LEMANKOA

1920 - 1980

A study of the effects of health care interventions on the people of a pre-industrial village in North Solomons Province, Papua New Guinea

by

ROY FREDERICK RHODES SCRAGG

M.D. (Adelaide), F.R.A.C.M.A., D.T.M. & H. (Sydney)

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SUMMARY

Lemankoa, a rural village on Buka Island, came into intermittent contact with Europeans during the nineteenth century. Population records are available since 1915 and have been analysed in depth since 1927. Major demographic changes have been related to the quality of successive health interventions.

From 1927 to 1947 the population fluctuated around 400 persons with crude birth and death rates of 41.5 and 40.7 per 1000. There is evidence that the death rate was falling by the late 1930s due to increased herd immunity not to health interventions. From 1942 to 1947 the war caused a rise in crude death rate to 50.9 per 1000 with an excess of deaths in males and the old and young.

From 1947 to 1960 modern medicines were available through a village health worker at a village aid post and the death rate fell to 18.7 while the birth rate increased to 51.1 - a growth rate of 3.24% per annum. At the same time social and economic development was occurring with a primary school in the village, a secondary school on the island and extensive plantings of cocoa and coconuts.

From 1960 to 1980 the application of national eradication and control programmes for yaws, tuberculosis and malaria and the effective child health programmes caused a further decline in death rate to 5.8 per 1000.

There was also a marginal decline in fertility to 43.4. Education of women took them into careers and hastened social change which was occurring throughout the community. Economic development continued to apace as plantations matured and the copper mine was developed. The achievement of Independence was also a catalyst.

Behind the scenes, the age specific fertility rate moved slowly from 4,370 through to 8,680 in 1967 and has since fallen to 6,710 by 1980. This decline is due to smaller family size for women aged up to 34 and is consistent with the start of demographic transition.

The change in mortality has doubled then trebled the expectation of

life at birth from male 22 and females 25 to male 64 and female 70 years. The aged now survive to be 80 year olds and will become a health care problem.

Lemankoa is atypical but the changes indicate what is happening in many other economically advanced areas of Papua New Guinea and how transition may be encouraged to commence.

PREFACE

DECLARATION

This thesis is a record of original work conducted during the years 1948 to 1980 in Papua New Guinea while a member of the Department of Public Health, and the University of Papua New Guinea and while self-employed in Adelaide. The data from Lemankoa 1947 to 1953, was used as a control in a study of depopulation in New Ireland - a thesis accepted in 1955 for the degree of Doctor of Medicine, University of Adelaide. The balance of the data has not been submitted for any other degree, award or diploma in any university.

OBJECTIVES

To determine the longitudinal changes in population, mortality, fertility and related parameters in the unique data for the period 1920-1980 from a Papua New Guinea village population.

To match the major changes with the historical record of epidemics, health interventions and other relevant events in Bougainville and adjoining populations.

To assess the extent of demographic transition and relate the long term trends to Papua New Guinea as a whole.

In the course of this study it became evident that there were four distinct periods separated by measurable changes in mortality in response to changes in the quality of health interventions and the socio-economic environment.

1920 to 1942: An epidemic era with stationary population and matching high mortality and high fertility in the post contact pattern but with

ineffective health interventions

1942 to 1947: The war era with declining population due to the epidemic nature of war.

1947 to 1960: The curative era with an increasing population due to a rapid fall in mortality caused by the paternalistic application of modern life saving medicines by village health workers through a village aid post but with increased fertility due to the destruction of traditional family planning practices and attitudes.

1960 to 1980: The preventive era with a more rapidly increasing population, and a further decline in mortality due to the application on a district and national scale of disease prevention programmes but with stable fertility until the 1970s when socio-economic development has started a fertility decline.

The demographic indices relating to these four eras are detailed along with the evidence for the quality of health care.

The changes are not typical of Papua New Guinea as a whole but there are other areas where they have been achieved. The changes in Lemankoa indicate the potential for mortality reduction and for national fertility transition if effective curative and preventive services are matched with economic and social development in the rural village.

WHY LEMANKOA?

In 1948, after 9 months in New Guinea, I undertook my first medical patrol with a visit to the Carterets Islands. Shortly after I visited all villages on Buka and adjoining islands and prepared the standard patrol report. On this patrol I lined the village inhabitants and conducted simple physical examinations. The 7,000 people inspected included the inhabitants of Lemankoa and the Solas villages (Figure 1.2).

