition of the Mandinka people. The underlying theme throughout much of the work which drew all aspects of the Gambian social and physical milieux together was that of seasonality (see for example Rowland et al in Chambers et al

1981). At the time I was working in The Gambia (1976-78) a method was being sought for monitoring the impact of an Integrated Rural Development Programme (IBRD 1976), other than formal economic and social cost-benefit analysis. The large amount of data available was used to monitor the impact of the project upon the target group (farmers who were growing groundnuts as a cash crop). The nutritional status of vulnerable groups (children under five, pregnant and lactating women) was studied to assess the impact on them of increased productivity, rather than examining only increased output in economic terms of higher exports and overseas income.

The situation on the Nembi Plateau seemed an ideal opportunity to test propositions developed in The Gambia, and to examine whether in an environment which unlike The Gambia was not overtly seasonal, any periodic, cyclical or seasonal patterns could be discerned within which to place the most obvious of the symptoms of the Nembi's problems - child malnutrition. In addition, I was anxious to see whether the monitoring of child malnutrition could be used as an estimate of the impact of the Southern Highlands Rural Development Project on the rural people.

In 1980 the National Planning Office commissioned Dudley Jackson, Professor of Business Economics in Aston University to investigate the distribution of incomes in Papua New Guinea. His report was published in February 1981. Jackson had also worked in The Gambia during 1976-78 and attempted in his study of incomes in Papua New Guinea to demonstrate the relationship between nutritional status and productivity or incomes. He concluded that for Papua New Guinea low productivity and thus low incomes could be equated with poor nutritional status of children. The data he used were those collected by Allen et al (1978, 1980) in their preliminary survey of the Nembi Plateau. By statistical modelling Jackson manipulated the data so collected to show that those families with low productivity also had children of poor nutritional status. Closer examination of the data however, shows the misleading nature of Jackson's analysis and conclusions. Initial misgivings, both mine and Bryant Allen's, prompted me to re-examine the data collected by Allen et al and to compare them with mine.

My misgivings were primarily that the precise relationship between incomes, productivity and nutritional status had not been demonstrated; that malnutrition was a symptom, within the community, of a complex interaction between socio-cultural, economic and environmental factors, which in Papua New Guinea was poorly understood; that future distribution of funds to provinces may possibly be made on assumptions which were not proven and which would lead to funds not being tied to specific areas of intervention already known to reduce malnutrition.

It thus seems to me that the Nembi Plateau is an ideal place in which to try to integrate within one study elements of both the social and physical milieux in an attempt to probe further the possible causes of malnutrition and to prise out some tangible relationships. As an in-depth localised study I see it as a possible supplement to broader surveys being carried out elsewhere in the highlands. The real problem lies in the multiplicity of factors impinging upon the nutritional status of children and as such the problem is great for one researcher to carry out. I have been able only to produce an analysis of a small community of people. Paradoxically it is an intensive study only by virtue of the range of factors which I have included as pertinent to understanding the nutritional status of children on the Nembi Plateau. To study each facet in more detail and on its own would have required the expertise of agronomists, nutritionists, soil scientists and anthropologists.

History and Sorcery

In taking an historical view of the man-land relationships on the Nembi Plateau I am aware of the difference between my perspective and that of the people with whom Janis Baines and I lived for 15 months from October 1979 to January 1981, the Pubi clan of the central Nembi Plateau. I have attempted to include elements of the pre-contact history of the Pubi, and of their own perceptions, to identify the origins of the fragile elements in Pubi man-land relationships which contact with a monetized economy have made more critical.

The Pubi have rationalised the upheavals they have experienced by associating them with sorcery. Their fear of sorcery gives an insight into the way in which the Pubi perceive their environment and their present condition. Although grossly fore-shortened, it illuminates the Pubi's conception of their origins and history.. Sorcery forms a backdrop to man-land relationships on the Nembi Plateau: malaria is not recognised as a disease by the Pubi but seen as a sickness resulting from the action of a particularly virulent form of sorcery practised by the people of the valleys and lowlands to the south of the plateau. The occurrence of malaria has thus been incorporated into the very fabric of Nembi society, permeating group relationships, kinship, descent and exchange, and as sorcery, it is the root cause of much inter-clan hostility. Their beliefs reflect the view that the Pubi are close to the spirit world. As well as the valleys and lowlands to the south the Nembi also fear pot-holes, sinks, rises and caves features which abound in the limestone of the Nembi Plateau as the dwellings of malevolent spirits,

Central to their fear is the belief that the root cause of sorcery is the latent antagonism between big-men and their followers: antagonism which more often than not parallels inter-clan enmities and alliances (see LeRoy 1979 for a description of this in the Erave valley to the south of the Nembi Plateau). In structure the Nembi social milieu is typical of highland societies (Read 1954, Watson 1964, Brown 1978a 1978b), in that they are characteristically fragmented. Members of cultural linguistic groups in the highlands do notpossess a common concept of common identity. Each group is comprised of many communities characterised by varying degrees of internal solidarity and external antagonism to each other (Read 1954:32). Ceremonial exchange and the rules of exogamy ensure some measure of inter-clan harmony.

Men strive to achieve renown through the accumulation of wealth and wives as manifest by their prowess within the exchange network. Sorcery and invoking the help of ancestral spirits have always been legitimate methods to aid success. Indeed preoccupation with the well being of the spirits of the dead, concern with present group unity, the exchange of women and the protection of children make ritual and propitiation an important part of Nembi life.

Like all highlanders (see Brown and Buchbinder 1976) the Pubi have a strong fear of the polluting influence of women (see Sillitoe 1979 for the fear of men for women in the Wola). A man's fear of his wife is tempered by distrust in that a woman when married remains a member of her natal clan. The Pubi believe that in the valleys to the south women have obtained semen from their husbands and given it to their brothers so that powerful sorcery can be used to kill their husbands. By removing men from the exchange network their wives will be released for marriage to other aspiring big-men, men who may indeed possess the means to practise powerful sorcery. To the north of the Nembi Plateau the Mae-Enga state 'we marry the people we fight' (Meggitt 1964:218), thus expressing the paradox of tension between clans that are related and compete within the exchange network and where a man's wife and mother belong to clans that may be his enemies.

In the past the Pubi, like the Enga, preferred to retaliate to sorcery and '...to ensure revenge by cutting down the enemy with axes' (Lindenbaum 1979:73, Meggitt 1977:40-41). As a consequence warfare was extremely fierce on the Nembi Plateau and in the surrounding valleys and was commented upon by early Administration Patrols into the area.* The system of clan alliance which follows the

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* 'Sorcery often starts off a feud. A man will die suddenly of sickness. In such cases the corpse is invariably cut open and

configuration of the tributaries of the Erave river system highlights the valleys as zones of conflict and of sorcery. The alliances of the left banks of the Nembi, Lai (Kawalka or Ka) and Wage rivers are called 'Aeron' and of the right banks 'Karinj' (letter appended to Patrol Report No.1 Mendi 1953/54 dated 24.9.53 from A.A. Roberts to D.C. at Mendi: also Patrol Report No.6 Nipa 1959/60). No love is lost between the alliances of the left and right. Paradoxically while the Pubi express fear of the valleys because of sorcery, they also view them with some nostalgia as their place of origin. It would appear that their fear of the valleys is of recent origin and indeed this is suggested by other evidence. A sequence of events which have taken place in the last 150-200 years has been compressed in the minds of the Pubi and labelled along with sorcery to justify why the Pubi no longer live in the valleys.

In common with much of the highlands of Papua New Guinea, the lower valleys to the south of the Nembi Plateau are characterised by large expanses of sparsely inhabited Kunai (Imperata cylindrica) grasslands. The remains of extensive areas of old garden sites can

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examined for signs of death through magic. Having decided to their satisfaction that sorcery caused the death, the people fix the blame on some contiguous group - probably quite innocent of guilty intent - and a death is exacted to even up the score, which starts off a fine, full-blooded feud.
(Patrol Report No.8 1954/55 Mendi, Sinclair)
About a month ago, a man from Detlworu was struck down with axes by a Karinj man for alleged sorcery against an Umimi native, who had mysteriously died from unknown sources (Patrol Report No.5 1953/54 Mendi J.A. Frew)
See also Mendi Patrol Reports No.1, 4 1953/54, 10 1960/61;
Erave Patrol Reports No.3 1956/57, 4 1957/58;
Kagua Patrol Report No.7 1960/61;
Lake Kutubu Patrol Report No. 1 1953/54;
Nipa Patrol Report No.1 1961/62

still be seen in the lower Wage valleys and the Erave valley. They were commented upon by early patrols.* In 1965 the CSIRO reported that the Kunai grass communities in those valleys are the result of man's repeated interference with the dynamic sequences of vegetation regrowth after abandonment of garden plots, by recultivation or burning. According to Brookfield the lower valleys and grasslands of the Eastern Highlands owe their existence to a number of factors (1964). Soil exhaustion, warfare and in the last 200-300 years the opportunity to migrate which the adoption of sweet potato (Ipomea batatas) offered, contributed to the expansion of the oecumene upwards to the higher valleys. More recently malaria has encouraged the abandonment of the lower slopes and valleys. It is the more recent spread of malaria that is the key to the Pubi's fear of the valleys.

Patrol Officers established fairly early on that the grasslands to the south of the Nembi Plateau mighthave been abandoned due to the spread of malaria although tribal fighting was also blamed by the people themselves** for the more recent movements.

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* Discussing the Lower Wage valley, D.H. Butler stated that 'the drawback to resettlement is that without doubt the area is malarious' (Patrol Report No. 1 Nipa 1960/61). In the Erave valley where population was sparse and where land had been offered to the Administration to purchase, it was stated '...a minute proportion of this land is under cultivation or even inhabited. The reason for this under-population is due to malaria that has spread around the Erave river' (Patrol Report No. 7 Nipa 1965/66).

** 'Over the total patrol many local migrations were noted. Areas populated pre-war were now deserted. Tribal fighting was blamed by most informants for these dispersals' (Patrol Report No. 1 1952/53 Mendi).

The Kewa people to the south of the Nembi Plateau call malaria a sickness from Erave - Pole Yanya - (Pole is the word for Erave, Franklin 1978:7), suggesting that traditional trade routes to the south, followed by early administrative patrols were the means of entry of malaria to the higher valleys. The lower Nembi Valley and the Erave valley to the south of the Nembi Plateau are a crossroads of trade routes. The passage of administrative patrols encouraged increased trade, mobility and hence the spread of malaria. Consequently in the last 50 years or so the pace of depopulation in the valleys has increased, as people have moved to higher altitudes.

Pacification and anti-malarial spraying programmes in the 1960s and the 1970s encouraged movement back to the once vulnerable valleys (PR 1 Nipa 1967/68). However in the last ten years as malaria has increased so has the Nembi belief in sorcery increased. Removal of the previously legitimate form of retaliation to sorcery - warfare - supports their belief that sorcery has increased. Evidence shows that the lower Nembi Valley, once a region of meso-endemic malaria is now hyper-endemic (SHP Health Dept. Unpub Report 1980).

The social milieu of the Nembi is thus coloured by their fear of sorcery and the supernatural. Sickness and death are major aspects of people's lives. The dead and dying are not closeted within hospitals as in western societies. Uneasy settlers the Nembi may be, but their belief in sorcery is at least a reasonable response to a complex set of circumstances that to them has become more complex since the arrival of the European.

Thesis Structure

This Chapter provides the background for a deeper analysis. The broad international and national concern with malnutrition and rural development has been discussed. Chapter Two examines the nutritional status of the Nembi children and the height and weight of their parents. Variation of the nutritional status of children across the plateau is examined and the children of the Pubi, the clan with which Janis Baines and I lived for 15 months, are placed in the context of their peers throughout the plateau.

The preliminary study of Allen et al (1978, 1980) had focussed upon the Puit clan in the Uba basin of the Nembi Plateau but a land-use survey had also been carried out for the Pubi clan about 2km to the west. Using the preliminary survey and land-use map as my guidelines I studied the Pubi in greater detail and mapped their gardens in order to gain some understanding of their system of land tenure as well as their social structure and organisation. With the help of Janis Baines and Mary Hermiz the anthropometric status of the children on the Nembi Plateau was measured. Janis Baines also monitored the children of the Pubi clan, noting from month to month their nutritional status, any episodes of sickness they had, and with the help of their mothers noted what each child had eaten for three days of every month. The weight and health of the women of the Pubi were also recorded from month to month. The survey extended from February 1980 to March 1981 during which time I collected genealogies and other information on social structure and organisation, as well as mapping the territory of the Pubi and their neighbours. Air photographs from the CSIRO in Canberra (Adastra 1959, RAAF 1972), and from the preliminary survey of Allen et al were used to measure clan territories. A plane-table, a tape, compass and clinometer were used to measure and map individual gardens. The amount of land each woman cultivated was also noted as well as the amount of land to which each man had access.

ChaptersThree, Four and Five present the social and physical milieux of the Pubi as a background to a more detailed analysis of the interaction between factors impinging upon the nutritional status of children. Chapter Three discusses the social milieu of the Pubi, their origins, their relationships with their neighbours, their social organisation and their land tenure system. The recent migration history of the Pubi and their neighbours is related to the population density in various parts of the Plateau. The marriage relationships between clans is also examined. Chapter Four describes the physical milieu of the Pubi and introduces the theme of seasonality. Chapter Five relates trade to the economy of the Pubi. Living in a relatively hostile environment the Pubi in pre-contact times relied upon their position between the highlands and lowlands to supplement the limited wealth of their own environment. Penetration by Europeans disrupted traditional trade and exposed and eroded the Pubi's tenuous relationship with ecological zones at lower altitudes as well as with their own. The struggle for balance between man and land on the Nembi Plateau was put under such profound stress that it has not been able to recover.

In the rest of the thesis the relationship between man and land is examined more closely. Chapter Six sets the analytical framework and proposes the questions to be examined. Chapter Seven examines the question of population growth, the causes of death and the rate of births since 1960. The issues of population density, carrying capacity, agricultural intensification and nutrition are then analysed in Chapters Eight and Nine. Throughout, the underlying themes are social cycles and seasonality. These two themes draw together the disparate elements of the man-land relationship on the Nembi Plateau and relate them to the nutritional status of children. The Pubi clan is used as a case study from which particular examples are drawn. The Pubi represent at a micro-scale the wider Nembi situation, and the broad problems of the Nembi are typical of other more remote and poor areas of Papua New Guinea. This analysis shows that the causes of, and thus the solutions to the problems of particular areas are to be found only by intensive in-depth research. It is by such methods that a more complete understanding will be obtained of the socio-economies of the people of Papua New Guinea and their role in the socio-economic development of the country.

CHAPTER TWO

THE NUTRITIONAL STATUS OF THE NEMBI COMMUNITY

The weakest kind of fruit drops earliest to the ground

(The Merchant of Venice IV i 115-116)

The nutritional state of children is the outcome of their food intake, their environment and its prevailing economic and disease conditions and the quality of their maternal care (Oomen and Malcolm 1958:3). With such a spectrum of factors influencing the nutritional well-being of children, advances upon a narrow disciplinary front are necessary, but some form of consolidation may be possible.

This complex situation may be clarified by analysing the processes and causes of malnutrition. Jonsson (1981) recognises processes at three levels: basic causes, underlying causes and immediate causes. Immediately observable or measurable are the symptoms or signs. On the Nembi Plateau and in other parts of Papua New Guinea these are the nutritional deficiency indicators, weight-for-age and height-for-age measurements and other clinical assessments of nutritional status (Sinnett 1975, Venkatachalam 1962, Hipsley and Clement 1950. See also Harvey for a comprehensive survey of the literature on clinical assessment of malnutrition, 1979). The symptoms however do no more than indicate that a problem exists.

The immediate causes of poor nutritional status are due to a combination of an inadequate intake of nutrients and a high incidence of morbidity. The synergistic interaction between these two factors is important and well known (Gordon 1976). Malnutrition in all its forms is not just a simple matter of food availability. Many variables intervene between the production and availability of food, and affect the actual food intake of individuals. These variables are the underlying causes of malnutrition. Factors such as cultural attitudes - food taboos, infant and child feeding practices, food preparation techniques - are as important as the availability of potable water, methods of sanitation and the adequacy of housing in determining the health and nutritional status of individuals (Jonsson 1981, Malcolm 1979). Access to resources as determined by the socio-economic structure of society is invariably unequal between both individuals and families. On the Nembi Plateau access to favourable land in non-malarious areas suitable for mixed garden crops, coffee, and sweet potato, is at a premium and may well have a direct bearing upon nutritional status. Nevertheless while inequality of access to resources may be an underlying cause of malnutrition, the basic causes are the socio-economic structures of society which determine that inequality.

The basic causes may be divided into two further categories: socio-economic structure, as recognised by Jonsson (1981), including ideology and politics, kinship and land-tenure as well as exchange and agricultural practices; and natural resources. This distinction is important because a '...natural resource is a cultural achievement meaningless outside the technological, social, and cultural context which defines it' (Sauer 1925 in de Souza and Porter 1974:22; see also Szentes 1971:31-41 for further discussion).

Malnutrition in children can be traced to a hierarchy of interacting causes, it is a socio-economic disorder. The conventional wisdom that pits population density against land area and productivity as an explanation of nutritional status is too simplistic. Looking only at the symptoms and equating them with ecological causes (see

Reutlinger 1977) bypasses historical, economic, political and ideological-cultural factors.

Vulnerable Groups and the Symptoms of Malnutrition

Malnutrition is not evenly distributed in populations. Groups of people who are more at risk may be identified (Wheeler 1980:442). Malnutrition most commonly occurs in children under five years of age. They are regarded as a particularly sensitive group within a community (see Joy 1973, Wheeler 1980) because of their rapid rates of physical growth and development. Another particularly vulnerable or 'at risk' group are pregnant or lactating women who also require more nutrients to cope with the demands made upon them by the developing foetus or breast-feeding infant. These two groups may be further subdivided on socio-economic and cultural criteria.

The identification of the most vulnerable individuals within these groups is primarily based upon the likelihood of death, ill-health or disability as a result of inadequate diets. The most common method and probably the easiest for assessing nutritional status is the application of anthropometric techniques, for example the measurement of the height and weight of individuals compared with some known standard or reference. Other methods include clinical examinations, biochemical tests, dietary intake studies and morphological studies. All are summarised by Jelliffe (1966) and the WHO (1979). The array of available techniques has meant that inter-regional comparisons have been difficult if not impossible.

In choosing between convenience and practicality on the one hand and accuracy and sophistication on the other the Department of Health in Papua New Guinea has placed emphasis upon anthropometry for inter-regional comparisons of nutritional status and health. The most usual measurements taken are height and weight and the age of each subject.

While genetic factors play an important if incompletely understood part in child development (see Malcolm 1970 for a discussion of these in a Papua New Guinea population), malnutrition, especially an imbalance of protein to energy foods is a major determinant of the rate of growth, a child's size at any given age and the ultimate adult height (Malcolm 1979:366). It is important to note that protein is necessary for growth as well as body maintenance, thus requirements for proteins are higher in young children. If the diet is short of energy foods (fats and carbohydrates) the protein may be used for the supply of energy rather than for maintenance and growth. Non protein energy foods however, cannot substitute for protein in the growth process. Thus protein foods and energy foods must be available in sufficient quantities and balance for adequate growth.

A child's health and nutritional status may also be affected indirectly through such factors that are his by accident of birth. The nutritional status of a child's mother during pregnancy is closely correlated to his birth-weight (see Singleton 1980 for an analysis of this relationship in PNG) and her nutritional status whilst breast-feeding (Shaw 1979) is equally important in determining whether that child thrives or not (Scragg 1955, McKay 1960, Barnes 1963, Sinclair

1978, Malcolm 1979, Harvey 1979). Thus variations in birth-weight, which are usually greater than váriations in height at birth reflect more the maternal environment than genetic factors alone. The condition of a child at birth affects its ability to survive, especially in a harsh and marginal environment as is most of the Papua New Guinea Highlands. The relationship of the mother and child whilst the child is still within the womb is the subject of a further study yet to be presented for a sample of Nembi Plateau women (Baines pers.comm. 1981).

Malnutrition,* more especially protein-energy malnutrition (PEM) produces its most serious and profound effects during the first three years of life (Malcolm 1979:362). Protein-energy malnutrition is an all embracing term that has come to include the two distinct clinical syndromes, kwashiorkor and nutritional marasmus within a continuum of conditions (WHO 1979:43-60, Harvey 1979). Until the distinction between the two conditions was questioned it was accepted that kwashiorkor arose from a diet which, while adequate in energy was predominantly deficient in protein. Marasmus was attributed to gross deficiencies in energy. Because kwashiorkor was seen as the more serious syndrome the theory developed that most malnutrition was due to a protein gap, a shortfall of protein in the diet. More recently it has been suggested that adults and children have been able to thrive on 'low' protein intakes, and field studies (see Wheeler 1980)

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* Malnutrition is generally regarded as being the result of a shortage of protein while a shortfall in calories/energy results in undernourishment. Because of the continuing debate upon what constitutes malnourishment, malnutrition and undernourishment I have used the term malnutrition to embrace all aspects of the syndromes.

suggest that kwashiorkor and marasmus are not different diseases but syndromes of one problem: a combined dietary deficiency of energy and protein.

In 1947 the New Guinea Nutrition Survey reported that whilst the population received inadequate energy intakes, the intake of protein was of greater inadequacy, and so maintained the assumption that a protein gap was responsible for poor nutritional status. Later studies in the 1950s and 1960s, (Scragg 1955, McKay 1960, Oomen 1958, 1961, Oomen et al 1961, Barnes 1963, Venkatachalam 1962) also proposed that protein deficiency was the major nutritional problem facing the population of Papua New Guinea. In the early 1970s, however, in parallel with opinion in other parts of the world the importance of the protein-gap in Papua New Guinea was questioned (see Harvey 1979:1-7 for a summary of the literature). Energy is now usually reckoned to be the factor most limiting in young Papua New Guinean children's diets although protein quality and quantity are very often low (WHO 1979:44).

Children suffering from PEM have a slower than normal rate of growth which may be further retarded by infections. Infections usually increase the overall demand for food by the body, yet often lead to loss of appetite. In addition, cultural responses to infections may dictate that certain foods are denied the sick child. For example, diarrhoea in young children often prompts mothers to deny them water, in the belief that this will make the stools more solid. Consequently many young children die from dehydration.

Shortfalls in dietary intake may arise because of cultural taboos on certain foods, or because young children are not only fed infrequently but must also fend for themselves to a great extent. In addition, at particular times of the year particular foods may not be available. These variables are discussed further in Chapter Nine when the food intake of Pubi children is examined.

The development of PEM thus involves inadequate dietary intake which may be exacerbated by increasingly frequent infections, leading to slow or static rates of growth which may develop eventually into conditions of the marasmus/kwashiorkor syndrome. Accompanying the slower rates of growth in children suffering from PEM are other conditions detrimental to their development. They may lose weight due to loss of body fat and muscle wasting. Skeletal growth may slow and stop completely. If the child's condition deteriorates there may be skin and hair changes and he may have diarrhoea and oedema (WHO 1979, Harvey 1979). Pathological and biochemical changes are also associated with PEM, seriously imparing the child's mental development (Hornabrook 1972, Monckeberg 1976, Sinclair 1978).

The measurement and identification of the malnourished child

A number of systems based upon anthropometric measurements are used to measure and classify PEM. Essentially they provide an index or an indicator of, among other things changes in either the quality or quantity of the diet or both. Two distinct but related kinds of information are combined within the indices based upon anthropometric measurements: first, the result of previous diet in relation to requirements, and second an estimate of the present and future functional ability of the individual in terms of health, morbidity and possibility of death. Two problems arise in measuring nutritional status: the assessment of the degree of risk involved, that is for a given height or weight the risk of being either functionally impaired or of dying; and the difficulty of establishing standard values of normality with which individual performance can be compared. A third problem, which stems from the first two is that of satisfactorily accounting for secular changes in standards and performance through time. This also raises the question of the use of 'international' standards of normality for growth (British or American derived values for normality) as opposed to using standards derived from the country concerned. Growth standards are used as a screening device applied to populations and for assessig the effects of medical or social intervention on the health of particular children. The use of large-scale growth data for comparing one population with another, or with itself at a later time, does not involve the use of standards and should be distinguished from the use of data to create standards. There is a further use of growth data which does not involve the construction or growth standards. Growth data can be used as an index of the general health and nutrition of a population.

I have used Harvard standards as my reference (Stuart and Stevenson 1959) and justify their use not only because they are recommended by the WHO Southeast Asia Regional Office (1979) and the Papua New Guinean Department of Health, but also because the Harvard standards are internationally accepted, allowing comparisons with other countries and areas of Papua New Guinea using the same 'yardstick' derived from a large sample of children based on described and exact methods. Using such a reference does not imply that Papua New Guinean children should be of similar weights and heights (Tanner 1978:109-121). They are not standards to be achieved but standards of comparison.

A widely used system which attempts to estimate risk associated with a particular weight for a particular age is that of Gomez et al (1956). Harvard standards were used as the reference weights, because within most developing countries the nutritional health of the population is changing rapidly due to intervention programmes as economies develop: comparison with a known and little changing reference is therefore essential. In the Pacific and South East Asia region the Gomez classification has been modified to take account of the possibility of genetic factors and other adaptations which have produced satisfactory levels of health at lower weights-for-age (and

Table 2.1 : The Gomez Classification and its Modification for SE Asia.

Percentage of reference weight	Nutritional status	PNG/SE Asia modification
91 and above	Normal	Normal 80 and above
76-90	1st degree malnutrition	malnourished 60-79
60-75	2nd degree malnutrition	
60 and below	3rd degree malnutrition	Severely malnourished 60 and below

indeed heights for age) than in American and British populations (Hipsley 1969, 1976, Malcolm 1970, Oomen and Corden 1970). The Gomez classification and its modification are shown in Table 2.1 and in what follows the Gomez modified categories are adopted as recommended by WHO (1979).

Gomez conducted his survey in a hospital and found children with third degree malnutrition had a 33 percent mortality rate. Such precise estimates of risk are not available for most groups in Papua and New Guinea, and misgivings about the application of international growth standards to Papua New Guinean populations are borne out by results of studies into nutrient and energy intakes. Energy and protein intakes have been shown to be exceptionally low by international standards but the level of physical fitness in adults has been found to be very high and the levels of severe malnutrition low (see for example Ferro-Luzzi et al 1975, Hipsley and Kirk 1965, Norgan et al 1974, Sinnett and Solomon 1968, Sinnett 1977). Harvard standards may therefore be set too high for Papua New Guinean children to adequately distinguish those children who are functionally impaired by poor nutritional status rather than being solely of lighter and shorter build (see Edmundson 1977, 1979, 1980a, for similar observations in Java).

Table 2.2 shows the application of the modified Gomez classification to the child population of the Tari Basin in the northwest of the Southern Highlands.

Table 2.2 : Probability of Death Within Two Months by Age and Nutritional Status in Tari SHP.

Age in months	Above 80 percent weight-for-age	60-79 percent weight-for-age	Below 60 percent weight-for-age
0-6	13%	42%	80%
7-30	3%	12%	40%
31-60	6%	1%	-

Source: D. Smith 1978 Preliminary findings of a nutrition survey in Tari Southern Highlands Province; mimeo, Dept. of Health.

Classifications which rely solely on comparisons of weight-for-age have various disadvantages. It is difficult to know whether low weight is due to an acute (short-term) episode of malnutrition or to chronic (long-term) undernourishment. For the latter case a child may be of low weight-for-age because he is "stunted" (low height-for-age). Then again he maybe of normal weight-for-height, although short for his age. Alternatively a child may be of low weight-for-age because he is of normal height-for-age but due to an acute episode of malnutrition is of low weight-for-age and therefore "wasted" (low weight-for-height). The terms "wasted" and "stunted" were introduced by Waterlow (1976) to describe the two conditions. He emphasised the point that different methods of classification will produce different answers and that the number of children falling into the different category cells will vary depending upon the indices used (Waterlow 1976:550).

Other areas of Papua New Guinea have been studied using the Waterlow classification (Harvey 1979, Hiles 1978). I have used Waterlow's classification utilising measurements of height-for-age and weight-for-height to allow comparison with these studies and to distinguish between long-term and short-term malnutrition. Table 2.3 shows Waterlow's classification as recommended for the Pacific region. Waterlow's original classification, with sixteen cells, was unwieldy especially for comparing a large number of populations and for a large number of age groups. Harvey (1979) summarises the discussions for and against Waterlow's classification. The arguments hinge upon whether weight-for-height is independent of age. Waterlow argues that for children under the age of four it is, although others have shown that Waterlow's Classification substantially underestimates the more severe cases of malnutrition (this is discussed in Harvey 1979). Its usefulness is that it distinguishes stunting, a long-term and chronic condition, from wasting, a short term condition. The distinction is important not least for policy decisions of nutrition intervention programmes. It has been argued that short stature <u>per se</u> is of no

Table 2.3 : Classification of PEM Recommended by WHO (1979) Modifying that of Waterlow (1976).

Height (length) for age (% of standard)(a)	Weight-for-Height (% of standard)(a)	
	Above 80	Below 80
Above 90	Normal	Wasted but not stunted
Below 90	Stunted but not wasted	Stunted and wasted

(a) Standard equals the 50th percentile of Harvard values (Stuart and Stevenson 1959).

real disadvantage and may be a long term adaptation to nutritional inadequacies (Malcolm 1970, 1979). Indeed Papua New Guinean highland adults, although of short stature, are physically fit (Sinnett and Solomon 1968). Short stature may be a successful genetic and somatic adaptation to the food supply and other conditions of highland environments (Malcolm 1970, see also Harvey 1979). A weight-for-height measure below the normal range would indicate an individual suffering from an inadequate food intake.

Nevertheless it could also be argued that not enough is known about the long term effects of stunting upon the health of an individual, either functional impairment or risk of death. Indeed a frequent misunderstanding in the use of growth standards, references and systems of classification is of the estimation of risk. Wheeler (1980:440-441) cites some classic examples where with no record of the number of deaths in particular age groups or nutritional categories, attempts were made to estimate the probability of death associated with particular weights-for-age. On the Nembi Plateau, precise details of deaths are not available, and it could be argued that to classify the children into categories of malnourishment is thus a futile exercise, if no estimate of risk or functional impairment is possible. There is however an ethical question involved in deciding whether one intervenes or not in the course of events in which malnutrition can be reasonably expected to lead to some deaths in order to obtain a probability measure of deaths at particular weights-for-age. It can also be argued with evidence from other areas and from clinical studies, that certain categories of children distinguished by anthropometry are at risk no matter how imprecise the probability statements. Malnourishment for children under the age of six months in the Tari Basin is a very serious risk to life indeed (Table 2.2). There is a 40 percent chance of dying between the age of 7 and 30 months if body weight is below 60 percent weight-for-age (Harvard Standard). Compared to the Nembi Plateau, Tari environment, soils and climate are more equable and the social structures and mores do not place such a burden upon women as the producers of food. Given the close relationship between nutritional status and risk of death in Tari, the Nembi Plateau, where the average child malnutrition rate is about 50 percent (children below 80 percent weight for age), child mortality associated with malnutrition is likely to be well above the Provincial mean of 229 deaths per 1000 children aged 0-5 (Department of Health, Mendi, 1980).

An ideal statement about the nutritional problems of the Nembi Plateau would relate to an identifiable population group and the risks involved. If we wish to make a meaningful statement on the nutritional status of the children of the Nembi Plateau we must be able to identify the families to which the children belong, by factors such as wealth, clan, ecological habitat, status or access to land. This could enable nutritional status to be related to other aspects of status within the community, to resources and to the possibility of improving the situations of those most at risk (Chambers et al 1981, Chambers 1982, Chen et al 1979, Joy 1973, Wheeler 1980).

The nutritional status of Nembi children

The National Nutrition Surveys of 1974 and 1978 assessed the nutritional status of children under the age of five surveyed by measuring their weight-for-age and comparing them with Harvard Standards. Nembi children were included in these surveys. The results of the two National surveys are possibly distorted by differences between sample sizes as well as variation in methods of measurement. Furthermore unknown errors, for which no error estimate can be calculated, in weighing and recording, serve to confound the interpretation of the various measures of weight-for-age in terms of morbidity, mortality and functional impairment. The National Nutrition Conference in Goroka in 1980 reported that the effect of unknown errors within the two National Surveys made invalid any cross sectional or longitudinal comparison based on their results (Report of the Nutrition Monitoring Group July 1980).

Despite all the shortcomings it is possible to compare the 1974 and 1978 Nutrition Surveys of the Nembi Plateau and the Nipa District if one is prepared to dissect the results a little in an attempt to see what they mean. In 1974 the Southern Highlands Province ranked ninth among nineteen provinces, with 37 percent of its children falling below 80 percent weight-for-age. In 1978 there was no change: 37 percent of the Southern Highlands Province's children remained under 80 percent weight-for-age, but the province had slipped to eleventh position.*

When the performance (in 1974), of Nembi Plateau children from Semin and Enjua Maternal and Child Health clinics (MCH Clinics) is compared to children of the Nipa Administration District of which the Plateau is a part, and those of the Southern Highlands Province, in 1974, the three areas show little difference although the children of the Nembi Plateau are marginally worse (Table 2.4). The sample sizes are small however and the Semin and Enjua clinics account for only 13.5 percent of the Nembi Plateau child population. The same observations for 1978 are probably a truer representation of the nutritional status of these three areas (Table 2.4 and 2.5).

The two clinics Semin and Enjua may be disaggregated from the 1978 results and compared directly with the result for 1974. Although they still differ slightly in sample size they are at least results for the same relatively small population of people. In 1974, 202 children were measured and in 1978, 204 but no estimate was available for what percentage this represented of the total number of children under five either registered at the clinics in the area or living in the area.

In 1978 10 percent more children were malnourished in the Enjua and Semin region than in 1974 (38.6% in 1974 and 48.5% in 1978).

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* There appears to be some confusion in the literature as to the percentage of children in the SHP falling below 80% wt/age in 1974. The National Nutrition Survey (1975) records 47% whilst the Province's records show 37%. Clarke and Cohill use 37% (1980) and I have followed their lead.

Table 2.4 : Nutritional Status of Nembi Plateau Children Compared with Children in Nipa District and the Southern Highlands Province 1974.

Weight-for-age	Southern Highlands		Nipa District[a]		Nembi Plateau[b]	
	No.	%	No.	%	No.	%
Over 80%	6880	63.4	2170	65.0	124	61.4
60-79%	3896	35.9	1143	34.2	76	37.6
Under 60%	79	0.7	25	0.8	2	1.0
TOTAL	10855	100.0	3338	100.0	202	100.0
Estimated No. of children under five	46776		6153		1538	
Percent of children recorded	23.2		54.2		13.5	
TOTAL POPULATION	233880		30763		7689	

a Nipa District is Nembi Plateau, Nipa Basin, Waga and Margarima census divisions.

b Nembi Plateau is only Enjua and Semin clinics

Source: Dept of Health Records, Mendi SHP; Clarke and Cogill 1980.

Table 2.5 : Nutritional Status of Nembi Plateau Children Compared with Children in Nipa District and the Southern Highlands Province 1978.

Weight-for-age	Southern Highlands		Nipa District[a]		Nembi Plateau[b]	
	No.	%	No.	%	No.	%
Over 80%	18135	63.5	3571	52.9	551	43.0
60-80%	9975	34.9	3013	44.6	682	53.2
Under 60%	455	1.6	170	2.5	48	3.8
TOTAL	28565	100.0	6754	100.0	1281	100.0
Estimated No. of children under five	49514		9150		1643	
Percent of children recorded	58.0		73.8		78.0	
TOTAL POPULATION	247471		45754		8217	

a Includes Nembi Valley and Foi Census divisions as well as the Nembi Plateau, Nipa Basin, Waga and Margarima Census Divisions.

b Includes Karamella, Askam, Mengisup, Enjua, Obua, Enip, Pumberal, Semin, Embi, Tobua, Tegibo, Uba and Toiowara census divisions.

Source: Department of Health Records, Mendi SHP; Clarke and Cogill 1980.

In 1980 these two clinics were included in an additional survey of the whole of the Nembi Plateau carried out by Mary Hermiz (MCH Sister, Oi), Janis Baines and myself. We adopted the accepted standard methods described in Jelliffe (1966). Allowing for any errors due to slight variation in method, our results are comparable with those for 1974 and 1978. We found that 46.7 percent of the children in the Semin and Enjua region were below 80 percent weight-for-age indicating very little difference over 1978 but a much larger difference - about 8 percent compared with 1974.

A similar increase in the number of malnourished children in 1978 compared with 1974 - approximately 12 percent - is also demonstrated by the National Survey results for the Nipa District. However, that may reflect only a difference in sample size and area. In 1978 the Foi Census Division was included in the Nipa District and over 60 percent of children in that Census Division were under 80 per cent weight-for-age. In addition in 1978, 57 percent of Nembi Plateau children were malnourished. Neither of the two groups (Foi or Nembi Plateau) had been included in the 1974 survey. The average number of malnourished children in the Nipa District in 1978 was 47 percent of the total and in 1974, 36 percent. One could speculate that because the figures for Enjua and Semin suggest a secular change for the worse since 1974 the figures for the whole of the Nipa District do also. I would suggest however that the inclusion of the Foi and the Nembi Plateau populations in 1978 effectively masks any secular change which may have taken place and renders any comparison between the two surveys at that level virtually useless. The question remains whether it is possible to postulate causes for any differences both spatial and secular?

It has been suggested that altitude may play an important part in the occurrence of malnutrition in the highlands (Powell and Powell 1972, Simpson 1976)* Data collected in the Southern Highlands would seem to bear out this suggestion. For example, the Semin and Enjua MCH clinics, the most northerly of the Nembi Plateau clinics, are at an altitude of approximately 2,000m, while those of the Foi Census Division lie entirely within the Lake Kutubu and Mubi river lowlands (700-900m). The latter have an average of 61 percent of children under 80 percent weight-for-age: 14 percent more than in the Enjua and Semin clinics.

Variation amongst the highland provinces however suggests that factors other than altitude may be at play. Despite the shortcomings in both the methods of analysis and the data used, Clarke and Cogill (1980) found that in the Southern Highlands, the nutrition of children living at altitudes above 1800m was not only significantly better than that of their counterparts at low altitudes (below 1,000m), but also better than those of children at intermediate altitudes. This latter finding was surprising. The environment above 1800m, was thought to be a difficult one for highland horticulturalists (Waddell 1972a, 1973) and it had been assumed that children in

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* The National Nutrition Survey proposed for 1982 will collect data within an ecological zone framework based upon altitude (unpub. paper at 1980 PNG Food Crops Conference presented by Provincial Health Office Alotau, Milne Bay).

the frost-prone and marginal high altitudes would be of poorer nutritional status than those in the intermediate altitude zones (IBRD 1978a). Results of a survey (Pneumonia Research Centre Tari, reported in IBRD 1978a) in the Tari Basin of the Southern Highlands also point to the operation of other than environmental factors. Nor is a simple relationship between economic development and nutrition likely. Jackson (1981), correlates nutritional status with the percentage of a province's income derived from subsistence production and with the percentage derived from the market economy.

Table 2.6, reproduced from Jackson's work, shows the proportion of income derived from commercial and non-market activities in each province, and the percentage incidence of malnutrition, in 1975. Jackson finds a positive and statistically significant correlation -a value of 0.694 between those variables (1981:189). The converse correlation of the percentage of a province's income derived from the market component of the economy with the percentage incidence of malnutrition (the percentage number of children seen whose weight was under 80 percent weight-for-age) was also statistically significant and negative -0.697. He concludes, 'the more commercially developed a province, the lower the incidence of malnutrition' (1981:192). Jackson's results are not surprising, but do little if anything to further understanding of the causes of malnutrition in Papua New Guinea within areas such as the Nembi Plateau, because the relationship between income and malnutrition remain unexplored and unknown. High correlations do not necessarily indicate a causal relationship and many other contributory factors may be involved.

Table 2.6 : Subsistence Agriculture and Malnutrition by Province.

Province	Percentage of province's income 1971/72, derived from (a)		Percentage incidence of malnutrition 1975
	Market component	Non-Market component	
Western	62.2	36.9	40
Gulf	60.0	40.0	45
Central (b)	92.7	7.3	37
Milne Bay	56.4	43.0	54
Northern	61.9	38.1	44
Southern Highlands	47.5	52.9	47
Western Highlands (c)	63.3	36.7	38
Simbu	49.3	50.7	55
Eastern Highlands	63.9	36.3	26
Morobe	78.6	21.4	40
Madang	67.3	32.7	52
East Sepik	60.3	39.4	46
West Sepik	58.7	41.3	62
Manus	80.6	17.9	33
New Ireland	75.0	25.8	32
East New Britain	88.0	12.0	23
West New Britain	81.6	18.4	36
North Solomons	91.5	8.5	28
Papua New Guinea	73.9	26.0	43

(a) Minor discrepancies (percentages should sum to 100) due to rounding in original table.

(b) Including National Capital District.

(c) Including Enga Province.

Source: Calculated by Jackson (1981:180), from Table 2 of M.L. Treadgold, "Regional Inequality in Papua New Guinea: Some New Evidence", Pacific Viewpoint, Volume 19, Number 2, September 1978.

I therefore decided to measure the weight and height and record the age of as many children under the age of five resident on the Nembi Plateau as possible. In this I was helped considerably by Janis Baines, Kathy Kilroy and Mary Hermiz. My objective was to construct a data set that was comparable to other surveys representative of the highlands: the Lagaip of Enga Province by Harvey (1979), and of the Kainantu people of the Eastern Highlands Province by Hiles (1978). From the data collected it is possible to first monitor any seasonal changes in nutrutional status; second, to examine a range of social and economic factors relating to nutritional status, for which it was not possible to collect for the larger sample. An additional sample of forty children was measured monthly for 12 months by Janis Baines.* The mothers of the children were also monitored. Their weights were recorded monthly and bouts of sickness of both mother and child also recorded. Information on diets was collected and is discussed in Chapter Nine.

Comparison of nutritional status of Nembi Plateau Kainantu and Lagàip children

During 16 MCH patrols from Ol and Det (Map 2.1) in June and August 1980 anthropometric data were collected for 1175 children of the Nembi Plateau under the age of five, which is approximately 78 percent of all children enrolled at MCH clinics and 70 percent of all children resident on the plateau in June 1980. The coverage of the plateau by MCH patrols from Ol Health Centre and Det Health Centre

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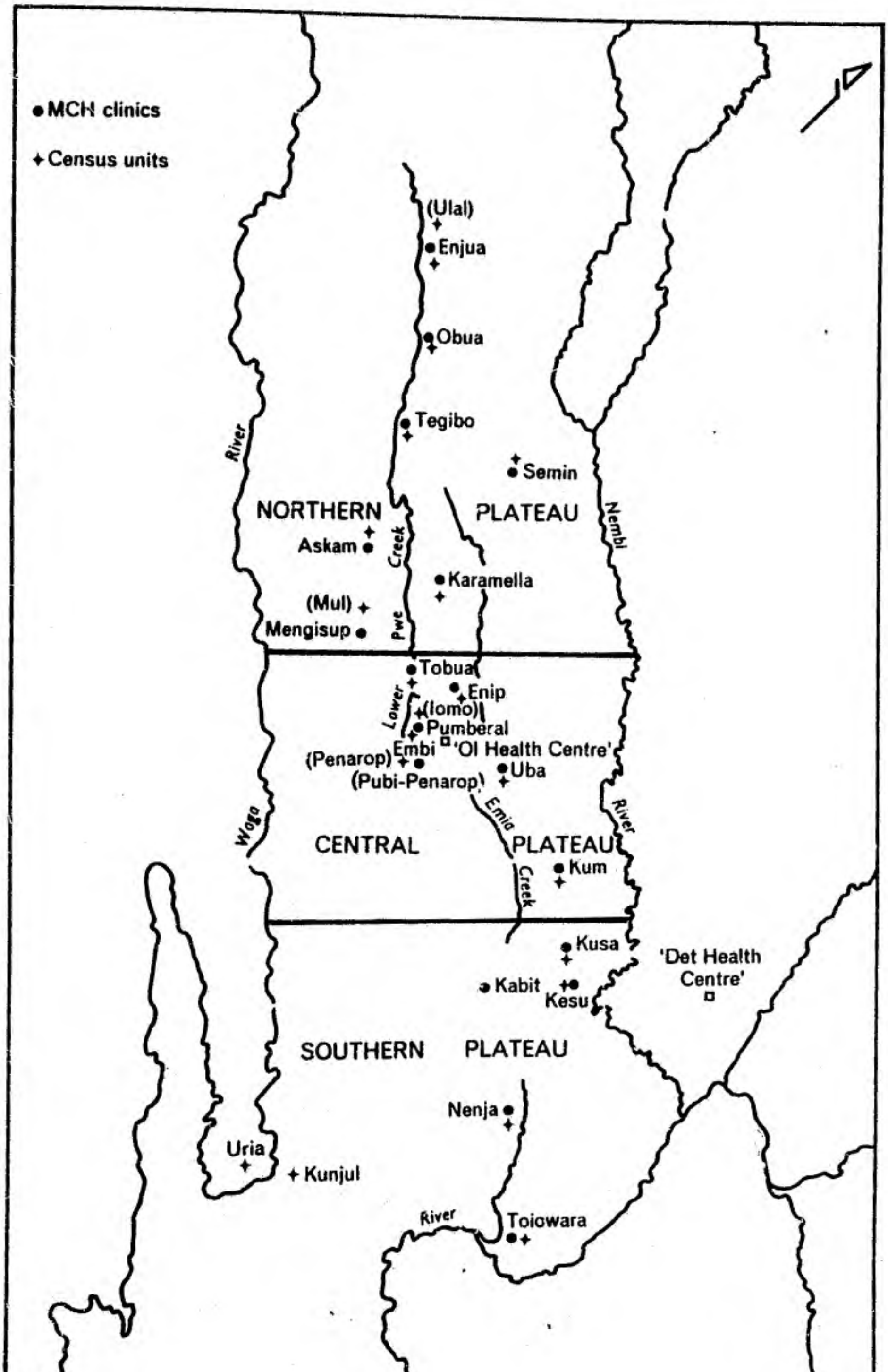
* Much of the data will be presented by Janis Baines as an M.Sc. thesis in 1983.



Map 2.1 : The Maternal and Child Health Clinics, and the Census Units of the Nembi Plateau and Nembi valley

is very conscientious and over 90 percent of the children on the plateau are registered at a clinic. Although the children are not a properly selected random sample population, they are reasonably representative of the total child population of the plateau. Birth weight data were also taken for 637 births recorded at Ol Clinic between 1971 and 1980.

The survey data set was reduced to 1162 cases as some of the children measured were already in the 61st month of life. Although similar to the growth patterns of children in Kainantu and Lagaip the cross-sectional data from the Nembi Plateau do show some important differences.

Weight-for-age

The Nembi child is lighter at birth than in most areas of Papua New Guinea (Clarke and Cogill 1978 unpub). The Papua New Guinea average is 3.1 kg (Taukoro and Guma 1978). From 1971 to 1980 the average birth weight of 637 Nembi children recorded at the Ol Health Centre was 2.7 kg, with 30 percent of births below or equal to 2.5 kg and therefore classified as low (WHO 1979). In 1979 and 1980 female neonates (99) on average were marginally lighter, weighing 2.71 kg, whilst males (133) on average weighed 2.82 kg. Harvey (1979) found that the average birth weight of Lagaip children was 3.03 kg. No data are available for the Kainantu region but it may be inferred that Kainantu neonates are heavier than on the Nembi Plateau from the heavier mean weight for Kainantu children between the age of 0 and 5 months (see Table 2.7 and Figure 2.1).

The Nembi child thus begins life significantly lighter than his counterparts in Enga or Kainantu. Consequently he can ill-afford to lose weight as he has less leeway before his weight becomes critical to his survival. From Table 2.7 and Figure 2.1 it can be seen that for the first two years of life, Kainantu and Lagaip children maintain their advantage and remain heavier than the Nembi Child. In the third and fourth years of life the patterns of growth remain similar, but the growth rate of the Nembi child is slower and by the fifth year of life the Nembi child is on average nearly 0.6 kg lighter than a Kainantu child.

Table 2.7 : Mean Weight-for-Age by Age Groups for Three Highland Communities - Nembi Plateau, Lagaip and Kainantu Children from 0-4.99 Years of Life.

Age Group Months	Nembi Plateau		Lagaip[a]		Kainantu[b]	
	No.	Mean wt. kg	No.	Mean wt. kg	No.	Mean wt. kg
0-5	133	5.1	86	5.5	59	5.5
6-11	126	6.9	129	7.3	54	7.4
12-23	254	8.5	251	9.0	118	9.2
24-35	214	10.8	245	11.1	76	11.1
36-47	230	12.4	205	12.6	54	12.8
48-59	205	13.7	158	14.2	45	14.3

a Harvey 1979
b Hiles 1978

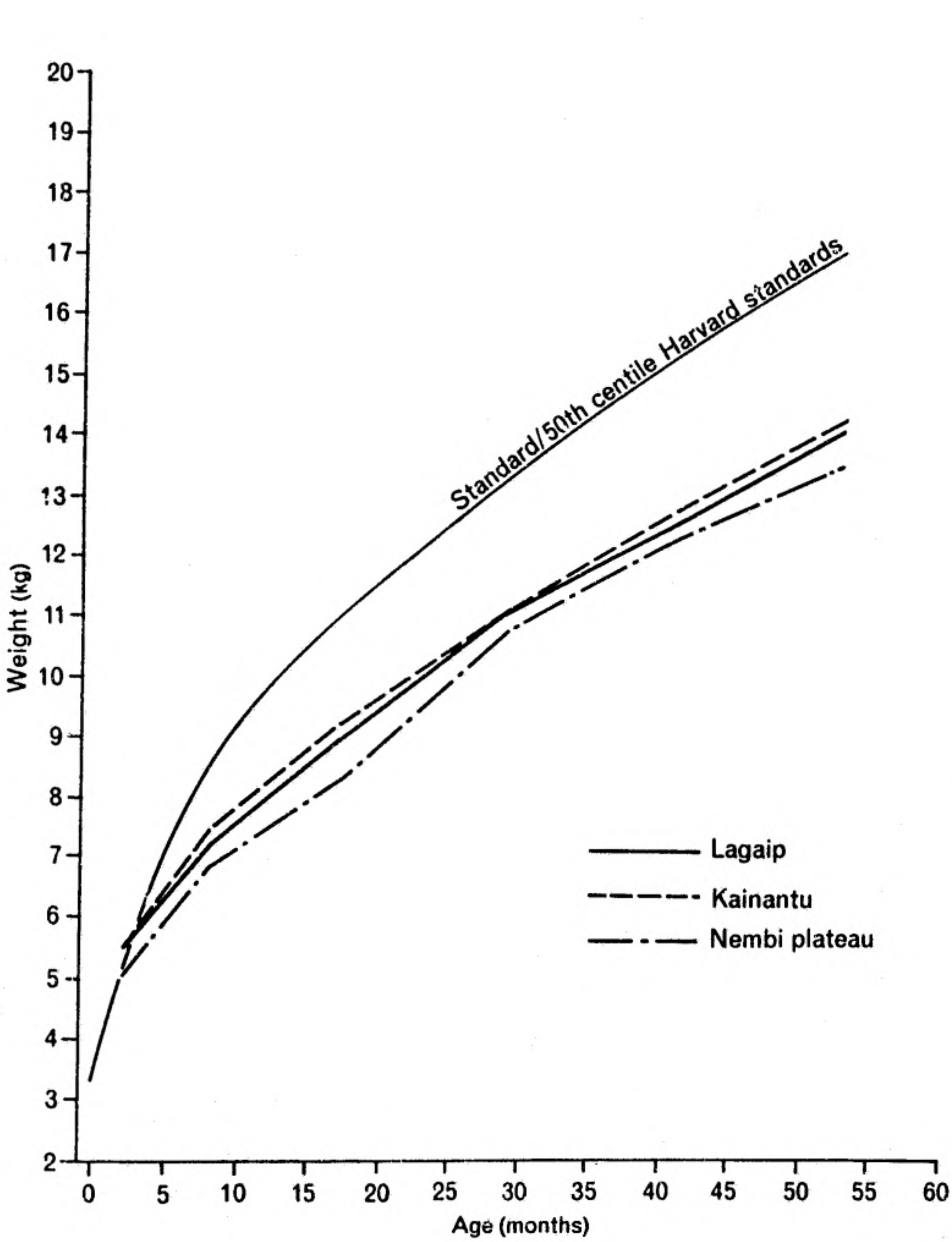


Figure 2.1 : The weight-for-age of Nembi Plateau, Kainantu and Lagaip children.

The Nembi child falters in his growth in the period from 6 to 23 months to a larger degree than does either the Kainantu or Lagaip child. He nevertheless recovers in the latter part of the second year and the first part of the third to very nearly catch up with the Lagaip and Kainantu children. The faltering of growth during this period is much more apparent when instead of comparing absolute weights-for-age, percentage weights-for-age are compared (Table 2.8 and Figure 2.2). Although the difference in status of the Kainantu child between the first and second six months of life is the greatest,

Table 2.8 : Mean Percentage of Expected Weight-for-Age by Age Groups for Three Highland Communities - Nembi Plateau, Lagaip and Kainantu Children from 0-4.99 Years of Life.

Age Group Months	Nembi Plateau		Lagaip[a]		Kainantu[b]	
	No.	Mean Percentage Weight-for-Age	No.	Mean Percentage Weight-for Age	No.	Mean Percentage Weight-for Age c
0-5	133	95.9	86	98.2	59	104.3
6-11	126	80.3	130	85.2	54	86.0
12-23	254	76.9	251	81.0	118	82.9
24-35	214	80.4	245	83.4	76	82.8
36-47	230	80.3	205	81.8	64	83.1
48-59	205	78.9	158	81.9	45	82.7

a Harvey 1979
b Hiles 1978
c In Table 2.7 the Mean Weight for Lagaip and Kainantu children are the same for children between the age of 0-5 months. The difference in the Percentage Weight-for-Age in this table is due to the age composition of the sample between the age of 0-5 months. The Kainantu children are younger.

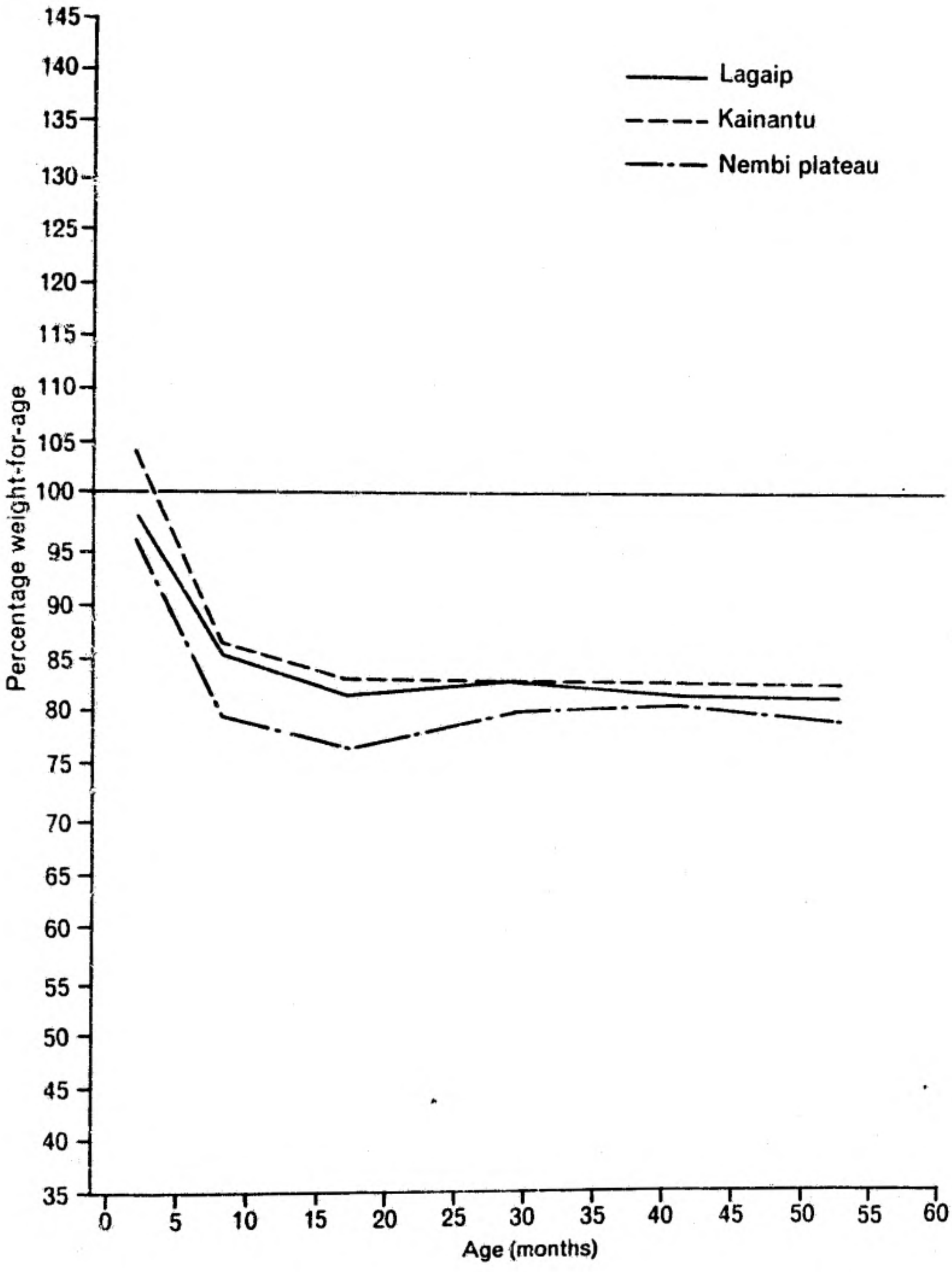


Figure 2.2 : Percentage weight-for-age of standard weight-for-age of Nembi Plateau, Kainantu and Lagaip children.

the Kainantu child, on average, dropping from 104 percent weight-for-age to 86 percent weight-for-age, the position of the Nembi child is rather more precarious at 80 percent weight-for-age. The growth path demonstrated by the Nembi cross-sectional data, and to a lesser degree by the Kainantu and Lagaip data, conforms to two general patterns of growth described for Papua New Guinean children.

Firstly, the growth rates are well below the Harvard standards and, on average, after the first six months of life, follow the 80 percent path. Secondly, a sharp decline in status occurs between the age of six months and one year followed by a slight recovery between the 20th and 30th months of life. The sharp decline in growth performance after the first year of life is the result of a number of factors, which are subsumed under the label of 'weanling diarrhoea'. The most important factors are the contamination of food by infectious pathogens (including the eggs of intestinal worms, see Jones 1976); the introduction of the child to a high bulk, low energy and low protein food supplement (sweet potato - see Binns 1975); the growing inadequacy of breast-milk to supply a child's nutritional needs after six months of age; and the increasing risk of a child introducing pathogens into his mouth and gut as his mobility develops (Biddulph 1973, WHO 1979:133-150). The better performance of the Kainantu and Lagaip child during the weaning period is probably related to their initial higher weight-for-age. On average their birth weights are higher, and possibly reflect a better health status of Kainantu and Lagaip mothers during pregnancy. Healthy mothers may also provide larger quantities of breast-milk and there is less risk of cross infection from mother to child (Bell 1978 discusses the immune response of undernourished Papua New Guinean children). Environmental factors, access to health care and indeed level of income and education of the mother may also have their effects upon the growth performance of children (Oomen 1961 and Malcolm 1974 provide summaries of factors influencing the health and nutritional status of Papua New Guinean children).

Height-for-age

A similar pattern exists in the mean height-for-age data (Table 2.9 and Figure 2.3). The three populations do not differ appreciably on this measure. A marked decrease in the rate of growth of height in the second year of life occurs subsequent to a decrease in the rate of growth in weight. From the second to the fifth year of life the rate of increase in height gradually slows. Height gain also declines at a slower rate than the decline in weight gain (Table 2.10 and Figure 2.4). Weight at birth and subsequent weight gain are much more variable than height, a reflection of nutrition and associated factors rather than genetic factors. More importantly weight variation responds more immediately to health and nutrition than does variation in height. Thus although all three areas have children who are similarly short and light by comparison with the Harvard standard reference for their age, the largest differences between the three populations are in weight-for-age rather than height-for-age. All three areas suffer from long-term dietary inadequacy to a similar degree but differ in the rate of acute malnutrition. Nembi children are light but not short in comparison to other highland children.

Table 2.9 : Mean Height-for-Age by Age Groups for Three Highland Communities - Nembi Plateau, Lagaip and Kainantu Children from 0-4.99 Years of Life.

Age Group Months	Nembi Plateau		Lagaip		Kainantu	
	No.	Mean ht. cm	No.	Mean ht. cm	No.	Mean ht. cm
0-5	133	57.1	86	58.2	59	57.3
6-11	126	67.4	129	66.3	54	66.4
12-23	254	74.7	251	74.6	118	75.2
24-35	214	83.5	245	83.2	76	82.2
36-47	230	89.6	206	88.9	64	88.7
48-59	205	95.1	158	94.9	na	na

Table 2.10 : Mean Percentage of Expected Height-for-Age by Age Groups for Three Highland Communities - Nembi Plateau, Lagaip and Kainantu Children from 0-4.99 Years of Life.

Age Group Months	Nembi Plateau		Lagaip		Kainantu	
	No.	Mean Percentage Height-for Age	No.	Mean Percentage Height-for Age	No.	Mean Percentage Height-for Age
0-5	133	98	86	97.4	59	98.3
6-11	126	96.5	129	95.1	54	95.1
12-23	254	92.5	251	92.5	118	93.1
24-35	214	91.4	245	91.1	76	90.6
36-47	230	90.1*	206	89.5*	64	89.2
48-59	205	89.4	158	89.3	na	na

* Note that the mean percentage of expected height-for-age of the Nembi and Lagaip children straddle very closely the 90% cut-off, of the Waterlow classification that divides stunted from normal children. The arbitrary nature of the cut-off emphasises a difference that is really very small.

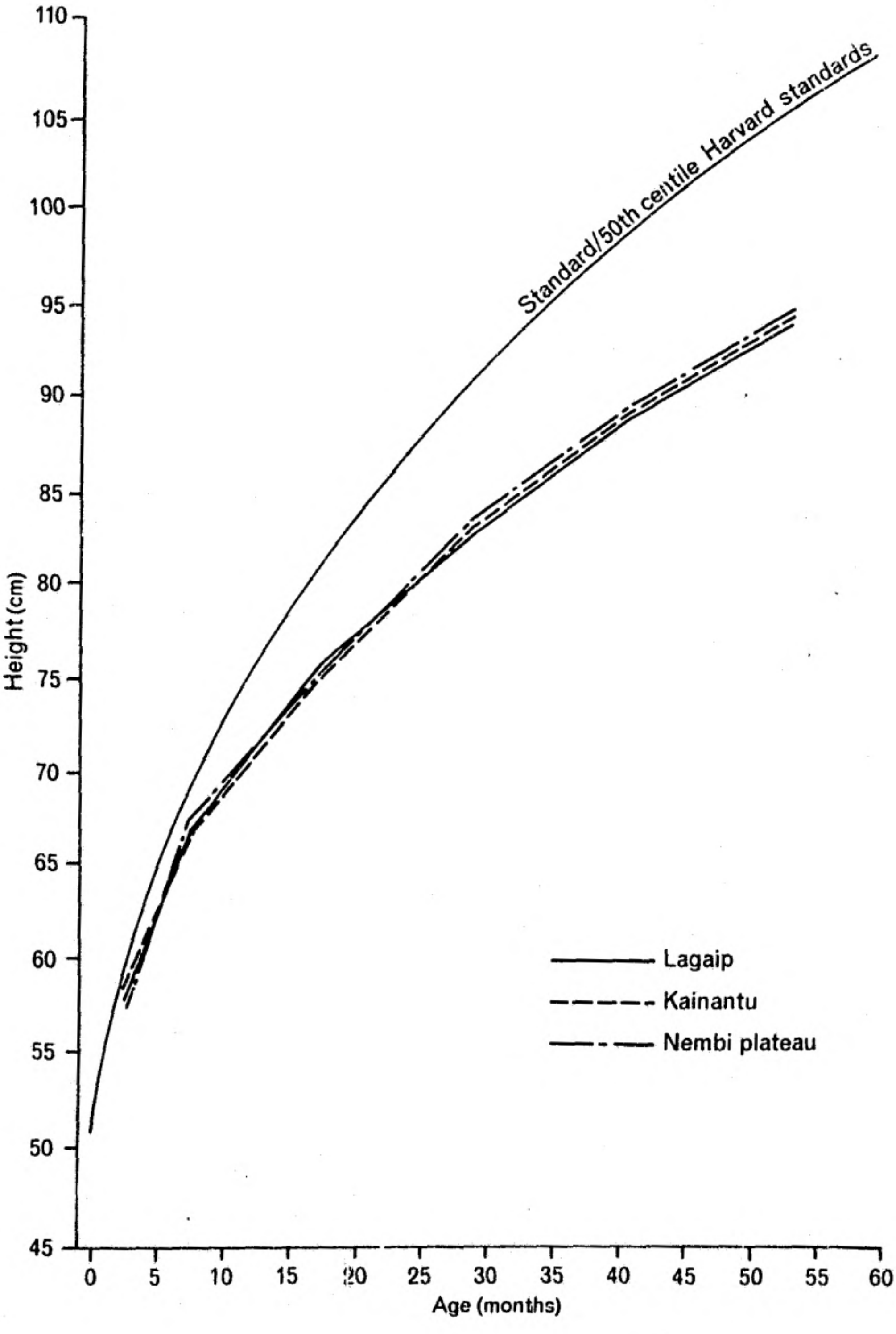


Figure 2.3 : The height-for-age of Nembi Plateau, Kainantu and Lagaip children.

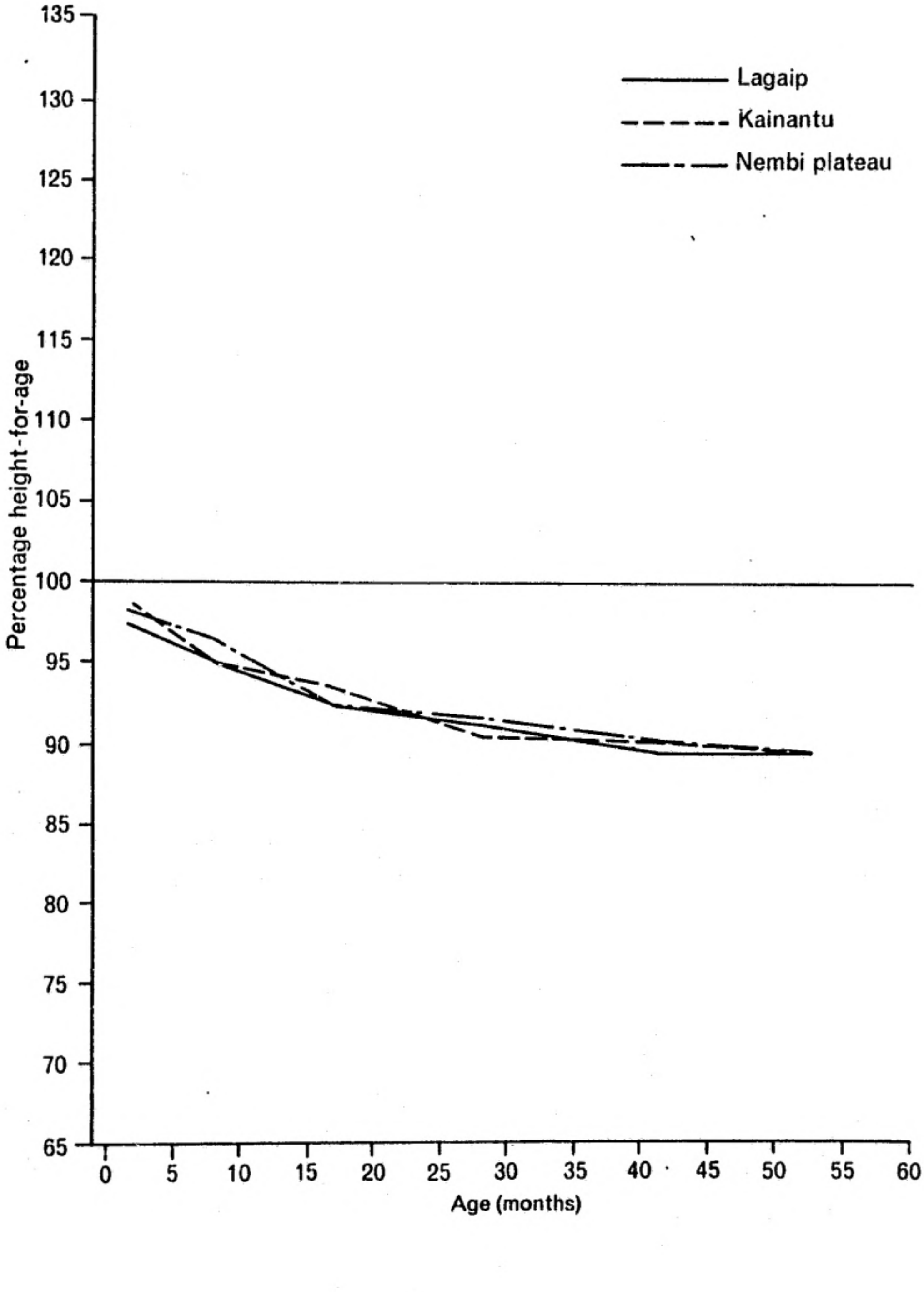


Figure 2.4 : Percentage height-for-age of standard height-for-age of Nembi Plateau, Kainantu and Lagaip children.

This is possibly environmental, for while length is less affected by short-term environmental factors, genetically the Nembi may be longer and therefore should perhaps be even heavier.

Weight-for-height: stunting and wasting

Weight expressed as a percentage of the standard weight for any particular height is a more specific measure of nutritional status than just weight or height-for-age. On the one hand, because the heights of the three groups are similar, differences between the groups in terms of percentage weight-for-height will reflect more closely differences in short term nutritional status (Table 2.11). On the other hand although stunting may have adverse effects on the

Table 2.11 : Mean Percentage of Expected Weight-for-Height by Age Groups for Three Highland Communities - Nembi Plateau, Lagaip and Kainantu Children from 0-4.99 Years of Life.

Age Group Months	Nembi Plateau		Lagaip		Kainantu	
	No.	Mean Percentage Weight-for-Height	No.	Mean Percentage Weight-for-Height	No.	Mean Percentage Weight-for-Height
0-5	133	102	86	101.7	59	110
6-11	126	88.5	129	96.6	54	98.7
12-23	254	85.9	251	92.6	118	93
24-35	214	92.3	245	95.5	76	97.4
36-47	230	95.3	206	98.3	64	101
48-59	205	95.8	158	99.5	na	na

health of an individual it reflects past bouts of nutritional trauma and/or longer term sub-optimal, but not acute, nutritional deficiencies. All three communities have a similar lower than standard height-for-age. However, the weight-for-height comparisons show marked differences between the three areas. In the same way that height-for-age and weight-for-age during the 6th to 11th month of life are low, it is also a period of low weight-for-height. The Nembi children have the lowest weight-for-height in all age groups. It is noticeable that during the first six months of life the weight-for-height is above 100 percent and their weight gain relative to their height is good.

Not only does the highland child become progressively more stunted, but he also loses weight relative to his achieved height throughout the second year of life. The Kainantu and to a lesser degree the Lagaip children recover their weight loss relative to their height over the next three years. The Nembi child remains on average 4 percent below standard weight for his height by the end of his fifth year of life and is thus both stunted and light for his age as well as light for his height in comparison to Lagaip and Kainantu children (Table 2.12). In the first year of life the greatest proportion of children exhibiting signs of malnourishment, either stunting, wasting or a combination of both are those of the Nembi Plateau. Nevertheless the difference between the three areas is very small with the Nembi Plateau having 13.5 percent, Lagaip 12.8 percent and Kainantu 11 percent of children malnourished. The more important difference between the three areas, for children in the first year of life is the prevalence of the <u>type</u> of malnutrition rather than its extent. For example children in the Kainantu region exhibit primarily stunting

Table 2.12 : Proportion of Stunted and Wasted Children in Three Highland Communities - Nembi Plateau, Lagaip and Kainantu Children from 0-4.99 Years of Life.

Nutritional Class	Age Group (months) 0 - 11			12 - 59		
	Nembi Plateau	Lagaip	Kainantu	Nembi Plateau	Lagaip	Kainantu
Normal	86.5%	87.2%	89.0%	61.9%	54.5%	61.2%
Stunted not wasted	3.5%	6.8%	9.2%	33.2%	43.0%	36.4%
Wasted	8.1%	6.0%	1.2%	2.6%	1.5%	1.4%
Stunted and Wasted	1.9%	0	0.6%	2.3%	1.0%	1.0%

(9.2%) and not wasting (1.8%) in the first year of life. The Nembi Plateau and the Lagaip have additional problems of wasting or acute malnutrition (10% and 6%), as well as stunting (3.5% and 6.8%).

By the time the children of all three areas have reached their fifth birthday between 33 to 43 percent of them are stunted. The extent to which stunting impairs the vital functions of a child is unknown. It may be an adaptation to long-term deficiencies in nutrients and to other environmental factors. It would appear that conditions affecting the nutritional status of children in all three areas produce stunting of growth for some children in the first year of life at differing rates which eventually even out in the next four years. It is interesting that Lagaip has fewer "normal" children that the other two areas - 54.5 percent as opposed to about 61 percent and possibly reflects the classification used rather than any real difference.*

From the foregoing it is clear that the Nembi child is of a poorer nutritional status than his Lagaip or Kainantu counterpart for the whole of the first five years of life. More importantly, his nutritional status in the first eighteen months of life brings him well below the 80 percent weight-for-age level and he is possibly stunted as well. But other than being relatively short and indeed thin for his height, it is not known to what degree his functions are impaired or indeed whether being short and relatively light is a functional disadvantage at all. The extent to which the growth pattern of Nembi children is an adaptation to their environment, food supply and diet is not known, neither is the extent to which their growth pattern reflects a response to a harsh and difficult environment. It may be that the adult population, the survivors of a difficult and risk-laden childhood, portrays in a better way than children the long-term effects of adaptation.

Nembi adults

Sinnett conducted research in the village of Murapin in the Enga Province in 1975. His data on heights and weights of adult men and women provide a useful comparison with Nembi adults. Murapin is a

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* Normal children are those who are neither stunted or wasted. The difference between the proportion of children who are normal in the three areas is exaggerated by the cut-off point below which a child is classed as stunted or wasted (see footnote page 74).

part of the Tukisenta MCH clinic which Harvey (1979) included in his survey of Lagaip children in 1978, further enhancing the usefulness of the comparison. Although both samples of adults are small, that for the Nembi Plateau being drawn from one clan, (the Pubi of the Pubi-Penarop), the standard deviations are similar in proportion to the means for both data sets, which suggests that they may be representative and contain no obvious anomalies. Table 2.13 compares the adults of Kongip village of the Pubi clan with the adults of Murapin.

Although similar in height to Lagaip males, Nembi males are appreciably lighter, which perhaps reflects not only the long term inadequacies of the Nembi diet and the poorer environment but also more immediate dietary shortfalls. The differences in height are not significant, but may possibly reflect a genetic difference. The data are inadequate to test this but as I argue later, (Chapter Three) the Nembi have intermarried with lowlands populations, who are generally taller than highlanders. The lower mean weight of the younger Nembi adult men possibly reflects a slower rate of maturity in comparison to those of Lagaip. It may also be a reflection of delayed marriages on the Plateau. Men do not marry until their late twenties and until marriage cannot rely upon a woman to provide them with regular meals. Unlike the Huli of the Tari Basin (Glasse 1968), Nembi men are reluctant to harvest and cook their own food. In common with other highlanders, and unlike Europeans the men of Lagaip and Nembi lose weight as they grow older.

Adult women are shorter than men. They reach maximum height and weight in their twenties. As they grow older their weight

Table 2.13 : Comparison of Kongip Adult Males with those of Murapin, Enga.

KONGIP

	Weight Kg			Height Cm			Percentage Wt/Ht
Age	No	Mean	SD	No	Mean	SD	
20-29	13	51.88	5.8	13	159.23	5.15	85-89%
30-39	15	54.06	5.52	15	159.93	3.91	85-89%
40-49	5	49.7	8.69	5	155.60	7.26	85-89%
50-59	7	47.6	2.47	7	154.87	3.39	80-84%
60 +	5	46.5	5.66	5	153.4	4.38	80-84%
MURAPIN (after Sinnett 1975:161)							
20-29	74	59.8	6.2	74	158.5	5.8	95-99%
30-39	102	55.8	5.8	103	156.9	4.9	95-99%
40-49	100	52.8	5.9	100	155.6	4.9	90-94%
50-59	38	50.2	6.9	38	155.4	5.9	85-89%
60 +	29	46.4	4.7	28	154.4	4.7	80-84%

Comparison of Kongip Adult Females with those of Murapin, Enga

KONGIP

	Weight Kg			Height Cm			Percentage Wt/Ht
Age	No	Mean	SD	No	Mean	SD	
20-29	21	51.15	5.53	21	150.8	5.12	100-104%
30-39	15	49.52	6.44	15	150.06	5.3	95-99%
40-49	8	43.68	4.03	8	147.87	4.81	85-89%
50-59	10	41.8	4.32	10	146.45	4.15	85-89%
60 +	8	37.68	3.81	8	143.25	2.8	80-84%
MURAPIN (after Sinnett 1975:161)							
20-29	92	50.8	5.4	92	150.2	4.8	100-104%
30-39	106	47.8	5.4	107	147.6	4.9	95-99%
40-49	91	44.1	4.6	91	146.7	4.1	90-94%
50-59	29	41.6	5.2	30	147.1	5.4	85-89%

steadily decreases, but Nembi women lose weight at a faster rate than those of Lagaip. The Nembi women are also shorter than Lagaip women in old age, even though their weights remain similar. Nembi women are of similar weight to Nembi men, but Lagaip women are much lighter than Lagaip men. This is especially so for men and women in their twenties. Nembi women lose weight dramatically during their thirties and forties, possibly reflecting the stress of child-bearing as well as their heavy work-load.

The growth path of Nembi males and females from birth to old age and death (Figure 2.5) in common with other Papuan New Guinea populations, is much slower than in European and American populations. Males mature at a slower rate than females and slow maturation may be an adaptation to inadequacies of diet. On average, girls reach menarche at 18, (pers.comm. J. Baines) very late compared with western women, at which time they are regarded as suitable for marriage. In addition menopause is reached at 44, (pers.comm. J. Baines) very early compared with western women and may also be a response to poor nutrition. I discuss the full significance of these factors later (Chapter Seven) but it is possible that the fertility of women is impaired to an extent which slows population growth, and may even be a response to population pressure upon available food resources.

This raises the question of what is adaptive and what is responsive, and whether the Nembi are less well adapted to their environment than the people of Lagaip. This question forms part of the hypotheses posed throughout the period of fieldwork and analysis of data. My broad conclusion is that anthropometric and physiological

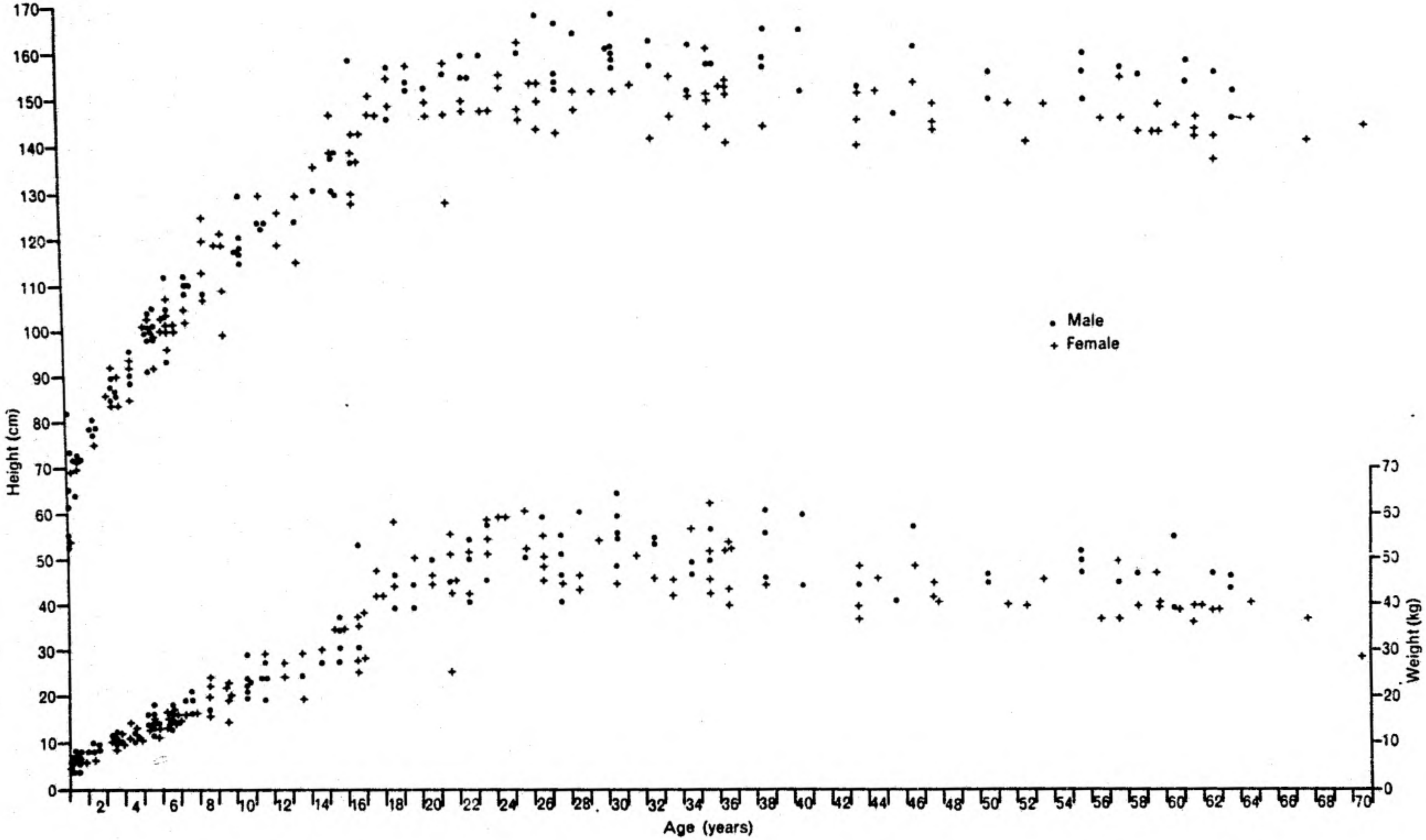


Figure 2.5 : Height and weight of Nembi Plateau adults and children.

adaptation alone is an inadequate explanation of the condition of the Nembi people, or for that matter of the Lagaip people. Technological, cultural, ideological and political factors complement the biological response of man to his environment. I would argue on the basis of Waddell's data (1972) that the Lagaip (Enga) are far better adapted technologically to their environment than are the Nembi. A closer examination of the pattern of malnutrition on the Nembi Plateau is a necessary preliminary to further discussion on the possible causes of the poor health and nutritional status of Nembi children. Before doing so however it is necessary to comment upon the adequacy of the data collected.

Whilst the data are of the type generally collected in nutritional surveys, they record only children who were living at the time of the survey. Thus the data provide a record of survivors. Any dissection of the data for comparison of different areas of the plateau must be treated with caution. Nevertheless some idea of the synergism of malnutrition and infectious disease, and their effect upon infant and child mortality rates, can be gained from analysis of data collected for the population of the Lower Pwe creek region of the central Nembi Plateau. The rest of the thesis is concerned with the clans of the Lower Pwe creek, especially the Pubi-Penarop clan pair whose major ceremonial group was at Kongip where we lived. Thus what follows is an attempt to place the Lower Pwe creek in the context of the wider Nembi pattern of child nutrition.

Nutritional status of different areas of the Nembi Plateau

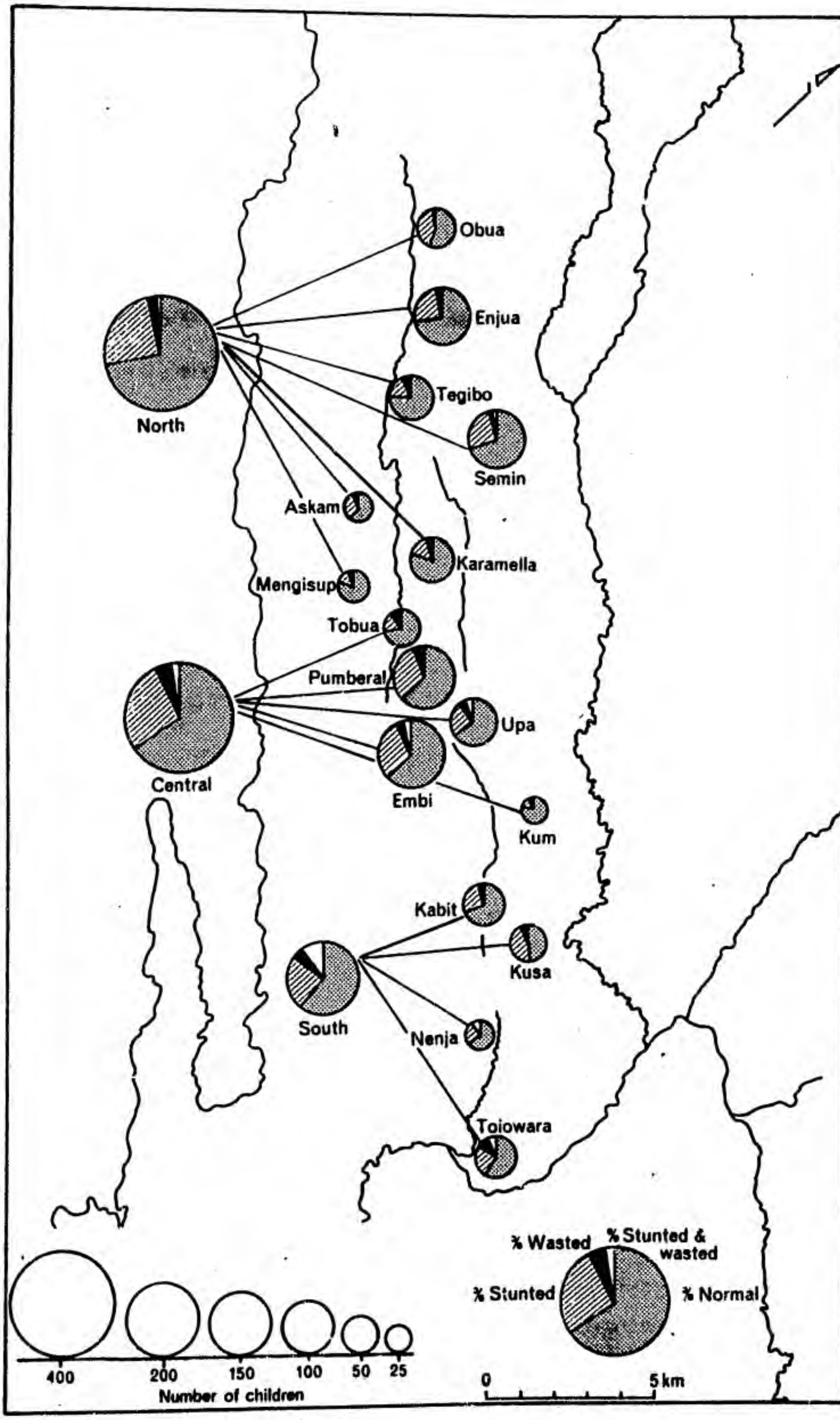
The Pubi-Penarop, living in the Lower Pwe creek at an altitude of around 1760 m are one of a number of clan pairs which inhabit the central Nembi Plateau (map 2.1). The Plateau can be divided on the basis of altitude and clan alliances into three, the northern, central and southern plateau. The central plateau may be further divided into the Pwe ipond el (people of the Pwe river) and the Yoel el (people of the valley - meaning beneath the mountain Arandei).

The Ol Health Centre is in a central position on the Nembi Plateau on a ridge overlooking the Lower Pwe creek: the home of the above two confederations of clans. Its inpatients and the majority of its outpatients are from the central plateau. Only occasionally do men and women from further afield come to the Ol Health Centre for treatment. Data for prevalence of sickness and disease are therefore more applicable to the central plateau than elsewhere. With this in mind, the importance of placing the nutritional status of the Pubi and the Pwe ipond el in the context of the rest of the plateau is emphasised.

By almost all criteria the children of the southern plateau appear to be of marginally poorer nutritional status than those of the northern plateau (Table 2.14 and Map 2.2). Once again it must be emphasised that the cut-off for 'normal' is above 90 percent height-for-age and above 80 percent weight-for-height, points which are

Table 2.14 : Stunting and Wasting on the Nembi Plateau (percent in each clinic).

Clinic	Region	Normal		Stunted		Wasted		Stunted & Wasted		Total Number
		%	No.	%	No.	%	No.	%	No.	
Kabit	south	69.5	41	27.1	16	1.7	1	1.7	1	59
Nenja	south	66.7	20	23.3	7	0	0	10.0	3	30
Kusa	south	48.9	23	44.7	21	4.3	2	2.1	1	47
Toiowara	south	59.7	40	23.9	16	9.0	6	7.5	5	67
Mean for	south	61.1	124	29.6	60	4.4	9	4.9	10	203
Kum	central	77.8	21	18.5	5	3.7	1	0	0	27
Embi	central	63.5	101	29.6	47	3.8	6	3.1	5	159
Pumberal	central	62.5	85	31.6	43	4.4	6	1.5	2	136
Tobua	central	72.9	35	16.7	8	10.4	5	0	0	48
Uba	central	66.3	55	24.1	20	4.8	4	4.8	4	83
Mean for	central	65.6	297	27.2	123	4.9	22	2.4	11	453
Karamella	north	79.7	55	18.8	13	1.4	1	0	0	69
Semin	north	70.2	87	25.8	32	1.6	2	2.4	3	124
Mengisup	north	81.6	31	13.2	5	5.3	2	0	0	38
Askam	north	63.6	21	30.3	10	6.1	2	0	0	33
Tegibo	north	75.7	53	18.6	13	4.3	3	1.4	1	70
Enjua	north	72.8	83	24.6	28	1.8	2	0.9	1	114
Obua	north	55.2	32	43.1	25	1.7	1	0	0	58
Mean for	north	71.5	362	24.9	126	2.6	13	1.0	5	506
TOTAL PLATEAU		67.4	783	26.6	309	3.8	44	2.2	26	1162



Map 2.2 : Nutritional status of Nembi Plateau children by Maternal and Child Health Clinics in the north, central and southern plateau

subjective and, in the absence of information on functional impairment of different degrees of malnutrition, arbitrary.

The percentage of children who are of normal weight-for-height and height-for-age varies from 48.9 percent for Kusa on the southern plateau, to 55.2 percent for Obua on the northern plateau, to 81.6 percent for Mengisup on the northern plateau. Despite the variation from one clinic to the next a general pattern can be discerned if clinics are grouped according to clan alliances and regional groupings. These regional alliances are discussed more fully in chapter three, but are based on marriages as well as ancestral links.

Of the southern plateau children, 10.4 percent more are below normal weight-for-height and height-for-age than the northern plateau children. The central plateau children fall between the two. More of the southern children are stunted than in the north and the picture is the same for acutely malnourished children, with 9.3 percent of the southern children stunted and wasted or wasted in contrast to 3.1 percent - a third as much - for the northern plateau.* Of all the clinics the most southerly, Toiowara at the junction of the Emia creek and the Erave, has only 83.6 percent of children in the normal or stunted categories with 16.5 percent of its children suffering from some form of acute malnourishment, the worst by far of all the Nembi

* The distribution of children between the categories in the southern plateau is significantly different from the northern plateau (χ^2 15.75 $p<.001$). The distribution in the central plateau is also significantly different from the northern plateau (χ^2 2.1 $p<0.04$). Between the southern plateau and the central plateau there is no significant difference in the distribution (χ^2 3.51 $p<0.32$).

Plateau MCH clinics. The children of Karamella and Obua are the best nutritionally with only 1.4 and 1.7 percent respectively acutely malnourished. The suggestion made earlier, that there may be a gradient in nutritional status from the south of the plateau to the north, has foundation. From the differences in the distribution of children between the categories there appears to be a significant difference between the southern and central plateau on the one hand and the northern plateau on the other. The difference may have some significance in that in Chapter Three I argue that the people of the southern and central Nembi Plateau come from the south and there may be genetic differences between the people of the northern and southern plateau.

The picture is the same if the categories of nutritional status are broken down into age groupings for each of the three regions of the plateau (Table 2.15 and Figure 2.6) The numbers in each group are small and comparisons must be made with care.

The proportion of children in all age groups, except between 36 and 47 months, who are acutely malnourished is consistently lower in the northern plateau than in the southern or central plateau. The children of the southern plateau are similar to those of the central plateau, although the percentage number of children exhibiting wasting is larger in the central plateau between the ages of 6 and 17 months.

The percentage figures give a misleading comparison between the three regions of the plateau. In the southern plateau in the first six months of life only one child is stunted and wasted and yet

Table 2.15 : Stunting and Wasting on the Nembi Plateau for Individual Age Groups in Three Regions (Waterlow Classification).

Region	Age Group (Months)	Normal		Stunted		Wasted		Stunted-&-Wasted		Total Number
		%	No.	%	No.	%	No.	%	No.	
South	0- 5	83.3	15	0	0	11.1	2	5.6	1	18
Central		92.3	48	3.8	2	3.8	2	0	0	52
North		96.8	61	1.6	1	1.6	1	0	0	63
Plateau		93.2	124	2.3	3	3.8	5	0.8	1	133
South	6-11	73.9	17	4.3	1	21.7	5	0	0	23
Central		68.1	32	8.5	4	14.9	7	8.5	4	47
North		91.1	51	1.8	1	7.1	4	0	0	56
Plateau		79.4	100	4.8	6	12.7	16	3.2	4	126
South	12-23	62.5	35	25.0	14	1.8	1	10.7	6	56
Central		71.0	71	15.0	15	10.0	10	4.0	4	100
North		72.4	71	16.3	16	7.1	7	4.1	4	98
Plateau		69.7	177	17.7	45	7.1	18	5.5	14	254
South	24-35	48.3	14	41.4	12	3.4	1	6.9	2	29
Central		60.7	54	33.7	30	3.4	3	2.2	2	89
North		79.2	76	19.8	19	1.0	1	0	0	96
Plateau		67.3	144	28.5	61	2.3	5	1.9	4	214
South	36-47	62.2	23	37.8	14	0	0	0	0	37
Central		54.3	51	44.7	42	0	0	1.1	1	94
North		60.6	60	38.4	38	0	0	1.9	1	99
Plateau		58.3	134	40.9	94	0	0	0.9	2	230
South	48-59	50.0	20	47.5	19	0	0	2.5	1	40
Central		57.7	41	42.3	30	0	0	0	0	71
North		45.7	43	54.3	51	0	0	0	0	94
Plateau		50.7	104	48.8	100	0	0	0.5	1	205

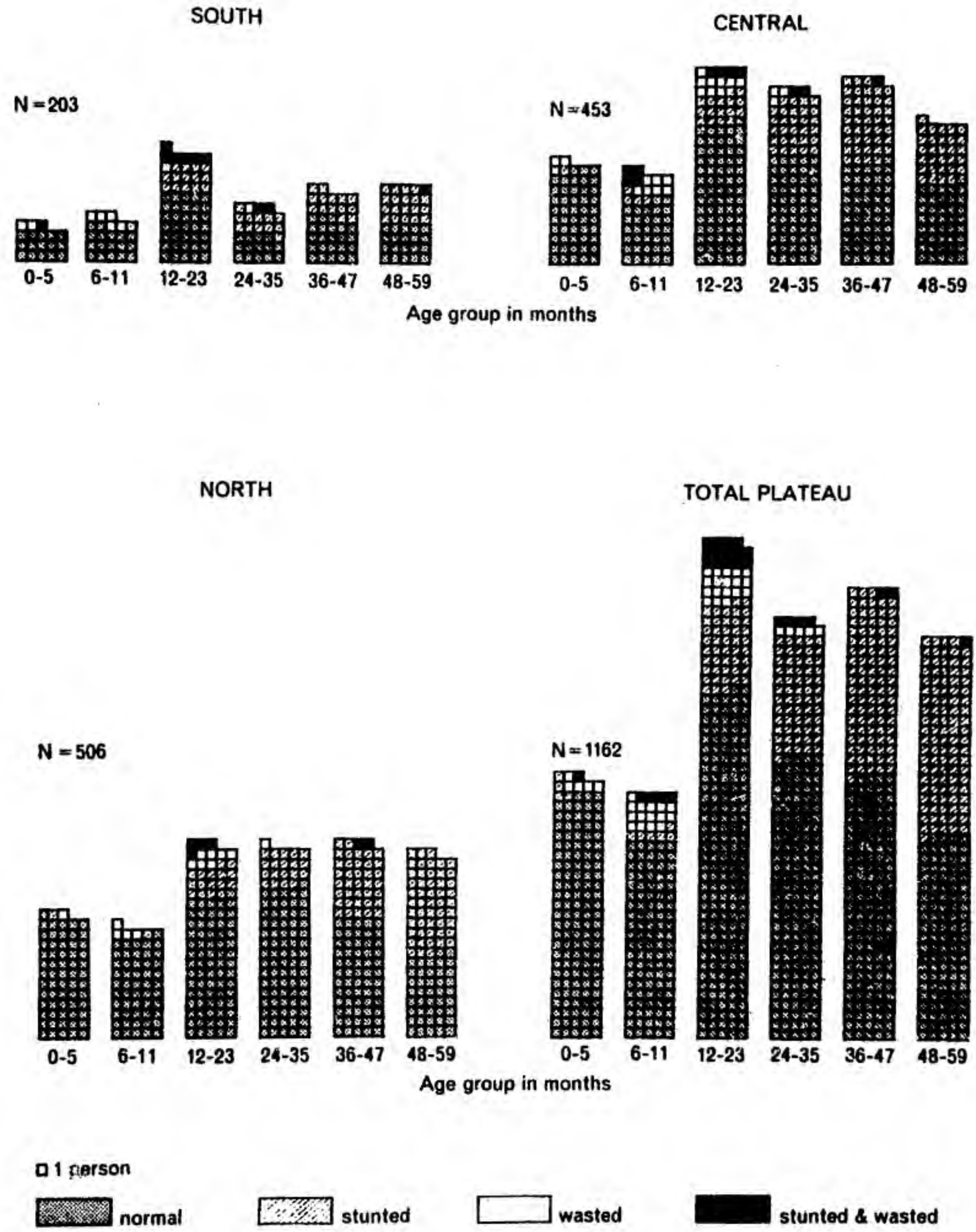


Figure 2.6 : Nutritional status of Nembi Plateau children by Maternal and Child Health Clinics in the north, central and southern plateau.

that one child accounts for 5.6 percent of the total number of children in that age group, a misleading incidence which must be viewed critically. On the rest of the plateau no children under the age of 6 months are both stunted and wasted although 3.8 percent are wasted and 3.8 percent stunted in the central plateau and 1.6 percent wasted and 1.6 percent stunted in the north. I suspect that more children do in fact become wasted as well as stunted in the southern plateau but do not survive for long and the data represent survivors only. My tentative conclusion is that in the first six months of life a child in the southern plateau has a more precarious existence, especially as on the central and northern plateau no child is stunted-and-wasted in this age category. A greater proportion of children in the southern plateau during the first six months of life are wasted. If a child on the southern plateau is stunted he is also more likely to be wasted.

The onset of malnutrition is thus earlier and more acute in the southern plateau. This pattern is recognised by the people of the central and northern plateau who view the southern plateau with suspicion as an area bedevilled with sorcery and evil spirits which kill infants. Their own children are not as severely affected, until between the age of 6 and 17 months when they too begin to lose weight and die.

In the southern plateau then, the problem of malnutrition starts earlier in life than on the central and northern plateau, It appears to remain more severe but because no record is available of those children that die, precise conclusions cannot be drawn.

Conclusion

In comparison to both international standards and other highland Papua New Guinea populations the Nembi people are both short and light. It is not known to what extent adults are functionally impaired, nor to what extent they display the long-term effects of adaptation to a poor diet (Wheeler 1980:447) and to an unwholesome environment. Likewise lack of age-specific mortality data preclude any precise measurement of the degree of risk of dying associated with any particular height or weight at any given age during childhood.

From anthropometric measurement of survivors however a picture of the prevalence of malnutrition has been built up for the children of the Nembi Plateau. The results from weight-for-age measurements are similar to the results of the Waterlow Classification which combines weight-for-height and height-for-age assessments.

Only a small proportion of Nembi children are severely malnourished: of 1162 children 33 (2.8%) were under 60 percent weight-for-age compared with 20 (2.2 percent) who were stunted-and-wasted (Table 2.14). If those who are wasted but not stunted are included then another 44 children (3.8 percent) are at risk. This comparison shows very nicely the difficulty of using the classification systems and highlights the problem of defining the cut-off point separating malnourished children from those who are well-nourished or adequately nourished.