Back at base at Sohano, Buka Passage, I realised the futility of such a patrol - it would have been nearly as effective to drive slowly through each village.

In November of that year I returned with note books and simple examining equipment to Lemankoa and seven Solas villages and examined and recorded details of some 1,100 people. During these visits I came into direct contact with the Catholic priests in Lemanmanu and Gagan. Both priests had records of the dates of birth of all their parishioners in the villages. Over the years since I and my research assistants have made repeated visits to these villages recording medical, physiological and demographic data. By the 1960s the priests gave me their "Status animarum", "Status defunctorum" and "Baptizorum" to help update my records. In 1969, a box of old records at Lemanmanu was made available that included a 1922 Status animarum for the 6 Haku villages of Lontis, Lemankoa, Lemanmanu, Tandeki, Iltopan and Hanpan.

The first birth dates in the church records and first date of birth estimations were recorded in 1915 by itinerant priests based on Hetau Island and over the years full villages lists were prepared. In 1922, a priest became resident at Lemanmanu and the earliest record book was started at that time with amendments made as vital events occurred. The priests maintained their records until the 1942 Japanese invasion when the books were hidden by a catechist in one of the caves where the villagers lived over that period.

The combination of all the records of vital events and the interrogation of the older men and women to link the pre and post war data has resulted in a longitudinal picture of demographic change in this large New Guinea village. Repeated regular visits combined with mission recording provided an exact date of birth for an increasing proportion. By 1948, only a few born before 1900 were not assigned a year of birth which was believed to be accurate. This quality of information justifies the detailed analysis included herein.

Almost everyone listed was seen at each visit and as a general rule temporary absentees have been included in the totals. Where marriage occurred into any other tribal group or province and children were born,

the individual was migrated out if they were resident in that village. If they were resident in a town they were kept on the record but not if living in the village of their spouse adjoining the town. Correspondence was maintained with employers outside the area to keep birth records accurate.

Lemankoa, selected by chance in 1948, was later studied in detail in comparison with depopulating areas in New Ireland (Scragg, 1957).

Over the years the change in mortality and fertility patterns have been reported (Scragg 1968; Ring and Scragg 1973). The consolidation of historical and current information into computer records is unique for New Guinea although similar church records are available for the Mekeo and Goilala (Scragg 1977). Previous papers made only limited mention of the situation prior to the war as there was no detailed comparative data from the other areas to study in depth.

ACKNOWLEDGEMENTS

The continuing studies of the people of Lemankoa village have been undertaken with the consent and co-operation of the people of that village.

In recent years the studies have been approved by the Medical Research Advisory Committees of the Department of Public Health, Papua and New Guinea, and the Medical Faculty of the University of Papua New Guinea and by the Institute for Papua New Guinea Studies.

I am grateful for the assistance of members of the Papua New Guinea, Department of Public Health who helped with both surveys and analysis - in particular, Albert Speer, Robert Scragg and Australian medical students who undertook follow-up visits in the 1950s and 1960s; Paul Pakits, Gerard Balai and MTT Galium of Lemankoa who assisted during all village visits; the several priests of Lemanmanu who gave free access to their sacred records and the Department of Community Medicine, University of Adelaide, for access to the University computer.

In the current analysis invaluable assistants have been: Ron Read with computer collation and analysis; Shail Jain with life table analysis; Ian Maddocks who read and advised on the final report Jan Nicholls and Diedre Cain who drew the maps and graphs, and Dianne Robinson and Carol Webster who spent many hours typing drafts and in word processing.

Last but by no means least is my debt to the people of Lemankoa who accepted a brash young doctor as a resident visit in 1948 and over the years have come together again and again to submit to questions and examinations the purpose and value of which must always have been a mystery to them.

1. HISTORY OF BUKA ISLAND

1.1 CONTACT, RECRUITMENT AND SETTLEMENT

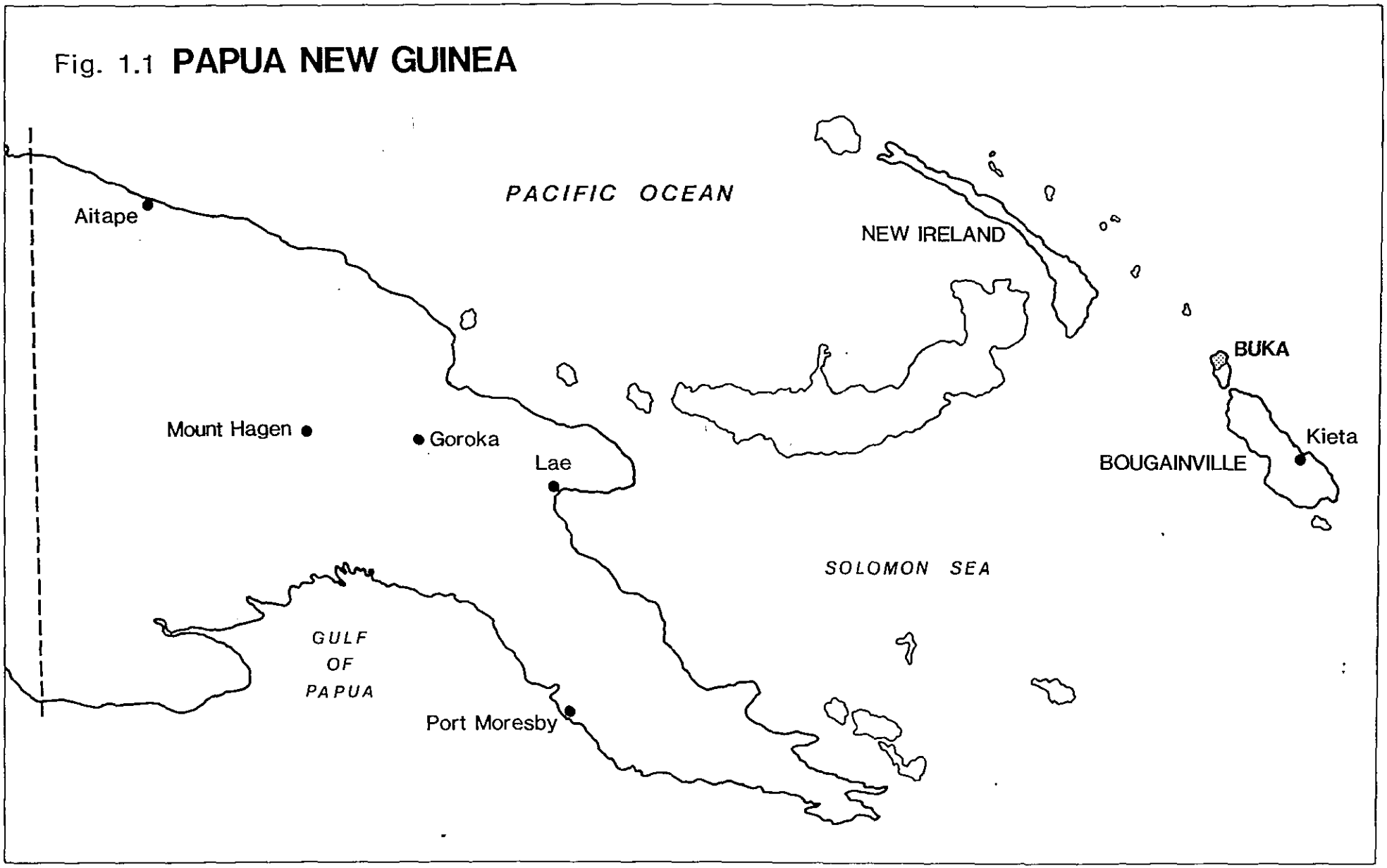
The first sighting of Buka Island in the northern Solomon Islands by a European appears to have been made by Carteret in July 1767, some 170 years after Mendana had attempted to colonise Santa Cruz in the eastern Solomons. In 1768, Bougainville passed off the east coast of "Bouka" as he named it after the cry "Bouca, bouca, onelle onelle" repeated by the many men who came out in canoes with coconuts. "Bouca" means "what are they saying?" in the local dialect (Guppy, 1887). In 1871 some 80 persons were massacred off Buka by the crew of the "Carl" (Ward 1972, p133). In 1882 Guppy, a naval surgeon, saw several Bouka men and women living in the Treasury Islands who were originally bought as slaves but this was the closest he came to Buka. He valued British domination of the area and regretted the passing of control to Germany by the arrangements of 1886.