Using the Waterlow classification we can conclude that 67.4 percent of Nembi children are of normal nutritional status (roughly 783 children of those measured) whilst 26.6 percent are stunted (309 of those measured) and exhibit longterm nutritional deficiences, and 6 percent are acutely malnourished i.e. wasted and stunted-and-wasted (70 children). The Gomez classification based upon weight-for-age seems to underestimate the problem of acute malnourishment (ie. under 60% weight-for-age) whilst also underestimating the proportion of children who are normal (ie. over 80% weight-for-age).

Of those 70 acutely malnourished children 19 were living on the southern plateau, 33 on the central plateau and 18 on the northern plateau. But whilst more acutely malnourished children were found on the central plateau, the southern plateau is the area with the poorest nutritional status. On the southern plateau 9.3 percent of children were acutely malnourished, on the central plateau 7.3 percent and on the northern plateau 3.6 percent (Table 2.14).

Despite the problems of comparing data sets collected under different conditions it can be seen that the Nembi Plateau has a problem of what can be called "hidden" malnutrition. Children who are between 60 and 80 percent weight-for-age (43.8 percent in 1980) suffer from this affliction. But because no comparison is possible between the infant and child mortality rates in the three areas, the rate at which children who slip from the 'road to health' also die cannot be estimated. On the Nembi Plateau in 1980 only six children (4.6 percent) between the age of 0 and 5 months were wasted, while in the age group 6 to 23 months, 52 children (13.6 percent) were wasted. But only nine children (4.2 percent) in their third year of life and three (1.4 percent) in their fourth and fifth years were wasted (Table 2.15). The increase in the incidence of wasted children during the first two years of life is startling, but the just as sudden decrease in the proportion of wasted children over the next three years is of greater significance. There is no evidence that the nutritional condition of wasted two year olds improves as they grow older. The only explanation remaining is that they die.

CHAPTER THREE

SOCIAL STRUCTURE AND ORGANISATION

I have gone far into most of the strange and hostile corners of this land. Sometimes the inhabitants have resented my intrusion,..."Is this your mother's country?" they have shouted at me from spur and crag. And when I could not answer them...they yelled insultingly at me, demanding my right to teach them how to live

J.G. Hides
(Savages in Serge 1938:2-3)

The origin of the Nembi people

Linguistic, archaeological and vegetation evidence and some clues from physical anthropology provide a picture of general migrations into the highlands of Papua New Guinea. The picture lends credence to the ethno-historical clues of tradition and legend and allows some specific inferences to be drawn about the peopling of the Nembi Plateau and the present disposition of its socio-economy (see Nelson 1971 for a similar analysis of the Nebilyer valley, and Hayano 1978, for the Awa of the Eastern Highlands).

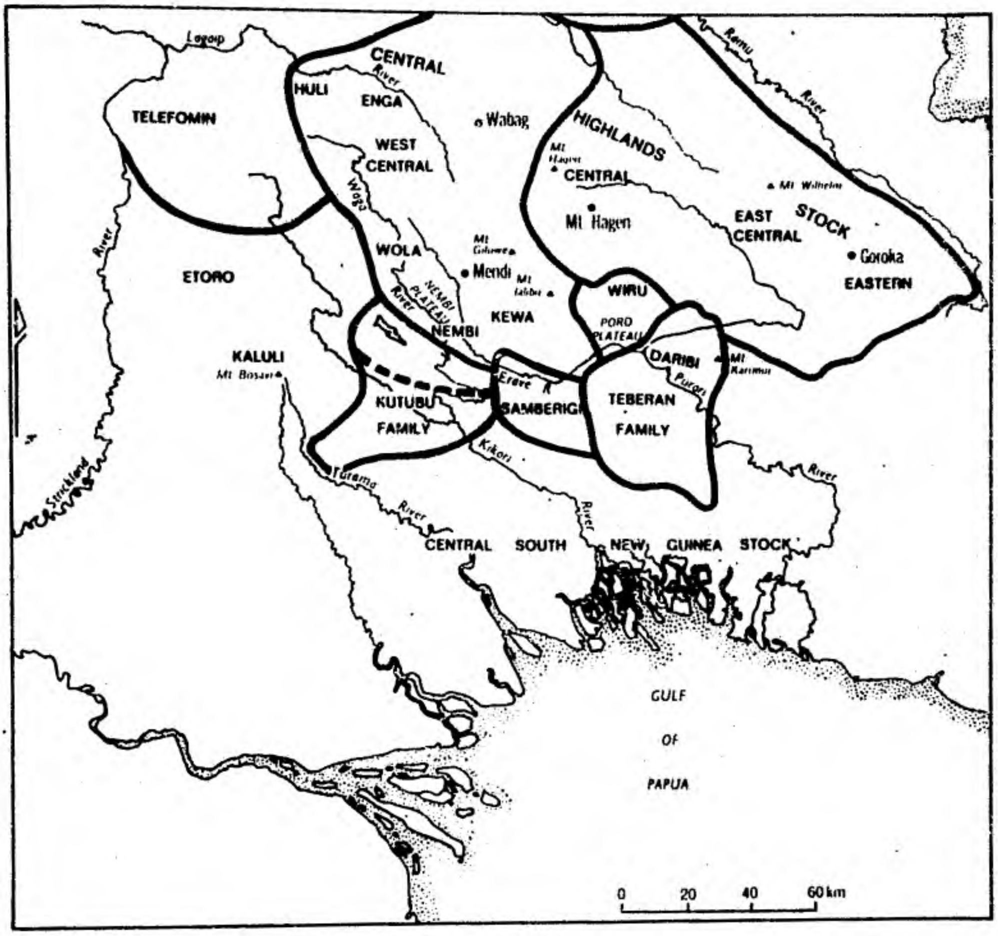
Archaeological and linguistic studies suggest that man probably migrated into the highlands from the west at least 50,000 to 60,000 years ago (Golson 1981, et Sequiter, Hope and Hope 1976, Wurm 1980, Wurm et al 1975). Initial movements of people speaking old Papuan languages took place between 15,000 and 10,000 years ago (Wurm 1980). Elements of their language survive today as isolates in areas not in the path of later migrations (Wurm 1980:11).

Later movements from the coastal regions, about 3,500-7,000 years ago (Wurm et al 1975, Wurm 1980), entered the highlands via the major rivers, such as the Sepik, Fly, Kikori, Strickland and Markham. People settled the lower highland valleys and superimposed a new gloss on the existing languages as well as modifying the vegetation to grassland (Hope 1980). Blood group evidence supports this pattern (MacIntosh et al 1958:193-195, Walsh 1972a:541).

Two blood genes occur in a continuum from the west to the east in the highlands (MacIntosh et al 1958:191) which suggests that the highland populations are a hybridization of the two populations which migrated into the region. The earlier occupied the entire island from coast to coast. The highlanders exhibit features characteristic of this first population rather than the second wave into the highlands whose characteristics are more strongly evident on the coast today (Juptner et al 1958:126, Kariks et al 1958, MacIntosh et al 1958:193, Walsh 1972a:540-53 and 1972b:896-901). It is possible that the Nembi Plateau was occupied by wandering bands of hunter-gatherers and swidden horticulturalists in the distant past. Legend and tradition do not recollect this period although stone artifacts - mortars, pestles and clubs similar to those found elsewhere in the highlands are relics of this period.

Lexico-statistical evidence of recent language change suggests migration patterns which place the southern Nembi Plateau as part of an area in which two distinct movements and language stocks meet (Map 3.1). To the northeast is the Central Highlands Stock and to the south the Central South New Guinea Stock of the Gulf lowlands (Wurm 1975). Linguistic patterns also suggest that a series of local migrations took place from an original hearth-land (Enga) which isolated the southern Nembi Plateau, producing a language confined to a relatively small area (Franklin and Voorhoeve 1973, Franklin K.J. and Franklin J. 1978).

The Nembi Plateau is part of the highland cultural and linguistic periphery and borders onto the intermediate lowlands to the



Map 3.1 : Simplified map of the languages of the Eastern Central Trans New Guinea Phylum

south and southwest (Brown 1978b:98). The Nembi's distant relationship to the Enga both in time (as shown by linguistic association) and space, reinforces that position. Indeed some elements of that relationship were recognised by the early explorers in the region.*

The Enga region is the homeland of the West Central Family of the Central Highlands Stock (Wurm et al 1975, Capell 1972:615, Franklin 1968:40 Franklin K.J. and Franklin J. 1978:72). The languages of this stock were probably becoming separate identities from the Proto-Engan as recently as 2,000 years ago (Franklin K.J. and Franklin J. 1978:72) as people migrated from the Enga hearthland. Two major migrations entered the Nembi, Mendi, Kagua, Ialibu and Erave region (see Map 3.2).

The first penetrated south to the Samberigi valley and the Poro plateau in the southeast. Later movements went northwest from the Poru plateau and from present day Erave (Franklin 1968, Franklin K.J. and Franklin J. 1978). Channelled by the limestone barrier of the Masina Range in the vicinity of Urida these latter movements followed the Erave river valley and possibly that of the Nembi northwards (Franklin 1968:40-41). Smaller bands of people scaled the Masina Range and eventually reached the Mubi river lowlands to the

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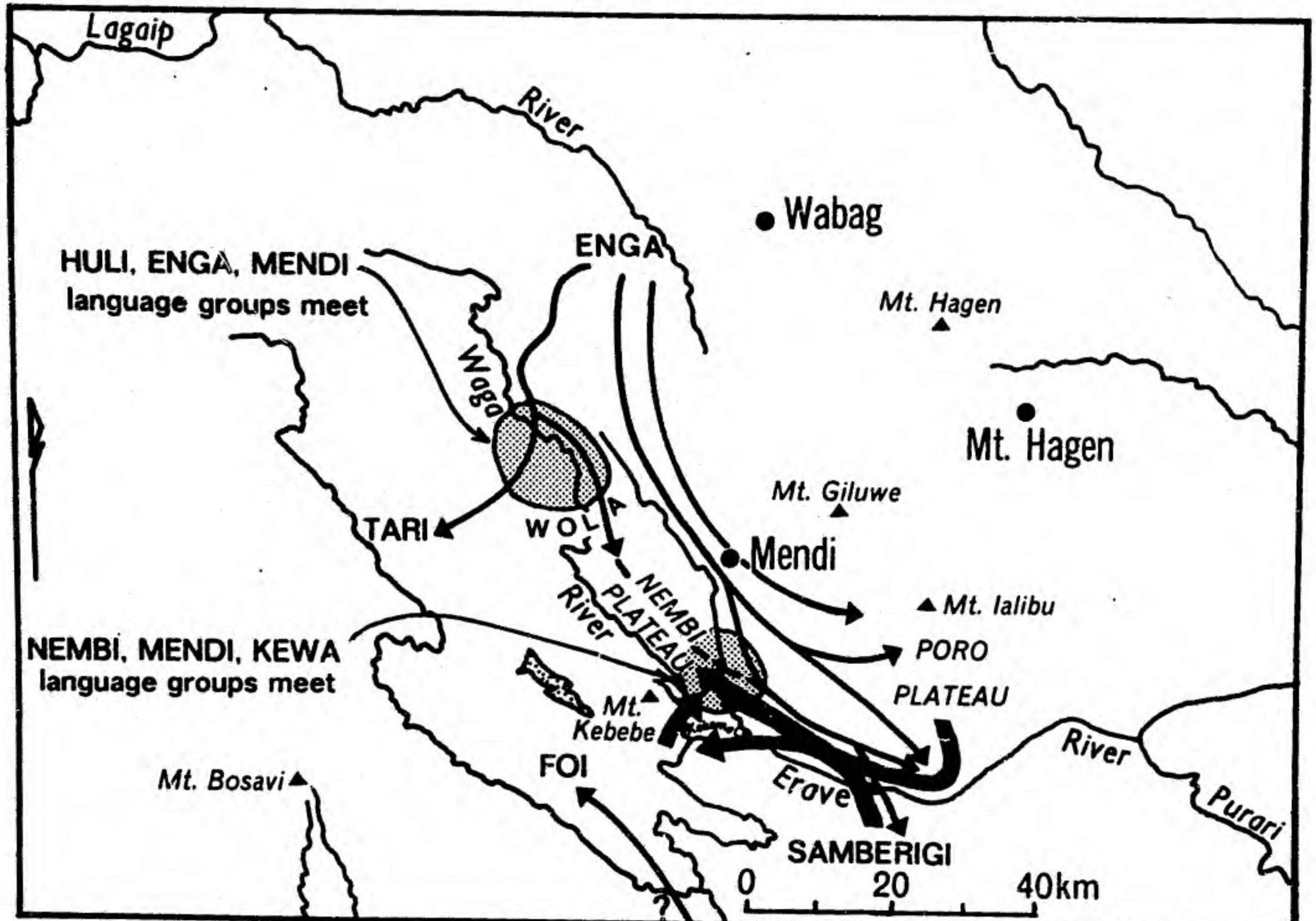
* 'I noticed that the linguistic groups were extensive. A Mendi interpreter could speak to people from the Hagen border to the lower Waga Valley, and a Tari man could make himself understood from Faua - one day NW of Kutubu - to the Wabaga boundary' Patrol Report No. 1 Mendi 1952/3.



Map 3.2 : Language migration from the Enga heartland (see text for detail)

west.* Concurrently migrations from the Enga hearthland went west through the upper Waga Valley to the Tari Basin, the Nipa Basin and possibly the Upper Nembi Valley. This last movement met that originating from Erave. Meggitt (1956:90) described the upper Waga Valley as an area '...of great anthropological interest, for here three highland cultures meet', the Huli, the Enga and the Wola of the Mendi language groups.

The lower Nembi Valley and the southern Nembi Plateau are a focus of similar interest. To the north are the Wola, to the south the Kewa, to the east the Mendi, and to the west the Foi of Lake Kutubu and the Mubi lowlands. Topography accentuates the lower Nembi Valley's central position to the convergence of these three highland languages, for here the valleys of the Mendi, Ankura, Angura, Lai and Nembi join to form the Erave. Dialect variation in the area is great and has lead to confusion in identifying language boundaries.

Tipton suggests (1980 pers comm) that the area of the southern Nembi Plateau, the Nembi Valley and part of the lower Lai

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* In the period before the war, Champion and other officers noted that the people of Iomesi on the Kokoma river (a tributary of the lower Waga above its junction with the Mubi) spoke both Kewa and Foi languages. After the war D.J. Clancy noted '... crossed the Kokoma creek ... and went to Iomesi village ... This village is half Waga and half Foi language groups...' Patrol Report No.1 Lake Kutubu 1950/51). The year before it had been noted that '... the people of Mubi have a good deal of contact with the Waga, and every Mubi village can claim varying numbers of Wagas living with them. Harabuio and Iomesi of course claim the greatest number. The latter villages are themselves built on the Waga - Mubi point and on a tributary of the Waga (the Kokoma) respectively. While we were at Iomesi a middle aged man, Tamari Amarabi, was present. I recognised [him] as one of the people seen on the Sugu river at a spot named Kamareba [to the east of the Masina range] ...' Patrol Report No. 2 Lake Kutubu 1949/50).

valley and the Erave valley, inhabited by some 17,000 people is a language area which she calls Nembi. It is the link between the Kewa and Mendi languages which the Franklins speculated must exist (Franklin K. and Franklin J. 1978:3, 83).

Links between Nembi and Foi are not definite although evidence suggests that there are some connections (Franklin 1973). It is not clear whether the Lake Kutubu languages belong to the Central South New Guinea Stock of the Gulf or to the Central Highland Stock, but Franklin and Voorhoeve suggest that they form a '...vital link between the highlands and lowlands...' (1973:167). The gradient of language association nevertheless extends from the northeast to the southwest. The Foi language is more closely related to the languages to the south than to the north (Rule 1977:107-110, Franklin and Voorhoeve 1973:151-186, Wurm 1975:14). The Kewa language to the south of the Nembi is also more closely related to Foi in the southwest than are other languages of the West Central Family to languages to the east and northeast (Franklin and Voorhoeve 1973:153-155).

The Kutubu languages are also closely related to those of the Papuan Plateau and Mt. Bosavi region to the northwest as well as those of the Samberigi/Sau and Karimui Plateau to the southeast (Franklin and Voorhoeve 1973:166, Donaldson and Franklin 1973:111-136). Together they form a band which borders the southern fringe of the New Guinea Highlands and which thus accentuates the position of the Nembi, in the west, at the edge of the highlands.

More recent movements, recorded in clan legends and tradition, confirms evidence from linguistics, archaeology and physical anthropology of the position of the Nembi at the periphery of the Central Highlands, at an interface between highland and lowland cultures. Extending southwards from the southern Nembi Plateau are three lobes of population. All three valleys the Om, the Emia and the Tula gap in the past and to a lesser extent at present are important routeways converging upon the Lower Pwe Creek Basin of the Central Nembi Plateau, the home of the Pubi-Penarop and Koin-Iomo clan alliances (Figure 4. 1).

Whilst tradition and legend describe the origin of some of the Nembi clans in the north, those of the Pubi-Penarop and the other clans of the Lower Pwe Creek suggest that they came through one or other of the three corridors from the south. The division between the direction of origin mirrors the evidence from linguistics. Indeed Pubi-Penarop and Koin-Iomo legend states that groups from the north had settled the Lower Pwe Creek and the rest of the Nembi Plateau before the arrival of the Pubi-Penarop and the Koin-Iomo from the south. The Pubi-Penarop believe that they originate from the Lake Kutubu and Mubi lowlands. The story is told in more detail in Appendix 3.1.

Kurop Pubi, the clan ancestor, and his descendents did not move directly from Kutubu to the Nembi Plateau. Settlements were also made in the Lower Waga Valley and in the hills surrounding the Lower Pwe Basin.

The similarities between the legends and the linguistic evidence are appealing, but Hayano (1978), cautions against speculation about the movements of non-literate people in the absence of direct sources. However, while the legend relates the Pubi's origin as Lake Kutubu, it is interesting to ponder whether the migratory movement of the people from the Erave area which spilled over the Masina range to the Mubi lowlands, also extended further north as far as the Lake. These proto-Nembi speakers may have mingled with the forebears of the Foi coming in from the Kikori lowlands and may have been the people of Kurop Pubi and Kurop Epi's generation. Patrol Officers in the late 1940s and early 1950s document a free movement between the Mubi lowlands, the Waga and the Sugu people (Kewa). The southern Nembi Plateau and the lower Waga Valley may have been, in the not too distant past, a blend of Foi and Nembi speakers.

Within the past ten generations however the Nembi have opted to become, and have been incorporated into, highland cultures as epitomised by the core areas of Enga and Chimbu (Brown 1978:98). To some extent the Nembi betray their past in that they regard sago (a lowland staple traded in from Lake Kutubu), as a delicacy. A big-man of the Koin-Iomo has access to sago palms on the Mubi river, up to 2 days walk away. In addition when the Nembi kill pigs at their large pig festivals (mok-enk), people from Lake Kutubu make the journey onto the plateau to partake of the pork killed, given to them not only by their trading partners but also by those whom they regard as relatives. The Nembi social structure and organisation nevertheless are now typical of the highlands.

The basis of social structure

The Nembi live in small hamlets (andaa) scattered through the grassy basins and on the lower slopes of the Nembi Plateau as well as in the lower Nembi valley, and parts of the Erave and Waga Valleys adjacent to the plateau. Since pacification by the Australian Administration in the late 1950s and early 1960s smaller settlements have been abandoned as people have relocated close to ceremonial grounds (hauma) in the more accessible parts of the plateau. Hamlets consist of family groups. The family (yem) is the fundamental kinship unit upon which the social system is based (see also Franklin 1978:383, Sillitoe 1979a, Ryan 1955, 1959, 1961, LeRoy 1975, 1979) and consists of a man, his wife or wives and their children. In the past men lived apart from women - the men in a men's house (enza) usually close to a ceremonial ground, and the women with their pigs in women's houses (tenda) amongst the gardens. Occasionally both men and women shared a partitioned house (ingatenda): the rear being for the women and pigs, and the front for the men.

Related family groups occupy adjacent territories or locales and because land tenure is invariably tied to kinship, real or ascribed, which also involves a dogma of inheritance, the local groups are essentially territorial descent groups. I have called them sub-clans. Individual sub-clans refer to themselves as no yem ("our families"), and refer to other sub-clans as nemi-yem ("their families"), which emphasises that sub-clans are composed of families reputedly related laterally through brothers, father's brothers and father's father's brothers (Barnes 1962). Such a process of patrifiliation has also been describe. for the Kewa by Franklin (1978:385).

A clan comprises a number of sub-clans which can claim descent from a common ancestor. The members of a clan will refer to all the families of their clan as _no yem_ regardless of their sub-clan, thus also stressing the commonality of a clan hierarchy based upon families which are related.* Clans are also paired: either as brother clans (_amien_), which can intermarry, or brother-sister clans (_engi-mbellien_), which cannot. Some clans, for example the Pubi and the Penarop, although paired as the Pubi-Penarop, are in the transitory stage of changing from _amien_ to _engi-mbellien_. The Pubi-Penarop sub-clans are shown in Figure 3.2 and their relative position to other clans on the plateau in Map 3 . 3. Marriage is prohibited between people who can claim a common ancestral link. Because brothers within a clan or clan pair (_amien_) share the bride-wealth of a sister when she marries they cannot also be contributors to that wealth, which they would be if marriage were taking place within a _engi-mbellien_ clan-pair. Thus as the availability of possible marriage contracts declines within an _amien_ pairing it becomes _engi-_

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* Sillitoe (1979:32) uses the term sem (yem) and identifies it with a specific use by the Wola to refer to families of individual men, but also in a qualified sense to related families in small groups _semengk_ (_yem kang_) and larger groups _semonda_ (_yem andao_). The Nembi have said they would use those terms but did not offer them as their own conception of the description of their segmentary descent groups. Sillitoe has probably ascribed too much of a specific meaning to the two terms. Indeed the principle meaning of _yem_ is line, clan, family or whatever but there is also a secondary but just as important meaning or usage as a collective noun marker e.g. _naik yem_ - a group of boys; _ten yem_ - a group of women; _men ponaip ngo yem_ - a group of pigs and dogs. (I am grateful to Ruth Tipton for helping me clarify this point - pers comm 1980, see also Ryan 1955:83-89, 1961:13).

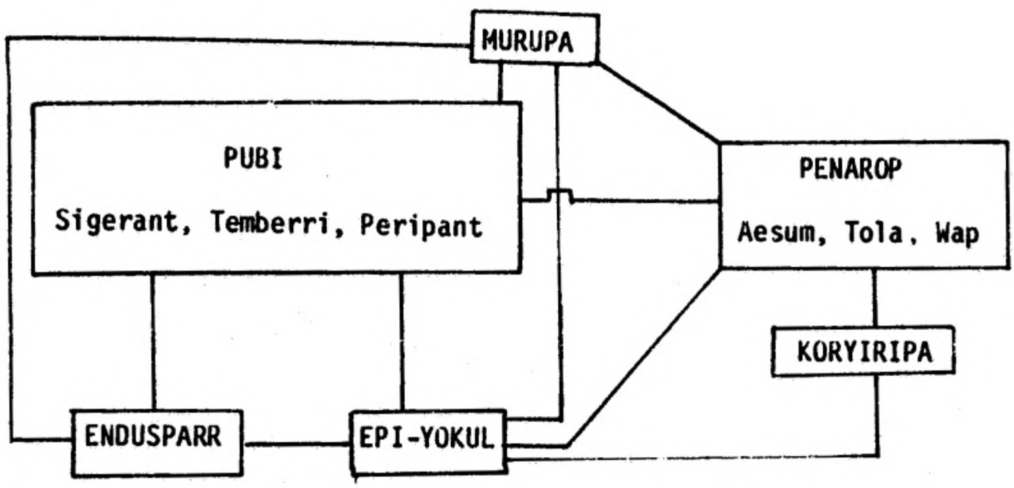
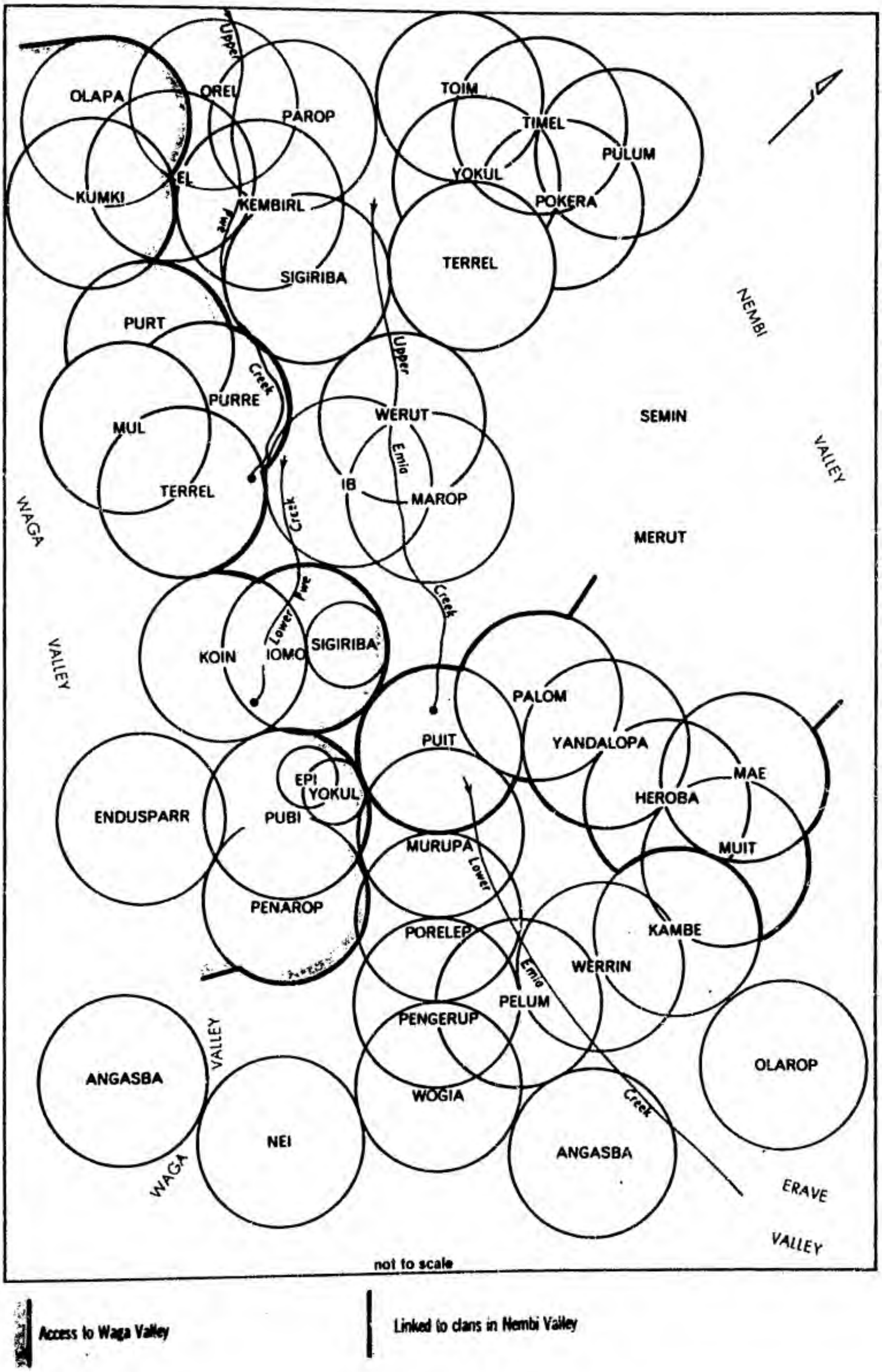


Figure 3.2 : Marriage links within the Pubi-Penarop.



Map 3.3 : Clans of the Central and Southern Nembi Plateau

mbellien, and the men of the pairing who are brothers also receive wealth when the women of either clan marry. By the same token the women are their sisters.

However, as links between clans and sub-clans across clan divisions are forgotten and become part of the more distant past, new pairings develop. People of various sub-clans may begin to intermarry, as has happened to the Epi-Yokul who are an amien clan-pair, and are also amien with the Pubi-Penarop. The Epi and Yokul were formerly sub-clans within the Pubi-Penarop. The sub-clans of the Pubi have in some cases an engi-mbellien relationship with sub-clans of the Penarop, and for others amien. The Pubi-Penarop, in the process of becoming engi-mbellien are thus also becoming yem-pomborr - one clan - rather than yem-elop - two clans. The system is complex and flexible. The vagaries of war and the high incidence of disease would have meant that for some groups the transition from sub-clan to clan, from clan-pair to large clan and clan to sub-clan could have been rapid. Some would have been absorbed and yet others would have split to form two. The segmentary model is but an abstraction of a more complex reality but with a nonetheless strong dogma of patrilineal descent.

Due in part to the trauma of contact, readjustments have been or are being made in the social structure of the Nembi people. To understand the potential paths of development for the area the processes taking place must be understood. Population increases and rapid rises in population density necessarily place pressure upon favourable productive land and therefore upon the means of acquiring land - the land tenure system. The land tenure system is intimately related to descent, kinship and residence and therefore group composition. Permeating through it all is the exchange network. Cutting across the ties of land but reflecting group allegiances are the influences of big-men (el-hauma) as political leaders and manipulators of the exchange of wealth.

Kinship, descent, residence, exchange and land tenure on the Nembi Plateau

The Nembi recognise a form of segmentary patrilineal descent and the idiom is in the vernacular ank para yem - the branches of the highland pandanus tree (see also Sillitoe 1979:42). They also talk of one phallus - teni pomborr - when relating geneaologies, demonstrating the importance of patrilineal descent as an idiom of group membership.

In 1962 Barnes suggested that '... it seems prudent to think twice before cataloguing the New Guinea Highlands as characterised by patrilineal descent'(1962:6). He argued many Southern Highlands societies could fit an ambilineal structure. Indeed for the Huli of the Tari Basin in the Southern Highlands Province, Glasse (1968) described a bilateral (cognatic) descent model. Ryan also noted that residential groups in the Mendi region to the east of the Nembi, were composed of agnates and affines: the clan in its commonest form '... is composed of an agnatic core, with more or less permanent accretions of cognatic and affinal kin, all claiming patrilineal or other descent from a common ancestor who usually gives his name to the group as a whole' (1959:270).

The Nembi, whilst stressing an idiom of one penis or patrilineage, also display in their clan composition a fair measure of ambilineality (Table 3.1). Ryan (1959) fought shy of positing an ambilineal system for the Mendi and proposed that whilst patrilineal descent is the dominant dogma, a man does not rely solely upon close agnates within the exchange network, but also on his neighbours and indeed upon his exchange partners who may be his affines.

Immediately to the north of the Nembi are the Wola, a dialect group of the Mendi. Sillitoe states that the Wola '...have permanent groups which at a casual glance an observer might think correspond to segmentary descent groups.' He adds that 'this is not so, they base their social organisation upon a different premise altogether' (1979:20). Sillitoe emphasised that exchange prompts the formation of

Table 3.1 : Non-agnates in the Clan Territories of the Lower Pwe Creek.

Clan	Number of non-agnate men married	Non-agnate men as a per-cent of all adult men (married)
Ib	19	24
Iomo	12	13
Koin	5	10
Sigiriba	6	8
Pubi	6	17
Penarop	8	16
Endusparr	0	0
Murupa	14	36
Epi-Yokul	2	5
MEAN		14

ad hoc 'action sets' in Wola society and that this is the principle behind group formation (1979:22,83-85). Ryan also noted that exchange was an important element in Mendi social organisation (1961:303), and although Sillitoe rejects Ryan's analysis he also observes, as did Ryan, structures which are distinctly ambilineal:

> 'The Wola have used the family as the building block for the other permanent groups of their society. Several families which are genealogically related by male and female links and which reside and garden in the same area, form a small, named group, and a number of these small groups (the exact number varies from two to ten or more) which people think share a geneaological connection in the dim past (they may forget the precise geneaological relationship) and which occupy a specific territory, constitute a named community. These communities, consisting of related people are exogamous and their members ought not to marry one another' (emphasis added)(1979:21-22).

Like the Nembi, the Wola, within the ambilineal context described above also emphasise some measure of a descent idiom through the analogy of the sem (the Nembi yem) to the branches of the pandanus tree (1979:42).

In criticising Sillitoe's analysis of the Wola social structure, Strathern (1979:99) makes the point that social relationships, which Sillitoe emphasises as being ad hoc, are in fact ordered by an underlying series of obligations between those who regard themselves as kin. Indeed, Sillitoe states that the Wola '...prefer to claim land on the territory where their fathers lived' (1979:39).

Because the Nembi are bound to their north by the Wola and to the east by the Mendi, and because they, like their neighbours, display a degree of ambilineality within their group structure whilst expressing a patrilineal idiom of descent, it is important to place any analysis of the Nembi social structure within the wider discussion of Highland New Guinea social structure.

The main arguments hinge upon the relative importance of kinship, descent, residence, and ceremonial exchange as the underpinning for group formation (Barnes 1962, 1967a, 1967b, Meggitt 1965, Kelly 1968, de Lepervanche 1967, 1968, Strathern 1971a, 1973, 1979, Sillitoe 1979, Wohlt 1978). After Barnes' cautionary note about applying segmentary descent models to Papua New Guinea Highland societies, de Lepervanche argued (1967, 1968) that local ties and common residence are the principle basis for group formation and are of greater importance than kinship or lineage _per se_. She argued that living together reflects the way people view their kinship ties within the local group and their right to cultivate land in that locality. Thus the potential members of a local group are determined by rules of kinship and descent which do not necessarily dictate the actual group composition. For the Wola, Sillitoe notes that members of a _sem_ '... must all be related in some way to qualify for residential rights on the same territory, and as a result they must all fit on a single genealogy of sorts...'(1979:33). The Nembi also recognise that access to land is intimately related to a person's ability to prove a right to land, and where a man lives and places his allegiances is not entirely fortuitous. Table 3.2 shows the categories within which the Nembi place men according to the manner in which each has justified his access to land and membership of a local group. A similar classification is described by Ryan for the Mendi (1959:257-289,

Table 3.2 : Residence classification of Local Group Members on the Nembi Plateau.

Suw ora		following his father's land	
Suw moora		following his father's ancestral land	
Ol ebowel	Engil suw obowa	following his mother's land	newcomers
	Orata andaa ebowa	following his wife's land	
Ais ora		following grandmother's land (father's mother)	
Tugel el		Farms land in his father's territory, his mother's territory and his wife's territory, or a combination of them	

1961:23). The Wola, Mendi and Nembi are centrally placed in the discussion of the nature of New Guinea highlands social structure and group composition, by this emphasis of land tenure in relation to descent systems.

The relationship between group structure land tenure and land availability was most forcibly put by Meggitt who proposed that the Mae Enga have a patrilineal descent system and that the '...coherence and elaboration of the Mae lineage system are largely a consequence of the limited availability of arable land' (1965:xv). If a land shortage exists on the Nembi Plateau, one might expect therefore, following Meggitt, to find the land tenure system to be fairly rigidly defined and the related kinship and descent system to reflect agnatic links. Comparing the Mae Enga with other culture groups Meggitt states '... the highland societies with the heaviest populations and the least land should possess the most clearly defined agnatic systems and the least flexible patterns of residence' (1965:268). The picture however is not so clearcut, for the Nembi or for other highlands groups. Kelly (1968) pointed out the contradiction between Langness (1964) on the one hand, who maintained that abundance of land makes strict unilineal descent unnecessary and thus agrees with Meggitt, and Barnes (1962:7) on the other, who considers optation useful when land is scarce. Brookfield and Brown (1963) found in Chimbu a relaxation of tenure rules under conditions of land shortage. Thus '... effects which appear to be mutually exclusive and directly opposed have been ascribed to the same cause' (Kelly 1968:36).

Wohlt attempted to test the relationship between agnation and land availability in the Kandep region of the Enga (1978). He concluded and agreed with McArthur's (1967) critique of Meggitt and cited Rappaport (1968:27) to show that there is no 'law' able to be abstracted from the individual case (Wohlt 1978:6-18). Because agnates are difficult to distinguish from affines in the more remote ascending generations and because assessing population density also has its difficulties, Meggitt's hypothesis may be applicable only to the Mae Enga.

In Table 3.1 I have made no attempt to distinguish between the non-agnatic members of the clans in the Lower Pwe Creek. I have not distinguished first generation in-migrants from second or third generation. It is interesting to note however that the Nembi reserve a particular category for men who are claiming right of access to land previously farmed by their paternal grandmothers - ais ora (Table 3.2) maintaining a cognatic distinction over three generations. The kinship system of the Nembi is Iroquois, bifurcate merging in the first ascending generation* (Appendix 3.1). The system is a relatively shallow three generations in depth and thus allows distinction between genetic and social kinship categories as well as patrilineal, affinal and cognatic links to be glossed and for the ideology of patrilineal affiliation to be emphasised. I would suggest that on the Nembi Plateau the process dominating the delineating of clans is one of filiation where the assertion of group unity through a dogma of common patrilineal descent is in fact symbolic. A patrilineal descent dogma operating within shallow genealogies allows the merging of two clans (two yem pomborr respectively) that are intermarrying as an amien clan-pair (yem elop) to become engi-mbellien or yem pomborr, thus subsuming some relationships which are in fact matrilineal. At its simplest patrilineal descent implies '..nothing more than a right or duty of sons to reside with and support their fathers, or of brothers, the sons of one father, to reside and support one another' (Scheffler 1973:778). In some cases a man's putative father has been his mother's brother. In other situations a man's cross cousins, especially his mother's brothers' sons and daughters, have been glossed to become his parallel cousins and therefore siblings and become to that man's children their parallel aunts and uncles rather than their cross aunts or uncles. The matrilineal link is thus subsumed.

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* FB is equated with F and MZ with M. FZ is known by a different term and so is MB. FB and MZ are the parallel uncle and aunt of ego. In ego's generation all cross cousins (FZS, FZD, MBS, MBD) are all called by the same term but differentiated from siblings. Parallel cousins (FBS, FBD, MZS, MZD) are differentiated by sex but classified with siblings.

In this, the situation is similar to the Wola who are more concerned with present day connections and their rationale rather than _past_ connections (Sillitoe 1979:41). In a situation of land shortage this allows people to choose where they live and to justify claims on land in territories where population pressures is not so great. Because a man may not know the complete genealogy of his local group does not mean that he is not concerned with descent as a means of justifying his position within a locality. The preference for patrilocal residence seems to emphasise descent as an important, although not the only principle behind group formation and maintenance.

That members of a locality group are not all necessarily agnates (although the Nembi _say_ they are), supports de Lepervanche's argument (1968) that local ties are the principal basis for group formation, that common residence matters more than genetic kinship _per se_ and that lineage (descent) is merely a political concept with a spatial aspect. Clans on the Nembi Plateau are thus primarily territorial units having recourse to a descent ideology, rather than a territorial unit whose membership is defined strictly agnatically. Because clans are composed of agnates and others whose ties may be affinal or uterine, does not necessarily demonstrate patrilineal principles which are poorly adhered to, any more than if, because a man flees to his matrilineal kinsmen for refuge when his clan is defeated in warfare, means that he is living matrivirilocally because the mores of Nembi society insist that he does. Indeed Langness (citing Barnes (1962)) states that '... people do not necessarily reside where they do because they are kinsmen; rather they become kinsmen because they reside there' (1964:172, Sillitoe 1979:39-42 and 142).

The argument nevertheless persists whether or not demographic pressure on land resources directly influence group structure and composition. For the Wola, Sillitoe states that there is no shortage of land (1979:38,45) and one might therefore suppose that Sillitoe's dismissal of descent and kin ties as important principles of group formation is thus justified. If population density on the Nembi Plateau is high because of a long and gradual increase in numbers (Allen et al 1978, 1980), group formation on the plateau should conform to Meggitt's analysis of the Mae Enga (1965). The situation however is not at all straightforward. An average of only 14 percent of the adult married men of the Nembi clans are non-agnates. This appears to be low in comparison to other highlands groups but only first generation non-agnates have been counted. Strathern (1973:104) described for the Kawelka clans the relationship of non-agnates and agnates and included up to third generation male non-agnates, both married and unmarried, to obtain his figure of 37 percent. MacArthur's (1967) critique of Meggitt's analysis (1965) further demonstrates the futility of comparisons.

Of the six married men of the Pubi who I have classified as non-agnates, three are residing matri-locally (engil suw ebowa), two are residing at their wives' territory (orata andaa ebowa), and one claims to be cultivating his mother's land as well as his father's (tugel el). The latter case is the son of an illicit relationship between a man and a women of what were, then, two sub-clans of the

Pubi, the Peripant and the Endusparr. The Peripant remains as a sub-clan but the Endusparr are now regarded as a clan and "legal" marriage now takes place between the Pubi and the Endusparr. The Endusparr have become part of an amien pair with the Pubi This case highlights the difficulty of distinguishing between agnates and non-agnates in ascending generations in a socio-political structure where categories of agnates and non-agnates are glossed within a dogma of patrifiliation and common descent.

Thus in the Lower Pwe creek basin it is uncertain whether the response of the descent system to a growing population pressure, has led to emphasis upon agnation or a relaxation of the definition of group composition. Meggitt (1965) suggested that there may be a possibility of synchronic comparison. However, the confusion of recent warfare and migrations on the Nembi Plateau, coupled with the importance of other factors pertinent to group formation, for example exchange and political structures, emphasise the ambiguity of response demonstrated by Kelly (1968). If two localities on the Nembi Plateau were to show considerable differences in the agnatic/non-agnatic composition of clans, any conclusions drawn suggesting that they are at different stages upon a continuum of response to recent population density increases would be dubious.

Nevertheless kinship and descent are important elements of Nembi social structure, and both presume genealogical connection, with kinship centred upon ego, and descent concerned with ancestry (Scheffler 1973:747-793). Although complementary in placing individuals with reference to each other the distinction is important.

Kinship, real or ascribed, emphasises present-day personal domains of relationships (thus the system's shallow classificatory depth) and is not primarily concerned with the organisation of groups (see Barnes 1967b:102). Descent on the other hand unites a group of people vis-a-vis other groups without necessarily implying how they should interact with people outside their group, and as an ideology of common ancestry may be invoked to tie individuals with a bond more fundamental than just kinship while also ascribing kinship obligations to each other.

The complex pattern of kin relationships which connect inter-marrying local units is expressed most forcibly by the exchange network. Affines and matrilateral kin participate in ritual pig-killing and it is the related exchange and obligations which are significant to every day living and present social organisation rather than the descent system alone. Nevertheless it must not be forgotten that the descent system, no matter how symbolic, provides the underlying social structure defining groups and thus ascribes kinship status with specific roles and obligations.

Rubel and Rosman (1978) echo F.E. Williams' question (1936) as to why groups living in the same environment exchange like for like and conclude that '...exchange must have a significance that is not utilitarian. Such ceremonial distributions are total social phenomena [and] manifest the interplay between the kinship and marriage structures, the nature of political leadership, the economic structure and the religious and symbolic system ...'(Rubel and Rosman 1978:1). Exchange is a complex phenomenom on the Nembi Plateau and, as Sillitoe stresses for the Wola, places a '...sociological emphasis upon the individual as opposed to the group...' (1979:28). However on the Nembi Plateau the emphasis upon the individual is constrained within the kin web and there is no ad hoc element to the system as suggested by Sillitoe.

Exchange is important to the Pubi. Its inflation since contact and the cessation of warfare, has made it even more important. But exchange has only become more important with respect to the time spent in the activity. As I discuss more fully in Chapter Five, inflation and the creation of new wants, and aspirations for 'goods' from the western economy have undermined the traditional exchange and trade networks of the Pubi and their neighbours. It is tempting to suggest that trade and exchange are fundamental to present day group allegiances but I believe that kinship and descent are as strong as they ever have been. With movement of people on to the plateau the Pubi have interpreted their kinship and descent systems as widely as possible in order to gain access to land on the plateau. In the future as the Pubi wish to justify their continued occupance of their territory they may emphasize agnatic descent to prevent encroachment by neighbouring groups. Those men with stronger personalities and possibly with greater influence in the exchange network may be able to manipulate the land tenure system and interpret ideology to suit their needs. It is the more powerful of the 'big-men' who will succeed and it is here that exchange, kinship and descent meet and merge.

The manipulation of kinship, descent ideology, exchange and the land tenure system by the men of the Peripant

Operating within the Pubi are two big-men (el-hauma) and two other minor big-men. The acknowledged leader amongst them is Ayab of the Sigerant sub-clan, who with his seven surviving wives (he has contracted 20 marriages and has had a maximum of 12 wives residing with him) lives at Kongip-hauma . He remains a powerful man despite his advancing years. His position is being challenged however by Korr of the Peripant sub-clan, who is also supported by Walleni, a minor big-man of the Peripant. In April 1976 the Pubi-Penarop, Murupa-Porelep, and the Eip-Yokul ceremonially killed their pigs. Since then the influence of Korr has waxed considerably as that of the ageing Ayab has waned. The exchange network and the influence the big-men does not exactly reflect the pattern of residence of the people of the Pubi and also cuts across sub-clan divisions. In this the Pubi emphasis the problem of trying to allocate people to neat and coinciding categories of kinship, descent, allegiance and residence, and especially in such a period of rapid change.

> Although Korr still maintains gardens within the Peripant sub-clan territory he resides and cultivates land for the most part at Ipendu in Murupa territory, the adjacent clan. The Peripant are in the process of dividing into two separate sub-clans, the Kongu, the men of which follow the example of Korr, and the Yop the man of which with those of the Temberi and the Sigerant sub-clans follow Ayab. The division within the Peripant was precipitated some thirty years ago when Wal the grandfather of Walleni (the aspiring minor big-man) was killed in an argument with Iengi, his clan brother. Wali's brothers, Yongo, Kurop and Komolko went to live at Ipendu with the Murupa. Korr is the son of Yongo (Figure 3.3). Elements of kinship within the Peripant, separate as well as join the Kongu and the Yop. The affinal links create ties that are not due solely to descent but emphasize relationships based upon exchange obligations which are matrilineal.

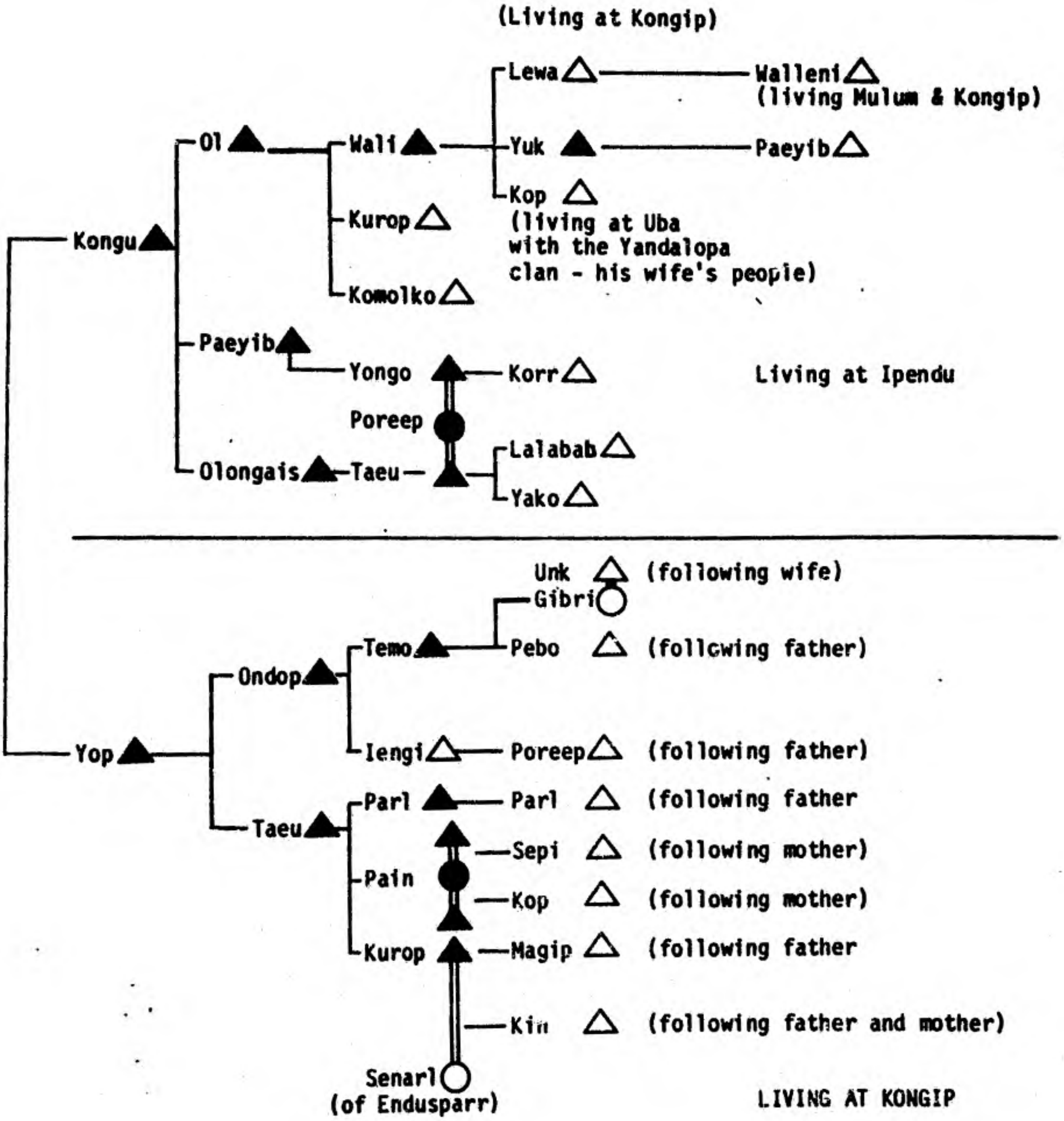

Figure 3.3 : The Peripant Sub-Clan of the Pubi. (Only married men shown)

Walleni kills pigs with the Peripant sub-clan of the Pubi. His mother Yalin, was of the Porelep clan. Walleni and his wives cultivate a large area of land within Porelep clan territory; land that Walleni's mother obtained from her brothers at Mulam. Walleni maintains a homestead at Mulam and his great-uncle Kurop with his wife Pokiam and their children, one of whom is married, also live there.

Taebel, a sister of Walleni's mother Yalin is married to Ayab, the big-man of the Sigerant, Walleni's father Lewa lives at Kongip and still supports Ayab in his exchange transactions. The descent links between Walleni and the children of Ayab, are patrilineal in as much as the Sigerant and the Peripant have the same putative ancestor, (Kurop-Pubi) and are therefore complemented and strengthened by the blood links between Taebel and Yalin. Indeed Taebel's children by Ayab are Walleni's parallel cousins and as such are his brothers and sisters (Ame and Mbelli). He will therefore receive bride wealth when his sisters marry and will be expected to contribute to his brothers' marriage payments.

Walleni and his father Lewa therefore have exchange obligations with Ayab that are defined both patrilineally and matrilineally. Ayab is also the undisputed big-man of the Pubi sub-clans, the Temberri and Sigerant, as well as the Yop section of the Peripant, the section to whom belongs Iengi, the man who killed Walli, Lewa's father and Walleni's grandfather. Walleni is therefore caught between two stools and his residence pattern demonstrates it. He maintains gardens at Kongip with his father in addition to those at Mulam with his mother. He maintains houses at Mulam and Kongip and supports the exchange networks of both Korr and Ayab, the latter through his father. Walleni also has three married sisters and has three wives. His own exchange network is therefore considerable, quite apart from his obligations within the Pubi.

Korr has the support of Lalabab and Yako, his half-brothers within the exchange network. All three of them have the same mother Poreep (see Figure 3.3) which demonstrates that leviratic marriage took place amongst the Nembi. Korr also draws support from Komolko and it is interesting to note that Komolko's wife Yamal is the mother by a previous marriage, of Korr's second wife Walebam, which thus strengthens the relationship between Komolko and Korr.

> The composition of the Yop is not so clear-cut and no one man has been able to channel the exchange obligations of his brothers through himself to the same extent as Korr of the Kongu. In addition to the odium of harbouring the man who killed his clan brother, the Yop, according to outsiders is made up of hangers-on. Sepi and Kop are residing and farming in their mothers' territory and are also regarded as 'rubbish men' in that their success in the trade network is limited. Kop is also a leper and is thus regarded as a 'stil-man', leprosy being the punishment of the habitual thief. Unk is living with his wife's kin but also has obligations to his natal kin as well as to Korr who is married to one of Unk's sisters. Kin was brought up in Unk's natal clan, the Sigiriba, his mother having married a brother of Unk's father when she found herself pregnant by her clan brother Kurop. Kin therefore contributes in the exchange network not only as a member of his natal clan, the Sigiriba, as a brother of Unk, but also in his present clan of residence, the Pubi (Peripant Yop) which is also his patri-clan, as the brother of Gibri the wife of Unk. He cultivates land in the Sigiriba, Pubi and Endusparr (his mother's) clan territory and is truly a man in the middle (<u>tugel el</u>).

The example of the Peripant sub-clan of the Pubi clan demonstrates that kinship, descent and ceremonial exchange are intimately related. Inasmuch as exchange operates through specific kin relationships, a person's group membership is obtained through filiation. Group unity is expressed and asserted through a dogma of patrilineal descent, which symbolically equates all members as "brothers". No single aspect is dominant and in the same way as the Kawelka of the Mount Hagen region have reconciled problems of ambilineality so have the Nembi. Strathern states that the Kawelka Hageners express a cognatic or ambilineal idiom, and the '...The usefulness of this double idiom, which alternately separates and equates "one father" and "one blood", is that it allows Hageners to maintain both that the males of their groups are agnatically related and that persons can obtain membership of such groups through their mothers as well as their fathers' (1973:15).

To a large extent the underlying principle which determines the configuration of clans on the Nembi Plateau is locality and land tenure. Waddell states for the Enga that '...Kinship can be achieved on the basis of locality, and that the dimensions and size of the effective autonomous unit or clan ... can be accounted for in terms of ecology, agricultural requirements and defence' (1973:9).

Migration, warfare and population density

In the fifty to sixty years prior to the establishment of Nipa Patrol Post to the north of the Nembi Plateau in December 1959, the Nembi way of life changed little as a result of colonialism. Although steel, increased supplies of shell and other trade goods entered the area and inflated the trade and exchange system of the Nembi, and exploratory patrols had traversed the plateau, their effect was magnified by the events that took place in the first few years after 1960 (Chapter Five).

Fighting and sorcery was endemic. The enmity between clans and alliances was influenced by the topography of the plateau. After pacification regional alliances formed the bases of local government council wards. Elections in 1980 for the Provincial Government demonstrated the continuing antagonism between clan alliances with members of individual alliances only supporting candidates from their own group. More dramatically, from May to October 1981, fierce fighting over territory in dispute since before the arrival of Europeans occurred along traditional divisions.

When the Administration first tried to stop clan fighting in the early 1960s the pattern of clan alliances and associated claims to territory were both extremely complex and fluid. With pacification clans lay claim to land previously exposed and vulnerable to attack and reclaimed land they previously owned but had been driven from in warfare.* The Administration recognised the clan boundaries and land occupied at contact and pacification as the de facto and de jure situation to be preserved in the future.** This formalised as the status quo, many disputes and the unequal distribution of land in the more fertile basins and corridors of the plateau. The lower Pwe creek was the scene of particularly fierce fighting because of its central position to movement onto the Nembi Plateau, from the southeast, south and southwest. Consequently since pacification it has also come under the greatest pressure from clans and individuals wishing to relocate closer to the roads, missions and the health-centre situated in and near the Lower Pwe basin. Justification for relocation is

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* R. Hoad in Nipa Patrol Report No.6 of 1959/60 commented 'we must assume, I believe, that over the next few years the population will continue to be unstable as different groups move back to reclaim formerly owned land'.

** The Director of District and Native Affairs, A.A. Roberts, appended a letter to his comments on the first patrol report from Nipa, carried out by J.J.Jordon in 1959. '...I suggest some record be made now of the people who are presently in possession of land. We shall sooner or later have to establish boundaries and it may be acceptable that the landowners are those in possession of land at the establishment of law and order'. Letter attached to Nipa Patrol Report No.1 1959/60 file 67/15/22.

expressed through the ambilineal descent system of the Nembi with emphasis on patrilineal links. Because of the changing nature of the relationships between neighbouring clans, from brotherhood to brother-sister and vice-versa, as well as the formation of new clans and clan-pairings with the disappearance of old ones, opportunities to justify relocation have been many.

Individual and clan and sub-clan claims to territory are legitimized by oral history and legends. Appreciation of the complexity of the situation and the extent to which various claims to territory are bound to group identity requires an understanding of Nembi history.

The Lower Pwe Creek Basin

The Koin-Iomo and the Ib were the strongest clans in the Lower Pwe Creek Basin in the central Nembi Plateau at the time of pacification.* Collectively they are called the Pwe ipond el (the men of the Pwe creek) and with the Pubi-Penarop and their allies who are collectively called the Yoel el (the men of the valley), they have occupied the Lower Pwe Creek Basin for at least the last 80-100 years or so. It was, however, a hard won position and reputation.

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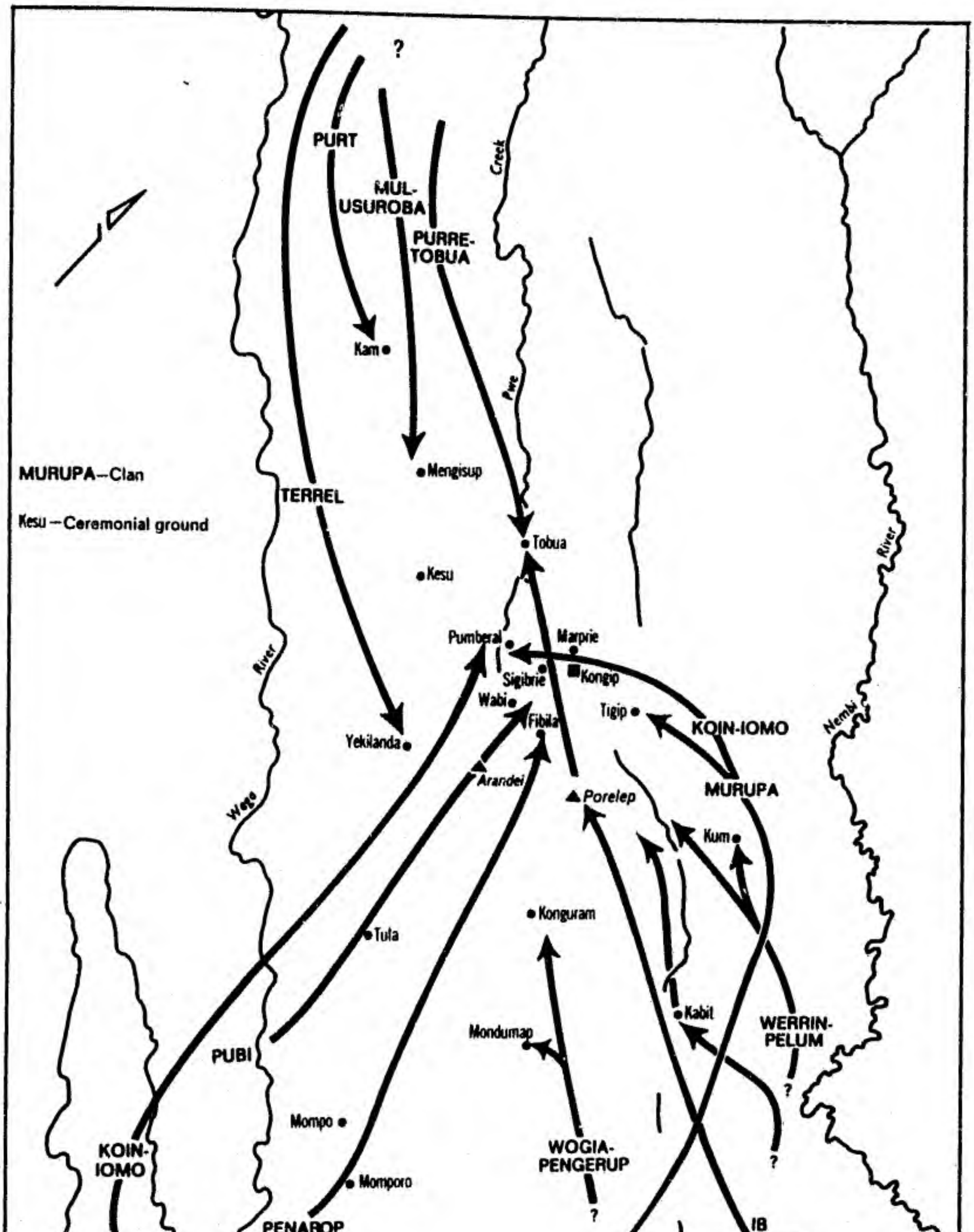
* 'Pumberal is the ceremonial ground of the Kon [sic] and Yom [sic] groups and is the centre of a very prosperous and very strong population. In the whole of the area there is not one sign of fighting having hit home at the people, there are no ring-barked trees, no destroyed gardens and all hamlets and ceremonial grounds are of considerable age and none have been destroyed in the past 40 years or so. The people are fully aware that they are strong and that they have been in the past, the top people of the area' (Patrol Report No.1 Nipa 1961/62)

The Koin-Iomo claim as their putative forebears the Murupa-Angasba clan-pair which in the early 1900s were located in the Lower Waga Valley (Map 3.4). In alliance with the Porelep-Ib who also claim they originated in the south in the Erave valley, and with the Pubi-Penarop, the Koin-Iomo drove from the Lower Pwe Creek Basin the cluster of clans now known as the Purt-Purre, the Mul-Terrel and the Sigiriba. Driven from the relatively hospitable terrain of the basin these defeated clans are now collectively called the Terenak, the men of the mountainside, and mostly occupy the rugged country to the west of the Lower Pwe Basin.

In the early 1900s the Terrel clustered around their ceremonial ground at Yekil-anda (Map 3. 4) and inter-married with the Purt who had their ceremonial ground at Kam-Hauma (Map 3.4) on the divide to the northwest. They were known as the Purt-Terrel (an <u>amien</u> clan-pair or two clans - <u>yem elop</u>). The Mul had a ceremonial ground at Mengisup-hauma (Map 3. 4) and were paired, also as brothers (amien) with the Usoruba. The Purre were paired with the Tobua and had their ceremonial ground at Tobua-hauma in the Lower Pwe Creek Basin.

Under pressure from the Koin-Iomo, Pubi-Penarop and the Porelep-Ib (as they are presently known) the Terrel fled the Pwe Basin and took refuge with affines. Naturally they went to Kam-hauma, the territory of the Purt. At the same time the Purre-Tobua were driven from the Pwe Basin. The Purre were beginning to marry with the Purt at Kam-hauma, because their relationship with the Tobua was



Map 3.4 : Movements of clans into the vicinity of the Lower Pwe Creek basin in the last 120 years

becoming engi-mbellien or brother - sister. The Purre thus rebuilt their ceremonial ground at As-hauma very close to Kam-hauma. The area is now known as Askam-hauma which emphasizes the present amien (brother) relationship of the Purt-Purre. The Tobua was absorbed into the Purre (yem pomborr). The Terrel also paired with the Mul and inter-married and built their ceremonial ground at Kesu-hauma close to Mengisup-hauma. The Usoruba were absorbed into the Mul (yem pomborr). The marriage relationships between the Mul, Terrel, Purt and Purre clans as at 1980 are shown in Table 3.3. Some individual families forsook the plateau altogether and went to the Waga Valley and remained there and were recorded by Patrols in the early 1960s.*

By claiming their rights to land through both the male and female line, members of the Purt-Purre and the Mul-Terrel assert that

Table 3.3 : Clan of Origin of Women in the Four Clans of the Terenak in 1980.

	CLAN			
Clan of origin	Mul	Terrel	Purt	Purre
Mul (and Usoruba)	11	6	7	9
Terrel	8	0	7	2
Purt	5	6	0	8
Purre	7	5	5	1
Sigiriba	8	7	3	3
Ib	6	1	0	0
Iomo	5	1	0	0
Merut	4	2	4	0
El-Kembirl	4	1	1	2
Kumki (Waga Valley)	4	0	1	0
Temberrl	2	2	3	0
Others	17	5	10	5

* Nipa Patrol Report No.5 1959/60, No.1 1960/61, No.10 1961/62.

the Koin-Iomo and Ib are trespassers on their land in the Lower Pwe creek. The story does not end there. The Ib (presently at Tobua-hauma) are reputed to have originated in the south of the plateau at Tamenda to the east of the Emia creek and overlooking the Erave river (Map 3). Their incursion onto the plateau was precipitated by both pressure from clans on the Kagua side of the Erave and by the more recent increase in the incidence of malaria which the Ib interpreted as sorcery (LeRoy 1979). Some sub-clans had probably settled at Porelep (Map 3) overlooking the Lower Pwe Creek Basin as long ago as the early 1900s. Those who remain at Porelep are called the Porelep sometimes the Porelep-Ib. To the northwest of the plateau, in the Waga Valley at Hebinja and Pinjib, other sub-clans of the Ib have settled. Others settled at Injib in the Nipa Basin, 40 km to the north of the Lower Pwe Creek Basin, and thus demonstrate that movements on the Nembi Plateau are rather more than localised flows between neighbouring clans. Watson (1970) discusses a more local situation in the Eastern Highlands.

In the twenty years since pacification the Purt-Purre and the Mul-Terrel have tried unsuccessfully to regain their territory in the Lower Pwe Creek Basin. Those who formerly fled to the Waga river valley have now mostly returned, at least to territory overlooking the basin. The result is that while the Mul-Terrel possess approximately 12.6 km^2 of total territory and the Purt-Purre a further 10.5 km^2 extending from the plateau to the Waga river, they mostly live and farm on their land closest to the road that runs the length of the plateau through the Lower and Upper Pwe Creek Basins. With a total population for the Mul-Terrel of 375 and of the Purt-Purre of 549, densities on total clan land are 30 and 50 per km^2 respectively: densities that are mid range for the highlands (see Brown and Podolefsky 1978).* Densities on land overlooking the Lower Pwe creek however are much higher, 120 per km^2 for the Mul-Terrel and 150 per km^2 for the Purt-Purre (Table 3.4).

The situation for the Ib and the Koin-Iomo is very similar. As well as struggling to maintain their position in the Lower Pwe Creek Basin, members of the Ib and Koin-Iomo who were living in the Waga valley before 1960 have moved back to the Lower Pwe creek. The Ib, though to a lesser extent than the Sigiriba, have grave problems of access to adequate amounts of land. The Sigiriba and Ib unlike the other clans, do not possess territory to the west to which they may return.

Land availability to the south of the Lower Pwe creek is as precarious and as much the result of migrations since pacification as

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* Central Simbu 89 km^2, Mae Enga 62 km^2, Gururumba (Upper Asaro) 44 km^2, Huli (C and N Tari Basins) 44 km^2, Dei (Mt Hagen) 38 km^2, Gahuku Gama (EHP) 35 km^2, Raiapu Enga 35 km^2, Bena Bena (Korofeigu) 34 km^2, Gadsup (EHP) 30 km^2, Siane (Watabung) 29 km^2, Kakoli (Tambul) 25 km^2, Kuma (S Wahgi) 19 km^2, Maring 15 km^2, Kyaka Enga 13 km^2, South Fore 12 km^2. These are based on Census Books and the Papua New Guinea village Directory of 1973 and are therefore subject to error.

Table 3.4 : Gross Population Densities of the Lower Pwe Creek Clans.

Clan	Gross density for total clan land (per km^2) a	Gross density for land on the Plateau (per km^2) b
Mul-Terrel	30	120
Purt-Purre	50	150
Koin-Iomo	83	249
Ib (Tobua)	136	136 c
Sigiriba (Lower Pwe)	252	252 c
Sigiriba (Upper Pwe)	269	269

a Includes all territory claimed by the clan or clan-pair as measured from air photographs (1:40,000) and Survey Sheets (1:100,000).

b Land on the plateau in 1980 that was neither primary forest nor well established secondary forest ie. land currently in use or either arable or fallow, including interspersed unusable tracts which are either too steep and rocky or are small pockets of primary and secondary forest.

c The clans do not have land in the Waga Valley.

in the rest of the basin. The Yoel el (Pubi-Penarop, Epi-Yokul, Murupa, Porelep and Endusparr) also have returned to their former territory in the Pwe Creek basin from clan land in the Lower Waga Valley in the last twenty years.

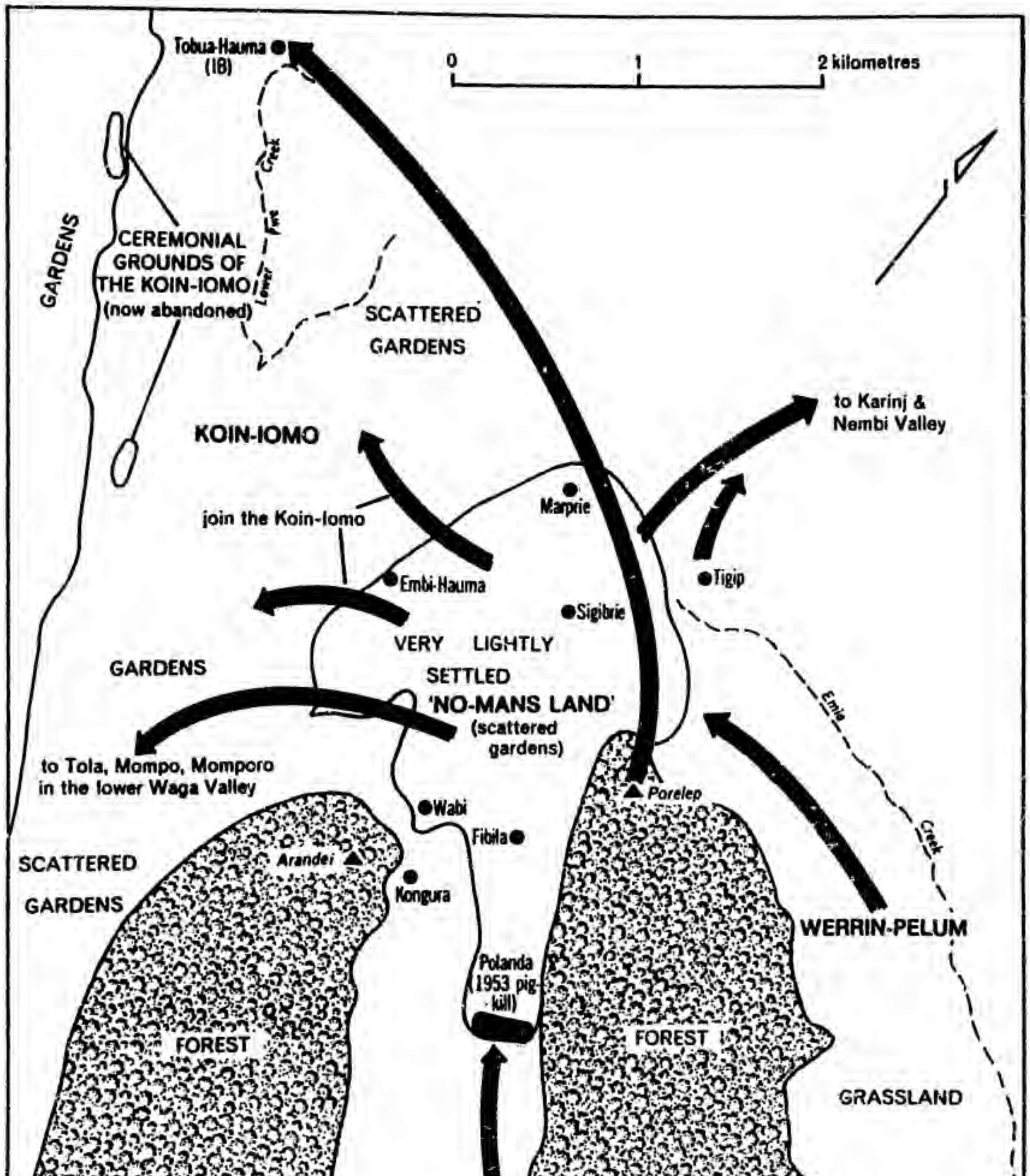
The Pubi-Penarop, Porelep-Murupa, Epi-Yokul and Endusparr are presently linked through marriage (Table 3.5). The present affiliations between those groups are intricately enmeshed with past alliances and clan-pairings. For example, although the Endusparr state that they have the same ancestor as the Pubi (Kurop Pubi) and came from the Mubi lowlands, they also say that they were on the Nembi

Table 3.5 : Clan of Origin of Women in the Clans of the Yoel El.

Clan of Origin	CLAN Pubi	Penarop	Eip-yokul	Murupa	Porelep	Endusparr
Pubi	0	9	3	0	3	4
Penarop	13	6	1	2	2	1
Koin	9	10	7	1	0	1
Iomo			4	0	1	1
Epi-Yokul	9	5	2	0	2	2
Porelep	2	3	0	3	0	1
Murupa	3	3	2	0	0	0
Endusparr	6	5	4	1	0	0
Ib	4	0	3	0	0	1
Sigiriba	6	3	4	2	0	0
Mul-Terrel	0	0	2	0	0	0
Purt-Purre	1	0	1	0	0	0
Karinj (Uba and valley)	8	0	3	17	1	2
Pelum and the an purl purl nak	6	8	3	11	5	1
Others	12	5	0	4	1	3

Plateau before the Pubi arrived. Indeed the Endusparr by all accounts could be one of the oldest clans, along with the Angasba (ancestors of the Koin-Iomo), on the Nembi Plateau. In comparison the other clans are parvenus.

Traces of old ceremonial grounds belonging to the Endusparr are discernible through the secondary vegetation growth. Two such places in the Lower Pwe Basin, Sigibrei and Marprei are now occupied by the Pubi (Map 3.4 and 3.5). In places, the benches cut into the steep hillsides where houses once stood, are still visible. The Pubi built their ceremonial grounds at Wabi and Polanda, and high on the slopes of Arandei overlooking the Pwe basin at Kongura.



Map 3.5 : Sketch map of the territory of the Pubi-Penarop and surrounding area on the Nembi Plateau showing movement of Pubi-Penarop clansmen seeking refuge from clans attacking from the south

To the south of the Yoel el, the An purl purl nak is a powerful alliance of clans which was the traditional enemy of the Yoel-el. Continued fighting effectively prevented close settlement of the Pubi Penarop, Endusparr, Porelep territory between the lower Emia creek and the lower Pwe creek (Map 3.5). The Pubi Penarop gardened and found protection on the steep hillsides and in the lower Waga Valley to the west. Some lived at their mother's natal clan or at the wives' clans (the Koin-Iomo and Ib) in the lower Pwe creek and the Karinj alliance of clans in the Nembi valley and the Upa region (Map 3.5). While the Koin-Iomo, the Ib and the Pubi-Penarop were successfully forcing the Mul-Terrerl, Purt-Purre and Tobua people from the Lower Pwe creek and the surrounding hills they in their turn were having to resist pressure from the An purl purl nak to the south.

In 1959 when the first patrol from Nipa Patrol Post entered the Lower Pwe Creek Basin and the Lower Emia Creek, the Pubi-Penarop had suffered defeat from the An purl purl nak alliance to their south (Wogia-Pengerup, Werrin-Pelum, Mae-Muit, Heroba-Yandalopa), and were scattered amongst neighbouring clans. Some had fled to their land in the Lower Waga Valley and the pass that leads to the Waga Valley. Some fled as far as the Nembi valley (Table 5.5). Five men from Endusparr still live there. In 1962, the majority of the Pubi-Penarop were still absent from the virtual 'no-mans land' between the Lower Emia and the Lower Pwe Creeks (Map 3.5). Some were in the process of returning to the area however,* and over the next 10 to 15 years the

* 'Departed Pumberal [the ceremonal ground of the Koin-Iomo] at 0730 for Penarop. Met about 6 men and two dogs on what was previously the Penarop ceremonial ground [Embi-Hauma], but which has been devasted by war. The majority of the group still in the bush

numbers living in the area increased dramatically. The enmity between the An purl purl nak and the Yoel el has a long and bloody history and the overall effect was for the Pubi-Penarop to practice a form of transhumance between the relative isolation and safety of the Waga valley and the Nembi Plateau. The spread of malaria, interpreted as sorcery, nevertheless prompted keen competition for land on the plateau.

Of the clans of the Yoel el the Pubi has the highest gross density of population on land on the Nembi Plateau in the vicinity of the Lower Pwe creek (Table 3.6). The Sigiriba clan in the Upper Pwe creek, the Pubi and the Koin-Iomo, have the most pressing problems of over-use of land. It may however, be a slightly over stated problem in that the Pubi also have access to an unspecified amount of land in the Lower Emia creek, currently lying fallow - probably another 50 ha or so - reputedly belonging to the nearly extinct Koryiripa sub-clan. But by the same token the densities of population on total clan land may also be misleading. The nature of the terrain - karst - and the patchy distribution of deep, fertile soils, seriously limits the amount of usable land. As much as 25 to 40 percent of land in some clan territories is unusable. Then again total clan land only includes land to the east of the Waga river. Members of most of the clans on the Nembi Plateau say they possess land to the west of the Waga river. The boundary with the Foi (Lake Kutubu and Mubi people) is reputed to be the Mubi river. Aerial photographs show traces of

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[Lower Waga] to which they fled some time ago because of tribal fighting' Patrol Report No.2 Nipa 1962/63. See also No.3, 8 1962/63.

Table 3.6 : Gross Population Densities of the Yoel el Clans.

Clan	Gross density for total clan land (per km^2) a	Gross density for land on the plateau (per km^2) b
Murupa	80	80
Penarop	29	On plateau 152 c Wage valley 105 d
Pubi	62	272
Epi-Yokul	30	69
Porelep	31	31

a Includes all territory claimed by the clan or clan-pair as measured from air photographs (1:40,000) and Survey Sheets (1:100,000).

b Land on the plateau that was neither primary forest nor well established secondary forest ie. land currently in use either arable or fallow, including interspersed unusable tracts.

c The land on the plateau currently being used and not primary forest or long-standing secondary forest on the divide to the west of the Penarop territory which separates it from the Lower Waga valley.

d The land in the Waga valley includes only that land which surrounds the main settlements of Mompo and Momporo. It does not include some of the Kunai grasslands that have not been cultivated for at least 15 to 20 years.

abandoned garden areas and in some places the traces of small hamlets are still discernible. The evidence suggests that migration onto the plateau has been rapid since pacification. The safety-valve of westward migration, frequently forced open by warfare, has now been effectively blocked by the attraction of the road on the plateau and the occurrence of malaria in the Waga valley.

Kongip-Hauma

Kongip-Hauma is one of the ceremonial grounds of the Pubi constructed since the Pubi returned to the Lower Pwe Creek Basin. In 1976 the Pubi held a pig-killing ceremony (mok enk), the first since 1953 when they made a truce with the an purl purl nak (witnessed by members of a patrol from Mendi - Patrol Report No.5 Mendi 1953/54). Pigs were killed at the ceremonial grounds of the Pubi-Penarop, the Murupa, Endusparr and other clans to the east of the Pubi. The slaughter and distribution of what was estimated to be over 2,000 pigs (pers com Ruth Tipton 1980) celebrated the cessation of hostilities between the Yoel el and the An purl purl nak to the south, 16 years previously.

Hostilities between the two alliances had been stopped by Patrol Officers in 1959 (Patrol Report No.5 1959/60). In the period between 1959 and 1976 those men who could claim land in the Pubi-Penarop territory on the plateau did so. Strategies employed by men who now belong to the Peripant sub-clan living at Kongip-Hauma, highlight the manner in which population density is related to social structure and land tenure. The flight from the valleys to avoid malaria (sorcery) provided further impetus for men to use all possible means except violence to gain land on the plateau. Cessation of warfare removed the right of might. In pre-contact periods of intense warfare the pace of change in inter-clan and intra-clan relationships was rapid, but the changes which took place between 1960 and 1976, were the greatest ever experienced on the plateau. The promise of prestige from accumulating cash added another imperative for relocation on the plateau close to the road being built the length of the Pwe Creek Basin.

In early 1959 the An purl purl nak in a concerted effort managed to kill one of the big-men and fight-leaders of the Pubi, a man of the Peripant-Yop called Temo.* The Pubi fled, especially those living on the Pwe basin floor (at Wabi-hauma, Fibila-hauma, and Embi-hauma). According to informants the majority of the Penarop were already living in the lower Waga valley at Mompo and Momporo (see Map 3.5). In 1959 the territory of the Pubi-Penarop on the plateau was a no-mans land.

> When Temo was killed and his body dismembered and distributed to the clans of the An purl purl nak, his two wives with their children returned to their natal clans. Paeyu went to Kunjurl in the Lower Waga valley (the Nei clan), only to return with her son Wi and marry Temo's clan brother, Yako of the Temberry sub-clan (note the marriage was leviratic). Temo's other wife, Pukem, went with her children to her natal clan the Koin. She later remarried into the Murupa clan. Pukem's eldest daught Gibri (Figure 3.3), married Unk of the Sigiriba while she and her mother were living in refuge at Pumberal. In 1960 Unk and Gibri returned to the Pubi territory. They were accompanied by Unk's clan brothers, Yap, Gabe and Tolueb, the sons of Pint. Kin, Pint's stepson whose true father was Kurop, Temo's brother, also returned to Pubi territory. Kin's mother, Senarl, had married Pint when she found herself pregnant by Kurop, and Kin had been brought up by Pint as his own son. Thus five men, all with connections to the Sigiriba (the clan with the smallest area of land on the plateau) were the first to move back into Pubi territory after cessation of hostilities with the An purl purl

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* Exchange payments still continue between the Pubi and their allies as well as with their old enemies the An purl purl nak in compensation for Temo's untimely death. The first payments were made in early 1960 at the insistence of Patrol Officers from Nipa who stopped the feuding (Patrol Report No.5 Nipa 1959/60).

> nak. Gradually the rest of the Pubi-Penarop returned. Kin, Unk and Yap remained in Pubi-Penarop territory while Gabe and Tolueb returned to Pumberal.

Unk remains in Pubi territory, living at Kongip by virtue of his marriage to Gibri. Kin, by asserting his right to cultivate and live on his mother's land and also his real father's land, also remains, as does Yap, exercising his right to cultivate land in his mother's natal territory. Yap's mother is of the Penarop. From 1960-1976 the Pubi-Penarop consolidated their position in their territory between the Lower Pwe creek and the Lower Emia creek. Some chose not to return to that area however and members of the Epi-Yokul, Penarop and the Temberry sub-clan of the Pubi remain in Koin-Iomo clan territory in the Lower Pwe Creek Basin. Others remain in Murupa territory and coupled with the influx of Angasba people from the Lower Waga valley, account for the high percentage of non-agnates in Murupa clan (Table 3.1).

The peace of the late 1960s and 1970s was shattered in 1981. The tensions associated with the uncertainty of living in close proximity to other clans, the fear of sorcery, the struggle for land and old enmities and fueds, erupted into warfare. The Sigiriba clan, members of which were the most forward in re-entering the no-man's land between the Pwe i pond el and the An purl purl nak, were at the centre of the dispute. The quarrel had been simmering long before the early 1960s and concerned the ownership of about 60 ha in the southern portion of the Upper Pwe Creek Basin about 8 km to the north of the Pubi. When the dispute had been brought to the notice of Patrol Officers in the early 1960s they had ordered that the land should lie idle and unoccupied until the dispute was formally settled. The Sigiriba were therefore forced to exploit other options to gain access to land elsewhere. By 1980 the relationships and obligations of the Sigiriba were widespread throughout the central Nembi Plateau so that when the dispute erupted in April 1981, the Sigiriba had such far-flung kin ties, many clans were drawn into the ensuing fighting. Nine men, including the son of the big man Ayab, of the Sigerant at Kongip-Hauma and Kwint, one time councillor of Kongip and a minor big-man of the Temberry were killed.

The Pubi in pre-1960 fighting against the An purl purl nak were helped by the Sigiriba, and were obliged to support the Sigiriba clan against clans to their north laying claim to the disputed territory. With members of the Sigiriba clan living and farming in Pubi territory as clansmen to the Pubi, the Pubi were inexorably bound to stand by their old allies.

The relationship between the Pubi and the Sigiriba, and their struggle for land on the Nembi Plateau close to the road is the epitome of the complex interaction between kinship, descent, exchange and group structure on the Nembi Plateau. Marriage and clan alliances are complex, and in the past warfare destroyed some clans and brought new clans into preeminence, thus encouraging a constant movement of people from one place to another. The pace of change was in some cases rapid with clans changing from ascendent to descendent with their fortune in warfare. Pressure on favourable land was relieved. Since 1960 cessation of warfare has been accompanied by in-migration to the plateau. The attraction of the road, coupled with an increase in malaria in the valleys, has led to increasing densities of population on the Nembi Plateau. The relationship between kinship, descent, and exchange is changing as clansmen manipulate the system to gain access to favourable land. Elements of order in the social structure of the Nembi are therefore in a state of flux. Access to land is thus a central issue on the Nembi Plateau. Understanding of the social structure with respect to land is an important pre-requisite to any form of intervention on the Nembi Plateau to promote any form of planned change. Natural population growth (Chapter Seven) alone is insufficient to explain the high population densities on the Nembi Plateau. Migration for a number of reasons, from malaria to the desire for cash, is at the heart of the problem.

APPENDIX 3.1

THE ORIGIN, GENEALOGY AND KINSHIP SYSTEM OF THE PUBI

According to legend the ancestral figure of the Pubi was one of two brothers living at Webitage in the Mubi lowlands. Their names were Kurup Epi and Kurup Pubi. One day Kurup Epi left some sak-sak (sago) in his canoe whilst he went to the village to collect his fishing gear. Whilst Kurup Epi was in the village a dog belonging to his brother Kurup Pubi smelt the sak-sak, climbed into the canoe, eat the sak-sak and then defaecated in the canoe before he ran away. As kurup Epi was coming back to his canoe he saw his brother's dog running away along the track. On reaching his canoe he saw that the dog had eaten his sak-sak and had left a turd neatly in its place. He became very angry and went to find his brother Kurup Pubi. Rather than fight with his borther, Kurup Pubi took his two wives and fled.

After walking for a day they came to the mountain, Kebebe. At last they came to the Waga valley. After so much walking they were becoming very hungry and Kurup Pubi called to his wives to stop and to cook some sago they had with them. However the fire would not light and they began to feel very cold and miserable. Then Kurup Pubi thought that he could smell wood burning and sweet potato cooking. He went off to investigate. He climbed a tree and had a look round. On the other side of the river he saw some smoke rising up. He climbed back down the tree and crossed over the river. He looked around and saw lots of taro gardens and banana trees and plenty of pigs in the surrounding bush. Further on he saw a lot of sweet potato mounds and then he saw a little house. Kurup Pubi climbed up to the house and entered the front porch, where a man, the owner of the garden he had just walked through was sitting.

The man nodded to Kurup Pubi and shook his hand and then asked him where he was going. The man offered two taro to Kurup Pubi to eat. Kurup Pubi ate one and then tucked the other into his belt. The man look at him questioningly and asked him what he was doing. Kurup Pubi told him that his two wives were waiting for him on the other side of the river and that they too were hungry. Eiotabe, (the ancestral figure to Koin-Iomo), the man in whose house Kurup Pubi was sitting and eating taro then said go and get your wives as I have plenty of taro and other foods. Kurup Pubi called his wives and introduced them to Eiotaba and his two wives. Eiotaba then gave some gardens to Kurup Pubi and gave him one of his two fish ponds and one of the two caves on the mountain side in which he could keep his seed and to live in whilst he was building a house.

The two men and their wives began to work the land on both sides of the river. Eiotaba had a son and a daughter and Kurup had a son and a daughter. One day the two men and their women left the children at home and crossed the river to go the the other side of the river to pick wing beans. There was no bridge so they used a canoe. When the children woke up they found that their parents had gone and decided to follow their footprints and find them. The four children followed the prints till they came to the Waga river, and there the footprints disappeared into the water. The children thought that their parents had walked over the water and so they tried to walk on the water and were drowned in the fast flowing river. When the parents returned they saw the children's footprints and when they did not find them in the houses they then supposed what had happened and that their children were dead. The two men cut off the tip of one of their fingers and threw it in the river. The two women cut their ears.

The men and their women stayed in their houses for a month and then they killed four pigs. Eiotaba suggested that they leave that sad place and move up the valley side onto the plateau to the east. At the top of the divide Eiotaba found an area of good ground, a place called Yekilanda (overlooking the area occupied by the Koin-omo - the Pwe Pond El territory). He stayed there with his wives and planted gardens. Kurup Pubi and his two wives then descended into the plateau and found the small hil 'Ol' and built their house at Marprei.

Kurup Pubi's wives bore him four sons. The first wife had Olump and Ebil. The second wife had Taey and Kenza. The two boys Taey and Kenza worked the ground now known as Embi and the two boys Olump and Ebil worked the grounds known as Kongip (a small stream the Kongip flows through the area) and Wabi. The boys took wives from the neighbouring groups, the Penarop and the Murupa and their sons then went and farmed other gardens in the same area:

The children of Ebil became the PUBI	(Groups
The children of Olump became the KORYIRIPA	within the
The children of Taey became the EPI	Pubi-
The children of Kenza became the ENDUSPARR	Penarop)

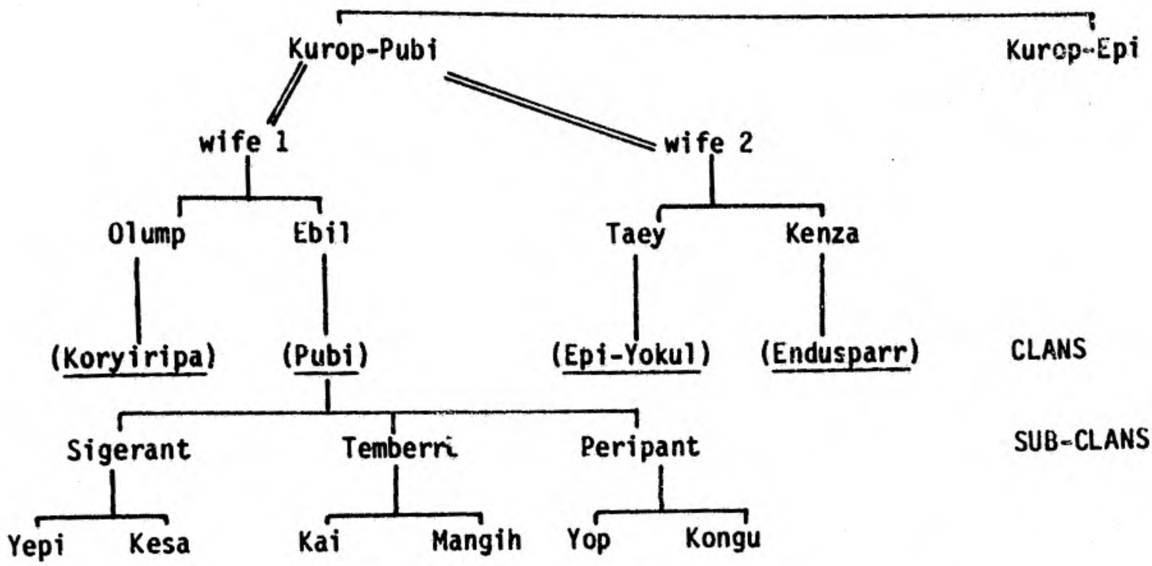
Ebil had three male children:	Sigerant Peripant Temberl	They in turn had	Yepi, Kesa Yop,Konguperl Kai, Mangi

Olump had two children: Koriyiripa
Wenk

Taey had four children: Omdul (undul)
Orlop
Welib
Karwant

Kenza had two children: Ilwe
Kombant

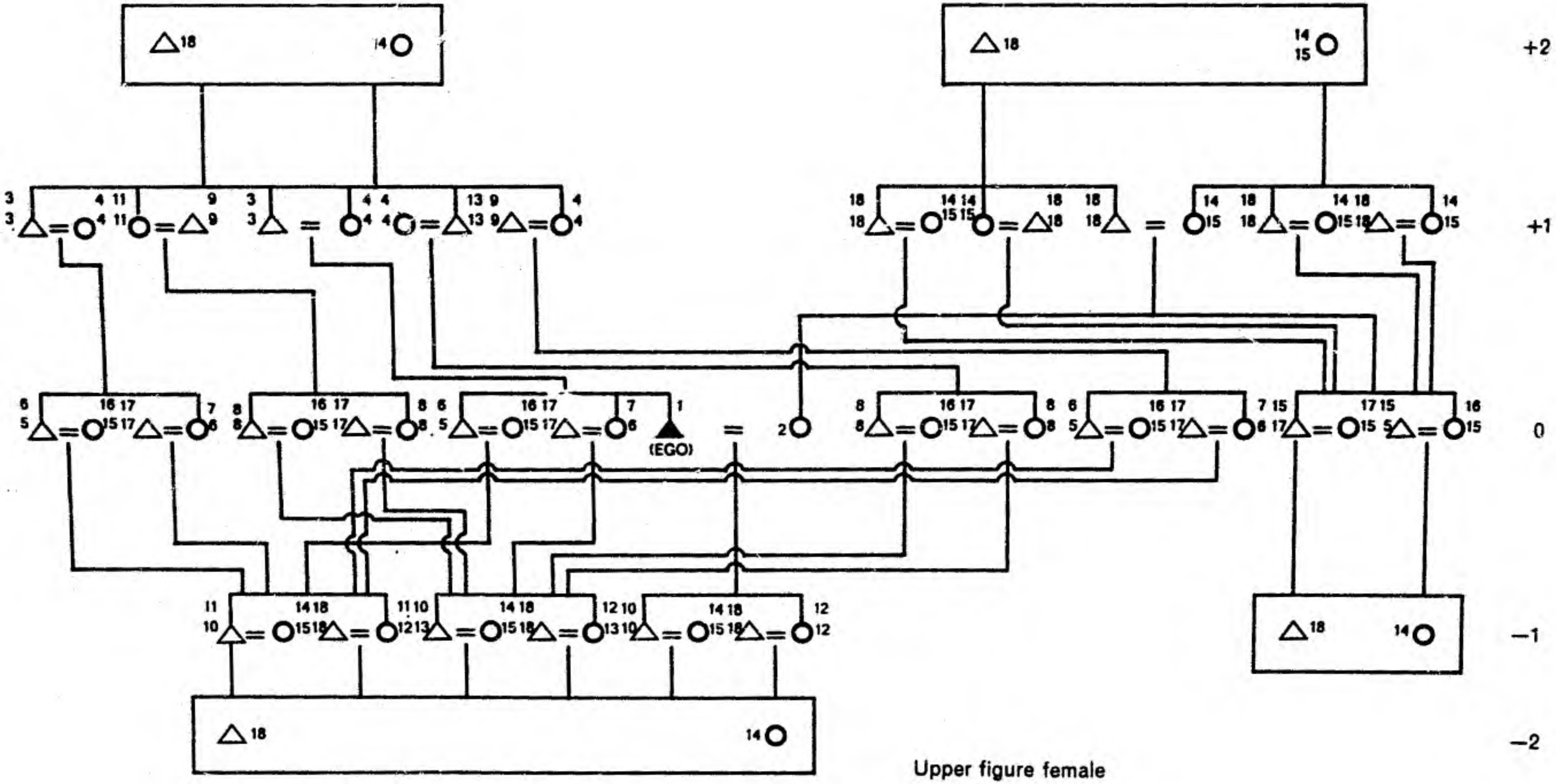
No doubt the pattern of subsequent events has become clounded and the genealogical record telescoped in the minds of the Pubi but the legend records ten generations from Kurop Pubi to the present (Figure A3.1). A story related by the Hegeso people of the Mubi valley confirms that a very long time ago a long-house stood at Webi-Tage close to the base of Mount Kebebe (pers comm J. Weiner 1981) and is shown on Map 3. The Pubi say that the descendents of Kurop Epi still live in the Mubi River - Lake Kutubu lowlands and they still trade extensively with them.



The generations of Iengi's forebears through which he traces his lineage to Kurop-Pubi.

Kurop-Pubi		
Ebil		
Tirup		
Man		
Yop		
Ekom		
Ondaap		
Iengi	Ego	(age c. 60 years)
Poreep		(age c. 35 years)
John		(age c. 7 years)

Figure 3.1 : A simplified genealogy of the Pubi.



Upper figure female
Lower figure male

The Nembi Kinship System

The Nembi Kinship System

1.	ALI	: H
2.	TEN	: W with prefix for number of wife
3.	ORA/YES	: F,FB
4.	OM	: M,MBW,MZ,FBW
5.	AME	: (Male speaking) B,FBS,MZS,WZH,WFBDH,WFZDH, WMZDH,WMBDH
6.	MBELLI	: (Male speaking) Z,FBD,MSD (Female speaking) B,FBS,MZS
7.	AKI	: (Female speaking) HBW,Z,FBD,MZD
8.	AI	: FZS,FZD,MBD,MBS
9.	ARAEL	: FZH,MZH
10.	IGI	: (Male speaking) S,FBSS,FBDS,MBSS,MBDS (Female speaking) S,FZDS,MBSS,MBDS,FZSS
11.	ORUMPA	: (Female speaking) BS,FZ,BD,MZSS,MZSD,MZDS,MZDD FBSS,FBSD,FBDS,FBDD (Male speaking) FZ,
12.	WANE	: (Male speaking) D,BD,MZSD,MZDD,FBSD,FBDD (Female speaking) D,ZD,FZSD,FZDD,MBSD,MBDD
13.	OBA	: (Male speaking) ZS,ZD,FZSS,FZSD, FZDS,FZDD,MBSS, MBSD,MBDS,MBDD
14.	AIS	: (Male speaking) MM,FM, and females of third ascending generation on wife's side and all females of ascending generations on father's and mother's side. All female descendants from 2nd descending generation and below 1st descending generation on wife's side. (Female speaking) FM,MM,SW,HM,HMBW,HMZ,HFZ,HFBW, HFM,HMM All females of above 2nd ascending generation and 2nd descending generation of own and husbands side.
15.	PARL	: (Male speaking) WM,WBW,WZ,BW,WFM,WMZ,WMBW,WFZ, WFBW,WMM,WFBSW,WFBD,WFZSW,WFZD, WMZSW,WMZD,WMBSW,WMBD,FZSW,FBSW, MBSW,MZSW,BSW,ZSW (Female speaking) HZH,HB,HFBS,HFZS,HFZDH,HFBDH, HMBS,HMBDH,HMZS,HMZDH

16. UNDUBA : (Female speaking) BW,HZ,FZSW,FBSW,MBSW,MZSW, HFZD,HFBD,HMBD,HMZD

17. PASE : (Male speaking) ZH,FZDH,FBDH,MBDH,MZDH,MZDH,WB, WFBS,WFZS,WMBS,WMZS
(Female speaking) ZH,FZDH,FBDH,MBDH,MZDH

18. SHUMBE : FF,MF,HMF,HFF,WFF,WMF,WF,HF,WFB,WMB,WFZH,WMZH,DH
Descending generation (2nd) males. On spouses side 1st descending generation males

19. OMURA : MB

CHAPTER FOUR

A HARSH ENVIRONMENT

If the clouds be full of rain, they empty themselves upon the earth

Ecclesiastes 11:3

Within the historical span of Pubi tradition and legend two periods of movement and migration have been identified. The first occurred 150-200 years ago while the other has taken place only in the last twenty years since the Patrol Post was established at Nipa.

The roots of present man-land relationships stretch as far back as the early period of migration. Initial production strategies employed by the Pubi's ancestors changed the environment; their actions, trials and errors, produced an agricultural system, as much influenced by a man-made environment as a pristine one. As their actions altered the environment so too did they have to adapt to a changed environment. This process of interaction, a process of evolution, has suffered a profound shock in the last twenty years. The pace of change was slow and the rapid change of external factors since 1960 has outstripped the capacity of the Nembi agricultural system to absorb them. An historical perspective is adopted, to describe the dislocations which have occurred and which now comprise the essential elements of present day man-land relationships. The broad base of the agricultural system is described as a background to a more detailed examination of particular elements that are of significance to production, food supplies, consumption patterns and the health of the Nembi population.

An agronomic watershed

Prior to the turmoil of the last twenty years, the Pubi-Penarop and many other clans of the south Nembi Plateau had shaped their way of life within a range of environments. The Pubi-Penarop and their neighbours planted sweet potato and taro swiddens on lands ranging in altitude from 1350 m in the Lower Waga valley, to 1740 m in the Lower Pwe Creek Basin and to over 1800 m on the ranges to the west. The surrounding forest provided additional forage for their pigs as well as a source of vegetable and animal protein for themselves. The Nembi Plateau is on the edge of the highlands. To the north are the intensive highland systems of agriculture which go down to 1100 m and merge with the more intensive lowland systems in the south which come up as high as 1400 m. The Nembi Plateau is part of this agronomic watershed.

The present agricultural system is, like all highland systems, an intensive system distinguished by an almost total focus upon sweet potato (Ipomea batatus). Elements of the extensive systems, based upon taro before the introduction of sweet potato, are present on the plateau but only because taro retains some importance in Pubi ritual. By contrast the cultivators of the Lake Kutubu lowlands, the Great Papuan Plateau and areas southeast of Erave Government station still depend upon taro (Colocasia esculenta) or sago (Metroxylon spp.).

The Pubi-Penarop also no longer utilise the full span of the environments open to them. Elements other than ritual are present, however, in the Pubi agricultural system and economy which relate them to those systems based upon taro and sago of the valleys and lowlands to the south. As Ryan (1961:10) noticed for the Mendi, the agricultural cycle of the Pubi is bound by the maturation rate of taro. The

Pubi are looking over their shoulder, as it were, to their taro gardens of the past which were situated mostly in the lower valleys to the south and southwest: a past which hinged upon the introduction of sweet potato and its superiority over taro in supporting complex social structures based upon the exchange of pigs (Brown 1978a, 1978b, Watson 1977).