The first Annual Report of the New Guinea Company for 1886-87 mentions the need to establish a station in the Solomon Islands and the acquisition of land by the Company in those islands (Sack 1979, p6). In the same year police were recruited from the islands and the men of the Solomons were commended as effective workers - a reputation they hold to this day. The population was denser in these islands and recruitment was encouraged.

There was a high level of recruiting from Buka matching the importance of "fertile" Buka to the German expansion in the South Pacific (Firth, 1982). 2,410 persons were recruited from 1887 to 1903. This exceeds the number of adult males in the Buka group of islands in 1914. Recruitment was on the 3-4 yearly roster and must have been to the limit with many older boys being indentured, particularly as 12 year olds were classified as adults. Mortality among labourers was high and there was less than a 80% chance of a labourer returning to his village.

Women were also taken but less frequently than from New Ireland. Chinese labour, many plantations and aggressive female recruitment present

Fig. 1.1 **PAPUA NEW GUINEA**



in New Ireland but not on Buka, may have been factors in the depopulation.

The village populations in the Southern Solomons were decimated by chicken pox, whooping cough, measles, influenza, gonorrhoea, tuberculosis and leprosy between 1870 and 1900 (Hogbin, 1939). Most of these infectious diseases affected the population of Buka.

In 1902 the Catholic Mission was driven out of Kieta by the local villagers. The district station was established there in 1905 and the mission set up a station on Buka in 1910.

In 1898-9 the Solomons were singled out as free from gonorrhoea and it is implied that there were no Europeans or Asians resident on the islands. Over the years there is little mention of disease in the islands except for severe influenza and virulent dysentery in 1912-13.

There is no clear picture of events during the years of transfer from German to Australian administration but the available services were under strain (Rowley, 1958). The only medical centre in 1921 was at Kieta. The closest permanent contact of western society to Lemankoa was through the mission station established in 1915 on Hetau Island and recruiters of labour were probably the most frequent visitors to the village (Figure 1.1, Figure 2.1).

1.2 ENVIRONMENT

A geographical description of Buka at the commencement of this study may be found in the 1921 annual report:

"88. The centre of administration is at Kieta on the north-east coast; the District has the same name, and includes Buka, as well as the more distant Nissan, Nuguria, Kilinailau, Tauu and Nukumanu Islands. There is also a Government station on Buka Passage, which separates Bougainville from Buka, and a police post at Buin, on the strait separating Bougainville from the British Solomon Islands Protectorate. Apart from these there are no European settlements of any note. There are plantations on the north coast, several along the north-east coast, one or two near Buin, and two on the northern part of the west coast. The area

alienated in Bougainville and Buka is 74,122 acres, and the area under cultivation about 21,370. The non-indigenous population of the district of Kieta in 1921 was 148.

"There are about 650 miles of roads and bridle paths in the District of Kieta. There is a road along the coast from Buka Passage to Toiumonapu, a road round Buka, and in Buin a number of roads on which bicycles and light vehicles can be used.

"89. Trade is but little developed. The most important product is copra; ivory nuts and some trepang and turtle shell also have been exported. Cotton thrives well at Kieta; and the luxuriant plant growth gives Bougainville a promising future as a plantation area."

"91. Buka, the most northerly of the Solomon Islands, lies to the north of Bougainville, from which it is separated by a narrow strait, and extends from 5° to 5° 29'S latitude, and from 154° 30' to 154° 40' east longitude. It has several mountain ranges, the highest of which reach to about 1,300 feet. In the south-west there is a mountain range of volcanic origin, reaching a height of 1,300 feet; to the north and east the island is of raised coral rock. The interior, except in the south-west, is a lowland of level and undulating country. Along the coast there are large areas of mangroves, and in the interior there is dense forest, but also some areas of grass land. A great number of low coral islands lie off the west and south coasts; and on them and on the west coast there are a few plantations. The principal harbour is Queen Carola Harbour on the west coast. The rainfall is abundant.

"The island is comparatively densely peopled; in 1913 there were about 6,800 natives on it and the adjoining small islands, and in 1921 about 7,600. The natives are Melanesians of very dark colour, often of powerful build and good intelligence. There is antagonism between the natives of the mountains and those of the coast, who are much the more numerous. There are numerous well-trodden native tracks, and a common market place. The natives of Buka are much sought after as plantation

labourers and as police in the Government service; they are eager for this employment, and a large proportion of them have been engaged."

Kieta District was called Bougainville District after 1947 and after 1975 became the North Solomons Province.

1.3 THE SOCIETY

The people of Buka were easy to contact and being of much darker skin were easily distinguished as different from others in New Guinea. Their inate intelligence established their identity among any society they entered. Like other tribes in New Guinea they had a social pattern peculiar to themselves.

Blackwood in 1929 lived and worked in a village near Buka Passage and reported on all aspects of life among the northern villages (1933). In 1938 Oliver worked in villages in the Siwai of south Bougainville and established variations between the north and south of the district (1955).

Ring studied the changes among women in Buka since the time of Blackwood and compared them with women of other areas (1973). Friedlander reviewed changes in the Siwai (1975). More recently Moulik (1977) studied the effects of the massive development and social changes associated with the copper mine on the people of southern Bougainville.

1.3.1 1920

Lemankoa is a Lontis coast village. Blackwood (1935, p19-27) has described these villages as set out in a long line with clear areas for dancing and fenced away from the sea even though fighting had long since ceased. Houses were built on bare earth, in the shape of a broad Gothic arch and roofed with sago palm. There was a men's area in the front and a women's at the rear. Men and boys used the sea as a latrine, and women used the bush backing their house.

Beds were the only furniture and were broad planks on small logs with bamboo as pillows. There was a permanent fire. Anything of value was stored in the rafters or, rarely, in trade boxes.

Each wife with children had her own hut and older wives without young

children often shared.

Women gardened and men hunted, fished, built huts or adzed canoes. Water was collected in bamboos by the girls.

Taro was available in adequate quantities and was the staple food supplemented by the many local foods still grown today. Barter was practised in all areas. Traditional money was used and the German Mark and tobacco were also accepted as exchange. Barter was the only form of trading except for employment as plantation labourers.

There was a medical tul tul in the village. A large number of plants were used as medicines for the many conditions recognised by these people. Their effectiveness is unknown but their doubtful value in serious disease is shown by the mortality of the era.

In all it was a highly organised idyllic existence except for the high mortality.

1.3.2 1948

Lemankoa, destroyed during the war, had been rebuilt on the beach sands with the people living in rectangular huts on the ground. Some had raised houses as required by the government that were little used. Water was from springs or collected in drums and waste disposal into the bush or sea. Diet was mainly indigenous foods from gardens that had recovered from the war. Books and radios were virtually unknown and there was a small primary school at Lemanmanu. There was an aid post with sulphonamides and atebrin in the village. Babies were born with the assistance of female relatives. Bicycles were rare, canoes were large and well built, and travel to Sohano was a major event by sea or a very long walk.

Primary production for profit was limited to coconuts and these were farmed in a casual manner to provide cash for special needs. Regular contact was still maintained with Nissan Island, 30 hours sail away across open water.

The future for any young person was restricted to marriage mainly

within the Haku group and only a select few had finished primary school pre war and were entering government work. Of persons aged over 40 only a handful could converse in English.

The main changes from 1920 were the presence in the area of a school and an aid post. The former had an impact on young male children and a few females. The latter was to change the established pattern of low expectation of life.

1.3.3 1980

Lemankoa was mainly in hamlets on the limestone ridge spread along the three miles of the main road as it passes through the village. About one third of the houses had galvanised iron roofs and tanks. The better houses were on high piles with cement floored rooms on the ground level. Only one house had a septic toilet, while others had shallow pits or no facility. Medical care and child health services were provided by a nursing sister at Lemanmanu - the next village.

There were three stores with a variety of imported food. The stores at Buka Passage held depleted stocks as buying by villagers was continuous. Sweet potato and fish were still freely available from family farms and fishing.

There were two tractors, many small trucks and several large ones. Two diesel power units served two theatres and groups of houses. Two cocoa fermenteries handled the cocoa beans from extensive plantations both within coconut plantations and standing alone. Houses had limited furniture but most had radios and cassette players. Members of some families had been to Hong Kong and other overseas cities but contact with Nissan had become a plane ride.