The migration in the last 200 years of the Pubi and their neighbours from the Lake Kutubu and Nembi lowlands and as recent as 60 years ago from the Lower Wage valley, brought taro dominant extensive swiddening systems originating from the south into close juxtaposition with intensive sweet potato dominant systems originating from the north. Swiddening was practiced on the Plateau but has been replaced by the sweet potato systems' large open fields. Taro and other subsidiary crops are only cultivated in small mixed gardens and are the remnants of the earlier period of swiddening on the plateau and in the valleys. They are also an adaptation to the local micro-environment, being cultivated in the more fertile of the doline floors. The present juxtaposition and mixing of the two systems is highlighted by the Pubi's access to the range of environments which extend from the Lower Waga to the Lower Pwe creek.

The Pubi regard the lowlands to their south with some nostalgia and according to the Pubi, the gardens of the Lower Waga valley, are bountiful and produce earlier than on the plateau. The climate is warmer and more humid (see also Patrol Report Nipa No.4 1959/60 for a similar observation) and a greater variety of crops can be grown.

Yams (Dioscorea spp.) fall out of production at about 1800 m and are rarely grown on the plateau except for the Emia creek valley and are more widely grown in the Lower Waga valley to the south. Only two species were seen in the Emia Creek - esculenta and bulbifera. The lowland pandanus (Pandanus conoides), is not grown on the Nembi Plateau yet is prolific in the Lower Waga as well as the Erave valley to the south. The highland nut pandanus (Pandanus jiulianetti) is not present except in the north of the plateau and then only on the higher ridges. Cassava (Manihot esculenta) is not often grown above 1700 m and does not grow well on the plateau although it is found in the Lower Waga and the Erave valleys. Lowland edible pit-pit (Saccarum edule) is very rarely found on the Nembi Plateau and Powell (1980) puts its upper limit to about 1800 m. It is found in much greater quantities in the lower valleys. Powell also puts the upper limits to greens Abelmoschus manihot and Amaranthus spp. at 1800 m. The Amaranths are not grown extensively on the plateau in the mixed gardens and although Abelmoschus is not so common, this is probably due to its susceptibility to insect attack rather than altitude.

Thus the Waga valley gardens have all the crops of the plateau and in addition have yams, lowland pandanus, lowland pit-pit, and breadfruit (Artocarpus altilis) and are able to produce paw-paws (Carica papaya) and pineapples (Ananas sativus). More importantly the Pubi say that beans especially the wing bean (Psophocarpus tetragonolobus), are more prolific in the Waga valley. Patrol officers in the 1950s and 1960s remarked upon the large mixed gardens that were almost entirely grown with this crop (Patrol Report No.3 1960/61 Nipa).

So the Pubi-Penarop, with opportunities to cultivate in the Lower Waga valley as well as on the Nembi Plateau, in common with other clans of the Lower Pwe creek, seem to be astride an agronomic watershed which separates two forms of highland agricultural systems. On the one hand is the more ancient one based on taro (Clarke 1977a, Watson 1965,1967,1977, Brookfield and White 1968) and on the other the more recent, based upon sweet potato. Paradoxically, rather than being advantaged in being able to partake of both systems, the Nembi have found themselves poised between them. In some respects that is an outcome of their history and their migration from the lowlands in the south. It also reflects an environment which places the Pubi at the periphery of modern highlands culture based upon sweet potato.

The adoption of sweet potato

Before the introduction and adoption of sweet potato, environmental constraints such as lower temperatures at higher altitudes, poor edaphic conditions and persistent rainfall restricted "close" Nembi settlement based upon the cultivation of taro, to between 1400 and 1800 m (Golson 1977). On the Nembi Plateau taro takes about 10-12 months to mature in comparison to 5-7 months for sweet potato depending upon variety. Taro takes 8-10 months in the Kutubu lowlands (pers.comm. J. Weiner 1981). The upper limit of cultivation of both is about 2750 m, (Clarke 1977a) but unless extensively fallowed, taro in comparison to sweet potato, is not so productive.* It is probable that the need to fallow taro and subsidiary crops to ensure adequate yields, combined with the slowness of forest regeneration at higher altitudes, required large areas of land for the agricultural cycle to operate when transferred to the Nembi Plateau. Thus combined with the effects of malaria at lower altitudes, it is likely population densities were maintained at a lower level than at present.

The introduction of sweet potato to the highlands has taken placein the last 400 years (Yen 1974, Golson 1981a, 1981b, 1981c, 1981d, White and Allen 1980).** On the Nembi Plateau, the Pubi-Penarop have probably been cultivating sweet potato extensively only in the last 150-200 years, gradually adopting the new tuber and some of the techniques involved in its cultivation as they migrated from the Lake Kutubu and Mubi lowlands. Pubi legend relates that as their ancestors migrated from the lowlands to the Lower Waga valley and so onto the plateau they were only offered taro by people they met on the way which suggests that either sweet potato was not grown or it was fed to pigs. It is probable then that by 150 years ago (six generations) the oecumene of the Nembi was not only centred at a lower altitude but that the Nembi Plateau was marginal to a cultivation system based on taro. Indeed for the highlands as a whole, an exotic

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* Taro maximum yield in the highlands recorded 13 tons per ha. Sweet potato yields from 6-23 tons per ha. The average is 14 tons per ha (Bourke 1980).

**Estimates for other highland areas vary from c100 years BP in the Nebilyer valley (Nelson 1971), 170 years BP in the Kaugel valley (Bowers 1968), 200-300 years BP in the Kainantu region (Watson 1965), and 250 years BP in the Wahgi valley (Golson 1981a).

tuber was the best hope of further expansion of the oecumene (close settlement), an expansion which because of malaria at lower altitudes had to be upwards.

Adoption of sweet potato and closer settlement of the plateau meant a relative as well as an actual locational and economic change for the Nembi: by moving closer to the upper limit for taro they were also at the margins of intensive sweet potato cultivation systems. The upper altitudinal limit to close settlement based upon sweet potato is, according to Brookfield, determined locally by terrain, persistency of cloud and rainfall and proneness to frost and drought. The lower limit is determined by the presence of malaria i.e. not an agronomic factor but one affecting settlement, the altitudinal limit of which has increased in the last 30-40 years to above 2000 m (Brookfield 1961:445, 1964:22-23), and which the Nembi have attributed to sorcery.

The Nembi are at the periphery of the highland intensive agricultural systems based upon sweet potato and the periphery of the cultures which generated them. The Enga, Chimbu and Meldpa represent the epitome of highland cultures based upon sweet potato. In these areas population densities are high but intensive cultivation techniques and pig husbandry, support complex exchange networks and ritual which are interwoven into an integrated whole (Brown 1978a, 1978b, Brookfield 1961, 1964, 1968, Watson 1965, 1967, 1977). The present high population densities on the plateau are misleading because they occur in the absence of the sophisticated techniques characteristic of the core areas of the highlands agriculture.

The adoption of sweet potato by the Nembi as in other parts of the highlands took place in the face of ecological and economic stimuli. The new plant also possessed important pioneering properties and in areas like the Enga it was these properties which were exploited, almost to their full, to raise the altitudinal limits of intensive agriculture and close settlement from about 1700 m to above 2700 m (see Waddell 1972a, and 1972b). In response to the pressure of growing populations and the opportunities presented by the higher fertility of the high-altitude soils (Brookfield 1962:252), sweet potato became associated with elaborate cultivation systems in the core areas. The new and more elaborate techniques were adopted by surrounding peoples and some techniques diffused to the fringes of the highland region. It is thus likely that sweet potato was introduced into the Nembi region from the north - Enga - as well as from the southeast and east. The apogee of sweet potato cultivation is encountered in areas of high population and occupation density (Brookfield 1962:252) in Enga and the Waghi valley. It is reasonable to assume that the more elaborate techniques of cultivation originated to the north of the Nembi Plateau.

With the adoption of sweet potato by the Nembi, higher population densities of both pigs and people could be sustained on the plateau: more people and their pigs were able to subsist on smaller gross areas (fallow and cultivated land) than if taro were the staple. The remnants of large taro gardens are recognisable in the more swampy parts of the plateau, evidence of past settlement of people and their pigs. It is in their joint contribution to the demand for an improved source of staple, that pigs are as significant as people in the process of agricultural change and intensification. Discussion of the role of pigs in the adoption of sweet potato is, however, not without controversy. Pigs are an important element of the present-day Nembi agro-economy and as competitors for a scarce food resource are as important as migration, access to land and group structure man-land relationships on the Nembi Plateau.

Pigs or people

Brookfield's argument that production for subsistence, social and trade purposes (1972b:38) can be distinguished provides an important framework for discussing the effect of pigs in the agricultural system of the plateau. The pig, is more important as an item of value in ritual activity and in systems of trade and ceremonial exchange than it is as a source of dietary protein (McArthur 1974, 1977). Although higher population densities were supportable once sweet potato had been widely adopted, offsetting this was the demand made by domestic pigs upon the new crop. The extent to which pigs were the prompt to adopting sweet potato on the Nembi is not known but the demand for pigs within the ritual and exchange system no doubt meant that pigs were also domesticated to some degree before the introduction of sweet potato.

Because of the lower productivity of taro however the pig herds were smaller and dependency upon wild pigs greater than at present. The scale of ceremony and prestation was correspondingly subdued. As the oecumeme expanded and the forest retreated so too did it become more difficult to rely on wild pigs. People on the edge of the forest had better access to pigs than those in the midst of the cultivated area. The need for pigs in ritual and exchange thus required an increasing domestic pig-herd. The availability of sweet potato and the demand for pigs acted on each other to the disadvantage of taro. The lower productivity of taro meant that the returns to labour were less than for sweet potato. As the need for greater inputs of labour increased with the need to fence gardens and protect them from the larger domestic pig herds so did the production of taro further decline. The transition from taro to sweet potato on the plateau was therefore probably gradual and prompted by an interaction between pressure of population and the need for pigs (see also Brookfield and White 1968). Taro was adopted into an already relatively complex system because it yielded better than taro under montane conditions, its adoption being facilitated because the basic husbandry of taro is little different from that of sweet potato - mounding and ditching to provide drainage, aeration of the soil and conservation of nutrients.

Watson (1965, 1967, 1977) on the other hand has proposed that adoption of sweet potato in the highlands took the form of an 'Ipomean Revolution' which involved rapid population growth and expansion, the development of crop specific agricultural techniques and the rapid expansion in the scale of society. In the Enga region sweet potato allowed fringe areas at high altitudes to be colonised and probably in such areas a relatively rapid expansion of population took place (Brookfield with Hart 1971:84, Waddell 1972, Bowers 1968, Flenley

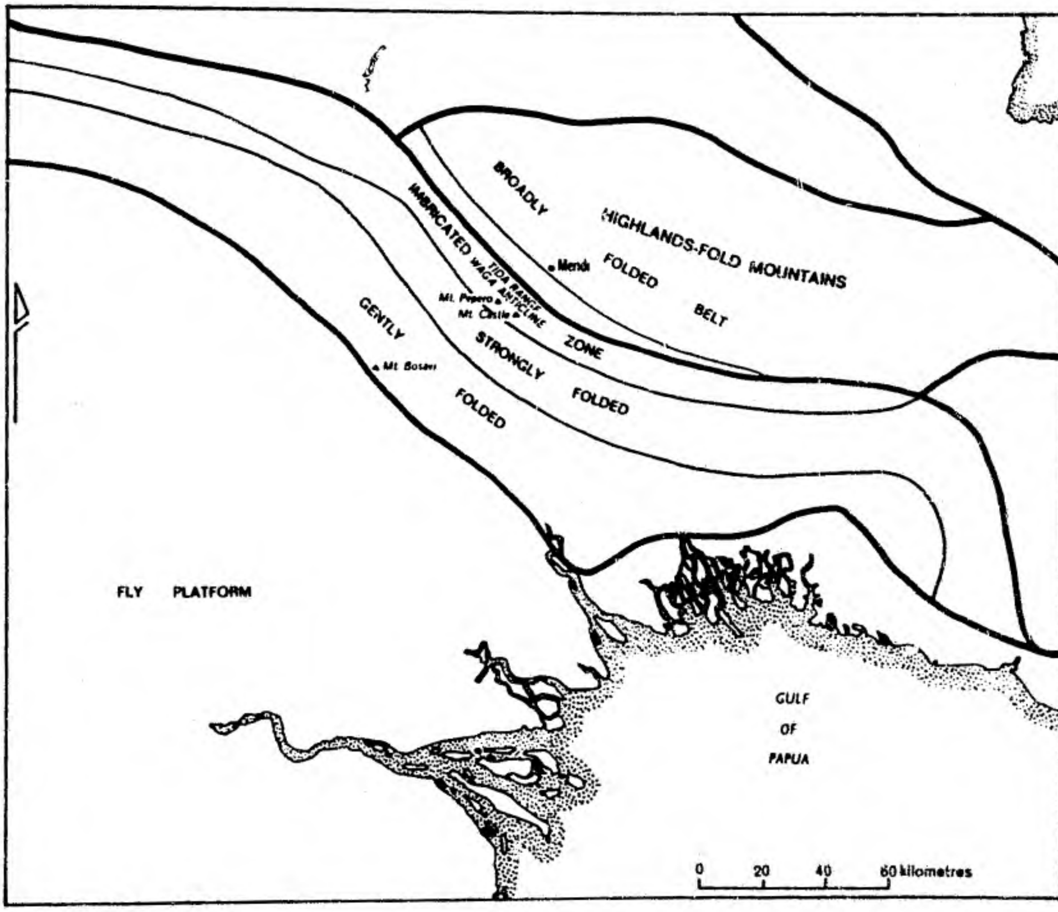
1967). For the Nembi however the story was probably different and it is more likely that population growth did not suddenly increase and the agricultural system was not dramatically transformed. Techniques found in a core area like slope and soil retention, planting in mounds of mulch, green compost, or enriched soil and fallowing with casuarina are still not utilised on the Nembi Plateau. Being on the fringe of the highlands the adoption of sweet potato probably took place over a number of generations as the southern Nembi migrated onto the Nembi Plateau and came into closer contact with people who had closer ties to the cultural heart of the Enga to the north. The Nembi have an agricultural system which produces pigs for wealth rather than pigs for protein and although pigs are eaten and contribute to a diet that is otherwise deficient in protein, the prompt for adoption of sweet potato was not necessarily pressure of population. The present high densities (Chapter Three) are the result of migrations, increases in fertility and decreases in mortality over the last twenty years, and the agricultural system of the Nembi has not adjusted in the face of such rapid changes in the man-pig-land ratios. The poverty of the Nembi environment, has been highlighted. Its rugged and inhospitable terrain and inclement weather, offset any advantage in being astride an agronomic transition zone and emphasize the position of the Nembi at the periphery of the highland culture-core.

The physical geography of the highland and lowland interface

The Nembi Plateau is located in the intensely folded Imbricated zone of the southern fold mountains of Papua New Guinea (Loffler

1977:13). The Mendi valley forms a border between the gentle folds of the 'Broadly Folded Belt' (Williams 1972) to the east and the 'Imbricated Zone' to the west where steep limbed, hogback anticlines and synclines, disrupted by faulting and overthrusts from the north-east form an intensely broken landscape (Brown and Robinson 1977:12, APC 1961, Williams 1972). The 'Imbricated Zone' is the northeastern edge of the 'Southern Fold Mountains', formed during the late Pleiocene and Pleistocene (Löffler 1977:13). To the south of the Southern Fold Mountains is the low-lying "Fly Platform' (Löffler 1977:7 and 16), the 'Stable Shelf' (APC 1961) or 'Southwestern Papuan Platform' (Brown and Robinson 1977), the crystalline rocks of the Australian Continental Shield. The intensity of folding increases from the broad valley of the Mubi river in the west to reach its pitch at the Waga river, the Nembi Plateau and the Nembi and Lai valleys (APC 1961:111), when folding becomes more gentle, merging with and dominated by the shield of Mt Giluwe in the northwest.(Map 4.1)

The Waga river bounds the plateau to the northwest and west. To the southwest the same river cuts the Waga Anticline (Mt Castle and Mt Pepero) in a spectacular waterfalled gorge to join the Mubi which flows to the Kikori. The Nembi Plateau does not exhibit the larger scale erosional surfaces associated with plateaux (Williams 1972:782, Löffler 1977:51), and is really a series of homoclinal ridges and hogbacks dipping from north to south and trending from the southeast to the northwest mimicing the surrounding region. From Lake Kutubu in the southwest to Mt Giluwe in the northeast are a series of rugged, forested, northwesterly trending hogback ridges of limestone, separated by corridors of less resistant rocks, siltstones, mudstones



Map 4.1 : The physiographic regions of the Southern Highlands and the Gulf region showing the location of the Nembi Plateau (Tida Range)

and greywackes partly covered by airfall volcanic tephras and lahars (Löffler 1977:27) (Map 4.2).

The plateau's position at the 'edge' of the highlands is accentuated by the abrupt rise of one of those hogbacks, the forested Tida Range, at 2100 m above sea level from the heavily forested Waga valley at 1450 m. (The Lower Pwe Creek Basin lies at 1740 m to the immediate northeast of this range). From the range, Mt Castle on the west side of the Waga river, the valleys of the Augu and Mubi rivers and the Lake Kutubu lowlands (1300 m below) form a forest covered vista dominated by the large volcanic cone of Mt Bosavi on the horizon to the west.

The topography of the Nembi Plateau

The plateau landscape is of varying forms of tropical karst, (Williams 1972, Jennings and Bik 1962, CSIRO 1965, Löffler 1977). Volcanic activity to the east and west in the Late Quaternary (at least 30,000 years ago), has in places modified the inhospitable karst to man's advantage (Blong and Pain 1976), by blanketing parts of the plateau and surrounding region with showers of ash, mud-flows and lahars. Where these deposits have been protected from erosive forces* good agricultural soils have developed. Cultivation is more intensive in such areas where the soils are the most fertile. The

* In some places lahars and ash falls have blocked river valleys. The Nembi, Lai, Mendi, Erave and Wage and upper Augu are incised in ashfilled vaaleys. The underlying karst formations are visible where the ash has been removed (Pain and Blong 1976, CSIRO 1965).

Map 4.2 : The relief for the Nembi Plateau and environs

volcanic soils are the deepest and oldest on the plateau and the oldest of any on the plateau (Rutherford and Haantjens, CSIRO 1965). Solution and mass movement has disturbed the soils on other base materials and in places caused the otherwise stable tephra soils to collapse where underlain by weaker sedimentary parent material (Blong 1975, Pain and Blong 1976, Blong and Pain 1976, Blong 1982, Pain 1981). Where sub-surface solution of limestone bedrock has continued beneath a mantle of tephra and other slumped deposits, surface collapse has resulted in, for example, the seemingly chaotic doline field of the Lower Pwe Creek Basin. Heavy and intense rainfall combined with over-cultivation have led to severe erosion. The sink-holes and dolines are characteristically choked with sediment and are prone to flooding.

The morphology of the karst has been largely determined by the dip of the bedding planes of the relatively massive limestone. The most notable features of the plateau are the 'chevron' pattern (CSIRO 1965) dipslopes and escarpments of the limestone cuestas resulting from the strongly bedded and steeply dipping bed rock. Gardening activity and burning has accentuated the chevron pattern with pockets of fertile volcanic soil perched in the notches of the dipslopes. The southwest facing cuesta and their dipslopes are steep (35-50°), scarp slopes are very steep (55-60°) and in places cliffed (Fig.4.1).

The Lower Emia Creek and the Om Creek Basins on the Southern Plateau are typically areas of 'Turmkarst' (Löffler 1977:55-58), Jennings and Bik 1962:1037, Williams 1972:769), where towers, cones, pyramids and pinnacles with intervening cockpits make a rugged and

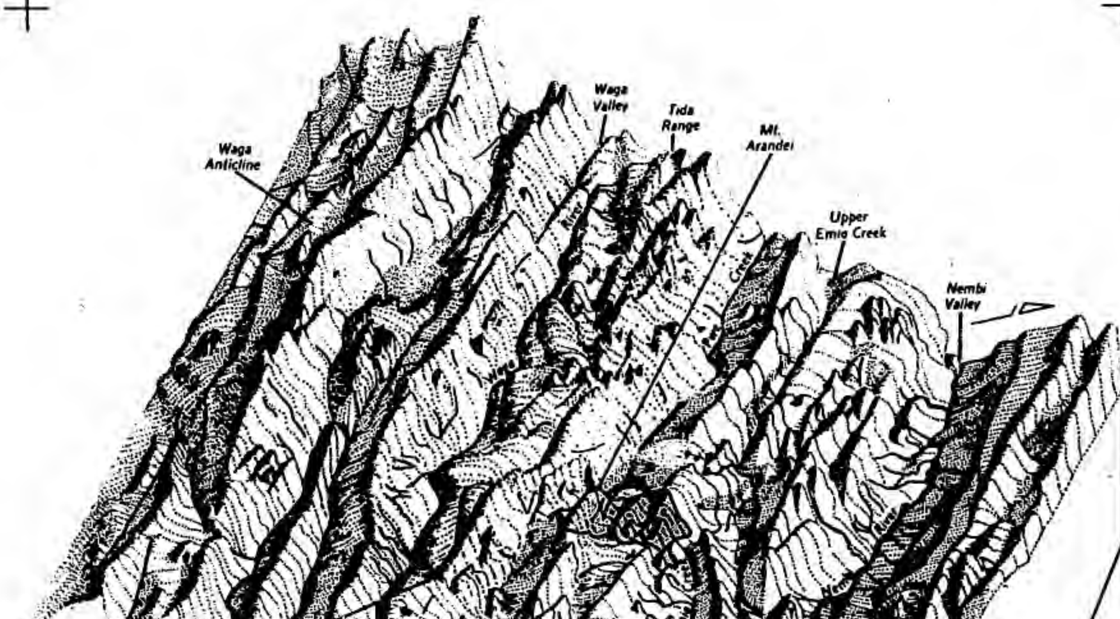


Figure 4.1 : Block diagram of the Central Nembi Plateau

spectacular landscape, completely devoid of flat, open land. By comparison the northern portions of the Nembi Plateau are less rugged and karst formations are less pronounced. There the limestone is overlain by weathered mudstones, siltstones, shales and sandstones of the Orubadi Beds (Brown and Robinson 1977), and sub-surface collapse has formed doline fields of varying sizes. Localised slumping has added to the confusion, although the largest dolines appear to be associated with strike fault depressions (Jennings and Bik 1962:1037).

The limestone cuestas divide the plateau into a series of parallel basins and valleys. Local relief is in the order of 500-600 m. It is in these valleys and basins that most present day farming takes place. The major drainage of the plateau, exploits these faults, following the strike of the bed rock to the south.

Vegetation and soils

Within the constraint of micro-climate man is the major determinant of the pattern of vegetation on the plateau. The same might be said for soils, for although the dominant factor in their formation appears to be the wet tropical climate, producing similar soils on diverse parent materials (CSIRO, Perry 1965:11), their fertility and stability have been modified by cultivation practices. The parallel, elongate ridges of the Nembi Plateau and the larger escarpments of the region to the east are forested islands in a sea of grass (Hope 1980). The more densely populated basins of the plateau support large areas of tall can grass, amongst which lie the gardens and scattered homesteads of the Nembi people.

Between 1,000 and 3,000 m in altitude the vegetation is lower montane rain forest. It is floristically less varied than the lowland hill forest of the Lake Kutubu lowlands (CSIRO Robins and Pullen 1965). At its upper limit it is sharply distinct from upper montane rain forest. The moss forest of beech and oak (Nothofagus spp., Lithocarpus molucca, Castanopsis accumminatissima) of the upper slopes and summits of the limestone ridges, being continually wet is also not an amenable habitat for man. The floristic composition of the lower montane rain forest varies with altitude, with the higher altitudes being dominated by the beeches and the lower slopes by the oaks. Emergent palms and hoop pines (Araucaria cunninghamii) are conspicuous on the southern plateau and the Lower Waga valley whilst stands of wild and domesticated Karuka (Pandanus spp.) are a feature of the higher western ridges in the north of the plateau. The oak (Castanopsis accumminatissima) is very common at the extreme north of the plateau and in the Nipa Basin, so much so that the people living there are called the Pea shorl nak - pea/tree leaf children.

The activity of man has left only remnants of the oak forest on the lower ridges and steep slopes of the northern and central plateau. Much more remains in the rugged sparsely populated cockpit country of the southern plateau. In places the larger cockpits and gentler slopes have been cultivated but are now abandoned. Here the oaks and beech are regrowing but their open canopy bears witness to the former occupation and abandonment of the more inhospitable parts of the southern Nembi Plateau.

The grasses of the corridors are predominantely Miscanthus, Imperata and Ischaemum. In places protected from burning, shrubby regrowth is present (Desmodium spp.), and the pioneer Dodonea forms a distinctive emergent through the grasses of old garden sites. The grasses are the dominant vegetation cover and extend from the corridors of the plateau to the valleys in the southwest, south and east. The Waga valley to the west is heavily wooded but patches of grassland occur which the Nembi identify as former garden sites. They point to the limit of the Nembi oecumene which has been abandoned in the last twenty years. In both the Erave and Lower Waga valley traces of drainage ditches and mounds are discernible through the short grass cover, substantiating oral accounts of recent movements to the plateau.

The plateau soils are predominately shallow brown soils and humic brown clay soils which form a complex mosaic in the Lower PWe creek and neighbouring corridors. Cultivation has blurred the distinction between the two soils by promoting erosion, slumping and mass-movement. Where localised disturbance has thinned the ashlayers the soil is less fertile, and the black or very dark brown top soil has a less well-developed organic layer or structure (CSIRO Rutherford and Haantjens 1965, Wood 1981).

The Nembi view the Erave and Waga valleys as a cornucopia of food crops. The valley soils have a high organic content, high nitrogen contents and high levels of exchangeable cations in their upper horizons (A. Hartley 1965). They are predominately humic brown clay soils (CSIRO Rutherford and Haantjens 1965) formed on sedimentary rocks and lavas as well as ash.

High intensity rainfall during the drier months combined with high annual rainfalls cause waterlogging as well as erosion, particularly on the thinnest of the shallow brown soils formed on the clayey Orubadi Beds. The water table is very close to the surface for karst country, and this has important implications for the cultivation of sweet potato and other crops. Throughout the basins deep drainage ditches are necessary for cultivation of sweet potato; even fallows under *Misçanthus* with deeper organic surface layers are extremely wet. Where erosion has been greatest, especially on the upper slopes of the dolines, the surface horizons have been almost totally removed, exposing the 'B' hòrizons. Here the dominant fallow is *Imperata* and organic layers are extremely thin.

Erosion and waterlogging also occurr in the lower slopes of the dolines and doline floors. Accumulation of top-soil from upper slopes has formed deep dark clay soils which very often have deep organic horizons. Although prone to flooding and waterlogging they are very fertile and are the site of mixed gardens. When fallow they are characteristically covered by a dense growth of *Ischaemum* spp.

In places the Orubadi Beds are so badly drained that gleyed plastic heavy clay soils have developed. In the locality of Tobua-Hauma in the Lower Pwe Creek Basin are true swamp soils, with some peat development have evolved. These soils are rarely cultivated but are used extensively as pig grazing areas.

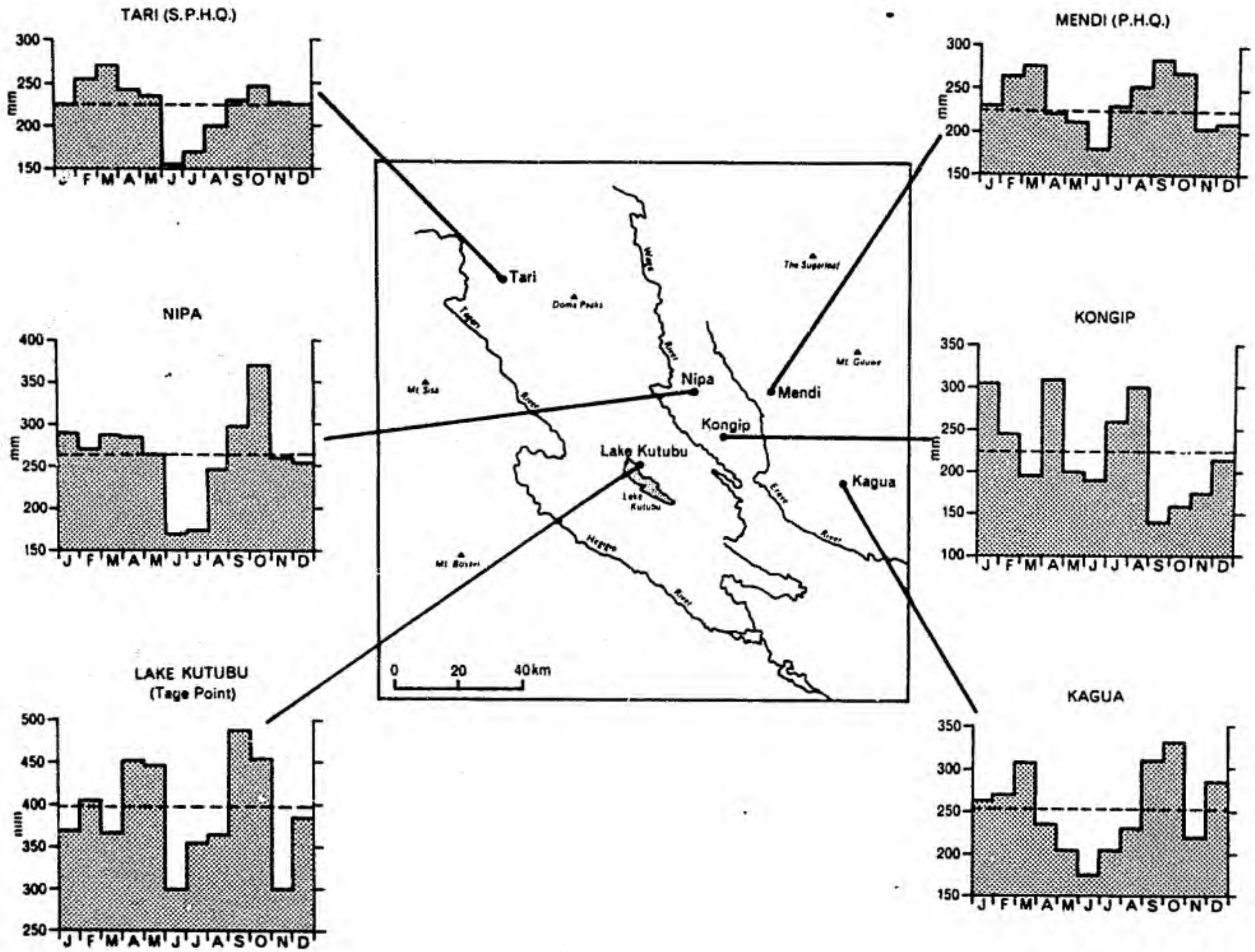
In contrast to the wetter soils of the dolines and lower slopes, soils of the upper slopes of the limestone ridges are relatively well drained. They are, however, thin and immature, resting for the most part upon the parent material: steep colluvial slopes, stoney outwash slopes and limestone slopes (CSIRO Rutherford and Haantjens 1965). Fragments of limestone occur throughout the profiles and soils are characteristically basic. These soils are sub-dominant to the Humic Brown Clay Soils, but are nevertheless an important component of the Nembi agricultural system. Sweet potato can be planted in them without mounding or drainage, although only one planting is possible before fallowing is necessary. Erosion has removed the soil in places and bare limestone protrudes through *Imperata* which is maintained by uncontrolled firing when the lower gardened slopes are cleared.

The underlying pattern of soils and vegetation is a zonal one but forest clearing activities of man have combined with the patchy distribution of volcanic ash deposits to produce a complex and jumbled mosaic. Soils may influence the locational patterns of Nembi agriculture, climatic factors especially rainfall, are a more important determinant of the dynamics of the agriculture system. To the temporary resident on the plateau the heavily laden clouds which roll up from the Kutubu and Mubi river lowlands wetly enshrouding the forested upper slopes and ridges, and the rugged limestone cliffs, press most upon the senses.

A description of seasonality on the Nembi Plateau

Climatic data are generally lacking for the whole of the Southern Highlands. No specific data exist for the Nembi Plateau except that which I collected during the 15 months of fieldwork and that collected by the agricultural officer at 'Ol' for a slightly longer period of time. The data collected is analysed in more detail in Chapter Eight when the agricultural system is also analysed more fully. Data from five other stations (collected variously between 1950 and 1975, Lake Kutubu, Nipa, Tari, Mendi, Kagua) provide a background in which to place the Nembi Plateau (Table 4.1 and Map 4.3).

The principal climatic controls are those associated with the movement of the 'intertropical convergence zone' (ITCZ), and the related monsoonal wind systems to the north and west. These changes are manifest in the changes experienced in the direction of the prevailing winds; the northwesterlies between December and March, and the southeasterlies from May to December. Because of the region's altitude (for the majority of the Southern Highlands) and position, centrally between the Sepik lowlands to the north and the Gulf of Papua lowlands to the south, there is no appreciable rain shadow effect from either wind system and seasonal contrasts in rainfall are relatively slight (very little data exist for the stations that are established and too few stations are in existence to demonstrate this accurately for the whole Province). Local orographic controls produce a far more complex distribution of rainfall, both seasonally and areally. The rainfall regime of the Nembi Plateau from



Map 4.3 : Rainfall of the Nembi Plateau and region

September 1979 to August 1981 varies greatly. The broken nature of the Plateau may itself give rise to local variation (Figure 4.2).

A CSIRO Survey in 1965 reported that a 'lack of seasonal contrast [is] characteristic of all climatic elements over the whole area. Rainfall [is] high ... [and] ... fairly evenly distributed throughout the year and in no part of the area is there a dry season' (1965:10). It was concluded that the area is '...generally free from lengthy periods of either very low temperature or large water deficiency, and optimum climatic conditions [for plant growth] normally prevail throughout the year' (CSIRO Fitzpatrick 1965:67).

Nevertheless, the Nembi, like the Chimbu (Brookfield and Brown 1963:2), are aware that the sun is hotter from November to January and is higher in the sky than during the rest of the year when it is farther to the north. They do not count the passing years: their timetable is measured by the seasons. When the Nemb tree blossoms (Combretaceae spp.), from September to December its white flowers distinct among the green of the forest, it is time to prepare and plant the mixed gardens and to plant sweet potato. Temperatures are warmer and the rainfall is beginning to be less variable than during April to August. The rhythm of life is distinctly seasonal and here, as in other parts of the highlands, seaonal variability in rainfall, no matter how slight and to a lesser extent in temperature, are important features of the environment (Fitzpatrick, Hart and Brookfield 1966, McAlpine et al 1975).

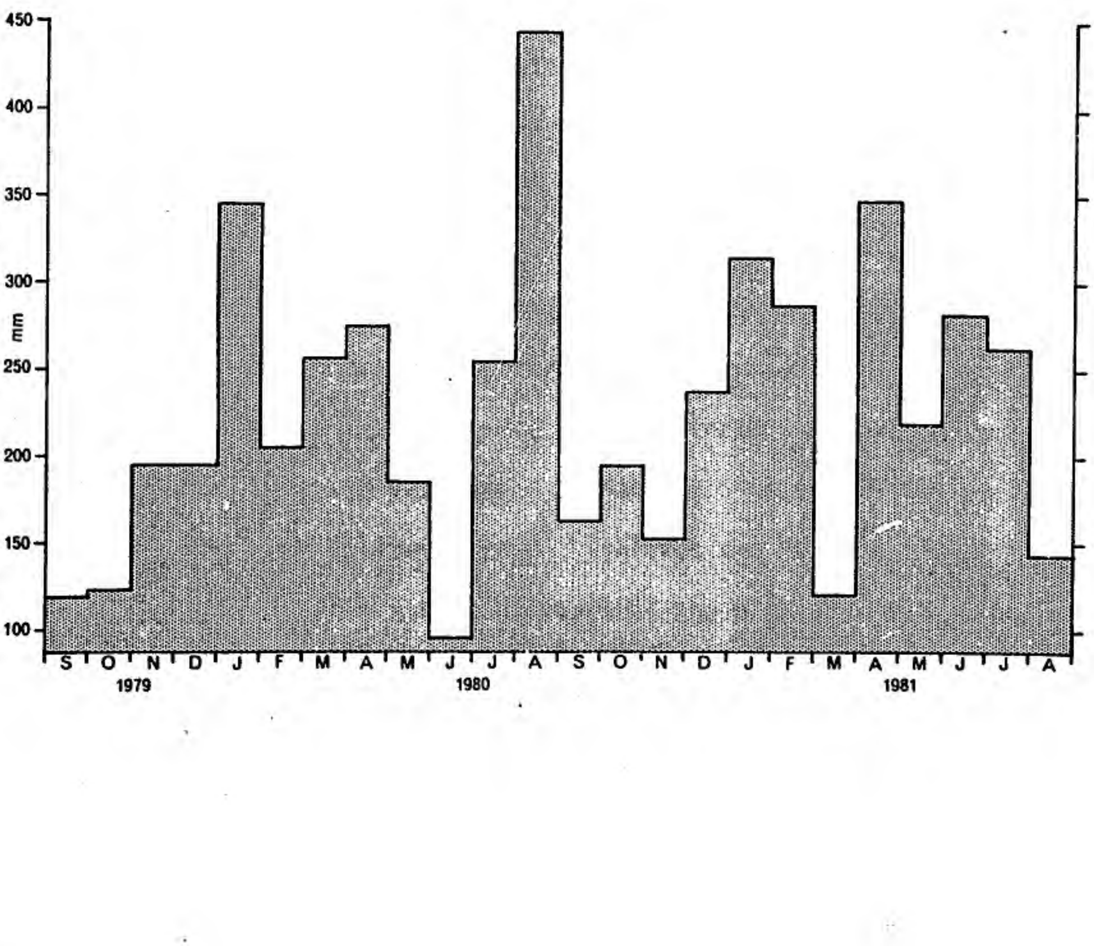


Figure 4.2 : Rainfall on the southern Nembi Plateau from September 1979 to August 1981

The seasonal pattern of atmospheric circulation (northwesterlies between December and March and the variable southeasterlies from May to October) are the main determinants of climate in tne highlands. The southeasterlies bring with them moist air masses originating over the Coral Sea and Gulf of Papua,* while the northwesterlies bring moist air from over the Bismarck Sea. Unlike the highland valleys to the east - the Wahgi, Chimbu, Asaro and Bena-Bena - those of the Southern Highlands are not generally enclosed on the south by high mountain ranges. The moist masses of the southeasterlies are therefore able to penetrate the valleys of the Southern Highlands, but are unable to significantly do so in the valleys further east (Brookfield with Hart 1971:5).

The eastern valleys have as a consequence, a marked contrast in seasonal rainfall, which has led to the erroneous conclusion that the more exposed valleys of the Southern Highlands experience no seasonality at all. During the period May to October, the southeasterlies do not penetrate far beyond the southern fringe of the central highland area. In the Southern Highlands the moist air is also restricted against the southern fringe of the highland ridge and valley system and penetrates north less than at other times. Only from March to May are the southeasterlies strong enough to spill over into the higher regions of the Southern Highlands. From September to November the northwesterlies penetrate the region (Fitzpatrick, Hart and Brookfield 1966, Brookfield with Hart 1971:5). A double maxima

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* The area to the south of the Nembi Plateau, the Kikori delta is among the wettest regions in Papua New Guinea with an annual mean rainfall of 5772 mm, much of it falling between May and October.

pattern occurs in the whole of the region surrounding the Nembi Plateau (Map 4.3) but is less marked than in the Eastern Highlands and rainfall is high in every month.

Although the climate of the Nembi is subject to two distinct seasonal influences, as Brookfield and Brown observed in the Chimbu (1963:23) the two periods overlap and the onset of the relatively wet and dry periods vary from year to year. The influence of the northwesterly winds, with upper atmosphere air movements (above 500mb) between November and April contributing to their ability to penetrate the highland region, masks to some degree the double maxima regime with a single period of higher rainfall between September and March (Brookfield and Brown 1963:23). This overlying effect varies greatly from place to place and although the rainfall regime for the Nembi Plateau, Nipa, Tari, Kagua and Lake Kutubu demonstrate its effect, Mendi does so to a lesser degree (Map 4.3). For example, from November to May the Nipa regime shows little variability, but Mendi shows a more distinct double maxima. The fact that the northwesterly air movements have a pervasive if variable effect is also demonstrated by the higher rainfall during December at Kagua and Lake Kutubu (see also Brookfield and Brown 1963:23).

A gradient is evident from the southwest to the northeast in the onset and duration of the drier period associated with the variable influence of the southeasterly air masses. Mendi's driest months are April, May and June when 22 percent of its rain falls. For the more southerly and western stations, (Tari, Nipa and Lake Kutubu), the driest period is later in onset than at either Mendi or

Kagua to the northeast, both of which are in partial rain shadows (Table 4.1).

Nothwithstanding the effect of the northwesterly airstreams decreasing the variability of rainfall in December, it is noticeable that November-January is also a drier period in general, though not so dry as that at mid-year. Once again there is great variability and whilst Tari does not show any December increase, Mendi only shows a small increase and at Nipa the increase is in January. Rainfall for two years at 01 (Figure 4.2) shows a marked fluctuation over the two years, a reflection of the great variability shown in the

Table 4.1 : Rainfall Regimes of Stations in the Southern Highlands (mm).

Station		Month												
		J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
Mendi	mm	231	267	277	222	213	183	239	253	284	269	204	219	2861
	%		27%			22%			27%			24%		
Kagua	mm	263	272	316	235	209	171	207	233	315	330	223	285	3059
	%			27%			19%			29%			25%	
Lake Kutubu	mm	370	412	367	453	446	297	356	364	487	454	299	385	4690
	%	25%			27%			22%			26%			
Nipa	mm	290	271	288	285	262	169	173	246	295	367	256	253	3155
	%	26%			27%			19%			29%			
Tari	mm	225	257	270	244	234	155	170	198	232	245	227	225	2682
	%	26%			28%			20%			26%			
Nembi	mm	334	234	248	297	204	96	257	440	170	203	153	247	2886
	%	25%		27%			19%			28%				

other stations. The drier period at the end of the year common to the rest of the region is plainly shown especially in the months September, October and November when only 18.2% of annual rainfall at Kongip fell in 1980. Like Nipa, which lies 30 kmto the north the effect of the lingering northwesterlies is marked in January. The significant time of the year for the Nembi people is between September and December when they are cultivating mixed gardens. This period is reflected in parameters other than monthly rainfall.

Temperature, humidity and cloud cover

Temperature and humidity are controlled, like the rainfall though to a lesser degree, by the circulation of the major air masses. In addition local circulations which reflect the rugged topography provide a variability which makes local conditions seem virtually independent of all but the most general regional conditions (see also Brookfield with Hart 1971:8). Local winds are related to the 'daily cycles of incoming and outgoing radiation' (CSIRO Fitzpatrick 1965:57), but the high degree of cloudiness diminishes the contrasts in diurnal radiation and thus the intensity of the wind. Cloud cover, or lack of it, also influences the temperature range, as do aspect and altitude.

In general the northwest season (October to March) is warmer, the diurnal range is greater and the mean minimum daily temperatures are colder than in the southeast season (Table 4.2).

Table 4.2 : Mean Monthly, Annual and Extreme Temperature Characteristics (Degree Celcius).

STATION NAME	TEMPERATURE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
Lake Kutubu	Extreme Max.	32.7	32.7	33.3	37.2	34.1	32.7	33.2	34.6	31.9	36.7	33.6	32.3	37.2
Station No.*	Mean Max.	29.2	29.1	28.7	29.0	28.9	28.1	26.7	26.6	27.6	28.9	29.6	29.3	28.5
200226	Mean	23.8	23.8	23.5	23.6	23.7	23.1	22.1	22.2	22.9	23.4	23.7	23.6	23.3
(810 metres)	Mean Min.	18.3	18.5	18.3	18.2	18.5	18.1	17.4	17.8	18.1	17.9	17.8	17.9	18.1
	Extreme Min.	11.7	15.6	11.7	11.7	11.6	11.6	5.0	12.2	11.6	11.1	5.6	6.7	5.0
Mendi D.H.G.	Extreme Max.	31.0	26.7	26.8	28.1	26.1	26.3	26.8	25.7	25.9	27.9	34.5	31.0	34.5
Station No.	Mean Max.	24.0	23.9	23.8	23.9	23.8	22.9	22.2	22.5	22.8	23.6	24.1	24.1	23.5
200339	Mean	18.5	18.6	18.6	18.5	18.4	17.5	17.2	17.4	17.6	18.0	18.2	18.5	18.1
(1675 metres)	Mean Min.	13.0	13.3	13.3	13.0	13.0	12.0	12.2	12.3	12.4	12.3	12.2	12.9	12.7
	Extreme Min.	6.1	8.8	8.3	7.6	9.1	4.9	5.9	5.8	3.2	4.5	6.4	7.9	3.2
Tari S.D.M.G.	Extreme Max.	28.3	30.8	28.1	28.9	28.4	32.2	30.6	32.8	27.8	29.6	28.3	33.3	33.3
Station No.	Mean Max.	24.4	24.2	24.2	24.4	24.4	23.5	22.8	22.9	23.3	24.2	24.4	24.4	23.9
200256	Mean	18.7	18.9	19.1	19.1	19.2	18.2	17.9	17.7	18.0	18.3	18.4	18.8	18.5
(1600 metres)	Mean Min.	12.9	13.6	13.9	13.3	14.0	12.8	12.9	12.5	12.6	12.3	12.4	13.2	13.1
	Extreme Min.	2.2	3.3	7.5	6.7	9.0	3.3	-2.2	4.4	1.7	2.7	3.4	4.5	-2.2
Kongip	Extreme Max.**	28.0	27.5	27.0	27.5	27.0	25.0	25.0	26.0	26.0	27.5	31.0	29.0	31.0
(1760 metres)	Mean Max.	25.5	24.3	24.5	25.3	24.1	21.8	22.8	22.6	23.3	25.6	27.5	26.5	
	Mean	21.2	20.1	20.0	20.1	20.2	19.0	19.1	19.2	19.1	20.0	21.5	21.0	20.0
	Mean Min.	16.8	16.8	15.5	16.2	16.3	16.2	15.3	15.7	14.8	15.2	15.5	15.6	
	Extreme Min.	14.0	15.0	13.5	13.5	15.0	14.0	12.0	13.0	12.0	12.2	13.0	14.0	12.0

* Refers to code in source.
** Instruments were not in a Stevenson Screen and are for only the months of 1980.

Source : McAlpine, Keig and Short 1975.

At Lake Kutubu the extreme maximum temperatures occur at the equinoxes, April and October, when the sun is higher. October through to January have the highest maximums at Mendi with April also having high temperatures. At Tari the highest temperatures occur in June, July and August as well as December and February. The lack of any real pattern demonstrates the importance of cloud cover and altitude in modifying temperature. At Kongip, the field station, the seasonal pattern is much the same as the surrounding region although temperatures are lower than in the lowlands. The northwest season (Oct-March) experiences the highest monthly maximum temperatures as well as the highest mean temperatures. July to November at Kongip, Mendi and Tari, have the lowest extreme minimum monthly temperatures and a real risk of frost exists in exposed areas.

Humidities are high throughout the year (CSIRO Fitzpatrick 1965:64, McAlpine et al 1975) (Table 4.3). The highest index of humidity at Lake Kutubu is at the equinoxes and a seasonal rhythm is also discernible for Tari and Mendi. The lowest values occur between October and January throughout the region (CSIRO Fitzpatrick 1965:64-65), although in the afternoon, humidity at Lake Kutubu is lowest in May, June and November. The difference between morning and afternoon humidities is not great, especially during the northwest season. The high relative humidities, combined with nightime fall in temperature generally result in saturated or near-saturated conditions during the early morning hours (CSIRO Fitzpatrick 1965:65). The risk of frost during the northwest season is reduced by the higher humidities.

Table 4.3 : Mean Monthly 0900 and 1500 Hr Relative Humidity (%) and Average Index of Relative Humidity.

STATION NAME	TIME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	ANNUAL
Lake Kutubu	0900	83	83	86	86	86	86	89	88	86	85	78	82	85
Station No.	1500	73	69	74	78	61	76	79	79	79	75	76	74	74
200226	Index	79	77	80	80	79	78	82	80	79	79	76	80	79
Mendi D.H.Q.	0900	78	82	80	80	78	79	83	83	78	73	74	76	79
Station No.	1500	71	75	73	76	75	76	79	80	79	73	72	72	75
200339	Index	78	77	78	78	78	77	78	69	79	75	76	76	77
Tari S.D.H.Q.	0900	83	83	83	83	83	83	88	83	82	77	77	79	82
Station No.	1500	68	70	70	71	71	73	76	76	76	75	68	73	72
200256	Index	79	78	77	78	78	79	77	82	81	79	78	78	79

Source : McAlpine, Keig and Short 1975.

Table 4.4 : Mean Monthly 0900 and 1500 Hr Total Cloud (OKTAS).

STATION NAME	TIME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Lake Kutubu Station No. 200226	0900	5	5	5	5	5	5	6	6	6	5	5	5
	1500	7	6	6	7	6	6	7	7	7	7	6	6
Mendi D.H.Q. Station No. 200339	0900	6	6	6	5	5	5	5	5	5	5	5	6
	1500	7	7	7	7	7	7	7	7	7	7	7	7
Tari S.D.H.Q. Station No. 200256	0900	5	5	6	5	5	5	5	5	5	5	5	5
	1500	7	7	7	7	7	7	7	7	7	7	7	7

Source : McAlpine, Keig and Short 1975.

Cloud cover, the remaining modifying influence on temperature and humidity, is similar from Tari to Lake Kutubu (Table 4.4). It is cloudier at Lake Kutubu in the late afternoons at the equinoxes. The stations show a characteristic build up of cloud during the day, although the build up at Mendi is greater from April to November and at Lake Kutubu in January, April and October. The overall picture shown by temperature, humidities and cloud cover, reinforces the pattern described for the rainfall. A slight but nevertheless locally significant seasonal cycle is apparent. An attempt to distinguish between different seasons of the year at Nembi, using the available parameters (Table 4.5) suggests that elements of a four season cycle

Table 4.5 : The Seasons of the Nembi Plateau.

Element	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Rainfall		high long wet				low long dry		high short wet			low short dry	
Temperature		warm max warm means warmest mins					lowest max colder means warm mins				hottest max warmest means coldest mins	
Humidity		high morning higher afternoon						high morning lower afternoon				
Cloud Cover								clear mornings cloudier afternoons				
Airmass Circulation	norwesterlies					southeasterlies			Nemb tree blossoms		north westerlies	

are present, especially in the rainfall regime, and to a lesser extent in temperature throughout the year. It is also apparent that south of the Nembi Plateau some elements of seasonality, increase especially in the rainfall pattern, while to the north and east other elements, such as the diurnal temperature range increases. With increase in altitude the risk of frost increases sharply from June until November.

Conclusion

The Nembi environment is not so harsh as to be uninhabitable. Just as the Nembi Plateau is located on the borders of the highlands and lowlands agronomically so too is it influenced by highland and lowland climatic systems. The high annual rainfall and the limestone produce a distinctively harsh environment. Soils derived from volcanic ash provide the incentive for the exploitation of favourable niches.

Although the elements of seasonality in the Nembi environment are not marked, they cannot be dismissed as irrelevant to the Nembi socio-economy. To the contrary seasonality in the environment of the Nembi Plateau has an influence on the socio-economy out of all proportion to its physical magnitude particularly to the southern Nembi and the Yoel el and Pwe Pond el. They have migrated from the south, an area of higher but more markedly seasonal rainfall and higher temperatures, to settle an area in which the variability of rainfall is greater and the temperatures both lower and more variable. In addition they have adopted as a staple, a tuber which although better suited than taro to their new environment, is subject to declining yields unless certain conditions are met.

Sweet potato produces poorly in periods of drought, water-logging or frost. Even short periods of stress can seriously impair yields. Spells of weather, either hot, cold, wet or dry, and their variability and intensity are as important as the broad climatic considerations for an understanding of the agricultural system and the socio-economy of the Nembi.

Seasonality in micro-climatic conditions effects both the supply of foodstuffs and socio-cultural aspects of the Nembi way of life. In Chapter Eight and Nine these conditions are related to the nutritional status of children. Dependence upon sweet potato which is not stored means that relatively small shortfalls in yield due to any adverse conditions can have grave results. Although the seasonal pattern of climate and weather is not marked, because the agricultural system is a one staple system, the significance of seasonality is accentuated.

Poised between the highlands and the lowlands the Nembi remain uneasy occupants of their environment. This environment which now imposes so many constraints on Nembi production, once offered a singular advantage. The valleys and ridges which channelled the movements of their ancestors as they moved onto the plateau also influenced the movements of trade between the people of the highland and lowland regions. The people of the Lower Pwe Creek Basin took full advantage of their position astride the trade routes. Although the abandoned their taro gardens for a more intensive cultivated crop they never abandoned their links with their "relatives" and trade partners and their products in the southern lowlands.

CHAPTER FIVE

TRADITIONAL TRADE AND THE MARKET ECONOMY

'... they buy to sell again, take in to send out, and the greatest Part of their vast Commerce consists in being supply'd from all Parts ... that they may supply all ... again'

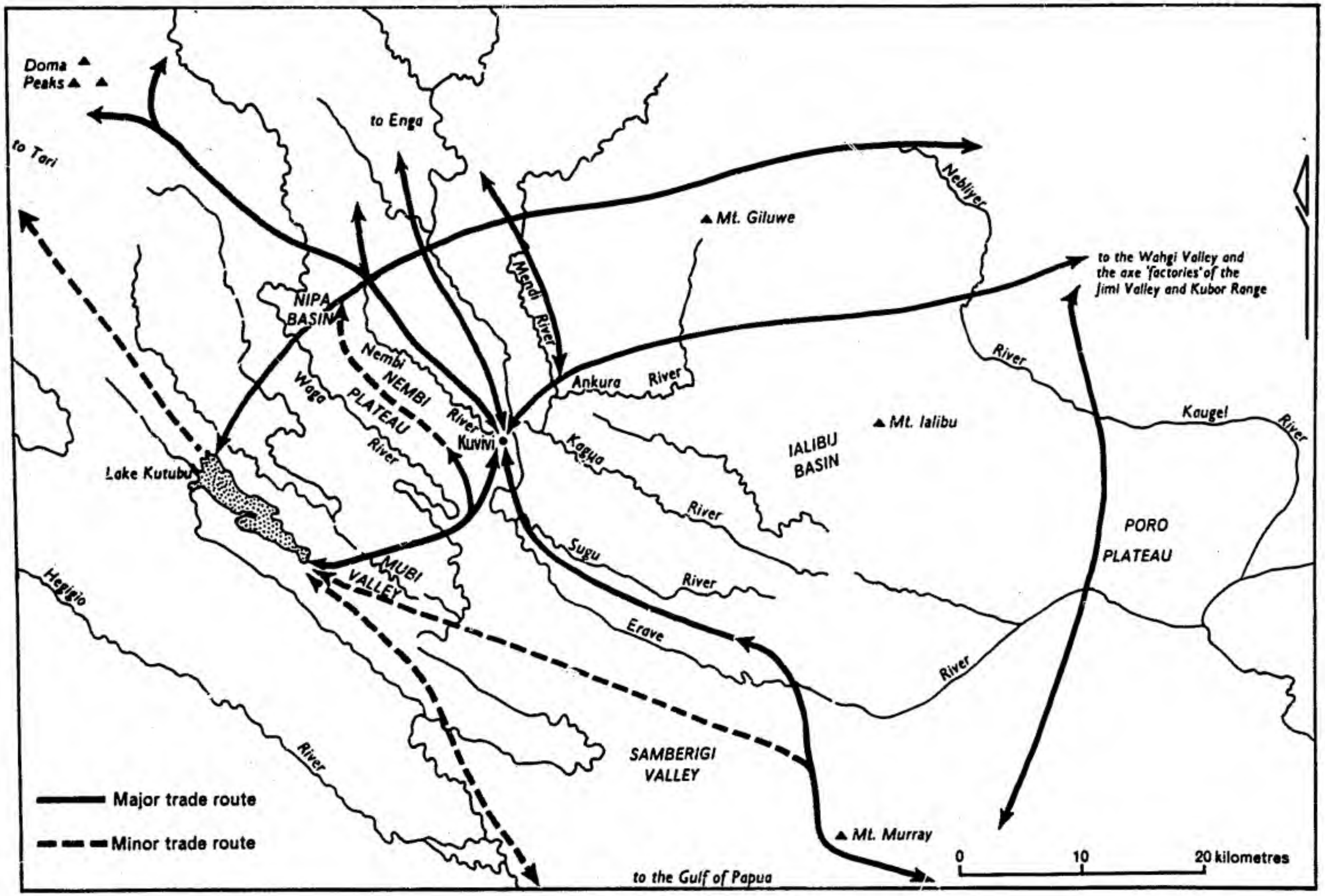
Daniel Defoe 1728:192 (A Plan of the English Commerce)

The Erave valley at Kuvivi, close to the confluence of the Mendi, Ankura, Kagua, Lai and Nembi was an important meeting and parting of ways. Here, trade routes from the highlands, the coast and lowlands converged. The traffic followed the trend of the valleys and interfluves, fanning out northwards to the Wola, Huli, Enga, Mendi and eastwards, skirting the shoulders of Mt Giluwe, to the M'Bonggu and the Meldpa. From the south came the track from the Samberigi valley and the Gulf of Papua (Map 5.1).

The clans of the southern Nembi Plateau were favourably located to take advantage of the exchange that took place at Kuvivi. From the protection of the walls of limestone they sallied forth into the exposed valley floor to trade. The Pubi-Penarop had important trade links, with people at all points of the compass. Their most important link however, was to the southwest and west with the Foi of the Mubi valley and Lake Kutubu.

From the Mubi valley the trade routes exploited gaps discordant to the trend of the topography, in the cuestas, cut by the rivers. One route went southeast from the lake and entered the Erave valley at its junction with the Sugu creek (Map 5.1) to serve the people of the Kagua, Erave and Samberigi regions further south. Another scaled the Waga anticline and then divided at Kunjurl. One branch continued across the Masina range to the Erave valley and Kuvivi.

Another route climbed onto the Nembi Plateau through the gap inhabited by the Pubi, providing them with access to the commodities of the Foi more immediately than at Kuvivi. The Pubi were at a



Map 5.1 : The convergence of trade routes at Kuvivi

gateway, to the grasslands of the Nembi Plateau and valley, the Nipa Basin and places to the northeast.* It was on this advantageous position, juxtaposed between the major confluence of routes at Kuvivi that the Pubi built their exchange economy.

Through trade the Pubi were able to stave off many of the disadvantages of living in an inhospitable environment. Trade became an extension of as well as a support for the intense competitive exchange networks between the Pubi and their allies and enemies. The products of other areas circulated within the Pubi economy to supplement its own meagre resources. Unfortunately, within that strategy lay the seeds of the Pubi's present bemusement.

The Pubi-Penarop and their neighbours had mixed feelings about the regions to the south. It was from the south that rumours of white man originated and to where the first white men to visit the plateau disappeared when they arrived from the north (Hides O'Malley Patrol 1935). The south was also the origin of the sickness (malaria) the Pubi-Penarop thought was caused by sorcery; the heart

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* Three other routes also connected the Foi to the Grasslanders in the east. One came directly across country to the Lower Pwe creek and was seldom used. It was called the Kebebe route because it crossed the Waga anticline at Mt Kebebe. This route is described in Pubi clan legend as that which the Pubi's ancestors followed onto the Nembi Plateau, (see Appendix to Chapter 3). A cave provided a resting place overnight. The other two routes joined the northern shores of Lake Kutubu with the Wola of the upper Waga valley and the Nipa basin. D.J. Clancy described these routes in 1950 (Patrol Report No.1 Lake Kutubu 1950/51) and I followed them in 1980. On two occasions I was accompanied by Capt. Michael Bird of the Royal Australian Engineers based in Mendi. I thank him for his logistic support on those occasions.

of bitter hostility between clans on either side of the Erave valley. But from the south came one of their most important rituals - the Timp cult - based upon the sacrifice of pigs to appease the ancestors.* Pearlshells and cowrie shells, important items of trade, also came from the south. The Nembi exchanged pigs for them with their trade partners in the south and southwest. When the Colonial Administration established a Police Camp at Lake Kutubu in 1937, the source of pearlshell and other commodities suddenly became much closer. Exploratory patrols followed the trade routes out from Lake Kutubu and the Mubi river lowlands to the grasslands in the east, buying food as they went with shells and steel. Sporadic and scarce supplies of valuable shell, began to be devalued, inflating the trade economy of people like the Pubi. In addition, supplies of steel and shell had begun to come in from the east with the establishment of Mt Hagen in the early 1930s.

Hide's Patrol of 1934/35 did not carry shell, (it brought cloth, steel and beads with which to trade) but the strength of the patrol and the fire power of the police, made a lasting impression the length and breadth of the Nembi Plateau. Many warriors were killed. Later patrols carried great quantities of shell however, and the

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*. Ryan (1961) describes the Timp cult in the Mendi region and attributes its origin to the south. Flint and Saunders described the cult when they entered the Samberigi valley in 1922, though they did not name it as such (Annual Report for Papua 1922/23). The Samberigi said they obtained it from the Gulf people. Hides described a cult house on the Nembi Plateau in 1935 (1936:152) situated on the ridge to the east of the Emia creek south of Kongip. Informants identified the place as Kesu and showed me where they still practised the ceremony. Champion described a Timp cult house in the Kagua valley in 1939 (Annual Report for Papua 1938/40:30).

Pubi's first perceptions of their economic inferiority, and that of their neighbours can be dated from that time. The fire power and material possessions of the Europeans were impressive, but it was their grand style and their behaviour in exchange that reverberated through the local economy (Hughes 1978). Patrol Officers were largely unaware of the effects their trading had on the traditional trade networks, but for the Pubi and their neighbours, the transactions in which they participated with Europeans only served to reinforce the notion that the Europeans were men 'rich beyond the dreams of avarice' (Hughes 1978:308).*

The establishment of Nipa Patrol Post in 1959 finally brought the source of wealth almost to the Pubi-Penarop's door step. The Lake Kutubu Patrol Post, closed during the Second World War, re-opened in 1949, and Mendi Patrol Post was established in 1951. The main lines of contact between the two centres skirted either to the north of the plateau through the territory of the Wola, or south following trade routes through the Masina range to the Mubi river lowlands. The Pubi although occasionally visited, were able to benefit from the trade of the patrols, but were not directly disturbed by them (Map 5.2).

Nipa Patrol Post was established specifically to halt the fighting in the Waga and Nembi valleys and on the Nembi Plateau. Demands made upon the Pubi-Penarop, coupled with the increased

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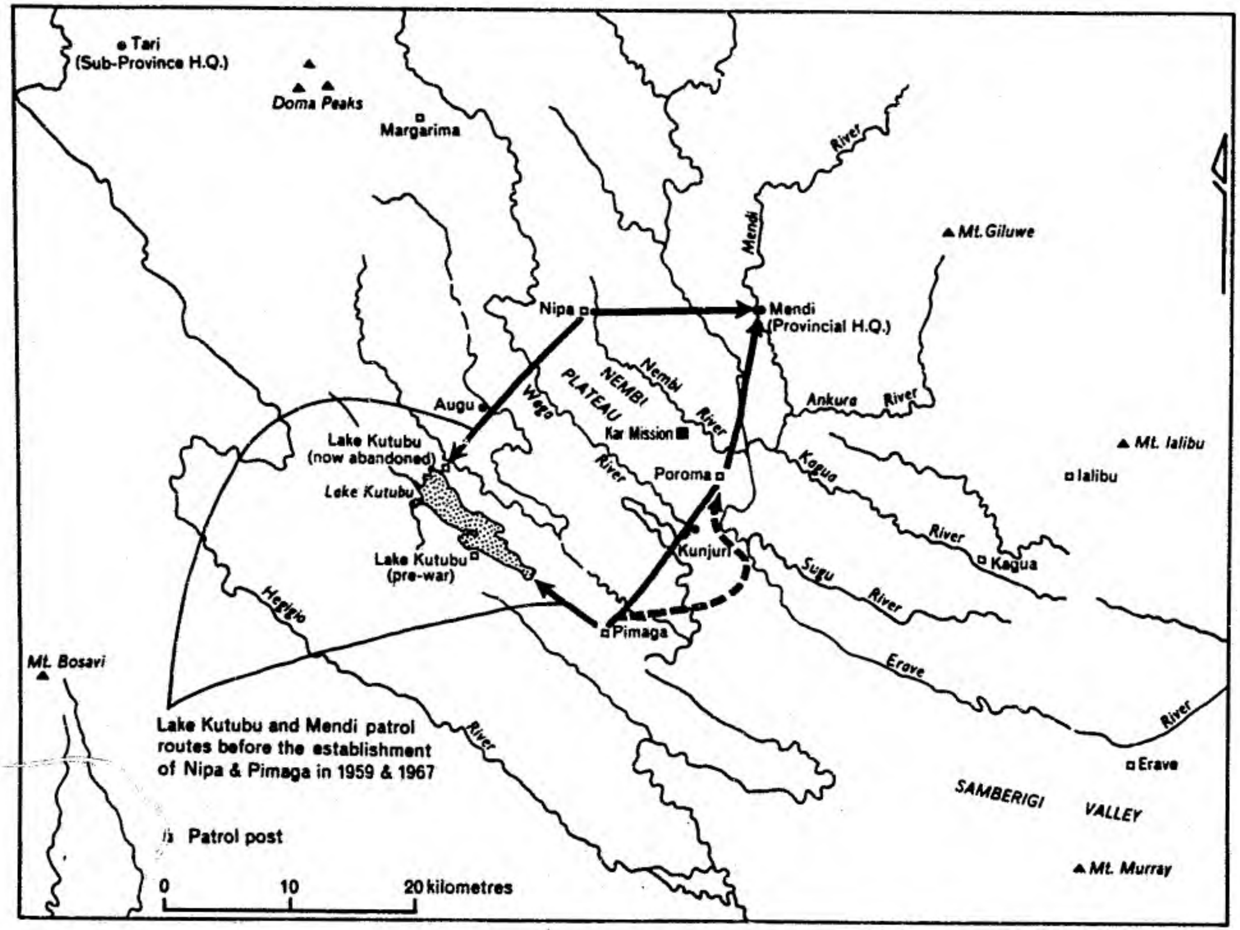
* The Annual Report for Papua 1938/39 documents an occasion when Adamson, patrolling from Lake Kutubu into the Wola region wanted to impress some men to bring food in exchange for trade items. The men ran off in confusion when shown a patrol box full of pearl shells. Annual Report for Papua 1938/39:20.



Map 5.2 : The passage of patrols from Lake Kutubu to Mendi

inflation of their trade and exchange networks, brought changes that outstripped the capacity of their economy to absorb them. A new possibility for achieving renown was introduced into the minds of the Pubi warriors. Wealth and prestige could be bought with bisnis - coffee, cattle and trade stores.

The Pubi began to lose their traditional autonomy. They were told that their agricultural techniques were poor, that their children were sick and thin and that their desire for material wealth was avarice. The Pubi-Penarop bowed to the kiap (Patrol Officer) and later, in their hope for material improvement, vested the power and prestige previously accorded fight-leaders and big-men, in the Local Government Council, the village magistrate and local politicians. As their self confidence was sapped the Pubi-Penarop began to lose their role as innovators and adapters within their own agricultural economy.

The overall result was that the Pubi became poised in anticipation of cues from the more powerful and coercive system as represented by Patrol Officers. As those cues either failed to materialize, or prompted even more false expectations, there evolved a general bemusement and dissatisfaction. By the middle 1960s some members of the Pubi and of other clans, had experienced stints of plantation work on the coast and in other parts of the highlands through the Highlands Labour Scheme. These men introduced a cosmopolitan element to the social life of the lower Pwe Creek Basin which fed the growing disillusionment. For the Pubi the cruelty of the colonial administration and later the national government, was that it neither left them alone with their own activities, customs and beliefs, nor fully included them into the wider economy. The Pubi now refer to all the Nembi people when they say they are the 'last men of Papua'.

Thus the Pubi-Penarop, who had strengthened their foothold in an inhospitable environment by their position in the regional trade network, lost that advantage as an inevitable consequence of contact with a wider and more powerful economy. A wedge was driven between the Nembi social and physical milieux.

The different scales of ecologic interdependence

To the south and southwest of the intermediate lowlands of Lake Kutubu, the Mubi valley and the Samberigi valley, and separating them from the coastal lowlands of the Gulf of Papua are a series of rugged limestone ridges. Conforming to the northwest-southeast pattern of relief found in the ranges to the north, but of lower altitude, they nevertheless present a formidable and largely uninhabited karst barrier extending from Karimui in the east to the Strickland river in the west. Early explorers called it 'broken bottle' country.* Two major rivers the Purari-Erave and the

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* 'The whole character of the country changed on the eighth day, when we came across coral rocks, which made our climbing very difficult, especially for the police and carriers. Although we were marching through rain all day, that night we were without water, for as fast as the rain fell it disappeared into large crevices in the coral' (Bell 1911:39). 'The rock is honeycombed and stood on end; it forms fissures and craters large and small, and every step has to be watched, for the limestone edges are as sharp as a broken

Kikori-Mubi, zig-zag across this horseshoe of limestone ranges. They and their tributaries provide the corridors linking the intermediate lowlands with the coast. Through these corridors the products of the littoral were traded and exchanged for those of the interior (Map 5.3).

It is hard to imagine that trade through such terrible country could have been for any reason other than necessity. The distance involved and the terrain were formidable. It seems highly unlikely that the men who trekked and canoed from Kikori and other parts of the Gulf lowlands to meet men from the Samberigi valley, at the confluence of the Sibereu and Kikori rivers, made the journey solely for social reasons.

By the same token neither did the men of the Mubi valley, who trekked with long bamboos of oil to trade at Kuvivi and in the lower Pwe Creek Basin, exert themselves primarily for the purpose of social intercourse or to keep the peace with their distant neighbours. The uninhabited forest would have been adequate protection. For those long distance trade routes from the Gulf into the intermediate lowlands, it would seem that the practical or economic usefulness of the goods exchanged dictated the necessity for trade: shells from the Gulf were bartered for stone axes, pigs and tobacco from the interior. No doubt an economic need prompted a social harmony which was mutually beneficial to both parties of the transaction, but even in the closely settled highland valleys, the distances over which trading parties

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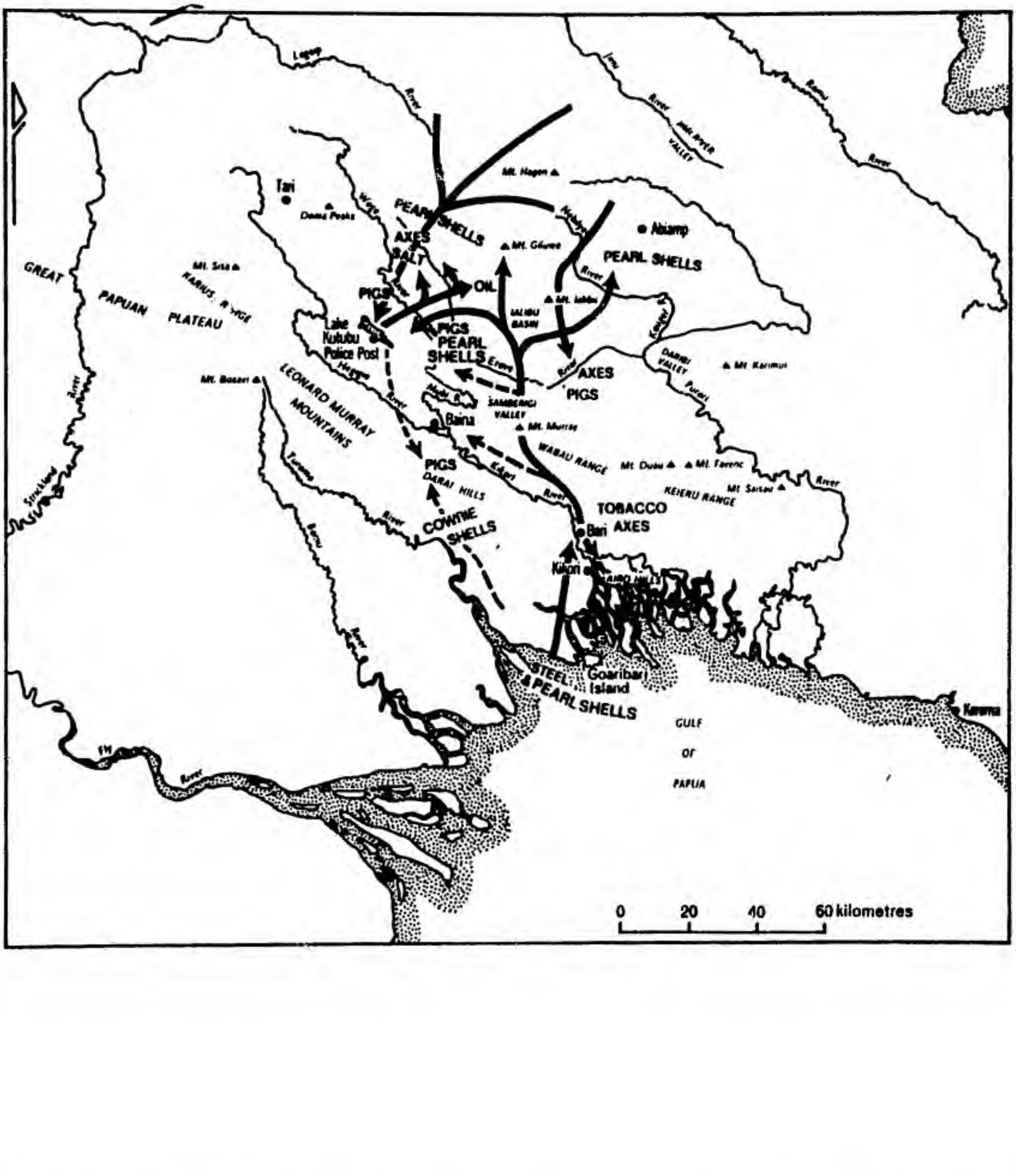
bottle... There are no running streams, no water, and the fissures and cylindrical stone pits appear bottomless to the eye. It is a desolate, silent land ...' (Hides 1935:41-42 at camp 13 and 14).



Map 5.3 : The commodities of exchange between the highlands and the littoral

sometimes travelled suggests something more than the need to maintain an orderly social environment was at stake.

The extent of long distance trade in the highland region was noted by Patrol Officers,* and Bulmer (1962) noted traders from the Chimbu 200km to the west selling plumes to the Enga in 1959. While at Wasemi Island on Lake Kutubu in 1936, Ivan Champion noted the presence of Grasslanders who had come to trade. Champion's party had been guided to Lake Kutubu by a trading party from the Mt Sisa region who had knowledge of the Grasslanders (1940:201-205).** Hides and O'Malley, earlier the previous year had met with a trading party on the Great Papuan Plateau bringing tigaso oil from the east (1935:31 camp No.5-6 21/3/35). Individual members of the Pubi also travelled relatively long distances for trading purposes.

Patrol officers appreciated the importance of Kuvivi (Map 5.1) where people from the Mubi valley*** would meet others from as faraway as the Mendi valley and exchange oil for pigs, shells and

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* S. Smith noted in the upper Mendi 'two natives who said they came from Wabak (Wabag). Our interpreters had difficulty talking to these people but from what we could gather a track leads east from here. For two days it is a good track. On the third day it crosses through swamp [kandep?] and on the fourth day there are Europeans. None of these natives [Mendi] had been there. They called the place Yanimanda [Wapenamanda?] and described what might be an airstrip' (Patrol Report No.2 Lake Kutubu 1950/51).

** Champion also met with Huli traders to the southwest of the Hegigio/Kikori river, who were carrying tobacco to trade for shells in the southeast. A few days later Champion was told that some pearlshells came from Kewa (1940:200-201).

***"At 1045 hrs reached Mato ceremonial ground [in the lower Nembi valley] of the Tundu group and after an hours talk with the people gathered there moved on, passing through Kuviri [sic] a well known pre-war camp site [see later section of this chapter], arrived at stone axes.* The exchange of pigs out from the more intensive highland regions in exchange for pearl shells is well recognized. LeRoy noted that the south Kewa used to do a lively trade with groups living below Mt Murray (the Samberigi). More importantly for my argument here, concerning the position of the Nembi in the trade net of the region LeRoy suggested that the word kewa is used from Tari in the west to Daribi in the east to designate neighbouring populations to the south who are a source of shells. He also says that for some grassland Kewa (Kagua and Ialibu Basins) the word merepa (Meldpa) indicates communities to the north which give pigs in exchange for pearl shells. A Kewa settlement therefore has a kewa settlement to its south and a merepa to its north; it will in turn be merepa and kewa for those settlements (LeRoy 1979:181-181).

Poroma ceremonial ground of the Polom group at 1300 hrs. Camp was erected... In the late afternoon a party of Mubi river natives arrived at Poroma with many long bamboo containers of tigaso oil. This oil is being awaited by the groups involved in the forthcoming pig feasts... Departed at 0800 hrs and at 0930 hrs rested on a ridge top immediately above Mato ceremonial ground where we could see several hundred people gathered to buy the tigaso oil from the Mubi river natives" (Patrol Report Nipa I 1961/62).

* "The principal trading article which the Mubis have to offer is tigaso oil, a vegetable oil obtained from trees in the Kutubu area and much prized by highland natives who anoint themselves with it on festive occasions. It is also probable that it was along these routes that there previously came many of the mother-of-pearl shell and European-manufactured steel articles which the people of the Lai, Nembi and Mendi valleys possessed before the establishment of the Government station at Mendi. The reciprocal trading item demanded by the Mubi natives appears to be pigs, which are plentiful in the colder mountain regions... the oil obtained from the Mubi natives is traded to Mendi, upper Lai and Nembi natives for salt, mother of pearl shells and pigs." (Patrol Report No.5 Mendi 1953/54.

These long distance trade routes were part of the network linking the highlands with the less densely populated lowlands. A denser network joined neighbouring highland groups linked with each other through kinship and marriage and filled in the pattern.

Entry to the highlands from the lowlands and intermediate areas was limited to a few points by the nature of the terrain. These included the two routes that cut the 'broken bottle' country and the routes from Lake Kutubu and Mubi river lowlands onto the Nembi Plateau. The Pubi, as guardians of one of the gateways, thus played an important role in the economy of the Grasslands as well as the Kutubu and Mubi lowlands. The trade of the Pubi-Penarop with the people of Kutubu, and with neighbours to the east, was not simply a question of commodities being passed from hand to hand and from group to group. Particular people would make it their business to go on a trading journey for a specific good and would take a specific commodity with them with which to exchange it. Even in 1980, when I lived with the Pubi, members of the clan went to Hegeso in the Mubi lowlands to obtain plumes and sago, and to tell their trade partners that the Pwe ipond el and some of the Yoel el planned to kill pigs in the new year. Indeed a feature of many of the ceremonial grounds (Hauma) of the Nembi Plateau, the Wola and the Mendi, especially to the southwest of Mt Giluwe along the old trade route to the Wahgi valley, are "Kutubu houses". These structures have four massive corner posts, each of possibly 2 metres in diameter. They are constructed specifically to house trade partners from the Kutubu region during the pig-killing ceremonies (mok-ink or mok-enk) of the Mendi and Nembi. Social intercourse between the Kewa south of the

Pubi with the villages of the Kokoma creek is similarly quite free. Many trade partners in these villages are affines. The Pubi claim that they trade almost exclusively with the descendents of Kurop Epi, the brother of Kurop Pubi, their apical ancestor.* It is perhaps no coincidence that Pubi and Epi are the names given to a tree species on the Nembi Plateau (Schlefflería) regarded by the Pubi clan almost as a totem.

Trade is important in varying degrees to all the people of the highlands. Nevertheless very few places had such a favourable position which offered bonuses additional to their own resources, as the Pubi. One parallel was the Minj district, the

> 'natural cultural and trading centre of the Wahgi valley...(with its)... great volume of livestock wealth unequalled in the length and breadth of the sub-division... There was a great deal of steel and valuable shell and they seemed to be more wealthy than the average Chimbu tribe simply by trading' (Downs Patrol Report July 1940, in Hide 1981).

Thus it seems that trade and its importance in the socio-economy of the Pubi was related to their relatively easy access to commodities of different environments and their position at a node of important route-ways.

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* Langlas states that a Foi trader usually restricted his visits to one or two villages where he was sure of a welcome. Foi traders also learn the language of their trade partners [cf the people of the Kokoma creek villages chpt 3 p103]. Langlas also found that Foi traders usually visited villages which were putatively of the same clan as their own (Langlas 1974:177).

Hughes (1971, 1973, 1977, 1978) emphasizes that trade throughout the highlands may have been based upon the ecological diversity between regions, a diversity also reflected in the variety of cultures. Sillitoe on the other hand has stressed the social aspects of trade between groups, with commodities being passed from hand to hand and along no specific pathways (1978:274, 1979). The two views are not incompatible with each other, but the importance of long distance trade based upon regional specialization is often forgotten in the shadow of the flamboyancy of more localised exchange of women and bridewealth. Strathern (1971) describes a situation which developed in the Hagen area in the early 1940s whereby the people of the Nebilyer valley attempted to regain through a 'cargo-cult' their previously advantageous position in the long distance trade of shells from the coast to the tribes further north and east, disturbed by the arrival of Europeans at Mt Hagen. Although the social structure of the people concerned, based upon the interrelationships of clans, was most prominently expressed through the medium of elaborate exchanges of wealth objects, particularly pigs and shells, it was the men of the lower Nebilyer who, through their ties to the south held command over the trade routes for pearl shells into the Hagen area (Strathern 1971:255, 263). The distinction between the two scales of exchange is clearly expressed and after the Administration arrived at Hagen the men of the Nebilyer found that the table had turned against them in the regional trade network. Shells were now more plentiful from the Hagen area (Hughes 1978). The situation that developed between the Pubi and their trade partners was similar.

<u>The commodities of different environments: pigs, pearlshells, axes and salt</u>

The Pubi and the southern Nembi retain a reputation for breeding especially large pigs which have five toes on one or more of their feet instead of the usual four.* Patrol Officers rather cynically regarded them as only another example of the unusual nature of the Nembi Plateau and its people.** The Hides O'Malley Patrol traversed the plateau from north to south in 1935 and noted that some of the pigs offered to them had five toes (P.I.M. October 24 1935). These especially large pigs represented the only commodity the Nembi produced themselves for which lowland people were willing to trade. Although some bird-of-paradise plumes were collected from the ranges to the west, the Nembi were only middle-men for other commodities. Stone axes and salt came from the north and east. They were exchanged, along with pigs, for tigaso oil and black palm bows from the west. Some pearlshells came from the east and west, but the majority from the south.

The Pubi-Penarop and their neighbours were intermediaries in the trade between the highland and lowland environments. The degree of polygyny (some big-men have as many as twelve wives) suggests that the amount of wealth from this role and available to the aspiring big-man, and in general circulation, was considerable. It seems probable that the harsh environment of the Nembi Plateau, coupled with the

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* Pigs with five toes on all feet are called <u>Wabila</u>, pigs with five toes on only one foot are called <u>Waga</u> and pigs with four toes on all feet are called <u>Menineh</u>.

** 'Having experienced the Nembi Division, an area which among other things seems to specialize in five-fingered pigs and six-toed children nothing that happened there would come as a surprise' (Patrol Report No.7 Mendi 1962/63).

limited sweet potato technology used by the Pubi-Penarop, was not sufficient to support such a degree of polygyny and related exchange compared with neighbouring areas without some supplementary activities. In 1980, twenty eight percent of married men of the Pwe ipond el and Yoel el had more than one wife. Ten percent of married men had more than three wives. Geneaological evidence suggests that this is a smaller number than in the past and is a further possible indicator that the scale of trade was disrupted by European contact.* Inflation due to the influx of pearlshells from the Administration has made it more difficult to collect the bride wealth. For example from 1925 to 1940 the number of pearl shells included by the Pubi in an individual bride wealth was approximately 35. Between 1971 and 1975 it was 76 pearlshells, plus nearly 150 kina in money - (Bride wealth is discussed more fully below). The collection of enough wealth to acquire a wife, and the maintenance of exchange obligations with ones in-laws remains the very essence of living. Trading with people from lower areas was thus necessary despite the hazards; not so much the risk of being killed by an axe but more by the secretive power of sorcery. The association in the minds of the Pubi, of the lower valleys with sorcery is emphasized as an underlying theme of the Nembi social milieu.

The importance of trade to the Pubi and the distances involved should not be underestimated. Evidence available from Pubi informants and Patrol Reports places the Nembi in an important

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* In 1980 40 percent of men over the age of twenty were bachelors. In the absence of trade young men cannot afford to marry. Indeed of those unmarried men 25 percent were away working on plantations -(they make up 10 percent of all adult males), probably to accrue enough wealth to be able to afford the bride wealth.

position with the regional trade network. Although circumstantial, such evidence is supported by the observations of others who have worked in the region. For example, five-toed pigs were found in the Delta Division to the south of the Nembi Plateau in 1928 (Patrol Report No.22 Kikori 1928/29 L. Austen). They were noted again amongst the Foi (Patrol Report No.16 Kikori 1929/30 I. Champion), and on the Turama river, in the Delta Division, in 1933* (Patrol Report No.7 Kikori 1933/34 C.H. Rich). Informants told Champion that the pigs seen by Austen in 1928 had come from the Foi people (the Ikobi) to their north and were traded south to the Bari people and the inhabitants of the Turama river region. Austen also remarked that the pigs he had seen on the Turama river had been traded via the people of Nawagera at the confluence of the Mubi and Kikori rivers (1934:24). Some indication of the reasons for such a widespread trade in pigs is given by Langlas (1974:29) who noted that the Foi were less proficient pig-husbandmen than other highlands people. He reasoned that it was thus advantageous for the Foi to import shoats (young hogs) from the Augu and Kewa to the east, and he estimated that over half the pigs in the Mubi valley were imported from the Nembi Plateau. F.E. Williams also remarked on the distances involved in the trade of pigs between the Grasslanders and the people of Lake Kutubu, and noted that 'small

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* A.S. Le Souef examined the trotter of a five-toed pig from the Delta Division in the early 1930s. He assumed that they were a 'throw-back' or some 'reversion of evolution'. The six-toed children reported by Patrol Officers (Patrol Report No.7 Mendi 1962/63) may be a result of inter-marriage within the plateau population. The system of clan-pairing described in Chapter Three meant that over a number of generations people eligible to marry could be quite closely related. A child was born with six toes in the Pubi when we lived there in 1980. (Le Souef was a Zoologist at the Sydney Zoo in the 1930s and was reported in the PIM October 24 1935).

sucklings are carried remarkable distances (in a string bag under the arm) to be exchanged for a string of cowries...' (1976:14).

The Foi method of raising pigs, no different from that practised in the rest of the lowlands, allows the pigs to forage. Because the males are castrated, shoats must be imported. It is a typically extensive method of production (see also the pig-husbandry Maring as described by Rappaport 1968:70-71, 105). A large number of young pigs die before they are weaned and productivity is therefore low. The more intensive methods of the Nembi, Wola and Kewa are more productive. Dornstreich (1977) succintly states some essential differences between extensive and intensive agricultural systems although it seems to me he has placed too much value on the calorific value of the pig rather than its social role; '... any significant emphasis on animal husbandry also requires an intensification of the methods by which the animals are to be fed. In New Guinea the only two possibilities in this respect are the cutting of more sago palms or a substantially increased commitment to horticulture. One rarely finds intensive pig husbandry in sago areas ...' (Dornstreich 1977:265). His explanation is that at altitudes where sago is found then fishing is a more productive method to obtain scarce protein than pig husbandry. Indeed in the Lake Kutubu lowlands fish is an important part of the diet. But by the same token the husbandry of pigs for social purposes is harder where sago is the staple. I suggest that this is the root reason for the trade in pigs and not the desirability of a scarce protein.

The Foi people traded for Plateau pigs with black palm bows and tigaso oilm and with pearlshells and cowries.* During the period when Europeans were in the Delta District/Gulf District, but not in the highland valleys steel may also have been an important commodity of exchange possessed by the Foi.

The interesting thing about the trade between the Nembi and the Foi is that unlike the Kewa and their neighbours to the north and south, the Nembi supplied not only pigs but also pearl shells and axes to their southwesterly neighbours. The Nembi had advantages additional to those associated with a more intensive system of production, compared with the lowlands, and which were related more to their location than environment. The environment of the southern Nembi Plateau is far from bountiful and is in some respects quite harsh (Chapter Four).

The Pubi had more direct access to the major traffic of pearlshells into the highlands from the Gulf of Papua via the Samberigi valley than the people of Lake Kutubu. In addition, stone axes manufactured in the Wahgi and Jimi 'factories' had to pass through the Nembi and Wola or the Kewa before they could be obtained by the Foi.

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* It seems that the Kutubu people may have been a source of cowrie shells to the Grasslanders. The cowrie shells, called Bari by the Foi come from the south via the people south of the Mubi/Kikori junction. Langlas says this cowrie trade was not important, as the Foi did not mention it (Langlas 1974:177-178). It is interesting to speculate on the origin of the word Bari as it is the same name of the people of the lower reaches of the Kikori - see later this chapter.

The Nembi relate that they possessed pearlshells (Pinctada maxima Jameson), cowrie (Cypraea spp.), tambu (Nassa spp.) and bailer shells (Melo spp.L) before the arrival of Europeans. They say that only a few pearlshell were obtained from the people of Lake Kutubu or from the east. By far the most came to the Nembi from the south through the Erave valley (the Samberigi route). More recently shells came from the east; the Nembi recognise these as of European origin and distinguish these newer shells from those traded from the south.

The people of Lake Kutubu believed that their best pearlshells came from the east via the Nembi and Wola; inferior ones came from the southeast (Williams 1976:176). The Foi spoke almost with awe of the fine specimens of pearl shell which belonged to the Grasslanders and told Williams that they did not obtain more from that source because they cost too much, thus emphasizing the difference in the relative wealth of the two systems. Apparently, the strength of the traffic from the Gulf through the Samberigi to the Kewa Grasslanders, and the effect it had on other trade patterns, spread much further than Lake Kutubu. People to the south of Lake Kutubu and to the west of Samberigi, not only obtained five-toed pigs from the north but also believed that pearlshells came from the same direction. Like the Foi, they distinguish between the shells from the south and those which they believed originated from some mythical cache inland (Austen 1935:22). The cache, according to Austen's report, apparently dried up, which would accord with the gradual exhaustion of the shallower and more accessible beds of the Torres Straits in the period before 1910, and when the Papuans of the Gulf had access to them as labourers (Hughes 1977:45, and 193, Beckett 1977). After about 1910 Papuans were not employed by the pearling industry as labourers.

The Foi, although having some direct contact with the coast via the Kikori, were very much out on a limb; a position that was taken advantage of by the Nembi who had direct links with the coastal lowlands and the Samberigi trade route.

It is a linked phenomenom that Williams should also remark that the Foi's stone axes were far rougher, and were utility implements compared with the 'beautifully shaped axes of the grassland (1976:189). Champion had also noted that the quality of stone axes improved as he travelled east from Lake Kutubu through the grassland valleys in 1936 (1940:246). The value of the stone axes to the Foi, is such that they do not use them to cut sago. Williams reported the use of a flinty stone that had been snapped off to provide a sharp edge (1976:190). He called this sago scraper by its Foi name wasa, and it is significant that Rhoads (1980:32,33) found the source of this cheaper stone to the south of Lake Kutubu, at Baina at the confluence of the Mubi and Hegigio rivers.

Axes found on the Nembi Plateau were identified as originating from Abiamp and the Jimi valley (Hughes pers comm. 1981). Axes of the same provenance have also been found in the Gulf lowlands (Hughes 1977:180 states some were collected by Hurley and McCulloch in 1923 and mentioned much earlier by Jukes in 1847:265-77). The 1893 Annual Report for British New Guinea reported the inhabitants of the lower banks of the Vailala river using stone adzes (1894:27) and members of

Staniforth-Smith's exploratory party of 1911 also mentioned stone axes and adzes being used in the Samberigi valley (Annual Report for Papua 1911:169).* In addition, axes of a nature suggesting they originated from the quarries of the Wahgi valley, were also found in the Turama river estuary (Jukes 1847:265-277), lending credence to the long distance over which not only axes were traded, but also other commodities such as five-toed pigs, from the Nembi region via the Foi of Lake Kutubu.

The axes of the Samberigi valley, unlike those of the Kutubu people, who were not on the direct trade route to the coast, were impressive and Beaver described them as of the very finest '...apparently of jade or greenstone, splendidly bevelled' (Annual Report Papua 1911:179). The Samberigi gave the impression that their axes were hierlooms and Patrol Officer Saunders unsuccessfully attempted to purchase one in 1922, (Annual Report Papua 1922:147, Patrol Report No.13 Kikori 1921/22). In the Samberigi valley, although stone axes were by no means in short supply, they were still treasured (Saunders 1924:25 and 29) reflecting their intrinsic as well as exchange value. On the Nembi Plateau in 1980, although axes were no longer in everyday use, ceremonial axes were still plentiful but valuable. Their value has probably increased in the last 30 or so years as production from the factories has halted. The trade in stone

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* Other reports describe stone clubs as well as axes being utilized by the inhabitants of the Gulf lowlands and the inland riverine districts (Annual Report for Papua 1893:27, 1909:55), where they were used with good effect: 'One of the natives grabbed one of them [the carriers] by the hair and smashed in his skull with a stone club' (Annual Report for Papua 1911:203). They were also reported from the Samberigi valley (loc.cit.:179).

axes was probably declining even in the early 1930s on the Nembi Plateau, and other parts of the highlands, as steel became more available.

Because there was no longer any active trade in stone axes in the early 1970s Sillitoe suggested that the Wola had always received stone axes only in a mere trickle from their source in the northeast and that they were hierlooms (1978:266). He reports that of 53 cases of men receiving stone axes amongst the Wola (surveyed in the early 1970s) 83 percent of them had inherited from their father. From this evidence Sillitoe concluded that the trade in axes has always been small. However in the mid-1930s Hides and Champion had seen steel, and indeed introduced more steel into the region, and by the 1960s the steel axe was ubiquitous. Steel was also introduced to the Hagen area in the early 1930s and the stone axe factories gradually ceased production. Stone axes retained only a ceremonial use, and as such, with the decline in trade and production, stone axes, had by the 1970s indeed become hierlooms thus highlighting the danger of interpreting history from present evidence. In the Samberigi valley unlike the Kutubu region, the reverence given to stone axes was probably a result of their relative cost rather than their short supply. It was reported that the Samberigi people obtained shells with which to purchase axes, by exchanging tobacco with the people of the Gulf (Patrol Reports Kikori No.17 1923/24, also No.3 1921/22, Saunders 1924:28-29, Annual Report Papua 1912:73, 1921/22:149).

Although the Nembi lost their advantage of trading axes to Lake Kutubu fairly soon after Europeans introduced steel into the region, they were further advantaged because the people of Lake Kutubu and the Mubi lowlands did not manufacture their own salt. In the highlands, salt is an important commodity and in great demand. The Nembi obtained most of their salt requirements from the Enga saltwells at Langku, Jolunda, or Aukera and Pipitaka on the Lagaip river (Meggitt 1956:102). The Foi obtained from the Wola and the Pubi* salt retraded from the Enga saltwells. Some came from the Samberigi to the southeast who manufactured their own from sago mixed with the pith of a kind of palm (Saunders 1924:31).

Trade in pearlshells, axes and salt was associated with the comparative advantage location gave the Pubi over the Foi, The trade in pigs reflected the advantage of a more intensive agricultural system made possible by the adoption of sweet potato. Trade in steel is a different story.

Steel, the harbinger of European penetration on the Nembi Plateau

The influx of steel, initially from the Gulf and later from the northeast as Europeans entered the valleys of the eastern highlands, accentuated the north-south flow of trade and strengthened the

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* 'Packages of squashed spherical shape, neatly bound with strips of pandanus leaf, are often to be found in Kutubu men's houses. They are of vegetable salt, about five lbs weight from Augu or the Wage where they are purchased with cowries (bari)' (Williams 1976:175). As this description is identical to the packages of salt produced from the Enga springs, it seems likely this was mineral and vegetable salt.

position of the Pubi and other Nembi clans dominating the trade with the Foi. No doubt some steel found its way to the Foi from the south,* but as the amount of steel entering the trade network increased, the position of the people in the southern Nembi Plateau and the Erave valley improved. The significance of the east-west routes to the Nembi Plateau did not increase until a police camp was established on Lake Kutubu in 1937. The Foi were then able to trade on more favourable terms with the Grasslanders, because they could obtain both pearlshells and steel axes from the Europeans by labouring at the police camp.

From 1937 the reciprocal demand for specialised products of highland and lowland environments began to be replaced by a common dependency upon the trade goods of the western economy. The highlands and lowlands were drawn closer together by their mutual dependency upon the western economy. At the same time increasing redundancy of the long distance trade routes began to pull the regions further apart. The highlands highway pulled one way and coastal traffic and air routes pulled another. The desolation of the "broken bottle" limestone wilderness still effectively separates the highlands from the lowlands to the south.

With the decline in trade from the south, the Pubi began to lose their focal role between the highlands and lowlands and to look east to Mendi and the monetized economy. They thus began to see

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* Champion whilst exploring Lake Kutubu saw men with old blunt tomahawks which they said came from Okani (1940:206). Okani is the Samberigi valley to the southeast.

themselves, with their backs to the forested lowlands and the Great Papuan Plateau, as the last men of Papua.

Jack Hides and James O'Malley noticed the first sign of steel since they had left the Papuan lowlands, on the Nembi Plateau* in early May 1935. Further south, where Erave Government Station now stands, Hides remarked that '...nearly every man carried an article of steel, most of the tomahawks being Brades, though one or two of Charleston Steel Works' (1935:98).**Hides surmised that the Charleston axes had been traded in from the north and the Brades from the south. Thus did Hides recognise the extent of trade in the highlands and provide a pointer to the fact that the Southern Highlands, the Purari-Kikori watershed, were influenced by European presence to the south and east.

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* Hides wrote: 'The first sign of steel today. A native with a Brades 378 No.1" axe head' (at camp 44, 12/5/35 [probably just north of Ebil between the Nembi Plateau and the Nipa Basin], 1935:80).

** Hides' report is very confused as to exactly where he was when he made this observation. I suspect that he was somewhere between the area where Erave station now stands and the Sugu river to the north. It is an area of rough limestone pinnacle country and lightly populated. In 1953, E.D. Wren, ADC at Lake Kutubu Patrol Post reported that he visited two villages close to the left bank of the Erave river, south of the Nembi Plateau, that Hides had visited in 1935: Kurusa and Awara (Patrol Report No.11 Lake Kutubu 1953/54 pp.33-34). Hides called these people the Iumburave and B.B. Corrigan in Patrol Report No.3 of Erave in 1956/57 reports travelling through typically Papuan villages between Sugu and Erave valleys. One of the villages was called Sumbure and could well be the Iumburave of Hides' report. Ten years before Hides' patrol, Rentoul made mention of a brand of axe in the Samberigi valley of a different kind than those distributed by the Administration - Harrison No.8. Rentoul was told that they had come from the coast. They may in fact have been distributed by Ben Butcher of the LMS at Aird Hill in the Kikori delta (Hughes 1977:48. Rentoul, Patrol Report No.14 Kikori 1924/25).

Champion saw many steel tomahawks which were old and blunt in the Mendi valley in November 1936 (1940:246) and three years before, Taylor and the Leahy brothers had noticed steel axes to the southeast in the Kaugel and Nebilyer valleys, and the Ialibu basin (although not in the Hagen area, Chinnery 1934:409-410, Leahy 1936:251), which they were told had come from the south (see also Hughes 1977:56). It seems likely that all the axes had come up from the Gulf through the Samberigi valley, except those that Hides suspected came from New Guinea and had probably entered the area with either the Leahys or the Fox brothers. Once again the trade route to the south and the Gulf brought the Pubi a commodity with which they could trade to their advantage with the Foi. But it was also steel which heralded the upheaval they were to experience with increasing intensity after Hides' and O'Malley's visit in 1935.

In 1929 Murray, the Lieutenant Governor of Papua, likened the exploration of Papua to what the French had called the policy of the oil stain (<u>la tache d'huile</u>). He pictured the influence of Government percolating throughout the territory, even to places unvisited by white men (Annual Report for Papua 1929/30:5). The flow of steel along the trade routes spread, like an oil stain, with rumour and other trade goods preceding the patrol officers into the highlands from the south.

The full extent to which steel had entered the highlands before Europeans will probably never be known, neither will the extent to which rumour of white men preceded their actual appearance, ever be realised. That there were rumours is undoubted, and patrols from

Kikori met many times with evasive answers to their requests for information on people living to the north.*

In 1968 a patrol officer suggested that because the Pubi-Penarop had close dialect ties with Mendi they had foreknowledge of the Administration attitude to warfare, accounting for the truculence displayed by the southern Nembi in their dealings with the Administration in the early 1960s (Patrol Report No.7 Nipa 1968/69). The roots of the Pubi-Penarop's resentment and that of their neighbours, probably go back further than the establishment of a Patrol Post at Mendi, to European penetration of the valleys in the south.

The Gulf of Papua was an important trade area and had been for many years before the establishment of the Government Station at Kikori in February 1912. The Torres Straits were the source of much of the pearlshell found in the highlands and undoubtedly iron and steel also followed the same route (Hughes 1977:25). Some steel, iron and brass in earlier days found its way into the region through shipwreck and from passing ships (Hughes 1971, 1977). Its scarcity

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* '...An hours walk next morning in a westerly direction brought us to the small hamlets of Forari and Saureme. Only five men were seen and denied knowledge of any other villages further to the west or north' [ie beyond the Kerabi valley near to Samberigi] Patrol Report No.15 Kikori 1922/23.
'...An old man said that the younger men were enquiring why the Government had come three times, that they did not understand the reason of the visits, and that some of the men had said that they did not want the Government to come as it upset their business (Patrol Report No.17 Kikori 1923/24; in the Samberigi valley).
Rentoul in speaking of the Bari said; '...In view of the fact that they are blood relations to the Okani, it is also natural that they should not volunteer information about that district or the tracks leading thereto [the Samberigi]'. Patrol Report No.14 Kikori 1924/25.

would have confined it mostly to the coastal region. By 1910 the large supplies of pearlshell which had entered the highlands had created a myth of a huge cache inland in the mountains. At the same time with the establishment of the Government Station in the Gulf the amount of steel passing northwards along the trade routes increased.* The importance of the trade routes was maintained. Steel and no doubt rumour of white men, preceded all the exploratory patrols from Kikori and Kerema into the hinterland of the Delta Division and the exploration of the trade routes leading into the highlands prompted and facilitated European penetration. Nevertheless it was a slow process. The broken bottle country isolated the Samberigi valley and the lower Mubi people from each other and from people to the north and south. Both groups were contacted in 1911 by the Staniforth-Smith patrol. In 1935 when Hides and O'Malley entered the region to the north, patrols from the Mandated Territory of New Guinea using aircraft to ferry supplies, were closer to entering the grasslands of Papua than were patrols from Papua staging supplies on the backs of carriers. It was not until Lake Kutubu had been discovered,** enabling seaplanes to deliver supplies, that the blank of the Purari/Kikori headwaters began to be filled by the Papuan Administration.

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* Thursday Island Government Station was established in 1889. Mabuduan, also established in 1889 moved to Daru in 1893 (Hope 1979:10,43). The LMS Station at Orokolo was opened in 1892 and so was that at Kiwai Island. In 1906 Kerema Government Station was opened and another LMS Station at the Urika mouth of the Purari, in the same year. Butcher opened Aird Hill at the mouth of the Kikori in the same years as the Government established its station. All traded with steel.

** Seen by Europeans from the air for the first time in 1935 during a reconnaissance after the Hides-O'Malley patrol, and first visited by a European when Champion arrived there in 1936.

When Staniforth-Smith and the search parties sent to find him entered the Samberigi valley and the lower Mubi valley in 1911 they found that the people possessed steel and had heard of the Kikori, Turama and Bamu rivers.* They found inland people wearing shells and thus supposed that they traded with the coastal people (Annual Report for Papua 1911:168). Bell, the Assistant Resident Magistrate (ARM) at Kerema, noted similarities between the Goaribari people of the Delta and the people of the Samberigi valley in 1911 and remarked especially on the fact that both groups wore a band of cowrie shells and a small crescent of pearlshell around their necks (1911:33,35). It was suggested that the inhabitants along the course of the Kikori were in touch with each other (Annual Report for Papua 1911:186) thus echoing the observation of Seymour Forte, the private secretary to the Administration, Sir Peter Scratchley, that people everywhere were eager to trade and that coastal people had inland trading connections (Annual Report for British New Guinea 1885:14-15).

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* James Chalmers explored the mouths of the Purari and Kikori Deltas in 1883 (Geographical Journal 9 1887) and Bevan travelled further upstream in 1887 and 1888 (Geographical Journal 9 1887, Couts-Trotter Geographical Journal 1890). HMS Fly under Capt. Blackwood had also ventured some way along the deltaic coast of the Gulf in 1843 and entered the mouth of the Kikori (Jukes 1847). MacGregor explored the coast and had travelled inland along the rivers in 1891 (Annual Report British New Guinea 1893), following the tracks of Chalmers, Bevan and Blackwood (see Hope 1979:8-10). The next significant exploration in the Gulf lowlands was the Little-McKay expedition up the Purari river in 1908. Accompanied by Pratt, a surveyor in the Queensland service and Eichorn, a naturalist, they were assisted by L.L. Bell, ARM at Kerema (MacKay and Little, Geographical Journal 38 1911; see also Bell, Victorian Geographical Journal 28 1911). Carne surveyed possible oil field sites on the Vailala river in 1911 (Annual Report for Papua 1912), which marked the beginning of extensive oil exploration in the Gulf and hinterland that still continues.

Until the Samberigi valley was again entered by Flint and Saunders in 1922, patrolling from Kikori was of a routine nature to explore and pacify the immediate hinterland of the Gulf (Hope 1979). Nevertheless the presence of steel was continually remarked upon, as were the trading connections between the various areas. These reports of trading links were instrumental in the exploration of the upper reaches of the Kikori.

Before Flint and Saunders set out on their patrol to fully explore the Samberigi valley, they attempted to find the Bara people who they knew were important intermediaries on the trade route from the coast to the interior.* Flint promised presents of steel to the Bara people to lead them to the Okani (as the Samberigis were known) and Saunders was surprised by the amount of steel that he found in the Samberigi valley when they eventually reached it later in the year.**

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* I was informed...that the village...belonged to the Bara people...The people from Dopima village (on Goaribari Island and responsible for the murder and eating of Chalmers and Tomkins in 1901) in years gone by used to come up the Kikori river to fight with these Bara people who were then living nearer the Kikori river (Patrol Report No.28 Kikori 1918). I visited per launch the village of Utiti (on the Kikori just north of Kikori station). The object was to endavour to elicit information as to the whereabouts of people known as Bara. It had been reported that these people (Bara) were in touch with those living in or near the Samberigi valley district (Patrol Report No.13 Kikori 1921/22).

** To my surprise, quite a lot were armed with steel axes, and when asked where they got them they shook their heads and pointed in the direction of Sebereu [down the Iehi creek toward the Bara and Kikori]. There was evidently a direct trade route with the coast...(Saunders 1924:25).

Flint and Saunders reached the Erave (Erewa) river which they recognised as the headwaters of the Purari, but did not cross it. They were intrigued however, to know whether people lived on the other side. People in the Kerabi valley told them that men lived on the other side, but it was impossible to cross (Patrol Report No.13 Kikori 1921/22). Subsequent patrols to the Samberigi valley attempted to elicit information on the people and the tantalising glimpses of grasslands to the north of the Erawa river (Patrol Report No.15 Kikori 1922/23, No.17 1923/24, No.14 1924/25, No.13 1925/26, No.19 1928/29, No.16 1929/30). Woodward and Saunders examined the country to the north of Samberigi through binoculars and saw Mt Giluwe in 1922. Saunders in 1924 was told of specific villages on the northern side of the Erave.

The possibility of establishing a police camp in the valley was considered, but rejected on Rentoul's recommendation in 1925, due to its isolation and difficulty of supply from the coast. In 1929 Champion and Faithorn traced the Erave from north of Samberigi to its junction with the Purari and to the sea. They crossed the Erave and following the left bank found some of the villages reported by Saunders in 1924, but did not suspect the large populations in the grasslands in the north.

One of the effects, however, of the patrols entering the Samberigi valley, was that trade between groups became more direct. In 1924 it was reported that Samberigi traders were themselves travelling down to Kikori, instead of using the traditional middle-men at Bara village (Patrol Report No.17 Kikori 1923/24). Thus the Pubi were not the only people to be adversely affected in the trade network by European interference. As trade became more direct the presence of Europeans became more widely known. When Hides and O'Malley finally made contact with the people of the grasslands it must have come as a surprise to the Grasslanders to see Europeans coming from the north-west rather than from the south. Hides noticed the use of the word Kiko to the south of the Nembi Plateau to signify a place to the south from whence came steel, beads and shell ornaments (Hides 1935:101). In 1939 Williams reported the use of the word Kiko to mean a place southeast of Augu which was a source of pearlshells. He also noted that Kiko meant anything European (Williams in Annual Report for Papua 1939:40, 47-48).

The Pubi were possibly aware of Europeans for much longer than the period immediately preceeding the Hides and O'Malley patrol. With the patrolling activity to the south and subsequently from the east, word spread of the white men and their wealth and power. As I have argued in Chapter Three the language links between the people of the Southern Highlands were such that long-distance trading parties could communicate quite easily. The patrol that established the airstrip at Mendi in 1951 had interpreters from Lake Kutubu who used a 'trade language' to make themselves understood (Patrol Report No.1 Lake Kutubu 1950/51).

Further penetration of the Grasslands, after Hides and O'Malley's patrol, continued to follow the network of trade routes in the valleys of the Purari headwaters and across the Poru plateau. Administration headquarters was at Lake Kutubu, which was initially though to be the hub of the trade ways (PIM April 1937:71, June 1937:33-34, August 1937:48, October 1937, November 1937).* Exploratory patrols from Lake Kutubu Police Post followed trade routes to the northeast and east.** Only two patrols entered the Nembi Plateau and only one traversed the Pubi territory before going south down the Emia creek to the Erave river and then to the Mubi lowlands (Radiogram 9/7/39 from Government Secretary to Canberra [Australian Archives A518 B251/3/1 part 2]). A great deal of tribal fighting was noticed by this patrol on the Nembi Plateau.

The Pubi were, however, isolated from contact with patrols from the Lake which crossed the lower Wage valley at Kunjurl to the south. Shells, steel, other trade goods and word of the patrols spread to the Pubi, but they remained relatively undisturbed. That they knew of the patrols presence is undoubted. When Champion and Timperly were ambushed at Kuvivi by clansmen of the Karinj alliance in June 1939, the Pubi who were members of the Karinj alliance and who regularly travelled to Kuvivi (and indeed some of them had affines at Olarop on the high limestone ridge overlooking Kuvivi), would have

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* A headline in the Pacific Island's Monthly for June 23 1937, suggested that Lake Kutubu 'May be Ancient Trading Centre of Unknown Papua'. However the problem of finding elsewhere a landing strip which could compare with Lake Kutubu as an anchorage for seaplanes, probably persuaded the Administration to establish Lake Kutubu Police Post. The main centres of population, as Champion well knew, were to the east.

** Copies of Patrol Reports for the period 1937 to 1940 at Lake Kutubu could not be found at Mendi, Port Moresby or Canberra. Telegrams from the Lieutenant Governor of Papua (Murray) to the Prime Minister's Department were found in the Australian Archives. The only other reference to Patrols in this period were found in the Pacific Island's Monthly and the Papua Annual Reports.

known of the incident.* Two clansmen were injured by rifle fire. A little to the south Champion had shot and killed a man 10 days earlier. The amount of shell and steel traded from Lake Kutubu and by the patrols through the grasslands must have been, by all accounts, quite considerable,** but the impact of the fire power of both Hides and O'Malley's patrol and those from Lake Kutubu must also not be underestimated.

Hides' patrol in 1934 killed at least 15 men (the figures differ with informants' stories and from the official patrol report) at Marboro-hauma, an hour's walk to the northeast of the Pubi. One of Hides' carriers died there from exhaustion (Strickland-Purari Patrol Report 1935:85, camp 46). The Merut clan who were attacking the patrol at the time thought that they were responsible for the man's death. An hour to the southeast of the Pubi at Eib, on a ridge overlooking the Emia creek and valley, Hides' patrol killed another two men (1935:89 camp 47).***

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* It is an important point that on this patrol Champion mentions meeting men from the Samberigi valley, who said they were trading, whilst he was traversing the region between the Sugu valley and Kagua (Papua Annual Report 1939/40:29-30), to the south of Kuvivi.

** The Police Post operated from 1937 to 1940 and up to five Europeans, 12 police and the same number of carriers were stationed there at any one time or on patrol in the surrounding areas. Up to three shells were paid for a pig and up to two for a copra sack of sweet potato (see Papua Annual Report 1939/40).

***An interesting point here is that these two men were from the Epi-Yokul sub-clans (as they then were) of the Pubi living at their mother's territory.

Lake Kutubu Patrol Post was closed in 1940, and except for a visit to the lake by the General Officer Commanding Angau in August 1943, to set up an emergency food store in case of evacuations across the island from the Sepik, the area was relatively little disturbed for ten years. Constable Girege who accompanied the Angau party, was a Kutubu man enlisted by Champion before the War (Angau War Diary Aug 14 1943), and had been one of Williams' informants when he was staying at Augu (Williams in Papuan Annual Report 1939:39). The only disturbance was the large number of aircraft that flew over the area in 1943/44 from Australia to bomb the Japanese bases on the north coast. The story goes that bombs were dropped near Kagua by a disabled bomber; a woman and a number of pigs were killed. Patrols from Kikori and from the Angau post in the Samberigi valley were reported by trading parties (mentioned in Patrol Report No.8 Lake Kutubu 1952/53), as were the activities of an Angau Officer in the Tari Basin (this most probably was Danny Leahy in 1943 [Ashton 1979]).

The aeroplane was not particularly new to the Pubi. They had seen the aircraft in which Hides, Champion, Williams, Taylor and Lett had surveyed Hides' patrol route. In the same year Champion surveyed his route before the Bamu-Purari patrol of 1935/36. The sound of aircraft landing upon Lake Kutubu to serve the Police Post would have been heard on the plateau. The people of the grasslands thought that Hide's, O'Malley and other Europeans had descended from the sky (Papua Annual Report 1938/39:20). Whether the Pubi thought that Europeans were spirits from the sky, I am not sure, but it is quite probable that when an aircraft went overhead, they may have thought, as suggested to me by one informant, 'there go the owners of the axes and shells.'* Then again, as my informant also pointed out, some climbed to the highest point and were determined to shoot the noisy bird with their bow and arrows.

Thus by 1949 when the Lake Kutubu post was reopened the Pubi and their neighbours had a shrewd understanding of the meaning of the patrols that crossed the grasslands. Wealth of a completely different order was possessed by the white men. He was also very powerful. Moreover the source of wealth, pearl shells and steel now was no longer to the south but to the west in the Wahgi valley and had for a short three years also been at Lake Kutubu.

When the Administration contemplated pacifying the Nembi Plateau, Europeans knew little of the Nembi, but the Nembi had already formed their own opinion of Europeans. In 1959 when Europeans came to Nipa, pre-conceived ideas of each other clouded the interaction of the two groups. From such unhappy beginnings stem many of the present misunderstandings in the area.

Nipa and the pacification of the Nembi

The Nembi Plateau was one of the last areas in the Southern Highlands to be pacified and declared a controlled area.** The Pubi

* A remarkably similar response was given to Patrol Officer Foldi when he enquired of the people at Lake Tabera what they thought aeroplanes were (Papua Annual Report 1937/38:27).

** Uncontrolled Districts were those where the rule of Australian Law had not yet been established. Only Government Officers on official see this as contributing to their present economic backwardness in comparison to other areas of the province (see Appendix 5.1).

In late 1949 a Patrol travelled to the re-established Station at Lake Kutubu* from Mt Hagen (Sinclair 1961:110) to look for a suitable site for an airstrip. They found none, but in 1950 a patrol left Lake Kutubu for the same purpose and found a suitable place in the Mendi valley (Patrol Report No.1 Lake Kutubu 1950/51).** With the help from a patrol from Mt Hagen the station at Mendi was quickly established (Patrol Report No.4 Mt Hagen 1950/51). In 1951 the Central Highlands District was divided into the Eastern, Western and Southern Highlands District. Mendi became the headquarters of the Southern Highlands. Tari Patrol Post was established in 1951, and the airstrip finished in 1952 (Patrol Report No.2 Lake Kutubu 1952/53). To the south of the Pubi, Erave and Ialibu Patrol Posts were established in May 1953 (Patrol Reports Nos.8,9,10 Lake Kutubu 1952/53) and in 1957 Kagua Patrol Post was opened.

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business were allowed into those areas. When fighting had been stopped and the people were no longer so volatile then the restrictions were lifted and the region declared 'controlled'.

* S. Smith and D.J. Clancy had built the new station on the north-eastern shore of the lake at Tage point. Before the war the Police Post had been at Tugiri on the southwest shore.

** Evidence of the extent of the long distance trade was presented to this patrol when they arrived at Mendi. Some of the clans men had in their possession a number of US Army knives, which they said they obtained from the northeast and pointed up the Mendi valley. The knives probably came from either Mt Hagen or Wabag, both Angau stations during the Second World War.

For nearly ten years before Nipa was built the Pubi were aware of the closing presence of the Administration. As Patrol Posts were built the Missions entered the region. Accompanying the patrol that set up Mendi was the Methodist Overseas Mission. The Unevangelized Fields Mission (UFM), now the Asian Pacific Christian Mission (APCM) established itself in the Lake Kutubu area in 1950. Thus the Pubi were caught between the expanding influence of the Missions as well as of the Administration (see Appendix 5.2 for Missions on the plateau).

The Pubi however, remained relatively undisturbed. The line of contact between Kutubu and Mendi was via Augu, the upper Wage valley at Haralinja or Hebinja, the Nipa basin and the upper Lai valley (Map 5.2).* Patrols to Erave and Kagua went to the south of the Lower Waga valley. People along both routes had seen patrols from Lake Kutubu in the pre-war period. The lower Wage and Kunjurl had seen one patrol pre-war (July 1938 Champion**) before McCleod's Patrol in 1952 (Patrol Report No.1 Mendi 1952/53). Occasionally patrols crossed the Nembi Plateau, but to the north of the lower Pwe Creek Basin and the Pubi, through the territory of their neighbours the Sigiriba at Karamella. Having come up the Nembi valley from Mendi some patrols crossed the plateau to the Wage valley on their way to Lake Kutubu (Patrol Report No.1 Mendi 1950/51, No.2 Lake Kutubu

* Thus continuing the influence that the Wola was subjected to by pre-war patrols although Sillitoe, in his ethnography of the Wola contended that western influence was minimal and had not significantly affected the way of life of the Wola by the time he lived with them in the early 1970s (1979:18-19, viii).

** Copy of Telegram 31/7/38 from Lake Kutubu Police Post to Port Moresby in Australian Archives CSR A518/B251/3/1 part 2.

1954/55, No.3a Erave 1957/58). Other patrols continued up the Nembi valley to join the main Lake Kutubu - Mendi line of contact in the Nipa Basin (Patrol Report Nos.4 and 5 Erave 1957/58).

The first post-war patrol to contact the Pubi was made in 1953 (although McCleod's patrol of 1952 had explored the lower Emia creek), and camped at Wabi, one of the Pubi ceremonial grounds (Patrol Report No.5 Mendi 1953/54). The Pubi remember the occasion because they were performing a dancing festival prior to killing pigs later in the year. They were not contacted again until patrols from Nipa began to enter the area in 1959. With the airstrip built, patrols began in earnest to pacify the Nipa Basin, Nembi valley and plateau.* The officer in charge at Nipa remarked upon the hostility of the people in the region, both amongst themselves and to the Administration (Patrol Report No.1 Nipa 1959/60) thus continuing the impression of earlier patrols.** The isolation of the Pubi was also noted by the Acting Director of Native Affairs, T.G. Aitchison, who commented that it was '... unfortunate that the lower Nembi and the southeastern Wage divide

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* The grass flats at Kuvivi and at Kar were considered as a site for a Patrol Post as well as Margarima in the upper Wage valley (Patrol Report No.4 Mendi 1952/53, No.5 Mendi 1954/55, No.1 Lake Kutubu 1953/54, No.1 Lake Kutubu 1954/55. All three sites were eventually used for airstrips - Poroma Patrol Post, Christian Union Mission and Margarima Patrol Post all opened in the late 1960s.

** Seven years before it was remarked that 'the natives northeast of Lake Kutubu have never been noted for their co-operation. They are arrogant and have been continuously parsimonious with food and assistance to patrols. Mr Champion has always reported adversely on the Nembi, Lai, Wage and Mendi peoples... To the northeast of Kutubu the locals appear to be very anxious to be rid of [the Government]. As yet they have had no serious clashes with the forces of law and order, and to date, ignorance has been bliss as far as consequences are concerned' (Patrol Report No.4 Mendi 1952/53 McCleod).

were isolated from the former Kutubu-Mendi line of contact ...' and that '... patrols travelling Mendi to Mubi missed this pocket of population' (File 67/15/29 Patrol Report No.2 Nipa 1959/60.)

The reaction of the Pubi and the Koin-Iomo to the Administration taking an active part in their affairs was particularly hostile. J. Jordan, the Officer in Charge at Nipa in 1959 reported that '... attempts were made to get the people to meet the patrol, but the only result was that the patrol was given a rather juicy badinage of obscene comments by persons sitting on nearby ridges'* (Patrol Report No.2 Nipa 1959/60).

Throughout the 1960s patrol reports document interclan hostility on the Nembi Plateau. It was a stormy period. Although not recognised at the time, without doubt the traumatic effects of Hides' patrol in 1935 and of the woundings at Kuvivi in 1939, as well as rumours that reached the Nembi from other areas had a deep effect upon the Nembi's reaction to the Administration. At times the people of the lower Pwe Creek Basin reacted violently to interference. The power of the Administration was demonstrated by the amalgamation of four patrols on the plateau to stop tribal fighting (Patrol Report No.10 Mendi, Patrol Report No.3 Nipa, Patrol Report No.7 Kagua, Patrol Report No.4 Erave 1960/61) between the <u>Yoel el</u> and the <u>An purl purl</u>

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* A Mendi Patrol was similarly treated:
'these parties called out the usual stock insults for the area such as, "We will skin your penis", "Go and drink your mother's menstrual fluid" and "Our axe will drink your urine". This latter threat apparently refers to the killing blow used in this area when the attackers strikes his victim through the back to the kidney' (Patrol Report No.4 Mendi 1961/62).

nak after the Pubi had fired arrows at a previous patrol (Patrol Report No.5 Nipa 1959/60). A patrol Officer had his leg broken by clansmen in 1961 and patrols to Pumberal had stones thrown at them (Patrol Report No.5 Mendi 1961/62, Patrol Report No.1 Nipa 1961/62). All in all the reaction to the Administration was one of hostile resentment* but the Administration was resolute in its task. By 1963 the Nembi had been cowed and the way opened for some sort of economic development to take place.** Inter-clan hostility surfaced again however, in the late 1960s. In an area close to the Nembi Plateau (the lower Nembi and lower Lai valleys), thought to be a peaceable area, clan fighting broke out in 1966 to settle old scores which the people thought had not been settled adequately by the Administration. It seems that the renewal of violence can be compared directly with the violence in 1981 in the Lower Pwe Creek Basin which is documented in Chapter Three whereby the Nembi attempted to regain their self-esteem and to take decisions for themselves. In 1966 the fighting in the lower Lai valley was subdued and the Poroma Patrol Post was established at Kuvivi in 1967 to keep law and order (Patrol

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* The rather more sensitive comments of Patrol Officer C.E.T. Terrell are a more realistic assessment of the Nembi people but were ignored. He wrote; 'I interpret what has been regarded as arrogance by previous patrols as a natural independence of thought and action, and the attitude prevailing is "if what I do doesn't suit you, well that's your concern"' (Patrol Report No.1 Lake Kutubu 1953/54).

** Some idea of how the Nembi viewed the Administration can be gleaned from the following:
'This patrol was a large one, and the Nembi people have a considerable respect for the Mendi police, consequently, everyone went out of their way to ensure that nothing occurred which might possibly arouse the patrol to action. Examples of this thing were found, for example, at Semin, where a deputation led by the VC approached me and wanted an assurance that we would not take any action against them because it was raining and the census had to be postponed' (Patrol Report No.7 Mendi 1962).

Report Nos. 8, 12, 18, 19 Mendi 1966/67, Patrol Report Nos. 3, 5 Nipa 1966/67).

In the same year (1967) the Patrol Post at Tage on Lake Kutubu was closed and Pimaga Patrol Post in the lower Mubi valley to the south of the Lake opened. Patrols no longer travelled through the area from the Lake to Mendi. Roads were being built from Nipa and Poroma to Mendi and aircraft served the Pimaga Post. The Pubi, who had sacrificed much of their traditional way of life, began to look towards Nipa and Mendi. In 1973 a base camp was established at Ol overlooking the Lower Pwe creek, and until it was disbanded in 1975 a Patrol Officer kept watch over the affairs of the clansmen.

The inexorable process of contact and subjugation of the Pubi was long and painful. They had been forewarned at least 50 years earlier. Steel, and then Administration patrols, as well as rumours of events in other areas were received with a sense of foreboding, resentment, anger and fear. The reaction of the Nembi warriors was thus mixed. The demand for traditional forms of wealth continued but these could now be obtained from Nipa, Mendi and other parts of the highlands by labouring. The Patrol Officers preached 'economic development' or '<u>bisnis</u>', and as the road network expanded out from Mendi and Nipa, the Pubi and their neighbours saw warriors from the Wahgi valley, who were more closely tied into the national economy come to Kuvivi in Toyota trucks to buy tigaso oil (see Appendix 5.3 for discussion of the road network in the region). The Nembi were brought into a wider economy, but unlike the pre-contact economy which was centred upon differences in ecological productivity from which the

Pubi and other clans took advantage, the new economy put them very much at a disadvantage.

Economic opportunity on the Nembi Plateau

The Southern Highlands Province supplied large numbers of labourers to the Highlands Labour Scheme (Harris 1972, 1974, 1975). The first recruits were taken from the Nembi Plateau in 1962 (Patrol Report No.4 Nipa 1962/63, see also No.7 1964/65). As noted (see fn page 211), 25 percent of single adult men on the Nembi Plateau were absent during 1980, working on plantations. In addition large numbers of people migrate to the plantations of the Wahgi valley during the coffee season in June to August each year. The lack of cash-earning opportunities on the plateau was attributed to varying factors by the Colonial Administration. An officer commenting in 1965 (Patrol Report No.5 Nipa 1965/66) on the potential of the plateau, mentioned that previous impressions of large areas of land not cultivated and therefore available for alienation or cash-cropping were erroneous and that warfare had caused many people to flee west to the Waga valley. In 1967 the ADC at Nipa (McNeill letter to the DC Mendi February 1967, file 67/2/3) pointed out that the plateau was an area of poor soils, with a shortage of land and that no cash crops were suitable for the area. In 1969 the interpretation was reversed. It was stated that economic development was so slow not so much because of resource constraints, as of the necessity of first bringing the area under Administration control. It was emphasised that land and labour were not in short supply, and that coffee was probably the most attractive crop because only a minimum of training and guidance would be necessary (Patrol Report No.1 Nipa 1969/70).

Patrol Officers reached no consensus of opinion on the economic future of the Nembi people and their prime concern was with administration. In the early 1960s people were encouraged to move from the Waga valley and ranges to the west onto the plateau (Patrol Report No.2 Nipa 1959/60, No.11 1965/66, and the Augu village Book 1960-1965) so that they would be more accessible to the Administration. In 1970 a problem of land availability was seen as the major constraint to economic development, along with a lack of money (Patrol Report No.2 Nipa 1970/71) and by 1972 it was surmised that there was probably not an absolute shortage of land on the Nembi Plateau but that the road was attracting people to move onto the plateau and into the lower Pwe creek (Patrol Report No.11 Nipa 1971/72). As I have shown in Chapter Three this was indeed the case but no proposals were made as to how such a vicious circle could be broken.

Coffee was introduced to the Nembi Plateau in 1965 (Patrol Report No.3 Nipa 1965/66). By 1971 only 7.4 ha of coffee had been planted on the Nembi Plateau (Uba 4 ha, Pumberal 1 ha, Tobua 1 ha, Enjua 0.7 ha, Tegibo 0.4 ha, Karamella 0.3 ha). Present hectarages are also very small. Other cash crops were introduced with even more disappointing results. Chillies were tried in 1971 (Patrol Report Poroma 1970/71) and are now grown only in the lower Waga valley where their bulk relative to their price makes it worthwhile to porter them to Poroma to sell to the Department of Primary Industry. Pyrethrum was introduced in the northern plateau and Nipa basin but without success (Patrol Report No.13 Nipa 1963/64).

As in other parts of the highlands the Pubi and the rest of the Nembi people were quick to appreciate the value of money: the lack of opportunity to earn it however was keenly felt (Patrol Report No.5 Nipa 1963/64). Money replaced trade items (pearlshells, cowries, cloth and axes) as payment for work on the Nipa airstrip, as payment of carriers and for firewood and food by patrols in late 1962 (Patrol Report No.4 Nipa 1962/63). The Nipa Station site was purchased with shell and axes, but at the end of 1965 the site for an airstrip in the Nembi valley at Kar was purchased by the Christian Union Mission for £105-15-0 (Patrol Report No.3 Nipa 1965/66).

Money began to enter traditional exchange transactions of the Pubi in the mid to late 1960s, but only after the value of the traditional items had dropped due to inflation. The average amount of money included in bride-wealth payments increased considerably from the late 1960s (Table 5.1). In 1980 Ayab, the big-man of Kongip asked for and received K800 as part of the wealth for his daughter when she married. He subsequently married his son to a woman from the Nembi valley and had to give K500 as part of the bride-wealth. The number of pigs in the bride-wealth has been remarkably consistent but the number of pearlshells has increased rapidly. Tigaso oil was dropped and so have cowries and salt, the latter two no longer being scarce items of value. Steel did not become part of the bride-wealth although stone axes were the first to lose their importance in the late 1930s. Although money was important on the Nembi Plateau by the

Table 5.1 : Bride Wealth from the 1920s to the Present.

1st Marriage — Mean number of items per bridewealth

Average Values	No. in Group	Pigs	Money (kina) (a)	Shell	Casso-wary	Cowrie necklace	Salt	Oil Tigaso	Black Palm Bow	Stone Axe	Other
1921-25	1	5	-	20	-	3	1	1	1	1	-
1925-30	4	2.5	-	31.25	-	4.75	2.25	1	0.25	0.25	-
1931-35	5	1.6	-	41.2	-	5.8	6.4	2.4	0.5	0.2	-
1936-40	12	2.2	-	32.1	-	6.9	5.1	3	2	0.6	-
1941-45	7	1.6	-	48.6	-	4.7	3.9	1.1	1.3	-	-
1946-50	3	1.5	-	40	-	5.5	4	2	1.5	-	-
1951-55	11	1.5	-	26.1	-	3.5	2.7	2.1	8.2	-	-
1956-60	8	1.75	-	47.5	-	7.1	3.6	2.4	0.1	-	1.3(b)
1961-65	12	2.1	-	53.3	0.1	3.9	2.4	1	0.8	-	
1966-70	12	1.7	1.7	40	0.7	1.8	1.1	1.1	0.4	-	0.1(c)
1971-75	13	2.2	146.2	76	2.1	0.1	-		-	-	0.1(d)
1976-80	12	3.6	165.0	61.1	0.5	-	-	0.1	-	-	-

2nd Marriage

1931-35	1	-	-	20	-	6	-	3	-
1936-40		-	-	-	-	-	-	-	-
1941-45	3	2.7	-	40	-	4.7	5	4	3.3
1946-50	8	0.25	-	33.1	-	4.4	2.1	2.1	0.25
1951-55	4	0.5	-	20	-	2.5	1.3	2.3	0.5
1956-60	2	1.5	-	20	-	0.5	1	0.5	-
1961-65	3	7.0		60	-	0.7	0.7	-	-
1966-70	3	0.7	33.3	20.3	-	1	1	0.3	-
1971-75	4	0.7	65	88.3	0.3	1	-	-	-
1976-80	3	0.7	53.3	26.7	0.3	-	-	-	-

3rd Marriage

1931-35	1	-	-	1	-	1	-	1	1
1946-50	1	4	-	100	-	6	5	1	-
1951-55	1	-	-	8	-	1	-	-	-
1956-60	1	-	-	40	-	-	1	1	-

(a) One dollar is equated with one kina.
(b) Bush wallaby
(c) Hen
(d) Steel knife

Source : Unpublished data Janis Baines (interviews with women). Cross-checked by interviewing the men myself. If any discrepancy then the woman's figure was accepted.

mid 1960s there were very few opportunities to obtain it locally.* The inflationary element in the bride-wealth initially caused the greatest concern to the Nembi, especially to the young men. They complained to Patrol Officers that they could not afford to obtain wives (Patrol Report No.20 Mendi 1961/62, No.5 Nipa 1965/66, No.9 Nipa 1966/67) and that the older men were maintaining a monopoly on the exchange of valuables.** Not surprisingly in 1970 the Local Government Council*** introduced a rule limiting the pearlshells in

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* The Big-man at Uba - of the Puit clan to the east of the Pubi - was appointed village constable early in the 1960s. A number of feuds with the Administration lead to him accruing a great deal of experience at Nipa jail. He was involved with a dispute over land when the Capuchin Friars wanted to build a mission at Uba which prompted them to build at Pumberal instead (Patrol Report No.3 Nipa 1962/63). However by 1968 he was probably the wealthiest man on the plateau by European standards. It was reported that his trade store had an average turnover of $120 a week and that he possessed a savings account of $500 at the Bank in Nipa (Patrol Report No.2 Nipa 1968/69). In the early 1970s he possessed two licenced Passenger Vehicles, and by 1980 he had a concrete drying floor for coffee. In 1980 he had 8 wives and was regarded as a big-man in every sense. Perhaps unusually he lived on his mother's territory, his father being a Tobua man. He also has a brother who is a big-man in the Semin clan to the north - his wife's clan. For the southern Nembi Plateau perhaps the limited opportunities to make money have already been taken advantage of by this big-man leaving very few if any, for anyone else.

** C.P. Dangerfield (Patrol Report No.9 Nipa 1966/67) estimated in October 1966 that before the Administration introduced large numbers of pearl shells into the district that a bride-wealth would have consisted of 6-8 pearl shells and one or two pigs. This accords with the data in Table 5.1. In 1966 Dangerfield recorded one bride-wealth that included one head pearl shell (worth about 20 ordinary shells) 24 ordinary pearl shells, 1 large cassoway and two large pigs. Once again this is close to average for 1966-70 in Table 5.1

*** The Nipa Local Government Council was established in 1966 to serve initially only the people of the Nipa Basin. The northern Nembi Plateau was included in 1967/68 and the southern Nembi Plateau in 1969/70.

any one bride-wealth to twenty (Patrol Report No.3 Nipa 1969/70). It is also not surprising that the rule was never adhered to.

After the cessation of warfare, previous clan enmities were contested within the exchange network. Coupled with competition for land and the lack of opportunity for obtaining cash, clan rivalry became fierce. In 1974 fighting broke out between the Pubi and their old rivals the An purl purl nak over the ownership of cattle. Cattle projects were started in 1968 at Enjua and Injip in the northern plateau and at Uba (Patrol Report No.2 and 3 Nipa 1968/69). In September 1971 a number of other places were also selected to have cattle projects as well as Pubi and the An purl purl nak (Patrol Report No.2 Nipa 1971/72). Before the enclosures were finished, the cattle arrived and were held in a compound at Nipa. The An purl purl nak finished their enclosure before the Pubi and went to Nipa to collect their beasts. The Pubi thought that the beasts were theirs and the two groups fought. Some of the cows were killed and clansmen were sent to jail in Nipa. In 1976 the remaining cattle were killed as part of a pig-killing ceremony.

In other parts of the Southern Highlands cassowaries were used to demonstrate economic prestige and clan strength (Sillitoe 1978, LeRoy 1979, Reid unpub paper n.d.). From Table 5.1 it can be seen that Cassowaries were not traditionally part of the bride-wealth. Between 1960 and the mid 1970s they had a brief importance.* In the

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* Cassowaries which were utilized in Mendi bride prices and for displays of wealth were worth 75 dollars or more in Mendi in 1968. The same cassowaries were worth one or two inferior kina shells in the Etoro-Petamini region of Mt Sisa. The shells in Mendi were

search for new expressions of wealth and prestige both the cassowary and cattle were shortlived.

Where cattle are still kept on the plateau (at Enip and Enjua) it is for prestige rather than as an economic enterprise. They are viewed as large pigs to be displayed and killed at pig-killing ceremonies. Thus has the economy of the Pubi and surrounding region been turned in on itself and yet at the same time its essential underpinning - trade - been removed and replaced by dependence upon the products of the monetized economy. Pursuit of prestige and renown still govern production and exchange but the economic base upon which they depend is crumbling. High population densities are causing declining yields and productivity. Roads and cash have drawn the region closer to Mendi and the rest of the highlands but only as a dependent periphery.

Conclusion

F.E. Williams wrote to Lieutenant-Governor Hubert Murray in 1925 that there was a real lack of understanding between the Government and the governed. However, Williams stressed that while '... we

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only worth a few dollars due to inflation resulting from the large numbers of shells injected into the local economy by the Australian Administration. The Mendi recognised the profit margins that could be exploited and even paid the airfare on government planes to fly to Komo patrol post to carry out the trade (Kelly 1974:11). Although the importance of the cassowary in displays of wealth was relatively shortlived (5-10 years in the Mendi region) the development of the trade and the cassowary displays is a good example of what contact did to traditional exchange relationships.

know little...[and]... the native knows less of us...' (Williams to Lieut-Gov., 27/4/1925, in West 1968:218), it seems with the Nembi the relationship was in many respects the other way round. The Pubi were aware of the passage of patrols through the watershed of the Purari and Kikori river systems and had probably heard rumours of Europeans before Hides and O'Malley wandered across the Nembi Plateau: and that experience probably colours still the Nembi's image of their presennt predicament. Outsiders' visions of the Nembi are also distorted by the reputation of the Nembi's fierce resistance and to an extent, despite their despondency, the Nembi's enduring pride and independence of spirit. A very real superiority in material wealth and power did not compensate for the Administration's superficial superiority in agronomic and economic expertise or imbue the Administration with any greater understanding of the Nembi agro-economy and physical environment.

Without implying any naive environmental determinism, it seems that the Nembi had come to terms with the deficiencies of their environment by trading with the inhabitants of others. Competitive exchange was the driving force that prompted innovation in production and kept alive the trade links, the trade links on which competitive exchange also fed. The 'shock of the new', the commercial economy, broke the threads holding together production, trade and exchange. The Pubi now no longer have anything with which they can bargain.

APPENDIX 5.1

THE CULT OF THE SIX-HEADED SNAKE

The Nembi believe that they are the last men of Papua. LeRoy (1975) reported the same for the Iapi people on the other side of the Erave river to Poroma, south of the Nembi Plateau in the late 1960s. In their similar beliefs the Iapi and the Nembi conceptualize the rapid changes that have taken place in the last twenty to thirty years. They also extend, within that concept the process by which Europeans, preceeded by steel and other artifacts, entered the region. Essentially the Nembi see themselves as having been by-passed. Moreover, their previous wealth has been undermined and they are now dependent upon Europeans for a paper wealth that they do not fully understand.

LeRoy reported that the Iapi believed that the Erave valley and the adjoining Sugu valley held a special property for Europeans. The Iapi appreciated that the Europeans had not come directly to the area but had first encircled it by establishing patrol posts all around it. Only then did the Europeans start to build a road through the Erave valley and another from Kagua to join it at the confluence of the Sugu and Erave. The Iapi firmly believed that a machine would be found in the confluence of the Sugu and Erave valleys which would be operated by a big-man to produce money (LeRoy 1975:460-462), once the roads had been completed. Their belief was strengthened by the fact that the huge expanse of short grass flats in the valley had been bought by the Administration. The fact that a cattle run was to be established was not sufficient answer as to why. LeRoy suggested that Missions, telling the people that Christ will return, coupled with the Iapi's own fear of the region because of the presence of one of their own dieties - Repanapada - led them to believe that some millenium type response would occur in the near future in the region.

LeRoy noticed this belief in 1972, but 6 years earlier there had been a similar 'cargo' belief that also extended to the warriors of the lower Pwe creek. Patrol Officers from Nipa and Mendi reported upon the cult, which was widely known as the 'Cult of the Six-Headed Snake' (Patrol Report No.5 Nipa 1965/55).

The beginnings of the cult were uncovered at Poroma which had its origin at the village of Kusa on the Nembi Plateau. There a man Puri had dreamt that at Mendi he should erect a spirit house close by a small pond. If the Nembi abandoned their other beliefs (note the similarity here between the exhortations of the missions in the region), then the new deity would cleanse them of all their badness/ sins. Unlike previously when the Timp cult had been adopted from the south this new cult required all other beliefs to be cast away.

The reward for such obedience would be wealth in the form of pearlshells and pigs that would be given by the Missions and the Administration at Nipa. When the people were all faithful followers of the cult then a six-headed snake would rise from the pond and tell Puri that it was time for him and his followers to collect the payment from Nipa. The Administration would then no longer send people to jail.

The cult gained adherents from the valley and the southern Nembi Plateau with the Koin-Iomo, Pubi, and the An purl purl nak as well as the people in the Erave valley attending a gathering close to Det. It died down as quickly as it had sprung up, but it is interesting that the Patrol Officer from Nipa who reported it also noted that the six-headed snake was a widely held symbol throughout the Nembi region. According to legend its appearance is associated with poor yields. At the time of the greatest cult activity from about November to January 1965 there had just been a four month drought in the region and food was in very short supply (Patrol Report No.5 Nipa 1965/66).

Whilst I was living with the Pubi a rather disturbing incident arose rather reminiscent of the cult in the valley. The Nembi Plateau had become the scene of intense interest from all Provincial Government Departments because of the poor health of the children in the area. Other than Patrol Officers telling the people that their children were sick, the people also believed that their ground was sick. A party of students from the Highlands Agricultural Training Institute in Mt Hagen stayed on the plateau in the early 1970s. Two health surveillances were carried out in 1974 and 1978 and the MCH clinic had been emphasizing to the Nembi that they had problems. In 1973 a team of specialists from Nembi and Port Moresby went to the Pubi region of the plateau for three weeks to undertake an intensive study. I followed that study a year later and a Volunteer Agronomist also took up residence on the plateau to undertake research. The Pubi became very much aware that they were thought of as underprivileged, and it was thus not surprising, although disturbing, when clansmen of the Pubi came to see me and told me that an old women had had a dream and they were all going to hear what she had to say. It turned out that she had dreamt that every village on the plateau was to get a Toyota truck and that particular houses were to become full of money. When I questioned the men as to where it was all going to come from, one of them replied that he expected the World Bank would provide it. The Southern Highlands Province is indeed in receipt of money from the World Bank to fund a development project, and some of the Pubi had heard talk of this on the radio and probably from over-hearing conversations between myself and the agronomist and the District Manager from Nipa. In addition the Local Government Council, meeting at Nipa, had been allocated money from the World Bank Project for culverting the roads in the District. The Pubi once again had high expectations for the future but little understanding. Their bemusement was only partially allayed by my explanations. My presence, with Janis Baines, for over a year probably added to the misunderstandings, although I like to think that they at least now realise that Europeans are as human as they are.

APPENDIX 5.2

MISSIONS ON THE NEMBI PLATEAU

The Methodist Overseas Mission helped to establish Nipa Patrol Post and then established themselves at Puril, a few kilometres to the south of the Government Station. They were the first mission into the area but their influence only extends to the extreme north of the plateau where they have a primary school at Enjua, opened in 1973.

The Nembi Plateau proper is under the influence of the Capuchin Friars Mission and the Christian Union Mission of Circleville Ohio. The Capuchin Friars initially patrolled the region from their base at Mendi and then from Soi (one kilometre north of Nipa) after they had built a base there in the early 1960s. From 1961 to 1964 the Capuchins were considering the establishment of a station on the Nembi Plateau and made overtures to both the people of Uba and Pumberal. Some sections of Nembi society wanted the missions and others did not. At Uba fighting broke out over the issue between Pei the big-man and Village Constable, and the rest of the villagers (Patrol Report No.3 Mendi 1962/63, No.1 Nipa 1963/64). Eventually the Friars built their mission station at Pumberal, but that too was not without difficulty especially as there were conflicting claims as to who really owned the land (see Chapter Three). A permanent station was established in 1969 after the site had been surveyed in 1964 (Patrol Report No.5 Nipa 1964/65). After the tribal fighting at Pumi in 1967 which prompted the establishment of a new Patrol Post at Poroma, the Capuchins purchased land at Det in the lower Nembi valley on its left bank. An airstrip was built and Det became the Capuchin Headquarters in the sub-district. It is now the main Health Centre serving the Nembi Plateau with the one at Ol, run by the CUM answerable to it.

The CUM initially established themselves in the Nembi valley, where they built an airstrip at Kar (Patrol Report No.3 1965/66) in 1965. CUM missionaries had been active in the area before that date however. A missionary was living at Tindom overlooking the Kar site in early 1964 (Patrol Report No.15 Nipa 1963/64, No.1 1964/65, No.5 1964/65). The CUM built a mission in the northern plateau at Montanda in the upper Pwe Creek Basin in 1967, and a health centre . It was opened in 1968. They then opened another station in the lower Pwe creek in 1969/70 at Embi.

During the 1960s and 1970s the influence of the two missions became thoroughly mixed, although there were times when the latent hostility between them broke the surface (Patrol Report No.5 Nipa 1965/66, No.1 1969/70). In the late 1970s the Seventh Day Adventist mission entered the region, once again opening old wounds and disputes about spheres of influence.

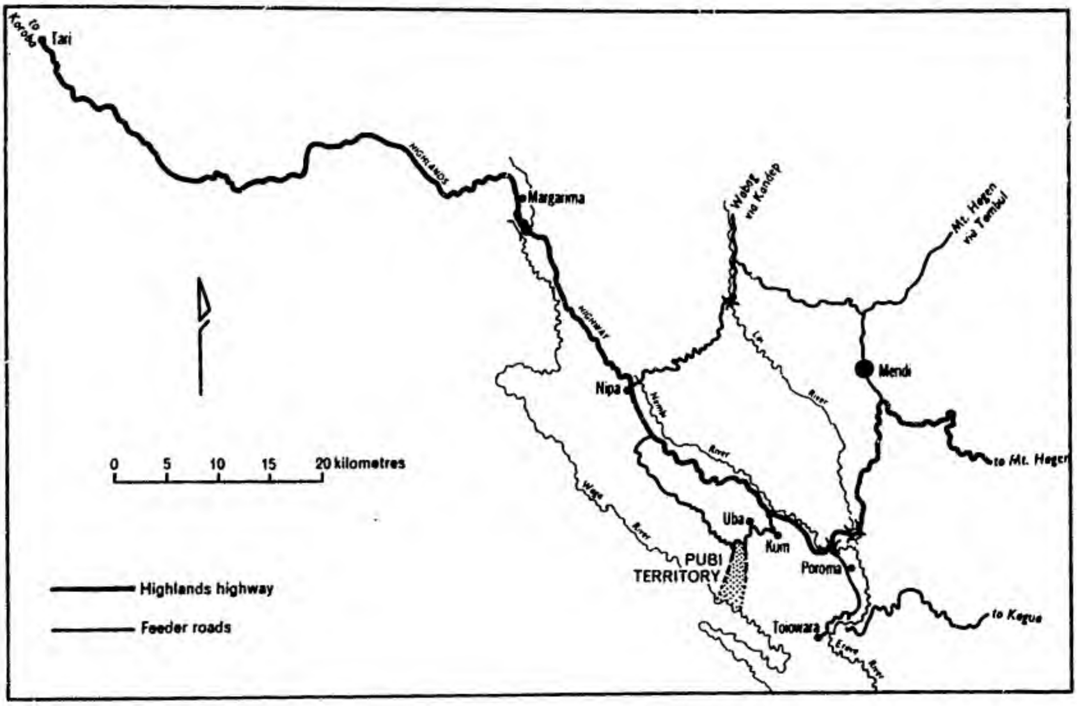
Both the Capuchins and the CUM hoped to win the souls of the warriors of the Nembi and of the warrior's wives and children, through the establishment of schools and aid-posts as well as trade stores. The Administration opened a school at Pumberal in 1970 as part of a plan to create a Community Centre and base camp in the lower Pwe Creek Basin. The Capuchins opened a school at Kum in the central plateau in

1972 and in 1973 the CUM opened a school at Montanda. They had already opened one in the Nembi valley at Kar in 1967. Maternal Child Health patrols were conducted by both missions with the Capuchins operating from an aid-post at Pumberal and the CUM from a hospital at Kar. When Embi was opened by the CUM they also transferred their MCH clinic to the plateau and the Capuchins from Det took over responsibility for the valley, relinquishing their operations on the plateau. The CUM also established a small clinic at Montanda. In 1981 the Embi clinic moved to Ol and the people of the northern plateau are now served from Nipa. The clinic at Montanda closed but the provincial Health Department is planning to build a sub-Health Centre in the upper Pwe Basin.

The reaction of the Nembi people to the missions was in many ways no different, after initial resistance, to their reaction to the Administration. They saw them as avenues for economic gain (Patrol Report No.1 Nipa 1965/66). Indeed they took advantage of inter-mission hostility to further traditional clan alliances and enmities. Apart from the prestige gained by a few who became pastors, a position of influence and perhaps patronage, some people gained from the help the missions gave in establishing trade stores and supplying them from their own bulk stores. More recently employment and training as para-medical staff at Embi and Montanda has provided cash as well as prestige.

APPENDIX 5.3

THE ROAD NETWORK OF THE NEMBI PLATEAU AND ENVIRONS



Road construction was used as a compulsory method of occupying men who would otherwise have been fighting. In 1966 the road from Nipa to Mendi via the upper Lai valley was completed and in 1964 the road from Nipa to Poroma was started. In 1967 the branch road from the Nipa - Poroma road was commenced onto the Nembi Plateau. Two years later it had reached Uba (Patrol Report No.1 Nipa 1969/70). The road to Poroma was completed in 1969 and extended southwards through the Erave valley to Toiowara. In 1974 the Nembi Plateau road was extended to Kum and then joined up with the Nipa-Poroma road to close the loop. The road from Poroma to Mendi via the lower Lai valley was completed in 1974 with the construction of a bailey bridge across the Lai (Patrol Report No.1 Nipa 1969/70, No.15 1974/75). In 1981 the highlands highway had been upgraded as far as Tari and the Nembi Plateau was thus by-passed by the Nembi valley section of the highway that came from Mendi via the lower Lai and Poroma. This will probably contribute further to the economic malaise of the plateau.

CHAPTER SIX

PEOPLE, PIGS, FOOD AND LAND: THE THEORETICAL CONTEXT

All the labour of man is for his mouth, and yet the appetite is not filled

Ecclesiastes 6:7

The Nembi socio-economy falls far short of that pristine state usually described or implied by some ethnographers for other parts of the Papua New Guinea Highlands (Rappaport 1968, Sillitoe 1979, Pataki-Schweizer 1980, Morren 1974, 1977, 1979, Dornstreich 1973, 1977). On the Nembi Plateau the relationship between culture and environment has come under profound pressures as the Nembi socio-economy has gone through a period of unprecedented change during the last 20 years. The hypothesis is that the poor nutritional status of children on the Nembi Plateau is the result of pressures upon the more fragile elements of the Nembi physical and social milieux. The degree to which nutritional status of children is an indicator of the recent stresses placed upon those fragile components of the Nembi milieux or the result of longer standing imbalances cannot be known. That nutritional inadequacies have always existed is undoubted and the short stature of Nembi adults is evidence of this. A measure of present inadequacies can be obtained only by examining in detail the Nembi socio-economy.

My difficulty is to avoid putting the Nembi people a safe distance at the other end of a microscope (Clarke and Ogan 1973:49), to avoid treating them as objects; and at the same time to recognize that whatever methodology is adopted to study the possible causes of malnutrition, it cannot be value free. As the Nembi's perception of the environment influences their use of it, so does an observer's perception of the Nembi's motives and manipulation of the environment mould the interpretation of their attachment to and use of that environment (Ley and Samuels 1978:20). As such the human condition whilst placing man in nature - the physical milieu - also abstracts him from it, in that the environment is what he perceives it to be.

Man-land relationships are a traditional concern of geographers. Culture and society have been the concern of anthropologists. More recently anthropologists have become aware of the importance of the physical and biotic environment of societies (reviewed by Grossman 1977, Mikesell 1978) and have attempted to utilize the ecosystem model to embrace man-land relationships within a single frame of reference. Many geographers on the other hand, have moved away from utilizing the ecosystem model to take a more philosophical standpoint and to explore man-land relationships as a geography of the mind (Tuan 1974, 1976 for example). Other geographers, disillusioned with their science as one that although asking the right questions never achieves answers, have pursued mathematical model building as their panacea (Chorley and Haggett 1967). Others, still asking what they believe to be the right questions,have embraced Marxism as their framework (Harvey 1973).

Use of the ecosystem model in the highlands of Papua New Guinea by geographers and anthropologists to study man-land relationships has generated what Mikesell has called a 'New Guinea Syndrome' (Mikesell 1978:8 - see also Brookfield 1968:103). It is a widely used theoretical framework and much of our understanding of the societies of Papua New Guinea is unfortunately couched in its terminology and concepts.

The model depends on some assumptions about the nature of New Guinea highland societies. Discussion has recently emphasized the invalidity of these assumptions and has direct relevance to the situation of the Nembi Plateau.

The New Guinea syndrome

With the exception of the work of Waddell (1972a) most of the studies using the ecosystem model have been made in the fringe areas of the highlands (Rappaport 1968, Clarke 1971, Dornstreich 1973, Morren 1974, Hyndman 1980 for example). Population densities are low in these areas and the individual communities are relatively isolated from each other and the rest of the highlands (see Brown 1978b). As such they have been the easiest to fit into an ecosystemic framework, although Waddell (1973:28) considered that all highland communities satisfied the dictates of the conventional ecologic method. They are viewed territorially as local ecological systems: each community is portrayed as discrete, unchanging and in harmony with the physical environment. The ecological method has therefore acquired almost axiomatic status in the study of highland societies.

The forcing of highland society to fit an ecosystem model reinforced a central assumption of the anthropological method. Clarkeand Ogan called this assumption 'virginity is valuable' (1973:43), and refer to researcher's concern with virgin territory far removed from the sullying effects of contact with the western world and of previous researchers. The highland fringe societies are regarded as the last of a dwindling number of such areas. Pristineness is substituted, in other societies of the highlands already tainted by Europeans, by using the 'ethnographic present' as a device to describe them as untouched traditional societies. This is a betrayal of the facts and more a description of the ethnographic past (see Smith 1980:83 for such a criticism of Sillitoe's ethnography of the Wola).

The flow of energy and nutrients is the fundamental process of ecosystems. Individual species related through trophic exchanges form a web dependent upon the primary producers - the green plants - capable of "fixing" the sun's energy. Man is dependent upon the green plants for survival. In the study of New Guinea highland societies trophic exchange has been emphasized, and Man assumed to be no more than a higher component of the food and energy exchange web (Rappaport 1968, Morren 1974, Dornstreich 1973, Hyndman 1980).

Various plants and animals are adapted to particular niches where they are best able to capture energy and nutrients and compete with other plants and animals.* A continuing evolution creates new niches and adaptations. Agricultural technology and the culture in which it is embedded, have therefore been viewed as an adaptation by man to his environment in order to satisfy his energy requirements (Waddell 1972a, 1973, Anderson 1973, Vayda and McCay 1975). Human populations are adapting to particular niches.

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* A niche is a particular habitat in space and time and is moulded by neighbouring niches occupied by different plants and animals.

I have no wish to force the Nembi condition into an ecosystemic interpretation, although the propositions of the ecosystem might be applied to the Nembi Plateau socio-economy, especially as my focus of interest is the nutritional status of those categories of people who are most vulnerable to shortfalls in food supply (Scrimshaw 1979). Specific interest in nutrition in other parts of the world has prompted studies to be made entirely within the 'adaptive strategy' model (Cattle 1976, Hasan 1967, Alland and McCay 1973). One might therefore study the trophic exchanges of the Nembi Plateau ecosystem and identify the perturbation disrupting the balance between the human population and the rest of the system causing high rates of child malnutrition, and in acknowledging perturbations assume also that other processes are rectifing the situation and restoring the balance.

Application of the ecosystem model to the Nembi situation, and indeed to any other in the highlands, thus makes a number of controversial assumptions about man-land relationships which have yet to be resolved. The most important concerns the concept of balance and homeostasis, a concept that has led to much confusion in the discussion of ecosystems. Self-regulation or homeostasis has been interpreted as both maintaining the status quo, - static equilibrium - and as regulating the degree of change within a system to manageable levels - dynamic equilibrium. On the one hand a stasis is implied such that maintenance of the present condition is paramount and that when change does take place it is catastrophic. Most applications of the ecosystem model to highland societies have adopted this stance. Dynamic equilibrium on the other hand, while emphasizing maintenance or at least a struggle to maintain a balance, does not assume a return to the status quo, but a new balance with new components in the equation.

Thus although differing from other abstractions of New Guinea highland societies in that the Nembi Plateau ecosystem is neither pristine nor in balance, it could be assumed that the imbalance is only temporary and thus still retain the ecosystem as the model of analysis. System maintaining forces could be postulated as operating to restore the status quo, while at the same time other forces may be labelled as system destroying,thus preventing that restoration.

It seems however, that the Nembi socio-economy and man-land relationship possesses a dynamism more suggestive of change than steady state. I think Myrdal's concept of cumulative causation (1957) is appropriate here. Changes in particular elements of the system, for example climate, bring forth adjustments in other elements which although countervailing do not restore the status quo but prompt changes in other elements, producing a constant jockeying for balance. It is when the pace of change in one or more elements outstrips the ability of other elements to keep pace, that disaster occurs, and not when changes in elements preclude maintenance of the status quo in man-land relationships.

The ecosystem model has also attracted other criticism (Salisbury 1975, Freidman 1974, Collins 1965, Connell 1978, Brown 1979). The arguments are complex and are compounded by subsequent modification to accommodate earlier criticisms. The ground therefore has been shifting constantly under those who have taken opposing standpoints.

The most fundamental criticism, despite the model's holistic properties (Fosberg 1963, Eyre and Jones 1966, Grossman 1977, Mikesell 1978), questions the utility of models adopted from the biological sciences for explaining and understanding human social behaviour (see Bennett 1976, Brookfield with Hart 1971, Clarke 1977b). Rappaport (1968), Waddell (1972a, 1973) and Morren (1974, 1977) have all been criticised for their use of the ecosystem model and the adaptive strategy concept, inasmuch as they have portrayed man as a 'cog' in a mechanistic system (see Brookfield 1973, McArthur 1974, 1977, Gardner 1980, 1981).

But reluctance by other anthropologists and geographers to dispense with the ecosystem model because of the possibility it offers of a 'grand synthesis', uniting the paradoxes of human endeavour with the scientific laws of the 'hard' sciences, has led to the concept becoming even more entrenched within particular fields of anthropology. Bennett (1976) qualified the use of the ecosystem to special categories of society. In recognising the usefulness of cybernetic models to the biological sciences, he acknowledged that their application to human behavioural environmental relationships could seriously distort reality (1976:56, 186). He proposed therefore that ecosystems analysis might apply only to particular types of society, among which are those of the highlands fringe and the highlands of Papua New Guinea. He labelled them the non-agrarian (hunting and gathering), and the tribal agrarian isolated systems

(1976:182). In more technologically advanced and complex cultures the systematic feedback loops that characterize ecosystems can mask the decision making of individuals. The more complex societies are those with accessible agrarian systems - peasant farming systems - or those with an industrial setting (1976:306).

The fallacy that the highland communities of Papua New Guinea satisfy the dictates of the 'conventional ecologic method' (Waddell 1973:28), is therefore perpetuated. In part this stems from the naive and misguided concern that anthropology must expand '... from its present rather ad hoc shape to a synthesising discipline at least as powerful as economic development theory' (Anderson 1974:266), theory which has long been realized as being far from powerful. The positivism of the ecosystem as well as its synthesizing qualities are as alluring as the positivism of economics. Nevertheless it has become increasingly apparent, as I have shown for the Pubi, that even pre-colonial fringe societies like the Tsembaga-Maring (Rappaport 1968) and the Mianmin (Morren 1974) as well as the Raiapu-Enga (Waddell 1972a) were neither insular isolated units nor in an immutable state of harmony with the biotic and physical environment. Pre-contact trade networks of the highlands rendered individual communities as anything but discrete, although their interaction was not comparable to their present dependence upon the monetized sector of the economy (Hughes 1971, 1977 and see Chapter Five).

Morren's analysis of the Mianmin (1974, 1977, 1979, 1981), a fringe people living in the mid-montane zone between the Donner and Thurnwald ranges and the lower montane zone of the middle May river attempted to answer the conundrum of how individual people participate in natural systems (1979:1). His analysis depended upon fitting the Mianmin into that particular category of societies which Bennett (1976) labelled as appropriate for ecosystem analysis. Morren isolated the Mianmin as a named local population identified with a particular territory of watersheds and valleys, exhibiting economic self-sufficiency, and a high degree of cooperation, coordination and sharing between sub-units in certain resource management strategies (1979:8).

Morren hoped to demonstrate the effect that seasonality - a perturbationoriginating in the non-living component of the ecosystem - had on the biotic community, on certain component populations including the human population, and on individual organisms (1979:1). Conterminously Morren wanted to illustrate how individuals and populations responded to such seasonalperturbation and how individuals are culturally equipped to operate the strategies that make up their population's adaptation (1979:1). He claimed to relate '...ideas to action by showing the connection between the participation of human populations in ecological processes and certain symbolic, cognitive, or ideological patterns which facilitate this participation' (1979:7). He also was concerned not to lose sight of the human element in his analysis of the relationship of man and land in Mianmin society.

Gardner's criticism of Morren is therefore pertinent to my analysis. Gardner pointed out the weaknesses of relating the action of individuals to the cybernetics of an ecosystem (1980, 1981). Morren was guilty of a form of syllepsis in that it is misleading to

'... discuss what people are doing as though it were something done by a culture...' and '... to suggest that what a person is doing in performing an intentional act is to be seen as something which a culture, a population or a gene pool is doing...' (1980:223). There is no tertium quid between the subject matter of the social and historical sciences and that of the biological (Gardner 1981:81). Thus it seems to me that the use of terms like community, population and organism in a biological sense hints at social Darwinism and may also introduce elements of tautology. Use of the concept of the adaptive strategy invites one to assume that what is there is adaptive and what is adaptive is there (see Alland and McCay 1973:144). It does not allow one to consider a situation like that presently on the Nembi Plateau as maladaptive.

I think conclusions apart from the theoretical arguments may be drawn therefore about the inappropriateness of the ecosystem model: firstly, although it may be persistently argued that small human populations living in relative isolation in the forests of the highland fringe can be studied as ecosystems, unless specific links in the system are explained and understood in great detail the concept makes it impossible for any one scholar to understand it (see Mikesell 1978:8). Secondly in searching for the 'grand synthesis' one is inevitably led to generalize before understanding the specifics (see also Brush 1975, Cowgill 1975, Fosberg 1976, Bayliss-Smith 1977). What is at stake is the relationship between theory and observation and a statement by Gregory is pertinent here on the nature of positivist explanations. He states that:

> '...an hypothesis is accepted (provisionally or otherwise) if the predicted event occurs and provided other things are equal. But suppose the predicted event does not occur: what then? This certainly does not falsify the hypothesis, because other things may not have been equal: categories outside the model may have influenced those within it. In order to put this possibility to the test it is necessary to turn to some more general theory which incorporates both the external and internal categories of the specific theory within its domain, and so specifies the effect of one on the other. But the general theory will also be protected by a ceteris paribus clause, and to rely on its propositions is only to present the original problem in a more general form. In short, positivism has no alternative but to issue a disclaimer about the implications of any nominally unsuccessful test because it has no way of distinguishing the failure of the model from the failure of other things to be equal...' (1978:66).

The ecosystem model is therefore nothing but an infallible abstract entity, and as such has become reified. Individuals making choices, interacting, negotiating, imposing constraints on one another, formulating their own perceptions of the environment are not considered (see Brush 1975:802). Man in Papua New Guinea is thus in danger of being relegated to a hapless position controlled by cybernetic processes where the ecosystem is sui generis not only irreducible to the action of individuals, but also, according to Gregory cannot be disclaimed. The immutable laws of population dynamics and systems ecology (Anderson 1973:190) define an entity above man mysteriously responding to laws of its own. In the study of economics a similar concept would be Adam Smith's formulation of the invisible hand in the market place.

In drawing this conclusion I do not however ignore the heuristic properties of the ecosystem model. I take the main lesson to be learnt as that proposed by Clarke (1971:200), who like Mikesell regarded the model as ensuring '... that nature and culture [are] not seen as separate entities or opposing forces, but as interlocking components...' (1978:8). With this in mind and recognizing that the 'sticky' force of habit may be formalised within cultural norms, I consider that individual creative and inventive forces as well as destructive forces which produce new patterns of work and dwelling (see Buttimer 1978:61) are more important than theoretical cybernetic feedback loops. Present interest in the biosphere and degradation of the 'world farm' (Clarke 1981 - but see Gale-Johnson 1973) highlight the fact that human choice, in contrast to natural selection, is by no means necessarily adaptive (Clarke 1977b:367).

I agree with Dasman et al that 'All economic development takes place within natural ecosystems, which may or may not have been ... modified by man' (1973:3, see also Clarke 1973:279) but prefer also to follow Brookfield's early statement to seek understanding of only part 'of the measureless dimensions and innumerable aspects of the real world' (1973:8; Djilas 1969:78-79). I disagree, therefore, with Bennett (see pages 263-64) and see man operating with imperfect knowledge within those parts of the biosphere which he occupies. Man must operate within certain ecological limits (Dasman et al 1973:3) to maintain the biological system and therefore to survive. I would argue that only a matter of degree (and not, as Bennett argues, a matter of kind,) separates man in the highlands of Papua New Guinea from the rest of the 'world farm'. Even the most conservative swidden agriculturalist of the highland fringe voraciously exploits localised portions of the forest for reasons other than the biological and the ecological. Declining yields force him to move on. Although possessing a considerable knowledge of the forest in which he lives and of the plants that he cultivates he possesses limited knowledge of ecological limits and balance. It is only because the scale of his destructive methods is small in comparison to western farming techniques that he has had little impact, in the past 10,000 years, on the huge forested areas of the highland fringe. Only in parts of the highlands where he has been the longest have the effects of man's activities had a marked impact on the landscape. The Imperata grasslands of the valley floors of the Western and Eastern Highland Provinces, and the tributaries of the Erave and Waga headwaters in the Southern Highlands, bear ample witness to the clearing of the forests by man, clearing which probably started as long ago as 10,000 BP (Hope 1980:155).

In other parts of the world there is ample evidence that considerations other than biological and ecological have dominated man's motives in exploiting the environment. An example is the relic of the complex farming system of the Maya in Belize, which in its heyday supported dense populations. Unwitting pressures of economic origin placed the delicate threads of the agro-environment under such a strain, that they parted and caused the agro-system to collapse (Lambert,D.H. 1981).

It is those pressures which are not biological or ecological in origin that are problematical to those who wish to place all Papua New Guinea societies in individual ecosystems. Social and economic behaviour is not soleiy controlled or able to be measured by the cybernetics of trophic exchanges alone. This has implications not only for the way in which I analyze the nutritional status of vulnerable groups on the Nembi Plateau but also to understanding agricultural change and development.

The imperative to produce

The ecological model, with its emphasis upon trophic exchange, although necessary to the understanding of highland societies, (inasmuch as all societies operate within the biosphere), is necessary but not sufficient to explain man-land relationships. The simple equation of population size as a function of agricultural technology, land-use and food production is insufficient. It follows then that nutritional status of 'vulnerable groups' is not necessarily the result of a simple function of population density, soil fertility and the subsistence production of an agricultural system. Consequently, prescriptions to rectify the incidence of high malnutrition which are concerned solely with such a function may fall far short of their objectives.

I propose then that the following is central to the understanding of the Nembi socio-economy. The Nembi clearly show some grasp of plant breeding, cropping systems, hydrology, pedology and methods to ameliorate the micro-climate, and appreciate factors of natural fertility. They also use exploitative, environment-degrading practices. In short, nutritional status reflects the pressures of social production and distribution as much as those of subsistence production upon the resource base. In addition competing demands of production for food and production for social consumption may in the most arcadian situation of plenty also produce low nutritional status of vulnerable groups.

The exigencies of production, both social and subsistence, at the time of contact on the Nembi Plateau, were prompting expansion of the oecumene into the Waga valley to the west of the plateau. While pressure was expanding the extensive margin, so to was the 'sticky force of habit' pitched against the innovative force of intensification in more favourable areas of the plateau. No doubt if it had not been interrupted by Europeans the process of intensification as well as expansion to the west would have continued. I would not suggest however, that some sort of halcyon existence was enjoyed by the Nembi before the colonial era, but it is fairly certain that the pace of change over the last thirty years has seriously disturbed the Nembi socio-economy.

On the Nembi Plateau my concern can be summarised as one of people, pigs, land and food: the balance between them, and the way in which that balance has been changing over the last twenty to thirty years. Conventional wisdom dictates that this balance is essentially one between population size, population density, and the productivity of land available to that population. It is this relationship that I will explore more fully not only to broaden and place it within the context of change as stimulated by forces new to the Nembi Plateau, but also to include those peculiarly human elements that make the man-land relationship more than simply trophic in nature. Production for social objectives, food habits, practices and taboos, the land tenure system, fertility control and contraception, abortion and infanticide are all factors contingent to the man-land balance.

The Puit and Pubi clans and the relationship between pigs, people and production

Following the preliminary survey of the Nembi Plateau by Allen et al in 1978, the data they collected werefurther analyzed by Jackson (1981). Jackson stated that because '... people on the whole do not waste food or deprive themselves of their food production for other purposes, ... low per capita consumption (and hence malnutrition) is caused by low per capita production i.e. by low per capita incomes' (1981:173). Brookfield (1972b) has made a statement with similar implications. In discussing the various demands made upon subsistence production - food, trade and exchange - he stressed that by far the most invariant of the types of production is production for food. He concluded that a '...direct relationship between the [food] needs of a population and its area may therefore be postulated with some confidence' (1972b:38). However, malnutrition may stem from the excessive demands made upon production by exchange and trade, and is thus a socio-economic disorder and not just a simple matter of food availability. Those least able to fend for themselves and who are dependent upon others for their food - children - or those who bear the brunt of the burden of production - women - are the ones most likely to suffer. Such a picture suggested for the Nembi Plateau is one of a modified subsistence affluence (Fisk 1962). It is related to what Clarke for the 'world farm' (1981:10) calls the cash imperative and which Bateson (1979:54) calls the philosophy of money. Incorporation of the Nembi socio-economy into the wider economy has reinforced and escalated the cash imperative (although in this case the imperative is more that of pigs rather than money) and in conjunction with other factors, migrations, declining yields and increasing family size for example, has diminished the ability of the Nembi to expand production to keep pace with the social demands made on production. Something has had to give - it seems to have been the nutritional status of vulnerable groups. Both the data collected by Allen et al (1978) and by myself suggest that this may be so.

The initial analysis of my data, describing the man-land relationships of the Pubi clan of the Pubi-Penarop clan pair follows the methods of Jackson for the Puit clan - a neighbouring clan in the central Nembi Plateau. I think the comparison is useful as a background to further analysis of the Pubi data, both in this chapter and the next three chapters. The data substantiates the argument that elements other than food supply alone are contributing to the incidence of malnutrition on the Nembi Plateau.

The gardens of the 33 adult men of the Pubi were surveyed by tape, compass and clinometer after initial mapping by plane-table techniques. All the men were from the Peripant, Sigerant and Temberry sub-clans who lived and farmed for the most part within Pubi territory. The gardens were divided into sweet potato gardens under cultivation and those that were fallow, and were distinguished from mixed gardens under cultivation and fallow. The amount of land cultivated by each woman was noted when a man had more than one wife. Where the data pertains to the men I have called the individual units

Households and collected additional data on the Household composition, as well as on the number of pigs reared and the number of coffee trees per Household. Data were also collected on the nutritional status of the children in each Household. Table 6.1 shows the data ordered as per Household but excluding the information on coffee trees and the nutritional status of children which is discussed later.

The data were compared with that collected by Allen et al (1978) and it was found that there were no significant difference between the two samples ($p>0.05$) in the areas under cultivation per Household. It was also found that there was no significant difference between the two samples when Household size was computed in adult equivalents ($p>0.05$). There were however, quite significant differences between the two samples in the number of persons per Household and the number of children per Household ($0.01<p<0.02$), but not in the number of adults per Household ($P>0.05$).* The number of pigs kept per Household in the two samples was also significantly different ($p<0.01$).

In the Pubi clan the size of Household was significantly smaller in 1980 than the size of Household in Puit clan in 1978. The difference is primarily due to the number of children, with the average Puit Household having 3.7 children and the Pubi Household 1.96 children. The Pubi Household also had a smaller number of pigs than in the Puit Household (2.9 for the Pubi and 6.3 for the Puit). The

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* Adult equivalents were measured as: persons 9 years of age and over = 1.0 adult equivalent; persons 1-9 years = 0.5 adult equivalents; persons less than one year = 0 adult equivalents.

interesting point is that although there is a significant difference between the two samples in household size and number of pigs there is no significant difference in the area under sweet potato cultivation. One would expect that the bigger the Household and the greater the number of pigs per Household, the greater the area under sweet potato, but this is not the case in the Puit and Pubi data. The explanation may be quite simple.

The mean number of adults per household is practically the same for both data sets, (Table 6.1) and it is the adults who cultivate the sweet potato. If all other things were equal then the adults in both locations may have been working at their limit, the limit being imposed either by their capacity to work or by the availability of land. However, all other factors were not equal and must be taken into account before any conclusions can be drawn. During 1980 there were two occasions when the pig population of the Pubi suffered from an Anthrax epidemic. The number of pigs planned for in the amount of sweet potato planted by the Pubi was initially higher than the number of surviving pigs counted in October 1980. The smaller number of children in the Pubi than in the Puit Households would also have meant more sweet potato in the Pubi Households available for pigs. Although the Anthrax epidemics removed the demand, and because sweet potato takes about 5 to 7 months to mature, the responsiveness of the area of sweet potato under cultivation to fluctuations demand is sluggish. The area of sweet potato would not have immediately contracted in response to the decline in pig numbers and this may account for the large area of sweet potato per person in the Pubi sample. In the Pubi clan there was $866m^2$ of sweet potato cultivated per person in the

Table 6.1 : Household Composition and Area Under Cultivation in the Pubi Clan.

House-hold		Area of sweet potato ha	Area of fallow ha	Area of mixed garden ha	Area of fallow ha	Adult equi-valent	Nos. of Adult	Child	Persons	Pigs
1	Lewa	1.0718	3.8124	0.0362	0.1971	4	4	0	4	8
2	Walleni	0.7162	0.3322	0.0857	1.7155	9	5	8	13	6
3	Kin	0.3988	2.3522	-	0.6392	4	3	2	5	2
4	Unk	0.4160	0.4823	-	0.3109	8.5	7	3	10	4
5	Paeyib	0.3593	2.2317	-	0.6839	5	4	2	6	7
6	Lalabab	0.4177	1.33	-	0.5164	4	3	2	5	9
7	Sepi	0.5844	1.4924	-	0.4729	7	7	0	7	0
8	Kop	0.3548	0.0143	-	0.2477	6.5	5	3	8	2
9	Parl	0.6220	0.6979	-	0.2538	2.5	2	1	3	0
10	Pebom	0.[illegible]00	0.0131	-	-	2	2	2	4	0
11	Iengi	0.5394	0.6410	0.1184	0.0236	4	4	0	4	4
12	Korang	0.1805	0.6175	0.3140	-	4.5	3	3	6	2
13	Magip	0.7326	0.6566	-	0.5463	5.5	4	3	7	6
14	Tale	0.3886	0.0529	0.0073	0.0581	3	3	0	3	2
15	Kwint	0.7421	0.1346	0.1487	0.4667	9	6	6	12	6
16	Sugura	0.2272	0.0437	-	0.1610	2.5	2	1	3	1
17	John	0.2543	0.0387	-	0.0663	2.5	2	1	3	0
18	Pebop	0.4027	0.9405	-	0.0326	4.5	3	3	6	1
19	Mei	0.7358	0.2412	-	0.2511	7	7	0	7	5
20	Yelib	0.2556	1.4298	0.0174	0.741	3	2	2	4	3
21	Piru	0.2770	0.0734	0.0394	0.0927	6	6	0	6	0
22	Yako	0.7348	0.5054	0.0503	0.1617	9	6	6	12	1
23	Ayab	2.5734	0.9118	0.0607	0.2825	18	15	6	21	6
24	Mente	0.2933	0.3265	-	0.0024	2	2	0	2	3
25	Yaba	0.4035	0.3467	-	0.2000	3.5	3	1	4	1
26	Kirl	0.2524	0.3583	-	0.0082	2.5	2	1	3	2
27	Penarop	0.3889	0.1317	0.0539	0.9980	2.5	2	1	3	0
28	Iomo	0.2683	0.4503	-	0.0887	2.5	2	1	3	0
29	Maeba	0.5881	0.2981	0.0144	0.3726	5.5	5	1	6	5
30	Lulua	0.6071	0.5042	-	0.1108	4.5	3	3	6	5
31	Aiyo	0.4921	0.2954	-	0.6262	4.5	2	3	5	3
32	Songo	0.4576	0.7913	-	0.2065	6	6	0	6	3
33	Kayent	0.3974	0.4770	-	0.1261	4	4	0	4	0
MEAN		0.5283	0.6977	0.0286	0.3230	5.12	4.1	1.96	6.1	2.9
STD DEV.		0.4203	0.8099	0.0631	0.3557	3.12	2.61	2.05	3.87	2.62
Puit Clan										
MEAN		0.5606	-	-	-	6.0	4.4	3.7	8.1	6.3
STD DEV.		0.3989	-	-	-	3.9	3.0	2.8	5.2	4.4

average household while in the Puit clan there was 592m^2 of sweet potato cultivated per person. This may however be misleading. The area cultivated per adult however was remarkably similar: for the Puit 1274m^2 and for the Pubi 1288m^2.

The relationship between supply and demand for sweet potato is important in the Nembi socio-economy. The demand variance is principally determined by the number of pigs and the number of pigs kept per Household is determined by the ability of the Household to meet the pig's demand for sweet potato. The more adults per Household the greater the production possible, and the larger the number of pigs able to be kept; assuming,that is, that land is freely available and not a constraint. But the nature of the demand for sweet potato is variable. Pigs are frequently killed for minor ceremonial occasions like mortuary feasts, or they die from disease. The amount of land planted under sweet potato is therefore based upon an expected demand which may in fact not materialise. Correlations between area of sweet potato and adults and pigs per Household must therefore be viewed critically because of the time lag between expected demand and supply.

The coefficients of determination (r^2) between the amount of sweet potato cultivated and the various measures of household size and the number of pigs in the Pubi and Puit clans (Table 6.2) show some interesting differences. In the Pubi clan 67 percent of the variation in the area of sweet potato planted per Household (where the Household is based upon the man irrespective of number of wives) is accounted for by differences in the number of adults or adult

Table 6.2 : The Relationship Between Pigs, People and Sweet Potato in Pubi and Puit Clans.

Dependent variable m^2 sweet potato	Independent Variable									
	Adult equiv.		Adults		Children		Persons		Pigs	
	r^2	t	r^2	t	r^2	t	r^2	t	r^2	t
Pubi (a)	0.67	7.9(c)	0.67	7.95(c)	0.17	2.55(d)	0.60	6.8(c)	0.18	2.65(d)
Puit (b)	0.06	1.08(e)	0.09	1.33(e)	0.03	0.72(e)	0.07	1.16(e)	0.45	3.85(e)

(a) the degrees of freedom for the Pubi data are 31.
(b) the degrees of freedom for the Puit data are 18.
(c) significant $p<0.01$
(d) significant $0.02<p<0.01$
(e) not significant $p>0.05$

Source: Pubi : from my field data 1980.
Puit : analysis of data collected by Allen *et al* 1978

equivalents in the household. Such a relationship, where 67 percent of variance is explained by the regression, is substantial. It is also significant in a statistical way. In the Puit clan however, the relationship is negligible, with only 6 and 9 percent of the variance in sweet potato cultivation being accounted for respectively by the variation in the number of adults and adult equivalents per Household. These two relationships are also not statistically significant. The opposite is true when the number of pigs is correlated with the area of sweet potato cultivated per Household. The coefficient of determination between pigs and area of sweet potato in the Households of the Pubi is small - 18 percent - but nonetheless statistically significant. The coefficient of determination in the Households of the Puit however, between pigs and sweet potato is substantial - 45 percent - and is also statistically significant.

Thus my earlier interpretation that number of pigs and number of adults are the major factors accounting for variation in sweet potato cultivated, is substantiated. In the Pubi clan, area under sweet potato increases per Household commensurate with the increase in number of adults per Household, while in the Puit clan it would appear that area under sweet potato per Household increases with the number of pigs per Household. There is an important modification to be made however, to this initial conclusion. Although the coefficients of determination for pigs in the Puit, and adults in the Pubi, are quite high, they do indicate that other factors are involved in explaining the variation between Households in areas of sweet potato under cultivation.

My reservations expressed earlier about the difference between theory and observation is thus borne out in a statistical fashion in that all other things are not equal. Other factors are impinging upon the production of sweet potato and pigs and the relationship which it has with household size expressed as adults. For instance in the Pubi equation of adults and sweet potato, 33 percent of the variation is unexplained, and in the Puit equation of pigs and sweet potato, 55 percent of the variation is unexplained.

The number of children per Household seems to be weakly related in a statistically significant way to the area of sweet potato under cultivation per Household in the Pubi clan (Table 6.2), but there appears to be no relationship in the Puit clan data between children and the area of sweet potato cultivated. From the data so presented it would be quite plausible to conclude that number of pigs is the only variable which correlates with the area of sweet potato in the Puit clan, whereas in the Pubi clan the weak correlation of pigs is supplemented by a weak correlation of children and a strong correlation of adults. It would not seem possible to analyze the Puit data any further, unless of course one were to restrict the analysis to pigs. The analysis of Jackson (1981:162-173) does the opposite.

The Puit Households examined

The highly significant and substantial relationship between pigs and area of sweet potato is largely glossed over in Jackson's analysis (1981:164-168), although he does compute the elasticity of area cultivated with respect to pigs. I will discuss that later. The purpose of Jackson's analysis was to demonstrate that production was related to child malnutrition. His subsequent analysis was based upon a correlation which was not only extremely weak, but also not statistically significant, and his computation of elasticity of sweet potato area with respect to children, and with respect to adults is spurious.* Indeed further examination of the Puit data shows this to be so, but before demonstrating this I want to reiterate the initial conclusions drawn by Allen et al (1978), the collectors of the Puit data.

Allen et al were reluctant to draw firm conclusions from their data and realized the inadequacies of the data for complex statistical analysis. However, using non-parametric techniques they found a strong correlation between the area of sweet potato and the number of

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* Perhaps a word on elasticities is in order here. By transforming the independent and dependent data of the regression/correlation equation to logarithms relative changes can be computed, rather than the absolute changes in variables with respect to each other. In the normal regression equation the B coefficients are absolutes - a measure of the slope of the line with respect to the y axis or the dependent variable. Thus in the regression equation of the transformed data the B coefficient represents the relative change of the independent variable with respect to the dependent variable.

The elasticity of area to pigs is:

$$P_E \text{ area cultivated} = \frac{\text{relative change in number of pigs}}{\text{relative change in area of sweet potato}} \times 100$$

The elasticity of area to adults is:

$$A_E \text{ area cultivated} = \frac{\text{relative change in number of adults}}{\text{relative change in area of sweet potato}} \times 100$$

Elasticity is the percentage response of one variable to the percentage change in another.

pigs per Household (T_s = +0.62 $p<0.01$), which was also statistically significant. They found a weak and not statistically significant correlation (1978:21) between the area of sweet potato and Household size measured in adult equivalents (+0.18 $p<0.50$). Jackson's conclusions (1981:167-168) have taken the analysis no further than those conclusions of Allen et al. Allen et al reported that they then divided the sample of Households into two groups according to whether the children were of good nutritional status or not. Weight-for-height was used to assess the nutritional status of the children. The two groups were adjusted so that they were mutually exclusive. Thus a Household with two women, and with children who were both malnourished and well nourished was excluded. They found no statistical difference between the two groups in area of garden land per head, although when what appeared to be an outlier was excluded from the group with malnourished children there appeared to be a significant difference ($p<0.026$). A statistically significant difference was found in family size between the groups ($p<0.024$) (1978:18). They found no significant difference in the number of pigs kept by the Households in the two groups.

Allen et al's broad conclusion was that child malnutrition cannot be directly related to garden area cultivated per Household, and cited the Household with two well-nourished children and one malnourished child, with the same father but different mothers, to indicate that other factors were involved (1978:18).

Jackson's analysis (1981:166-167) of elasticities were supposed to go beyond these broad conclusions of Allen et al.

My contention is that it did not, and indeed Jackson's analysis may have considerably confused the issue of the relationship between child malnutrition and incomes (either cash or subsistence) in Papua New Guinea.

The weak simple correlations of adults and children with the area of sweet potato cultivated in the Puit Households, was hidden in Jackson's analysis (1981:165) by his use of a multiple correlation equation that included pigs, adults and children as independent variables. Thus the strength of the correlation between pigs and area under sweet potato masked the weak correlations of the other two variables. While pigs on their own gave a coefficient of determination of r^2=0.45 (Table 6.2) the coefficient of multiple determination with pigs, children and adults as the independent variables was R^2=0.59 (Jackson 1981:165). However in that multiple regression equation the coefficient for children was not statistically significant although that for adults was, and both together only added another 14 percent to the amount of variance explained in the dependent variable - the area under sweet potato. Pigs are by far the most important variable in the Puit situation, and as such any further analysis should investigate the place of pigs in the agricultural system, and this is what was recommended by Allen et al (1978).

Analysis of elasticities between children and area under sweet potato, and between adults and area under sweet potato also providesno deeper explanation than Allen et al's conclusions. The role ofpigs was conveniently ignored in Jackson's analysis (1981: 162-172) to enable the contention that there was a relationship between child malnutrition and production to be emphasised. Intuitively the contention is reasonable and has obviously coloured Jackson's conceptual model in which to analyse the Puit data. The data from Puit do not suggest that there is a strong link between nutritional status of children and production per Household.

The regression coefficients and the t values of the multiple regression model used by Jackson on the data collected by Allen et al for the Puit clan (Table 6.3) show that for the addition of an extra pig to the Household another 657 m^2 of sweet potato would be cultivated. This assumes that all other things are equal i.e. that

Tabke 6.3 : Relationship between Adults, Children, Pigs and Sweet Potato in Households of the Puit Clan.

Dependent variable - sweet potato	Number of Adults	Number of Children	Number of Pigs	R^2
Arithmetic				
Regression coefficient	582	-144	657	0.598
t value	2.22	0.52	4.49	
Significant	<0.05 yes	<0.05 no	<0.05 yes	
Logarithmic				
Regression coefficient	.731	-.211	.632	0.734
t value	3.64	1.34	5.65	
Significant	<0.05 yes	<0.05 no	<0.05 yes	

Source : Jackson 1981:165, Table 4.5

the number of children and adults in the equation are held constant. But the regression equation of pigs, adults and children as the independent variables, accounts for only 60 percent of the variance in the area cultivated per Household. It is clear that all other things are not equal because 40 percent of the variance is unexplained and therefore cannot be accounted for let alone be assumed to be held equal as an extra pig is added to the Household.

Table 6.3 also shows the elasticity of area of sweet potato to pigs, adults and children. The elasticity for pigs is 0.6, which means that for a 10 percent change in the number of pigs per Household there is a 6 percent change in the amount of sweet potato cultivated. Similar figures were obtained for the number of adults per Household. The marginal propensity to cultivate sweet potato with respect to adults (that is the amount of sweet potato cultivated for one extra adult), is 582 m^2 if all other things are equal. The elasticity of sweet potato cultivated with respect to adults is 0.7 (Table 6.3); that is a 10 percent change in the number of adults per Household will be accompanied by a 7 percent change in area of sweet potato cultivated. However as noted, pigs are by far the most important element of the regression equation. Nevertheless it is interesting to note that for both pigs and adults the marginal propensities to cultivate land and the elasticities to cultivate land are very similar, suggesting that pigs compete with people for food. Pigs can therefore be equated with people in the regression analysis and I adjust the household sizes accordingly later when I again compare the Pubi and Puit data.

I noted earlier that demand for sweet potato is related to the number of pigs and the ability of adult members of the household to supply the demand. An important conclusion was that in attempting to meet demand the Nembi gardener makes an estimate of expected demand, a demand which can change drastically in the period between planting and harvesting the sweet potato crop. This is discussed further in Chapter Eight and Nine, but in relation to the computation of elasticities it can be suggested that the elasticities are not perfect (1.0) because of the fluctuations in demand over time and the inability of supply to be immediately responsive to those fluctuations. Perfect elasticity would be a 10 percent change in area cultivated for a 10 percent change in number of pigs and adults, there would be The seasonal nature of sweet potato planting affecting the equating of supply with demand is an important element of the Nembi agro-economy and is discussed in Chapters Eight and Nine.

The position of children in the Household and the effect they have on production, if any, is rather more difficult to explain. Unlike the regression coefficients for pigs and adults, that for children, as already noted, is not statistically significant in either the single regression (Table 6.2) or the multiple regression (Table 6.3). Any attempt at explanation is therefore more purely speculative. Jackson notes however that the regression coefficient for children is negative (Table 6.3) and therefore concludes, notwithstanding the statistical insignificance of the regression coefficient, that children do not contribute to sweet potato cultivation. Moreover, he also states if other things are held constant (which again I stress in the real world are not) then increases in children will decrease the amount of sweet potato cultivated by 144 m^2 for every extra child in the Puit Household. Thus Jackson returns to the implications of Allen et al's conclusion that there is a relationship between child malnutrition and area cultivated (production). The negative relationship as shown by the negative regression coefficient is also in the right direction, and suggests that the more children there are the less land is culivated and therefore the lower the productivity of the Household. It is however not so straightforward.

Allen et al reported that the brunt of the labour in the Nembi socio-economy is borne by the women (1978:19). Indeed they stated that Nembi women appeared to be working near to their physical limit. If the women are therefore responsible for the upbringing of children and other household chores as well as production of sweet potato, then in Jackson's model if all other things are equal, an increase in the number of children in the household may well have a negative impact on the area cultivated. Jackson's analysis draws the same conclusion as Allen et al and indeed the conclusion is plausible, that the nutritional status of children is related to the work load of women. But it is not related to the productive ability of mothers in terms of sweet potato in quite the way that Jackson hoped to demonstrate i.e. the more children to look after the less land is cultivated. Rather, it is more a situation in which the more children there are the less they are cared for.

When the Puit sample of Households is divided into two sub-samples, one of Households with malnourished children and the other with well-nourished children a number of important differences

Table 6.4 : Households of the Puit Clan Grouped According to Nutritional Status of Children.

HOUSEHOLD NUMBER	AREA OF SWEET POTATO	ADULT EQUIV.	ADULTS	CHILDREN	PERSONS	PIGS
Households with well nourished children						
1	3298m^2	4.0	3	2	5	4
3	5206m^2	4.0	3	3	6	9
10	2875m^2	4.5	3	3	6	9
15	5178m^2	7.5	4	9	13	3
20	4864m^2	3.5	2	4	6	6
Average	4284m^2	4.7	3	4.2	7.2	6.2
Std Dev.	1112m^2	2.3	0.7	2.7	3.2	2.7
Households with malnourished children						
5	2668m^2	6.0	6	1	7	1
7	4075m^2	6.0	4	3	7	2
8	2175m^2	3.5	2	3	5	5
11	9088m^2	20.5	15	12	27	4
13	7556m^2	10.5	8	7	15	7
18	4738m^2	7.5	4	5	9	7
Average	5050m^2	9.0	6.5	5.2	11.7	4.2
Std Dev.	2741m^2	6.1	4.6	3.9	8.3	2.5
t (a)	0.62	1.59	1.84	9.5	1.22	1.27
Significant $p<0.05$	no	no	yes	no	no	no

Source : Data supplied by Bryant Allen

(a) : the t value for comparison of the sample means.

emerge (Table 6.4). The nutritional status of the children was assessed by weight-for-height measurements rather than weight-for-age, so dividing the Puit households according to present nutritional status of children rather than to long-term or chronic malnutrition. Comparing the analysis of Allen et al and that of Jackson there appears to be some confusion about which group some Households belong to; the Households with malnourished children or the Households with well-nourished children. It appears to be an error in typing.* A point worth mentioning here concerns the use of weight-for-height in assessing the present nutritional status of children. It may be argued following the discussion on the difficulty of comparing supply and demand of sweet potato in relation to pigs, that the supply and demand of sweet potato with respect to children is also subject to some degree of time lag. I suspect however that little forward planning is involved in planting sweet potato particularly for children as distinct from planning the supply of food for everybody in the Household. From my own observations it is the number of pigs that are actively planned and for which the production of sweet potato is managed to some degree. Although present nutritional status is what is at stake in the present analysis, not past episodes of malnutrition, it may be that the Households that are poor managers of pigs and sweet potato production go through more periods of short-

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* One Household in particular, labelled as Household no. 18 in the report by Jackson (1981:165 Table 4.4), is placed in the group of Households whose children are well nourished. In the same report in Table 4.6 it is included with those Households with malnourished children. Allen et al include it in the group with malnourished children (1978:18 Table 5). Allen et al also included Household 19 in the group of Households with malnourished children: Jackson regards it as a Household where no information is available on the nutritional status of the children in the Household.

fall in sweet potato than do good managers and therefore long term nutritional effects may be also involved. Herein may lie a clue to the poor nutritional status of some ch' ,en and this clue may be deduced from the data in Table 6.4. Jackson however interprets the situation differently.

From Table 6.4 it can be seen that the only significant difference between Households with malnourished children and those Households with well nourished children is in the number of adults in the Households. Although on average there were more children in the Households with malnourished children, the difference was not significant, nor was the difference in total area of sweet potato cultivated significant. When the average area cultivated per adult equivalent is computed for the households in the two sub-samples then a significant difference is also found (Table 6.5). The area cultivated per adult equivalent in the six Households with malnourished children was approximately 40 percent less than in the Households with well nourished children. Considering the conclusions drawn by Jackson from the multiple regression model (Table 6.3), that increases in the number of children have a negative effect on the margin of propensity to cultivate sweet potato, it would therefore be reasonable to expect there to be more children in the malnourished Households. Referring back to Table 6.4 it can be seen that the Households with malnourished children have on average 5.2 children compared with 4.2 children in the Households with well nourished children. But the difference is not significant and it would seem then that Jackson's proposal that malnourished children are associated with lower production in Households with large numbers of children

Table 6.5 : Area Cultivated Per Adult Equivalent in Puit Clan.

Well nourished households			Malnourished households	
Household Number	m^2 per Ad/equiv.		Household Number	m^2 per Ad/equiv.
1	824		5	445
3	1301		7	679
10	638		8	621
15	690		11	443
20	1389		13	719
			18	632
Average	968			589
Std Dev.	351.79			118.25
t value		2.57		
Significant		$p<0.05$ yes		

Source : Bryant Allen,field data

does not hold true. Remembering that the number of adults (rather than adult equivalents) is positively associated with the marginal propensity to cultivate sweet potato, it would also be fair to conclude that Households with larger numbers of adults would cultivate more land. There is thus the paradox of those Households with malnourished children having a larger number of adults (6.5 adults, 9 adult equivalents) than those Households with well nourished children (3 adults, 4.7 adult equivalents), yet cultivating a smaller area of sweet potato per adult. If the nutritional status of children is related to the work capacity of women then the ratio of children to adults should be larger in the Households with malnourished children. The opposite is true, and in the well nourished Households the ratio is 1:4:1 (that is 1.4 children for every adult) and in the

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malnourished Households the ratio is 0:8:1 (that is 0.8 children for every adult). Thus Jackson's conclusions from the regression equations is not borne out by the data, highlighting the fact that Jackson's conclusions were based upon regression coefficients that were not statistically significant and on a theoretical model that was unsound.

There may be a relatively simple explanation for the smaller area cultivated per adult in the Households with larger number of adults and one which is related to the diminishing utility of cultivating larger areas as Households increase in size. This is related to Sahlin's (1974) use of "Chayanov's rule" in peasant agriculture and the Domestic Mode of Production. There may also be a land constraint preventing expansion. These two points are discussed later in Chapter Eight when the Pubi data is analyzed more fully.

The picture becomes even more complicated when a distinction is made between supply and demand in the two sub-samples. The ratio of area cultivated to adult equivalents gives a measurement of area to consumers. Pigs are also consumers that are equivalent to an adult person and when they are included it is interesting to note that the ratio of area cultivated to consumers (adult equivalents plus the number of pigs - pigs being equated to 1 adult equivalent), is virtually the same for both sub-samples (Table 6.6). There is no statistically significant difference between the two sub-samples on that criterion. The only difference being in the relative proportion of pigs to people. Thus it would seem that production is geared to meet demand for sweet potato by humans and pigs and is between $379m^2$ and

Table 6.6 : Area of Sweet Potato Per Consumer Unit[a] in Households with Malnourished Children and Households with Well Nourished Children in the Puit Clan.

Well nourished Households		Malnourished Households	
Household Number	Area of sweet potato per consumer m^2	Household Number	Area of sweet potato per consumer m^2
1	412	5	381
3	372	7	509
10	213	8	256
15	493	11	371
20	512	13	432
		18	327
Average	400		379
Std Dev.	119.466		86.72
t value		0.365	
Significant		$p<0.05$ no	

a One pig equals one consumer unit. Human consumer units are computed as adult equivalents as per footnote on page 274, and as per Table 6.4.

Source : Computed from data supplied by Bryant Allen.

400 m^2 per consumer unit whether it be a pig or a human in both groups of Households. This contrasts sharply with the figures given in Table 6.5 for area cultivated for adult equivalents alone.

In the well nourished Households there are more pigs than adult equivalents, in the malnourished Households there are more adult equivalents than pigs, suggesting that more pigs could be reared in those households. Yet the overall demand is the same for both sets of Households. It would seem then that there is no causal relationship to be deduced, from the data presented, between the nutritional status of children and the amount of sweet potato cultivated. Indeed this is the conclusion that Allen et al came to (1978:18) and which the regression coefficient computed by Jackson (1981:164) also shows child nutrition cannot therefore, from the data available, be related to production or imputed incomes. Moreover the regression coefficients of the multiple regression model shown in Table 6.3 and the simple regressions in Table 6.2 have already shown pigs and not children to be the most significant factor contributing to variations in the amount of sweet potato cultivated.

Turning again to the supply side of the equation where there is what Jackson terms a paradox. In Households with well nourished children there are less adults than in the households with malnourished children. Thus in those households with well nourished children there are on average 3 adults providing for 10.9 consumer units. In those Households with malnourished children there are on average 6.5 adults providing for 13.2 consumer units. Consequently in Households with well nourished children, each adult cultivates 1503 m^2 of sweet potato and in Households with malnourished children each adult cultivates 880 m^2 of sweet potato:* that is assuming all adults contribute equally to production. This also suggests there is no necessary relationship between nutritional status of children and the amount of work that their mothers are undertaking. This is explained in Chapters Eight and Nine.

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* The difference is highly signifcant: $t=2.37$ $p<0.05$.

To summarize then it would appear that from the data collected the number of children in different Households has little if any effect on the area of sweet potato cultivated. The difference is more likely to be due to the number of pigs per Household. There is a caveat here however inasmuch as there is a time lag in supply matching variations in demand. It also appears that there is little evidence to link child malnutrition with production. Once again this can be shown by returning to Allen et al's conclusion where they also found that Households can have both malnourished and well nourished children present. Individual women may have well nourished as well as malnourished children.

In short, although the purpose of this analysis of the Puit data has not been solely to criticize Jackson's analysis, it does show that a regression model of elasticities and absolute changes has to be interpreted very carefully. Not only does the amount of data being manipulated have to be adequate to bear the use of such techniques, but also the interpretation of such statistical modelling has to be based upon a sound conceptual model of the socio-economy to which the data pertain. A serious flaw in Jackson's conceptual model was his neglect of pigs and failure to distinguish between supply and demand. In addition even if pigs were adequately incorporated in the model a large degree of variance in the amount of sweet potato cultivated remains unexplained. Moreover the question as to what may be contributing to the high degree of malnutrition on the Nembi Plateau remains unanswered.

The rest of this chapter and indeed of this thesis addresses that question. My analysis is limited to the data collected in the Pubi clan, but stems directly from my reworking of Jackson's analysis of the Puit clan and my criticisms of it.

The Pubi Households: a preliminary examination

One of the problems with Allen et al's data is that the sample is not large enough. The data set for the Pubi has 33 Households and is therefore a better sample size for statistical modelling, although ideally it too should be larger. I have already compared the Pubi data with the Puit data and shown that the Pubi Households were smaller with fewer pigs and children, but with the same number of adults and area of sweet potato per Household as in the Puit Households. The simple regression and coefficients of determination (Table 6.2) demonstrated that in the Puit clan there was a close link between pigs and area of sweet potato, which as shown in the multiple regression (Table 6.3) was also closely linked to the number of adults per Households.

In the Pubi Households not only were pigs and adults related to the area of sweet potato cultivated, but so too were the number of children per Household (Table 6.2). I now want to turn to coefficients of multiple determination in the Pubi data before looking more closely at supply and demand of foodstuffs in the Pubi agricultural economy and possible explanations for child malnutrition.