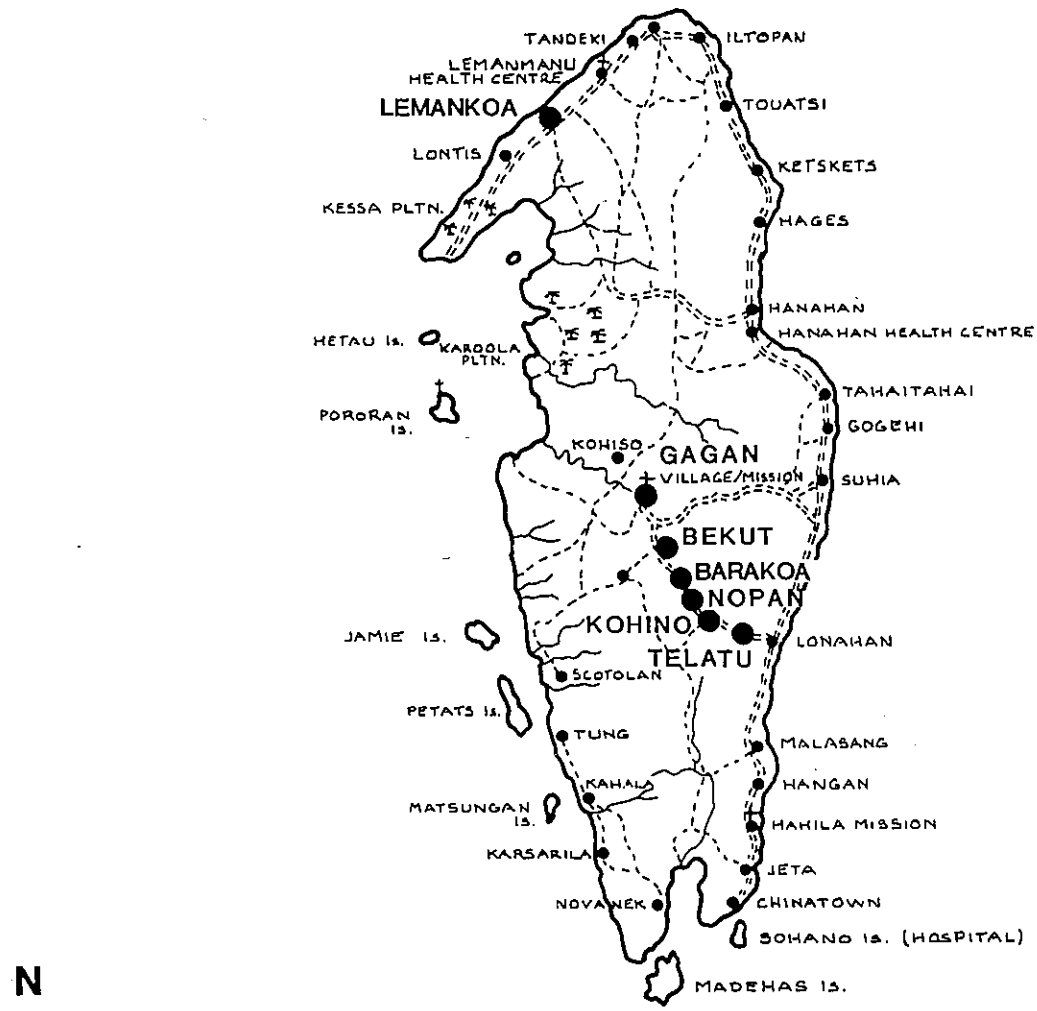
A majority of familes had one person employed at Bougainville copper mine at Arawa near Kieta. This employment was more available to residents of Lemankoa as a senior officer of the company was from Lemankoa. Many young people had completed studies at the universities and other tertiary colleges and two were completing degrees in medicine.

A large group of adolescents were at high schools on Buka and elsewhere in the North Solomons. These were very well supported by their families with an average of K4 a week pocket money (K1 = $1.28). Many had cassette recorders and other evidence of wealth. The majority of persons in the village were English speaking. Young men and women were resident in and married into all provinces of the country and spouses from other provinces were resident in the village.