As in the simple regression analysis, the greatest amount of variance explained in the area of sweet potato cultivated per Households in the Pubi is by the variation in the number of adults in the Households (Table 6.7). Although pigs in the simple regression (Table 6.2) account on their own for 18 percent of the variance in sweet potato cultivated, when placed in conjunction with adults in a multiple regression they only add an extra 2 percent to the amount of variance explained by adults on their own (Table 6.7). Moveover the coefficient for pigs in such a multiple regression is not statistically significant. Likewise children add little to understanding the

Table 6.7 : Adults, Children, Pigs and Sweet Potato in Pubi Households.

Dependent variable - sweet potato	Adult Equiv.	Number of Adults	Number of Children	Number of Persons	Number of Pigs	R^2
Coefficient t value	0.1031 6.9(a)	- -	- -	- -	0.0223 1.26(c)	0.69
Coefficient t value	- -	0.1176 6.59(a)	0.0199 0.88(c)	- -	0.0255 1.46(c)	0.71
Coefficient t value	- -	- -	- -	0.0777 5.84(a)	0.0240 1.22(c)	0.62
Coefficient t value	- -	0.1223 7.19(a)	- -	- -	0.0290 1.17(c)	0.70
Coefficient t value	- -	- -	0.06391 1.89(b)	- -	0.0526 1.99(b)	0.27

(a) Significant $p<0.05$
(b) Significant one tail test $p<0.05$
(c) Not significant

Source : Field data collected 1980.

variation between Households of the area of sweet potato cultivated, although when coupled with the variation in the number of pigs they together explain 27 percent of the variation in sweet potato area (note the coefficients are significant if a one-tail t test is used). It is unfortunate that the data for the Pubi Havebeen marred, because of the anthrax epidemics, by the inadequacies of the information concerning pigs per Household. Nevertheless the anthrax epidemics at least highlight the difficulties of linking supply and demand across the time period it takes sweet potato to mature and be ready to harvest. Despite that inadequacy it can be seen that there is little relationship between the number of children per Household and production of sweet potato (area under cultivation).

Conclusions

The next three chapters investigate further the relationship between consumption and production and consumers and producers. The time element is important to the analysis and has two important components embodied within it. On the one hand is the cyclical fluctuation in the number of pigs per Household over the 15 to 20 years between major pig festivals (mok enk). Interwoven with this long term cycle is that of the seasons. Particular times of year are reserved more for some tasks in the agricultural system than for others, even though all tasks take place throughout the year. Chapters Eight and Nine deal with these cycles of production and their interaction with consumption and the effect they have on nutritional status of vulnerable groups. Complicating the issue is the effect of colonial contact and intervention over the past twenty to thirty years.

The ratio between producers and consumers has changed radically since the late 1950s. Population growth, over and above those increases in population densities due to the migrations described in Chapter Three, has been animportant element contributing to the instability in the Nembi socio-economy in the last twenty or so years. Chapter Seven thus has as its subject the changing proportion of producers to consumers. In addition a seasonal aspect is introduced with this theme, for births and deaths have a distinct cyclical pattern throughout the year. What I have called social cycles are therefore described as important elements of the Nembi socio-economy which must be considered with the physical or agronomic factors of production and consumption.

The cycles are also explored to discover their relationships, if any, to the nutritional status of children. In particular the role of pigs within the economy is examined as is the relationship between mothers and their children. Features of the physical milieu which have an effect upon the health of mothers and their childrenare also examined . Disease and ill-health exacerbate poor nutritional status and as well, contribute to lowering the productive capacity of producers in the economy.

What follows then in the next three chapters is an attempt to tease out the important threads in the fabric of the Nembi socio-economy. It is not a description of a static ethnographic present, and change is an essential part of the story that lends dynamism and indeed an element of instability to the man-land relationship on the Nembi Plateau.

CHAPTER SEVEN

LIFE AND DEATH ON THE NEMBI PLATEAU SINCE THE EARLY 1960s

It is not death but life, the conditions and manifestations of life that are the subject of Human Geography

Jean Brunhes Human Geography: an attempt at a positive classification principles and examples

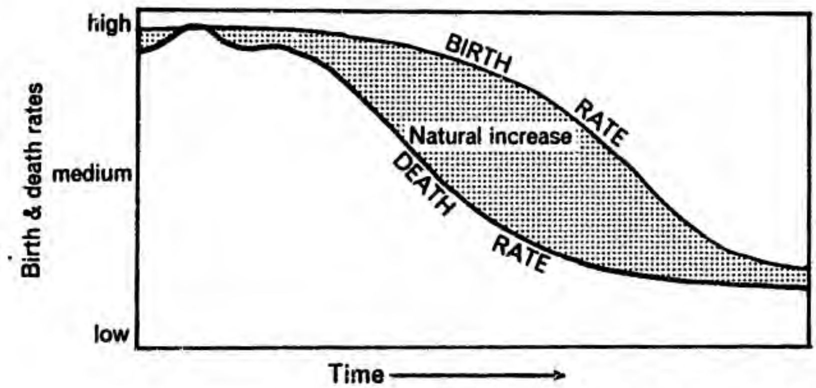
Trans T.C. Le Compte 1920:606

Three separate bodies of literature are relevant to the changing balance between producers and consumers on the Nembi Plateau. First at a broad scale are the conflicting theories of the consequences of population growth, and the relative importance of changes in fertility and mortality rates. They may be summarized within the well known demographic transition model, in which conditions of high mortality and high fertility give way to conditions of low mortality and low fertility. Second, at a similarly broad scale are those arguments that seek in various ways to relate population change to food supplies, technology and environment. Malthus and the Classical Economists grappled with these problems, Brookfield (1962, 1964) and Boserup (1965) have proposed alternative interpretations.

Third, at the household scale Chayanov's examination of peasant economies in Czarist Russia (Thorner et al 1966) and Sahlins' (1974) application of Chayanov's model to Melanesian 'peasant economies' are the theoretical counterparts of the previous and purportedly more pragmatic concern with 'carrying capacity' that developed in studies of African farming systems (see Allan 1965).

Demographic transition

The demographic transition model, based upon the economic and demographic history of northwestern Europe since the 17th century, because of its emphasis on the fluctuating differential between changing rates of mortality and fertility as determinants of the rate of natural increase of population is sometimes referred to as the 'vital revolution' or the 'demographic cycle' (see Trewartha 1969, Stolnitz 1965). A slow and steady growth of population may be maintained by conditions of high fertility and high mortality as well as low fertility and low mortality (Figure 7.1) During the transition



Source: *Adapted from Trewartha, 1969*

Figure 7.1 : The demographic transition.

from one extreme to the other in Europe the rate of natural increase was high and compounded in particular areas by the rapid growth of cities due to migration from rural areas. Rural to urban migration remains one of the biggest problems in less developed countries today. Rural people in Papua New Guinea are motivated to migrate to urban centres, although mostly for only short periods of time, by the hope of fulfilling increased expectations of economic gain which cannot be met in their home areas: parallels may be seen on the Nembi Plateau. Cessation of warfare and construction of roads since the early 1960s have become the catalysts for rising expectations of what the Nembi call <u>bisnis</u> and what Patrol Officers labelled economic development.

The consequent relocation of clans and sub-clans over the last twenty years described in Chapter Three has masked the rate of natural increase of the Nembi population. While some groups have seemingly experienced very high gross population growth rates, others have remained static or have declined; the process of demographic change has been modified and indeed hidden by local circumstances of migration. In this chapter, I examine and question some of the fundamental tenets of the demographic transition model. This necessarily entails both 'macro' and 'micro' aspects of population change, food production and consumption. It links the broad picture to that of the Pubi and the Yoel El households.

Pre-industrial Europe experienced high birth and death rates and it is assumed that fluctuations in the death rate lay behind fluctuations in the rate of natural population increase. Fertility was maintained at a steady and high level by what Malthus referred to as the 'passion between the sexes' (1970:70-71). In pre-contact times on the Nembi Plateau however, abstinence, abortion, prolonged lactation, infanticide and warfare contributed to keep the numbers born and surviving to a level able to be supported by the resources of the environment: fertility was culturally controlled and the 'passion between the sexes' bridled. On the Nembi Plateau the resource level of the environment is that perceived by women, for it is they who shoulder the productive burden. In the past they determined the numbers born and able to be supported by their labour and their use of environmental resources. Woman remain the major producers, but many of the factors which operated to limit population size now no longer do so.

On the Nembi Plateau the main factor contributing to the increase and decrease in population is the dependency ratio, the relationship between productive and non-productive members of the household. It was not simply food production or carrying capacity in some mysterious way controlling the size of the population. Rather it was, and to some extent still is, the ability of the women to utilize socially defined resources and to limit the size of their families. This is not to suggest that I view past man-land relationships on the Nembi Plateau as a form of possibilism. The point is that fertility was controlled among the Nembi. Malthus's 'passion between the sexes' is therefore not assumed here. Fertility in pre-colonial Nembi society may have been not so high as predicted by the demographic transition model. The evidence is discussed later, but I first want to discuss the other side of the equation - the mortality rate - and the effect which it had on population growth.

If it is assumed that 'the passion between the sexes' is constant and unchanging, fluctuations in the death rate are argued to be the principle cause of change in the rate of population growth (see McKeown and Brown 1955 and McKeown and Record 1962). This is not necessarily so, and questions what causes fluctuations in the death rate also remains unanswered. The usual assumption is that in Western Europe, shortage of food, directly linked with pressure upon resources (McKeown 1979:71-73) produced disease, famine and war which dictated the mortality rate. This explanation is Malthusian. In the extreme case of crop failure, famine may have occurred. The periodic frosts in the highlands of Papua New Guinea occasioning localized food shortages, undoubtedly increased mortality rates within vulnerable age groups - young children and the aged. Nevertheless in the highlands it was probably disease, especially that linked with poor hygiene that accounted for the majority of deaths, not food shortages directly. The demographic transition model may therefore underestimate the degree of fertility control which existed in pre-colonial Nembi society.

The causal link between mortality rates and food supplies may similarly, be over simplified. According to the demographic transition model, population increase results from a decline in the death rate preceding a slower decline in the fertility rate. The Nembi population is experiencing fairly rapid growth. The underlying causes are not clear, but high mortality from environmental disease coupled with a measure of fertility control by Nembi women, contributed to a low pre-colonial rate of natural increase. A measure of fertility control has been lost and mortality has been reduced by medical intervention.

After pacification in the early 1960s mortality was reduced by the prohibition of warfare, innoculation programmes, introduction of antibiotics (especially penicillin), and vermifuges. The reduction in the incidence of disease has been of greater importance than increases in food supply in reducing the mortality rate. The mortality rate was reduced, but not by increases in the standard of living as predicted by the demographic transition model. Furthermore the fertility rate has increased amongst Nembi women in the last twenty years, contributing significantly to the rate of population increase. Thus the demographic situation on the Nembi Plateau differs from that proposed by the demographic transition model, and this has important implications for the future. Not the least of these is that declining population growth rates elsewhere in the world may be occurring for a multitude of reasons, and provide no simple lessons transferred to the Nembi situation.

Population growth on the Nembi Plateau

The people of the Nembi Plateau and adjacent valleys were first counted 1962 at a time when patrols from Nipa were enforcing a ban on fighting with increased vigour (Chapter Three, Chapter Five). Relatively few people were enumerated in 1962: the majority of people on the plateau were not recorded until 1966. Even then people in remote pockets refused to come forward and have their names entered in the village books.*

From 1966 the population of the Nembi Plateau and adjacent valleys increased at an average rate of 2.0 percent per annum, a rate below the national average but higher than average for the Southern Highlands Province (Table 7.1). Chimbu Province, one of the most densely populated areas of the highlands, had the lowest annual growth rate (1966-1980). Chimbu Province has a history of outmigration (Howlett et al 1976:25-60). Indeed Howlett et al reported that outmigration from Chimbu increased by more than 11 percent per year

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* Carrying out the Census in July 1980 on the Nembi Plateau, as part of the National Census, I located people who had never before been enumerated, who assured me that others still living in the Waga valley and in the valleys beyond had not been registered. Fully aware of the events since the early 1960s and travelling frequently onto the plateau and indeed into Mendi, these people prefer to live the lifestyle of their ancestors in relative isolation.

Table 7.1 : Population Growth on the Nembi Plateau, Southern Highlands, the Other Highlands Provinces and Papua New Guinea.

	1966	1979	1980	Average Annual Growth Rate
Papua New Guinea (a)	2184986	-	3006799	2.3
Eastern Highlands	204032	-	277180	2.2
Chimbu	167245	-	178490	0.5
Enga	291142(b)		164476	
Western Highlands			262886	
Southern Highlands	184101	-	235647	1.8
Nembi Plateau (c)	8269	10632	-	2.0
Nembi Plateau and valley	10665	13816	-	2.0

(a) Includes non-indigenous population.

(b) Enga Province and the Western Highlands Province were formed from the Western Highlands District in 1975.

(c) Penarop, Iomo, Pumberal, Uba, Tobua, Enip, Karamella, Mul, Askam, Tegibo, Obua, Semin, Enjua, Ulal, Nenja, Toiowara, Kum, Kusa and Kesu census units.

Sources : Field data; Summary of Statistics 1976/77, National Statistics Office, Port Moresby 1981.

between 1966 and 1971 (1976:42), and whilst the annual increase of those born in the Province was 1.6 percent, the annual increase of those resident in Chimbu was only 0.7 percent, (1976:39). As on the Nembi Plateau, pressure on resources has increased, but in the Chimbu Province 'it is because... people have already sought their own solution to the problem by migrating to other areas that pressure on existing resources has been tolerable' (Howlett et al 1976:40).

The Nembi Plateau presents a different picture. Unlike Chimbu, where densities in pre-colonial times were extremely high, thus forcing 'spontaneous migration' to adjacent areas which continues today (Ploeg 1975) population densities on the Nembi Plateau were lower. Opportunity existed for outmigration into the valleys and slopes to the west (Chapter Three). Since contact, the effect of spontaneous migration on the Nembi Plateau has had the opposite effect to that in the Chimbu. Population densities in favoured areas have increased due to in-migration from the emptier areas to the west, with people taking advantage of kin ties to gain access to land on the plateau. Out-migration has been negligible: only two families (from the Semin cluster of clans) have resettled permanently on small holdings in the Wahgi valley of the Western Highlands. Most migration to places outside the Nembi Plateau is circular in nature and largely involves males. Because land in particular areas on the plateau is at a premium, absences away from home are short to ensure that access to land is maintained.

Accurate data to demonstrate the movement of people on the plateau and the increasing concentration of population into the upper and lower Pwe creeks and the Uba basin after the cessation of warfare are lacking. The movements described in Chapter Three are difficult to quantify, not least because it took at least four or five years before all the people were enumerated on the plateau (Table 7.2). Less than half of the Nembi people were enumerated at the first census in 1962.* The census of the northern clans on the plateau was completed earlier because of the influence of the Nipa Patrol Post.

* By comparison Van de Kaa (1971:59) estimated that only 69 percent of Papua New Guinea's population was enumerated in 1950, but over 98 percent in 1966.

Table 7.2 : Population growth on the Nembi Plateau and in the Nembi Valley from 1962 to 1966.

	1962	1963	%inc	1964	%inc	1965	%inc	1966	%inc
Northern Plateau	2159	2829	31.0	3504	24.0	3650	4.2	3776	3.4
Central Plateau	1167	1682	44.1	2080	23.7	2185	5.0	2365	8.2
Southern Plateau	744	1604	115.6	1902	18.6	1999	5.0	2128	6.5
TOTAL PLATEAU	4070	6115	50.2	7486	22.4	7834	4.6	8269	5.6
Valley	877	1856	112.0	2159	16.3	2327	7.8	2396	3.0
COMBINED TOTAL	4947	7971	61.0	9645	21.0	10161	5.3	10665	5.0

Source : Patrol Reports Nipa Patrol Post.

In the Nipa Basin census patrols commenced in 1961. Movement of people in the southern plateau, as well as their hostility to the Administration, prevented a full census until the late 1960s. The population on the plateau is now much larger than in the Valley. Population movements on the Plateau described in Chapter Three are reflected in the yearly census records (Table 7.3). Kunjul and Uria were the last Census units to be formed as they are in the more remote and isolated lower Waga Valley. On the plateau the Mul and Penarop Census Units were the last and the reluctance of people to be censussed was marked. As late as 1966 the number of people coming forward to be counted in the Penarop Unit was 36 percent more than in the previous year. The population of Mul Unit increased by 15 percent in the same period (see Chapter Three for migration details). By 1966 the growth of the Nembi population as shown by the annual censuses had

Table 7.3 : Population Increase on the Nembi Plateau by Census Unit from 1962 to 1966.

	1962	1963	%inc	1964	%inc	1965	%inc	1966	%inc
Penarop	-	175	-	286	63	350	22	477	36
Iomo	251	362	44	431	20	440	2.1	424	-4
Pumberal	157	234	49	250	7	257	2.8	270	5
Uba	387	424	10	524	24	529	1	581	10
Tobua	195	?80	44	349	25	374	7	381	2
Enip	177	207	17	240	16	235	-2	232	-1.3
Central Plateau	1167	1682	44	2080	24	2185	5	2365	8.2
Nenja	102	313	206	386	23	374	-3	401	7.2
Toiowara	225	264	17	239	-9	225	-6	234	4
Kunjul	-	-	-	95	-	134	41	160	19
Uria	-	-	-	-	-	54	-	54	-
Kum	160	471	194	559	19	581	4	650	4
Kusa	117	365	212	397	9	409	3	412	0.7
Kesu	140	191	36	226	18	222	-2	217	-2.2
Southern Plateau	744	1604	116	1902	19	1999	5	2128	6.4
Karamella	358	377	5	397	5	394	-.7	404	2.5
Mul	-	-	-	209	-	231	11	265	15
Askam	201	408	103	512	25	556	9	569	2.3
Tegibo	229	273	19	439	61	452	3	448	-.9
Obua	217	295	36	329	12	352	7	347	-1.4
Semin	357	626	75	726	16	765	5	787	2.9
Enjua	492	524	7	546	4	558	2.2	583	4.5
Ulal	305	326	7	346	6	342	-1.1	373	9.1
Northern Plateau	2159	2829	31	3504	24	3650	4.2	3776	3.5

Source : Nipa Patrol Post Patrol Reports.

begun to slow down considerably; at least 97 percent of the population had been enumerated.

Census returns for the period 1967 to 1980 are also inadequate and inaccurate (Table 7.4). The most complete set of records are for the central and northern plateau. For example, the growth in population of the Semin and Ulal Census Units from 1979 to 1980 reflects inaccuracies in the 1979 census rather than either a

Table 7.4 : Population Increase on the Nembi Plateau by Census Unit from 1967 to 1980.

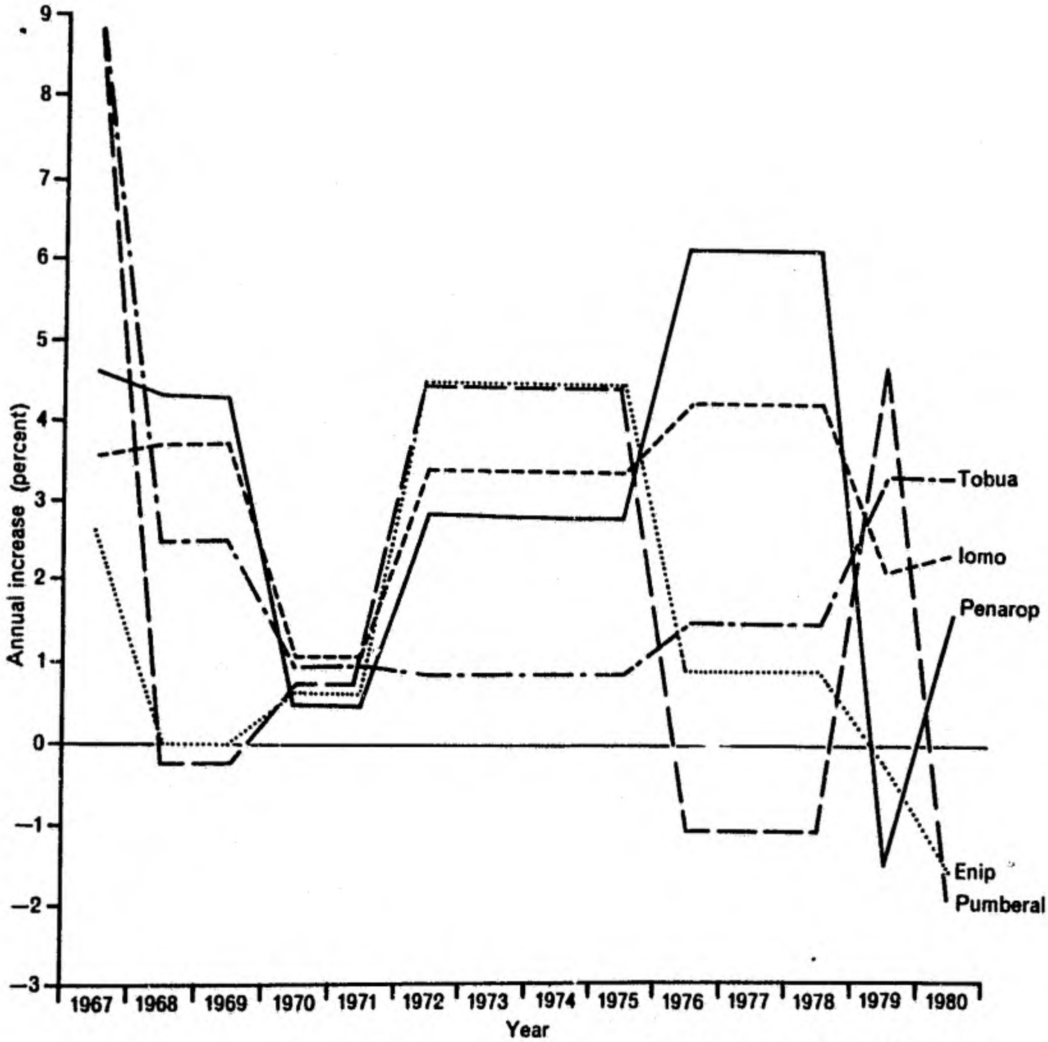
	1967	%inc	1969	%inc	1971	%inc	1975	%inc	1978	%inc	1979	%inc	1980	%inc
Penarop	499	4.6	543	4.3	549	0.5	614	2.8	735	6.2	724	-1.5	734	1.4
Iomo	439	3.5	472	3.7	482	1.0	551	3.4	626	4.3	639	2.1	654	2.3
Pumberal	294	8.9	293	-.2	297	0.6	355	4.5	343	-1.1	359	4.7	352	-1.9
Uba	577	-.7	602	2.1	621	1.5	783	6.0	n.a.	n.a.	823	1.2	835	1.4
Tobua	415	8.9	435	2.4	443	0.9	459	0.8	482	1.6	498	3.3	482	3.3
Enip	238	2.6	238	0	240	0.4	287	4.5	294	0.8	293	-.3	288	-1.7
Central Plateau	2462	4.1	2583	2.4	2632	0.9	3049	3.7	n.a.	n.a.	3336	2.9	3345	0.2
Nenja	403	0.5	385	-1.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	393	0.1	393	0
Toiowara	278	19	286	1.4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.				
											589	2.2	535	-9
Kunjul	226	5.6	199	-12	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.				
Uria														
Kum	681	4.8	716	2.5	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	656	-.9	589	-8.9
Kusa	424	2.9	439	1.8	n.a	n.a	n.a.	n.a	n.a.	n.a.	581	3.1	n.a.	n.a.
Kesu	229	5.5	228	-.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	377	5.7	n.a.	n.a.
Southern Plateau	2241	5.3	2257	0.4	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2596	1.6	n.a.	n.a.
Karamella	414	2.5	435	2.5	431	-4.6	484	2.9	479	-.3	495	3.3	495	0
Mul	273	3.0	284	2.0	274	-1.8	385	8.9	393	2.1	380	-3.3	375	-1.3
Askam	587	3.2	603	1.4	599	-.3	591	-.3	600	1.5	584	-2.7	549	-5.9
Tegibo	470	4.9	475	0.5	484	0.9	358	-7.2	383	2.3	384	.3	377	-1.8
Obua	357	2.9	393	4.9	415	2.8	624	10.7	655	1.6	674	2.9	653	-3.1
Semin	817	3.8	870	3.2	875	0.3	990	3.1	n.a.	n.a.	986	-.1	1093	10.8
Enjua	608	4.3	616	.7	612	-.3	663	2	n.a.	n.a.	703	1.5	729	3.7
Ulal	408	9.3	437	3.5	443	.7	505	3.3	n.a.	n.a.	494	-.5	557	12.7
Northern Plateau	3934	4.2	4113	2.2	4113	0	4600	2.7	n.a.	n.a.	4700	.5	4828	2.7
TOTAL PLATEAU	8637	4.5	8953	1.8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	10632	1.9	-	-

Source : Nipa Patrol Post Patrol Reports.

large natural increase or a large inmigration. There are gaps, with a number of years for which no data could be found in any records at the Nipa Patrol Post.

By 1967 most of the large scale movements of people back to their clan land on the Nembi Plateau were over. Movements continued between Census Units on the plateau as families and individuals, relocated between their patriclan, matriclan or wife's clan. A small migration of people from the Waga valley in the west continued. The Mul census total increased by 8.9 percent per annum between 1971 and 1975 and represents such a movement from the Waga valley. The decline of 7.2 percent in the Tegibo Census Unit from 1971 to 1975, accompanied by an increase of 10.7 percent per annum in the neighbouring unit of Obua during the same period, represents movements between the two units as well as between neighbouring groups.

In the lower Pwe basin creek between 1975 and 1978 the average annual increase of population in the Penarop Census Unit was 6.2 percent per annum. This was due to continued movement onto the plateau of the Penarop clan from the Mompo and Momporo area of the lower Waga river, as well as the return of members of the Pubi clan from neighbouring areas in the lower Pwe creek and the Uba basin. The complex movements of people hides the secular increase of population on the Plateau between 1962 and 1980. To an extent this is shown in the cyclical nature of the rate of growth in particular census units (Figure 7.2). The census units show a similar although not synchronous, pattern. The exception is the trough in 1970 and 1971.



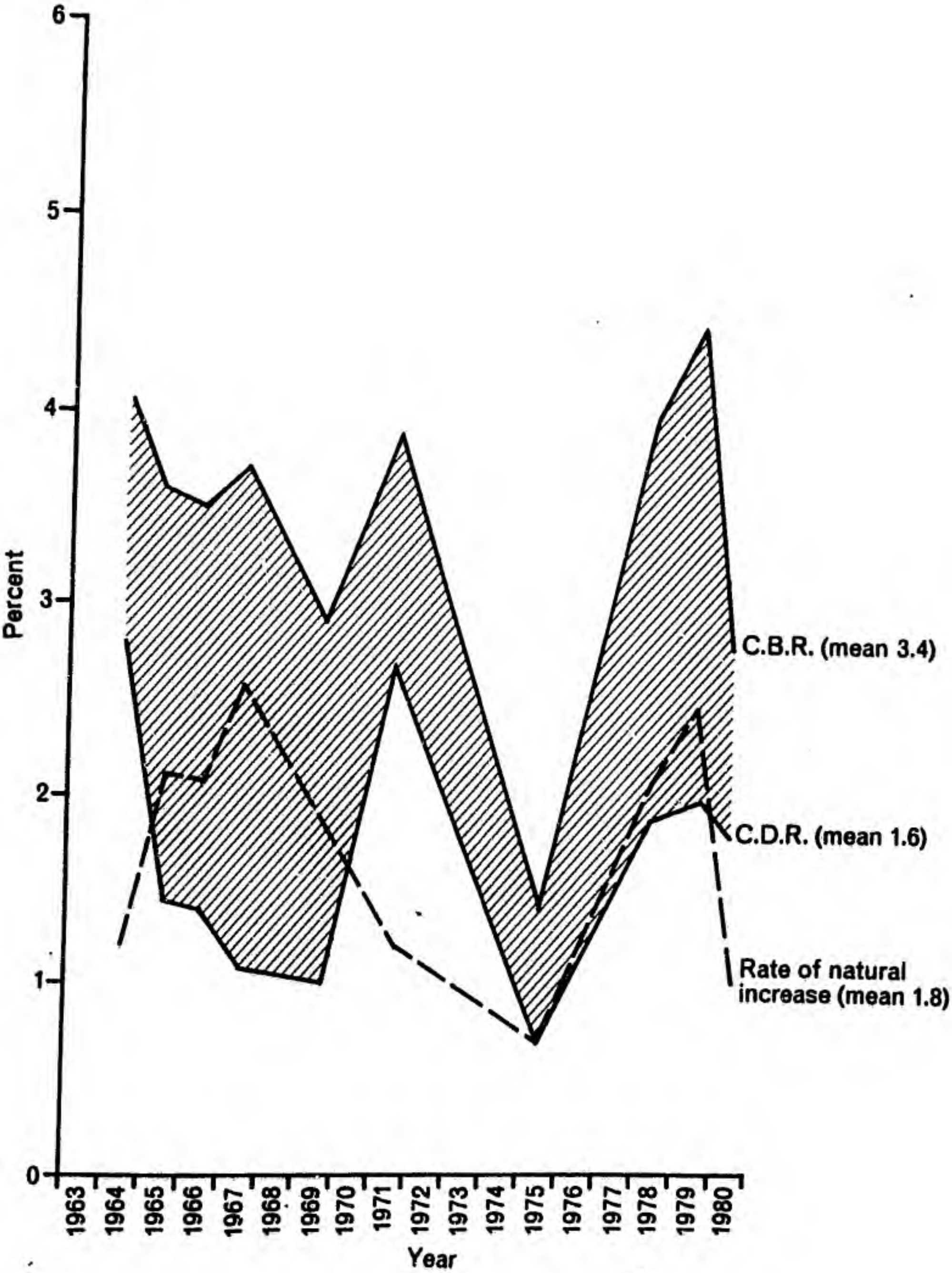
Source: *Nipa Patrol Reports & Table 7.4*

Figure 7.2 : The annual rate of population growth in the clans of Lower Pwe Creek basin from 1967 to 1980.

A series of severe frosts from October 1971 to January 1972, preceeded by a six month drought, and followed by an influenza epidemic in 1973, caused an unusually high number of deaths throughout the region. Such a pattern of peaks and troughs every three to five years is not unusual but makes determination of the precise long term secular trend difficult.

A similar pattern is shown by the fluctuations in vital rates, rather than the overall growth rate (which includes migration) of the Nembi population from 1964 to 1980 (Figure 7.3). The low growth rate in 1970 and 1971 (Figure 7.2) is reflected in the low rate of natural increase (1.2 percent) the result of a high death rate (2.7 percent), counteracting a higher crude birth rate (3.9 percent in Figure 7.3). We can assume infant deaths were high. Between 1971 and 1975 the precise rates of change in vital statistics are not known although they probably declined. Regardless of the rates of change between known rates at particular dates a general trend can be interpreted for the period from 1964 to 1980 (Figure 7.3).

By international standards a death rate of over 1.5 percent is high (Trewartha 1966:49), as is a birth rate over 4.0 percent. The birth rate on the plateau in the 1960s was not particularly high. Van de Kaa (1971: Table 7.2 and 7.6), estimated that the crude death rate in Papua New Guinea probably fell from a level of 3-3.5 percent in 1946 to around 2.1 percent in the 1961-1966 period, and to 1.6 percent in the intercensal period between 1966 and 1971. The death rate for Papua New Guinea is thus still high and that of the Nembi Plateau, at between 1.6-2.0 percent, even higher. The birth rate on the Nembi



Source: *Nipa Patrol Reports*

Figure 7.3 : Vital rates of the Nembi Plateau population from 1964 to 1980.

Plateau has been relatively low with a mean of 3.4 percent for the period from 1964 to 1980. The crude birth rate for the Southern Highlands Province in 1971 was 3.9 percent and for the highlands region 4.2 percent.

The evidence from the age and sex structure of the population shows that population has increased by about 30 percent in the last 20 years on the Nembi Plateau. A decline in the death rate and a increase in the birth rate has taken place, and except for the period from 1964 to 1969 the birth rate closely mirrors the death rate with a high birth rate being accompanied by a high death rate, and a low birth rate accompanied by a low death rate. Change in the infant mortality rate would thus appear to have been the important factor determining increase in population numbers.

In Papua New Guinea death rates have fallen for all age groups, but the normal trend for a population undergoing a stage of rapid mortality decline, is for improvements in probability of surviving to be more noticeable among the oldest and youngest age groups than among those between the ages of 10 and 45. The decline in mortality is usually most marked among infants and children aged 1 to 4 (Skeldon (1979:49). Although precise data are not available for the Nembi Plateau population, it is reasonable to expect a similar process to have take place and the present structure of the Nembi population suggests this to be so (Figure 7.4). The proportion of the population under the age of 15 is high (c.40 percent). This is discussed more fully later. The imbalance between males and females in the older age cohorts is also high. Mention has been made of the Nembi's fear of

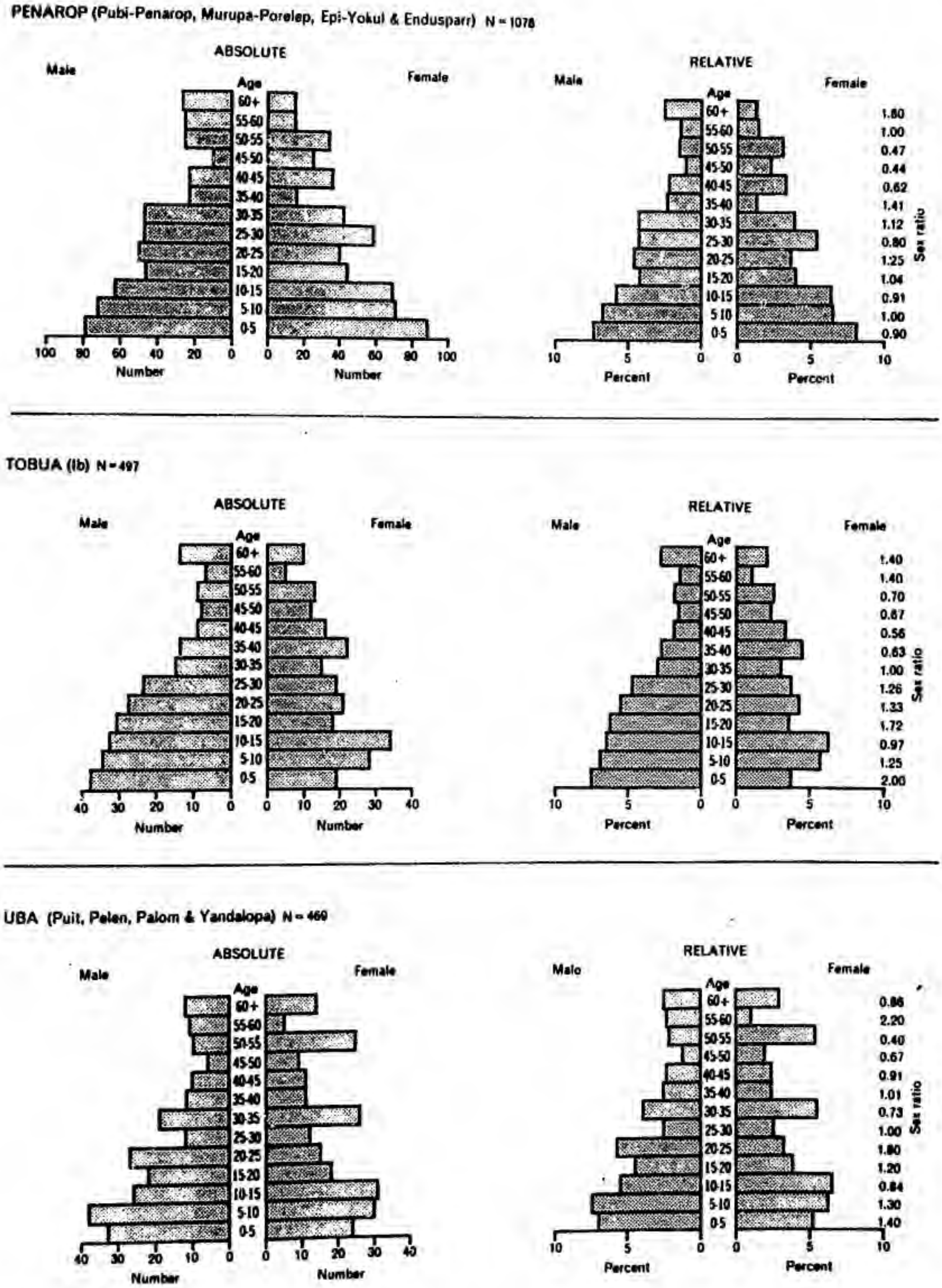
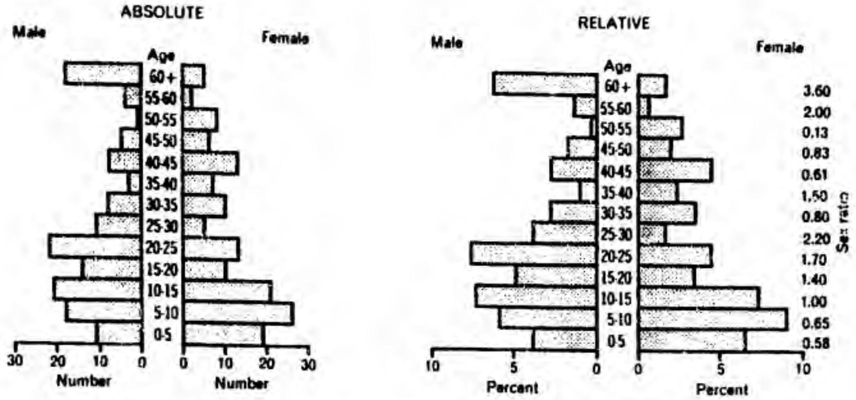
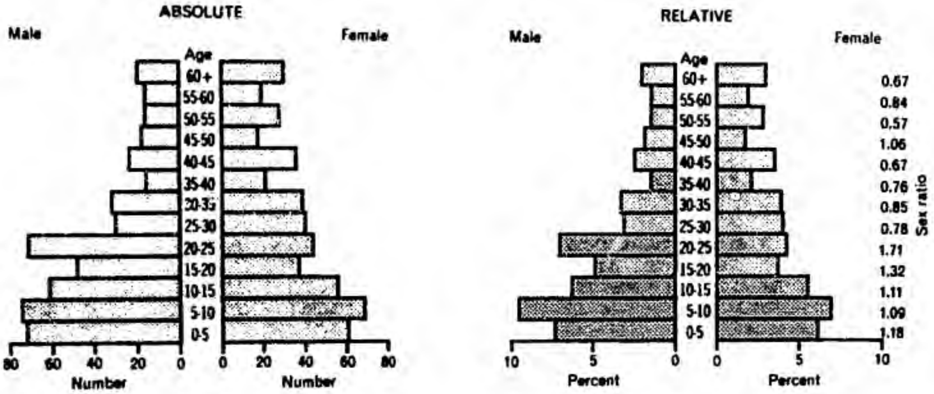


Figure 7.4 : Age and sex structure of the clans of the Lower Pwe Creek basin.

ENIP (Werut-Marop) N = 288



PUMBERAL & IOMO (Koin-Iomo) N = 999



CLANS OF THE LOWER PWE CREEK & UBA BASINS N = 3334

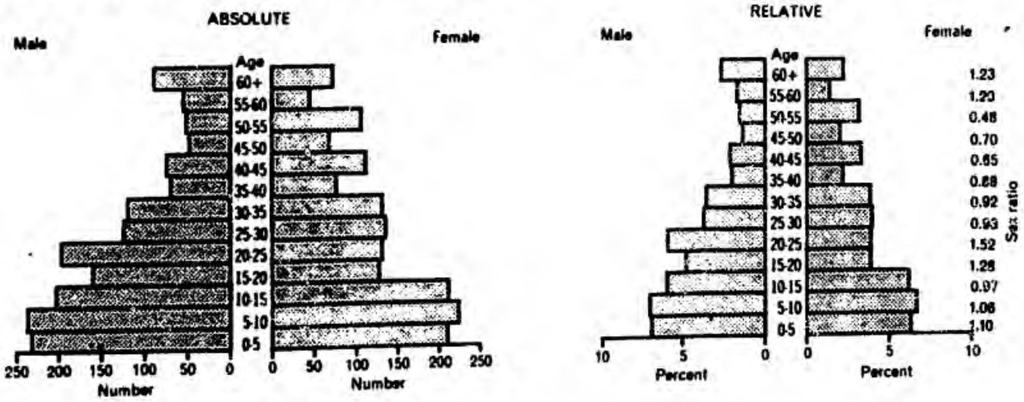


Figure 7.4 : continued

sorcery in the valley and on the plateau. The basis of their belief is shown by the imbalance of males to females in the older age cohorts. The total population of 3,334 in the lower Pwe creek and the Uba basin is comprised of 1674 males and 1660 males of all ages, giving an overall sex ratio of 101:100. The national average was 108:100 in 1971 and that for the Southern Highlands Province 95:100. The ratio for the whole of the Nembi Plateau reported by the National Census of 1980 was 81:100, although that also reflects a high degree of absenteeism of adult males working on plantations is the months of June, July and August.

Enip Census Unit, which consists of the Werut-Marop clan-pair, and the Pubi-Penarop unit have sex ratios of 0.98 and 0.93 respectively, ratios which are similar only to the older age groups of the other clan clusters. For the total population (Figure 7.4), there is a marked break in size and sex ratio between cohorts over and under the age of 35. The sex ratio of cohorts older than 35 is imbalanced against males, ranging from 0.92 in the 35-40 cohort to 0.48 in the 50-55 cohort. This quite dramatic surplus of women over men is due to the heavy fighting that was once endemic on the Nembi Plateau and which was halted in the early 1960s. The older age cohorts (55-60, and people over the age of 60) show a reversal in the sex ratio - 1.2 and 1.23 respectively, reflecting a lower life expectancy for women; the result of the debilitating effects of child bearing and rearing, as well as hard work in the gardens. The removal of the risk of death in war has also increased the life expectancy of males and more survive into old age, thus contributing further to the imbalance in the two highest age groups. Except for the Pumberal and Iomo Census

Units (the Koin-Iomo clan-pair) this is reflected in the other population clusters.

At the same time as fighting was stopped on the Nembi Plateau in 1960, health patrols began, or at least a European medical officer, or a medical orderly accompanied Administration Patrols from Nipa. As a result age cohorts between six and thirty five are appreciably larger than those above thirty five years of age. By the early 1960s everybody began to benefit from some sort of medical care no matter how irregular and boys who were below the age of fifteen in 1960 were destined not to experience the risks associated with warfare as they grew older.

Another break in the age and sex structure occurs between children presently (1980) under fiteen and the older cohorts. The younger cohorts are appreciably larger than the older ones to a degree that cannot be accounted for by normal wastage rates. After 1965 regular health patrols and Maternal and Child Health Clinics, were conducted on the plateau by the Christian Union Mission for Kar and the Catholic Mission from Det in the Nembi valley. From 1969, when the Christian Union Mission was established at Embi, clinics have been conducted monthly for most areas of the plateau. The effect of these clinics and other health care measures has been of major significance to the younger age groups.*

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* Prior to the establishment of the mission Health Centres early patrols from Nipa were accompanied by Medical Assistants who in addition to dressing wounds from fighting, also distributed antibiotics and immunised people against yaws and tetanus. These measures combined with those to combat leprosy, pneumonia and other diseases, no doubt lowered the overall death rate. Nipa Patrol

An further point of interest is the ratio between males and females in the younger age cohorts, where there are more boys than girls, compared with the ratio in older age groups. Girls have been proportionately more advantaged by the effects of the health patrols and clinics than have boys (as shown in Figure 7.4) even though there are more boys than girls in the younger cohorts. In pre-colonial times boys were favoured over girls. The strength and success of the clan against its enemies (and sorcerers), depended upon its fighting force rather than its women. An attitude of desiring and favouring male children remains very strong and accounts for the residual advantage that boys have in numbers over girls under the age of fifteen. It is most marked in the Ib clan (Tobua Census Unit) where the ratio of males to females under the age of five years is 2.00 and the clan cluster of the Upa basin where the ratio is 1.4 (see Figure 7.4). The nutritional status of males and females under the age of five further reflects this favouritism. During the first two years of life, the period which is most precarious for young children (Chapter Two) the average percentage weight-for-age of males is 85.7 whilst that for females is 79.25.

A contributory factor to the imbalance of males over females in the younger age groups especially in the Tobua and the Koin-Iomo clans is possibly the preparations for the pig kill that took place in April 1981. This is discussed more fully in Chapter Nine but where the pig population is large, then pressure placed upon the women who care for the pigs, as well as pressure placed upon

No.5 of 1964/65 injected everybody who attended the census, with anti-yaws penicillin.

Errata: page numbering skips 323-332.

available food supplies, adversely affects the nutritional status of young children. Female children are more likely to suffer during times of hardship than are males, a combination of low birth weight, and both benign neglect and active discrimination by parents in favour of their male siblings.

An examination of the age and sex structure of the population of the lower Pwe creek and Upa basins gives a reasonably clear picture of population change in the last 20 to 30 years, more so than an analysis of the vital rates computed from the census returns. The older and younger age cohorts have enlarged and men and women live longer. Warfare has ceased, young children are protected from epidemic diseases, and mothers and children are protected to some extent, during pregnancy, childbirth and the immediate post-natal period from tetanus and other infections.

The most immediate effect of the relative changes in the birth and death rates has been upon the ratio of producers tc consumers within the households.* It is here that the macro-scale of the demographic transition meets the micro-scale of the household and relates the process of population change on the Nembi Plateau, and in the lower Pwe creek in particular, to the discussion of the previous chapter. Household composition of the Pubi and Puit clans has not been static: it is the alteration of the dependency ratios within Nembi society, combined with pressure upon favourable areas of land,

* Producers and Consumers are defined below. A rather different definition is used in Chapter Nine.

which provides an insight into the cause of high rates of child malnutrition.

Dependency ratios on the Nembi Plateau

The ratio of Pwe Creek Basin females between 15 and 60 years of age, who do the most work in the gardens, to the rest of the population is 1 : 3 (Table 7.5). Even if males between aged 20 and 60 were to work half as much as females aged between 15 and 60, the ratio would still be 1 : 1·7. This imbalance has come about in the last twenty years. The proportion of children under the age of 15 is as

Table 7.5 : Dependency Rates for the Clans of the Lower Pwe Creek and the Uba Basin of the Nembi Plateau (percent).

	Total	Pubi-Penarop	Koin-Iomo	Tubua	Enip	Uba Basin
PRODUCERS						
Females between 15 and 60	28	29	28	28	26	28
DEPENDENTS						
Females under 15 Females over 60 Males under 20 Males over 60	50	49	49	49	52	49
PARTIAL PRODUCERS						
Males between 20 and 60	22	22	23	23	22	23

Source : Field data 1980.

much as 41 percent of total population in some clans (Figure 7.4 and Table 7.6). The number of aged dependents is negligible and most elderly people continue to work in the gardens. In other parts of the highlands the percentage of children under the age of fifteen is similar. Sinnett (1975) reported for the Murapin 43.6 percent of the population under the age of fifteen and Bowers (1968) 40 percent for the Kaugel valley population. Buchbinder (1973) recorded 35 percent for the Maring population. In 1971, of the whole of Papua New Guinea's population, 43.8 percent were under fifteen, and in the Southern Highlands Province the proportion was 44.8 percent (Central Planning Office 1974). The Maring are an ageing population due to a number of special reasons (Buchbinder 1973), but the rest of Papua New Guinea has a smaller proportion of its population under the age of fifteen than usual for a developing country where 45-47 percent is a normal proportion.* Thus although nearly 40 percent of the Nembi population is under the age of fifteen the proportion is likely to increase even further.

Table 7.6 : The Percentage of Population in the Clans of the Lower Pwe Creek which is under the Age of Fifteen.

	Pubi-Penarop	Koin-Iomo	Enip	Tobua	Uba	Total
Percent under fifteen years of age	41.0	39.5	40.0	37.6	38.8	39.6

Source : Field data 1980.

* World average population under fifteen is 37%, for Africa 44% (with Algeria and the Sudan 47%); for Southeast Asia 44% (Philippines 47%); Central America 46% (Honduras 51%, Nicaragua and Costa Rica 48%). By contrast the average for Europe is 25%, the lowest being Sweden with 21% (UN Demographic Year Book 1978).

The birth rate on the Nembi Plateau which averaged 3.4 percent between 1964 and 1980 is lower than the average for most other regions of the World*.

The death rate declined with increased medical and administration intervention (control of warfare) and the birth rate increased due to the abandonment of traditional fertility control practices. Areas of the highlands with a longer period of contact have higher birth rates than the Nembi Plateau. For example in 1971 the birth rate in the Eastern Highlands was 4.6, in the Chimbu 3.7, and in the Western Highlands 4.5. The Southern Highlands, the most neglected of the provinces has a birth rate of 3.9 (see Agyei 1979:21-32). The pressure upon household producers is thus likely to increase in the next 15 years, at least until the children of today are able to take their place as productive members within the Nembi socio-economy.

Child/woman ratios and fertility on the Nembi Plateau

For each women between the ages of 20 and 45 in the clans of the lower Pwe creek and Uba basin in 1980 there were 0.75 surviving

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*

	Rate of natural increase	Birth Rate	Death Rate
Melanesia	2.5	4.2	1.7
Polynesia and Micronesia	2.1	3.5	0.8
Africa	2.7	4.6	1.9
Asia	2.1	3.4	1.3

Source : UN Demographic Year Book 1978.

children under the age of 5 years. The usual method of estimating this fertility measure is to divide the number of children under the age of five by the number of fecund women, usually the women between the ages 15 and 49. If this method were applied to the Nembi data the ratio would be much lower and would compare more closely with other parts of the highlands (Table 7.7). The low figure for the Southern Highlands Province indicates the relatively low fertility of the region, and the high child death rate compared with the rest of the highlands. The Nembi Plateau figure of 750 children under 5 years of age per 1000 fecund women (between 20-45 years of age), despite the difference in age groups, is low. The reasons for using a different age range for fecund Nembi women is discussed later, but it implies that population growth in the Southern Highlands and the Nembi Plateau will continue to increase. It can be equally argued that a high infant and child death rate reduces the child/woman ratio and a reduction in child mortality rates will increase the child/woman ratio.

Table 7.7 : Fertility Ratios of the Highland Provinces in 1971.

Province	Children (0-4.99)/1000 women (15-49)
Southern Highlands	696
Western Highlannds (incl Enga)	757
Chimbu	789
Eastern Highlands	842

Source : Agyei in Skeldon 1979:21-32.

However, fertility on the Nembi Plateau appears to be low (Table 7.8). Before examining the evidence for this it is necessary to digress slightly. The Ib clan (Tobua Census Unit) with a population density of 136 km^2 (Tables 3.4 and 3.6), the second highest in the region) has the lowest child/woman ratio (Table 7.8). The highest child/woman ratio found in the Pubi Census Unit (Table 3.6), where the population densities of the census unit clans which average 46 persons per km^2, are the lowest in the region. A degree of relationship between the child/woman ratio and population density may be indicated from these figures. In addition within the Tobua Census Unit 10.4 percent of children are malnourished while in the Pubi Census Unit (Enip, Penarop and Uba clinics) only 6.9 percent are malnourished (see Table 2.15). Nevertheless in the Tobua area the effects of long term malnutrition (stunting) are much less than in the Pubi area, and the 10.4 percent of Tobua children mentioned above are all acutely malnourished (wasted) rather than stunted and wasted. Tobua children appear therefore be suffering from a short term nutritional problem, which may be related to the large number of pigs in the area prior to the pig-kill in April 1981 and not the human population density alone.

Table 7.8 : Child/Woman Ratios in the Lower Pwe Creek and Uba Basin.

Census Unit	Children (0-4.99)/1000 women (20-45)
Total	754
Pubi-Penarop	856
Koin-Iomo	747
Enip	625
Tobua	613
Uba	760

Source : Field data 1980.

The Pubi did not take part in the pig kill. This is discussed further in Chapters Eight and Nine, but the above suggests the ratio of children to women rather than gross population density, is more closely associated with nutritional status of children at the level of the clan.*

To return to the changing fertility pattern of the Nembi Plateau, in pre-colonial times, post-partum intercourse taboos, a high degree of polygyny, infanticide and abortion contributed in varying degrees to maintain relatively low fertility of the Nembi population (see Bulmer 1971 for the other parts of New Guinea). In addition, compared with women of developed countries those of the Nembi Plateau have a shorter fecund life, from around 24 years, rather than the normally assumed 34 years. Just as short stature may be an adaptation to the poor resource of the physical environment of the Nembi, (see Sinnett and Solomon 1968, Sinnet 1975, 1977 for the Enga, and Malcolm 1970 for the Bundi), so too may the age and sex composition of a population and its fertility be an adaptation to the environment. The fecundity of women may reflect the slow growth and maturation of people generally, and be a biological rather than a cultural component of the interaction between population and resources, a factor that neither Malthus and the classicial economists nor Boserup and Brookfield considered.

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* The same is also true for land cultivated on the Nembi Plateau. The Pubi and other clans comprising the Yoel el have an average density on cultivated and fallow land on the plateau of 118 per km^2 which is still lower than the Tobua figure of 136 per km^2.

Fertility and agricultural intensifiation

If, as Boserup contended (1965), population growth is the cause of the intensification of agriculture and not the effect then the question, what prompted or prevented population increase remains unanswered. Groves (1978) neatly summarizes some of the main arguments linking demographic factors, including population density, to theories of the origin of agriculture. Although he is primarily interested in looking at the transition from hunting and gathering to cultivation as the major mode of resource exploitation the arguments presented are relevant to the Nembi situation. Groves points out that Boserup also stated 'agrarian history knows relatively few examples of ... steady (population) growth and many more of population growth interrupted by frequent set-backs' (1965:62), suggesting that agricultural intensification did not take place at an adequate rate for production to keep pace with demand. Methods of population control were also used, and if intensification of cultivation involves more and harder work, a society would try and produce for the least amount of effort and intensify only if it really needed to. Groves states 'the existence of conscious, culturally santioned methods of population control is highly significant: the societies which practise them do not want to expand, and even put up with the undoubted distress of infanticide to avoid expansion' (1978:28). On the Nembi Plateau I am not sure whether infanticide caused any great distress, as infants are not named until they are at least a year old when they are then considered to have a spirit. On the Plateau as in much of the highlands, pressure to produce for pigs almost certainly prompted some form of culturally sanctioned population control. The skewed sex ratios of the adult population of the Nembi suggest that infanticide was practised and that baby girls were killed more frequently than boys.

Other factors also controlled population growth on the Plateau. A biological as opposed to a cultural response to resource availability and management is the fecundity of women, which is directly related to their nutritional status (ESCAP 1981). Malcolm (1970) has shown that for a Bundi population the age of puberty in girls is inversely related to their adult height (see Tanner 1968, 1980). He expressed the relationship in the formula:

$$\text{Age of Menarche} = 62.71 - 0.303 \times \text{Adult height (cms)}$$

Buchbinder, using Malcolm's formula found that the age of menarche of Maring women was 18.8 (+1.75) years. Janis Baines interviewed 100 women of the Pubi clan and using a repertoire of known events which had taken place in the last 50 years, was able to estimate reasonably accurately the age of menarche for 34% of them. She found the mean reported age of menarche for Nembi women was 18.1 (n=34)(Table 7.9). Using Malcolm's formula, an average age of 17.4 years is obtained for onset of menses in Nembi women. This suggests that the recall of the women and the methods Baines and myself used are reasonably accurate and the data obtained reliable.

The late onset of menarche contributes to the relatively low fertility of the Nembi population. In association with various taboos on sexual intercourse and the atavistic fear that men have of women's sexuality the fertility of women is further diminished because of delayed sexual maturity. It is for this reason the lower age of 15 was not used to classify fecund women and girls. Later onset of menarche results in a longer generation timespan, and therefore a slower rate of replacement of the population. Nembi women also cease menstruating earlier than women elsewhere.* The earlier occurrence of menopause combines with the late onset of menarche, to further reduce fecundity and therefore fertility. The maximum number of children a women could expect to have if all survived beyond the

Table 7.9 : Estimated Age at Menarche and Age at Menopause of Women in the Pubi Clan, Nembi Plateau.

Age Cohort	Age at Menarche						Age at Menopause										
	16	17	18	19	20	Ave.	40	41	42	43	44	45	46	47	48	49	Ave.
Under 20		1				17											
21-25			1	3		18.8											
26-30		1	1	3		18.4											
31-35		1	2	1		18											
36-40	1	1	3	2		17.9											
41-45			2	2		18.5				1							43
46-50			1	1		18.5		1	1	2				1			43.2
51-55			2			18									1	1	48.5
56-60		2		2		18	1		2	1	1	2		1		1	44.1
61-65		1				17											
Over 66											1						44
TOTAL	1	7	12	14		18.1	1	1	3	4	2	2		2	1	2	44.3

Source : Retrospective Mortalities interviews conducted by Janis Baines 1980.

* The median age of menopause among American women in 1974 was 49.8 years (Treloar 1974). Secular rises in the age of menopause may be related to nutritional status. Scragg (1977) indicated that among malnourished rural New Guinea women the median age of menopause was 43.6 years while among better nourished women it was 47.3 years.

period of breast-feeding is further limited by a period of adolescent infertility which occures for about two years after the onset of menses.* This is probably also the case in western societies (Weideger 1977, Tanner 1980). If children are breast fed for four years and during this period a woman abstains from sexual intercourse she could have a maximum of seven possible confinements during her fecund life. For a sample of forty Pubi women who had passed the age of menopause in 1980, the average number of pregnancies brought to term was 5.5, which although appreciably higher than the 3.76 that Buchbinder reports for the Maring (1973:95) is still low by third world standards.** The Total Fertility Rate for Papua New Guinea in 1971 was 6.2 (Agyei 1979:26) for women between 15 and 49.

The Nembi fall into MacArthur and Wilson's typology (1967) of the hunter-gatherer and 'simple' cultivator populations in contrast to the peasant-cultivator populations in which society is larger, settled and has denser populations, but in which food supply is larger, and more variable and infant mortality higher and a life expectancy lower

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* It is also considered to be 'bad form' if a girl conceives and bears a child too soon after marriage. A young woman marries before she is twenty. In the past this could have been before she had reached menarche. Readiness for marriage is determined by other physical signs, for example the drooping of a girl's breasts.

** Although the average Total Fertility Rate for Low-income countries was 5.4, many had rates that were much higher; Kenya 7.8, Niger 7.1, Malawi 7.0. Saudi Arabia had the highest at 8.0 and many others were over 6.0. The Total Fertility rate is the number of children born per women if she were to live to the end of her fecund life and bear children at each age in accordance with prevailing age-specific fertility rates. A replacement level would be 2.2 (IBRD 1980, World Development Report Table 18). The sample size for the Nembi population precluded obtaining age-specific fertility rates.

(Howell 1976 in Groves 1978:30). The Nembi live in a more or less predictable environment with consistent, and density-dependent mortality rates (the death rate follows the birth rate, a result of both the poor environment as well as conscious control), low reproductive rates, slow rates of maturity and thus late entry into reproductive life. Other societies in variable and unpredictable environments have characteristically high and density-dependent periodic mortality, high reproductive rates, rapid development and maturity and thus early entry into reproductive life (MacArthur and Wilson 1967).*

The 'simple' cultivator populations, like the Nembi, living in poor but essentially predictable environments can utilize methods of population control to suppress those 'surplus to requirements' (Groves 1978:30) because the proportion of offspring that will survive can be estimated. On the other hand the settled and more peasantized societies, inhabit environments which although they provide a better diet, are unpredictable, the Polynesian societies of the Pacific for example (Diamond 1977: cited in Groves 1978:21). In such societies crop failure (perhaps from natural disaster) can be calamitous and mortality rates can be extremely high. To cope with the possibility of high mortality reproductive rates are high.

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* For example the age at Menarche for the ! Kung is 16.5, the Bundi of New Guinea 18.0, the Kaiapit of New Guinea 15.6, the Chimbu of New Guinea 17.5, and the Tutsi of Rwanda 16.5, whereas for more peasantized societies the age at menarche is lower - Kerala (rural) 14.4, Xochimilco (Mexico) 12.8, Maya (Guatemala) 15.1, Ibo (Nigeria) 14.1 (from Groves 1978:31).

Measures of fertility among Nembi populations, as well as Crude Birth Rates and the number of children born per woman suggest that in comparison to other parts of the world, although fertility is high, it is still comparatively low. If in the third world, improved nutritional status and increasing incomes are related to each other as well as to increases in fertility (see IBRD 1980:66), then increases in population can be expected on the Nembi Plateau. More importantly the ratio of consumers to producers in the subsistence sector of the economy can be expected to increase. There are other indications that this is taking place. The average spacing between children of Pubi women who had completed their fecund life by 1980, was 5.6 years. The spacing between children of women who were still fecund in 1980 was 3.7 years. More ominously traditional taboos concerning intercourse, breast-feeding and marriage are breaking down and it is this rather than increased incomes or improved nutritional status that is prompting higher birth rates. Missionary activity is responsible for the virtual disappearance of some methods of fertility control - abortion and infanticide. On the other hand, although the Catholic Mission runs the Health Centre at Det in the Nembi valley and is responsible for the sub-Health Centre at Ol, contraceptive devices are available for Nembi women and their husbands. But only 7.4 percent of the Pubi women were using family planning devices (including condoms for this husbands) in 1980, and then more to space their children than to curtail family size.

Health, nutritional status, child mortality and environment

Of the 90 or so recorded pregnancies that were brought to term by the 18 women who had reached menopause by 1980 (Table 7.9), 44 percent of the children born, died before the age of 15, an extremely high proportion even by the standards of other third world countries where the average death rate by age fifteen is approximately 20 percent (IBRD 1980:54 Figure 5.2). The death rate on the Nembi Plateau has declined in the last 20 years and is reflected in the proportion of the population under 15 (Table 7.6) and by the age and sex composition of the population (Figure 7.4). Exact figures are not available as not all births or deaths are recorded on the Nembi Plateau, but an indication of the decline in death rate can be shown for children under the age of five. Of 91 children born between 1975 and 1980 in the Pubi clan, 17 died before reaching the age of five, a crude child mortality rate of 186/1000, which is probably an underestimate as neonatal deaths are often forgotten. In 1971 the same measure for Papua New Guinea was 195 and for the Southern Highlands Province 229, the highest child mortality rate of the 20 provinces (Skeldon 1979:52). Although the crude child mortality rate for the Nembi would thus appear to be high it is nevertheless an improvement on a probable rate of 250-300/1000 in pre-colonial Nembi society.

Such a high child mortality rate has important implications for interpreting the high degree of malnutrition amongst Nembi children. It primarily emphasizes that the 1162 children whose nutritional status was assessed are survivors and that the occurrence of malnutrition is thus underestimated because no indication is given of the large number of children who have died. The high child mortality on the Plateau is probably a more powerful indicator therefore of the condition of the Nembi people, their economy and their environment, than the assessment of the nutritional status of the surviving child population.

The magnitude of the problem is apparent when the child death rate on the Nembi is compared with other parts of the world. In developing countries deaths of children under the age of five as a percentage of total deaths is on average about 40 percent (IBRD 1980:54). In Sweden deaths of children under the age of five account for only 1 percent of all deaths and in most industrialized countries over 80 percent of deaths are of people over 65 years of age (IBRD 1980:54). On the Nembi Plateau exactly comparable figures are not available, but of the 95 deaths recorded at Ol Health Centre from 1978 to 1980, 26 percent were of children under the age of 1 year while 51 percent were of children under the age of 16 years.

Despite the introduction of medicine and antibiotics the child death rate remains high, but it would be simplistic to assume that malnutrition alone amounts for such a situation. While the high child death rate is to some degree a reflection of poor nutritional status (this is explored more fully in Chapters Eight and Nine) it is more the outcome of poor environmental hygiene. The environment in which children are brought up remains virtually unchanged from pre-colonial times and indeed because of overcrowding and the misuse of latrines it may be worse (see also Feachem 1977 for the Enga). The death rate has been reduced by medical intervention and cessation of warfare, and immunization and antibiotics are a comparatively cheap means to improve health and their initial impact is effective and impressive but improvements of a more fundamental nature have been neglected.

To adequately assess the nutritional status of children. the wider issue of public health and hygiene despite shortcomings in the data must therefore be considered. Nutritional status must be related to infectious disease and environment, rather than food production alone. I consider that neglect of public health is one of the major problems of rural Papua New Guinea*, and one which distinguishes and contrasts the demographic situation of the Nembi from that of pre-industrial and early industrializing Europe. The contrast is interesting and provides insight into the demographic processes of the Nembi population. Describing the demographic history of the British Isles, McKeown has stated that:

> 'health was transformed from the eighteenth century because of improved nutrition, better hygiene and contraception and without a significant contribution from immunization and treatment before the twentieth centry; and although the point is purely theoretical, it is unlikely that medical intervention would have been effective if the other advances had not occured' (1979:143-144).

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* It is significant that the IBRD appraisal mission for the Southern Highlands Rural Development Project was not sympathetic to improved environmental health as a major objective of the project, preferring instead to equate number of newly trained nurses, rather than a decrease in the child mortality rate, with dollars spent (IBRD 1978, see also MacPherson 1980:291-351 for a critique of the health policy of the project). MacPherson noted that in 1978 only 3.7 percent of the Provincial Health Budget of the Southern Highlands was allocated to health improvemeht while 80 percent was allocated for health care (1980:301, Table 9.2).

In the Nembi context, the point is far from theoretical for modification of the environment to mitigate health hazards, as well as mofification of people's behaviour for health purposes, have taken second place to what might be called orthodox medical intervention. The policy implications are enormous. The process of population growth and the man-land relationship on the Nembi Plateau undoubtedly have important implications for the Nembi's future but European contact and intervention has complicated the simple equation of population, agricultural technology, land use and food production. The pre-conditions for a decline in the death rate and therefore for a decline in fertility are not present on the Nembi Plateau. Because the death rate is high, so too is the birth rate and sickness, disease and death are still predominantly caused by poor environmental health, a factor of poverty. Parents therefore want enough children to ensure some will survive.

Environmental health and the cause of death inpatient health patterns: public health and degenerative disease.

Much disease on the Nembi Plateau is the result of poor environmental hygiene rather than disease of a chronic or degenerative nature (Table 7.10), a pattern which is common in developing countries (Hirshman 1980) and in Papua New Guinea. The causes of reported deaths in Papua New Guinea is slowly changing from one due almost entirely to environmental-related, acute diseases and trauma, to one due to both acute and degenerative disease (Skeldon 1979:68-69).

Table 7.10 : Annual Totals of In-Patients to Ol Health Centre from 1978 to 1980 and Reasons for Presenting

	1978		1979		1980		Total	
	No.	%	No.	%	No.	%	No.	%
ADULTS (16+ yrs)								
Respiratory	104	21.1	76	16.5	75	21.8	255	19.6
Enteric	42	8.5	48	10.4	24	7.0	114	8.8
Malaria	259	52.4	215	46.6	117	34.0	591	45.5
Viral	12	2.4	4	0.9	2	0.6	18	1.4
Pig-bel								
Psychic reaction	4	0.8	1	0.2	4	1.2	9	0.7
Other	73	14.8	117	25.4	122	35.5	312	24.0
TOTAL	494	100	461	100	344	100	1299	100
CHILDREN (1-16 yrs)								
Respiratory	70	14.6	46	12.3	59	17.9	175	14.8
Enteric	169	35.4	100	26.8	90	27.4	359	30.4
Malaria	153	32.0	120	32.2	37	11.2	310	26.3
Viral	11	2.3	27	7.2	83	25.2	121	10.3
Pig-bel	39	8.2	34	9.1	18	5.5	91	7.7
Psychic reaction	1	0.2					1	0.1
Other	35	7.3	46	12.3	42	12.8	123	10.4
TOTAL	478	100	373	100	329	100	1180	100
INFANTS (0-11 mths)								
Respiratory	46	35.7	72	37.1	70	36.5	188	36.5
Enteric	34	26.4	50	25.8	56	29.2	140	27.2
Malaria	33	25.6	55	28.4	5	2.6	93	18.1
Viral	4	3.14	10	5.2	40	20.8	54	10.5
Pig-bel								
Psychic reaction								
Other	12	9.3	7	3.6	21	10.9	40	7.8
TOTAL	129	100	194	100	1924	100	1515	100

Source : Inpatient Records Ol Health Centre.

The leading cause of adult admissions to the Ol Health Centre is malaria, accounting for 45.5 percent of adult inpatients over the three year period from 1978-1980. In the younger age groups although malaria still accounts for a large proportion of admissions (26.3 percent of children and 18.1 percent of infants) other diseases are as important. The most common complaints for children between the ages of 1 and 16 are enteric, which include dysentery, diarrhoea and gastro-enteritis. Only 8.8 percent of adult admissions were for these related diseases, compared with 27.2 percent of infant admissions. The most common cause of admission among infants however, was respiratory disorders (36.5 percent), which were also the third most common cause of admission for children and the second most common for adults.

Only those cases deemed serious enough to warrant overnight detention at the Health Centre have been recorded, but it can be seen that the majority of inpatients suffer from the effects of poor environmental conditions. Such conditions may be summarized as the 'conditions of poverty' because they are associated with poor housing, poor water supplies and poor sanitation. The data also record only those people presenting to the Ol Health Centre and are therefore mainly representative of nearby areas although severely ill and traumatised people who become inpatients, come from a wider area.

Outpatient Health Patterns; Poor Public Health

The most common complaints presenting to the Det Aid Posts in 1978 were also disease associated with sickness resulting from poor environmental and personal hygiene. Of a total of 1101 cases presenting in one month at Det Aid posts, 55 percent (600) were classed as cutaneous, scabies, dermatitis and other skin complaints, conditions which are symptomatic of poor personal hygiene.* The next most common reason for presenting were respiratory tract diseases which accounted for 17 percent (185) of outpatients. Fever (probably malaria) accounted for 12 percent (130) and enteric complaints a further 9 percent (100) of cases (Department of Health Mendi 1980).

Comparable and recent data for the rest of Papua New Guinea are not available but for the year ending 1972 of total hospitalizations (Papua New Guinea National Health Plan 1974-1978) (170,865 cases), respiratory infections (including pneumonia), amounted for 20 percent (34,648); skin infections 4 percent (6552); gastroenteritis, 9 percent (15,905); and malaria, 6 percent (10,297), all diseases predominantly associated with poor environmental hygiene. The gravity of the problem is emphasized when the cause of death is examined, both for the Nembi people and for Papua New Guinea as a whole, and especially for children under the age of five.

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* A patrol officer noted in the mid 1960s that 'the people make no attempt to wash when they are dirty but always seem anxious to obtain soap. They do not associate dirt with disease...' (Patrol Report No.7 Nipa 1965/66).

The causes of death

Epidemic diseases, mostly recently introduced, do occur on the Nembi Plateau.* In September 1965, an outbreak of dysentery occurred in the Enip Census Unit 2 km to the north of the Pubi, and killed 5 percent of the population in three weeks. Twelve were children. In September and October 1969 a 'flu epidemic struck the Nembi Plateau and Nipa Basin. In the Nipa Basin 112 people died, while on the Nembi Plateau it killed 50. The disease entered the area with an Administration patrol from Mendi (Patrol Report No.3 Nipa 1969/70). Another 'flu epidemic struck the Nembi Plateau in December 1973. In 1979 and 1980 measles epidemics occurred in the central Nembi Plateau

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* Measles, chicken-pox, influenza and other diseases, including dysentery have been introduced to the highlands of Papua New Guinea. Buchbinder reports that 'flu epidemics were widespread throughout the highlands in the 1960s (1973). Reports exist however of 'flu epidemics in the 1930s. McCarthy reported a meeting with a missionary doctor near the Dutch New Guinea border in 1937 who explained that there was a widespread 'flu epidemic in the area (1970:93). Hide also reports local recollection of a bik sik in the Koge area of the Chimbu in the 1930s (1981:72-74) and cites an unpublished volume by Bergmann (1971) who stated that a severe ''flu epidemic went through the highlands' (vol.1:68). Nelson (1971) reported a bik sik for the lower Nebilyer valley and dates it to the 1930s. He reported that it was the introduction of malaria to the region, but this seems unlikely and was probably the flu epidemic reported by Bergmann and Hide. Evidence for epidemics exist and Bowers (1971) reports real depletions in the age cohorts of the Kaugel, born between 1930 and 1945. The population pyramids in this chapter show similar depletions. In the same period a widespread dysentery epidemic in the highlands was reputedly brought into the area by Canadian airmen who had crash landed in the Eastern Highlands (ANGAU War Diary Jan 1944). Danny Leahy reports in his diary the outbreak of dysentery in the Enga region (Ashton 1978:185) which has also been reported by Feachem (1977:165). Onka, Strathern's informant of the Meldpa also reports a bik sik that occurred when he was young (1979:19) and it is also reported in the Chimbu by Ivinskis et al (1956:143-157. It was probably either dysentery outbreak of the war or the 'flu epidemic of the 1930s.

which although only killing three children (Table 7.11) accounted for 123 children being hospitalized at the Ol Health Centre in 1980 (Table 7.10).

But the environmentally related diseases, bronchitis and other respiratory diseases, diarrhoea and dysentery remain the greatest threat to life. Associated fever and excessive excretion of nitrogen by children with these diseases lead to losses of energy and protein which exceed the daily intake. The body's reserves, already small, are depleted and progressively drained. A rapid onset of protein-energy malnutrition usually occurs under these conditions (WHO 1979). Breast-fed children are protected from infections by natural antibodies contained in breast-milk and are not as prone to problems associated with malnutrition until they are about four to six months old, when the breast-milk becomes inadequate to supply all their needs. Supplementary foods are often of an inadequate quality to ensure that the child thrives (Chapter Nine). Although not starving, the child's growth is retarded and he is prone to infection and disease; the inadequate diet lowers the child's resistance to disease in a disease-laden environment. Of the major causes of death of patients from among the Nembi Plateau population presenting and recorded at the Ol Health Centre from 1978 to 1980 (Table 7.11), only 4.1 percent of deaths (4) were directly attributed to malnutrition, a level which is comparable to the National average of 3.6 percent (119) of total deaths (Central Planning Office 1974). Deaths due to diseases either related to malnutrition, exacerbated by malnutrition or rendering the sufferer prone to malnutrition are nevertheless high among children and infants on the Nembi Plateau. Diarrhoea and

Table 7.11 : Cause of Death by Age Group of Inpatients 1978-80 at Ol Health Centre

Disease	Adults (16 yrs)	Children (1-16 yrs)	Infants (0-11 mths
Malaria	5	2	2
Pig-bel	-	18	-
Diarrhoea	-	6	9
Dysentery	3	4	-
Pnuemonia and respiratory disease	6	1	7
Measles	-	2	1
Meningitis	-	1	4
Liver/kidney failure	2	-	1
Heart failure	2	-	1
Anaemia	-	1	-
Malnutrition	-	1	3
Neo-natal death	-	-	4
Other	3	2	4

Source : Health Records at Ol Health Centre.

associated dehydration account for a high proportion of deaths recorded; 16 percent (10) of children dying between the ages of 1 and 16, and 25 percent (9) of infant deaths. The average for the Southern Highlands in 1978 was 10 percent of deaths attributed to gastro-enteritis and other intestinal infections (Mendi Department of Health 1980, see also MacPherson 1980, Table 8.2), while in 1972 the average for Papua New Guinea was 11.3 percent of deaths related to such diseases (Central Planning Office 1974).

Respiratory diseases that may or may not be related to poor nutritional status, but also reflect the smokey atmosphere of houses and the damp cold climate of the highlands, are major killers. They were the leading cause of death among adults at Ol Health Centre (Table 7.11), and the second most frequent cause of death of infants. In the Tari Basin, 19 percent (309) of deaths recorded (1606) in Tari hospital from 1971 to 1976 were attributed to respiratory diseases other than pneumonia (Mendi Department of Health 1980). Pneumonia accounted for a further 20 percent (316) of deaths. In the Southern Highlands the two combined, accounted for 34 percent of deaths in rural areas in 1978 (MacPherson 1980, Table 8.2).

Malaria is the second most frequent cause of death among adults, and is the fourth most prevalent cause of death for all age groups combined. Of the adult deaths recorded in the 01 Health Centre, 22 percent (5) were due to malaria, compared with a provincial average of 7 percent and a national average of 3 percent. There is no provincial spraying programme in the Southern Highlands to prevent breeding of the vectors and the valleys to the south and west of the Plateau are malarious. The links between the people of the valleys and the plateau is reflected in the high incidence of malaria on the Plateau. Road building activity in the province is providing ideal breeding sites for the mosquitoes and thereby facilitating spread of the disease (Mendi Department of Health 1980)

One of the most enigmatic causes of death, especially of young children between the ages of 5 and 14, is Pig-bel (Enteritis necroticans). Approximately 50 percent of deaths of children between the ages of 1 and 16 were due to this disease on the Nembi Plateau between 1976-78. Pig-bel accounted for 15 percent of deaths in Mendi hospital in the same period, second only to pneumonia which caused 18 percent of deaths (Southern Highlands Health Records 1980). Pig-bel is thought to be related directly to the diet of highlanders. It is associated with long periods of low protein intake which leads to an inability to produce sufficient amounts of trypsin in the gut to adequately digest the large amounts of protein that are ingested during ceremonial pig-kills, or on other occasions when protein-rich meals are eaten. Indeed sweet potato and other foods eaten in the highlands are not only low in protein content, but also contain inhibitors to trypsin activity.*

In summary it can be inferred that compared with Europe where the rate of mortality was greatly reduced by improvements in public health and better diets (see McKeown 1976 and 1979 for summaries of the literature and controversy surrounding this issue), mortality on the Nembi Plateau and throughout the highlands has been reduced by direct medical intervention, innoculation, immunisation and antibiotics. Nevertheless life expectancy remains low (44 years in the Southern Highlands in 1974; National Health Plan 1975), and young children are susceptible to environmentally-caused disease and death especially those young children suffering from stress associated with weaning and the introduction of solid foods into their diet. An inadequate food supply lies at the root of malnutrition, but factors other than the quality and quantity of foods consumed by individuals contributes to their nutritional status and health. Although only 2 percent of deaths in Health Centres in the Southern Highlands was attributed to malnutrition in 1978 (Mendi, Department of Health), diseases associated with the poor environmental condition, the leading

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* A research programme is currently investigating the prevalence of trypsin inhibitors in the Nembi diets (Anders, Baines, Bradbury and Miller - research proposal nd.)

cause of death, mask the high degree of malnutrition, especially among young children. As more children survive the first few months of life on an inadequate diet so more children become susceptible to the diseases of poverty. As the number of children increase, the number who die from the effects of poor hygiene, poor sanitation, poor housing and polluted water increases. Although MCH clinics have reduced perinatal deaths from tetanus and other diseases, and child mortality from contagious viral disease has been reduced by immunisation, little if any effort has been made to reduce infant mortality by improving living conditions. The numbers dying therefore appears to be closely related to the number born (Figure 7.3) and the explanation of the cyclical pattern in the death rates of the clans of the lower Pwe Creek Basin lies in a cyclical pattern in the birth rate.

Cyclical and seasonal patterns of birth and death

When the cyclical nature of the variation in the birth rates of the clans of the lower Pwe Creek Basin is examined more closely an underlying seasonal trend is discernible. This is clearly shown by the monthly number of births recorded at the Oi Health Centre (Figure 7.5). The pattern of recorded births compares with that shown in Figure 7.3. One difference is that the data from the censuses are based upon an intercensal period which runs from June to June whilst data from the health clinic are from January to December. Nevertheless the trends are similar and the drop in the birth rate shown in Figure 7.3 during 1974 and 1975 is reflected in Figure 7.5. The number of births recorded every year has probably increased as women

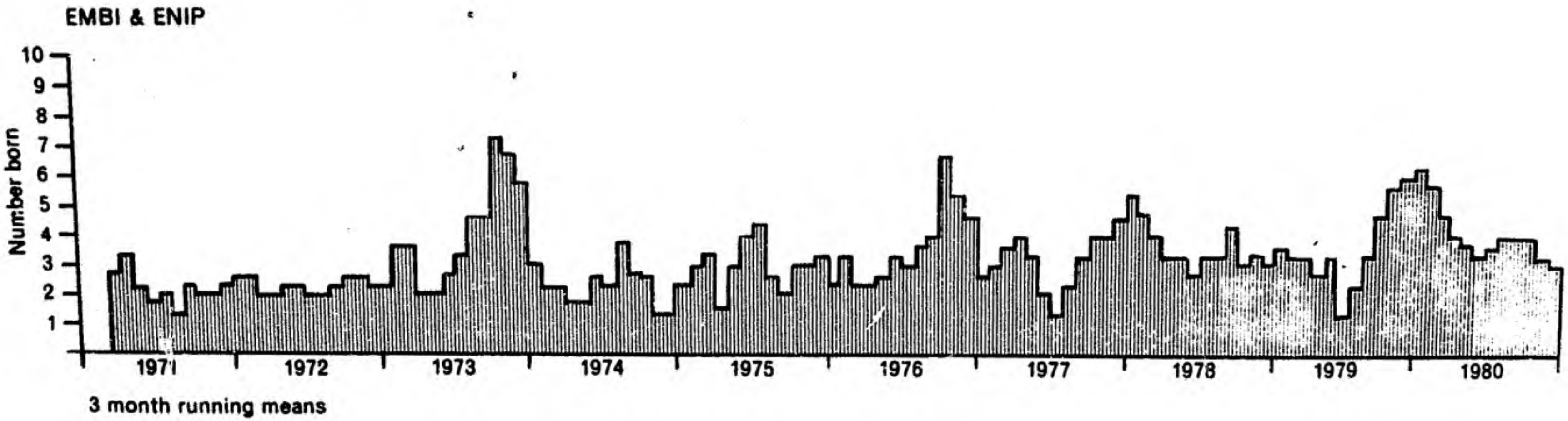

Figure 7.5 : The cyclical and seasonal pattern of births at Embi and Enip Maternal and Child Health Care Clinics catchments (Pubi-Penarop, Porelep, Murupa and Werut-Marop clans) recorded at Oi Health Centre from 1971 to 1980.

have lost their fear of the Health Centre and become more willing to leave the security of their husband's clan territory to attend anti-natal clinics, bear their children at the Health Centre and attend MCH clinics regularly.* This probably biases the overall trend, but the rise in the number of births in 1979 and 1980 is also reflected in Figure 7.3, and the fluctuations from year to year and from month to month are probably a fair representation of the actual birth pattern in the central and southern Nembi Plateau. The only exception may be those children born outside the Health Clinic and whose mothers were not recorded as pregnant by the Clinic. They are most likely to be women pregnant for the first time, who not having older children would not be recorded on the Clinic lists. If the neonate died before being registered at an MCH Clinic then no record would exist of its short life. Most children born outside the Clinic are registered at an MCH clinic as soon as possible, but the data collected may underestimate the number of pregnancies brought to term (Figure 7.5).

Births peaked between 1971 and 1980 in 1973, 1976 and 1980 The lowest number of births occurred in 1974 and 1975 and the early part of 1976. Thus births appear to peak on a three to four year

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* Patrol Officers noted the fear that people had of attending clinics in the mid 1960s and the role which the missions had in helping people to overcome this fear:
'There is an excellent coverage of all villages by both Mission and Government Health Staff' (Patrol Report No.3 Nipa 1965/66).
'The Missions are doing a lot of good work in this way [health] but the people are still showing fear and do not come in for treatment, others only come in when their illness has reached an advanced stage and little can be done for them. The fears are gradually being overcome by having Medical Patrols constantly through the area and by the people seeing the results of medical treatment' Patrol Report No.7 Nipa 1965/66).

cycle. Some particular explanations of deviations from the general pattern follow. The pig-kill that took place in April 1976 among the clans of the Yoel and the Uba basin may have disrupted normal sexual relations between men and women. The women are responsible for pig-rearing and child-bearing and it would appear that most women did not have children in the period immediately prior to the pig-kill when the pig-herd was being built up to its maximum. In late 1976 following the pig-kill there was a remarkably high number of births which suggests increased sexual activity after the ceremony. Although in many ways the evidence is anecdotal, it nevertheless suggests that the proposition made in Chapter Six, that pigs and land are more closely related than children and land, is a realistic assessment of the relationship between pigs, children, land and producers. Further evidence of this is presented in Chapters Eight and Nine.

Clans other than those in the Embi and Enip MCH clinics also show annual and periodic fluctuations in the number of births (Figure 7.6). Tobua shows the clearest trend in number of births per year, peaking in 1973/74 and 1978/79, and the interval appears to correspond to the period of breast-feeding and post-partum intercourse prohibition. Such an explanation for the cyclical trend in births is however, not wholly satisfactory. It does not explain why a large proportion of women conceive at the same time. A possible explanation is that a cohort of young men may marry within a short space of time and because their wives of necessity live and work in close proximity to each other their menstrual cycles may become roughly synchronised (see Weideger 1977) which could produce a significant pattern in the

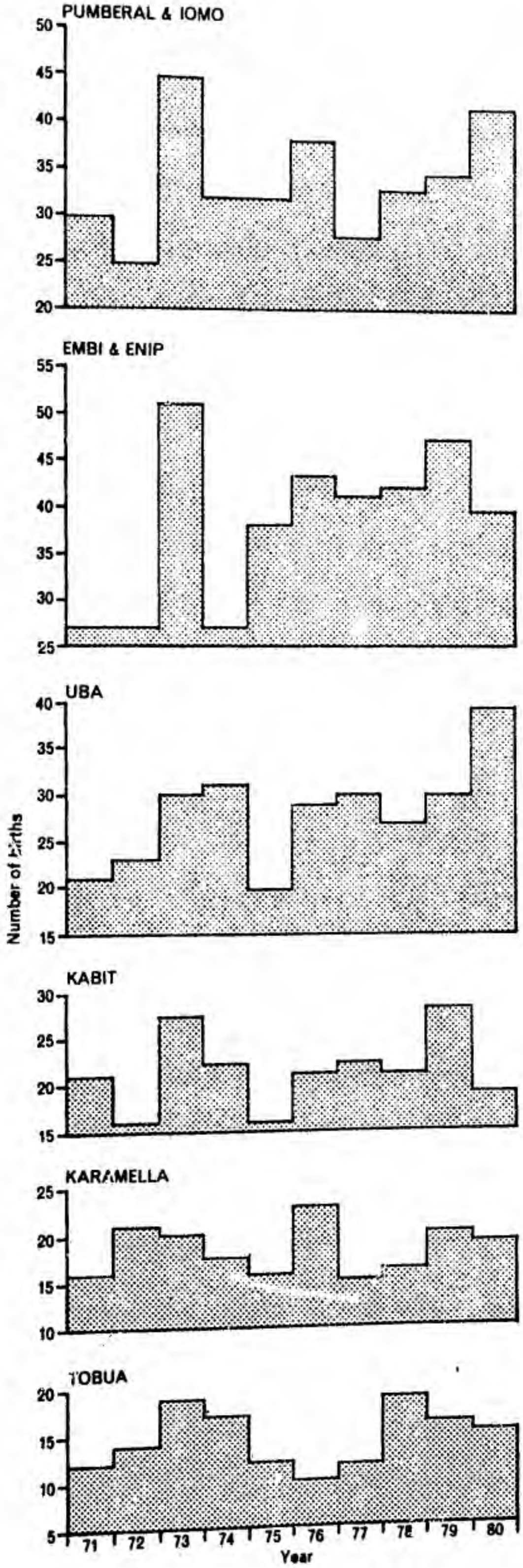

Figure 7.6 : Number of births recorded at Ol Health Centre for the clans of the Lower Pwe Creek basin from 1971 to 1980.

number of births.* Kabit clinic also shows a clear pattern of peaks roughly 3-5 years apart. The other areas have patterns which while less clear are nonetheless similar to those of Tobua and Kabit and may be similarly explained. A long term research project could have as its objective to try and record the confinements of all women in a particular area in order to precisely document mechanisms operating (see Wolanski 1978). The present system of registering births by clinic areas masks the marriage alliances between clans (see Chapter Three), and the effect of cohorts of young men marrying within a short space of time (see also Lindenbaum 1977:36, for similar observations in the highlands).

As well as the periodic pattern a seasonal pattern of births can be discerned. With the exception of 1971/72 when the recorded number of births was probably below the actual number of children born, and in 1974/75 when the preparations for the pig-kill early in the following year complicated the issue, the number of births per month for the clans of the Yoel El peaked from September through to February in every year, (Figure 7.7). Conception takes place

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* When Janis Baines interviewed women on the subject of sexual behaviour and tried to elicit age of menarche, menopause, marriage and age at the birth of their children, the women used the mixed garden cycle as a method of determining the spacing of the events relative to each other. The mixed garden period was a period of much sexual activity and perhaps two mixed garden cycles would pass before a women was pregnant for the first time after marriage. On one occasion a woman on being asked how many mixed gardens separated two of her children misunderstood the question and replied that her husband had had four acts of intercourse with her before she become pregnant again. I think this serves to demonstrate the extraordinary memory of some of the women, as well as giving an insight to their opinion on sexual intercourse. We estimated the woman to be in her mid sixties at the time of the interview.

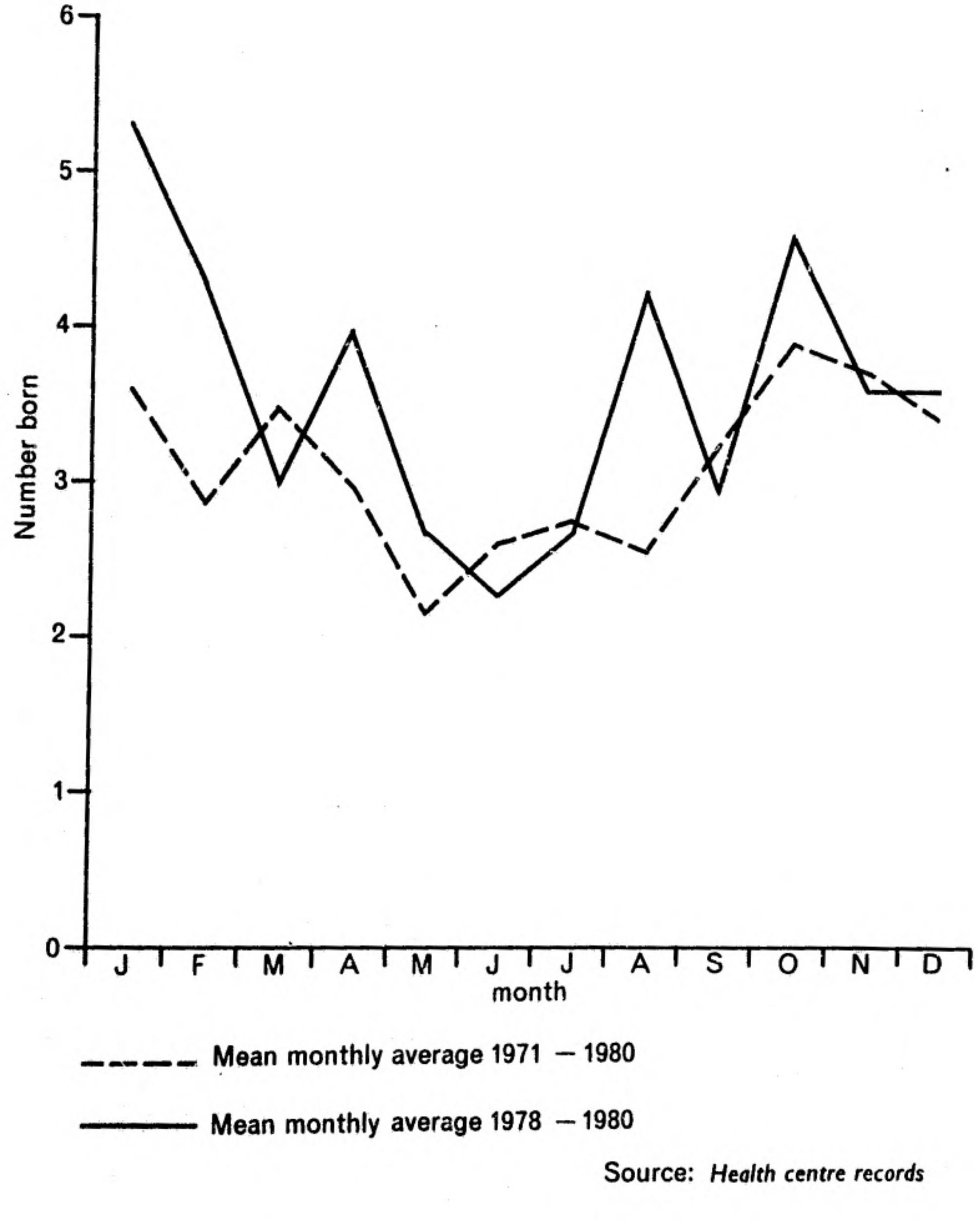

Figure 7.7 : The seasonal pattern of births in the Yoel el (Pubi-Penarop, Endusparr, Murupa, Porelep and Epi-Yokul.)

predominately during February, March and April and minimally between September and December. The former period is when work in the mixed gardens has finished and some of the crops are being harvested, the latter period is when women are working hardest in the gardens. The seasonal workload of women within the yearly agricultural cycle and the contribution of men are discussed in detail in Chapters Eight and Nine, but some aspects are important to the discussion here. Men do not spend a great deal of time in the gardens, although in the mixed gardens they usually construct fences, dig drainage ditches, clear undergrowth and secondary growth and plant bananas, sugar cane and taro. The mixed gardens are planted from October to December and by February are in production, when the women reduce their work rate and also plant less sweet potato. The reasons for this are discussed in Chapter Eignt. Although the men revert to discussing and planning their exchange activities at the end of the mixed garden period, they also say this is a period of hard work, euphemistically referred to as "planting beans". It is however, of a different nature than making gardens:

> 'Nau mipela i gat wok, em i hat wok tru, em i no wok belong pikinini na man i stap nating. Em i hat wok bilong man i gat meri. Nau mipela bai planim bin'.*

In short, they ritually protect themselves against female pollution by incanting the appropriate words and performing the correct rituals and follow their wives to the gardens. This is not to suggest a mass

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* Now we have work to do, it is very hard work, and is not the work of children or of bachelors. It is the hard work that is the lot of the married men. Now we will plant beans.

exodus of men and women to the gardens. However this is the time when many women whose children are ready to be weaned, if not already pregnant, become so. Intercourse takes place in the long grass and secondary bush of the garden fringes. Not all women conceive during this period, but the majority do.

The periodic patterns of births and deaths on the Nembi Plateau are related (Figures 7.3 and 7.4) and as the pattern of births appears to be seasonal, as well as fluctuating from year to year, so too is there a seasonal pattern of deaths, as well as cyclical variation in mortality from year to year. The pattern of child death in the Ol Health Centre catchment area from 1975 to 1980 is one in which the majority of deaths occur between February and July, the long rainy season when the incidence of disease is highest (Figure 7.8). In other parts of the world, for example The Gambia, a similar pattern of higher incidence of infant and child morbidity and mortality has also been shown to occur during the rainy season (see for example Rowland et al 1981:164-181) when conditions are such that respiratory disease is encouraged and faecal contamination of food and water increases. It is debatable whether the cold rain or the smokey atmosphere within the small and crowded houses has the most detrimental effect upon the health of young children. It is possible however to narrow the analysis further and to distinguish a particular category of children more likely to die at this time of year.

The relationship between nutritional status and weanling diarrhoea was noted (Chapter Two) as an important contribution to the low weight-for-age and overall growth faltering of children aged between 5 months to nearly two years. Comparing the seasonal pattern of births in (Figure 7.7) with the seasonal pattern of deaths (Figure 7.8) the peak of deaths from about February to July corresponds to the period when children born between August and January (when most children are born) are beginning to take solid foods and are thus exposed to disease and death. The seasonal frequency of disease prevalence by type, recorded as the number of inpatients at Ol Health Centre of all age groups (Figure 7. 9) suggests a seasonal occurrence in pig-bel, diarrhoea and respiratory diseases malaria and other viral diseases as the major killers of children and infants. It might be inferred that the main causes of death of young children and infants in the early part of the year are viral, enteric and parasitic diseases, while respiratory diseases are the main killers in the mid-year period.

The cyclical pattern of the birth and death rates are therefore closely related, with seasonal fluctuations in infant and child mortality being dictated not only by the number of children born during the latter part of the year but also by an environmental seasonality that not only makes particular times of the year more hazardous for young children but also would appear to be the underlying cause of fluctuations in the birth rate from season to season. The implications this has for the assessment of nutritional status of Nembi children and its underlying causes are complex but important. The relationship between producers and consumers, between food and land take on new meanings and perspectives in a context of periodic and seasonal cycles not only in the physical environment but also in cultural and social factors.

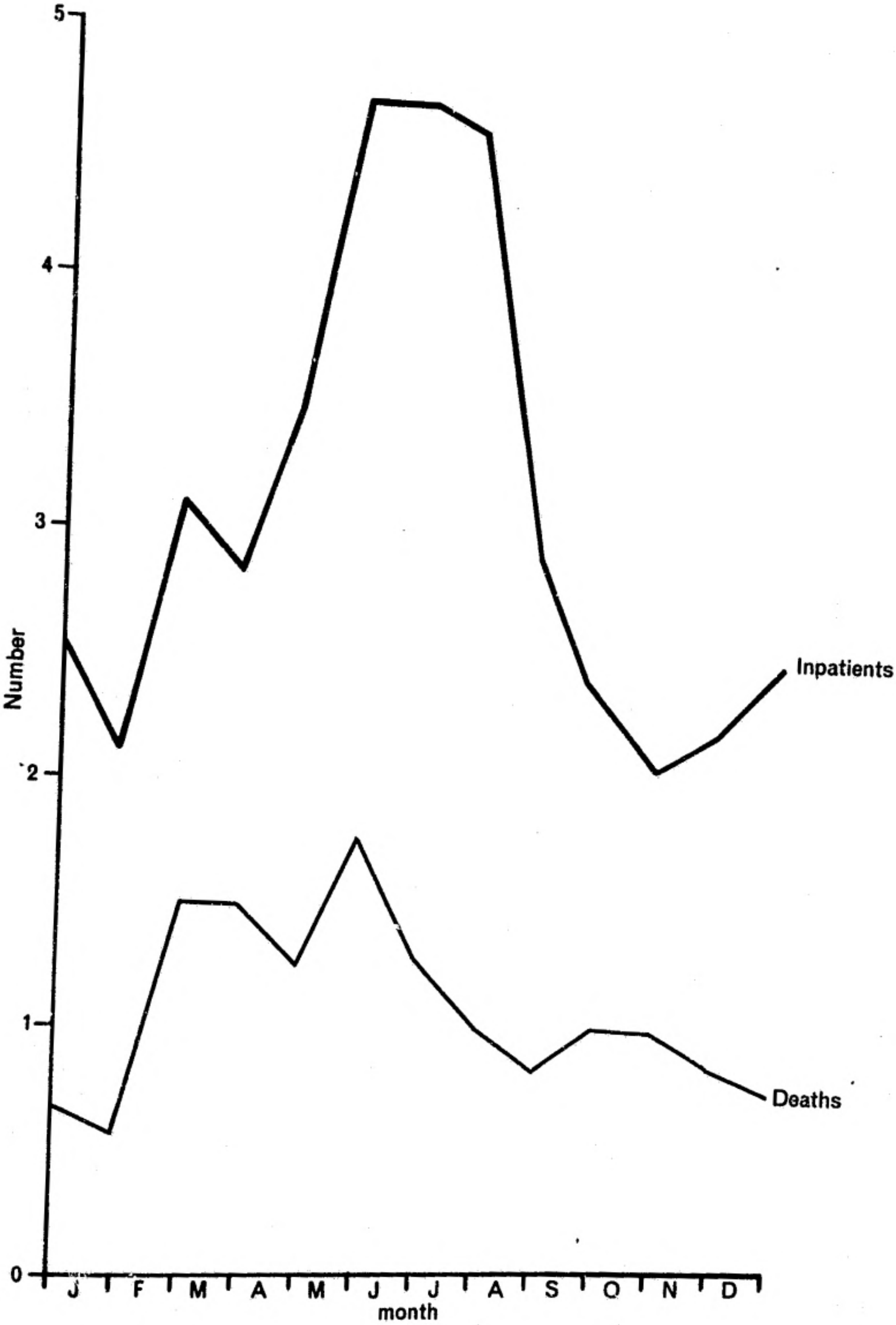
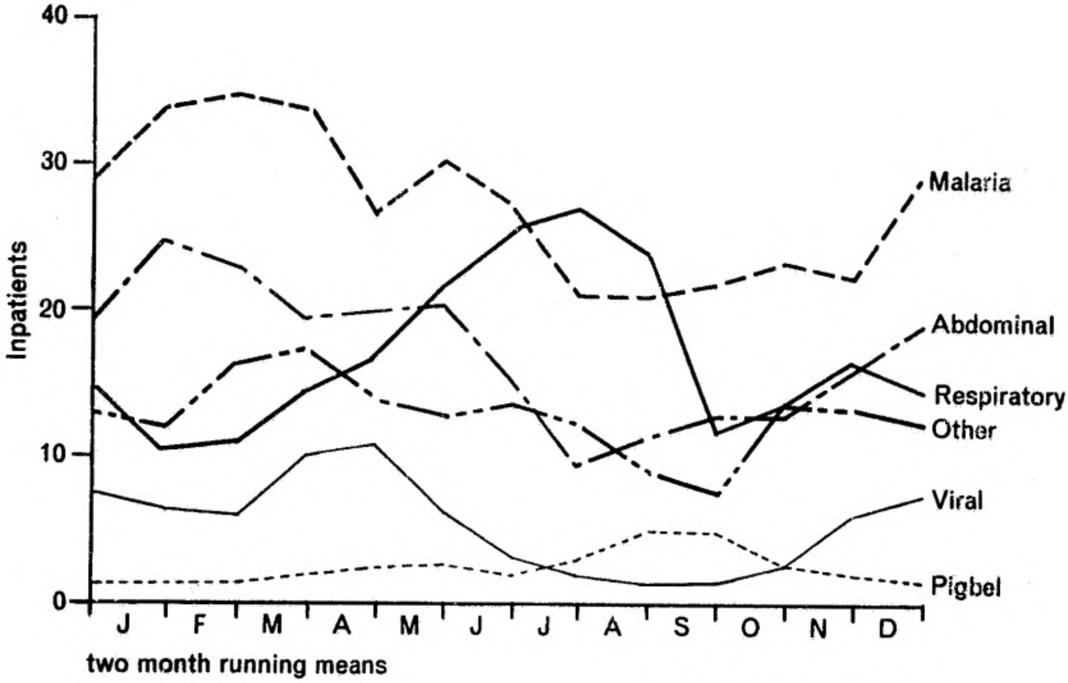


Figure 7.8 : The seasonal pattern of child deaths (0-5 years old) and in-patients at Ol Health Centre (1975-1980).



Source: *Health Centre Records*

Figure 7.9 : The seasonal pattern of disease as shown by in-patients recorded at Ol Health Centre (1975-1980).

A demographic transition

The simple demographic transition model cannot accommodate the processes and situation of the Nembi Plateau population. This does not negate however its usefulness in helping to understand the processes of population change (Figure 7.10).

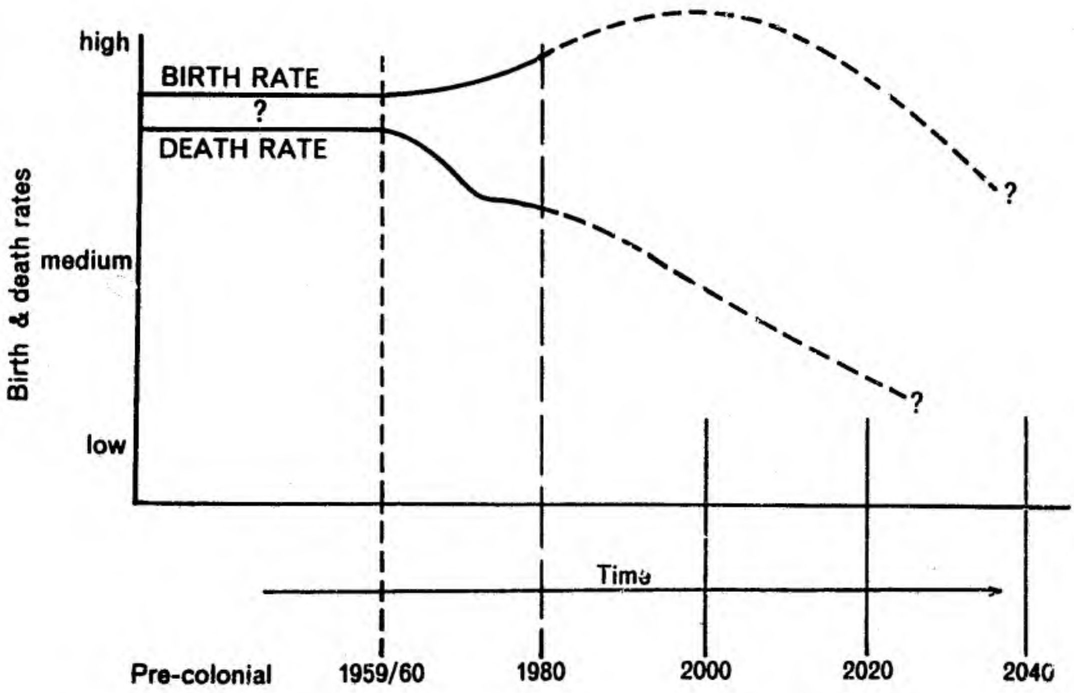


Figure 7.10 : A model of demographic change on the Nembi Plateau.

Other aspects of change in developing countries have also been compared with the processes that took place in Western Europe in the 18th and 19th centuries, and close analogies proposed. They too have been criticised but they nevertheless have provided useful insights. The best known model which proposed direct parallels between the presently developing countries and Western Europe was that of Rostow (1956, 1960) and although formulated over twenty years ago the arguments it raised are still relevant today. Two years before Rostow published his model, Simon Kuznets (1954) had also compared the past performance of the 'advanced economies' with underdeveloped countries but found the analogy far from satisfactory. Postan (1962) on the other hand pointed out that lessons might still be learnt from the experiences of Europe, even if no exact parallels could be drawn. For example, in a period when industrialization was seen as the sine qua non of development policies in developing countries, he emphasized that the economic transformation in Europe had been firmly rooted in change and improvements in living standards - the quality of life - in rural areas. Such an observation is relevant to the present Nembi Plateau situation, and if no exact parallels can be drawn then at least some understanding of the processes can be gleaned from the differences between the two situations. Even if one agrees with Fei and Ranis (1969) that colonialism prevented a smooth transition from pre-colonial self-sufficiency to industrial capitalism, then an understanding of the interrupted processes which led to dependency is also necessary. It is paradoxical that despite persistent attempts to apply theories derived from 'Anglo-Saxon economics' (Seers 1963:80) to the rural economies of underdeveloped countries, the possibility that lessons can also be learnt from European economic history has been rejected. The underdevelopment theorists claim that Rostow's and similar theories, while attributing a history to the developed countries, deny all history to the underdeveloped ones (Frank

1967:37). The underdevelopment theorists thus argue that there is no historical precedent from which to draw lessons.

It seems however that although particular developing countries may have had widely varying experiences and their network of links vis-a-vis the rest of the world has been very different from those which connected 18th and 19th century Europe with its empires, some processes and mechanisms are common to both: only rates and the interaction between those processes are different, and this is particularly true in the mechanisms of population growth. For although part of the divide that separates the developed from the developing countries is the demographic transition, each falls along a continuum. The demography of the Nembi population is typical of developing countries: its clearest distinction from the developed world is its high level of fertility and mortality. Medical intervention has reduced the mortality rate but it may be argued that such intervention has only marginally outpaced the increase in the number of deaths which has paralleled the increase in the number of births. The real problem on the Nembi Plateau lies with environmental hygiene and health, and herein lies the essential difference between the developed and developing world.

In industrializing Europe in the 18th and 19th centuries, it is argued that falling mortality preceded a gradual decline in fertility (see McKeown 1979 for summary). Mortality has also fallen among the Nembi population, so why has fertility increased rather than declining? I have attempted to answer that question in this chapter and in so doing have drawn some implications for the nutritional status of children on the Nembi Plateau.

One of the crudest explanations for why the 'rich get rich and the poor get children' is lack of prudence and ignorance of contraception. Although the older men of Nembi say that young men have less restraint, an observation which is given some credence by the gradually closing interval between births, the desire for children and concern with the strength of one's clan is as strong as it has ever been: and that is the major reason to have children on the Nembi Plateau. Self interest, manifest as concern with appeasment of the ancestors, the desire to have children who will ensure that pigs will be sacrificed to one's own spirit when one dies, children who will till the ground and look after the forest through which one's spirit wanders, is the driving force in maintaining a high birth rate in the face of a high risk of one's children dying before the age of fifteen. It can be argued that such self interest is of the same kind which prompted the middle classes in Victorian England to postpone marriage, causing the fertility rate to decline (Banks 1954), and which also prompts an Indian peasant farmer to have many children.

In Victorian England the risk of dying before fifteen declined substantially from the early 18th century. To maintain or raise one's standard of living, one restricted the size of one's family. Fertility decline prompted by self interest followed a decline in the death rate, which in turn represented a better standard of living and improved environmental hygiene. Although there has been a decline in the death rate on the Nembi Plateau it is not indicative of a better standard of living which might also be expected to prompt a decline in the birth rate, but rather of the mechanical intervention of medicines, immunisations and antibiotics. Infant and child death rates remain high and the chances of a newborn child surviving to adulthood remain relatively low. The underlying support for a decline in the birth rate does not exist on the Nembi Plateau: the standard of living remains low and indeed seems destined to continue to remain low in the foreseeable future (Chapter Five). The living conditions on the Nembi Plateau must change if an appreciable improvement in health and nutrition in children is to occur and if the birth rate is to decline.

The Nembi population is certainly undergoing a transition, and although the components are the same as those in the transition that took place in European populations their interaction is different. The pressure is most keenly felt by those who have to produce for an increased number of dependents - the women who cultivate the gardens. Malnutrition and poor health may have been common in pre-colonial times, but it is my contention that for the present generation of children under the age of fifteen, although the risk of contracting and dying from acute disease has been relieved, the risk of dying from diarrhoea, gastro-enteritis, respiratory disease and other viral infection has not. Indeed with women working harder in the gardens, those children least able to fend for themselves and the most dependent upon their mothers for their well-being are the ones who will continue to suffer. If acute disease does not cause a child's death then the likelihood of dying from a poverty related disease is still high and that risk is highest during the long wet season for children beginning to take solid food. Indeed the prognosis for the Nembi child given the present form of medical intervention and social and economic development is gloomy. Social and economic development, no matter how limited, is likely to result not simply in a replacement of infectious disease by chronic degenerative disease, but rather in an increase in the total spectrum of disease in which vascular disease, diabetes, hypertension and cancer will be added to the existing problem of infectious disease. Malnutrition is but another symptom of poor public hygiene and overcrowding, the increased workload of the women and the neglect of those least able to fend for themselves in an atmosphere of bemusement and anomie.

CHAPTER EIGHT

THE CYCLE OF THE SEASONS: PRODUCERS AND PRODUCTION IN THE NEMBI AGRICULTURAL SYSTEM

But there's wisdom in women, of more than they have known.

Rupert Brooke, June 1913

No close correlation exists between number of children and area of sweet potato under cultivation per household. The nutritional status of children is not simply related to production, and the relationship between a mother and her child may have some bearing upon the nutritional status of children. Women in the same household may have children of widely different nutritional status and a mother may also have children who are of different status. The relationship between producers and their dependents may be therefore an important element contributing to the poor nutritional status of Nembi children.

The patterns of change in the vital rates of the Nembi Plateau population show a very high dependency ratio has developed during the past twenty years. The dependency ratio however, is not the only factor in the demographic picture contributing to the poor nutritional status and health of the Nembi children. Environmental hygiene is poor and this, rather than just a shortage of food may contribute most to the ill-health of the population and the poor nutritional and health status of children in particular. A seasonal pattern of births and deaths provides additional evidence that environmental hygiene and infectious disease lie at the root of the poor health of children. Very young children entering weaning during the early part of the year are most vulnerable and likely to die from diseases associated with poor sanitation, unclean water, and poor housing conditions exacerbated by wet and inclement weather.

The close relationship between the cyclical and seasonal patterns of births and deaths prompts further analysis of seasonal cycles in the Pubi socio-economy. At the same time it also suggests that the relationship between mother and child is of more importance to the well-being of the child than if the relationship were simply one of producer to consumer.

The broad socio-economic structures and the physical environment of the Pubi are the underlying and basic causes of nutritional status of individuals. Seasonality is a major factor, and the cycle of social events and the agricultural calendar highlight the roles of women as both producers and mothers.

Women in Nembi society

Women have an important if unsung role within the Pubi socio-economy. From the cultivation of gardens and rearing pigs, to the exchange of pearl shells and other valuables, women have to divide their time and energy. In Pubi society a woman's work is never done, for particular obligations, tasks and roles are attached to a woman's status as a daughter, sister, wife and mother. Her procreativity is bought by the exchange of goods: having children is nothing more than an occasion which stimulates the flow and exchange of valuables. Marriage marks the beginning of a continuous partnership between affines, which begins with the transfer of a women's labour from the social, economic and political affairs of the clan of her father and brothers to that of her husband. Only with the birth of a child does a woman's loyalty shift from her natal clan to her husband's. Her position, however, remains ambivalent as demonstrated by the bilateral nature of the land tenure system of the Pubi and the composition of residence groups (Chapter Three). Because the relationship between a child and his mother is central to his well-being, the whole fabric of Pubi socio-economy therefore has a bearing upon his nutritional status.

Population change, agricultural production and the social definition of resources are all interwoven with the role of women. The various taboos and rituals associated with their roles as wives and mothers, have a bearing on the health of children. A woman's menstrual fluids and emissions are believed to be damaging to the health of males. It is believed by the Pubi that a young boy's growth will be retarded if he continues to live with his mother so boys, after about the age of seven, live with their fathers and may therefore not have such ready access to food as their sisters. During a woman's menses and for a month after confinement, she is forbidden to offer food to any male, except sons at her breast, in case they become sick and die. Her menfolk must obtain food from other female relatives. Again, her young sons may be at a disadvantage. She is also forbidden to go into the gardens for fear of damaging the crops. Much of the ritual a young man learns is to protect him from the debilitating effects of women. A good mother is one who observes the taboos and rituals to protect her children from supernatural dangers.

A good wife obtains shells and other trade items from her kin for her husband, and encourages his investments in the exchange network. A good daughter encourages exchange between her father and brothers and her husband. Men recognize the role that women play in exchange by privately giving gifts and by publically giving them pork when they kill pigs. On the Nembi Plateau (and by all accounts in the surrounding valleys: Ryan 1955, 1959, 1961, 1969 and LeRoy 1975, 1979), women act for themselves within the exchange network and are important to the way in which men manipulate the system. As a mother, wife and daughter a woman is a woman in between (Strathern, M. 1972); she is the conveyor of goods between affines who are obliged to be exchange partners (Ryan 1969:170). The exchange within and through a marriage is reciprocal: a man has continually to give gifts to his wives and their kin. Only while gifts are exchanged are marriages extant.

A woman's role in the Nembi socio-economic and political spheres is thus by no means passive. Her choice of residence and her role in the exchange network have important consequences for her children and also for group structure and composition. Women can affect the well-being of their children and indirectly, the well-being of the clan in more intimate ways. A woman can limit the size of her family by abortion and infanticide (Chapter Seven). The seclusion in which women used to and still do give birth in specially constructed huts, if they do not go to the health sub-centre, allows them to decide whether or not a child survives. A variety of taboos are related to the breast-feeding and conceiving of children. Breaking these taboos brings shame to the mother and father and may prompt abortion or infanticide. In general the taboos promote better health of the child, although that may not be the reason behind their observation. A child's nutritional status is affected by his birth rank, number of siblings and the period for which he was breast-fed (see Binns 1975 for references).

Social mores of the Pubi insist that whilst breast-feeding, sexual intercourse is forbidden: the semen, it is believed, will contaminate the mother's milk and poison the infant or child causing him to be stunted in growth. Thus post-partum amennorhoea combined with sexual abstinence for up to four and one half years whilst breast-feeding not only limits the fecundity of women, but promotes better health of children. It has been and still is the woman's prerogative to decide when sexual intercourse should resume. A woman will give her husband a leaf from a particular tree to signify that she is ready. If a child is small then breast-feeding and abstinence will be prolonged. For example one woman of the Pubi had three children at intervals of four to five years (a normal spacing - Chapter Seven). Their small stature and weight however was a source of scorn for their parents by other people in the village. It was asssmed that the parents had not observed the post-partum sexual intercourse taboo.

A related reason for limiting the size of families was to ensure mobility during times of warfare. It was essential for survival that a woman was not burdened with two children who could not run and at least partially fend for themselves. She could not carry both in a stringbag on her back. Twins therefore were either killed or one disposed of.*

* It is still believed that a man is only capable of 'building' one child at a time within a woman. A woman who bears twins is therefore an adulteress. The punishment for women for adultery used to be death.

Table 8.1 : Some Restrictions on Eating Some Foods in the Pubi Clan.

FOOD	RESTRICTION
All foods	Taboo to be given by women to males during menses ond for one month after child birth. During this time husband's brothers and their families supply food.
Green leafy vegetables	When child has diarrhoea - not given.
Marita (Pandanus brosimos)	Forbidden to be eaten by women. Association of the red colour of the marita with women's menstrual blood. The tree would die if its fruit were eaten by women. It is forbidden for women and unmarried males to eat the last marita of the season. Children would be born blind.
Cassowary	Forbidden for women during pregnancy. Children would be born with large protruding eyes like the cassowary.
Snakes	Forbidden for women during pregnancy. Children may develop qualities of the snake. Cold, and evil.*
Pit-pit	Not given to young children as believed to cause worms and stomach pains.
Pig meat	Not given to children as believed to case stomach pains and worms.
Insects, rats and lizards	Only eaten by young children and women (men did eat them once).

* This belief appears to have developed due to mission activity on the Nembi Plateau.

A woman's role as gardener responsible for the selection and planting of most of the food crops also influences the health of children. Along with observation of certain food taboos, (some of which are listed in Table 8.1) the variety of foodstuffs available is her responsibility. Certain foods are taboo in particular categories of people and some foods reserved for some people in preference to others. From birth the antagonism between the sexes is expressed by denying some food, for example marita (Pandanus brosimos) to girls.

Perhaps of greater importance is the preference given to male children. Men prefer to have sons and express disappointment if their wife's firstborn is a girl. At a man's death his mortuary payments are paid by his sons, be they classificatory or consanguineal. His well-being in the spiritual world is dependent on killing pigs which are offered to the spirits and distributed with pearl shells to his maternal kin. It is encumbent upon sons to perform this duty for their fathers. In the eyes of her husband a woman is not a "good woman" if she does not bear him a son and he may suspect her of sorcery.

Nevertheless unmarried daughters are indulged by their fathers, who rarely force them to work hard. They are important elements of future trade relationships. When a girl marries she will bring wealth. A father, to ensure that she marries according to his wishes, will try not to alienate her, or precipitate a situation in which a daughter marries someone he thinks unsuitable. The father-daughter relationship is very close. When a man is dying, it is his daughter who whispers to him and reassures him rather than his wife, who he fears. For the same reasons brother-sister relationships are close. It is not unusual after a woman is no longer fertile, even if her husband is still alive, for her to return to her brother's hearth and to care for him in their old age. In the Pubi clan Yengi's sister Eriam (as well as his wife) looks after him.

A man's relationship with his wife and mother are the most ambivalent. On the one hand the close bond developed between mother and son persists through to adulthood. Not only did she feed and look after him as a young child but his flesh is fashioned from her blood. Her natal clan therefore has a claim over his body for which his father made exchange payments in compensation and for which is own sons will also make compensation at his death. This link is the cause of much friction and sorcery between clans (Chapter Three). His relationship to his wife is also fraught with danger but of a more immediate nature. His intimacy with his wife is dangerous to his health because he is exposed to possible sorcery attacks as her allegiance is to her natal clan and she can deliver his semen to his would-be assailants (Chapter Three). It is believed that it takes four to six acts of intercourse to 'build' a child within a woman. Her blood forms the flesh whilst his semen forms the bones. At death, the flesh rots and returns to the soil. The bones, composed of the essential 'hard' substance do not rot but remain.

Traditionally therefore Nembi men had little to do with women and consequently even less to do with young children except to make sure that ritual and taboo were strictly observed to ensure the child's growth and well-being. A man's sister's children, for which he receives compensatory exchange payments, are as much concern to him as are his own offspring. Relationships between clans are therefore tense (Chapter Three).

Women are an important channel through which access is gained to favourable land (Chapter Three). Interest in male children for the continuity and strength of the clan also meant that widows with male children were sometimes re-married to the brother of their dead husband. Widows may also marry into a different clan and may take their children with them. The bride wealth takes into account the woman's previous marriage payments. Within the net of relationships set by the flow of goods created by the marriage, children when they are older may decide their allegiance to a particular clan of residence. Allegiance is usually kept and shown by girls upon marriage by the distribution of the bride-wealth to the clan where they were brought up. Their children will view that clan as their matri-clan where they can claim land. Husbands will continue to give shells to the clan where the bride-wealth was distributed, to those who cared for the girl as a child, be they her true relatives or her putative kin.

Thus women are the custodians of two kinds of wealth: pigs and men. They are a means of acquiring wealth and the accumulation of wives is the way to renown, prestige and big-man status (el hauma). Pigs are the only reproducible form of wealth, and their rearing is the responsibility of the women. Other forms of wealth, pearl shells, bows, axes, oil and plumes were obtained by trade (Chapter Five). Investment in women for their labour is economically sound, and investment of the wealth they create provides the opportunity for renown. Accumulating women is therefore socially esteemed as well as economically necessary.

Women as producers

A woman's role is to produce, be it pigs, foodstuffs or children. Whether a child survives or not, is healthy or weak, is more a matter for the spirits and the result of ritual and sorcery, than of child-care in the western sense of the word. Given the importance of exchange in the Nembi socio-economy, the role of women as producers of pigs overides her role as a mother. She cultivates sweet potato for her pigs rather than her children, and her heavy workload means that her role as a mother suffers.

That other roles other than production of sweet potato for food alone, are important to women is demonstrated by further analysis of the data presented in Table 6.1 for the households of the Pubi clan. In Chapter Six, adopting the analysis of Allen et al (1978) and Jackson (1981) the households were classified with the male as the head of each individual household regardless of the number of women in each household. Households may also be analyzed with women as the heads of households. A household with three women (wives) will now become three separate units or 'hearths' (Table 8.2). Because the women are responsible for providing food for their families as well as preparing it, I have called the units based upon women 'Hearths'. The 33 households of Table 6.1 thus become 52 hearths in Table 8.2.

Table 8.2 : Women as Heads of Hearths in the Pubi Clan (areas - ha).

Hearth Head	Area of sweet potato	Area of fallow	Area of mixed garden	Area of fallow	Age of women	Adult equiva-lent	Number of			Pigs
							Adult	Child	Persons	
1 Yalin	1.072	3.812	0.036	0.197	55	4	4	0	4	8
21 Yalim	0.342	0.130	0.022	1.329	36	3.5	2	3	5	5
22 Pulam	0.245	0.080	0.017	0.000	28	3.0	2	2	4	0
23 Kombo	0.130	0.122	0.046	0.387	35	4.0	2	4	6	1
3 Lulubin	0.399	2.352	0.000	0.639	31	3.5	2	3	5	2
4 Gibri	0.417	0.482	0.000	0.311	36	8	6	4	10	4
51 Mupanq	0.238	1.991	0.000	0.684	26	4.5	3	2	5	7
52 Manu	0.122	0.240	0.000	0.000	60	1	1	0	1	0
6 Tolokeum	0.418	1.330	0.000	0.516	29	4	3	2	5	9
71 Iombone	0.392	0.227	0.000	0.222	45	3.5	3	1	4	0
72 Keno	0.293	1.265	0.000	0.251	45	3.5	3	1	4	0
8 Egbin	0.355	0.014	0.000	0.248	35	6	4	4	8	2
9 Mu	0.622	0.698	0.000	0.254	21	2.5	2	1	3	0
10 Mone	0.200	0.013	0.000	0.000	26	3.0	2	2	4	0
11 Eriam	0.539	0.641	0.118	0.024	50	4	4	0	4	4
12 Pagaiam	0.181	0.618	0.314	0.000	30	4	2	4	6	2
131 Pukem	0.393	0.129	0.000	0.246	55	2	2	0	2	0
132 Lelem	0.267	0.000	0.000	0.102	28	3.5	2	3	5	6
133 Erap	0.073	0.528	0.000	0.199	26	2	2	0	2	0
14 Wesa	0.389	0.053	0.007	0.058	55	3	3	0	3	2
151 Tenonk	0.238	0.016	0.035	0.039	25	4	3	2	5	0
152 Kubinu	0.300	0.018	0.067	0.256	35	3.5	2	3	5	4
153 Netubiabe	0.204	0.100	0.046	0.172	27	3.0	2	2	4	2
16 Perbam	0.227	0.044	0.000	0.161	22	2.5	2	1	3	1
17 Margaret	0.254	0.039	0.000	0.066	24	2.5	2	1	3	0
18 Yandin	0.403	0.941	0.000	0.033	36	4.5	3	3	6	1
191 Luluban	0.352	0.111	0.000	0.120	45	3	2	2	4	5
192 Omonu	0.384	0.131	0.000	0.131	42	3	2	2	4	0
20 Onobam	0.256	1.430	0.017	0.074	26	3	2	2	4	3
21 Puam	0.227	0.074	0.039	0.093	58	6	6	0	6	0
221 Waram	0.247	0.208	0.000	0.044	44	5	3	4	7	1
222 Awanu	0.225	0.162	0.000	0.000	36	3.5	2	3	5	0
223 Paeyu	0.262	0.136	0.050	0.118	54	2	2	0	2	0
231 Melamin	0.280	0.042	0.000	0.010	50	2	2	0	2	0
232 Wabin	0.268	0.041	0.000	0.000	33	3.5	2	3	5	0
233 Shuem	0.339	0.128	0.000	0.000	43	4.0	3	2	5	0
234 Weib	0.599	0.016	0.000	0.052	46	3.5	2	3	5	0
235 Lubin	0.304	0.114	0.000	0.000	50	2	2	0	2	0
236 Taebel	0.383	0.289	0.000	0.022	46	3.5	3	1	4	0
237 Tenayo	0.401	0.281	0.061	0.198	47	4.5	1	4	5	6
24 Aesil	0.293	0.327	0.000	0.002	22	2	2	0	2	3
251 Olemnonk	0.270	0.200	0.000	0.206	26	2.5	2	1	3	1
252 Kinen	0.134	0.147	0.000	0.000	26	2	2	0	2	0
26 Tolam	0.252	0.358	0.000	0.008	20	2.5	2	1	3	2
27 Sarah	0.389	0.132	0.054	0.998	26	2.5	2	1	3	0
28 Mobuan	0.268	0.450	0.000	0.089	26	2.5	2	1	3	0
29 Eyam	0.588	0.298	0.014	0.373	50	5	4	2	6	5
301 Marinu	0.355	0.174	0.000	0.060	26	2.5	2	1	3	5
302 Mines	0.253	0.330	0.000	0.051	26	3	2	2	4	0
31 Pomberan	0.492	0.295	0.000	0.626	45	3.5	2	3	5	3
32 Pabim	0.459	0.791	0.000	0.207	52	6	6	0	6	3
33 Tondem	0.397	0.477	0.000	0.126	26	4	4	0	4	0
MEAN	0.334	0.443	0.018	0.192	36.7	3.4	2.6	1.6	4.2	1.9
STD. DEV.	0.158	0.688	0.048	0.262	11.6	1.24	1.09	1.3	1.66	2.4

Numbers refer to the households as numbered in Table 6.1.

Source : Field data - July-December 1980.

The average area of sweet potato cultivated per woman is about one-third of a hectare, enough for an average of 2.6 adulls, 1.6 children and 2 pigs (Table 8.2). The standard deviation of the area of sweet potato cultivated per hearth is notably smaller than the standard deviation for the average area cultivated per household in Table 6.1. The variation between area cultivated per woman is thus low and regardless of how many women are in any one household, their workload is similar. Indeed the seven women of household number 23 cultivate very similar areas. This is discussed more fully later in connection with analysis of the variation in sweet potato cultivated per woman and its relationship to her age and number of pigs as well as the number of children she has.

Simple and multiple regression models were constructed (Table 8.3) to see if a clearer picture of the relationship between people, pigs, food and land could be obtained at the level of the 'hearth'. Bearing in mind the proposition that women are the main producers within the Nembi socio-economy the results are surprising.

The simple regressions with sweet potato as the dependent variable give very low coefficients of determination (r^2). The highest is that between pigs and area cultivated per woman (r^2 = 0.17), which leaves 83 percent of the variation in sweet potato cultivated per woman, small though it is, unexplained. The regression coefficient is nevertheless statistically significant, as is that in the equation correlating the age of women and the area of sweet potato they cultivate, the coefficient of determination of which is also extremely low. The relationships of adult equivalents, persons, children and adults to area of sweet potato are negligible. Again it is unfortunate that the information for pigs is incomplete for then a clearer picture might have been drawn on the relationship between area of sweet potato and demand. It can be seen from comparing Table 8.3 with Table 6.1 that definite advantages accrue to a man with more than one wife. An average woman cultivates about a third of a hectare of sweet potato whether she be the only wife or co-wife of a man. Thus the coefficients of determination when the household is the unit show

Table 8.3 : Adults, Children, Pigs and Sweet Potato in Pubi Hearth Units; Simple Coefficients of Determination

Dependent variable: sweet potato	Adult equivalent	NUMBER OF Adults	Children	Persons	Pigs	Age of Women	r^2
Coefficient	0.0295	-	-	-	-	-	0.05
t value	1.7(b)	-	-	-	-	-	
Coefficient	-	0.042	-	-	-	-	0.08
t value		2.15(a)	-	-	-	-	
Coefficient	-	-	-0.003	-	-	-	0.0
t value	-	-	0.189(c)	-	-	-	
Coefficient	-	-	-	0.016	-	-	0.03
t value	-	-	-	1.21(c)	-	-	
Coefficient	-	-	-	-	0.027	-	0.17
t value	-	-	-	-	3.236(a)	-	
Coefficient	-	-	-	-	-	0.005	0.12
t value	-	-	-	-	-	2.6(a)	

(a) significant $p<0.05$
(b) significant $p<0.05$ one tail test
(c) not significant

Source : Field data 1980.

the variation between households resulting primarily from the number of wives a man has. In short a man with more wives has more pigs, more sweet potato, more children and there are more adults in that household. A man with a single wife will have less of everything. Throughout the Pubi households then, the variance of the individual factors (pigs, area, children, adults etc), will appear to be related, for they will vary together as the households get larger, that is as the number of wives increases. On the other hand little of the variance is explained in Table 8.3 because the variance in sweet potato cultivated per woman is very small. What little variance there is, seems to be related to the number of pigs a woman possesses, although the relationship is weak. Even if the data on pigs were more complete I suspect that the coefficient of determination would not be above about 50 percent, because of the time lapse between supply and demand. To successfully explore the relationships between household composition and area of sweet potato and number of pigs, the data would have to be collected on a number of occasions throughout the year.

This argument is substantiated by looking at the case of Ayab and his wives. In October 1980 Ayab (No.23 Table 6.1) supported on 2.573 ha of sweet potato, 15 adults, 6 children and 6 pigs. Each of Ayab's 7 wives cultivated an average of 0.368 ha of sweet potato, an area slightly larger than the mean (0.334 ha) for all the women (Table 8.2). One of Ayab's wives cultivated 0.268 ha, another 0.059 and another 0.401 ha, which suggests rather a larger than expected variance from the mean of all the women. But Ayab's wives work together and two or three cultivate land which Ayab has designated as

belonging to one of them, before they move onto the land allocated to another of them. This explains some of the variation between Ayab's wives in area cultivated at any one time. The women with the largest area of sweet potato is Weib with 0 9 ha. All her pigs died during 0.595
the anthrax epidemic. Tenayo, with 0.4 1 ha has 6 pigs. The other 0 401
wives did not have pigs at the time of the survey but the data suggest that the variation in area cultivated by Ayab's wives is also related in some small way to the number of pigs they had planned for (and in the case of Tenayo still had at the time of the survey) as well as to the sharing of cultivation.

A further point to be drawn from comparing the analysis of the data based on households with that based upon hearths, is that the work a woman performs does not decrease if she is a co-wife. Although co-wives may, and most do work together, especially women who have gardens in close proximity, the amount each woman cultivates in a polygymous household is not necessarily less than if she were a man's only wife. It is interesting to note that age does contribute something to explaining the variation between women in area cultivated (Table 8.3). Pigs and the age of the woman together account for the greatest amount of variance in area of sweet potato cultivated, but that is still low, at 29 percent (Table 8.4). A definite relationship exists between the age of a woman, the number of pigs she keeps and the area of sweet potato she cultivates, but although the regression coefficient is statistically significant it is a weak relationship. All other independent variables are not significantly related to the area of sweet potato cultivated, although if a one-tailed t-test is used then the number of adults per household comes very close to being

Table 8.4 : Adults, Children, Pigs and Sweet Potato in Pubi Hearth Units; Coefficients of multiple determination.

Dependent variable: Sweet potato	Adult equivalent	NUMBER OF Adults	Children	Persons	Pigs	Age of Women	R^2
Coefficient	0.014	-	-	-	0.025	-	-
t value	0.845(b)	-	-	-	2.798(a)	-	0.19
Coefficient	-	0.03	-	-	0.024	-	
t value	-	1.59(b)	-	-	2.84(a)	-	0.21
Coefficient	-	-	-0.013	-	0.028	-	
t value	-	-	0.084(b)	-	3.33(a)	-	0.19
Coefficient	-	-	-	0.005	0.026	-	
t value	-	-	-	0.36(b)	2.95(a)	-	0.18
Coefficient	-	-	-	-	0.027	0.005	
t value	-	-	-	-	3.39(a)	2.79(a)	0.29
Coefficient	-	-	-	0.004	0.026	0.005	
t value	-	-	-	0.29(b)	3.11(a)	2.75(a)	0.29
Coefficient	-	0.015	-	-	0.026	0.004	
t value	-	0.786(b)	-	-	3.1(a)	2.36(a)	0.30
Coefficient	-	0.015	-0.004	-	0.026	0.004	
t value	-	0.776(b)	0.249(b)	-	3.059(a)	2.22(a)	0.30
Coefficient	-	0.029	-0.012	-	0.025	-	
t value	-	1.52(b)	0.732(b)	-	2.91(a)	-	0.22

(a) significant $p<0.05$
(b) not significant

significantly, but weakly related, along with pigs, to the area cultivated. However the strongest of the regression equations simply consists of the number of pigs and the age of the woman as the independent variables.

No real relationship is apparent between number of adults and the area cultivated per woman (Table 8.4), suggesting that women are indeed the only productive members of the households or of the hearth units, and produce virtually the same regardless of the number of other adults in the hearth unit. The conclusion (drawn in Chapter Six) that number of adults is strongly related to area of sweet potato per household is thus modified to the extent that women are the more important variable, and that the age of the woman influences the amount of work she does. It could be suggested that the age of the woman as an independent variable subsumes other variables. For example until a certain age, women who are older are more likely to have more children as dependents, which may be the important factor governing the relationship of age with area cultivated. But it seems this is not the case (Table 8.4) as there is absolutely no relationship between the number of children per hearth and the area of sweet potato.

Using multiple regression and simple regression with the hearth as the dependent variable thus brings me no closer to isolating factors impinging upon the nutritional status of children than did analysis with the household as the dependent variable. What the analysis has shown is that no direct relationship can be expected between the work a woman does as expressed by area under sweet potato, and the number of children she has. It is more likely related to the number of pigs she tends or plans to raise by the time her sweet potato has matured. However, an indirect relationship may hold between the woman's workload and the nutritional status of her children. A child's health is probably not affected by the production of sweet potato per se, that is of food for both humans and pigs, but is affected by the very fact that his mother is working. The data so far presented cannot show this relationship, although the intimacy of the dependence of a child on his mother has been shown to be of paramount importance to his health, especially between the ages of 5 and 24 months.

A seasonal pattern has been shown to exist for births and deaths, and children entering weaning at a particular time of year are likely to die than at other times. Other aspects of the Nembi socio-economy may also be seasonal and the fluctuations in supply and demand from planting to harvest in production of sweet potato (Chapter Six) bears the proposal out to a limited degree. Planting is predominantly in the period September to January and further examination of the production system on the Nembi Plateau and the role which women play in it reveals additional elements of seasonality pertinent to the nutritional status of children.

Mixed gardens and sweet potato fields

The seasonal nature of the Nembi agricultural system and climate has been discussed (Chapter Four). The system developed at a lower altitude in a climate of higher annual rainfall and temperatures, and hinged upon the cultivation cycle of taro. On the Nembi Plateau the rainfall variability is greater, the temperatures both lower and more variable, and there is a risk of frost from October through to February. Sweet potato is now the staple crop, and although better suited to the Nembi Plateau than taro, is adversely affected by frost, soil water-logging and drought. Much of the cyclical aspects of the Nembi socio-economy owe their origin to factors in the Nembi's past when they were cultivating taro at lower altitudes, rather than simply to the climatic regime under which the Nembi presently cultivate.

Nembi agriculture consists, as in other parts of the highlands, of mixed gardens and sweet potato fields (see Appendix 8.1). Although seemingly separate entities, they are components of a complex whole. For example while a large number of species are cultivated in the mixed gardens, the sweet potato fields are planted with a relatively large number of cultivars. Both reflect a cultivation strategy which attempts to ameliorate all possible risk associated with a seasonal climate which has periods of drought as well as flood. The different maturation rates and phenology of the various species in the mixed gardens and the cultivars in the sweet potato field, whilst reflecting the seasonal nature of the husbandry of the Nembi, also minimise the risk of total crop failure, for not all plants will be at the same stage of growth if frost, drought or flood occurs: although some varieties will be more at risk and at more vulnerable stages in their growth than others, some will be more resistant and will survive.

The division of labour whereby the men seem only seasonally active, either clearing the fallow mixed gardens ready for planting or constructing and repairing fences, but the women seem to be continually in the sweet potato fields and mixed gardens, compounds the illusion of an agricultural system divided into two. Increased pressure upon favourable land on the Nembi Plateau also accentuates the differences between the mixed gardens and the sweet potato fields. Mixed gardens are not always cultivated. When a man's mixed garden land is lying fallow on the plateau he does not necessarily cultivate a mixed garden in the Waga valley or the ranges to the west as he would have in the past. Not every woman had a mixed garden under cultivation in the mixed garden season of 1980 (Table 8.2). In the past brothers cleared land for a mixed garden which was divided amongst their wives and other female kin. Shortage of land on the plateau and reluctance to move to the west means this now rarely takes place.

Lewa of the Peripant farms a mixed garden in Murupa territory adjacent to that of the Pubi (Figure 8.1) and demonstrates not only the complexities of the kinship links within the Peripant sub-clan (Chapter Three) but also the way women can gain access to mixed garden land. The importance of women in the land tenure system as well as in the production system is also accentuated by the division of land within Lewa's mixed garden. Lewa gardens in Murupa territory by virtue of his mother being of that clan. He used to live there in pre-contact times. Lewa's daughters, even though married and living in their husband's territories, still cultivate mixed garden land with their father. Walleni's second wife Pulam does not have any of the

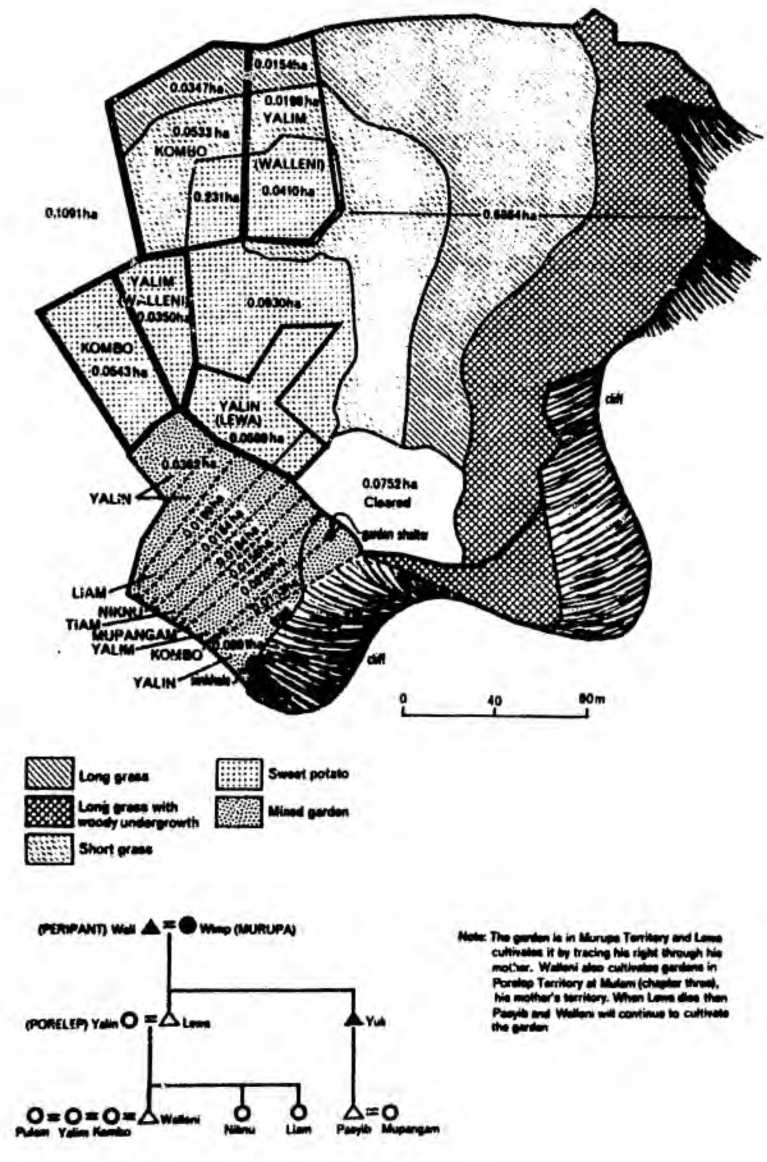


Figure 8.1 : Lewa's mixed garden in Murupa territory and the manner in which he divided it among his close kin.

mixed garden cleared by her father-in-law. Pulam's children are all females and Walleni was displeased with her. Indeed he suspected her of sorcery. For this reason he did not give her any mixed garden land from his father. Lewa's mixed garden demonstrates that a woman may gain access to mixed garden land that is not her husband's.

The exchange network of valuables between affines includes access to mixed garden land, even if only for one season. With pressure upon favourable land on the Plateau (Chapter Three) this aspect of land tenure is becoming more important. Only 16 women had a mixed garden (Table 8.2), either their husband's or other kin in 1980. Only 9 however, did not have access to any mixed garden land at all because their husband did not possess any. In such cases the women are totally reliant upon kin to obtain mixed garden products or land to plant them on. As population increases and pressure upon land on the Nembi Plateau increases then the number of women with no direct access through their husbands to mixed garden land will increase: that is assuming there is no migration to the valleys in the west.

Over the last twenty years not only has mixed garden land become in short supply, but also the variety of cultivars of the different species in the mixed garden has declined. The variety of cultivars in the sweet potato fields has also declined and introduced varieties with higher yields now dominate (Table 8.5). Within a very short distance the complement of cultivars can vary considerably and changes in dialect add to the difficulty of identifying varieties without a specialized knowledge of the botany of sweet potato. The mix of varieties within the sweet potato fields is important for a

Table 8.5 : Sweet Potato Varieties of the Central Nembi Plateau.

Varieties indigenous to the Nembi Plateau:
Memeri, Yesalap, Sabul, Maka, Mengil, Gibali, Tul, Kirola, Moma, Segaria, Siksak, Kul, Kunjip, Morawel, Yom, Arget(i), Barl(i), Imu(i), Ipop(i), Kowa(i), Kur(i), Merere(i), Mormade(i), Mudiyame(i), Peke(i), Sigil(i), Sopa(i), Tangeold(i), Tenso(i), Tonguld(i), Wapkank(i), Wep(i)
Varieties introduced to the Nembi Plateau:
Asol, Balus, Bulof, Wanmun, Tumun, Foamun, Sokul, Kiko, Goroka, Gomini, Perbam, Belin, Welkaukau (Merican)*, Porinonk

(i)Varieties rarely found today under extensive cultivation.

* Kiko and Merican may be the variety Okinawa introduced to Lake Kutubu before the war by Ivan Champion - 'Before the war Okinawa sweet potato was introduced to Lake Kutubu with excellent results except that its propogation followed trade routes up to Tari rather than across the grain of the country to Mendi. Some was introduced to Mendi in 1951/52...' Letter from McCarthy to DO Mendi 67-15-44 Mendi Patrol Report No.7 1959/60.

Source : Field observation and discussion with Euclid d'Souza and Janis Baines.

number of reasons. Most importantly it helps preserve and indeed encourages increase in the gene pool of the sweet potato species. Although planted from cuttings which therefore ensures continuity of the variety, some plants do flower and therefore allow sexual reproduction (as oppose to vegetative reproduction) to take place with the possibility of genetic change and new varieties developing. Nevertheless most concern by expatriate agronomists with depletion of gene pools has been centred upon mixed gardens and not the sweet potato fields. Mixed gardens are viewed as a microcosm of the 'natural' woodland ecosystem. Multi-cropping has been seen as ecologically sound and as imperative to preserve stability and continued production. Erosion of the technqiues of mixed gardening with an increase in the drift towards mono-cropping must therefore be avoided to prevent build up of pests and diseases as well as depletion of the genetic material that encourages diversity and stability.

The diversity within the sweet potato monocultures is also in danger. Fears for the nutritional consequences stemming from neglect of mixed gardens have prompted much of the interest in them by researchers (see for example Lambert 1975 for a rather exaggerated view of this). Mixed garden crops are important dietary supplements to the staple sweet potato, providing much needed additional protein and vitamins, especially for children. Rather simplistically the introduction of coffee has been seen as competing directly with mixed gardens for land and as causing a decline in nutritional status of children (Lambert 1975). The evidence for this is very weak (Hide 1980). The nutritional importance of the sweet potato has only recently become better understood, having previously been regarded merely as a rather unglamorous staple.

The potential for improvement with nutritional quality of the sweet potato must be enormous given the improvements in yield, protein content and quality in rice and other grains. Higher yielding varieties of sweet potato have been selected and tried at Aiyura Highlands Agricultural Experimental Station in the Eastern Highlands and introduced into other parts of the highlands including the Nembi Plateau. Wanmum, Tumun, and Foamun were introduced to the Nembi Plateau by students from the Highlands Agriculture Training Institute in Mt Hagen in 1977, but no attempt has been made to improve protein content or quality. Thus traditional varieties have been superseded by higher yielding varieties and valuable genetic material important to the task of selecting varieties of better nutritional quality have been lost. The widespread adoption of sweet potato in the past and the demise of taro relegated mixed gardens to small areas within the expanse of open fields of sweet potato. The quality of the Nembi diet was sacrificed, as elsewhere in the highlands, for quantity so that both pigs and humans could be fed. The present adoption of higher yielding varieties is but a continuation of the process of loss of dietary variety and quality, and is not likely to improve nutrition but merely help maintain the <u>status quo</u> in the face of increasing population and growing pig herds.

The mix of varieties within the sweet potato fields of the Pubi (Table 8.6) is designed to meet the demands of both human and pig

Table 8.6 : The Variety of Sweet Potato Grown in Gardens of the Pubi Clan (Percentage Number of Plants of Each Variety).

	Garden													
Variety	A	B	C	D	E	F	G	H	I	J	K	L	M	Mean
Sokul	51	11	42	20	60	91	35	29	39	69	26	35	24	41
Kiko	16	9	8	45	9	3.5	10	33	24	8	18	8	21	16
Perbam	7	19	25	6	7.5	2.5	11	15	14	6	10	3	17	11
Asol	7	2	0	0	1	0	1	0.5	0	0	0	0	0	1
Porinonk	0.5	1	0	0	6	0.1	2	0.5	0	0.2	0	0	1	1
Gomini	3.5	15	5	6	7.5	0.2	5	10	4	1.5	7	5	2	5.5
Siksak	12	13	0.5	4.5	2	1.2	21	4	2	0.2	0	14	15	7
Kirola	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Gibali	1.5	25	18	1.5	3	0	6	4	3	0.4	4	12	1	6
Goroka	0	4	2	17	3	1.5	9	3	13	14	34	16	19	10.4
Wanmun	0	0	0	0	0	0	0	0	0	0	0	7	0	0.5

populations. Whilst families may have particular preferences the distinction between varieties grown for human or pig consumption is still made. The variety 'Goroka' is generally thought suitable only for feeding pigs.* An averge of 10 percent of sweet potato grown is of that variety. Sokul is the most popular, its creamy flesh being valued for its flavour. It is also one of the heaviest yielders. Trials conducted by D'Souza on the Nembi Plateau have shown that Sokul is capable of producing up to 9.5 tonnes per hectare under village conditions on the Nembi Plateau (D'Souza 1980 pers comm unpub. field data), a yield which is low by highland standards.

Data I collected from gardens in the Pubi territory show that one garden planted to Sokul with very little of other varieties yielded 11.3 tonnes per hectare. Another produced only 2.6 tonnes per hectare. The average yield was 7.14 tonnes per hectare for the six gardens (with a mixture of cultivars) that were surveyed, higher than the 6.3 tonnes reported by Bourke and D'Souza for the neighbouring clan territory of the Puit. The average weight of individual tubers is small (96 grammes in the Pubi area in contrast to 47 grammes at Puit) and would be considered in other parts of the highlands fit only for pigs to eat.

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* My main sponsor and informant in the village, judging from the reaction that his comments drew from his kinsmen spoke for them all when he said that 'Goroka em i wan kain kaukau mipela save givim long pik. Sapos mipela kaikai mipela bai kapupu nogut tru na traut' - We give Goroka to pigs. If we eat it, it makes us fart and we vomit.

The agricultural system of the Nembi is thus characteristic of much of the highlands in the variety of crops and cultivars grown though yields are low (see Chapter One). The variety of sweet potato cultivars grown however has not been stressed enough by other researchers (Clarke 1971, Waddell 1972). The large number of cultivars in the sweet potato fields has important implications for the seasonal supply of foodstuffs for both pigs and humans and enables the seasonal cycles of the social milieu as shown by the activity of women to be linked to the cycles of the seasons.

Seasonal activity of women in the gardening cycle

Harvesting and planting of sweet potato as in other parts of the highlands (Waddell 1972a:49, Clarke 1971:162-163, Brookfield and Brown 1962:46-47), takes place throughout the year with individual mounds being harvested up to four times. However, in contrast to Chimbu, where Brookfield and Brown state (1962:50) there 'is no clearly defined agricultural calendar: any operation may be carried out at any time of the year', agricultural activity on the plateau appears to be distinctly seasonal. It is probably true that the seasonality of the Chimbu agricultural cycle has been underestimated by Brookfield and Brown (they admit to a certain periodicity) and there appears to be an overt seasonality on the Nembi Plateau in cultivation of the mixed gardens and the sweet potato fields.

The mixed gardens are cleared and planted during the months from September to December, but some women plant mixed garden crops virtually the year round in small patches of their sweet potato fields. By December much of the activity in the mixed gardens has finished although work in the sweet potato fields continues. The seasonal pattern of women's activities was monitored from April 1980 to February 1981 in the Pubi clan (Figure 8.2). Three times a month for 12 months Janis Baines interviewed 33 women of the Pubi clan who had children under the age of five and asked them to recall their activities in the previous 24 hours. The graphs in Figure 8.2 show the percentage number of women who recalled particular activities. The seasonal pattern of most activities is noticeable, although the pattern for mixed garden activity and work in the sweet potato gardens is not so marked as expected. The most marked seasonal contrast is in ceremonial and communal activities which in 1981 were mostly burials, communal mourning and funeral prestations, and fits remarkably well with the seasonal pattern of child deaths (Figure 7.9).

For six weeks after a death, close relatives remain secluded within the dead person's house. Food is brought to them by friends and more distant relatives. The mourning women do not work in the gardens unless absolutely necessary and then only to harvest sweet potato.

Caring for pigs appears be an an all year round responsibility whilst concern with coffee is minor: coffee is picked for immediate cash demand. The household tasks of cooking, looking after children at home and making bilums (string-bags) and other activities that keep the women around the house appear to occupy the women more between July and October, and again during January and February. June

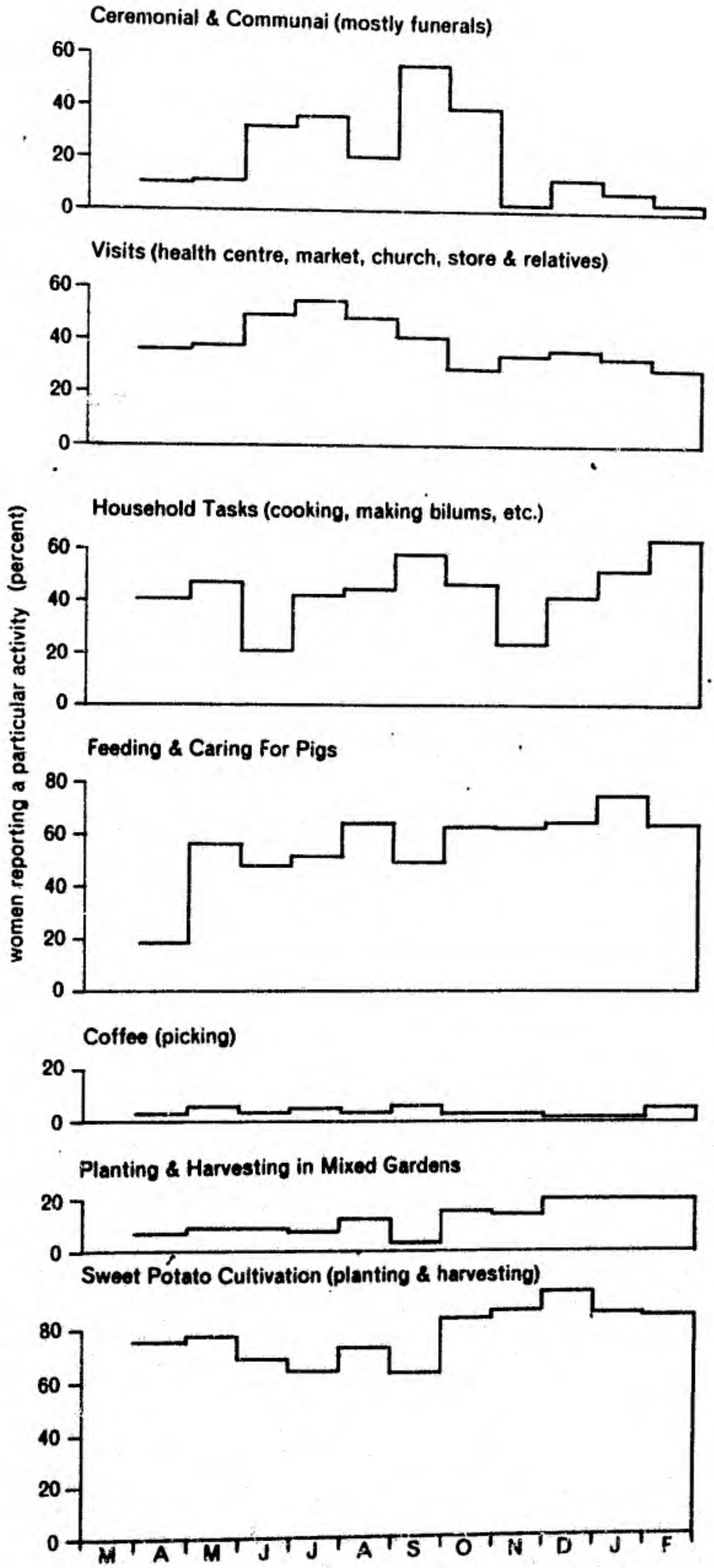

Figure 8.2 : The seasonal activity of Pubi women from April 1980 to February 1981.

and November are when the women put less emphasis on activities in the home. It would appear that from between June or July to the middle of September is a slack period in the agricultural cycle and time is spent either in the house or visiting friends and relatives or participating in ceremonial and communal activities. Although from October to April a great deal of time is spent in the sweet potato fields or the mixed gardens, time is also spent around the house. However little time is spent at communal or ceremonial activities during this period and visits to relatives or the health centre are less frequent. Women are probably too tired from their work in the gardens to spend a great deal of time on other activities.

The seasonal pattern of women's activities is reflected in their health and especially in their weights (Figure 8.3). More Pubi

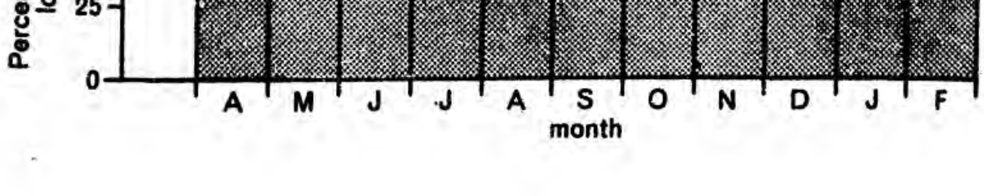

Figure 8.3 : The percentage number of women losing weight or not gaining weight in any one month relative to the previous month.

women lose weight from September to February than at other times of the year. From September to February the women work in the mixed gardens (Figure 8.2) but this alone does not account for the large increase in the number of women losing weight in that period. It would appear (Figure 8.2) that the seasonal nature of sweet potato cultivation is not marked and certainly not enough to account for the seasonal change in women losing weight. However the picture is very much clearer when the activity in the sweet potato fields is broken down into preparing ground, collecting planting material, planting and harvesting (Figure 8.4). The heaviest work is preparing the ground for planting. Most of the preparation of sweet potato fields takes place at the same time that the mixed gardens are being prepared, which undoubtedly accounts for the weight loss of the women. The implications which the weight loss of women has for the nutritional status of children, both those breast-feeding and those that are already weaned, as well as those still in the womb, are discussed in more detail below. It is sufficient at this point to note that the relationship between the area of sweet potato a woman cultivates and the nutritional status and the health of her child is rather different from that implied by Jackson's analysis and by my earlier analysis in this chapter. The critical relationship is not between area cultivated, food availability and nutritional status of the child, but rather between the seasonal workload and health status of the mother and the nutritional and health status of the child.

The reasons for such a marked seasonality in cultivation of sweet potato and of mixed garden crops in an environment that although marginal does not have an markedly seasonal climate are complex.

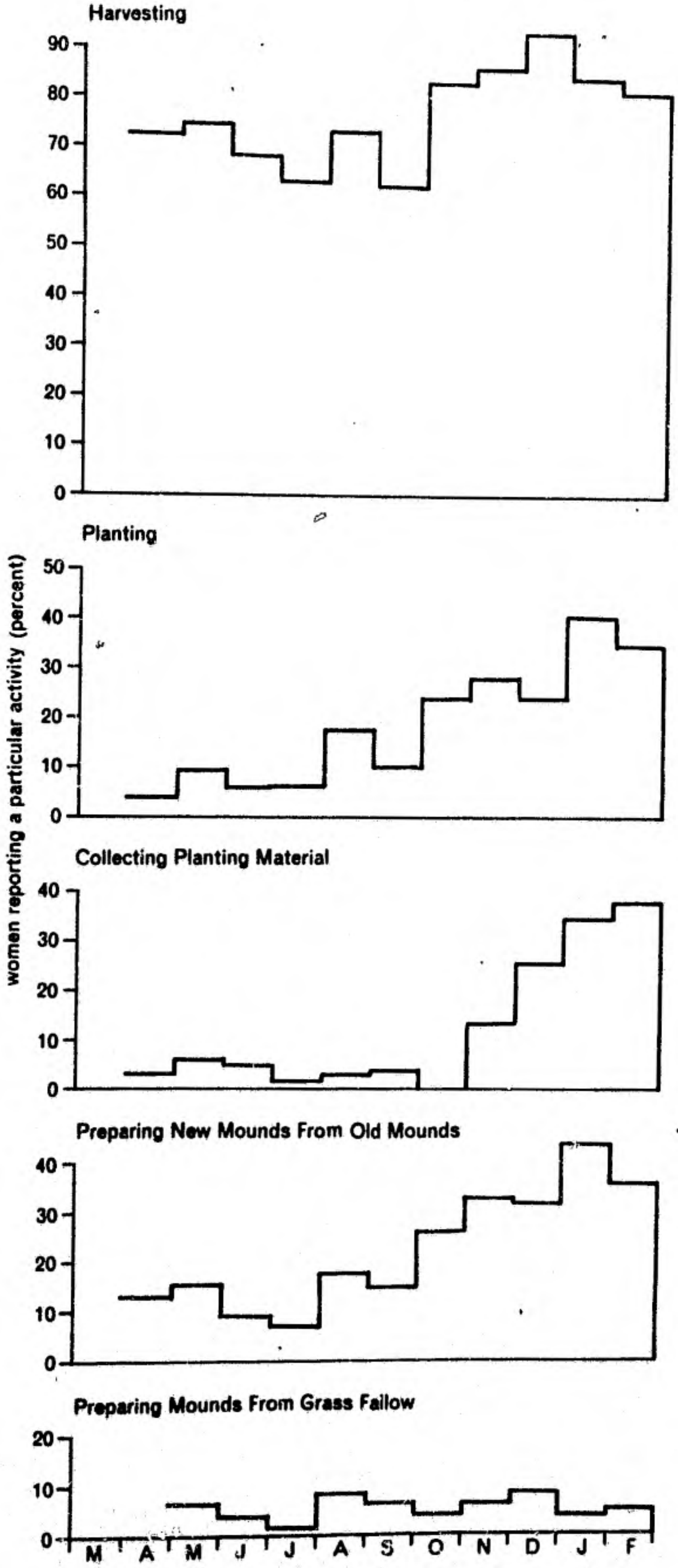

Figure 8.4 : Seasonal activity of the Pubi women in the sweet potato fields from April 1980 to February 1981.

Although the evidence I present is not quantitative I believe that it yields valid conclusions. The value of actually timing the periods spent in activities in the gardens and elsewhere is doubtful. Most studies that have adopted that technique (Clarke 1971, Waddell 1972, Grossman 1979 and Morren 1977 for example) present data from usually one or two short periods of observation which suggest a precision and degree of accuracy which is at best misleading. From a period of limited observations they have extended their interpretations to embrace the whole year. In addition economists have neglected to adequately consider the role of ceremony and social activities in the lives of Papua New Guineans. For example Fisk's analysis of the subsistence sector (1962, 1964) takes only cursory account of social activity, which economists regard as non-work but which Papua New Guineans see as an essential part of their lives. Brookfield's distinction between various forms of production, (discussed in Chapter Four and Six), is also valid to this discussion.

Production and Seasonality

Although there are valid social reasons (ie funerals etc.) why areas of similar sweet potato are not planted in every month of the year, there are also climatic factors which underlie those social factors. There are possible links between the seasonal occurrence of deaths the seasonal pattern of social activity, and the seasonal pattern of births, but to say that the seasonal pattern of births (which is largely reflected in the pattern of infant deaths) is dictated by the activities of the women completes the circular nature of the argument and begs the question of the role which climatic seasonality and agronomic factors play in the agricultural and hence the social cycle. No doubt the physical and social milieux interact, but the relatively limited technology of the Pubi has not released the Nembi entirely from the tyranny of environmental determinism. The picture is complicated considerably because the agricultural strategy of the Pubi developed at lower altitudes and was based upon taro (Chapter Four).

Taro is significant because climatic conditions do not appear to be an important factor governing its time of planting (Rangai 1977:4). Planting therefore follows harvest. The plateau however, has a significantly wetter period of the year from late December to early May (Chapter Four) and as with other areas of the highlands where taro is a secondary food, it is planted at the end of the dry period before the onset of this wetter season. I suspect that this is because taro and other mixed garden crops planted at this time give marginally higher yields than if planted at other times of the year. By contrast in the Kutubu and Mubi lowlands from where the Pubi migrated, gardens are prepared and planted throughout the year, and taro at these lower altitudes (800-1000m), has a maturation cycle of about 9-10 months (Weiner 1982 pers comm). Sago however is the main staple and is also available throughout the year. Perhaps part of the answer to the seasonality of production on the Nembi Plateau lies in the difference of maturation time for taro at low and high altitude. My interpretation may also be applied, with some modification for local conditions and migration history, to the rest of the Mendi region.

When the Pubi and other groups of the southern Nembi Plateau lived at lower altitudes and grew taro more widely, gardens were prepared all year round. There was a slight increase in activity during August, September and October before the onset of the wetter period of the year (Chapter Four). With the introduction of sweet potato, the planting of mixed gardens declined and they also began to be planted at the optimal time of the year to maximize yields which because of the ritual involved, centred upon taro . The significance of the seasonal variation in climatic factors therefore increased, not least because taro is planted from the setts of the previous crops, which thus has to be harvested to make setts available. However, on the Nembi Plateau taro takes longer to mature, than in the lowlands about 11-12 months, and although it is the first crop to be planted in the mixed gardens it is the last to be harvested. The ritual significance of taro (see Chapter Three and Four; Ryan 1961:10) dictating that mixed gardens are planted when taro setts become available thus emphasized the longer agricultural cycle of the plateau. Decline in the importance of taro has not been accompanied by any shift in the period of mixed garden cultivation or by a shortening of the cycle.*

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* Other factors have caused the amount of taro planted to diminish. The ravages of the Taro beetle (Papuana woodlarkiana and Papuana huebneri) and of the Taro Hawk moth (Hippotion celerio) combined with the small returns compared with sweet potato do not encourage its widespread cultivation although taro "Kankong" (xanthosoma spp.) is sometimes planted in drainage ditches where the water helps prevent the taro beetle from attacking the corms. Pubi clansmen claim that infestation by the taro beetle has become worse since the arrival of the European and that taro was until recently still grown extensively on the plateau. I have discussed this in Chapter Four, but it is worth mentioning again that areas which were once large communal taro gardens can still be recognised on the plateau.

Although taro is not so widely grown as it was once it retains its ritual significance and the mixed garden cycle seems to be governed by the time taro takes to mature. A seasonal pattern of sweet potato cultivation also interacts with that of taro and the mixed gardens.

Sweet potato varieties differ in their maturation cycle which emphasizes the close similarity between the variety of crops of the mixed gardens and the sweet potato fields with their mixture of varieties. The variety Goroka is ready for harvest approximately 7-7.5 months from planting and 2 to 3 good harvests can be taken before replanting. Sokul matures in about 4.5-5 months and will also yield 2 to 3 good harvests. Perbam and Kiko, the other two most popular varieties (Table 8.6), are quick maturing and produce only one harvest after about 4 months. The result of the seasonality of planting and different maturation rates of the various cultivars in both the mixed gardens and sweet potato fields, coupled with the demise of taro is that a 'gap' in food supply occurs variably between August and early December. When taro was more widely grown this 'taim hangri' was filled by taro coming into production, complementing the smaller supply of sweet potato, and other swidden crops. The seasonal planting of sweet potato has not been adjusted adequately to compensate for the relatively rapid decline of taro. Indeed the seasonal planting of sweet potato also suggests that it was synchronised with the earlier maturation of taro at lower altitudes in the Wage valley (9-10 months) rather than the Nembi Plateau (11-12 months), thus emphasizing and lengthening the gap in food supply (Figure 8.5).

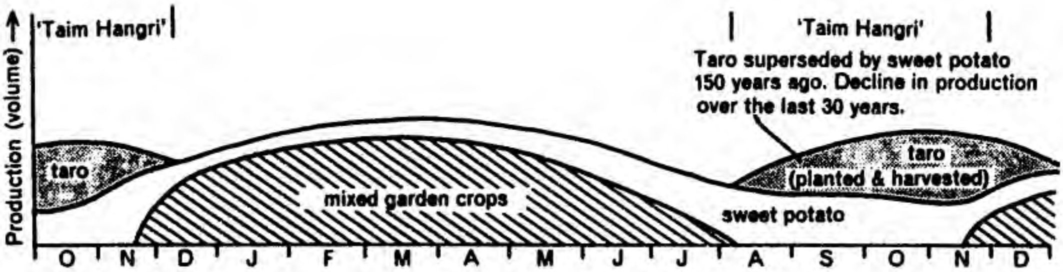

Figure 8.5 : Taro, sweet potato and mixed gardens; their interaction and seasonal cycle.

With the decline in taro cultivation it is surprising that sweet potato has not been planted to replace food supplies previously provided by taro. But other factors impinge on the growth and maturation of sweet potato which are more fundamental to the explanation of the seasonal cycle of the Nembi agricultural system.

Periods of drought, water-logging and frost seriously affect the yield of sweet potato (Chapter Four). The duration of rainy and rainless periods, rainfall intensity and the risk of frost at different times of the year are more important aspects of climate affecting the agricultural cycle than total monthly rainfall and mean monthly temperatures.

The climatic data collected for the Nembi Plateau spans the period from September 1979 to August 1981. I collected rainfall figures at Kongip from October 1979 to March 1981. D'Souza, collected data for the longer period at Ol Agricultural Station 2 km away. Temperatures were collected for the same periods and I have merged both sets of data. I have utilized data collected from Mendi and Nipa during the 1950s and 1960s to supplement my own and D'Souza's climatic observations. Such a short run of data is insufficient to draw accurate conclusions.

The probabilities of receiving specified amounts of rain in a given month or year are taken from the records available for Mendi and Nipa (Table 8.7). The coefficient of variance for the annual rainfall of Nipa is 10 percent and for Mendi 12 percent (expressed by the standard deviation as a percentage of the annual mean) using all available records. Thus although the differences between the highest and lowest monthly rainfall figures are quite large the probability of very long periods of drought or excess affecting the annual total by very much is low. The coefficient of variance for fluctuations from month to month over the year is 13 percent for Mendi and 20 percent for Nipa. Brookfield and Hart (1966:13-14) stated that a coefficient of less than 15 percent for monthly rainfall over the year in the Pacific region was low and one above 25 percent exceptionally high. Nipa therefore, on these criteria, has a high seasonal variability of rainfall but a low variability from year to year.

Table 8.7 : Probability of Monthly and Annual Rainfall for Mendi and Nipa.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MENDI P.P.														
(1951-70)	LOWEST	104	172	107	117	78	96	25	52	98	86	95	123	2245
	10	122	178	119	119	142	118	61	144	176	176	98	129	2511
	25 L.Q.	176	219	209	164	171	144	150	204	233	190	138	145	2542
	30	197	219	227	167	181	144	186	206	243	205	160	146	2542
	50 MED.	239	249	296	245	217	176	242	264	296	263	210	210	2838
	70	269	333	351	263	231	204	328	304	331	330	233	263	2976
	75 U.Q.	284	334	362	268	239	218	331	310	345	337	237	292	2976
	90	319	351	385	311	282	280	361	351	385	432	332	342	3129
	HIGHEST	335	470	425	317	384	339	370	396	468	435	363	348	3312
NO. OF RECORDS		17	16	18	17	18	19	19	18	18	18	18	17	13
NIPA P.P.														
(1960-70)	LOWEST	116	137	120	135	127	73	39	58	178	270	115	128	2643
	10	222	212	151	191	133	87	39	58	186	272	151	146	2643
	25 L.Q.	254	218	249	210	171	125	149	228	209	288	164	219	2960
	30	258	231	256	236	178	127	177	228	210	312	203	228	2960
	50 MED.	284	245	287	267	264	152	202	241	259	345	248	242	3112
	70	333	303	358	329	298	183	218	330	327	381	261	284	3374
	75 U.Q.	341	303	371	353	365	223	218	330	399	425	314	285	3374
	90	401	516	375	364	370	275	257	380	433	495	387	324	3901
	HIGHEST	416	516	409	471	434	310	257	380	515	554	471	430	3901
NO. OF RECORDS		11	10	11	11	11	11	10	9	11	11	11	11	9

Source : McAlpine, Keig, Short; 1975 (Table 5 and 6).

Taking the difference between the lower and upper quartiles, the mid-year period of June and July, and from December to February have the lowest variability of rainfall range: but the former have low monthly totals and the latter period high monthly totals. June and July are consistently drier than the rest of the year and December to February consistently wet. The seasonal pattern described in Chapter Four is thus confirmed.

Further analysis of intensity of rainfall and days of wet and dry weather also demonstrate a similar seasonal pattern (Table 8.8). October to January and April to July are both periods with a large number of rainless days (less than 1mm of rain), but no one day has had more than 100mm of rainfall for as long as records have been kept at Mendi, and the daily intensity of rainfall in comparison to other parts of the tropics is not high (Brookfield and Hart 1966). Intensities are lowest in May to June and in November and December.

To summarize so far, the middle and end of the year not only have a low variability in rainfall, but also a large number of rainless days and rainfall of low intensity. The two periods have one important distinction in that the mid-year period is drier. In addition October to December experience the coldest night temperatures with a risk of frost (Chapter Four). At mid-year not only is the diurnal range lowest, but the mean temperature also lower than for the rest of the year. The four season cycle is thus reinforced by the periodicity of weather and rainfall characteristics.

Table 8.8 : The Average Number of Days Per Month with Rainfall within Specified Classes (mm per day) at Mendi.*

	CLASS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
MENDI **	0	9.87	7.13	6.53	9.93	10.40	12.07	10.93	8.60	7.80	9.13	12.47	10.20
	1-4	8.13	6.87	7.87	7.13	8.60	6.87	6.87	8.13	7.60	7.67	5.73	7.27
	5-24	10.60	12.00	13.93	11.00	10.33	9.73	10.07	12.07	12.20	11.00	9.80	11.80
	25-49	2.20	2.07	2.40	1.87	1.40	1.00	2.53	1.73	2.07	3.07	1.87	1.53
	50-99	.20	.20	.27	.07	.27	.33	.60	.47	.33	.13	.13	.20
	100-149	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	GE 150	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

* Nipa data was not analyzed.
** Note that the top line is the number of rainless days per month.

Source : McAlpine, Keig, Short; 1975 (Table 7).

The pattern is further demonstrated when spells of weather are examined; that is periods of consecutive rainless or rainy days rather than just number of rainless or rainy days in any one month (Table 8. 9). If sweet potato is prone to drought and flooding then some idea of their duration is important to understanding the strategies adopted by the Nembi to obviate their effect.

Periods of drought are more likely to occur at mid-year when the monthly number of rainless days is also highest. The chance of very long spells of rainless days however (more than 7 consecutive days with less than 1mm of rain per day) are more likely to occur at the end of the year. Thus not only does June and to a lesser extent May and July have low monthly rainfall totals they are, in an absolute sense the driest months of the year, but also the intensity of daily rainfall in June, is less than at other times of the year and there is a risk of periods of drought. Only at the end of the year, from October to December, is the weather similar.

A significant factor which emerges is that the seasons of wet weather which separate these two seasons of dry weather are of different lengths. During the long wet season, (January to May), the rainfall is also less variable than it is between August and late September. The risk of short periods of intense rainfall and therefore local flooding is greatest at the equinoxes.

Analysis of the Nembi weekly rainfall totals obtained from the combined records at Kongip and Ol shows a pattern similar to that deduced from the Mendi and Nipa data (Table 8.10). The variability in

Table 8. 9 : Frequency Distribution of Rainless Periods Classified by Time of Commencement (in 26 Fortnightly Periods) and Length (in Days) - 1956-1970

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
	1-2	35	26	39	27	14	18	29	22	19	34	30	28	32	20	23	23	25	23	27	24	25	16	32	25	35	23
L	3-4	6	2	1	5	4	1	5	7	5	3	6	6	10	3	6	6	4	2	4	6	4	4	4	7	6	1
E	5-6	5	2		1	2	2	5		1	2	4	1	1	4	1	2		2	1		1	2	3	2	1	3
N	7-8					1							1	1	1	1			1			2	1	2		2	
G	9-10								1			1	1	1	1	1		2						1			
T	11-12																										
H	13-14																				1						
	15-16																										
	17-18																						1				
I	19-20																										
N	21-22																										
	23-24																										
	25-26																										
	27-28																										
D	29-30																										
A	31-32																										
Y	33-34																										
S	35-36																										
	37-38																										
	39-40																										
	41-42																										
	43-44																										
	45-46																										
	47-48																										
	49-50																										

J F M A M J J A S O N D

Source : McAlpine, Keig and Short; 1975 (Table 9).

Table 8.10 : Weekly rainfall on the Nembi Plateau from September 1979 to August 1981 (mm).

Week No.	Date	1979	1980	1981
1	January 1 - January 7	-	26.5	91.0
2	January 8 - January 14	-	28.0	62.0
3	January 15 - January 21	-	94.0	66.8
4	January 22 - January 28	-	51.0	66.3
5	January 29 - February 4	-	117.5	42.3
6	February 5 - February 11	-	53.5	79.8
7	February 12 - February 18	-	22.3	94.5
8	February 19 - February 25	-	49.3	98.0
9*	February 26 - March 4	-	99.0	13.8
10	March 5 - March 11	-	69.8	45.8
11	March 12 - March 18	-	31.3	4.3
12	March 19 - March 25	-	71.8	40.8
13	March 26 - April 1	-	33.5	19.0
14	April 2 - April 8	-	94.0	91.5
15	April 9 - April 15	-	46.3	48.0
16	April 16 - April 22	-	69.3	86.3
17	April 23 - April 29	-	39.0	118.8
18	April 30 - May 6	-	61.5	35.8
19	May 7 - May 13	-	37.5	82.0
20	May 14 - May 20	-	82.5	66.5
21	May 21 - May 27	-	27.0	34.5
22	May 28 - June 3	-	14.5	12.5
23	June 4 - June 10	-	0.5	127.8
24	June 11 - June 17	-	63.5	48.0
25	June 18 - June 24	-	6.5	70.0
26	June 25 - July 1	-	21.3	25.0
27	July 2 - July 8	-	143.3	139.0
28	July 9 - July 15	-	26.3	33.5
29	July 16 - July 22	-	55.8	21.0
30**	July 23 - July 30	-	22.5	57.8
31	July 31 - August 6	-	19.8	24.5
32	August 7 - August 13	-	47.8	29.3
33	August 14 - August 20	-	135.5	8.8
34	August 21 - August 27	-	120.0	37.0
35	August 28 - September 3	-	153.8	-
36	September 4 - September 10	63.4	65.3	-
37	September 11 - September 17	8.0	65.3	-
38	September 18 - September 24	31.7	1.3	-
39	September 25 - October 1	12.0	9.3	-
40	October 2 - October 8	20.0	19.0	-
41	October 9 - October 15	66.0	71.5	-
42	October 16 - October 22	37.8	71.5	-
43	October 23 - October 29	0	28.5	-

Table 8.10 Continued

Week No.	Date	1979	1980	1981
44	October 30 - November 5	42.3	15.0	-
45	November 6 - November 12	35.5	54.8	-
46	November 13 - November 19	71.3	6.8	-
47	November 20 - November 26	16.7	28.5	-
48	November 27 - December 3	84.8	56.8	-
49	December 4 - December 10	48.2	55.0	-
50	December 11 - December 17	38.8	56.0	-
51	December 18 - December 24	24.5	68.5	-
52	December 25 - December 31	85.3	52.5	-

* Week 9 has 8 days in each leap year.
** Week 30 has 8 days every year.

rainfall during the year and from year to year is immediately apparent, but with dry periods in mid-year and at the end of the year in 1979 and 1980. The last week in January, the first week in July and the last three weeks of August 1980 were exceptionally wet, flooding many of the dolines on the plateau. Similar events occurred in the last week of April, the first week of June and the first week of July in 1981. October 1979 and June 1980 were exceptionally dry months. Along with the mild frost that occurred in late October and early November 1980, the rainfall data show that there were periods in the year when conditions were such that growth of sweet potato could have been expected to have been adversely affected.

The seasonal pattern of rainfall is reflected in the seasonal regime of mean weekly point run-off on soils on the Nembi Plateau (Figure 8.6). The maximum soil moisture storage capacity for soils on the Nembi Plateau is assumed to be 100mm following Fitzpatrick's (1965:67) assessment for soils in general throughout the Enga and Southern Highlands Provinces (Waddell comments that this is probably too high 1972a:161-162). Analysis of soil water deficits assumed that

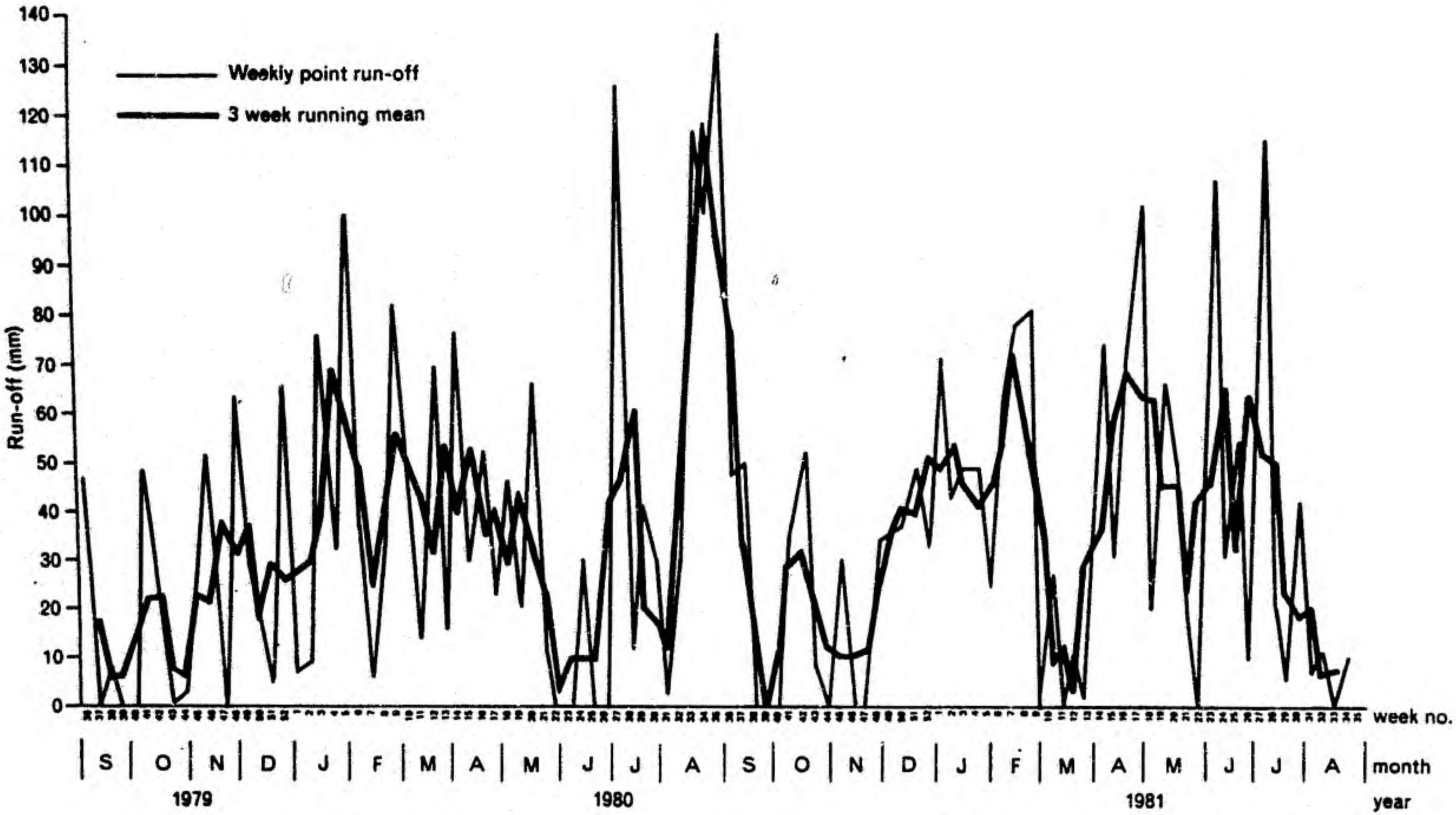

Figure 8.6 : Estimated mean weekly point run-off from September 1979 to August 1981.

poorer soils on the Nembi Plateau had a maximum soil moisture storage capacity of 50mm.*

Estimated evaporation (E) from an evaporimeter was not available for the Nembi Plateau; instead weekly figures were used from the Mendi data available on file at the CSIRO Division of Land Use Research at Canberra** (Table 8.11).

Table 8.11 : Weekly Evaporation (E) from a Standard Tank at Mendi.

Week	E mm	Week	E mm	Week	E mm	Week	E mm
1	24	13	21	26	18	39	19
2	23	14	21	27	17	40	20
3	22	15	20	28	17	41	22
4	22	16	20	29	18	42	23
5	21	17	20	30	19	43	24
6	20	18	19	31	21	44	24
7	20	19	20	32	22	45	24
8	20	20	20	33	22	46	24
9	20	21	20	34	22	47	23
10	20	22	20	35	21	48	23
11	21	23	20	36	20	49	23
12	21	24	20	37	19	50	23
		25	19	38	19	51	24
						52	24

Source : CSIRO

* The analysis utilized a computer programmed Water Balance Model developed by CSIRO (Keig and McAlpine 1974, McAlpine and Short 1974) which assumes that actual evapotranspiration (ET) is related to estimated evaporation (E) from a standard tank evaporimeter (Fitzpatrick 1963) by the relationship ET = 0.8 E (est) for those weeks with available soil moisture plus rainfall exceeding 50 percent of the assumed maximum available soil moisture storage (100mm), and by ET = 0.4 E (est) below this level.

** My thanks are due to John McAlpine and Gael Keig of CSIRO Land Use Research Division for their help in using the Watbal programme and for useful discussion.

Waddell (1972a:160-164), measured soil moisture tension, representing the energy required by plants to remove moisture from the soil rather than total soil moisture storage, in the Enga region. He demonstrated significant moisture loss consequent on complete tillage during the mid year dry period, affecting cultivation of sweet potato. Periods of soil water deficit were experienced on the plateau during the period from September 1979 to August 1981 on both, 'good' soils and 'poor' soils (Figure 8.7) The 'good' soil is equated to the deep loams, and the 'poor' soil to the shallow brown earths described in Chapter Four. Due to the physical and energy properties of capillarity and water tension the moisture deficit becomes more important as the deficit gets larger. Thus a deficit of 50 percent is more serious than simply twice the stress of a deficit of 25 percent. Significant deficits occurred in both the mid-year and the end-of-year dry periods.

Water-logging of the soil is a distinct problem on the Nembi Plateau both during the long wet season early in the year and during the short wet season associated with the August-Stember equinox (Figure 8.6). In February and August 1980 rainfall was so heavy and intense that the dolines remained flooded for a week or more. Water-logging on both occasions (Figure 8.6) persisted long enough to affect the yields of sweet potato. Erosion of top soil is also a significant problem on the plateau, its extent was not investigated during the field work.

The precise manner in which water-logging of the soil, soil moisture deficit or low temperatures and frosts affects the growth of

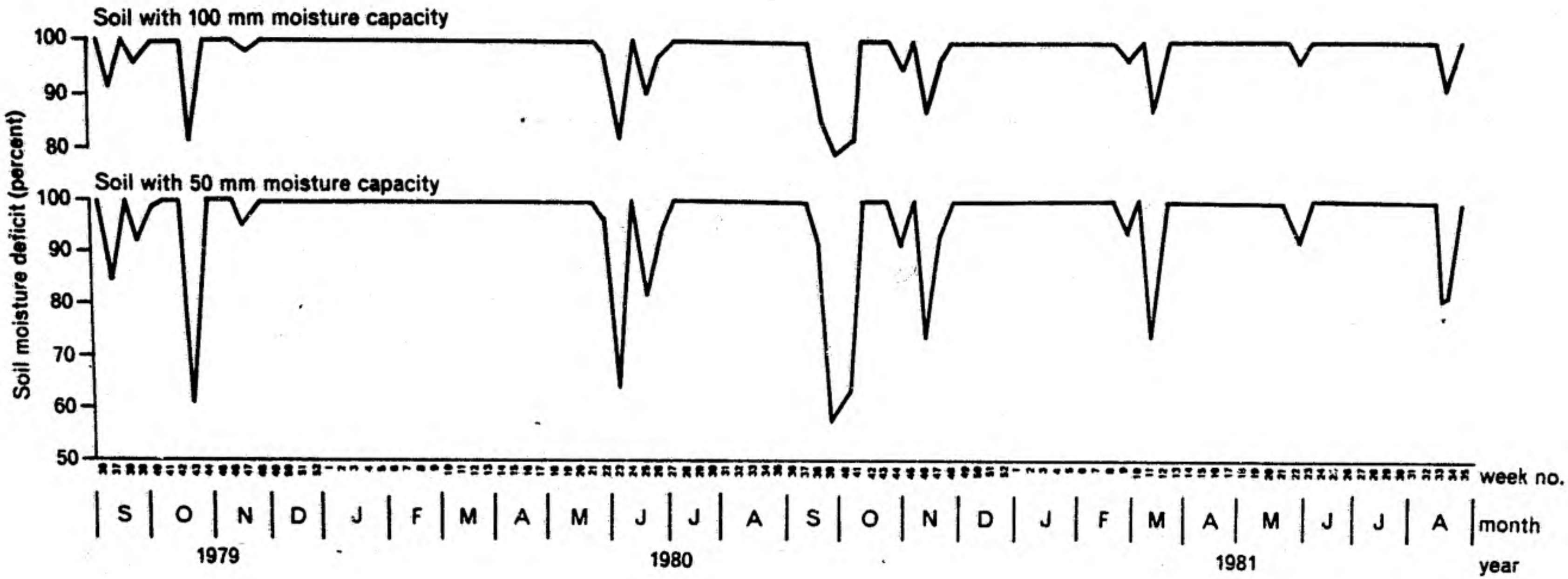

Figure 8.7 : Estimated weekly soil moisture deficits on good and bad soils on the Nembi Plateau from September 1979 to August 1981.

sweet potato plants and their yields is complex and varies depending upon the stage the plants have reached in their life cycle. Three more or less distinct phases are distinguisned in the growth cycle of sweet potato: an initial phase when the roots grow extensively and the vine grows only moderately; a middle phase when the vine grows vigorously and the tubers are initiated; and a final phase when the tubers increase in bulk but little further growth of leaf, vines or fibrous roots takes places. Various conditions adversely affect yield if they occur during any of those three phases (Table 8.12). In general sweet potato grows best at temperatures above 24°C, and growth is severely retarded at temperatures below 10°C. Tuber formation is encouraged by short day conditions with low light intensity (Onwueme 1978:168), conditions that prevail from April to September on the Nembi Plateau. The shortest day length is about 11.5 hours (McAlpine, Keig and Short 1975:156), which is approaching the optimum for tuber growth. Day lengths over 13.5 hours seriously impair tuber development, but day length on the Nembi Plateau (6°S) does not exceed 12.3 hours (McAlpine et al 1975). It is reported that for commercial production in West Africa sweet potato is planted at the beginning of the rainy season so that the crop matures as the rainfall is declining at the end of the season (Onwueme 1978:178). This is also the traditional practice on the Nembi: most of the planting takes place at the beginning of the longer of the two wet seasons of the year (October to February; see Figure 8.4).

Table 8.12 : The Stages of Growth of Sweet Potato and Conditions Affecting Yields.

Phase	Conditions and affect
I	
Root establishment (Planting to 10 weeks	Drought in first six weeks - seriously reduces yields (Edmond and Ammerman 1971). Water-logging prevents adequate deep root development.
II	
Tuber initiation ** (10 to 16 weeks)	Drought seriously reduces yields (Kay 1973) Water-logging seriously reduces yields (Watanabe et al 1968)
III	
Tuber bulking (16 weeks to harvest)	Water-logging seriously reduces yields (Watanabe et al 1968) Drought reduces yield. Frost causes tubers to rot.*

** Frost is discussed later.
* Tuber initiation can start as early as 4 weeks after planting and may be concentrated between 4 and 7 weeks under tropical conditions (Wilson and Low 1973). On the plateau altitude masks the effect of the tropical latitude.

In Papua New Guinea the most well known effects on the growth and yield of sweet potato are those of frost; largely because of the interest in the widespread frosts of 1972. Wohlt et al (1982) point out that the most important conclusion to come out of the observations of the effects of the 1972 frosts is that frost-induced food shortages do not occur immediately following the frost. At the higher altitudes of the Enga Province the worst periods of shortage are likely to arise about five months after the frost and again about 12 to 14 months after the frost. The agronomic reasons for this are unclear but Scoullar (1972, cited in Wohlt et al 1982), has provided observations from which conclusions can be drawn. He showed that during tuber bulking (phase three) a significant frost will cause tubers to cease growing and to rot in the ground. However those tubers that are more mature may survive to be harvested gradually, although they will have ceased growing. A frost during the period of tuber initiation (phase two) will set the growth of the plant back by as much as 5 months. The vine will be burnt back, but will regrow, although the yield will be lower than normal. A frost in the early stages of growth will, depending upon the severity of the frost, set the growth of the plant back as well as lowering the yield. Thus a frost that damages a mature crop will not be such a problem as one that damages the growing plants. The mature tubers will survive for up to three months in the ground, but four to five months later food supplies will begin to decrease. Because the practice of storing tubers is virtually unknown, shortfalls in food supply consequent upon frost, drought or water-logging are critical.

The occurrence of frost, drought or periods of intense rainfall is distinctly seasonal; frost from October to the end of the year; water-logging early in the year during the long rainy season and later in the year in the short rainy season, with the risk being higher in the latter season (Table 8.8); and the risk of drought in the mid-year period as well as in October and November, with the more severe droughts likely to occur, but very infrequently, in the latter period.

I believe therefore that the seasonal planting of mixed and sweet potato gardens, is not only related to the maturation cycle of taro, but also timed to ensure the minimum effect from adverse -

climatic conditions. The Nembi are risk minimizers. They plant the majority of their sweet potato and mixed gardens at the beginning of the long rainy season (November, December and January), when frosts will only delay the crop and not destroy it (Figure 8.8). By February the mixed gardens have yielded most of their produce, and sweet potato, pit-pit and other green vegetables form a protective cover to the soil. If flooding occurs only those gardens in the dolines will suffer, but they are already near the end of their productive period. Sweet potato planted in November to January is ready to harvest in April to June although some is allowed to stay in the ground through to August and later in the dry period of the year. Because bulking of the tuber has taken place before June the yield is not greatly affected by any soil moisture deficits through July and August. Because the planting of sweet potato declines rapidly after January the amount of the annual crop going through its bulking stage during the mid-year dry period is relatively small. By the same token the amount of the crop that is bulking is also small during the August-September wet period, the short dry season that follows and the period which carries the risk of frost. Sweet potato that matured before late June and early July is carried over for those periods, being stored in the ground on the vine. Planting increases in August-September and by late November early December early maturing varieties are ready to harvest. If there are shortfalls these varieties are harvested earlier, before they have completed bulking. The majority of sweet potato in the ground at this period (August to November) will be either mature or will be going through tuber initiation and early bulking.

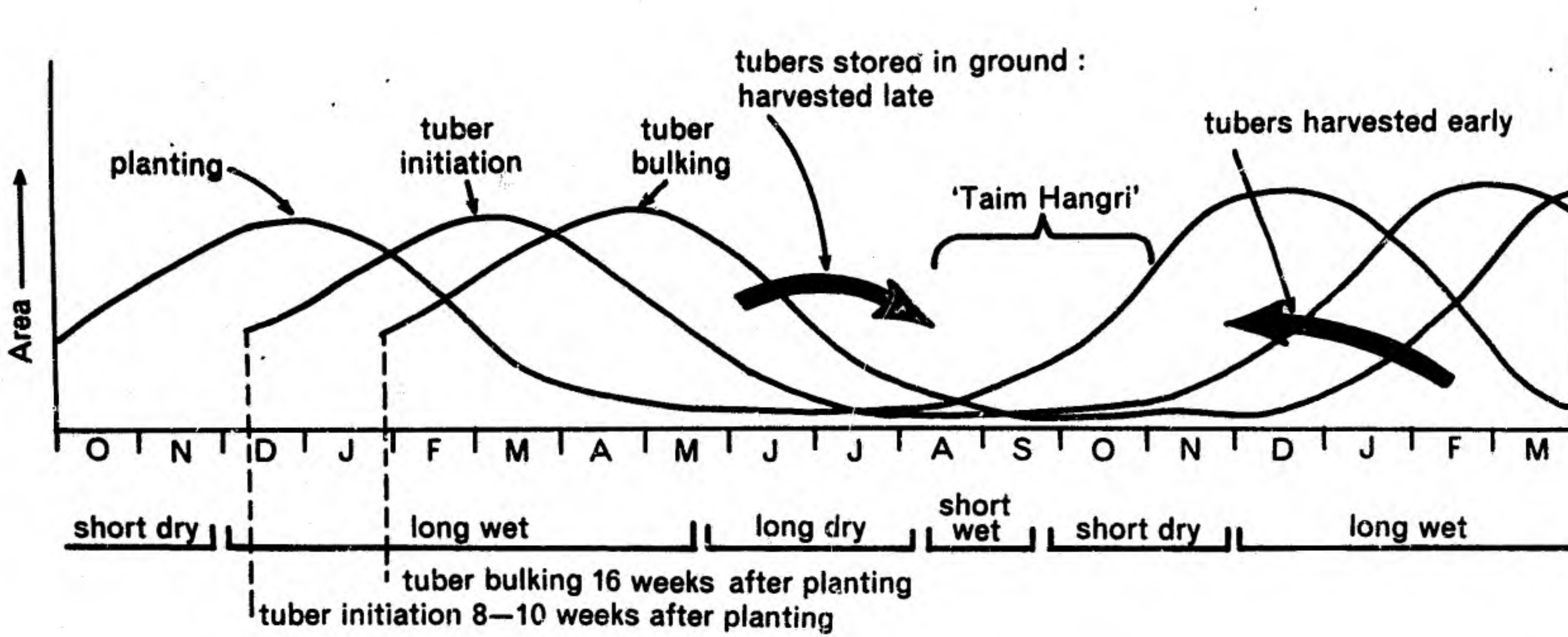

Figure 8.8 : Schematized annual cycle of sweet potato planting, tuber initiation, tuber bulking and harvesting on the Nembi Plateau.

The importance of the wide range of cultivars of sweet potato grown on the Nembi Plateau is now apparent, as is their relative frequency (Tables 8.5 and Table 8.6). Sokul is a long maturing cultivar and 41 percent of sweet potato planted is of this variety. It (and Goroka) are the most likely to be stored in the ground after the tuber has finished bulking. Perbam and Kiko, accounting for 16 percent and 11 percent of cultivars planted, are quick maturing and the most likely to be harvested early. The significance of taro is also emphasised (Figure 8.8) by the period of taim hangri from August to October. Taro planted in the mixed gardens in October to December is ready to harvest by late August and September.

Conclusion

The seasonal activity of women in the Nembi socio-economy is regulated by the necessity to plant sweet potato to minimise risk of crop failure due to drought, water-logging and frost. Women work hardest from September through to late January and their effort is reflected in their general health. Many women lose weight during this period and the pattern of weight loss corresponds quite closely with the strenuous activity of preparing gardens and planting sweet potato vines. For example in December 1980 the number of women losing weight declined from the previous month's total and then increased again in January when nearly 95 percent of the women lost weight. In December fewer women reported that they were preparing new gardens than in November but more reported that they were harvesting sweet potato, a less onerous task (Figure 8.3 and 8.4). The relationship between a mother and the nutritional status of her children is less a matter of the gross area of sweet potato she is cultivating and more an outcome of increased workload she has from September to January.

In Chapter Seven I demonstrated the months from January to May/June were particularly dangerous for children being weaned as they were prone to disease associated with weaning at a period of the year when the chances of contracting disease were higher. I have now shown that for the four months at the end of the year (September to December) the child-mother relationship is under stress. This will also adversely affect the health of children and especially young children. Thus, without examining food supply and consumption I have demonstrated that other factors impinge upon the simple model of population size, household size, area cultivated and nutritional status of children. The static model of regression equations is inadequate, not least because of the seasonality of supply which is dictated by an agricultural cycle dominated by sweet potato and the lingering presence of taro.

APPENDIX 8.1

THE AGRICULTURAL SYSTEM OF THE NEMBI GARDEN TYPE AND CROPS CULTIVATED

From September through to December men clear the Imperata and Ischaemum grass fallows, construct fences and clear ditches to protect the gardens from pigs. A notable feature of the Nembi landscape is the small stone walls built from limestone boulders enclosing many of the mixed gardens. They are a traditional method of enclosure and whilst some may consider them the result of a shortage of timber to construct fences I think that the over abundance of boulders may also have encouraged their use before timber became relatively scarce. In the lower Waga valley where timber is more plentiful, mixed gardens are still enclosed by drystone walls conspicuous by their whiteness. The mixed gardens are invariably sited in the bottom of dolines. Some measure of protection is afforded the gardens by the steep limestone cliffs but this advantage is offset by the risk of flooding and of seedbeds being washed out by heavy rainstorms. Women share the planting with the men after the women have tilled the soil to a fine tilth.

Bananas are planted by the men at regular intervals through the garden as well as several varieties of sugarcane. The women plant beans (Dolichos Lablab, Phaseolus lunatus, Phaseolus vulgaris, Psophocarpus tetragonolobus), various leafy green vegetables (Hibiscus manihot, Amaranthus spp., Oenanthe javanica, Rungia klossii), and highland edible pit-pit (Setaria palmaefolia), as well as corn, onions, tomatoes, cucumbers, pumpkins and cabbages that have been introduced by Europeans. Sweet potato cuttings are also planted, and with the edible pit-pit and Rungia serve as a developing cover crop as the rest of the vegetables are harvested. Table A8.1 shows some of the great variety of crops grown in both the mixed gardens and open fields as well as growing wild on the Nembi Plateau.

Mixed gardens are generally only cultivated for one year although some of the food plants in them continue to produce for a longer period of time. Setaria palmifolia, Hibiscus manihot, Rungia klossii as well as Ocenanthe javonica and Nasturtium schlecteri continue to yield and contribute significantly to the Nembi diet until they are overwhelmed by weed growth. Mixed garden sites are characteristically re-colonized by the creeping grasses Paspalum conjugatum (which the Nembi call Belli teni - the Europeans' grass) and Ischaemum polystachium (what the Nembi call Yamla) which form a dense, choking and tangled cover which is replaced by (Miscanthus floridulus), woody shrubs (Desmodium spp.) and trees (for example Dodonea viscosa). The length of time a mixed garden site is left to fallow depends on the number of suitable sites that a man possesses for mixed gardens and/or his decision to cultivate a mixed garden or not in any particular year. The average fallow of mixed gardens in the lower Pwe Creek basin is conservatively estimated at four or five years. A number of different types of mixed gardens are recognized by the Nembi and are detailed in Table A8.2. As described in Chapter Four an important category in the past was the taro garden. In addition to Taro (Colocasia esculenta) yams (Dioscerea alata and D. bulbifera) were also grown to a much greater extent than today and in the same garden. These gardens were called Maa-berre-yegil-yem (taro and yam

Table A8.1 : Food Plants of the Nembi Plateau

Scientific Name	Common Name	Nembi Name and Varieties
Psophocarpus tetragonolobus (c)	Winged bean	Pharl - Ulalu, Onk, Kom, Tibul, Pomberey, Menwebi
Dolichus lablab (C)	Hyacinth bean	Tegian - Sumbage, Sorel, Peraliki, Sumpomberey
* Phaseolus vulgaris (C)	Common bean	Besa
* Phaseolus lunatus (C)	Lima bean	Lima
Musa (spp) (C)	Banana	Eibel - Morumba, Tuul, Pem, Kimbami, Uyent, Mele Ondol, Pengip, Omu, Yaba, Kusbura and *Belli eibel
Saccharum officinarum (C)	Sugarcane	Wal - Awl, Mendi, Komben, Pore, Magip, Komp, Yekip, Kabel, Kendamungieiba, Kenkel, Engim, Simkal
Rungia klosii (C)	Rungia	Tani - Maban perel, Eb tani, Komborani, Tani pomberey
Amaranthus (spp) (C)	Amaranthus	Kormp - Karop, Kupi, Kambage, emi, aeturi
Hibiscus (Abelmoschus) manihot (C)	Aibika	Ushes - Kupe, Ment
Oenanthe javanica (C,W)	Oenanthe	Tege
Setaria palmifolia (C)	Highland pit-pit	Kore - Boko, Age, Koyare, Ul, Kowis, Komp, Ombo
Saccharum edule (C)	Lowland pit-pit	Kwim
Nasturtium schlecteri	-	Oka - Okake, Oka
Nastus elatus (C)	Bamboo (shoots)	Peekumu
Ficus copiosa (C)	Kumu musong	Tulup - Noko, Pomberem
Lagenearia siceraria (C)	Bottle gourd	Pe Ombua
Dicliptera papuana (C)	Hemigraphis	Kenjulo
Dioscorea alata (C)	Greater yam	Mberre - Mungi, Kekil, Tegi, Kom, Kambe, Kesuabwa, Pirul, Penga, Kaviar
Dioscorea bulbifera	Potato yam	Yekil - Omnongora, Wopf
Solanum nigrum (C,W)	Karakap	Suroku
Diplasium spp.	Fern	Koink
Colocasia esculenta (C)	Taro	Maa - Karobe, Kombol, Munt, Murl, Mes, Tegian
* Xanthosoma sagittifolium (C)	Chinese taro	Maa usa
* Manihot esculenta (C)	Cassava (Tapiok)	Te
* Nasturtium officinale (W,C)	Watercress	Wara Karas (Kaleis)

Table A8.1 continued

Scientific Name	Common Name	Nembi Name and Varieties
* Solanum tuberosum (C)	Potato	Asbus
Pueraria lobata (C,W)	Pueraria	Olioron
* Pisum sativam (C)	Pea	Mbellien Pharl
* Sechium edule (C)	Choko	Lipsok
* Zea mays (C)	Corn	Kanap
Cyathea (spp) (W)	Fern	Eng, Woil, Wein
* Arachis hypogea (C)	Groundnut	Kalap
Commelina diffusa (W)	Wandering Jew	Embiamo
Coix lachryma jobi (W)	Job's tears	Olump
* Lactusa sativa (C)	Lettuce	Letis
Rubus rosifolius (W)	Raspberry	Memini
Zingiber officinale (C,W)	Ginger	Sembi (Ymin)
* Lycopersicon esculenta (C)	Tomato	Tomat
Cucumis sativus (C)	Cucumber	Olak
* Cucurbita moschata (C)	Pumpkin	Bumbkin
* Ananas comosus (C)	Pineapple	Pinap
*Carica papaya (C)	Pawpaw	Porpor
*Brassica oleracea (C)	Cabbage	Kabis
* Brassica chinensis (C)	Chinese cabbage	Salsall, Sari-sari, Pimusa
* Baucus carota (C)	Carrot	Karot
* Allium cepa (C)	Spring onion	Kori
Pennesetum macrostachylum (W)	-	Wakma
Ipomea batatas (C)	Sweet potato	Ole
Castanopsis accuminatissima (W)	-	Pae
Coix gigantea (W)	-	Orlop
Glycine max. (C)	Soya bean	
Cajan cajanus (C)	Pigeon pea	
Pandanus brosimus (W)	Karuka	Ank
Pandanus julianetii (C)		
Pandanus conoides (C)	Marita	

C cultivated
W. wild
* introduced recently

Table A8.2 : The Mixed Gardens of the Nembi

Category	Translation
Koree - Tani yem	Sacchanum edible and Rungia
Phar - Tegian yem	Winged bean and Hyacinth bean*
Kormp - oka yem	Spinach garden
Mberre - Yegil yem	Yam garden
Maa - Mberre - Yegil yem	Yam and Taro garden
Maa - yem	Taro garden

* Note that the collective noun marker yem is used in this expression This is described in Chapter Three in connection with descent and group ideology and its use in the above context seems to me to emphasize the point that the word yem, or shem is not purely a word to describe groups or clans as used by Sillitoe (1979).

gardens).** The altitude of the plateau is too high to grow yams widely: they are restricted to the Waga valley and the lower Emia creek for the most part. The existence however, of the taro and yam gardens as a separate category further emphasizes that the Nembi of the lower Pwe creek probably migrated from lower regions to the south of the plateau, a process described in Chapters Three and Four. The fallow mixed garden is called yem ebal. Older Nembi men say that many years ago Pandanus conoides yams, various green vegetables and sweet potato were all grown in the same garden. Again this suggests that the Nembi of the lower Pwe creek formerly also lived at lower altitudes and cultivation was not separated into the mixed gardens and the open fields of sweet potato.

** Patrol Officers remarked upon the large bean gardens of the Nembi valley in the early 1960s. 'The feature of agriculture peculiar to this area is the large bean gardens which border on the narrow flats of the Nembi river... The gardens may be single and small in size, from half an acre. More usually they are composite and cover an area of up to fifteen acres. The individual blocks are always well fenced' (Patrol Report No.3 Nipa 1960/61).

There are three types of sweet potato field Ole omap, the most common, are large open fields with the sweet potato planted in mounds. Ole shulyem are gardens made on the extremely thin and patchy soils of the mountain sides. The sweet potato cuttings are planted directly without mounding into small pockets of soil among the limestone outcrops. Ole yemka are fields in which the soil is also not mounded: the ground has been newly cultivated after a long period of fallow (Ole yem munpae). Ole Shulyem are abandoned after one season, the soils being too thin for replanting. Ole yemka in their second season are mounded and become ole omap.

Close to the houses are another category of garden, the Andaa ga yem. These are small mixed kitchen gardens, and are generally cultivated throughout the year. They are distinguished from the other mixed gardens by the presence of tobacco. One side of the house is usually used as part of the garden boundary. Many of these gardens on the Nembi Plateau have also clumps of birds-eye chillie bushes (Capsicum annuum), remnants of earlier attempts by the Department of Agriculture to introduce a cash crop to the area. Coffee is the only cash crop of the Nembi Plateau (see Chapter Five) and is grown either in the kitchen gardens close to the houses where, like the tobacco, it can be protected from theft or in the more fertile and better drained mixed gardens.

Some mixed gardens form part of the sweet potato fields. Although most mixed gardens are situated in the doline floors, surrounded by sweet potato on the higher slopes, patches of moist and more fertile soil within the sweet potato fields which when fallow are characteristically covered with *Yamla* (*Ischaemum polystachium*), are planted with mixed garden crops. They are planted by the women without the help of their husbands. In such cases the men have abdicated their responsibility to make a mixed garden that season, either expending their energies on manipulating the trade network, working on the roads under contract or playing cards. In some cases where men are absent working on plantations, their women depend on kinsman to obtain access to mixed garden land.

Men also plant what are usually thought of as mixed garden crops in the sweet potato gardens. Sugarcane is planted either as boundary markers between plots belonging to different women or in clumps called *Wal yem* (sugar gardens) within the open fields. Sometimes bananas and sugar are planted together in small gardens, *Eibel - Wal yem* (Banana and sugar gardens).

Two highly specialized forms of mixed garden are also found on the Nembi Plateau, one the domain of the women and the other the domain of the men. That of the men, only found in the southern plateau, the Erave valley and the lower Wage valley are the orchards of oil pandanus or *marita* (*Pandanus conoideus*). In the orchards are also grown the other usual mixed garden crops when it is not fallow. One man of Kongip, Sepi who has paternal kin in the Erave valley, has extensive orchards of more than one hundred trees in the Erave valley at Urida. Taboos exist concerning who may enter the gardens and eat of the fruit. These gardens are called *Aberri yem*.

The gardens that are peculiarly associated with the women are Uriba yem or Ulwobaem; gardens in which sedges (Eleocharis dulcis) are used to make their rather skimpy skirts are grown. They are located in secluded, well watered spots and may be owned by one woman or a number of related woman or co-wives. Very often the women plant taro (Colocasia esculenta) on the fringes of these gardens, which are really small and shallow artificial ponds.

CHAPTER NINE

THE CYCLE OF THE SEASONS: CONSUMERS AND CONSUMPTION IN THE NEMBI AGRICULTURAL SYSTEM

This is the state of man: today he puts forth
The tender leaves of hope; tomorrow blossoms,
And bears his blushing honours thick upon him;
The third day comes a frost, a killing frost...

Henry VIII, 111,ii.15-18.

The proof of the strategy employed by the Nembi in their agricultural system, outlined in the previous chapter, is literally in the eating. The high level of malnutrition among children under the age of five and the short stature of adults are the result of poor environmental health and the heavy workload of women. These stresses acting upon a population already made vulnerable because of an inadequate diet, inadequate in both quality and quantity, are the primary cause of malnutrition in poverty stricken families. So far I have discussed those factors, other than food supply, which cause poor health and poor nutritional status. Even relatively small variations in those factors between families and between individuals may be the difference between survival or death. Minor differences in quality and quantity of food intake may tip the balance between acute malnutrition and health on a diet which is basically inadequate (Schofield 1979:95).

The important distinction between quality and quantity is an important one in the diet of the Nembi. Quality is reflected in the mixture of foods available and their contribution to a diet which, when 'balanced', supplies all the essential nutrients as well as the energy required by the human body to grow and function. The quality of the Nembi diet changes through the year as some foods become available and others go out of season, and the mixed gardens as well as the foods of the forest are important to the quality of the Nembi's food intake. For some families the quality of diet may be worsening as access to suitable land on the plateau suitable for mixed gardens becomes more restricted as more people leave the forest to crowd the plateau.

Population pressure on the Nembi Plateau also threatens the quantity of food available, not only of the staple, sweet potato, but also of the produce from the mixed gardens. It is a reasonable assumption that since the influx of migrants from the valleys in the west, the fallow period for sweet potato fields on the Nembi Plateau has become shorter in the last 20 years. Yields have probably declined. The increased imbalance between numbers of producers and numbers of consumers (Chapter Seven) has placed an increasing burden upon the shoulders of women and has also reduced the average amount of food available per person. The marginal yield for marginal labour inputs has declined.

In this relatively harsh environment the ability to absorb shocks within the agricultural system, has always been small. The decline in quality and quantity has not been uniform through the agricultural system, especially throughout the whole agricultural cycle. That period of the year between August and December when the line between supply and demand is most finely drawn is most vulnerable. The amount of sweet potato, mature and in the ground and able to be carried from June and July through to August and September has become insufficient. The amount of sweet potato able to be harvested in October before it has reached maturity has also become increasingly insufficient and 'hungry times' have become more frequent and more severe.

The problem distils out into two broad but closely related themes: intensification or the relationship between consumers and producers; and food availability and the diets of vulnerable groups, especially of children under the age of five. Seasonality interlocks them both to such an extent that the nutritional status of children is affected by both sets of factors and varies throughout the year.

Consumers and Producers: Agricultural Intensity

Agricultural intensification has been defined in a number of ways: as the frequency of cultivation against constant land and time (Boserup 1965); as increasing inputs of capital, labour and skills against constant land (Brookfield 1972b); and as increasing outputs against changes of capital, labour, skills, land and technology (Turner 1981). All three interpretations are based upon the production function of output to population with technology as the intermediate variable as shown in Figure 9.1 by the Total Product curves 1 and 2. Technology includes those techniques that allow land to be cultivated more frequently necessitating increased inputs of either capital, labour and/or skills to increase output.

Assuming a minimum level of subsistence and social production for any given population (MS in Figure 9.1), marginal product must not fall below that level even though total product from the system has not reached its maximum, if a satisfactory and culturally determined standard of living is to be maintained. When marginal product (MP_1) has reached zero (D) then total production (Total Product 1) has reached its maximum. The optimum relationship between population (in the case of the Nembi, the Nembi and their pigs, B_1), and output is achieved when marginal product (MP_1) is equal to average product

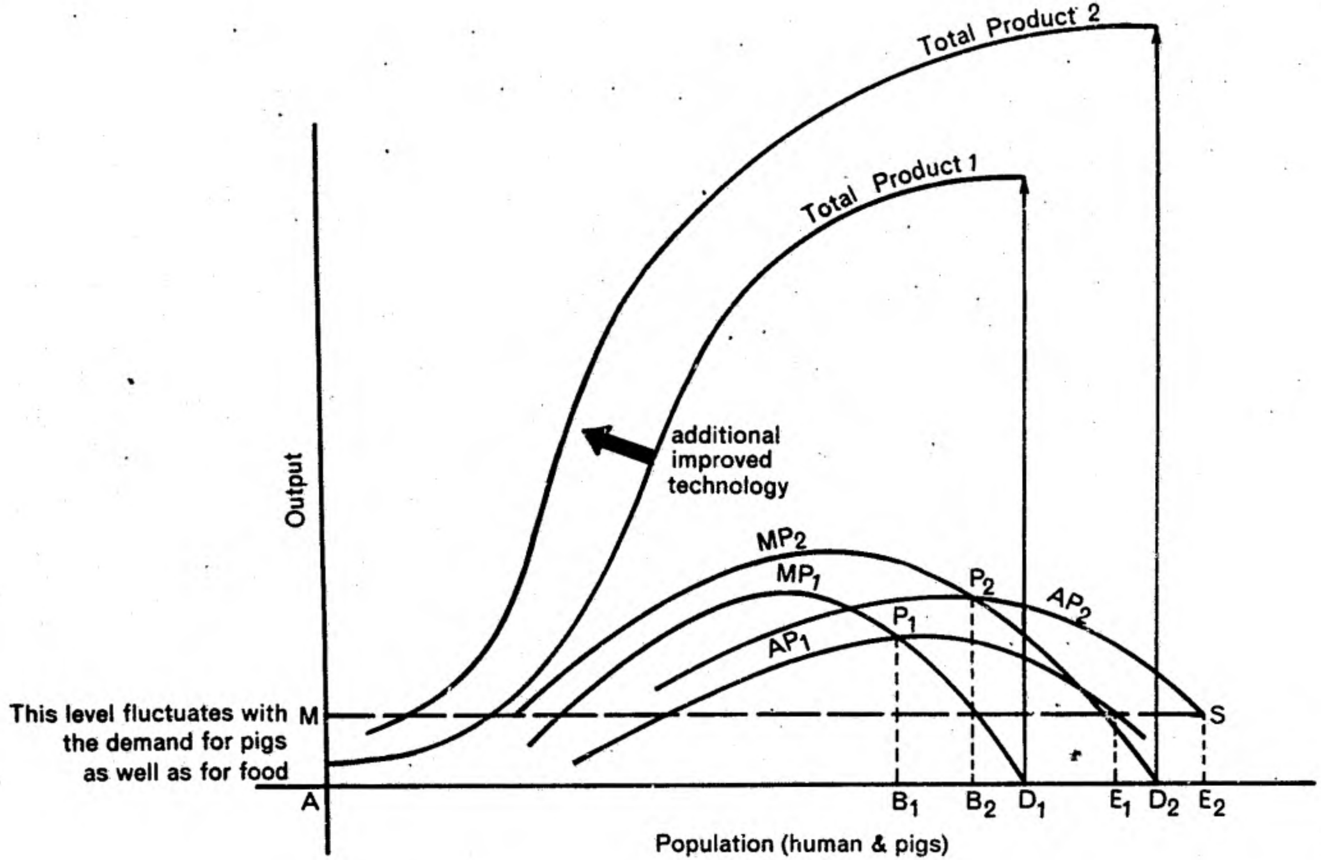

Figure 9.1 : Technological change and optimum population.

(AP_1) at point (P_1). At this point (P_1) the addition of one extra unit of population, a person or family also increases output, but not enough to maintain the average output per population unit. If the population increases by one pig then output stays the same but in both cases the average output per unit of population begins to fall as the marginal product also declines. The standard of living as measured by average product thus begins to fall and approach the level MS.

Optimum population (B_1) and the minimum level of subsistence (MS) at any given level of technology are analagous to the concept of carrying capacity. Street (1969) and Feachem (1973) have demonstrated the mathematical problems in defining carrying capacity and Bayliss-Smith (1980a, 1980b, 1981) the conceptual problems which its use involves. Essentially it is a static concept and assumes that for any given environment there is an optimum population which can be supported at a given level of welfare. Exceeding the carrying capacity, either too many people or too large a herd, precipitates a decline in welfare as well prompting the possibility of environmental degradation.* The concept of carrying capacity, as well as optimum theory, assumes that all other factors are held constant as effective

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* Waddell showed that for the Raiapu-Enga, the elimination of the forest cover as agriculture developed not only modified the environment to a grassland agricultural system, but also aggravated the incidence of certain hazards at the micro-level. The two most prevalent are soil moisture deficits and low night temperatures resulting in frosts. The removal of tree cover off the slopes not only allows drainage downslope of cold air into the cultivated valley bottoms but also lowers the ambient temperatures due to reduced surface evaporation and transpiration from the forest (Waddell 1972a and 1973:45).

demand, or the number of mouths, human or otherwise increases. The subsequent decline in welfare prompts either a decrease in the rate of population growth and indeed a decline in population back to the level at which marginal product equals average product (population size B_1 in Figure 9.1), or a development in technology that raises the level of productivity. The production function curve Total product 1 becomes - Total product 2 (Figure 9.1) and marginal product (MP_2) and average product (AP_2) then equilibrate at P_2 and population B_2 is able to be supported without a loss in welfare.

Elements of both Malthusian population theory and of the theories of Boserup (1965) are present in this simple model of agricultural change and intensification. Malthus postulated that as population increased it would eventually outrun the means of subsistence. The crux of his theory was that growth of population would maintain average productivity (AP) per head at a level less than the marginal product (MP), and very close to the minimum level of subsistence (MS). Other than deferment of marriage, part of what Malthus labelled 'preventative checks', he argued that other 'positive checks', war, famine and disease, act to maintain the balance between population and food supply. The precise relationships and mechanisms operating between population growth, the positive checks and the means of subsistence are not very clear in Malthus's model. Obviously famine is directly related to food supply, the means of subsistence, but the other positive checks are not necessarily so directly related:

> 'all the causes which tend in any way prematurely to shorten the duration of human life, such as unwholesome occupations; severe labour and exposure to the seasons; bad and insufficient food and clothing

> arising from poverty; bad nursing of children; excesses of all kinds; great towns and manufactories; the whole train of common diseases and epidemics; wars, infanticide, plague and famine' (1798, 1970:250).

A synergistic relationship exists between poor nutritional status of children and disease on the Nembi Plateau, and malnutrition on the Nembi Plateau is the result of a socio-economic disorder (including demand for pigs) rather than simply one of absolute food shortage brought about because population has outrun the means of its subsistence. The array of positive checks listed by Malthus emphasizes a complex socio-economic problem rather than a simple and direct relationship between food supply and population size, although no explanation is offered how the positive checks are related to each other, to popuation size, or to food supply. Even famine, although related to bad and insufficient food, arises from poverty, in itself a complex socio-economic phenomenon. The periodic famine conditions occurring in the highlands of Papua New Guinea as a result of frost or drought are localised and of brief duration.

The agricultural system of the Nembi has become adapted to the risk of frost, drought and periods of extremely wet weather. When such events occur and food shortages ensue, they are by no means the result of population pressure, of population size outstripping the means of its subsistence. Admittedly the severity of the effects of a frost, drought or flood may be greater where the degree of risk taken is largest and where the amount of leeway between supply and demand is smallest, but that still does not equate population size with food supply alone. Measures on the Nembi Plateau such as birth-spacing, post-partum intercourse taboos, postponement of marriage, abortion and infanticide, were important in controlling population size. Those measures also included, and to an extent still do, strategies in the agricultural system designed to offset the physical determinism imposed by the cycle of the seasons. Here the analysis draws close to including what Boserup proposed as a rebuttal to Malthusian models of population change and agricultural intensity: agricultural technology. The two models are compellingly similar and suggest that Malthus's ideas have been much maligned and misinterpreted (Flew 1970:7-55).

Neo-Malthusians have interpreted Malthus as proposing a static production function in which the relationship between population and productivity conforms to a self-regulating and self-maintaining system. Improvements in the standard of living (food supply) lead to increases in the size of population. Checks to population increase begin to operate as the size of population exceeds the means of subsistence. As the standard of living falls so too does the rate of population increase. In Boserup's model the role of technological change is emphasized. Technological change maintains average output. The production function, shown in Figure 9.1, shifts upwards and to the left (production function 1 becomes production function 2). Boserup as well as Clark and Haswell (1967) stated that population growth forces technological change.

Boserup contended that marginal return (MP_1) does not reach zero or indeed fall below the minimum subsistence level (MS). She assumed that any given area has a hierarchy of feasible agricultural systems commensurate with its resource endowments. People will adopt a system which offers the best return for the least effort. With population possessing the propensity to increase (no matter how slowly) and the demand for pigs probably being infinite, higher levels of technology will be adopted progressively. The shift to a new production function will take place as the pressure of population and the demand for pigs reduces average productivity to below its maximum. Only occasionally will the conservative "sticky force of habit" which resists change (Buttimer 1978:61) result in the marginal productivity approaching zero, as Geertz (1963) documented for rural Java, more usually new technology will be adopted.

The mixed gardens of the Nembi Plateau may well be remnants of an earlier less intensive and therefore less production swiddening system, as may the continuing inertia of the Nembi in relying upon the phenology of taro in dictating the agricultural cycle be also a remnant of that system. In what many have interpreted as the Malthusian situation, marginal productivity falls below the level of minimum subsistence and may even approach zero. Given the inherent conservatism of using tested and proven techniques and the propensity of people to expend the least effort for a given level of return, the progressive adoption of higher levels of technology no doubt always lags behind population growth and the demand for increased productivity. But inventions and new methods are not conjured from thin air and an array of known, but not necessarily proven, techniques are available to every group of agriculturalists. Necessity may not be the mother of invention but it certainly becomes the reason for eventual adoption of more intensive techniques.* Malthus was not

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* The chronology of the industrial revolution/economic transformation of the U.K. and Europe has become central to the debate amongst

unaware of the role of technological change (Flew 1970:7-55); he simply underestimated the pace of change and overestimated the indolence of the rural poor. Boserup and Malthus do not differ very much in the assumptions they make in their models, but only in the interaction between the various factors. Both present either side of the same equation and it will probably never be resolved whether population growth is the result of technological change or the reason for technological change. It is probably a combination of them both.

Brookfield sums up the implications the model of a hierarchy of production fucntions has for the concept of carry capacity.

> There is no single solution to the question of carrying capacity, from which way we work. If we define a set of resources, crops and technology, we can obtain varied populations according to desired levels of input and desired living standard, or surplus production. If we vary the land tenure system, and hence the system of asset and income distribution, we obtain a further new set of results. If on the other hand, we begin by defining the

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economic historians about the role of the agricultural sector in economic development. The consequences of economic transformation in the U.K.; urbanization, rapid population growth, division of labour and the dominance of the factory system, so evident in the 19th Century were shown to be firmly rooted in the changes taking place in all aspects of economic, social and political life. The evolutionary rather than the revolutionary aspects of these changes are now stressed. '...the increase in agricultural output does not appear to have been due primarily to the discovery of new ways of doing things. The improved methods were the result of the accumulation of a very large number of small adaptions, and while a few of them do sum up the methods which can legitimately be regarded as new (the advances in cattle breeding for example), the substitution of turnips and grass crops for fallow, the technique responsible for the most revolutionary changes, was already known. That is to say, the increase in output, where it was not merely the result of the employment of more men and land, arose from the spread of the best existing techniques rather than from the invention of new ones.' (H.J. Habakkuk, 1968 'Economic functions of English landowners in the 17th and 18th centuries', Essays in Agrarian History, Vol.1, ed. W. E. Minchinton, David and Charles).

> population to be supported, and its standard of living, we will then find that this can be achieved in various ways, requiring different levels of intensity, and different combinations of production for local subsistence and for external trade respectively (Brookfield 1980:19).

It appears that the Nembi have reached that point where new technology is needed in order to shift the production function upwards and to the left. The low yields, the periodic food shortages, the poor nutritional status of the children, and the small variation between area cultivated per woman in the hearth units discussed in Chapter Eight suggests that marginal productivity is probably equal to if not less than average productivity. The story so far suggests that external influences have brought the Nembi to such a sorry pass and it is thus probably true to say that the Nembi do not possess an array of more intensive techniques with which they can raise their marginal productivity. The pace of change (population and land shortage) has been externally induced and too rapid for the pace of innovation and adoption of new techniques.

The Pubi hearth units and agricultural intensification

Analysis of the household and hearth units of the Pubi has been concerned so far with explaining variation in the dependent variable, the area of sweet potato cultivated. The only comment made of the independent variables was to distinguish consumers from producers. I now want to assess the differences between the Pubi hearths in terms of their of production. The relationship between consumers and producers is central to the analysis of intensification.

Not all hearth members contribute equally to either production or consumption. Individuals of each sex in different age groups of each hearth have been weighted to assess the number of consumer units and producer units in each hearth (Table 9.1). There are no universally accepted standards for assessing the number of consumer and producer units from the age and sex structure of households and hearths in Papua New Guinea. Recent researchers (Sahlins 1974:103, Modjeska 1977:233 and Grossman 1979:256) have used different assessments based upon their own observations of individuals relative contribution to production and consumption. In both categories I have taken the adult married woman aged between 15 and 50 years as the standard unit, and weighted all other members of the hearth by

Table 9.1 : Consumer and Producer Units Assessed for Age and Sex

CONSUMER UNITS

SEX	AGE				
			Unmarried	Married	
	0 - 5	6 - 14	15 - 50	15 - 50	over 50
Male	0.4	0.7	1.0	1.0	0.8
Female	0.4	0.7	0.9	1.0	0.7

PRODUCER UNITS

SEX	AGE					
				Unmarried	Married	
	0 - 5	6 - 9	10 - 14	15 - 50	15 - 50	over 50
Male	0	0	0	0.25	0.5	0.4
Female	0	0.1	0.3	0.5	1.0	0.6

comparison with her. The weighting for consumer units holds no surprises except that I have distinguished between children under and over the age of five. Neither Modjeska nor Sahlins distinguish between children who are pre-adolescent.

Producer unit weightings are the hardest to determine because of the lack of precise labour input data. Consumer units weightings are based upon food consumption patterns (J. Baines pers.comm. 1981). From observation pre-adolescent boys contribute nothing to the production of either the mixed gardens or the sweet potato fields. Young girls on the other hand are with their mothers in the gardens and begin to use a digging stick from an early age. By the time she reaches adolescence (about 17 to 18 years), a young unmarried girl is probably doing as much as 50 percent of the work done by her mother and aunts. When unmarried an adult man relies upon his mother and sisters to provide for him, and when married works in the gardens only half as much as his wife. If a man is polygynous his labour effort and his contribution to consumption is, ideally, divided equally between the hearth units of his wives. Table 9.2 shows the composition of the Pubi hearths in producer and consumer units. Some of the hearth units have been amalgamated.*

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* Units listed as 51 and 52 in Table 8.2 have been amalgamated. The woman in 52 is the mother of the husband of 51. She has no other children with her and contributes to the work of her daughter-in-law. Units 131, 132 and 133 (Table 8.2) have been amalgamated to give one hearth unit (Table 9.2). Unit 131 is the mother of the husband of units 132 and 133. Unit 133 was newly married and was working with her co-wife rather than as a separate hearth unit.

Table 9.2 : Producer and Consumer Units in Pubi Hearths.

Woman		Consumer A	Producers B	Ratio A/B	Group
1	Yalin	3.1	2.2	1.4	A
2 1	Yalim	3.13	2.26	1.38	*H
2 2	Pulam	2.43	1.26	1.93	*H
2 3	Kombo	3.53	1.36	2.6	*E
3	Lulubin	3.8	1.5	2.53	*H
4	Gibri	7.8	3.65	2.13	*D
5 1	Mupangam	4.5	2.35	1.91	*H
5 2	Manu				
6	Tolokeum	3.5	2.1	1.67	*H
7 1	Iombone	3.2	1.8	1.77	H
7 2	Keno	3.2	2.05	1.56	H
8	Egbin	6.1	3.0	2.03	*D
9	Mu	2.4	1.5	1.67	*A
10	Mone	1.8	1.0	1.8	*E
11	Eriam	3.2	1.85	1.73	A
12	Pagaiam	4.2	1.5	2.8	*E
13 1	Pukem				
13 2	Lelem	5.2	3.2	1.63	*B
13 3	Erap				
14	Wesa	2.5	1.5	1.67	H
15 1	Tenonk	3.13	1.41	2.2	*H
15 2	Kubinu	2.83	1.16	2.44	*H
15 3	Netubiabe	2.13	1.16	1.83	*E
16	Perbam	2.4	1.5	1.6	E
17	Margaret	2.4	1.5	1.6	*H
18	Yandin	4.5	1.75	2.6	*H
19 1	Lulubam	2.5	0.8	3.12	C
19 2	Omonu	2.5	0.8	3.12	C
20	Onobam	2.6	1.5	1.73	H
21	Puam	5.5	3.0	1.8	F
22 1	Waram	4.43	1.86	2.38	*H
22 2	Awanu	3.13	1.26	2.48	*E
22 3	Paeyu	1.33	1.16	1.15	G
23 1	Melamin	1.14	1.07	1.06	G
23 2	Wabin	2.64	1.17	2.26	*H
23 3	Shuem	3.54	1.67	2.12	*H
23 4	Weib	2.94	1.37	2.15	*A
23 5	Lubin	1.14	1.07	1.06	G
23 6	Taebel	2.84	1.62	1.75	H
23 7	Tenayo	3.44	1.5	2.29	*H
24	Aesil	2.0	1.5	1.33	H
25 1	Olemnok	1.9	1.25	1.52	H
25 2	Kinen	1.5	1.25	1.2	E
26	Tolam	2.4	1.5	1.6	*H

Table 9.2 Continued

Woman		Consumer A	Producers B	Ratio A/B	Group
27	Sarah	2.4	1.5	1.6	*H
28	Mobuam	2.4	1.5	1.6	H
29	Eyam	4.8	2.7	1.78	B
30 1	Marinu	1.9	1.25	1.52	*H
30 2	Mines	2.6	1.55	1.68	*H
31	Pomberan	3.5	1.5	2.33	A
32	Pabim	5.5	3.0	1.83	D
33	Tondem	4.0	2.0	2.0	H

Group refers hearths which have similar characteristics in intensity of production.

* Hearths where data recorded on nutritional status of children for 12 months from February 1980 to February 1981. These children are the subject of a study by Janis Baines which is to be presented for the degree of MSc at the London School of Tropical Health and Hygiene in 1983.

The weighting of individuals to transform them into producer consumer units renders the data unsuitable for statistical analysis, including multiple regression and other techniques which assume that the data sets are independent and normally distributed, although other research workers have utilized regression techniques (Sahlins 1974, Modjeska 1977, Hide 1981). It is clear that the weighting given to people according to whether they are classified as either consumers or producers adds a bias to the transformed observations which makes them neither normally distributed and continuous nor independent of each other.* The number of people in each household is independent from one household to the next. The schema set out in Table 9.1 transforms the number of people into either consumers or producers according to a scale that is not of an interval nature. This not only precludes the use of parametric tests but also links the individual households to an underlying weighting scale. Such a weighting scale could also be manipulated to produce a data set (consumers and producers in each household) which when correlated with a dependent variable would produce any desired result.** While non-purists might make a case

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* Using parametric tests such as regression analysis makes the following assumptions of data, the population data, not the sample data: (a) that the population data are normally distributed; (b) that the observations are independent of each other, that the value of any one case does not affect that of others; (c) that the populations being considered have the same variance; (d) that the variables are available on the interval scale (Gregory 1971, Poole and O'Farrell 1971, Mark and Peucker 1978, Gould 1970).

** Using a single regression model produces an r^2 value close to zero when the model is based upon hearth units. When the household is the unit of analysis then r^2 of 0.75 are obtained between area of sweet potato cultivated as the independent variable and either producer or consumer as the dependent variables. However consumers and producers have a high degree of collinearity (r^2 0.9).

for using simple regression techniques on such data, an additional objection can be raised to the use of multiple regression. Because the new variable consumers and the new variable of producers, are constructed from the same basic variable (number of people per household), then the two new variables are not independent of each other and cannot be treated as additive in a model of multiple regression. The relationship between the original variable (people) and the two new variables (consumers and producers) has a high degree of collinearity.

I have divided the hearth units of the Pubi into eight groups (Table 9.2). The groupings were determined by examination of three sets of relationships: the ratio of hectares of cultivated land per hearth unit to the number of consumers per hearth unit; the ratio of hectares of cultivated land to producers; and the relationship between the ratio of hectares of cultivated land to producers and that of consumers to producers. The three relationships are plotted in Figures 9.2, 9.3, and 9.4.

The ratio of hectares of cultivated land to producers in Figure 9.2 was computed to test the supposition that as the number of producers increases so to will the number of hectares of cultivated land per hearth unit increase. The ratio also gives an indication of the intensity of labour utilisation. From Figure 9.2 it can be seen that the hearth units are remarkably similar in the area cultivated despite the variation in the number of producers. It might be concluded that the distribution shown in the graph conforms to what Sahlins (1972:87) calls Chayanov's rule: that is, the greater the

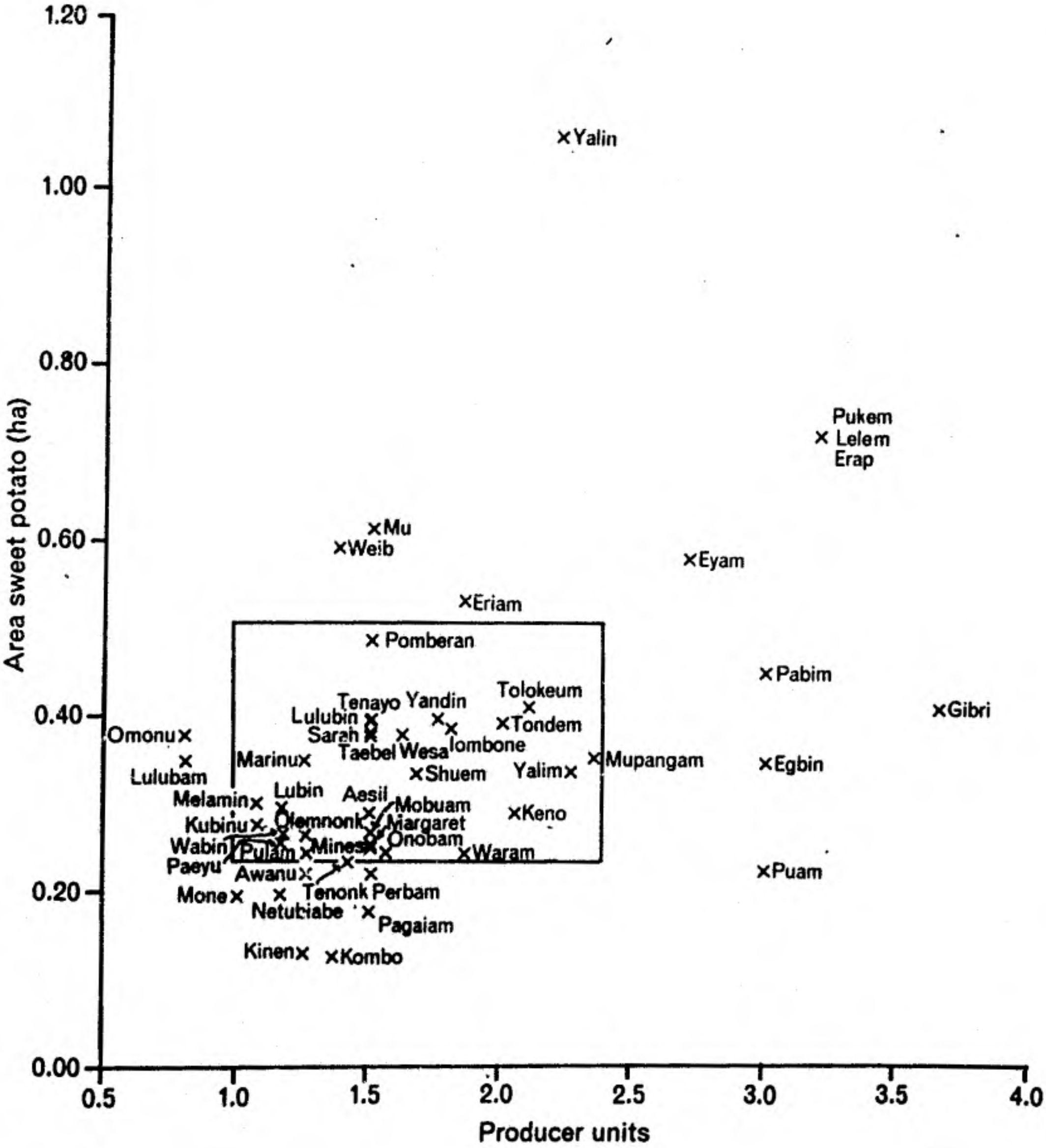

Figure 9.2 : The relationship between the area of sweet potato cultivated per hearth unit and the number of producer units per hearth unit .

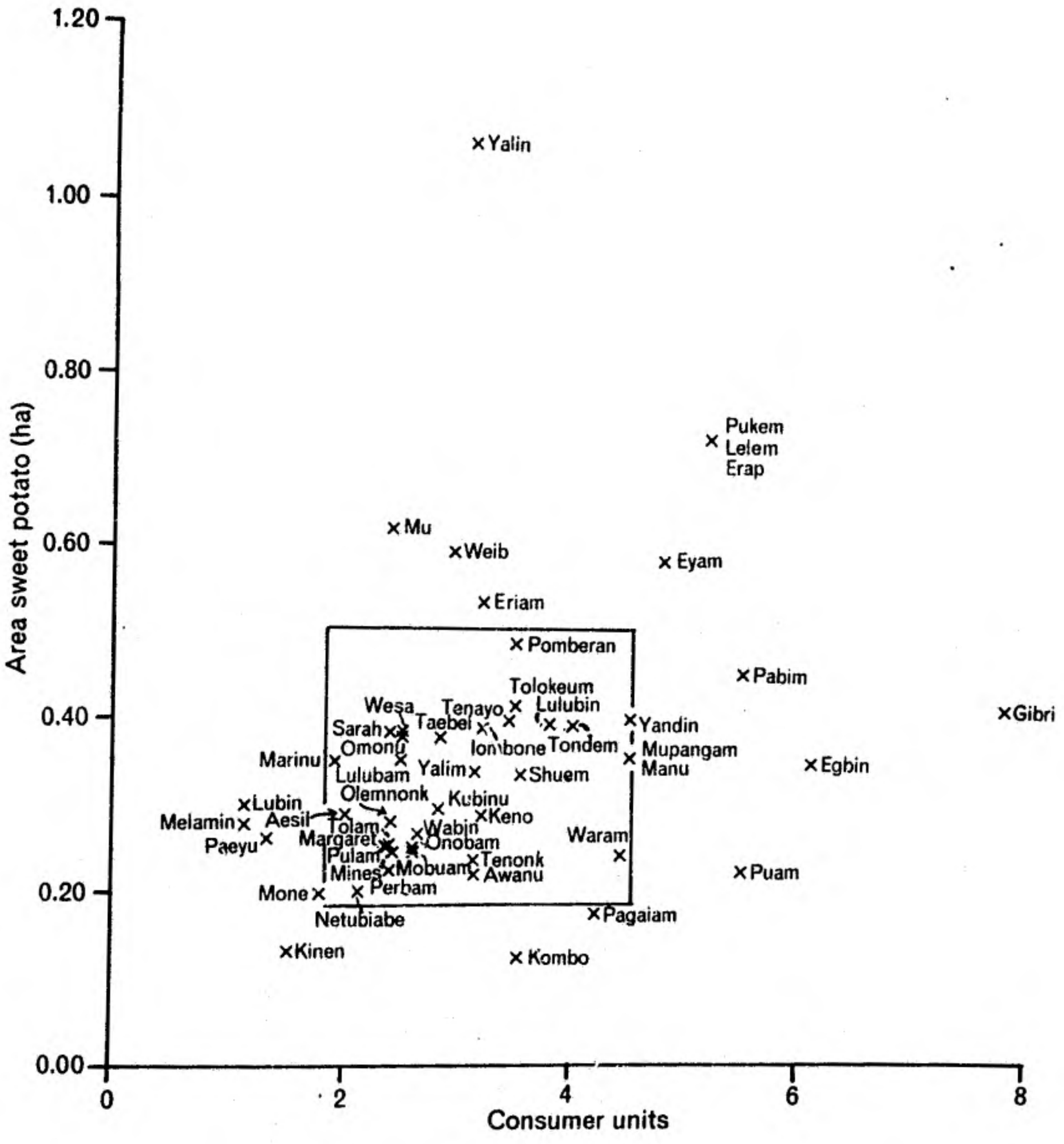

Figure 9.3 : The relationship between the area of sweet potato cultivated per hearth unit and the number of consumer units per hearth unit.

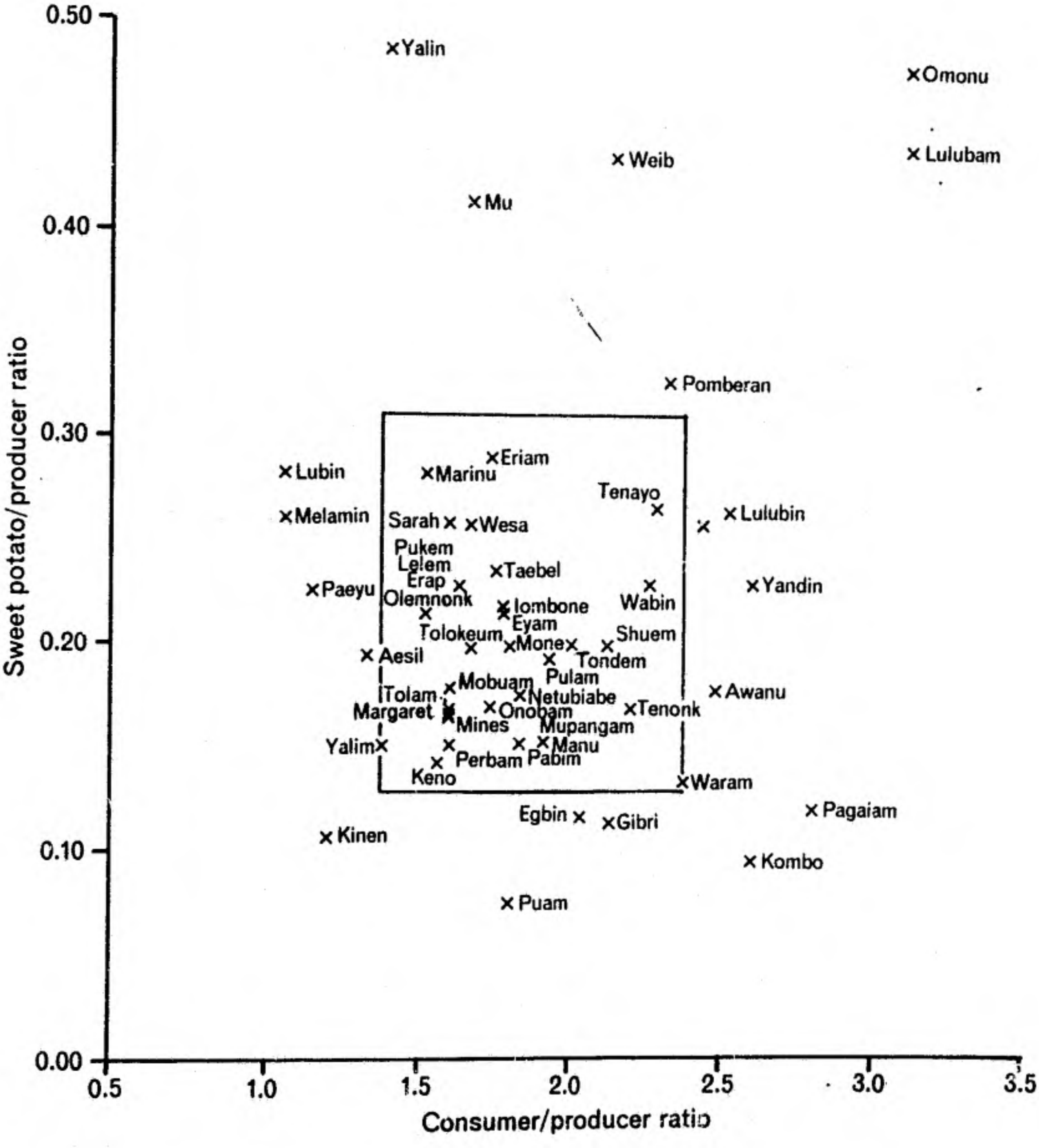

Figure 9.4 : The relationship between the ratio of area of sweet potato cultivated to producers with the ratio of consumers to producers.

relative working capacity of the hearth the less its (individual) members work. Producers as a category are however determined by a weighting system, and because I have shown that the variation in the area cultivated between individual women is small (Chapter Eight), it would appear that the weighting system is rather more biased than I expected. Factors other than simply the number of producers in each hearth unit are at play. Apart from the personal whim of each woman, her age, and the number of pigs she possesses, a land constraint may also operate, to determine the area cultivated by each hearth unit. The area a Pubi woman cultivates may be related to her husband's ability to gain access to land which is on the Plateau. Hearth units in groups D and E may reflect such a situation.

Assuming that as the number of consumers increases so too will the area cultivated expand, the ratio of area cultivated to consumers is also a measure of intensity (Figure 9.2). As with the ratio of producers to area, the lower the ratio the greater the intensity of production or consumption per unit area cultivated. Because of the close ties between consumers and producers, both being derived from the number of people in each hearth unit, the picture shown is very similar to that of cultivated area to producers. Some interesting differences will be discussed later when individual hearth units are analyzed, but an initial conclusion might be that because of a relative land shortage, (reluctance of people to move from the Plateau to their land in the Waga valley), the area cultivated is similar for every hearth unit. Then again, because the brunt of the work is borne by women, other factors impinging upon the ability of the woman to work may be influencing the cultivated area per hearth, rather than simply the number of consumers.

A further measure of intensity can be obtained by comparing the ratio of area cultivated to the number of producers in each hearth unit with the ratio of consumers to producers in each hearth unit (Figure 9.3). The ratio of consumers to producers gives a measure of the dependency ratio in each household analagous to the ratio of children to adults. In Chapter Seven the ratio of children to fecund women as well as the ratio of women aged 15 to 60 to the rest of the population were used as crude estimates of the dependency ratio (Table 7.5). The number of consumers per producer is an indication of the intensity of production, it being assumed that the smaller the relative proportion of producers the more they must work to assure a given or desired state of domestic well-being. Conversely the greater the proportion of producers to consumers the less the producers work (Sahlins 1974:89). The ratio of area cultivated to producers gives an indication of labour intensity.

Ideally the area cultivated per producer should mount in rough relation to the ratio of consumers to producers. Thus intensity of production rises relative to the number of consumers, and the higher the consumer/producer ratio the harder the producer must work, so increasing the cultivated area per producer. No linear relationship appears in the Pubi data, which is remarkably tightly grouped suggesting that labour intensity may well be increasing but on the same area of land. The areas of sweet potato cultivated (Table 9.2) may also be underestimates of the actual work (labour intensity of the woman). Women cultivate new sweet potato mounds from old, and because the area measured includes newly planted, ready-to-harvest and recently-harvested gardens, the recently-harvested may have been under-estimated due to being reworked and replanted.

Eight groups of hearths can be distinguished according to their intensity of production (Table 9.3) Group A, from the relatively large area of sweet potato cultivated per hearth appears to be producing a surplus, but the ratio of consumers to producers is

Table 9.3 : Differing Levels of Intensity in Pubi Hearth Units

Group*	Area Cultivated	Number of Producers	Area Cultivated	Number of Consumers	Ratio of area cultivated/Number of Producers / Number of Consumers/ Number of Producers
A	large	average	large	average	high / average
B	large	large	large	large	average / average
C	large	small	large	average	high / high
D	average	large	average	large	low / average
E	small	average	small	average	low / low to high
F	large	large	large	large	low / average
G	average	average	average	small	average / low
H	average	average	average	average	average / average

* Refer to last column of Table 9.2.

about average for those households which suggests that their surplus was going to be put to other purposes, probably pigs, which had died from anthrax by the time of the survey. The hearth units in Group A are listed in Table 9.2 and Yalin has 8 pigs, Pomberan has 3 pigs and Eyam 5 pigs. Both Mu and Weib lost an unknown number of pigs in the anthrax epidemics. In Group B the large amount of sweet potato cultivated seems to be dictated by the large number of consumers, which with a large number of producers available gives an average ratio of consumers to producers, and an average ratio of hectares to producers. In both Group A and B land availability does not appear to be a constraint upon production, and the men of all the hearths in the two groups are agnates within the Pubi clan. In Group C also there appears to be no constraint upon access to land because Mei, the husband of the two women in the group, Omonu and Lulubam, is a minor big-man of the Temberi sub-clan of the Pubi. In contrast to Group B and some of Group A, the women of Group C work harder - the ratio of area cultivated to producer is high. The necessity for such hard work appears to be the large number of consumers to each producer, which is compounded by the fact that Lulubam has 5 pigs to look after and feed. Nevertheless Omonu and Lulubam maintain an average area under cultivation per consumer.

The other groups, excepting Group H, are at a lower level of production. In Group D, Pabim, Egbin and Gibri have average consumer to producer ratios but a small total area cultivated in comparison to other hearths. Thus the area cultivated per producer is smaller than expected as is the area cultivated per consumer. It might be expected that the children in these three hearths would display signs of malnutrition, reflecting the low productivity of the hearth units but they are no worse than average for the Pubi children. The reasons for this add a complicating factor to the rather simple analysis of production intensity using ratios of cultivated land to producer and of consumer to producer. Gibri and Egbin are married to men who have trade stores: the production from their land is supplemented by food bought with cash. Neither man is a true agnate of the Pubi clan,* and both are putative members of the Peripant sub-clan (Chapter Three). Three factors are therefore interacting in dictating the area cultivated by Egbin and Gibri. One is their ability to work and their husband's access to available land. Another is the need for land which must be weighed against the opportunity to obtain food from the trade store. The picture is further complicated in that both women have pigs to look after, Egbin two and Gibri four.

Pabim, the other woman in Group D has three pigs to feed as well as an above average number of consumers for the area cultivated. The ratio of consumers to producers is however about average, which suggests that Pabim's hearth unit may be obtaining additional food from elsewhere. One of Pabim's sons works as a hospital orderly at the Ol Health Centre and his monthly salary contributes to the overall income of the hearth unit.

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* Unk the husband of Gibri is of Sigiriba and the Pubi is his wife's territory, while Kop the husband of Egbin is living at his mother's territory.

The group of women who cultivate a small area compared with the number of producers is the most complex to explain. Perbam, Awanu, Mone, Netubiabe, Pagaiam, Kinen and Kombo form Group E while Puam is alone is Group F. Kinen and Kombo have the lowest ratios of cultivated area to producers. Kombo has a reputation for being a hard worker, which is at variance with the evidence of the small area she has under cultivation, but most of her gardens surveyed were at Mulam outside the Pubi territory. I suspect that either I did not survey all her gardens or that her system of management gave an undue bias to the area she cultivated. As she cultivated new mounds of sweet potato she reworked mounds that had just been harvested, thus masking the extent of her work. Kinen on the other hand spent some time away from her husband staying with her mother. Not having any children and being newly married she still had obligations to her parents. Her co-wife, Olemnonk looked after their husband Yaba.* The greatest contrast is between Mone and Pagaiam. Both have a small area of sweet potato, but Pagaiam has a lower ratio of cultivated area to producers. Mone has a low number of consumers to area cultivated while Pagaiam has a high number of consumers per unit area cultivated. Consequently while Pagaiam has a small cultivated area per producer but a high consumer to producer ratio, Mone has an average cultivated area per producer as well as an average consumer/producer ratio. Mone has a small area cultivated because her husband works in Kundiawa and remits a portion of his wages to her regularly. Pagaiam on the other hand is recognized as a lazy woman, and her husband has a reputation as a

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* After I had left the area this man, the son of Ayab the big-man of the Sigerant sub-clan of the Pubi was killed in the middle of 1981 fighting on the side of the Sigeriba clan against the clans to the north.

'rubbish man' who neither does very much to help his wife in the gardens nor acquits himself well in he exchange network. Her problems are accentuated in that she has two pigs to feed while Mone has none.

The other three women in the group, Perbam, Awanu and Netubiabe while having a small area of sweet potato under cultivation, support an average number of producers (thus a relatively low ratio of area cultivated to producers). However, they have an average cultivated area per consumer, though the higher than average ratio of consumers to producers suggests that Awanu has to work relatively harder than the other two.

Puam has an average ratio of consumers to producers in her hearth unit but a low area of sweet potato. She has no pigs and is generally regarded as a woman who does not work hard. Puam, Kombo and Pagaiam's production intensity are the lowest of the Pubi hearth units.Among the hearth units with larger area of cultivated land per producer and a low consumer to producer ratio are Lubin, Melamin and Paeyu. Significantly although producing a surplus neither of them have young children or pigs. I have classified as average the other 27 hearth units in group H: they exhibit similar ratios of cultivated area to producers, cultivated area to consumers and of consumers to producers.

The overall conclusion to be drawn is that the majority of hearth units cultivate a remarkably similar area of sweet potato no matter how many consumers or producers are in each hearth. In the majority of the hearths, the number of consumers or producers also varies little. More importantly those with higher consumer/producer ratios do not necessarily cultivate more land which further suggests that either cultivable land on the Nembi Plateau is a major constraint, or that women are working at near their limit.

Land under cultivation

Of the various measures of the intensity of Pubi production perhaps the easiest to measure is population density per unit area of cultivated land; a more precise measure than the gross density of population (327) on total clan territory (5.28 km^2), which is 62 people per km^2, or of the density of occupance on their land on the Nembi Plateau (1.2 km^2), 272 people per km^2 (Table 3.6). The intermeshing of clan territories makes it difficult to distinguish boundaries and to measure precisely the amount of land possessed by each clan. Members of different clans may also cultivate gardens in each other's territories. Clansmen of the Peripant Kongu of the Pubi clan as well as members of the Temberri and Sigerant sub-clans cultivate land outside Pubi territory and some members of the Endusparr retain and cultivate land within the Pubi territory. Most of the Pubi households cultivate within Pubi territory. I did not measure the gardens of those Pubi who had no gardens under cultivation with the clan territory at Kongip, nor the gardens or household size of the Endusparr clansmen who retained land in Pubi territory and the following densities may therefore be underestimates.

The total number of people in the households of the Pubi (Table 6.1 and the hearths in Table 8.2) is 200, and the total area of land either under sweet potato, mixed gardens or fallow is 51.405 ha, which gives a density of 389 people per km^2 of enclosed and cultivated land, or 0.257 ha per person. The density increases sharply when only cultivated land is considered (18.36 ha), to 1089 persons per km^2 or 0.092 ha per person. In comparison to other parts of the highlands the density of people on cultivated land in the Pubi territory is very high (Table 9.4). A further 50 ha, cleared in the past by the Nembi, now lies fallow under long grasses and woody regrowth. The soils of this fallow land are either of poorer quality or are extremely wet, and it is on parts of this territory presumably with the better but water-logged soils that in the past the Nembi had some of their taro gardens. A further 17 ha of the Pubi territory on the Nembi Plateau in the Pwe basin is unsuitable for cultivation, being either outcrops of rock or areas where the soils are too thin. The small area of sweet potato and mixed garden per person on the Nembi Plateau (Table 9.4) thus reinforces the conclusion (Figures 9.2, 9.3 and 9.4) that either land availability on the Nembi Plateau is a constraint or the inability of women to work harder is restricting the area being cultivated.

It is more likely a combination of both factors, although the constraint on land availability is relative and not absolute, and is related to the attraction of living on the Nembi Plateau which has led to locally high population densities. Most clans have freely available land in the valleys to the west of the plateau but bringing new land into cultivation is the responsibility of the men and digging

Table 9.4 : Comparison Between the Pubi and Other Highland Groups in Area of Land in Subsistence Crops (cultivated land), per Head

Location	Area per head (ha)	Remarks
Mae-Enga	0.06-0.08	Sweet potato gardens for human consumption
Duna*	0.77	
Kapauku**	0.095	
Central Chimbu	0.09	
Wissel Lakes, Irian Jaya	0.09	
PUBI	0.092	Total cultivated land
	0.087	Sweet potato field
	0.005	Mixed garden
	0.115	Fallow sweet potato field
	0.050	Fallow mixed garden
	0.257	Total fallow and cultivated
Kanusa, Eastern Highlands	0.10	
Notofona, Eastern Highlands	0.12	
Raiapu Enga	0.16 (.105)	(sweet potato)
Korofeigu, Eastern Highlands	0.23	
Aiyura, Eastern Highlands	0.25	

* Modjeska 1977
** Pospisil 1963

Source : J.M. Macewan, Subsistence Agriculture, in R. Densley (Editor) Agriculture in the Economy: A Series of Review Papers, Vol.3 Department of Primary Industry, 1978.

drainage ditches and constructing fences are onerous tasks, and land is not often cleared. Reluctance of the men to work in the fields or to bring new land into cultivation is probably the reason why a relatively large area of the Pubi territory remains under long grass and woody regrowth fallow. It may also be argued that part of the men's reluctance to bring fallow areas under cultivation is the difficulty of obtaining wood for fences. Although areas of secondary growth are plentiful, the oaks and beech trees from which the most suitable wood for fencing is obtained, are of sufficient size only on the ranges to the west of the Pubi territory and the lower Pwe creek.

Reluctance to move back to clan territory in the west of the plateau in the last twenty years has resulted in the evolution of an interesting system of fallowing. Traditionally, when a man married he was given territory by his father and uncles. He, his brothers (and cousins) cooperated to clear new ground. The wives of brothers also cooperated and gradually assumed some of the workload of their mothers-in-law. Areas of new ground would then not be cleared, except in times of emergency when families had been ousted from their territory by enemies, until the next generation of sons married. The interval between fallowing was thus about a generation - 20 to 25 years. In the last twenty years with the pressure of population increasing on the plateau that system of fallowing has been modified.

The initial result was that people moved back to areas on the plateau that although fallow had not been fallow for very long, and which were brought again under cultivation. Secondly, as sons married they did not clear new ground but remained on their father's territory. Thus areas of enclosed land belonging to a group of brothers changed from being a patchwork of cultivated and fallow land to being almost totally cultivated. Consequently not only was the cycle of cultivation and fallow between enclosed and unenclosed land interrupted, with no new uncleared land being brought under cultivation, but the fallowing cycle within the enclosed areas also became shorter.

Sweet potato mounds in many gardens are now made from others as soon as they are harvested. Consequently soil fertility is declining and yields decreasing. The return to a woman's labour has decreased, and as yields have declined still further she has tried to compensate by cultivating more, and so compounding the vicious circle of diminishing marginal returns for marginal labour inputs. Because of the increasing pressure to maintain production of the staple - sweet potato - labour spent in cultivating mixed gardens has declined. Women are exhausted, and the diet is declining in both quantity and quality. No doubt the marginal return of woman's labour has never been very high, and the demand for pigs made a woman's life one of drudgery, but in the last twenty years her position has worsened. The high degree of background malnutrition (stunting) among children and the small stature of adults demonstrates the overall nutritional problem that existed before contact. The problem is however becoming more serious. While a woman may regard the increased survival of her children as a blessing, it has also meant increased pressure upon her time and labour.

Production and consumption

An average household has 0.528 ha of sweet potato, and 0.029 ha of mixed garden, which supports 4 adults, 2 children and 3 pigs. The average yield of sweet potato is 7.135 tonnes per hectare, thus each household produces 3.7694 tonnes of sweet potato each year. Pigs are fed on average of 1.3 kg of sweet potato a day* which over the year accounts for 1.423 tonnes or 38 percent of total production. Researchers in other areas of the highlands have reported similar amounts of sweet potato fed to pigs. Waddell (1972a:118) showed that the Raiapu Enga fed 64 percent of their sweet potato production to their pigs, a pig consuming on average 1.4 kg a day. In Raiapu households Waddell demonstrated that there was a surplus production of sweet potato per head of population over that required by humans of 2.2 kg a day, enough for 1.6 pigs. He showed that the pig:human ratio was 1.7:1. The ratio of pigs to humans among the Pubi households is 0.5:1. The differences in the ratios reflect to some extent both the different stages at which the Raiapu and the Pubi were in their pig cycles when the pig censuses were taken and the effect of the anthrax epidemics on the plateau during 1980.** It also reflects the much lower yields of the Pubi sweet potato fields.

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* The rations given to pigs of various sizes were weighed and then averaged.

** Brookfield and Brown define a pig cycle as the progression from a very few pigs immediately after a large pig-killing ceremony to a maximum number immediately before the climax of the next ceremony (Brookfield and Brown 1963:58). The maximum number of pigs which Waddell estimated could be maintained by the Raiapu Enga before a Te (pig-kill) was 3.3:1. The average for the Modopa sample of households in 1966 (where Waddell worked) was 2.3:1 (Waddell 1972:118).

In the Pubi households 62 percent of sweet potato production is consumed by people (2.3464 tonnes) giving an average per capita consumption per day of 1.07 kg. The average amount consumed by Raiapu Enga as calculated from Waddell's data was 1.3 kg (1972:118-119). For the Kapauku Pospisil calculated an average per capita sweet potato consumption of 1.98 kg a day, with that for adult males being 3.33 kg a day (1963:196, 376, 395), while in the Chimbu Hipsley and Kirk (1965), stated that adult males consumed 1.3 kg of prepared sweet potato. It would seem therefore that even the low ratio of pigs to humans of 0.5:1 among the Pubi is putting pressure upon the food supply of Pubi.

The most startling comparison between the Pubi and other areas of the highlands is shown by the production of sweet potato per capita per day (Table 9.5) although the area cultivated per person by the Pubi, Kapauku and Raiapu Enga are similar (Table 9.4), that for the Duna is appreciably lower. Differences in production must therefore be accounted for by differences in yield: that for the Raiapu is between 18 to 24 tonnes per hectare (Waddell 1972a:117); the Kapauku between 12 and 26 tonnes per hectare (Pospisil 1963:444); for the Duna about 14 tonnes per hectare (Modjeska 1977:133) and for the Pubi about 7 tones per hectare. It is also noticeable that the Pubi have the lowest ration for their pigs and the lowest amount for human consumption. The Kapuaku with the smallest number of pigs consume the largest amount of sweet potato.

The main conclusion is that the Pubi achieve a low level of production, but require a relatively high level of labour input and

Table 9.5 : Production of Sweet Potato and Sweet Potato Consumption Per Capita Per Day in Four Highlands Communities.

Places	Production per capita per day kg	Ratio of pigs to people#	Pig ration kg	Human Consumption kg
Duna*	5.6	0.55:1	2.0	3.00
Raiapu Enga**	3.6	1.7 :1	1.4	1.3
Kapauka***	2.75	0.17:1	4.5	1.98
Pubi	1.7	0.5 :1	1.3	1.07

* Modjeska 1977:131-144. It is extremely difficult to determine what of Modjeska's data is derived from empirical evidence and what is based upon assumptions which are poorly stated. Note that the production figures are sweet potato equivalents and that there appears to be a surplus over and above the demand by both humans and pigs.

** Waddell 1972 Chapter Four.

*** Pospisil 1963:196, 297, 376, 395.

\# Other figures are Mae Enga 1:1 (Meggitt 1958:288); Chimbu 1.5:1 (Brookfield and Brown 1963:59); Angoiang 0.5:1 (Rappaport 1968:14,57); Tsembaga Maring 0.83:1 (Clarke 1971:18, 84); Barabuna 0.86:1 (Grossman 1979:243).

land use intensity to achieve this: the marginal productivity of labour is extremely low. The technology of the Pubi however, is the same which they would use if they were cultivating with a long fallow system. There is very little composting, mulching or use of any other techniques to raise yields, which implies that in the future the Pubi must either adopt new technology and thus shift their production function upwards and to the right as in Figure 9.1, or clear new land. The men must work.

Against this background of an already critically low level of production, fluctuations in the number of pigs throughout the duration of the pig cycle can be expected to have an important effect upon the well being of those people least able to fend for themselves - young children during periods of shortage. The seasonal nature of produc- in Chapter Eight can also be expected to be reflected in seasonal fluctuations in nutritional status.

<u>Nutritional status and consumption</u>

The low agricultural productivity of the Pubi and the variation about that low level has produced the poor nutritional status of children under the age of five. Variations in the nutritional status of children are not however, directly related to variation in the area of sweet potato cultivated per woman although the variation in sweet potato cultivated per woman is small. Disease levels at particular times of the year as well as the work load of women whilst planting mixed gardens and sweet potato from September to January, seem to be more directly related to variation in nutritional status among young children. In this section I take the nutritional status of 38 Pubi children, measured by their weight for their height, as the dependent variable and regress upon it other independent variables in an attempt to come closer to explaining the variation in tion with a definite season when food supply is inadequate, described nutritional status among the child population of the Pubi and especially to point to factors causing severe malnutrition and death.

Table 9.6 shows the children of the Pubi hearth units, their age and nutritional status as well as the number of coffee trees

Table 9.6 : Nutritional Status of Children and Their Age, and the Number of Coffee Trees in Pubi Hearth Units.

Hearth Unit No.	Child	Weight-for-Height %	Child's Age and Sex (months)		No. of Coffee Trees in Hearth	Height-f Age %
21	Pomberey	85	36	F	81	92.3
22	Buka	99.3	71	F	81	87.0
22	Rut	84.7	20	F	81	86.0
23	Mary	87.7	30	F	81	89.5
3	Sam	98.3	43	F	124	85.0
4	Daniel	98.2	59	M	193	96.0
4	no name	80.4	10	M	193	99.5
5	Julie	89.1	48	F	46	89.5
5	no name	109.5	7	M	46	102.0
6	Rosie	88.9	41	F	199	92.6
6	no name	73.6	0	F	199	103.0
8	Buka	97.2	52	M	29	90.4
9	no name	91.2	17	M	2	94.4
10	Kep	111.8	63	M	0	93.0
10	Parin	94.4	33	F	0	93.0
10	no name	94.4	7	M	0	104.8
12	Joseph	85.5	44	M	100	88.8
12	no name	75.0	11	M	100	97.8
132	Betti	88.9	31	F	255	90.5
151	Ben	96.1	55	M	201	92.0
151	Benni	84.6	14	M	201	99.2
152	Lus	94.6	63	M	201	88.0
152	Monica	92.7	29	F	201	94.7
153	Buka	85.7	37	M	201	90.5
17	Pret	102.3	29	M	0	97.3
18	Jacob	96.6	60	M	13	89.2
18	no name	96.5	2	M	13	103.5
221	Moses	98.4	42	M	126	89.0
221	no name	82.1	11	M	126	94.0
222	Tum	98.4	39	M	126	88.8
232	Yok	90.1	57	M	18	83.4
232	no name	80.1	9	F	18	94.2
233	Taranonk	90.1	77	F	18	84.0
234	Simon	90.5	65	M	18	92.3
237	Maria	95.2	60	F	18	89.3
26	David	97.2	18	M	42	97.0
301	no name	84.5	10	M	53	95.3
302	Kep	86.3	34	M	53	92.0

possessed by each hearth unit.* Other variables are taken from Table 8.2. Weight-for-height was taken as the dependent variable, rather than weight-for-age or height-for-age, because it is nearly independent of age (Tanner 1978). However such a measure reflects current nutritional status and episodes of recent acute malnutrition and weight loss. I have therefore computed the height-for-age for each child also to obtain an assessment of long-term nutritional status. Height-for-age should reflect the chronic food shortage of the Pubi, the background of poor health, the prevalence of infectious diseases, and the hard work of the women. Against this background episodes of acute malnutrition reduces the nutritional status of children already suffering from disease and inadequate diets, to levels critical to their survival.

Only two children in the Pubi appear to be in a critical condition, that is, they are wasted. Tolokeum's young daughter (who is not yet named) is only 73.6 percent weight for her height although she is 102 percent of her height for her age. Like most Pubi babies she is long and thin but as the second daughter she is not being cared for properly. Lalabab her father wanted a son. She was born in November 1980 at a time when her mother was very busy in the sweet potato fields and mixed gardens, a time of physiological and psychological stress. Her milk supply was probably inadequate for

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* Coffee is the only cash crop grown on the Nembi Plateau and has therefore been used to give an indication of cash income of individual hearth units. As discussed later in the Chapter, coffee is grown on soils previously planted with mixed garden crops.

the child and in addition, because Tolokeum was working in the fields she was not able to breast-feed her child on demand.

The other child suffering from acute malnutrition is Pagaiam's youngest son who is only 75 percent weight-for-height although he also is close to 100 percent height-for-age. This would suggest that he has suffered no previous episodes of acute malnutrition. However at 11 months of age he is passing through the stressful time of weaning (Table 8.2). His mother has the reputation of being a "poor mother" she quarrels with her husband and does not feed her children regularly often leaving them to wander and fend for themselves or get food from other mothers, which may account for her youngest child's poor nutritional status.

The result of the regression analysis is shown in Table 9.7. The amount of explained variance is relatively low, 33 percent, and the first conclusion to be drawn from the model is that other factors are at play. Thus confirming my earlier conclusion, that regression analysis with the factors collected conforming to the simple model of land and people is inadequate to explain the nutritional status of children. The size and composition of the hearth units explains nothing of the variation in nutritional status. The single and largest explanatory factor is the age of the child, with nutritional status improving with the child's age. According to Waterlow (1976) weight-for-height is age independent for children under the age of 6. The obvious conclusion is that either the sample of children is biased, or that the nutritional status of children does indeed improve with age. There are very few children in the younger age groups, and

Table 9.7 : Nutritional Status of Thirty-Eight Pubi Children Under the Age of Five and its Possible Correlates.

Dependent Factor; Weight-for height	Age of child	Area of mixed garden	Number of coffee trees	Age of child's mother	Area of sweet potato	r^2/
Coefficient	0.159					
t value	2.748(a)					0.
Coefficient	0.156	-0.036				
t value	2.82(a)	2.18(a)				0.
Coefficient	0.150	-0.033	-0.025			
t value	2.79(a)	2.00(a)	1.71(a)			0.
Coefficient	0.181	-0.033	-0.025	-0.287		
t value	3.24(a)	2.06(a)	1.69(a)	1.628(b)		0.
Coefficient	0.180	-0.038	-0.025	-0.239	-0.011	
t value	3.22(a)	2.28(a)	1.736(a)	1.316(b)	1.034(b)	0.

a Significant at the 5 percent level $p<0.05$ One tail test.
b Not significant at the 5 percent level $p<0.05$ One tail test.

normally the nutritional status of the children under 5 months of age is satisfactory (Chapter Two). If that age group is ignored, the nutritional status of children does indeed improve as they get older and leave the rigours of weaning behind them. The poor nutritional status of Tolokeum's younger daughter emphasises the bias. In addition the older age groups are biased as they represent survivors, and by definition the fittest of their cohort. The weakest cannot be accounted for as they have died.

The other factors, except for mixed garden area, all had a negative relationship with the dependent factor as shown by negative coefficients. Thus in the model, the greater number of coffee trees the larger the area under sweet potato, and the older the mother, the poorer the nutritional status of children. Ignoring for the moment the number of coffee trees per hearth, the relationship of mother's age and area under sweet potato with the nutritional status of children suggests that the work load of the mother as well as her ability to work affects the nutritional status of her children. It is not that the older woman cannot cultivate enough sweet potato to feed her child, but more probably that she also has other children to support. Thus whilst maintaining the area of sweet potato she has always cultivated she divides the time she previously invested in looking after one child between two or more children.

The relationships while statistically significant are nevertheless very small and interpretation must be made critically.

The number of coffee trees accounts for 10 percent of the variation in nutritional status of children. It is however a negative relationship (the coefficient is negative). Because the area of mixed gardens has a positive correlation to the nutritional status of children (explaining a further 12 percent of the variance), it is tempting to suggest that coffee production competes with mixed gardens for available land and time. Few women lack access to mixed garden land, although they are dependent upon their husbands to clear the ground for them and to build fences. It may be that those women with coffee feel that they do not have to cultivate a mixed garden because they expect to be able to buy extra food from the cash earned from coffee. The income from coffee however, comes during the mid-year period and does not compensate for lack of mixed garden foods earlier in the year. Thus a child may be denied the products of both the mixed garden and the trade store in the first part of the year. Children whose mothers have mixed gardens may therefore have marginally better nutritional status.

These interpretations are only tentative and the regression analysis accounts for only 38 percent of the variation in nutritional status of Pubi children. The seasonal pattern of vulnerability to infectious disease, and the effect of a seasonal pattern of women's work on the nutritional status of children, has already been demonstrated, and it is logical to conclude that at least part of the unexplained variance in nutritional status is accounted for not only by those factors, but probably also by seasonal fluctuations in food supply. All data so far analyzed has been of a cross-sectional nature, that is the nutritional status of a child population at one time of the year - July to August. The age-sex composition of the child population at any time of the year may also introduce a bias and post bouts of poor health and nutritional deprivation, represented in a child's present anthropometric status by a child's height is hidden by classifying children according to their weight-for-height or present nutritional status. Events of a more cyclical nature over a period of time which may affect the growth of young children are masked. The most important cycle in the Nembi socio-economy is the periodic fluctuations in the number of pigs kept by the Nembi people. Operating within that long term cycle is the seasonal fluctuations in the gardening system.

Pig cycles and the nutritional status of young children

In November 1977 the children of Embi Maternal and Child Health clinic (Pubi-Penarop clan-pair plus children from Endersparr, Murupa and Porelep clans) were assessed as part of the 1978 National Nutrition Survey (National Planning Office) for their nutritional status according to their weight-for-age. In June 1980 they were again assessed by myself, Janis Baines and Mary Hermiz and their height-for-age recorded as well. Table 9.8 compares the results of both surveys. The pattern in 1980 showed an improvement over 1978 with 51.2 percent of children over 80 percent weight-for-age rather than 37.1 percent. But the proportion of children under 60 percent weight-for-age was greater in 1980 than in 1977.

Table 9.8 : Percentage Weight-for-Age* of Embi Children in 1977 and 1980.

	Percentage weight-for-age					
Age Group	Under 60		Between 60 and 80		Over 80	
	1977	1980	1977	1980	1977	1980
0- 5	0 (0)	0 (0)	33 (4)	8.3 (2)	67 (2)	91.7 (24)
6-11	0 (0)	10.5 (2)	52.6 (12)	43.5 (8)	47.7 (9)	47.0 (10)
12-23	8.3 (3)	10.7 (3)	63.9 (23)	53.6 (15)	27.8 (10)	35.7 (10)
24-35	3.3 (1)	3.2 (1)	56.7 (17)	48.4 (15)	40.0 (12)	48.4 (15)
36-47	0 (0)	3.2 (1)	62.8 (27)	51.6 (16)	37.2 (15)	45.2 (14)
48-59	3.4 (1)	4.0 (1)	65.5 (19)	68.0 (17)	31.1 (9)	28.0 (7)
TOTAL	2.9	5.0	60.0	43.8	37.1	51.2

* As noted in Chapter Two the height of individual children was not recorded by the National Survey in 1977 and the less stringent weight-for-age classification was used.

The variation between the results of the two surveys prompts speculation as to whether the differences are due to a real improvement in nutritional status of children or to other ephemeral factors. It is probable that some difference is due to the different time of the year in which the surveys were carried out (November 1977 and June 1980) and the varying performance of particular age groups throughout the year. The data available are not really adequate for a thorough analysis but the difference between the two surveys of Embi appears to be largely accounted for by the improved nutritional status of children under six months of age in the 1980 survey (91.7 percent of children under six months of age were over 80 percent weight-for-age in 1980 while only 67 percent of children under six months of age were over 80 percent weight-for-age in 1977). A possible explanation might be found in the month of birth of those children, reflecting not only a combination of the time of year when they commenced to take solids, with the period when their mothers were working hardest in the gardens but also their birth weights. In the 1980 survey the Embi children recorded under the age of six months were all born between January and June the period of greatest disease prevalence, while in the 1977 survey they were born between June, and November, the healthier period of the year, but the period when mothers work hardest in the gardens and are losing weight.

This hypothesis is tested later with longitudinal growth data for children in the MCH clinic of the lower Pwe creek registered at Ol Health Centre. The proportion of children who were acutely malnourished in 1980 at Pubi (Table 9.8) between the ages of 6 and 23 months was twice as much as in 1977. Although there were more children over 80 percent weight-for-age in 1980 in that age group, it appears that conditions were such that children who were borderline cases between being malnourished and acutely malnourished became acutely malnourished. Although the overall picture might suggest that the pattern in 1980 was better than in 1977, with more children over 80 percent weight-for-age, the proportion of children acutely malnourished and therefore with the greatest risk of dying was higher in 1980.

The pattern for the adjacent clinic, Pumberal (The Koin-Iomo clan-pair and some members of the Sigiriba clan) is similar to the pattern for Embi clinic in that no single change can be identified for all age groups between 1977 and 1980 (Table 9.9). The status of some cohorts improved and of others deteriorated in 1980 compared to similar cohorts in 1977. Taken as a whole however, it appears that the Pumberal Clinic children have a poorer nutritional profile in 1980 than in 1977 with the proportion of children over 80 percent weight-for-age smaller in 1980 (48.2 percent) than in 1977 (55.8 percent). Like the Embi children however, the proportion acutely malnourished in 1980 was larger than in 1977. Interesting differences appear in the Pumberal MCH clinic when the age groups are compared and it is especially remarkable that among those children between 6 and 11 months in 1980, 13 percent were acutely malnourished compared with 6-11 months old children in 1977 when only 7 percent of them were malnourished. In the older age groups there were smaller proportions of children over 80 percent weight-for-age in 1980 than in 1977. Thus although in both the Embi and Pumberal clinic the proportion of acutely malnourished children increased from 1977 to 1980 especially

Table 9.9 : Weight for Age of Pumberal Children in 1977 and 1980.

Age Group	Percentage weight-for-age: Under 60 1977	1980	Between 60 and 80 1977	1980	Over 80 1977	1980
0- 5	0 (0)	9 (1)	21.0(3)	18.0 (2)	79.0 (11)	72.0 (8)
6-11	7.0 (1)	13 (2)	42.8(2)	7.0 (4)	50.2 (7)	60.0 (9)
12-23	5.1 (2)	0 (0)	38.5(15)	69.7 (23)	56.4 (22)	30.3 (10
24-35	0 (0)	0 (0)	41.7(10)	53.8 (14)	58.3 (14)	46.2 (12
36-47	0 (0)	0 (0)	44.0(12)	54.2 (13)	56.0 (15)	45.8 (11
48-59	0 (0)	0 (0)	52.6(20)	50.0 (13)	47.4 (18)	50.0 (13
TOTAL	1.9	2.2	42.3	49.6	55.8	48.2

in the 6 to 11 months and 12 to 23 month cohorts, the proportion of normal children (over 80 percent weight-for-age) in Embi clinic was higher in 1980 than in 1977, and was lower in Pumberal clinic in 1980 than in 1977.

The largest differences in the Pumberal clinic are in the second, third and fourth years of life. The proportion of children who were over 80 percent weight-for-age in 1980 is 26 percent less than in 1977 for children in their second year of life and 10 percent less in their fourth year of life. It might be concluded that the Pumberal children were therefore more malnourished in 1980 than in 1977.

A contrast in the change of nutritional status over nearly three years is thus demonstrated by two contiguous populations of children in the lower Pwe creek and perhaps highlights the difficulty of assessing the nutritional status of the community by using intermittent cross-sectional surveys to identify problem areas and vulnerable groups and to interpret from them trends over time (Chapter Two). It is clear that the factors affecting the nutritional status of children on the Nembi Plateau are legion, ranging from factors impinging upon the mother-child relationship to disease prevalence,. both weight and month of birth. A tentative explanation for the contrast between the Embi and Pumberal children illustrates the point.

In April 1976 the clans Pubi-Penarop, Epi-Yokul (all in the area served by the Embi clinic) the Porelep-Murupa, Puit-Palom and Al-Pelen (served by the Uba clinic) held a pig ceremony. The Pubi-Penarop and Epi-Yokul had previously held one in 1953 (see Chapter Three) and the Uba region held one in August 1961 (see Patrol Report Nipa No.1 1961/62). In April 1981 the Koin-Iomo, Ib and the Werut-Marop (the Pumberal, Tobua and Enip clinics) held a pig-kill. They had previously held one in August 1961 (Patrol Report No.1 Nipa 1961/62). On each occasion large numbers of pigs were slaughtered and pork distributed. The ceremony in April 1981 marked the end of a period in which the Pumberal women had had a great deal of responsibility in looking after large numbers of pigs. The high degree of management and coordination needed, in what is essentially an egalitarian and acephalous society, to stage a pig kill meant that on each occasion there were false starts and the women were under considerable strain for a protracted length of time. The date for the Pumberal pig kill was set many times before it eventuated, and the Pumberal women complained bitterly that they had so many pigs to look after. The large number of pigs meant that gardens were always being damaged. At the time of the 1977 nutrition survey there were less children in Pumberal clinic severely malnourished than in Embi clinic. There was an especially high proportion of children of the 12-23 month cohort in Embi acutely malnourished and only 28 percent of that cohort were above 80 percent weight-for-age (Table 9.8), a marked contrast to the nutritional pattern of the 12-23 month cohort in 1980.

The contrast in the Pumberal clinic appears to be in the opposite direction with children's nutritional status worse in 1980 than in 1977 in the cohorts 6-11 months and 12-23 months, with only 30 percent of the latter cohort being above 80 percent weight-for-age in 1980 compared with 56 percent in 1977 (Table 9.9).

It is tempting to draw a simple correlation between the incidence of the pig kills and poor child nutrition and to assume that more pigs means less food for human consumption. The point is, however, that the mother-child relationship is put under greater strain. It is not the shortfalls in food supply _per se_ but more probably the heavier load placed upon the mother in her role as exchange transactor, and the rearer of pigs as well as producer of food for her family, that is critical. Many of the Pubi women were caring for pigs agisted from the Pumberal area in 1980 which may account for the high incidence of acute malnutrition among very young children (Table 9.8) in 1980. Although the older children were of better nutritional status than in 1977, both Pubi and Pumberal young children were adversely affected by the large number of pigs in 1980.

The vulnerability of the Pubi children to fluctuations in the pig-herd is mirrored by their sensitivity to fluctuations in food supply caused by environmental disasters. Even with a very small ratio of pigs to humans* the production of sweet potato provides an average daily per capita consumption for humans of 1.07 kg (Table 9.5), only 82 percent of the daily consumption of the Raiapu Enga. Waddell estimated that sweet potato accounted for 63 percent of the weight of total food intake by the Raiapu Enga (1972a:123-124). Venkatachalam (1963:9) measured the equivalent in Chimbu at 77 percent Both areas have more highly developed agricultural systems than the Nembi and it is extremely unlikely that increased production from the mixed gardens of the Nembi in comparison to the Enga or the Chimbu compensate them for the low yields of sweet potato. Seasonal fluctuations in food supply, a food supply that is low by highland standards, and periodic disasters are therefore of critical importance to the Nembi, for they are already under stress not only because their food supply at the best of times is low, but also from other factors of the physical and social milieux.

The periodic occurrence of seasonal food shortages

The worst frost in living memory appears to have occurred in 1940 or 1941 and was accompanied by a prolonged drought lasting up to

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* 0.5:1 - which is an underestimate because of the decrease in the size of the herd due to anthrax.

seven months (Brown and Powell 1972:5). Other significant frosts occurred in 1949, 1950 and 1962 (Brookfield 1964:25). On each of these occasions food supplies were severely limited over wide areas of the highlands. Usually frosts and other events precipitating shortfalls in food supply are localised: a result of the broken terrain and the great variation in local micro-climate. In pre-contact times an important strategy employed to offset the effects of such localised disasters was to migrate, usually to lower altitudes to live with kin until the sweet potato and other crops had recovered (Ryan 1961, Wohlt 1978). These migrations were by no means haphazard: Wohlt states that in the Yumbisa area of the Enga (the upper Margarima area on the border of the Enga and Southern Highlands Province) particular families had specific kin with whom they lived in times of hardship (Wohlt et al 1982:7).

Such a strategy was also used by the Nembi and other groups and Patrol Officers from Nipa and Mendi reported food shortages in the 1960s and 1970s. The demands for food to be supplied to feed large numbers of carriers and police, made by patrols along frequently patrolled routes could however, have given a misleading picture. Patrols visiting small and localised populations living from day to day and harvesting sweet potato as they needed it, could gain the impression that food was in short supply because the available surplus would not have been high. I suspect that when Jack Hides traversed the plateau in 1935, the reluctance of the Nembi to give the patrol sweet potato was in part related to this situation. In addition, there may have been a food shortage because of inclement weather in the previous four or five months. Hides and his patrol crossed the plateau in mid-May 1935: a frost in late 1934 followed by a dry period could have resulted in the shortage in May, although no evidence exists to support this theory. Perhaps the real reason for an apparent unwillingness on the part of the Nembi to supply food to the patrol was related to the fierce warfare at the time between the clans through whose territory Hides passed. In warfare on the plateau it was common to destroy as much as possible of the enemy's food gardens and the Semin and Merut clans through whose territory Hides passed, were at war when the patrol crossed the plateau.

A patrol in 1962 reported a food shortage in the Nembi valley, but the patrol closely followed two previous patrols to the same area, and food had been given to those patrols (Patrol Report No.5 Nipa 1961/62). Another patrol from Nipa and patrolling the Margarima area to the north reported people moving from the higher slopes of the Waga valley near Margarima to the lower area around Nipa, after a frost in September 1961 had destroyed gardens in the Margarima area (Patrol Report No.8 Nipa 1961/62).

A food shortage was reported on the Nembi Plateau in August 1962 and it was also noted that the period from October to January was usually a period of food shortage (Patrol Report No.4 Nipa 1962/63). It was suggested that this was related to the fall in garden activity during May and June: the driest part of the year.*

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* The decrease in garden activity during May and June (Chapter Eight) is not, as has been suggested for other areas, due to men migrating to Hagen to harvest coffee.

A patrol also noticed a food shortage in the Nipa basin and Nembi Plateau area in February 1964 (Patrol Report No.7 Nipa 1964/65). It was commented that a period of regular food shortage occurred between December and early February. In June 1965 a shortage of food was reported in the lower Waga valley, southwest of the plateau (Patrol Report No.8 Nipa 1964/65), and in September of the same year frosts were reported in the Margarima area after three to four months of relative drought (Patrol Report No.1 Nipa 1965/66). A marked shortage of sweet potato was noticed throughout the region. Frosts again occurred in December 1965 (Patrol Report No.6 Nipa 1965/66) in the Margarima area, and in February 1966 a report stated that there had been a four month drought in the southern Nembi Plateau and Nembi valley from August to November 1965 (Patrol Report No.5 Nipa 1965/66). An unusual feature of this drought was that it was thought to have been instrumental in some way to the occurrence of the short-lived cargo cult of the six-headed snake (see Appendix 5.1).

Food shortages are therefore not unknown to the Nembi and their occurrence during particular times of the year is recognised by them. The strategies adopted by the Nembi to minimise the effects of seasonal conditions are thus not wholly an unthinking response which they have adopted from their forefathers. Apart from the periodicity of the food shortages reported by patrol officers, the seasonal nature of their occurrence is also marked. The seasonal pattern of the composition of diets of Pubi children displays a similar pattern.

The seasonal pattern of consumption

Sweet potato is by far the major component in the Nembi diet. Its supply is seasonal, but the supply of the supplementary foods of the mixed garden is decidedly more so. From March 1980 to February 1981 Janis Baines collected information on the availability of foods and the composition of the diets of 40 children under the age of five from the hearths and production units of the Pubi. The pattern of availability of foodstuffs demonstrated by the composition of the children's diets (Figure 9.5), reflects the seasonal availability of foodstuffs in the weekly Saturday market at Ol (unpublished data D'Souza pers comms. 1981-82).

The importance of sweet potato, even in the diets of young children, is immediately apparent, and the seasonal supply of some mixed garden foods is marked. Of interest is the steady number of children reported to have eaten tinned fish and rice. A slight seasonal pattern is apparent and more children were given tinned fish between August and September, and in March. Rice consumption also peaks in September, as does the consumption of biscuits from the trade store and it appears that store-bought foods supplement children's diets when supplies from the mixed gardens are at their lowest. Both rice and tinned fish are important sources of protein and are discussed later when the actual nutritional composition of the children's diets is examined.

The consumption of pork appears to coincide with the peak in funerals (Figure 8.2) during the year. Pork is distributed at

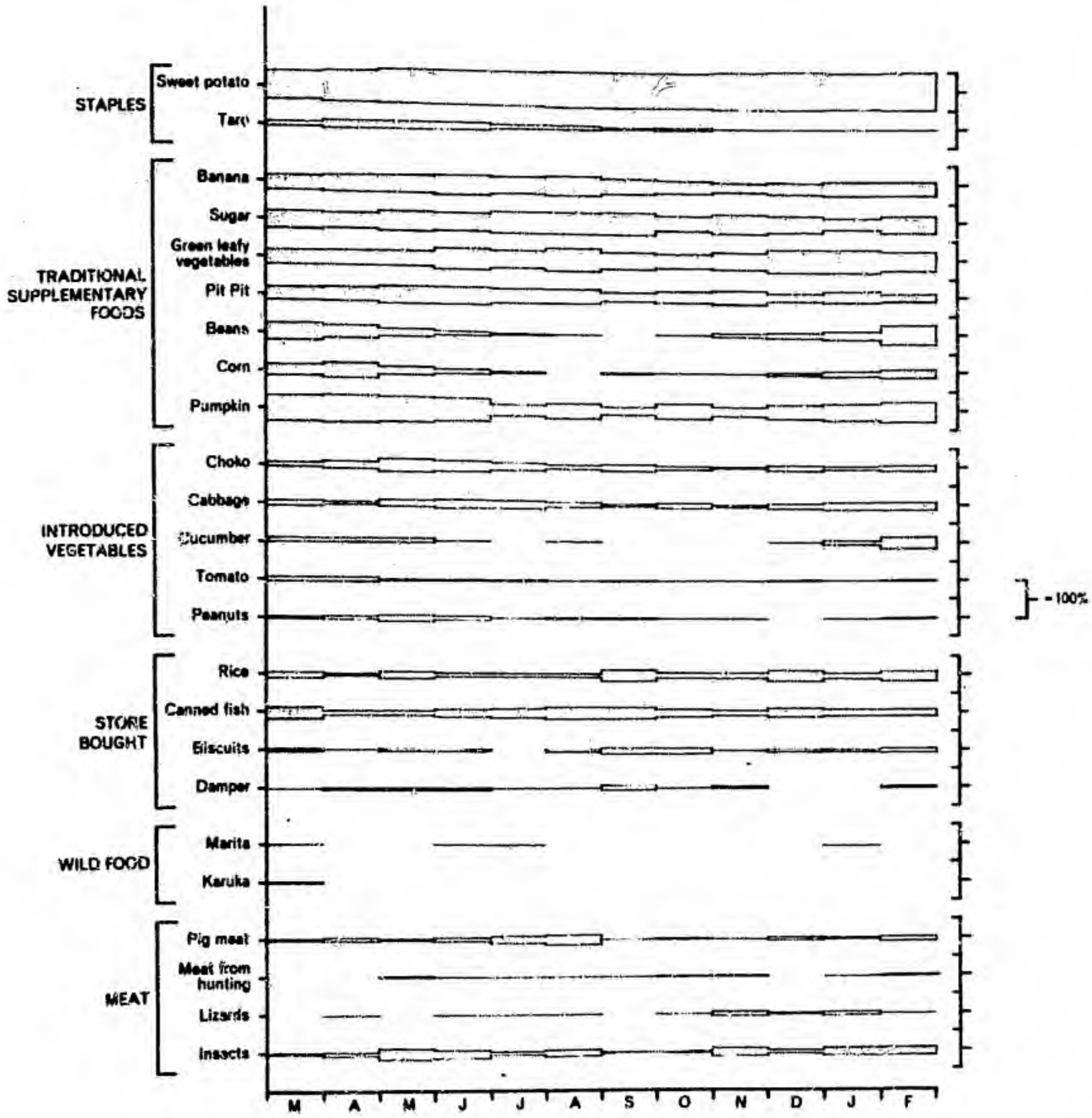

Figure 9.5 : The seasonal pattern of dietary composition of the Pubi children

* The division for each food represents 100 percent. The pattern is composed of the percentage number of times a food was reported consumed per month. Each of 40 children's mothers were interviewed three times a month randomly, and asked to recall the diet of her child for the previous 24 hours. There were therefore a possible 120 times that a food could be reported consumed.

funerals. The consumption of grasshoppers and other insects coincides with periods of the year when the women are either in the gardens and therefore able to collect the insects as they clear the ground, or when the weather is comparatively dry as in May and June, when insects are abundant.

As well as assuming that the availabil[illegible] of foods in the Pubi region can be interpreted from the composition of the children's diets, an attempt was made to quantify the amounts of each food eaten in order to determine their relative nutritional importance in the diets. Each woman was asked how many portions of a particular food she had given her child or she had seen here child eat. Each woman was asked to demonstrate regularly throughout the year what she meant by a portion of each foodstuff. These were weighed and an average taken for the portions of each foodstuff of all the women. This method of dietary survey is discussed in the WHO Monograph The Health Aspect of Food and Nutrition (1979:221-233) and the limitations and merits of such a method are not discussed further here except to acknowledge that the results of the survey are only best estimates and are not meant to imply any high degree of precision. The results do however give a good overall impression of the variation throughout the year of the diet of children of various age groups. As best estimates I believe them to be a fair representation of average supplementary diets for the age groups.* It must be noted that no attempt was made

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* It need hardly be said that to weigh every piece of food eaten by 40 children for three days a month for 12 months would be an impossible task for a single researcher with other demands upon her time. Unless the techniques were critically assessed and the sample were to be made smaller the results would also probably imply an accuracy that could be misleading.

to measure the consumption of breast-milk, which is a very important component of young childrens' diets.

The seasonal pattern of consumption by Pubi children of various green leafy vegetables (Figure 9.6) measured by the number of standardized portions eaten per month, demonstrate the ability of Rungia to produce continually throughout the year. It is supplemented with Amaranthus from March to May after Rungia's first harvest. The seasonal consumption of the other minor mixed garden crops is marked, especially that of Sechium edule leaves (choko) and Nasturtium schlecteri. Pumpkin leaves (young shoots) appear to be a standby in the middle of the year, August and October, and also are eaten in large quantities from December to February.

Supplementing the leafy green vegetables is a fairly wide range of beans. The consumption of beans is also very markedly seasonal (Figure 9.7). During September none were eaten by Pubi children and I assume that none were available. In pre-contact times and in the immediate post-pontact era the Nembi had a reputation for their large bean gardens especially in the Nembi, Erave and Waga valley. On the plateau the wing bean, the traditional bean of the Nembi, does not produce so well as in the warmer and lower valleys. The larger amounts of the introduced beans, which produce more prolifically on the plateau, the common bean especially, consumed by the Pubi children at particular times of the year also point to beans as a social food. Because huge amounts are ready to be harvested at any one time they are distributed widely to friends and kin. Beans are among the first of the mixed garden crops to be harvested and are

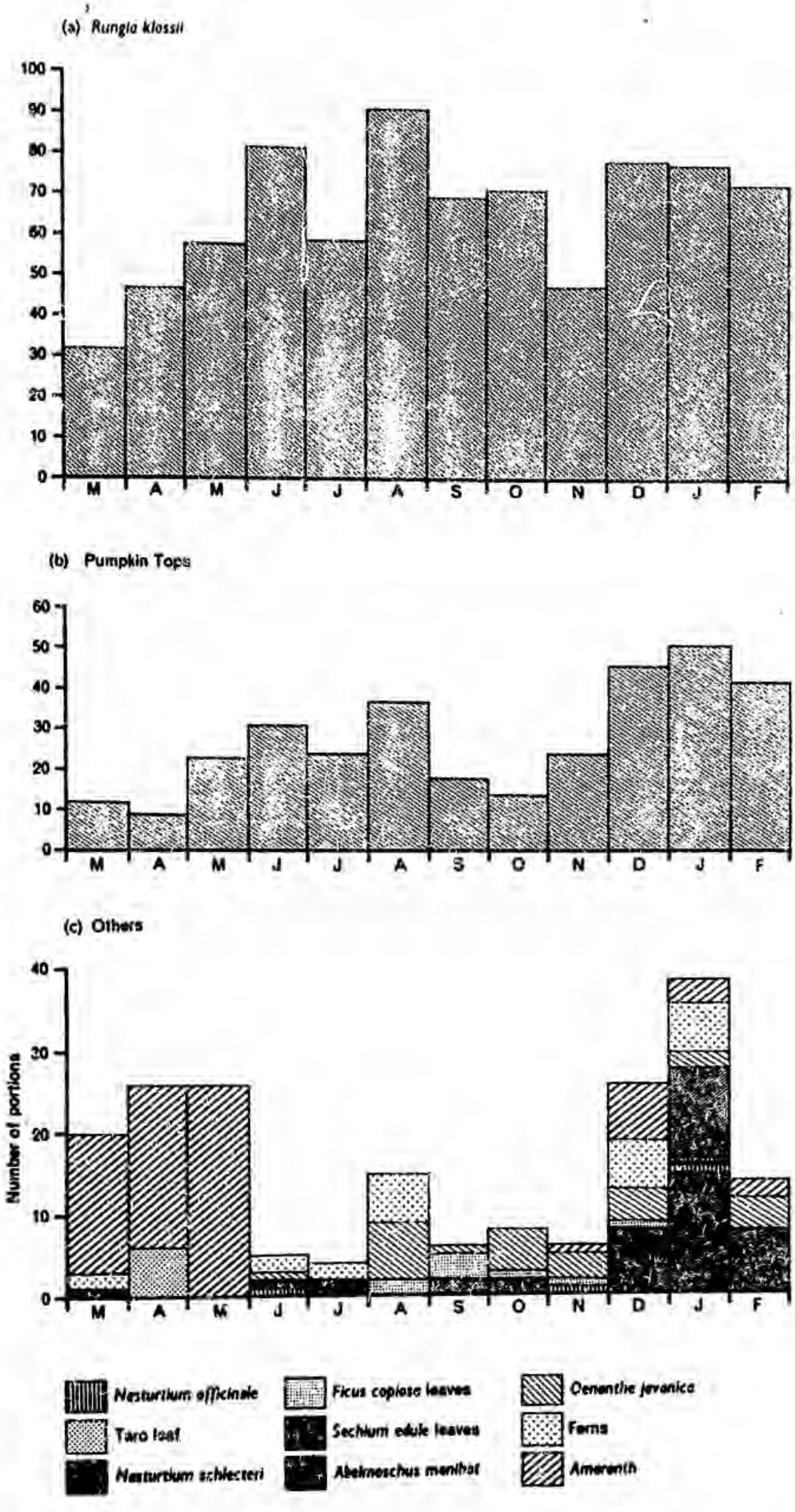


Figure 9.6 : The seasonal consumption of green leafy vegetables by Pubi children.

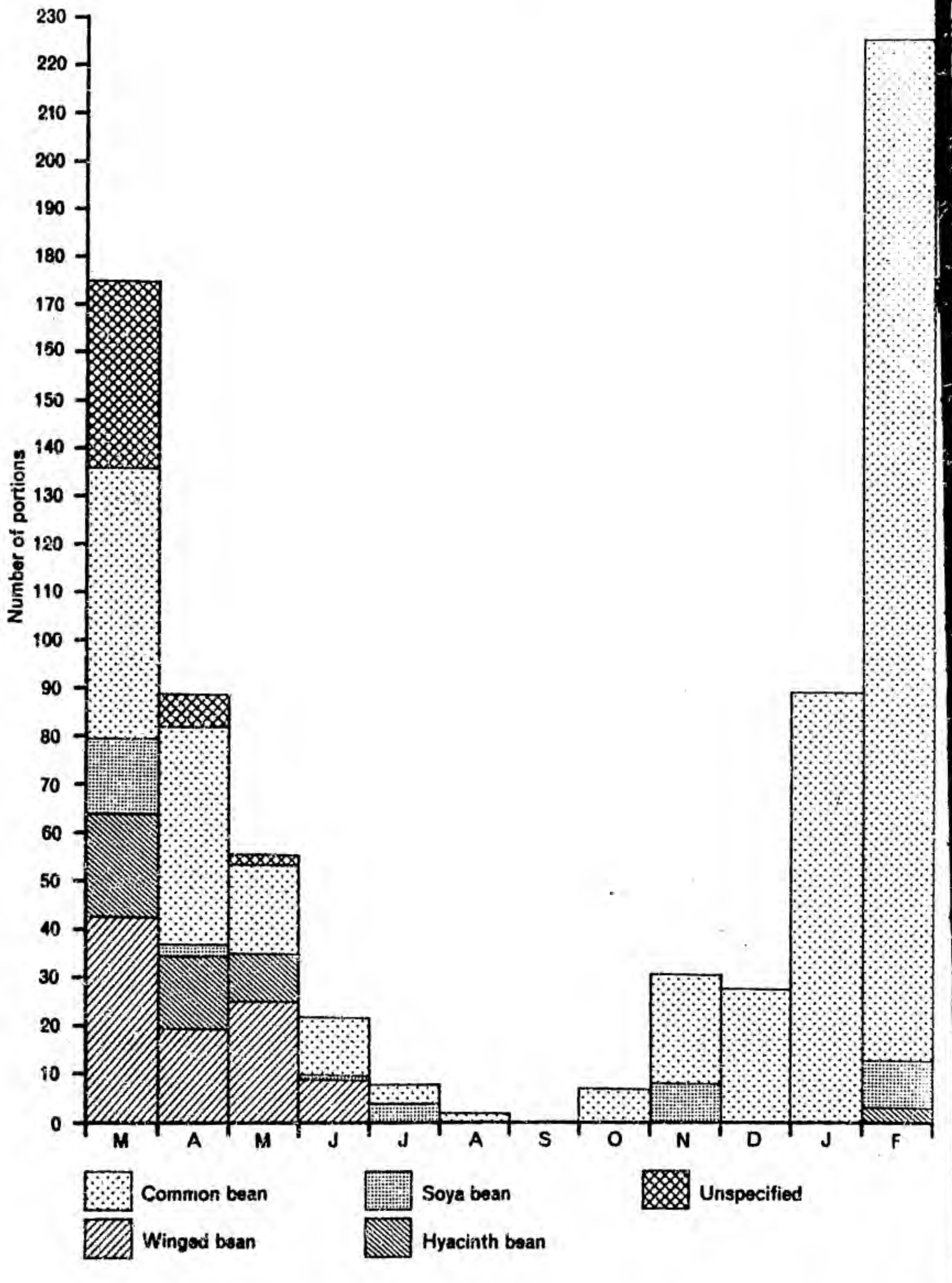


Figure 9.7 : The seasonal consumption of beans by Pubi children.

cleared totally from each garden when mature, to allow the other ground-hugging crops to develop. Not all women plant their gardens at the same time and the different times at which the beans become available provides the excuse for a continual social round as obligations and debts are repaid and collected.

The composition of young children's diets therefore changes markedly throughout the year. From July to about October is the period with the smallest quantity and the least variety of foods available from the mixed gardens. The diet is supplemented with store bought tinned fish and rice. For children under about the age of four years the foods from the gardens are also supplemented with breast-milk. I suspect that the quantity of breast-milk a woman has available for her child also varies throughout the year possibly reflecting her work-load in the gardens and her nutrutional status. From August the quantity of sweet potato as well as mixed garden crops begins to decline, and during this period of relative hunger women begin to clear ground and plant sweet potato with increased vigour. Their subsequent weight loss both due to increased work and the poor diet is reflected in the reduced quantity (but not necessarily the quality) of breast-milk they are able to produce (Bailey 1965).

The nutritional quality and quantity of children's diets throughout the year are shown only for children under the age of 2 years (Table 9.10), for they are the most vulnerable to shortfalls in food supply either in their mother's diet or their own. It is most remarkable that young children under the age of two months are given solid foods - mostly bananas and pumpkin. Comparison with recommended

Table 9.10 : The Nutritional Quality of the Diets of the Children Under the Age of Two Years in Pubi Clan - the average intake for one day.

Average Daily Intake for the Year

Age (mths)	Weight gm	Energy kcal	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	Percentage of days** breast-milk only taken
0- 2	156	103	3.0	0.9	23.1	8.0	24.2
3- 5	312	212	7.2	2.2	44.3	8.3	8.5
6-11	538	437	12.6	4.7	89.8	8.6	2.4
12-23	828	671	17.4	6.8	142.1	6.8	3.1

MAY 1980 - Average daily intake

Age (mths)	Weight gm	Energy kcal	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	Percentage of days** breast-milk only taken
0- 2	267	168	2.3	0.7	40.8	4.6	33.3
3- 5	345	203	5.6	1.4	45.6	7.9	0
6-11	866	588	22.1	4.9	120.3	8.7	0
12-23	812	747	21.7	14.2	140.8	7.9	0

AUGUST 1980 - Average daily intake

Age (mths)	Weight gm	Energy kcal	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	Percentage of days** breast-milk only taken
0- 2	no sample						
3- 5	393	470	38.8	12.8	50.9	16.7	0
6-11	498	445	13.2	7.5	84.4	7.4	0
12-23	753	647	18.3	11.9	122.3	7.2	0

NOVEMBER 1980 - Average daily intake

Age (mths)	Weight gm	Energy kcal	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	Percentage of days** breast-milk only taken
0- 2	156	78	1.3	0.4	18.6	5.1	50.0
3- 5	168	188	1.9	0.5	44.4	2.1	0
6-11	469	475	11.6	7.6	91.1	5.1	0
12-23	820	715	11.7	3.5	165.8	4.7	0

FEBRUARY 1981 - Average daily intake

Age (mths)	Weight gm	Energy kcal	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	Percentage of days** breast-milk only taken
0- 2	125	67	1.0	0.3	17.1	6.4	18.2
3- 5	211	105	1.7	0.5	26.0	6.0	33.3
6-11	536	324	7.6	1.9	74.0	6.9	0
12-23	917	766	18.0	4.6	171.9	6.5	0

* n = the number of diets recorded in that age group for that month.
** Every child was also fed breast milk every day. In addition a percentage of all diets consisted solely of breast-milk. The solid intake tabulated is thus the total solids eaten in each age group divided by 'n' and thus underestimates total intake for some children.

Source : unpublished data collected by Janis Baines and condensed from Tables in Appendix 9.1.

daily intakes of calories and protein with any real degree of accuracy is not possible because the amount of breast-milk consumed was not recorded for the younger age groups, and neither is the quality of the protein known. That is, the amino acid composition of the protein has not been determined. Eight of the twenty eight amino acids required for growth and maintenance of the body cannot be synthesized by the human body and must therefore by supplied from the diet. Shortfalls in supply of any of these eight essential amino acids limits the use to which protein intake can be put. Some protein foods contain essential amino acids in the proportions required by the human body (milk, eggs and meat for example), and have a Net Protein Utilization (NPU) of 100%. A deficiency in one or more essential amino acids below the level of human requirement restricts the degree to which the other amino acids can be used in protein synthesis, thus lowering the Net Protein Utilization. The recommended daily requirements for both protein and energy for the Southwest Pacific Region are shown in Table 9.11.

It is generally accepted that breast-milk cannot supply all a child's nutritional needs after about the age of 6 months (WHO 1979:151), by which time he needs from 900 to 1000 kcal a day in energy and 23 grams of protein (note it is protein with an NPU of 60, that is 100 percent of it is usable, a proportion generally accepted [WHO 1979] for diets composed primarily of starchy tubers). Despite the shortcomings in the data it can be seen that the diet of the Nembi child from 6-11 months provides him on average with 437 kcal of energy about half the recommended level (Table 9.11), and 12.69g of protein, of which only about 60 percent is useable (about half the recommended

Table 9.11 : Recommended Daily Intakes of Energy (kcal) and Protein (Net protein utilization of 60 percent)*

Age (both sexes)	Average body weight	Energy Intake: Total kcal	Energy Intake: Per kg body weight kcal
Under 3 months	-	-	120
3-5 months	-	-	115
6-8 months	8.2	900	110
9-11 months	9.4	990	105
1-3 years	13.4	1360	101

		Protein Intake: g	Protein Intake: g
Under 3 months	-	-	2.40 (complete)**
3-5 months	-	-	1.85 (complete)**
6-8 months	8.2	23	2.71
9-11 months	9.4	23	2.40
1-3 years	13.4	27	1.99

* NPU of 60 percent is that recommended for converting diets composed principally of starchy roots and tubers.

** Mainly breast milk and therefore an NPU of 100 - a complete protein.

Source : WHO 1979; The Health Aspects of Food and Nutrition Tables 3 and 4.

intake). It is unlikely that his milk consumption makes his intake up to the recommended levels of protein and energy. The diets of children over the age of 12 months are proportionately much more inadequate.

Although the percentage of kilo calories supplied by protein is above 4 percent, the level that is considered as a safe level of protein intake (WHO 1979:35), with such low energy intakes it can be assumed that the Pubi child is both energy and protein deficient and what protein he eats he burns as energy. A seasonal pattern is also evident and the month of November would appear to be more critical on that criterion, although the situation is very poor throughout the year. The diets of young children are therefore probably inadequate not only throughout the year but more so at particular times of the year. Children have a lower energy and protein intake in the period from August to November which is also the time of the year when milk supply is also more likely to be inadequate and when mothers are under the greatest amount of pressure from work. Children between 6 and 11 months also appear to be slightly more disadvantaged in February.

Three seasonal trends have thus been identified in the lives of the Pubi children: the seasonal trend in infectious diseases, the seasonal trend in the workload of their mothers; and the seasonal trend in their diets. All are related to both the climatic events on the Nembi Plateau, and to the way of life of the Nembi. The web of interaction is complex and no one child is subject to quite the same combination of stresses as another.

The growth response of children to seasonal patterns in the social and physical milieux

Two cycles are interacting to affect the nutritional status of Nembi children. On the one hand the time of year in which a child is born affects his growth progress, and on the other the transition from dependency upon the breast to taking supplementary solids. From about 5 to 18 months of age is a precarious time no matter what time ofyear. It follows that if a child is more vulnerable to sickness and disease at certain periods of the year and if his period of initial weaning at six months coincides with one of those seasons, he is doubly disadvantaged. The time of year in which a child is born is therefore critical for two reasons. Firstly his initial birth weight, that also determines to some degree his future growth-path, directly reflects the well-being of his mother. A woman's health and nutritional status during pregnancy are important in determining the birth weight of her child, and a woman's health is determined to a large degree by her workload, food availability and the prevalence of disease and sickness at any particular time of year. Prepregnant weight is an important factor determining the weight of any woman's child as well as weight gain during pregnancy. (Bergmann and Bergmann 1979, Malcolm 1979, Singleton 1980). From September to February more women lose weight than in the rest of the year. A seasonal fluctuation in the weight of women thus affectsthe gestational weight gain of women and therefore the birth weight of children. Secondly the time of year in which a child is born determines the season at which he will be fed supplementary foods for the first time.

The result of the complex interaction of all the factors involved is that a seasonal pattern of increase in weight is apparent in children under the age of five years (Figure 9.8). The pattern appears to overlap with that of the women (Figure 8.3), and different age groups of children under five years of age also display slightly different patterns, although the overall effect of seasonal fluctuations is similar. Between August and November, and the period from January to March appear to be favourable periods of weight gain in children. An important distinction is between the children under and over six months of age and is central to my interpretation of the pattern. It appears that the seasonal pattern of weight gain of children under six months coincides with the availability of food from mixed gardens and therefore with their mother's improved nutritional status during the period January to March. For children older than six months, it appears that a combination of poor dietary intake and a high risk of morbidity during the long wet season and short dry season (the period from December to July) makes them liable to falter in their growth-path. Between January and March, despite the high risk of sickness and disease the majority of children over the age of six months gain weight, but once the production from the mixed gardens declines the number who succumb to disease and lose weight increases. August, September, October and November are periods of poor food supply but the risk of morbidity is lower. The percentage gaining weight therefore begins to increase. In December the risk and incidence of morbidity again provides a stumbling block to a child's growth-path.

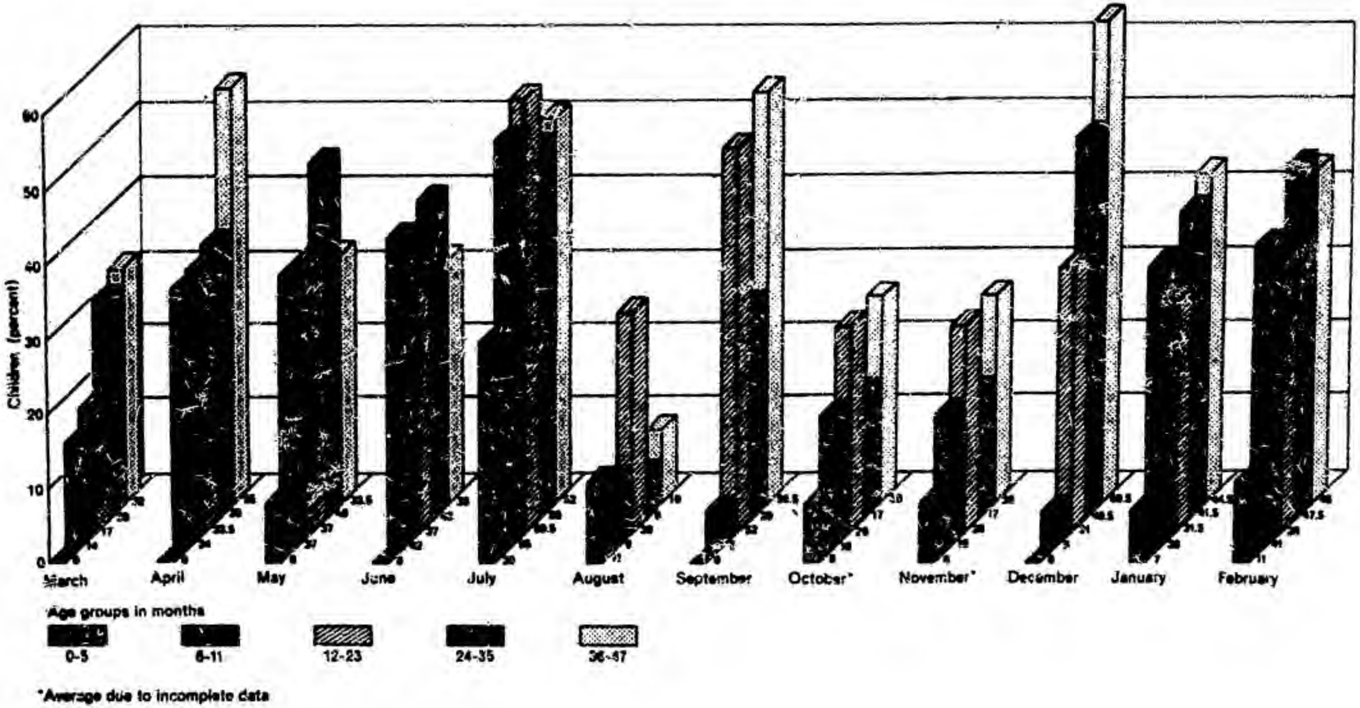
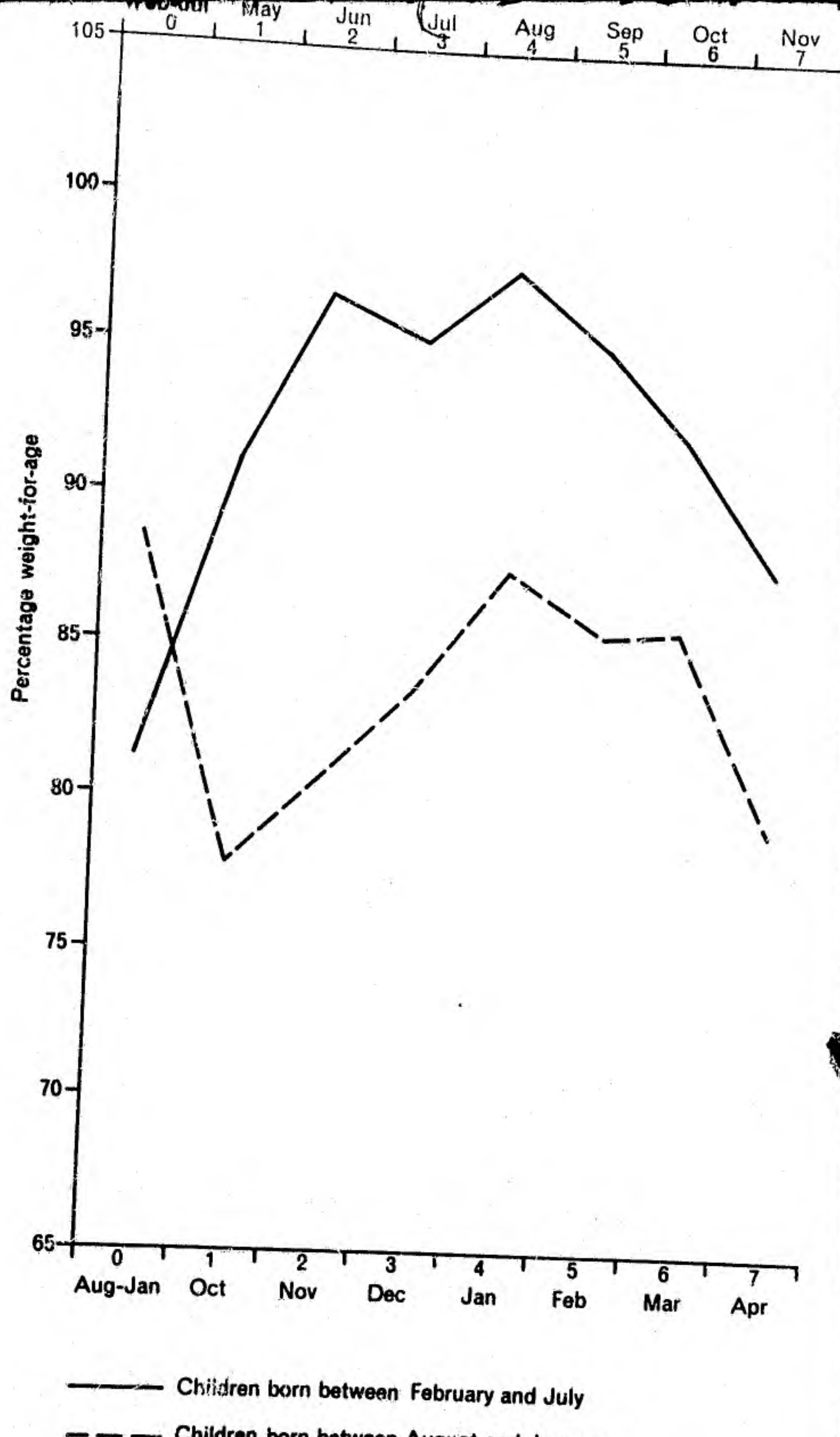


Figure 9.8 : Percentage of children attending Embi and Pumberal Maternal and Child Health Care Clinics from March 1980 to February 1981 not gaining weight or losing weight from one month to the next.

The pattern of growth of children born at two different periods of the year is shown in Figure 9.9. Those children born in the period from August to January have a higher birth weight than those born between February and July, reflecting the health status and weight of the mother. From September through to January the work load of the mother is reflected in the sharp decline in the nutritional status of her child. As her nutritional status improves with the availability of mixed garden foods the status of the child improves, only to decline at about 4 to 6 months as he is introduced to solids of inadequate nutritional quality. In this period when risk of morbidity is high, he is liable to contract weanling diarrhoea and other complaints. He also has a high risk of dying.

Children born between February and July, although of low birth weight in comparison to children born at other times of the year, are able to be breast fed on demand and therefore gain weight rapidly in the first three months of life. Their mothers are not preoccupied in the sweet potato fields and mixed gardens and her health status as reflected in her weight is good. The risk of morbidity is normally high during this period but the natural immunity provided by breast-milk and the better care afforded the child by a mother who is neither so physically tired nor subject to such psychological pressure than during the mixed garden season contributes to the child's well-being. When it is time for his mother to cultivate the next mixed garden in the following year the child is better able to cope with episodes of morbidity and with the trauma of weaning. His higher percentage of weight-for-age, at time of weaning gives him an advantage over those born between August and January.



Feb-July n	25	19	15	12	16	10	13	13
Aug-Jan n	35	15	15	24	26	24	25	16

Figure 9.9 : The growth path of children for the first eight months of life born at different times of the year.

Nutritional status and change over time are thus the result of complex interactions of various factors that may also vary periodically in their intensity. The data I have presented do not allow the assessment of probabilities of the degree of risk associated with birth at a particular time of the year, nor of the risk of occurrence of frost and drought. Moreover the children upon whom I have based much of this thesis were survivors. In the final analysis the nutritional status of young children is determined by the multifarious role of women in Nembi society, as producers, wives and mothers and the interaction of a multitude of factors such as pig-kills, rainfall, temperature, disease and workloads as well as food supply. No one particular factor can be singled out as causing the high rates of child malnutrition on the Nembi Plateau, except possibly that of poverty. The cause of that poverty is the result of both the harsh environment of the Nembi Plateau which offers little in the way of resources or opportunities which would integrate the plateau economy more fully into that of the province, and the result of contact with a more powerful economy that has destroyed what little strengths the Nembi economy in pre-contact times possessed.

APPENDIX 9.1

EVALUATION OF DIETARY COMPOSITION OF THE PUBI CHILDREN FROM MARCH 1980 TO MARCH 1981

Janis Baines conducted a food intake survey of 40 children under the age of five. Food portions were not weighed but each mother was asked to recall what her child or children had eaten in the previous 24 hours and to indicate quantity in terms of portions i.e. a whole tuber, a handful, or the equivalent of a 10 toea portion sold in the weekly market at Ol. Each mother was interviewed three times a month and three daily diets collected for each child every month. During the period of field work each woman was asked to demonstrate at regular intervals what she meant by a "portion" of various foodstuffs. These portions were then weighed and averaged for each foodstuff for the whole year. A crude quantitative measure was thus obtained for dietary analysis. The portions were assessed for percent edibility and their composition taken from the various food composition tables.*

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Code	Reference
P	Platt B.S. Tables of representative values of foods commonly used in tropical countries. MRC spec.rep.ser.No.302 HMSO 1962.
W(2)	WHO Bailey R.V. ed. Health Aspects of Food and Nutrition. 2nd Ed. 1969.
W(3)	WHO Health aspects of Food and Nutrition. 3rd Ed. 1979.
K	King, M. Nutrition for Papua New Guinea, Department Public Health, PNG 1975.
N	Morgan, M.G., Durnin, J.V.G.A., Ferro-Luzzi, A. 'The composition of some New Guinea foods.' PNG Agricultural Journal 30. 1-3, Sept. 1979.
A	Australian Food Tables, Thomas and Conden 1977.

The percentage of each portion that was measured to be edible of the various foods eaten by the Pubi children are shown in Table A9.1.

Table A9.1 : Food Portions Used in Diets.3

Food	% Edible	Portion gm	Edible Portion gm	Ref.	
Rice (hulled, polished, raw)	100	25	25	W(3)	
Potato, Irish	87	42	37	W(3)	
Potato, sweet	87	94	84	W(3)	
Taro	84	132	111	W(3)	
Yam	88	42	37	W(3)	
Peanut	100	22	22	W(3)	
Beans (dry)	100	7.85	7.85	*	
Green leaves	*	*	61.6	*	
Bamboo shoots	56	58	32	W(3)	
Cabbage	85	144	122	W(3)	
Corn (grain)	100	71	71	W(3)	
Cucumber	80	117	94	W(3)	
Mushroom	91	76	69	W(2)	
Onion (green leek)	47	39	18	W(2)	
Pumpkin (fruit)	83	275	228	W(3)	
Choko	83	170	141	W(2)	
Tomato	94	25	24	W(3)	
Pit-Pit	50#	30	15	W(2)	
Banana	100	46	46	W(3)	
Pawpaw (skin removed)	100	89	89	W(3)	
Pineapple	55	59	32	W(3)	
Sugarcane (peeled)	43	60	26	W(3)	
Beef (med. fat)	80	21	17	W(3)	
Chicken (mature whole plucked)	64	21	13	W(3)	
Pork (med. fat)	88	21	19	W(3)	
Insect (locust)	81#	6.8	5.5	W(3)	5
Rat	64#	21	13	W(3)	
Lizard	80#	23	18	W(3)	2
				W(2)	
Bush birds	64#	21	13	W(3)	1
Cat/possum/wallaby	64#	21	13	W(3)	1
Frog	64#	13	8	W(3)	1
Tinned meat	100	57	57	W(3)	

Table A9.1 continued

Food	% Edible	Portion gm	Edible Portion	Ref.
Hen egg	89	70	62	W(3)
Bush egg (oven bird)	89#	220	196	W(3) 4
Fresh fish	100	20	20	W(3)
Tinned fish	100	70	70	W(3)
Dripping	100	46	46	P
Pork fat	100	10	10	W(2)
Coca cola	100	285	285	W(3)
Cheese pops (crisps)	100	25	25	A
Biscuits (plain)	100	19	19	W(3)
Scone	100	75	75	K
Chewing gum	N/E	5	5	A
Lowland Pandanus	100	10	10	W(3),P
Highland Pandanus	100	1.5	1.5	W(2)
Asbin (wing bean tubers)	100#	11	11	N

* Table A9.5 and Table A9.6

My estimate

NOTES:

1 For possum, bush wallaby, bush cat, birds and frogs all were taken to be 64 percent edible, composition based on chicken.

2 For lizard, % edible was taken from that of a caterpillar to be 80%, composition based on chicken. Ref. W(2).

3 For all % contribution of calories from protein, figures were taken from Ref W(2).

4 Bush egg composition was taken to be the same as that of hen eggs.

5 4 insects were taken as 1 portion: composition was taken as for a locust.

The portion for beans and green leafy vegetables were computed as a composite portion, that is an average portion of beans combines a measure of the relative frequency with which each variety is eaten with the composition of each variety. The same method was used to compute the composition of an 'average' portion of green leafy vegetables.

Computation of a portion of beans and its nutritional composition

The size of an edible portion of beans for each variety is shown in Table A9.2 and the proportion in which the beans were eaten throughout the year is shown in Table A9.3.

Table A9.2 : Beans : composition of 1 portion.

Bean	Edible %	(Wet) moisture* %	One wet portion gm	One edible portion gm	One edible dry portion gm	Ref.
Wing Bean	91	89.1	35	32	4.5	W(3)
Hyacinth	91	89.1	35	32	4.5	W(3)
Soyabean	91	89.1	35	32	4.5	W(3)
Kidney & all others	91	89.1	66	60	9.0	W(3)

* Value for moisture content was taken from reference W(2) using 'fresh moist kidney beans' as the standard.

Table A9.3 : Number of Portions of Beans of Various Types Eaten Throughout the Year by Pubi Children.

Bean Type	Nos. of portions	Size of one dry edible portion gm		Total weight consumed in the year			
Wing Bean	96.2	X	4.5	433	gm	dry	edible
Hyacinth	48.7	X	4.5	219	gm	dry	edible
Soyabean	41.0	X	4.5	185	gm	dry	edible
Other	543.2	X	9.0	4889	gm	dry	edible
TOTAL	729			5726	gm dried seed (edible)		

The amounts eaten throughout the year of each type of bean were then used to compute the composition of an average portion of beans which is shown in Table A9.4. This portion was then used in computing the composition of Pubi diets. A similar method was used for the analysis of the contribution of green leafy vegetables to the children's diets.

Table A9.4 : Composition of an Average Portion of Beans.

Bean Type	%(Dry) moist.	Energy kcal	Protein gm	Fat gm	Carbo-hydrate gm	Protein kcal	Percentage kcal from protein
Winged	9.7	1754	142.0	73.6	158.0	503.4	28.7
Hyacinth	12.1	731	47.1	2.6	134.5	166.7	22.8
Soyabean	11.3	727	63.3	30.3	62.0	334.4	46.0
Other	12.2	16427	992.5	58.7	3065.4	3926.1	23.9
Total for 729 portions	12.0*	16639	1244.9	165.2	3419.9	4935.1	25.1*
1 Portion	12.0	27	1.7	0.2	4.7	6.8	25.1

* Mean value

The size of an edible portion of the various green leafy vegetables is shown in Table A9.5. The number of portions and the gross edible weight was computed for the total amounts of the various green leafy

Table A9.5 : Edible Portions of Green Leafy Vegetables.

Vegetable	% edible	portion gm	edible portion gm	Ref.	Classification
Rungia klossi	80	61	49	W(3)	dark green leaves
Amaranthus	66	105	69	W(3)	leaves & stem
Brassicas	83	88	73	W(2)	
Fern	50*	45	23	W(3)	light green leaves
Pumpkin tops	100	91	91	W(3)	
Taro leaves	80	90	72	W(2)	
Sechium edule (Choko leaves)	100	91	91	W(3)	%moisture as for pumpkin tops
Oenanthe Javanica	80	88	70	W(2)	medium green leaves
Ficus	80	45	36	W(3)	dark green leaves
Nasturtium spp. (Watercress)	80	60	48	W(3)	dark green leaves
Abelmoschus manihot	80	45	36	W(2)	%moisutre taken as dark green leaves for W(3)

* Estimated by observation.

vegetables eaten by the Pubi children throughout the year. An average portion of green leafy vegetables was then computed and this is shown in Table A9.6.

The children's diet were then analysed by age groups: 0-2 months; 3-5 months; 6-11 months and 12-23 months. An average daily diet was computed for each age group for the whole year and then computed for May, August and November 1980 and February 1981 to ascertain whether any seasonal differences existed. The results are shown in Table A9.7 to A9.10.

Table A9.6 : Composition of a Composite Portion of Green Leafy Vegetables.

Vegetable	No. of Portions	Edible portions gm		% (Wet) moist.	Energy kcal	Protein gm	Fat gm	C/H gm	kcal from protein	Percentage kcal from protein
Rungia klossi	808.5	39617		85.0	16243	1980.9	277.3	2575.1		
Amaranthus	53.5	3692		88.4	1181	110.8	18.5	210.4		
Brassicas	33	2409		92.2	554	53.0	7.2	98.8		
Fern	23.7	545		3.0	125	8.2	1.1	26.2		
Pumpkin leaves	334.5	30440		92.6	6392	913.2	121.8	913.2		
Taro leaves	6	432		85.0	246	21.6	10.8	28.5		
Sechium edule (Choko leaves)	18.2	1656		92.6	348	49.7	6.6	49.7		
Oenanthe Javanica	27.2	1902		91.0	476	38.0	5.7	91.3		
Ficus	7.5	270		86.0	103	59.4	-	20.0		
Nasturtium spp.	5	240		85.0	98	12.0	1.7	15.6		
Abelmoschus manihot	2	72		82.7	34	4.2	0.2	6.2		
TOTAL	1319	81275		88.0	25800	3251	450.9	4035		
Single Portion	1	61.6	MEAN	88.0	20	2.5	0.3	3.1	4.9	24.7*

* Average for dark and medium green leaves in reference W(2).

Table A9.7a : Composition of the Daily Diet of Children 0-2 Months of Age from March 1980 to February 1981.*

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
YEAR											
March 1980 to February 1981	62	Sweet potato	8	672	71.5	753	7.4	2.0	177.4	2.0	15
		Pumpkin	23	5244	91.9	1416	36.7	10.5	346.1	9.6	136
		Banana	70	3220	69.9	3413	33.8	9.7	898.4	4.6	157
		Tinned fish	7	490	68.0	730	108.8	26.5	7.4	28.0	204
		Pig fat	1	10	-	82	0.3	8.9	-	-	-
		Sugar	1	26	81.4	17	0.1	0.1	4.6	1.7	(0.3)
Total				9662		6411	187.1	57.7	1433.9		512
Average 1 days diet:				156		103	3.0	0.9	23.1	8.0	8.2
Years diet:				56387		37189	1096.2	338.5	8310.8		

* All are breast-feeding.

The percentage contribution of different foods to the average daily diet of 0-2 months old child.

Food	Weight gm	Weight %	kcal Total Energy	kcal %	Protein gm	Protein %	Fat gm	Fat %	Carbo-hydrate gm	Carbo-hydrate %	kcal from Protein	kcal from Protein %
Sweet potato	10.8	6.9	12.1	11.7	0.1	3.3	(0.03)	-	2.9	12.4	0.2	2.4
Pumpkin	84.6	54.2	22.8	22.1	0.6	20.0	0.2	22.2	5.6	24.2	2.2	26.8
Banana	51.9	33.3	55.0	53.4	0.5	16.7	0.2	22.2	14.5	62.8	2.5	30.5
Tinned fish	7.9	5.1	11.8	11.5	1.8	60.0	0.4	44.4	0.1	0.4	3.3	40.2
Pig fat	0.2	0.1	1.3	1.3	(0.04)	-	0.1	11.1	-	-	-	-
Sugar	0.4	0.3	0.3	0.3	(0.002)	-	(0.002)	-	0.1	0.4	-	-
Total	156	999	103	100.3	3.0	100.0	0.9	99.9	23.1	99.9	8.2	99.9

On 15/62 days (24.2%) babies had no soild supplements and thus had breast-milk only.

Table A9.7b : Average daily diet during May 1980 of 0-2 months old child.*

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
May 1980	3	Sweet potato	3	252	71.5	282	2.7	0.8	66.6	2.0	6
		Pumpkin	2	456	91.9	123	3.2	0.9	30.1	9.6	12
		Banana	2	92	69.9	98	1.0	0.3	25.7	4.6	5
Total				800		503	6.9	2.0	122.4		23
Average 1 days diet:				267		168	2.3	0.7	40.8	4.6	7.7

* 1/3 days was breast-milk only (33.3%).

The percentage contribution of different foods to the average daily diet during May 1980 of a 0-2 month old child.*

Food	Weight gm	%	kcal Total Energy	%	Protein gm	%	Fat gm	%	Carbo-hydrate gm	%	kcal from Protein	%
Sweet potato	84	31.5	94	56.1	0.9	39.1	0.3	40.0	22.2	54.4	2	26.0
Pumpkin	152	57.0	41	24.5	1.1	46.4	0.3	45.0	10.0	24.6	40.0	51.9
Banana	31	11.5	33	19.5	0.3	14.5	0.1	15.0	8.6	21.0	1.7	22.1
Total	267	100	168	100.1	2.3	100	0.7	100	40.8	100	7.7	100

* 33.3% days breast-milk only.

Table A9.7c

The average daily diet during November 1980 of a 0-2 months old child.*

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
Nov. 1980	2	Sweet potato	1	84	71.5	94	0.9	0.3	22.2	2.0	2
		Pumpkin	1	228	91.9	62	1.6	0.5	15.0	9.6	6
Total				312		156	2.5	0.8	37.2		8
Average 1 days diet:				156		78	1.3	0.4	18.6	5.1	4.0

* 1/2 days was breast-milk only (50%).

The percentage contribution of different foods to the average daily diet during November 1980 of a 0-2 month old child.

Food	Weight gm	%	kcal Total Energy	%	Protein gm	%	Fat gm	%	Carbo-hydrate gm	%	kcal from Protein	%
Sweet potato	42	26.9	47	60.3	0.5	38.5	0.25	37.5	11.1	59.7	1	25.0
Pumpkin	114	73.1	31	39.7	0.8	61.5	0.25	62.5	7.5	40.3	3	75.0
Total	156	100	78	100	1.3	100	0.4	100	18.6	100	4	100.0

50% days breast-milk only.

Table A9.7d : The average daily diet during February 1981 of a 0-2 month old child.*

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
Feb. 1981	11	Pumpkin	4	912	91.9	246	5.4	1.8	60.2	9.6	24
		Banana	10	460	69.9	490	5.0	1.0	128.0	4.6	23
Total				1372		736	11.4	2.8	188.2		47
Average 1 days diet:				125		67	1.0	0.3	17.1	6.4	4.3

* 2/11 days breast-milk only (18.2%).

The percentage contribution of different foods to the average daily diet during February 1981 of a 0-2 month old child.

Food	Weight gm	Weight %	kcal Total Energy	kcal %	Protein gm	Protein %	Fat gm	Fat %	Carbo-hydrate gm	Carbo-hydrate %	kcal from Protein	kcal from Protein %
Pumpkin	83	66.4	22	32.8	0.61	60.0	0.2	66.7	5.5	32.2	2.2	51.2
Banana	42	33.6	45	67.2	0.4	40.0	0.1	33.3	11.6	67.8	2.1	48.8
Total	125	100	67	100	1.0	100	0.3	100	17.1	100	4.3	100.0

18.2% days breast-milk only.

Table A9.8a : Composition of the daily diet of children 3-5 months of age from March 1980 to February 1981.*

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
March 1980 February 1981	71	Sweet potato	52	4368	71.5	4892	48.0	13.1	1153.2	2.0	98
		Taro	2	222	75.4	209	4.9	0.9	46.6	3.7	8
		Pumpkin	46	10488	91.9	2832	73.4	21.0	692.2	9.6	272
		Banana	89	4094	69.9	4340	43.0	12.3	1142.2	4.6	200
		Greens	6	370	88.0	120	15.0	1.8	18.6	24.7	30
		Sugar	6	130	81.4	87	0.3	0.5	22.9	1.7	1
		Tinned fish	20	1400	68.0	2086	310.8	75.6	21.0	28.0	584
.		Setania sp.	1	15	92.4	4	0.1	-	1.0	4.5	(0.2)
		Pig	2	38	42.5	174	4.5	17.1	-	13.2	23
		Cabbage	1	122	93.0	27	2.0	0.4	5.4	15.6	4
		Choko	6	846	95.0	127	6.8	0.8	29.6	13.0	17
		Cheese pops	1	25	1.8	142	1.3	10.0	12.5	6.4	9
Total				22118		15040	510.1	153.5	3145.2		1246
Average 1 days diet:				312		212	7.2	2.2	44.3	8.3	17.4
Years diet:				113705		77318	2622.3	789.3	16169	.	

* 6/71 days breast-milk only (8.5%).

The percentage contribution of different foods to the average daily diet of a 3-5 month old child.

Food	Weight gm	%	kcal Total Energy	%	Protein gm	%	Fat gm	%	Carbo-hydrate gm	%	kcal from Protein	%
Sweet potato	62	19.8	69	32.7	0.7	9.7	0.2	9.5	16.2	36.6	1.4	8.0
Taro	3	1.0	3	1.4	0.1	1.4	(0.01)	-	0.7	1.6	0.1	0.6
Pumpkin	148	47.3	40	19.0	1.0	13.9	0.3	14.3	9.7	21.9	3.8	21.8
Banana	58	18.5	61	28.9	0.6	8.3	0.2	9.5	16.1	36.3	2.8	16.1
Greens	5	1.6	2	0.9	0.2	2.8	(0.03)	-	0.3	0.7	0.4	2.3
Sugar	2	0.6	1	0.5	(0.004)	-	(0.007)	-	0.3	0.7	(0.02)	-
Tinned fish	20	6.4	29	13.7	4.4	61.1	1.1	52.4	0.3	0.7	8.2	47.1
Setaria sp.	(0.2)	-	(0.06)	-	(0.001)	-	-	-	(0.01)	-	(0.002)	-
Pig	1	0.3	2	0.9	0.1	1.4	0.2	9.5	-	-	0.3	1.7
Cabbage	2	0.6	(0.4)	-	(0.03)	-	(0.006)	-	0.1	0.3	0.1	0.6
Choko	12	3.8	2	0.9	0.1	1.4	(0.01)	-	0.4	0.9	0.2	1.1
Cheese pops	(0.4)	-	2	0.9	(0.02)	-	0.1	4.8	0.2	0.5	0.1	0.5
Total	312	99.9	211	99.8	7.2	100	2.1	100	44.3	100.2	17.4	99.9

Table A9.8b : The average daily diet during May 1980 of a 3-5 month old child.*

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
May 1980	17	Sweet potato	12	1008	71.5	1129	11.1	3.0	266.1	2.0	46
		Pumpkin	14	3192	91.9	862	22.3	6.4	210.7	9.6	83
		Banana	20	920	69.9	975	9.7	2.8	256.7	4.6	45
		Tinned fish	3	210	68.0	313	46.6	11.3	3.2	28.0	88
		Taro	1	111	75.4	104	2.4	0.4	23.3	3.7	4
		Choko	3	423	95.0	64	3.4	0.4	14.8	13.0	8
Total				5864		3447	95.5	24.3	774.8		274
Average 1 days diet:				345		203	5.6	1.4	45.6	7.9	16.1

* All children had solid food on all days observed.

The percentage contribution of different foods to the average daily diet during May 1980 of a 3-5 month old child.

Food	Weight gm	%	kcal Total Energy	%	Protein gm	%	Fat gm	%	Carbo-hydrate gm	%	kcal from Protein	%
Sweet potato	59	17.1	66	32.7	0.7	12.5	0.2	13.3	15.7	34.4	2.7	16.9
Pumpkin	188	54.5	51	25.2	1.3	23.2	0.4	26.7	12.4	27.1	4.8	30.0
Banana	54	15.7	57	28.2	0.6	10.7	0.2	13.3	15.1	33.0	2.6	16.3
Tinned fish	12	3.5	18	8.9	2.7	48.2	0.7	46.7	0.2	0.4	5.2	32.5
Taro	7	2.0	6	3.0	0.1	1.8	(0.02)	-	1.4	3.1	0.2	1.3
Choko	25	7.2	4	2.0	0.2	3.6	(0.02)	-	0.9	2.0	0.5	3.1
Total	345	100	202	100	5.6	100	1.5	100	45.7	100	16.0	100.1

Table A9.8c : The average daily diet during August 1980 of a 3-5 month old child.*

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
August 1980	3	Sweet potato	3	252	71.5	282	2.7	0.8	66.6	2.0	7
		Pumpkin	1	228	91.9	62	1.6	0.5	15.0	9.6	6
		Banana	4	184	69.9	195	1.9	0.6	51.3	4.6	9
		Tinned fish	7	490	68.0	730	1.9	[illegible].6	7.4	28.0	204
		Cheese pops	1	25	1.8	142	1.3	10.0	12.5	6.4	9
Total				1179		1411	116.3	38.4	152.8		235
Average 1 days diet:				393		470	38.8	12.8	50.9	16.7	78.3

* All children had solid food on all days observed.

The percentage contribution of different foods to the average daily diet during August 1980 of a 3-5 month old child.

Food	Weight gm	%	kcal Total Energy	%	Protein gm	%	Fat gm	%	Carbo-hydrate gm	%	kcal from Protein	%
Sweet potato	84	21.4	94	20.0	0.9	2.3	0.3	2.4	22.2	43.5	1.9	2.4
Pumpkin	76	19.4	21	4.5	0.5	1.3	0.2	1.6	5.0	9.8	2.0	2.6
Banana	61	15.6	65	13.8	0.6	1.6	0.2	1.6	17.1	33.5	3.0	3.9
Tinned fish	163	41.6	243	51.7	36.3	93.8	8.8	70.4	2.5	4.9	68.0	87.3
Cheese pops	8	2.0	47	10.0	0.4	1.0	3.0	24.0	4.2	8.2	3.0	3.9
Total	392	100	470	100	38.7	100	12.5	100	51.0	99.9	77.9	100.1

Table A9.8d : The average daily diet during November 1980 of a 3-5 month old child.*

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
Nov. 1980	2	Sweet potato	4	336	71.5	376	3.7	1.0	88.7	2.0	8
Average 1 days diet:				168		188	1.9	0.5	44.4	2.1	4.0

* All children had solid food (sweet potato) on all days observed.

Table A9.8e : The average daily diet during February 1981 of a 3-5 month old child.*

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
February 1981	3	Sweet potato	1	84	71.5	94	0.9	0.3	22.2	2.0	2
		Pumpkin	2	456	91.9	123	3.2	0.9	30.1	9.6	12
		Banana	2	92	69.9	98	1.0	0.3	25.7	4.6	5
Total				632		315	5.1	1.5	78.0		19
Average 1 days diet:				211		105	1.7	0.5	26.0	6.0	6.3

* 1/3 days breast-milk only, 33.3% no solid foods.

The percentage contribution of different foods to the average daily diet during February 1981 of a 3-5 month old child.*

Food	Weight gm	Weight %	kcal Total Energy	kcal %	Protein gm	Protein %	Fat gm	Fat %	Carbo-hydrate gm	Carbo-hydrate %	kcal from Protein	kcal from Protein %
Sweet potato	28	13.3	31	29.5	0.3	17.6	0.1	20.0	7.4	28.5	0.6	9.8
Pumpkin	152	72.0	41	39.0	1.1	64.7	0.3	60.0	10.0	38.5	4.0	65.6
Banana	31	14.7	33	31.4	0.3	17.6	0.1	20.0	8.6	33.1	1.5	24.6
Total	211	100	105	99.9	1.7	99.9	0.5	100	26.0	100.1	6.1	100.0

* 33.3% breast-milk only.

Table A9.9a : The average daily diet of children 6-11 months of age from March 1980 to February 1981.*

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
March 1980 to February 1981	123	Sweet potato	329	27636	71.5	30952	304.0	82.9	7296.9	2.0	553
		Taro	15	1665	75.4	1565	36.6	6.7	349.7	3.7	58
		Pumpkin	94	21432	91.9	5787	150.0	42.9	1414.5	9.6	556
		Banana	47	2162	69.9	2292	22.7	6.5	603.2	4.6	105
		Corn	8	568	62.5	761	23.9	9.7	174.4	9.0	68
		Rice	24	600	11.8	2196	38.4	4.8	482.4	7.1	156
		Greens	46	2834	88.0	920	115.0	13.8	142.6	24.7	227
		Bean	8	63	12.0	216	13.6	1.6	37.6	25.1	54
		Sugar	23	598	81.4	401	1.2	2.4	105.2	1.7	7
		Tinned fish	48	3360	68.0	5006	745.9	181.4	50.4	28.0	1402
		Biscuit	9	171	8.4	696	15.4	13.3	126.7	6.4	45
		Seteria sp.	20	300	92.4	81	1.5	0.6	52.8	4.5	4
		Tinned meat	1	57	54.2	146	14.1	9.6	-	38.2	56
		Pig	9	171	42.5	781	20.3	77.0	-	13.2	103
		Wallaby	1	13	35.8	25	1.5	2.1	-	40.4	10
		Rat	1	13	35.8	25	1.5	2.1	-	40.4	10
		Insect	2	11	66.3	16	1.5	0.5	1.5	59.7	10
		Dripping	2	92	1.0	820	-	91.1	-	-	-
		Cucumber	3	282	96.2	34	1.7	0.3	7.6	15.0	5
		Cabbage	4	488	93.0	107	7.8	1.5	21.5	15.6	17
		Tomato	1	24	93.8	5	0.3	0.1	1.0	18.5	1
		Pawpaw	1	89	87.1	40	0.4	0.1	10.5	5.2	2
		Choko	21	2961	95.0	444	23.7	3.0	103.6	13.0	17
		Yam	4	148	76.4	129	2.8	0.3	29.5	5.0	6
		Mushroom	3	414	88.1	153	9.9	7.9	17.4	25.5	39
		Cheese Pops	1	25	1.8	142	1.3	10.0	12.5	6.4	9
TOTAL				66177		53740	1555.0	572.2	11040.5		3520
Average 1 day:				538		437	12.6	4.7	89.8	6.6%	29

* 3/123 breast-milk only, 2.4%

Table A9.9a continued : The percentage contribution of different foods to the average daily diet of children 6-11 months old from March 1980 to February 1981.

Food	Weight gm	%	kcal Total Energy	%	Protein gm	%	Fat gm	%	Carbo-hydrate gm	%	kcal from Protein	%
Sweet potato	225	41.9	252	57.7	2.5	19.8	0.7	15.2	59.3	66.3	4.5	15.7
Taro	14	2.6	13	3.0	0.3	2.4	0.1	2.2	2.8	3.1	0.5	1.7
Pumpkin	174	32.4	47	10.8	1.2	9.5	0.3	6.5	11.5	12.8	4.5	15.7
Banana	18	3.4	19	4.3	0.2	1.6	0.1	2.2	4.9	5.5	0.9	3.1
Corn	5	0.9	6	1.4	0.2	1.6	0.1	2.2	1.4	1.6	0.6	2.1
Rice	5	0.9	18	4.1	0.3	2.4	(0.04)	-	3.9	4.4	1.3	4.5
Greens	23	4.3	7	1.6	0.9	7.1	0.1	2.2	1.2	1.3	1.8	6.3
Bean	1	0.2	2	0.5	0.1	0.8	(0.01)	-	0.3	0.3	0.4	1.4
Sugar	5	0.9	3	0.7	(0.01)	-	(0.01)	-	0.9	1.0	0.1	0.3
Tinned fish	27	5.0	41	9.4	6.1	48.4	1.5	32.6	0.4	0.4	11.4	39.8
Biscuit	1	0.2	6	1.4	0.1	0.8	0.1	2.2	1.0	1.1	0.4	1.4
Setaria sp.	2	0.4	1	0.2	(0.01)	-	(0.004)	-	0.4	0.4	(0.03)	0.1
Tinned meat	-	-	1	0.2	0.1	0.8	0.1	2.2	-	-	0.5	1.7
Pig	1	0.2	6	1.4	0.2	1.6	0.6	13.0	-	-	0.8	2.8
Wallaby	(0.1)	-	(0.2)	-	(0.01)	-	(0.02)	-	-	-	0.1	0.3
Rat	(0.1)	-	(0.2)	-	(0.01)	-	(0.02)	-	-	-	0.1	0.3
Insect	(0.1)	-	(0.1)	-	(0.01)	-	(0.02)	-	(0.01)	-	0.1	0.3
Dripping	1	0.2	7	1.6	-	-	0.7	15.2	-	-	-	-
Cucumber	2	0.4	(0.3)	-	(0.01)	-	(0.002)	-	(0.01)	0.1	(0.06)	-
Cabbage	4	0.7	1	0.2	0.1	0.8	(0.01)	-	0.2	0.2	0.1	0.3
Tomato	(0.2)	-	(0.04)	-	(0.002)	-	(0.001)	-	(0.1)	-	(0.008)	-
Pawpaw	1	0.2	(0.3)	-	(0.003)	-	(0.001)	-	(0.1)	-	(0.02)	-
Choko	24	4.5	4	0.9	0.2	1.6	(0.02)	-	0.8	0.9	0.1	0.3
Yam	1	0.2	1	0.2	(0.02)	-	(0.002)	-	0.2	0.2	(0.048)	-
Mushroom	3	0.6	1	0.2	0.1	0.8	0.1	2.2	0.1	0.1	0.3	1.0
Cheese Pops	(0.2)	-	1	0.2	(0.01)	-	0.1	2.2	0.1	0.1	0.1	0.3
TOTAL	537	100.1	437	100	12.6	100	4.6	100.1	89.5	99.8	28.6	99.3

Table A9.9b : The average daily diet of a 6-11 month old child during May 1980.

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
May 1980	3	Sweet potato	9	756	71.5	847	8.3	2.3	199.6	2.0	17
		Pumpkin	5	1140	91.9	308	8.0	2.3	75.2	9.6	30
		Banana	1	46	69.9	49	0.5	0.1	12.8	4.6	2
		Greens	6	370	88.0	120	15.0	1.8	18.5	24.7	30
		Setaria sp.	3	45	92.4	12	0.2	0.1	3.1	4.5	1
		Tinned fish	2	140	68.0	209	31.1	7.6	2.1	28.0	59
		Rice	2	50	11.8	183	3.2	0.4	40.2	7.1	13
		Sugar	2	52	81.4	35	0.1	0.2	9.2	1.7	1
TOTAL				2599		1763	66.4	14.8	360.8		153
Average 1 day				866		588	22.1	4.9	120.3	8.7	51

The percentage contribution of different foods to the average daily diet during May 1980 of a 6-11 month old child.

Food	Weight gm	Weight %	kcal Total Energy	kcal %	Protein gm	Protein %	Fat gm	Fat %	Carbo-hydrate gm	Carbo-hydrate %	kcal from Protein	kcal from Protein %
Sweet potato	252	29.1	282	48.0	2.8	12.6	0.8	16.3	66.5	55.3	5.7	11.2
Pumpkin	380	43.9	103	17.5	2.7	12.1	0.8	16.3	25.1	20.9	10	19.6
Banana	15	1.7	16	2.7	0.2	0.9	(0.03)	-	4.3	3.6	0.7	1.4
Greens	123	14.2	40	6.8	5.0	22.4	0.6	12.2	6.2	5.2	10	19.6
Setaria sp.	15	1.7	4	0.7	0.1	0.4	(0.03)	-	1.0	0.8	0.3	0.6
Tinned fish	47	5.4	70	11.9	10.4	46.6	2.5	51.0	0.7	0.6	19.7	38.6
Rice	17	2.0	61	10.4	1.1	4.9	0.1	2.0	13.4	11.1	4.3	8.4
Sugar	17	2.0	12	2.0	(0.03)	-	0.1	2.0	3.1	2.6	0.3	0.6
TOTAL	866	100	588	100	22.3	99.9	4.9	99.8	120.3	100.1	51.0	100

Table A9.9c : The average daily diet during August 1980 of a 6-11 month old child.

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
August 1980	17	Sweet potato	40	3360	71.5	3763	37.0	10.1	887.0	2.0	75
		Taro	2	222	75.4	209	4.9	0.9	46.6	3.7	8
		Pumpkin	12	2736	91.9	739	19.2	5.5	180.6	9.6	71
		Banana	13	598	69.9	634	6.3	1.8	166.8	4.6	29
		Rice	4	100	11.8	366	6.4	0.8	80.4	7.1	26
		Greens	6	370	88.0	120	15.0	1.8	18.6	24.7	30
		Sugar	3	78	81.4	52	0.2	0.3	13.7	1.7	1
		Tinned fish	7	490	68.0	730	108.8	26.5	7.4	28.0	204
		Biscuit	1	19	8.4	77	1.7	1.5	14.1	6.4	5
		Setaria sp.	2	30	92.4	8	0.2	0.1	2.0	4.5	(0.4)
		Pig	9	171	42.5	781	20.3	77.0	-	13.2	103
		Cabbage	1	122	93.0	27	2.0	0.4	5.4	15.6	4
		Choko	1	141	95.0	21	1.1	0.1	4.9	13.0	3
		Yam	1	37	76.4	32	0.7	0.1	7.4	5.0	2
TOTAL				8474		7559	223.8	126.9	1434.9		561
Average 1 day				498		445	13.2	7.5	84.4	7.4	33

The percentage contribution of different foods to the average daily diet during August 1980 of a 6-11 month old child.

Food	Weight gm	%	kcal Total Energy	%	Protein gm	%	Fat gm	%	Carbo-hydrate gm	%	kcal from Protein	%
Sweet potato	198	39.7	221	49.8	2.2	16.7	0.6	8.1	52.2	62.0	4.4	13.3
Taro	13	2.6	12	2.7	0.3	2.3	0.1	1.4	2.7	3.2	0.5	1.5
Pumpkin	161	32.3	43	9.7	1.1	8.3	0.3	4.1	10.6	12.6	4.2	12.7
Banana	35	7.0	37	8.3	0.4	3.0	0.1	1.4	9.8	11.6	1.7	5.1
Rice	6	1.2	22	5.0	0.4	3.0	(0.04)	-	4.7	5.6	1.5	4.5
Greens	22	4.4	7	1.6	0.9	6.8	0.1	1.4	1.1	1.3	1.8	5.4
Sugar	5	1.0	3	0.7	(0.01)	-	(0.02)	-	0.8	1.0	0.1	0.3
Tinned fish	29	5.8	43	10.0	6.4	48.5	1.6	21.6	0.4	0.5	12.0	36.3
Biscuit	1	0.2	5	1.1	0.1	0.8	0.1	1.4	0.8	1.0	0.3	0.9
Setaria sp.	2	0.4	(0.47)	-	(0.01)	-	(0.006)	-	0.1	0.1	-	-
Pig	10	2.0	46	10.4	1.2	9.1	4.5	60.8	-	-	6.1	18.4
Cabbage	7	1.4	2	0.5	0.1	0.8	(0.02)	-	0.3	0.4	0.2	0.6
Choko	8	1.6	1	0.2	0.1	0.8	(0.006)	-	0.3	0.4	0.2	0.6
Yam	2	0.4	2	0.5	(0.04)	-	(0.006)	-	0.4	0.5	0.1	0.3
TOTAL	499	100	444	100.5	13.2	100.1	7.4	100.2	84.2	100.2	33.1	99.9

Table A9.9d . The average daily diet during November 1980 of a 6-11 month old child.

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
Nov. 1980	17	Sweet potato	48	4032	71.5	4516	44.4	3.6	1064.4	2.0	90
		Taro	8	888	75.4	835	19.5	3.5	186.5	3.7	31
		Pumpkin	7	1596	91.9	431	11.2	3.2	105.3	9.5	41
		Banana	2	92	69.9	98	1.0	0.3	25.7	4.6	5
		Greens	6	370	88.0	120	15.0	1.8	18.6	24.7	30
		Setaria sp.	6	90	92.4	24	0.5	0.2	6.1	4.5	1
		Tinned fish	6	420	68.0	626	93.2	22.7	6.3	28.0	175
		Rice	5	125	11.8	458	8.0	1.0	100.5	7.1	33
		Sugar	2	52	81.4	35	0.1	0.2	9.2	1.7	1
		Dripping	2	92	1.0	820	-	91.0	-	-	-
		Corn	1	71	62.5	95	3.0	1.2	21.8	9.0	6
		Choko	1	141	95.0	21	1.1	0.1	4.9	13.0	3
TOTAL				7969		8079	197	128.9	1549.3		415
Average 1 day				469		475	11.6	7.6	91.1	5.1	24.5

The percentage contribution of different foods to the average daily diet during November 1980 of a 6-11 month old child.

Food	Weight gm	%	kcal Total Energy	%	Protein gm	%	Fat gm	%	Carbo-hydrate gm	%	kcal from Protein	%
Sweet potato	237	50.7	266	56.0	2.6	22.2	0.2	2.6	62.6	68.6	5.3	21.6
Taro	52	11.1	49	10.3	1.1	9.4	0.2	2.6	11.0	12.1	1.8	7.3
Pumpkin	94	20.1	25	5.3	0.7	6.0	0.2	2.6	6.2	6.8	2.4	9.8
Banana	5	1.1	6	1.3	0.1	0.9	(0.018)	-	1.5	1.6	0.3	1.2
Greens	22	4.7	7	1.5	0.9	7.7	0.1	1.3	1.1	1.2	1.7	6.9
Setaria sp.	5	1.1	1	0.2	(0.03)	-	(0.01)	-	0.4	0.4	0.1	0.4
Tinned fish	25	5.4	37	7.8	5.5	47.0	1.3	17.1	0.4	0.4	10.3	42.0
Rice	7	1.5	27	5.7	0.5	4.3	0.1	1.3	5.9	6.5	1.9	7.8
Sugar	3	0.5	2	0.4	(0.006)	-	(0.01)	-	0.5	0.5	(0.03)	-
Dripping	5	1.1	48	10.1	-	-	5.4	71.1	-	-	-	-
Corn	4	0.9	6	1.3	0.2	1.7	0.1	1.3	1.3	1.4	0.5	2.0
Choko	8	1.7	1	0.2	0.1	0.9	(0.006)	-	0.3	0.3	0.2	0.8
TOTAL	467	100	475	100.1	11.7	100.1	7.6	99.9	91.2	99.8	24.5	99.8

Table A9.9e : The average daily diet during February 1981 of a 6-11 month old child.

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
February 1981	4	Sweet potato	7	588	71.5	659	6.5	1.8	155.2	2.0	13
		Pumpkin	5	1140	91.9	308	8.0	2.3	75.2	9.6	30
		Banana	2	92	69.9	98	1.0	0.3	25.7	4.6	5
		Greens	3	185	8[illegible].0	60	7.5	0.9	9.3	24.7	1[illegible]
		Biscuit	1	19	8.4	77	1.7	1.5	14.1	6.4	5
		Bean	3	24	12.0	81	5.1	0.6	14.1	25.1	20
		Cucumber	1	94	96.2	11	0.6	0.1	2.5	15.0	2
TOTAL				2142		1294	30.4	7.5	296.1		90
Average 1 day				536		324	7.6	1.9	74.0	6.9	22.5

The percentage contribution of different foods to the average daily diet during February 1981 of a 6-11 month old child.

Food	Weight gm	Weight %	kcal Total Energy	kcal %	Protein gm	Protein %	Fat gm	Fat %	Carbo-hydrate gm	Carbo-hydrate %	kcal from Protein	kcal from Protein %
Sweet potato	147	27.3	165	50.9	1.6	20.8	0.5	25.0	38.8	52.5	3.3	14.9
Pumpkin	285	52.9	77	23.8	2.0	26.0	0.6	30.0	18.8	25.4	7.4	33.3
Banana	23	4.3	25	7.7	0.3	3.9	0.1	5.0	6.4	8.7	1.1	5.0
Greens	46	8.5	15	4.6	1.9	24.7	0.2	10.0	2.3	3.1	3.7	16.7
Biscuit	8	1.5	19	5.9	0.4	5.2	0.4	20.0	3.5	4.7	1.2	5.4
Bean	6	1.1	20	6.2	1.3	16.9	0.2	10.0	3.5	4.7	5.1	23.0
Cucumber	24	4.5	3	0.9	0.2	2.6	(0.025)	-	0.6	0.8	0.4	1.8
TOTAL	539	100.1	324	100	7.7	100.1	2.0	100	73.9	99.9	22.2	100.1

Table A9.10a : The average daily diet of children 12-23 months of age from March 1980 to February 1981.*

Food N = 227	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
Sweet potato	730	61320	71.5	68678	674.5	184.0	16188.5	2.0	1374
Taro	36	3996	75.4	3756	87.9	16.0	839.2	3.7	139
Pumpkin	207	47196	91.9	12743	330.4	94.4	3114.9	9.6	1223
Banana	214	9844	69.9	10435	103.4	29.5	2746.5	4.6	480
Corn	61	4331	62.5	5804	181.9	73.6	1329.6	9.0	522
Rice	169	4225	11.8	15464	270.4	33.8	3396.9	7.1	1098
Greens	245	15092	88.0	4900	612.5	73.5	759.5	24.7	1210
Pineapple	1	32	87.0	15	0.2	0.1	3.7	3.9	1
Bean	118	926	12.0	3186	200.6	23.6	554.6	25.1	800
Sugar	287	7462	81.4	5000	14.9	29.8	1313.3	1.7	85
Tinned fish	60	4200	68.0	6258	932.4	226.8	63.0	28.0	1752
Biscuit	41	779	8.4	3171	70.1	60.8	577.2	6.4	203
Setaria sp.	142	2130	92.4	575	10.7	4.3	144.8	4.5	26
Pandanus nuts	12	18	9.0	123	2.1	11.9	4.0	6.0	7
Pig	23	437	42.5	1997	52.0	196.7	-	13.2	264
Beef	2	34	59.8	93	5.8	7.5	-	38.2	36
Chicken	3	39	35.8	75	4.5	6.2	-	40.4	30
Lizard	4	72	35.8	139	8.3	11.5	-	40.4	56
Frog	1	8	35.8	15	0.9	1.3	-	40.4	6
Rat	1	13	35.8	25	1.5	2.1	-	40.4	10
Insects	6	33	66.3	49	4.5	1.4	4.4	59.7	29
Dripping	5	230	1.0	2049	-	227.7	-	-	-
Peanut	9	198	7.3	1085	46.3	89.7	42.8	16.3	177
Cucumber	27	2538	96.2	305	15.2	2.5	68.5	15.0	46
Cabbage	50	6100	93.0	1342	97.6	18.3	268.4	15.6	209
Tomato	28	672	93.8	134	8.1	2.0	28.2	18.5	25
Onion	4	72	87.8	31	1.3	0.1	6.8	8.5	3
Scone	8	600	(?)	2124	57.6	66.0	325.8	6.4	136
Choko	101	14241	95.0	2136	113.9	14.2	498.4	13.0	278
Chicken egg	2	124	73.7	101	16.0	14.3	1.0	33.2	34
Yam	2	74	76.4	64	1.4	0.1	14.7	5.0	3
Sugar cane	1	15	92.4	4	0.1	(0.03)	1.0	4.5	(0.18)
Mushroom	7	483	88.1	179	11.6	9.9	20.3	25.5	46
Irish potato	12	444	78.3	364	8.9	0.4	83.0	6.7	24
Banana shoots	2	30	92.4	8	0.2	0.1	2.0	4.5	(0.36)
Total		188008		152427	3947.7	1533.4	32256.2		10329
Average 1 day		828		671	17.4	6.8	142.1	6.8	45.9

* No days breast-milk = 7/227 = 3.1%

Table A9.10a : The percentage contribution of different foods to the average daily diet of children 12-23 months of age from March 1980 to February 1981.

Food N = 227	Weight gm	% %	kcal Total Energy	% %	Protein gm	% %	Fat gm	% %	Carbo-hydrate gm	% %	kcal from Protein	% %
Sweet potato	270	32.6	303	45.0	3.0	17.2	0.8	11.9	71.3	49.9	6.4	13.5
Taro	18	2.2	17	2.5	0.4	2.3	0.1	1.5	4.0	2.8	0.6	1.3
Pumpkin	208	25.2	56	8.3	1.5	8.6	0.4	6.0	13.7	9.6	5.4	11.9
Banana	43	5.2	46	6.8	0.5	2.9	0.1	1.5	12.1	8.5	2.1	4.6
Corn	19	2.3	26	3.9	0.8	4.6	0.3	4.5	5.9	4.1	2.3	5.1
Rice	19	2.3	68	10.1	1.2	6.9	0.1	1.5	15.0	10.5	4.8	10.6
Greens	66	8.0	22	3.3	2.7	15.5	0.3	4.5	3.3	2.3	5.3	11.7
Pineapple	(0.14)	-	(0.07)	-	(0.0009)	-	(0.0004)	-	(0.016)	-	(0.003)	-
Bean	4	0.5	14	2.1	0.9	5.2	0.1	1.5	2.4	1.7	3.5	7.7
Sugar	33	4.0	22	3.3	0.1	0.6	0.1	1.5	5.8	4.1	0.4	0.9
Tinned fish	19	2.3	28	4.2	4.1	23.6	1.0	14.9	0.3	0.2	7.7	17.0
Biscuit	3	0.4	14	2.1	0.3	1.7	0.3	4.5	2.5	1.7	0.9	2.0
Setaria sp.	9	1.1	3	0.4	(0.04)	-	(0.02)	-	0.6	0.4	0.1	0.2
Pandanus nuts	(0.07)	-	1	0.1	(0.009)	-	0.1	1.5	(0.02)	-	(0.03)	-
Pig	2	0.2	9	1.3	0.2	1.1	0.9	13.4	-	-	1.2	2.7
Beef	(0.15)	-	(0.4)	-	(0.03)	-	(0.03)	-	-	-	0.2	0.4
Chicken	(0.17)	-	(0.3)	-	(0.02)	-	(0.03)	-	-	-	0.1	0.2
Lizard	(0.3)	-	1	0.1	(0.04)	-	0.1	1.5	-	-	0.2	0.4
Frog	(0.004)	-	(0.07)	-	(0.004)	-	(0.006)	-	-	-	(0.03)	-
Rat	(0.06)	-	(0.1)	-	(0.007)	-	(0.009)	-	-	-	(0.04)	-
Insects	(0.14)	-	(0.2)	-	(0.02)	-	(0.006)	-	(0.02)	-	0.1	0.2
Dripping	1	0.1	9	1.3	-	-	1.0	14.9	-	-	-	-
Peanut	1	0.1	5	0.7	0.2	1.1	0.4	6.0	0.2	0.1	0.8	1.8
Cucumber	11	1.3	1	0.1	0.1	0.6	(0.01)	-	0.3	0.2	0.2	0.4
Cabbage	27	3.3	6	0.9	0.4	2.3	0.1	1.5	1.2	0.8	0.9	2.0
Tomato	3	0.4	1	0.1	(0.04)	-	(0.009)	-	0.1	0.1	0.1	0.2
Onion	(0.3)	-	(0.13)	-	(0.006)	-	(0.0006)	-	(0.03)	-	(0.01)	-
Scone	3	0.4	9	1.3	0.3	1.7	0.3	4.5	1.4	1.0	0.6	1.3
Choko	63	7.6	9	1.3	0.5	2.9	0.1	1.5	2.2	1.5	1.2	2.7
Chicken egg	1	0.1	(0.4)	-	0.1	0.6	0.1	1.5	(0.004)	-	0.1	0.2
Yam	(0.3)	-	(0.28)	-	(0.006)	-	(0.0007)	-	0.1	0.1	(0.01)	-
Sugar cane	(0.004)	-	(0.018)	-	(0.0004)	-	-	-	(0.004)	-	-	-
Mushroom	2	0.2	1	0.1	0.1	0.6	(0.04)	-	0.1	0.1	0.2	0.4
Irish potato	2	0.2	2	0.3	(0.04)	-	(0.002)	-	0.4	0.3	0.1	0.2
Banana shoots	(0.001)	-	(0.0004)	-	(0.00008)	-	(0.00004)	-	-	-		
Total	827	100.0	673	99.6	17.4	100.0	6.7	100.1	142.9	100.0	45.2	99.6

Table A9.10h : The average daily diet of children 12-23 months of age during May 1980.

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
May 1980 N = 17	17	Sweet potato	35	2940	71.5	3293	32.3	8.8	776.2	2.0	66
		Taro	8	888	75.4	835	19.5	3.6	186.5	3.7	31
		Pumpkin	7	1596	91.9	431	11.2	3.2	105.3	9.6	41
		Banana	21	966	69.9	1024	10.1	2.9	269.5	4.6	47
		Corn	3	213	62.5	285	8.9	3.6	65.4	9.0	26
		Rice	18	450	11.8	1647	28.8	3.6	361.8	7.1	117
		Greens	18	1109	88.0	360	45.0	5.4	55.8	24.7	89
		Bean	10	79	12.0	270	17.0	2.0	47.0	25.1	68
		Sugar	42	1092	81.4	732	2.2	4.4	192.2	1.7	12
		Tinned fish	6	420	68.0	626	93.2	22.7	6.3	28.0	175
		Biscuit	4	76	8.4	309	6.8	5.9	56.3	6.4	20
		Setaria sp.	23	345	92.4	93	1.7	0.7	23.5	4.5	4
		Beef	2	34	59.8	93	5.8	7.5	-	38.2	36
		Chicken	3	39	35.8	751	4.5	6.2	-	40.4	30
		Insects	3	17	66.3	25	2.3	0.7	2.3	59.7	15
		Dripping	2	92	1.0	818	-	91.0	-	-	-
		Peanut	4	88	7.3	482	20.6	39.9	19.0	16.3	79
		Cucumber	3	282	96.2	34	1.7	0.3	7.6	15.0	5
		Cabbage	9	1098	93.0	242	17.6	3.3	48.3	15.6	38
		Onion	4	72	87.8	31	1.3	0.1	6.8	8.5	3
		Scone	2	150	(?)	531	14.4	16.5	81.5	6.4	34
		Choko	11	1551	95.0	233	12.4	1.6	54.3	13.0	30
		Chicken egg	1	62	73.7	101	8.0	7.1	0.5	33.2	34
		Irish potato	4	148	78.3	121	3.0	0.1	27.7	6.7	8
TOTAL (17 days)				13807		12691	368.3	241.1	2393.8		1008
Average 1 day				812		747	21.7	14.2	140.8	7.9	59

All solid food

Table A9.10b continued

The percentage contribution of different foods to the average daily diet of children 12-23 months of age during May 1980.

Food	Weight gm	%	kcal Total Energy	%	Protein gm	%	Fat gm	%	Carbo-hydrate gm	%	kcal from Protein	%
Sweet potato	173	21.3	194	26.1	1.9	8.8	0.5	3.6	45.7	32.5	3.9	6.6
Taro	52	6.4	49	6.6	1.1	4.7	0.2	1.4	11.0	7.8	1.8	3.0
Pumpkin	94	11.6	25	3.4	0.7	3.3	0.2	1.4	6.2	4.4	2.4	4.0
Banana	57	7.0	60	8.1	0.6	2.8	0.2	1.4	15.9	11.3	2.8	4.7
Corn	13	1.6	17	2.3	0.5	2.3	0.2	1.4	3.8	2.7	1.5	2.5
Rice	26	3.2	97	13.0	1.7	7.9	0.2	1.4	21.3	15.1	6.9	11.6
Greens	65	8.0	21	2.8	2.6	12.1	0.3	2.1	3.3	2.3	5.2	8.8
Bean	5	0.6	16	2.2	1.0	4.7	0.1	0.7	2.8	2.0	4.0	6.7
Sugar	64	7.9	43	5.8	0.1	0.5	0.3	2.1	11.3	8.0	0.7	1.2
Tinned fish	25	3.1	37	5.0	5.5	25.6	1.3	9.3	0.4	0.3	10.3	17.4
Biscuit	4	0.5	18	2.4	0.4	1.9	0.3	2.1	3.3	2.3	1.2	2.0
Setaria sp.	20	2.5	5	0.7	0.1	0.5	(0.04)	-	1.4	1.0	0.2	0.3
Beef	2	0.2	5	0.7	0.3	1.4	0.4	2.9	-	-	2.1	3.5
Chicken	2	0.2	4	0.5	0.3	1.4	0.4	2.9	-	-	1.8	3.0
Insects	1	0.1	1	0.1	0.1	0.5	(0.04)	-	0.1	0.1	0.9	1.5
Dripping	5	0.6	48	6.5	-	-	5.4	38.6	-	-	-	-
Peanut	5	0.6	28	3.8	1.2	5.6	2.3	16.4	1.1	0.8	4.6	7.8
Cucumber	17	2.1	2	0.3	0.1	0.5	(0.002)	-	0.4	0.3	0.3	0.5
Cabbage	65	8.0	14	1.9	1.0	4.7	0.2	1.4	2.8	2.0	2.2	3.7
Onion	4	0.5	2	0.3	0.1	0.5	(0.006)	-	0.4	0.3	0.2	0.3
Scone	9	1.1	31	4.2	0.8	3.7	1.0	7.1	4.8	3.4	2.0	3.4
Choko	91	11.2	14	1.9	0.7	3.3	0.1	0.7	3.2	2.3	1.8	3.0
Chicken egg	4	0.5	6	0.8	0.5	2.3	0.4	2.9	(0.03)	-	2.0	3.4
Irish potato	9	1.1	7	0.9	0.2	0.9	(0.009)	-	1.6	1.1	0.5	0.8
TOTAL	812	99.9	744		21.5	99.9	14.0	99.8	140.8	100.0	59.3	99.7

Table A9.10c : The average daily diet of children 12-23 months of age during August 1980.*

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
August 1980 N = 14	14	Sweet potato	40	3360	71.5	3763	37.0	10.1	887.0	2.0	75
		Taro	1	111	75.4	104	2.4	0.4	23.3	3.7	4
		Pumpkin	13	2964	91.9	800	20.7	5.9	195.6	9.6	77
		Banana	11	506	69.9	536	5.3	1.5	141.2	4.6	25
		Rice	13	325	11.8	1190	20.8	2.6	261.3	7.1	84
		Greens	20	1232	88.0	400	50.0	6.0	62.0	24.7	99
		Sugar	20	520	81.4	348	1.0	2.1	91.5	1.7	6
		Tinned fish	6	420	68.0	626	93.2	22.7	6.3	28.0	175
		Setaria sp.	11	165	92.4	45	0.8	0.3	11.2	4.5	2
		Dripping	1	46	1.0	410	-	45.5	-	-	-
		Choko	5	705	95.0	106	5.6	0.7	24.7	13.0	14
		Pig	8	152	42.5	695	18.1	68.4	-	13.2	92
		Yam	1	37	76.4	32	0.7	0.1	7.4	6.0	2
TOTAL (14 days)				10543		9055	255.6	166.3	1711.5		655
Average 1 day				753		647	18.3	11.9	122.3	7.2	46.8

* All solid food

Table A9.10c continued

The percentage contribution of different foods to the average daily diet of children 12-23 months of age during August 1980.

Food	Weight		kcal Total Energy		Protein		Fat		Carbo-hydrate		kcal from Protein	
	gm	%		%	gm	%	gm	%	gm	%		%
Sweet potato	240	31.9	269	41.6	2.6	14.1	0.7	5.9	63.4	51.8	5.4	11.5
Taro	8	1.1	7	1.1	0.2	1.1	(0.03)	-	1.7	1.5	0.3	0.6
Pumpkin	212	28.2	57	8.8	1.5	8.1	0.4	3.4	14.0	11.4	5.5	11.8
Banana	36	4.8	38	5.9	0.4	2.2	0.1	0.8	10.1	8.3	1.8	3.8
Rice	23	3.1	85	13.1	1.5	8.1	0.2	1.7	18.7	15.3	6.0	12.8
Greens	88	11.7	29	4.5	3.6	19.5	0.4	3.4	4.4	3.6	7.1	15.2
Sugar	37	4.9	25	3.9	0.1	0.5	0.1	0.8	6.5	5.3	0.4	0.9
Tinned fish	30	4.0	45	7.0	6.7	36.2	1.6	13.6	0.5	0.4	12.5	26.3
Setaria sp.	12	1.6	3	0.5	0.1	0.5	(0.02)	-	0.8	0.7	0.1	0.2
Dripping	3	0.4	29	4.5	-	-	3.3	28.4	-	-	-	-
Choko	50	6.6	8	1.2	0.4	2.2	0.1	0.8	1.8	1.5	1.0	2.1
Pig	11	1.5	50	7.7	1.3	7.0	4.9	41.5	-	-	6.6	14.1
Yam	3	0.4	2	0.3	0.1	0.5	(0.007)	-	0.5	0.4	0.1	0.2
TOTAL	753	100.2	647	100.1	18.5	100.0	11.8	99.9	122.4	100.1	46.8	99.9

Table A9.10d : The average daily diet of children 12-23 months of age during November 1980.

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
November 1980	13	Sweet potato	68	5712	71.5	6397	62.8	17.1	1508.0	2.0	128
		Pumpkin	7	1596	91.9	431	11.2	3.2	105.3	9.6	41
		Banana	21	966	69.9	1024	10.1	2.9	269.5	4.6	47
		Rice	5	125	11.8	458	8.0	1.0	100.5	7.1	33
		Greens	13	801	88.0	260	32.5	3.9	40.3	24.7	64
		Bean	4	31	12.0	108	6.8	0.8	18.8	25.1	27
		Sugar	15	390	81.4	261	0.8	1.6	68.6	1.7	4
		Setaria sp.	6	90	92.4	24	0.5	0.2	6.1	4.5	1
		Lizard	4	72	35.8	139	8.3	11.5	-	40.4	56
		Rat	1	13	35.8	25	1.5	2.1	-	40.4	10
		Insect	1	6	66.3	8	0.8	0.2	0.7	59.7	5
		Cabbage	1	122	93.0	27	2.0	0.4	5.4	15.6	4
		Choko	5	705	95.0	106	5.6	0.7	24.7	13.0	14
		Yam	1	37	76.4	32	0.7	0.1	7.4	5.0	2
TOTAL (14 days)				10666		9300	151.6	45.7	2155.3		436
Average 1 day				820		715	11.7	3.5	165.8	4.7	33.5

Table A9.10d continued

The percentage contribution of different foods to the average daily diet of children 12-23 months of age during November 1980.

Food	Weight gm	%	kcal Total Energy	%	Protein gm	%	Fat gm	%	Carbo-hydrate gm	%	kcal from Protein	%
Sweet potato	439	53.5	492	68.8	4.8	4.4	1.3	39.4	116.0	70.0	9.8	29.3
Pumpkin	123	15.0	33	4.6	0.9	7.8	0.2	6.1	8.1	4.9	3.2	9.6
Banana	74	9.0	79	11.0	0.8	6.9	0.2	6.1	20.7	12.5	3.6	10.7
Rice	10	1.2	35	4.9	0.6	5.2	0.1	3.0	7.7	4.6	2.5	7.5
Greens	62	7.6	20	2.8	2.5	21.6	0.3	9.1	3.1	1.9	4.9	14.6
Bean	2	0.2	8	1.1	0.5	4.3	0.1	3.0	1.4	0.8	2.1	6.3
Sugar	30	3.7	20	2.8	0.1	0.9	0.1	3.0	5.3	3.2	0.3	0.9
Setaria sp.	7	0.9	2	0.3	(0.03)	-	(0.01)	-	0.5	0.3	0.1	0.3
Lizard	6	0.7	11	1.5	0.6	5.2	0.9	27.3	-	-	4.3	12.8
Rat	1	0.1	2	0.3	0.1	0.9	(0.002)	-	-	-	0.8	2.4
Insect	(0.46)	-	1	0.1	(0.06)	-	(0.015)	-	(0.05)	-	0.4	1.2
Cabbage	9	1.1	2	0.3	0.2	1.7	(0.03)	-	0.4	0.2	0.3	0.9
Choko	54	6.6	8	1.1	0.4	3.4	0.1	3.0	1.9	1.1	1.1	3.3
Yam	3	0.4	2	0.3	0.1	0.9	(0.007)	-	0.6	0.4	0.1	0.3
TOTAL	820	100	715	99.9	11.6	100.2	3.3	100	165.7	99.9	33.5	100.1

Table A9.10e : The average daily diet of children 12-23 months of age during February 1981.

Date	No. Sample	Food	Portion	Weight gm	% Moisture	kcal energy	Protein gm	Fat gm	Carbo-hydrate gm	Percentage kcal from protein	kcal from protein
February 1981	29	Sweet potato	117	9828	71.5	11007	108.1	29.5	2594.6	2.0	197
		Pumpkin	30	6840	91.9	1847	47.9	13.7	451.4	9.6	177
		Banana	26	1196	69.9	1268	12.6	3.6	333.7	4.6	58
		Corn	17	1207	62.5	1617	50.7	20.5	370.5	9.0	146
		Rice	28	700	11.8	2562	44.8	5.6	562.8	7.1	182
		Greens	32	1971	88.0	640	80.0	9.6	99.2	24.7	158
		Pineapple	1	32	87.0	15	0.2	0.1	3.7	3.9	1
		Bean	38	298	12.0	1026	64.6	7.6	178.6	25.1	258
		Sugar	40	1040	81.4	697	2.1	4.2	183.0	1.7	12
		Tinned fish	4	280	68.0	417	62.2	15.1	4.2	28.0	117
		Biscuit	6	114	8.4	464	10.3	8.9	64.5	6.4	30
		Setaria sp.	6	90	92.4	24	0.5	0.2	6.1	4.5	1
		Insect	1	6	66.3	8	0.8	0.2	0.7	59.7	5
		Peanut	1	22	7.3	121	5.1	10.0	4.8	16.3	20
		Cucumber	11	1034	96.2	124	6.2	1.0	27.9	15.0	19
		Cabbage	10	1220	93.0	268	19.5	3.7	53.4	15.6	42
		Choko	5	705	95.0	106	5.6	0.7	24.7	13.0	14
TOTAL (29 days)				26583		22211	521.2	134.2	4984.1		1437
Average 1 day				917		766	18.0	4.6	171.9	6.5	49.6

Table A9.10e continued

The percentage contribution of different foods to the average daily diet of children 12-23 months of age during February 1981.

Food	Weight gm	%	kcal Total Energy	%	Protein gm	%	Fat gm	%	Carbo-hydrate gm	%	kcal from Protein	%
Sweet potato	339	37.0	380	49.6	3.7	20.7	1.0	22.7	89.5	52.0	6.8	13.8
Pumpkin	236	25.7	64	8.4	1.7	9.5	0.5	11.4	15.6	9.1	6.1	12.3
Banana	41	4.5	44	5.7	0.4	2.2	0.1	2.3	11.5	6.7	2.0	4.0
Corn	42	4.6	56	7.3	1.7	9.5	0.7	15.9	12.8	7.4	5.0	10.1
Rice	24	2.6	88	11.5	1.5	8.4	0.2	4.5	19.4	11.3	6.3	12.8
Greens	68	7.4	22	2.9	2.8	15.6	0.3	6.8	3.4	1.8	5.5	11.1
Pineapple	1	0.1	1	0.1	(0.007)	-	(0.003)	-	0.1	0.1	(0.03)	-
Bean	10	1.1	35	4.6	2.2	12.3	0.3	6.8	6.2	3.6	8.9	18.0
Sugar	36	3.9	24	3.1	0.1	0.6	0.1	2.3	6.3	3.7	0.4	0.8
Tinned fish	10	1.1	14	1.8	2.1	11.7	0.5	11.4	0.1	0.1	4.0	8.1
Biscuit	4	0.4	16	2.1	0.4	2.2	0.3	6.8	2.9	1.7	1.0	2.0
Setaria sp.	3	0.3	1	0.1	(0.017)	-	(0.007)	-	0.2	0.1	(0.03)	-
Insect	(0.2)	-	(0.3)	-	(0.03)	-	(0.007)	-	(0.02)	-	0.2	0.4
Peanut	1	0.1	4	0.5	0.2	1.1	0.3	6.8	0.2	0.1	0.7	1.4
Cucumber	36	3.9	4	0.5	0.2	1.1	(0.04)	-	1.0	0.6	0.6	1.2
Cabbage	42	4.6	9	1.2	0.7	3.9	0.1	2.3	1.9	1.1	1.4	2.8
Choko	24	2.6	4	0.5	0.2	1.1	(0.02)	-	0.9	0.5	0.5	1.0
TOTAL	917	99.9	766	99.9	17.9	99.9	4.4	100.0	172.0	99.9	49.4	99.8

CONCLUSION

Problems abound. Its authorship? A sequel?
Its hero-villain, whose ways so little mend?
The plot? Still dark. The style? A shade unequal
An what of the denouement? And, the end?

Walter De La Mare 'The Last Chapter'

Clearly there is some dissonance between many of the elements in the Nembi physical and social milieux. Yet, although these maladjustments have their origins in pre-contact conditions, they have now become impediments to the future well being of the Nembi socio-economy. Whereas in the past, adjustments were able to be made to accommodate changes in the smooth continuity of the Nembi way of life, the pace of change since 1960 has outstripped the capacity for it to be absorbed.

It seems that the location of the Nembi Plateau at the interface between the highlands and lowlands provides the foundation from which the present instability has sprung. Environment, agro-economy, and social organisation are all in one way or another brought together and can be expressed in relation to that interlocation. The Pubi, overlooking the lowlands, have interpreted their ills and difficulties as the result of sorcery, but anomalies remain. For while the Nembi view the valleys and lowlands with some fear, they also regard them with nostalgia as the home of their ancestors, where gardens yielded in abundance. Thus even in the ability of the Pubi to rationalize their condition between the highlands and the lowlands there are elements of contradiction.

Increasingly the Pubi are coming to terms with the monetized economy and the fact that many of their old ways are gone. But here also there are contradictions. While the Pubi would not wish to return to the times when they lived in real fear of their neighbours, and they appreciate what medicines and vaccines have done for them, much of their uncertainty stems from the failure of a hazy vision of a new materialism to become reality. A blend of disappointment, frustration and anger clouds the Pubi's image of themselves.

They believe that the relatively harsh government of the kiaps was putting them on the right road: while they were being told what to do, they at least thought they were working toward some goal of economic development. Since independence the Pubi have felt increasingly neglected and their confidence, which was severely sapped by their experience of pacification, has not been restored. Having acquiesced to promises of wealth, the Pubi are keenly aware that they do not possess the knowledge with which to obtain it, knowledge which they believe is being denied them by the neglect of Government. Thus concern with wealth and their interaction with the monetized economy has diverted the Pubi away from seeking opportunities within their own socio-economy. Instead the majority wait for 'economic development' to come to them. At the same time, the vacuum created by cessation of fighting and lack of economic opportunity has been filled by a more intense preoccupation with the traditional exchange economy. Pressure upon the agricultural system has thus increased as the socio-economy has become more intense and the very foundation of the Pubi way of life has come under profound pressure. Points of weakness in the man-land relationship and socio-economy on the Nembi Plateau have reached critical levels. These relationships have a complex history, and a direct bearing upon the present imbalances.

Earlier chapters have shown that the Nembi Plateau has relatively high population densities, its population is characterized by high dependency ratios, and its agricultural system is based on short fallows and gives low yields. I have demonstrated that these conditions are not the result of a gradual increase in population over the past hundred years that has now exceeded the carrying capacity of the physical resources. The relatively high rates of malnutrition and malnutrition-related disease among children under the age of five and the high child death rates are a reflection in part of a recently induced socio-economic disorder. This socio-economic disorder also includes the disruption of the cohesion and harmony between Nembi culture and their environment.

The problem is essentially one of practicalities. The harsh reality is that more than 200 children of every 1000 born die before the age of five, and nearly half of all children under the age of five suffer from some measure of malnutrition.

Seasonality in the Nembi way of life

Perhaps the most difficult aspect of the Nembi way of life to summarize and to draw conclusions from is the apparent seasonality in births, deaths, sickness and disease, and its conformity with the social and agricultural cycle. Climate is unfashionable as an explanation of poverty (Chambers 1981:1), but while I do not impute any causal primacy to seasonality as an explanation of the poverty, or of the high rates of malnutrition of the Nembi, it is nevertheless an important framework of analysis. I have shown that seasonal factors either alone or more importantly, in their interactions, operate to the disadvantage of children born at particular times of the year.

The picture is a composite in which different factors take on varying levels of significance at different times of the year. My analysis of the Nembi condition has refined further the possible explanations for high rates of child malnutrition. My starting point was observation of children under the age of five and the hypothesis of those children between the ages of six and eighteen months were most vulnerable to disease and malnutrition. I can now offer a clearer definition of vulnerability for the Nembi Plateau children. Those children born when their mothers are working hardest in the gardens (from August to January) are the most vulnerable. Although their birthweight is satisfactory and they are on average heavier than children born at other times of the year they are unable to be breast-fed on demand. Thus by the time these children are being weaned (January to June) they are of lower weight-for-age and are thus more prone to disease and death. Moreover the early part of the year is also the period when a child is <u>more likely</u> to contract disease and die.

On the other hand those children born between February and July gain weight rapidly, despite their lower birth weight which reflects poor gestational weight gain during the gardening season. The mothers of these children born between February and July have fewer production responsibilities in this period and can devote more time to take care of their children. Thus when children born between February and July enter weaning they are healthier and more able to cope with the physiological and psychological stresses involved in their introduction to solid foods. Between January and June, when the prevalence of disease is highest they are being breast-fed and thus not only gain some immunity through their mother's milk, but also are less likely to ingest pathogens than if they were eating solids.

The pattern of seasonal risk is strengthened by the seasonal pattern of births and deaths. The evidence suggests that conception peaks between February and May after the heaviest work load in the gardens is over. Thus more children are born between October and January when women once again are working hardest in the gardens and least able to care for their children. It is not surprising that the number of child deaths peaks between February and June.

No doubt the seasonal pattern of conceptions is related to the agricultural cycle of the Nembi, although precisely in what way it is difficult to say. It is certain that since the beginning of sustained contact with Europeans in the early 1960s the increased demands made upon the women has exaggerated the seasonal cycle of production, and what have always been critical times of the year have become acute. Pressure upon favourable land and the increase in the dependency ratio have increased the work load of women and the return for their extra effort is smaller. The socio-economy is thus on a downward spiral of declining yields with increasing inputs.

Overlapping the seasonal cycles and at times exacerbating them, are cultural cycles of longer duration, the most important being periodic increases in the pig-herds prior to the large pig-festivals (mok enk), which occur every 15 years or so. Not only is the agricultural cycle designed to ameliorate conditions of seasonal water-logging, drought and frost but also to match demand of fodder and food by pigs and people with supply. The Nembi socio-economy has an internal dynamism that is both periodic and seasonal. The complexity of the Nembi socio-economy is apparent.

The seasonal and periodic cycles embedded within the Nembi agricultural system throw light on another characteristic attributed to highlands agricultural systems, that of subsistence affluence. The periodic build-up in the pig-herd moves the analysis away from the implication that climatic seasonality is the root cause of the Nembi's ills.

Subsistence affluence

While Fisk's (1962) concept of subsistence affluence is in many respects a true description of pre-contact Papua New Guinea society it is also, paradoxically, misleading. On the Nembi Plateau the people produce for subsistence, trade and social activities. However, Fisk's analysis considered only time spent in subsistence activities, and thus dismissed time spent in cultural activities, such as ceremony, exchange and even the manufacture of tools and shelter, as time spent in idleness and therefore non-productive. His conclusion was that Papua New Guinean subsistence economies were affluent to the extent that surplus labour was available to be siphoned off and put to work in the growing cash economy. Similarly, Sahlins (1974) argued that affluence could be achieved by satisfying wants through producing much or by desiring little and that many rural economies systematically underutilize resources. I would agree with Fisk and Sahlins that the pre-contact economies of the highlands, including that of the Nembi, were affluent, but for different reasons.

Brookfield's (1972b) division of production into subsistence, social and trade components suggests that very little time was available to highlanders to be truly idle. The elaborate ceremonial exchanges of the Nembi,held on large level ceremonial grounds carved from the hillsides,must have absorbed many hours of productive effort. The Nembi were undoubtedly affluent, but not so much by the amount of leisure time as in the elaboration of their social and cultural life. There are obvious implications here for the causes of the high rates of malnutrition. The distinction between production of sweet potato to feed pigs and production to satisfy people's dietary needs is central to any understanding of the problem. Women work both to rear pigs and to feed their families, and also expend energy and time in caring for their children. Although it is fairly obvious that there is some sort of 'trade-off' in producing food for the family and producing to feed and rear pigs, it has not often been recognized that child-rearing is also demanding of a woman's productive effort. Basically, a woman's work effort may be directed to three areas, and the allocation of her work effort in varying proportions between those three areas is reflected in the health and well-being of her children. The proportionate allocation of work effort between production for pigs, production for subsistence, and child care is affected not only by the stage in a woman's life cycle but also by that of the hearth and family unit and that of the pig and ceremonial cycle of the clan and clan-cluster. My conclusions are tentative in that they represent only a segment in time. Bearing in mind the tripartite division of women's work effort it is possible to re-examine Sahlin's (1974) model of subsistence affluence and his application of Chayanov's rule.

Chayanov's rule as interpreted by Sahlins (1974:87), is: 'the greater the relative working capacity of the household, the less its members work', which suggests that those households with a lower consumer/producer ratio have more leisure time and on that criterion are more affluent. In fact as I showed for the Puit and Pubi clans if pigs are included as consumers the productive effort of adults (and they are more probably women than men) in terms of area of sweet potato cultivated, is very similar for all households. The women in the hearth units in the Pubi clan also cultivate very similar areas of sweet potato suggesting that they have comparable work loads. The interesting difference between my data from the Nembi Plateau and those used by Sahlins is that the hearth units of the Pubi do not show a wide spread from hearths with a low consumer/producer ratio to hearths with a high consumer/producer ratio. That is, they do not show a strong linear relationship with area under cultivation or with the ratio of area cultivated to producer.

If Sahlin's interpretation of Chayanov's rule were adapted to the Pubi data it could be suggested that the Pubi women work at comparable levels because they all operate under the constraint of similar and limited wants. Indeed Sahlins stated (1974:87) '...the customary norm of welfare has to be fixed at a level attainable by the larger number of them [households], leaving underexploited the powers of the most efficient minority'. The assumption is that if the most efficient were able to maximise their production, the resulting inequalities would lead to disruption of the social realtions. The ceremonial exchange net of the Nembi could thus be interpreted as a form of redistribution of wealth.* On the plateau, there are other factors to be considered. Although there are differences between women both in their capacity and in their desire to work, a shortage of land combined with declining yields has produced a situation in which most women work at their limit.

It might be concluded that the proportion of pigs to human consumers in each hearth dictates the amount of food available for people and thus the nutritional status of children. This is only part of the explanation of the high level of background malnutrition on the Nembi Plateau. Smith's (1979) cogent criticism of Sahlin's (1974) application of Chayanov's analysis of Russian peasant agriculture to Melanesian agro-economies are of direct relevance to my interpretation of the situation on the Nembi Plateau. Smith (1979:478) suggests that a better Chayanov's rule would be: 'The degree of self-exploitation of labour is established by some relationship between the measure of demand satisfaction and the measure of the demand for labour'. That is, the utility derived from an extra unit of work per producer (marginal utility of output) has to be weighed against the drudgery of extra work effort (marginal disutility of effort). A related concept is that of the law of least effort. In those hearths with a high human consumer/producer ratio more work will yield more utility than in households with low human consumer/producer ratios. By the same

* Perhaps Sillitoe's argument that the exchange network of the Wola provides the basis of social cohesion might be strengthened if this were indeed the case and ceremonial exchange were a form of arcadian communism.

token the disutility of the increasing drudgery is higher for those hearths with a low consumer/producer ratio. Thus the equilibrium between effort and income will come at a lower point for hearths with a low consumer/producer ratio than for households with a high consumer/producer ratio and while productive intensity is inversely related to productive capacity, it is not proportionate to the consumer/producer ratio (Smith 1979:480).

It is unfortunate that my data on pigs in the Pubi hearths are inadequate for a full analysis. Nevertheless it is interesting to speculate what may be operating within Pubi hearths in the light of Smith's criticism of Sahlins. Because of the low yields of sweet potato on the Nembi Plateau the drudgery of marginal effort is obviously very high. The utility to be derived from total work effort can however be divided depending upon whether production of sweet potato is for people or pigs. I would suggest that the marginal utility of effort is higher in producing for pigs than for people; women are more likely to put extra effort into producing for pigs (wealth and prestige) than for people. The driving force of production is not to eat but to generate and sustain social relationships through the production and exchange of pigs. If this is the case then the apparent paradox described in Chapter Six that households with well-nourished children had more pigs, a higher consumer/producer ratio and a higher cultivated area per adult than households with malnourished children, can be partially explained. In a general sense nutritional status is related to food intake. If production is related to the number of pigs - a number that cannot be predicted precisely from the time of planting of sweet potato to the time of harvest - then the food available for human consumption is also higher. In short, although production of sweet potato is ostensibly for pigs with a surplus for human consumption, it does not prevent people from eating more than their share. Because of the disutility of effort the marginal propensity to cultivate sweet potato is not constant and it may be that a household with a low pig/people ratio cultivates proportionally less per person than a household with a high pig/people ratio where the utility of cultivating more (supposedly for pigs to generate wealth and prestige) is higher. The disutility to produce for food increases faster than the disutility of producing for pigs.

On the Nembi Plateau women primarily produce sweet potato to provide fodder for pigs rather than food for people. In times of acute shortage of food pigs are killed only as a last resort. Before such drastic action is taken people least able to fend for themselves go without food or at least go short. Although a high proportion of Nembi children are malnourished some are more so than others. Children unable to forage for themselves and dependent upon their mothers for food are thus of poorer nutritional status. Children under stress, as at weaning, are additionally vulnerable to the stress (associated with the drudgery of production) experienced by their mothers. The unhealthy environment, the high work load of women, the low yields and poor quality of diet combine to varying degrees not only at different times of the year but also at different times during the pig-cycle and during the life of a child. It seems that the disutility of caring for children rises steeply as the pressure of producing for pigs increases. Although in the hearths with more pigs, total production may increase and be higher, children who are vulnerable due to a combination of their age and the season of the year will be disadvantaged because their mothers are working harder. In the past such disutility to bear and care for children prompted abortion, infanticide and other methods of fertility control. Medical intervention on the Nembi Plateau has been a mixed blessing.

What little measure of subsistence affluence the Nembi still possess has always been bought at a cost, the health of children. This is not to say that young children are actively discriminated against but that the heavy work load of the women makes neglect unavoidable. To maintain their relative wealth in the face of inflation induced by contact with the western economy the Nembi must produce more. The children suffer, while the periodic pressure to increase the pig herd accentuates the problem over a time frame longer than simply seasonal. Declining marginal productivity has rendered periods of possible stress and hunger more acute and critical.

Given the inflexibility of production for exchange it can fairly be said that there are too many Nembi people in an inhospitable environment. The problem is one of too many mouths to feed, an artefact of culture-contact.

Too many mouths

The epidemiological transition, in which improvements in environmental health increased child survival rates, in Europe took place relatively slowly and allowed a gradual adaptation of fertility control as it became desirable. On the Nembi Plateau although child mortality is high it has undergone a short and sharp decline in the last twenty years. On the other hand, fertility has increased. The process has thus been very different from the European experience, not least because decline in mortality has not been due to any great improvement in environmental health. Although lessons may be learnt from the classical European demographic and epidemiological transitions there are no exact parallels. The decline in mortality will undoubtedly continue as the public health of the Nembi improves, and that process also begs the question as to the role of fertility control in the future of the people of the Nembi Plateau.

Here too there are elements of eurocentrism in that methods of fertility control and contraception developed in western developed countries are commonly thought as the only effective measures. The measure of fertility control that the Nembi managed before contact has been ignored. Moreover the intricate interconnections of the many aspects of the Nembi way of life and economy and their effect upon fertility are in sharp contrast to the tenets of most family planning programmes. It is not simply a matter of teaching people to use western contraceptive methods. The preconditions for their use must be present. Fertility control, health and nutrition improvement, and agricultural development are facets of the multi-dimensional problem of culture-contact. Intervention programmes must therefore also be multi-dimensional to be effective. Intervention cannot be half-hearted and rather than the western economy being allowed to swamp that of the Nembi Plateau, the true worth of the Nembi socio-economy must be recognized and methods devised to help the two ways of life to mesh more equitably.

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