In summary, the people of Buka have always been aggressive in seeking education, social change and economic development. They encouraged German involvement when those of Bougainville still argued. They filled more than their quota in the early Rabaul and Porporang schools. The actually sought recruitment.

The current state of Lemankoa is typical of most of Buka and is one of total community change to match the 1980s while retaining village links with primary production and the sea.

Fig. 2.1 **BUKA** ISLAND 1953



2. LITERATURE REVIEWS

2.1 DEMOGRAPHY

2.1.1 Historical Demography

Historical demography relies on records prepared in individual societies by priests and others interested in the origin and fate of human souls. Most studies have been done in Europe but others have used the recordings of priests where they worked around the globe. All assessments in the Pacific have endeavoured to cover nineteenth century populations (McArthur 1961, Bakker, 1979, Refshauge, 1981).

In Papua New Guinea most anthropologists and others doing studies in the first contact situation were overwhelmed by the anthropology of the situation and had little regard for demography. Most of the church records covering the post contact era were lost in the war but the few existing have been partly studied (Scragg 1977).

Barth (1975, p270) was fortunate in being resident with the Baktaman soon after contact in 1968 and has recorded precontact mortality. Among these Western Province people the causes of precontact deaths in siblings of those living were:

War	Accident	Sickness	Childbirth	Infant	Total
18	2	27	1	6	54

These proportions may not be true for other areas some 70 to 100 years earlier but they indicate a basically violent society.

2.1.2 Western Pacific

Polynesia, Fiji and the New Hebrides have long histories of demographic studies triggered by the disastrous epidemics associated with occasional western contact over the 18th and 19th centuries (McArthur 1961, Buxton 1925).

Similar studies were undertaken in New Guinea by a large number of workers among which were Hoffman (1913) and Cilento (1932) and Chinnery (1931, 1950).

"All investigators obtained totals of the populations studied by

them. All have shown from these a shortage of children and an excess of males in the living population. Crude death and birth rates have been obtained by using native memory for recent deaths and for the number and outcome of past pregnancies. These observations relied on the use of native memory and were thereby inaccurate to a degree. They have shown only that the number of births was less than the number of deaths, and confirmed that depopulation was occurring. As far as fertility, they have shown that it is low, and absolute sterility common in the depopulating areas." (Scragg, 1957 p4)

In more recent years all countries were stimulated first by the South Pacific Commission and later by their independence to define their demography, both past and current. Recent publications included Gilbert and Ellice Island (Veltman 1980), New Hebrides (McArthur 1981), Tokelau Island (Hooper 1973) and Tonga (Bakker 1979).

2.1.3 Papua New Guinea Censuses

All annual reports give estimates of population for subdistricts, districts and the whole country. Until 1961 most district figures included subdistricts where the population was estimated. The figures were often inconsistent within areas but gave an overall indication of size. Age groups were indefinite and fertility and mortality difficult to assess.

In 1966 a sample census was done but not reported demographically until 1971 (van de Kaa). This report set a clear but arguable bench mark for the future and was issued as the second sample census was being taken. The 1971 census was reported by a series of authors who gave a further indicator to the future but little guide on the relative value of interventions (Skeldon 1979).

In 1980 the first total census was done. Numbers for villages through to districts and some tables of variables for provinces are available but full assessment will take some years (National Statistical Office 1982).

2.2 EPIDEMIOLOGY

2.2.1 Cause

The development of health care and the need to define the nature of morbidity and mortality and assess the value of interventions triggered a series of studies.

The papers came entirely from health workers and described the mortality and morbidity among groups of people in a series of villages - Buka and New Ireland by Scragg 1968 and 1969; Anguganak by Sturt and Stanhope 1968, Losuia by Stanhope 1969,; Baiyer Valley by Beecroft, Stanhope and Burchett 1969 and Oro Bay by Dowell and Stanhope 1970. Most of these studies were associated with the "New Guinea Mortality Survey" initiated by Atkinson in an endeavour to clearly determine the amount and types of cancer in the country (1974). They set out causes of death and detailed age specific mortalities to enable a determination of expectation of life in small populations. They gave the first indication of patterns in mortality.

From 1963 to 1965 Vines undertook the Epidemiological Sample Survey into all regions except Papua (1970). This provided a more representative assessment of mortality and fertility than any study prior to that time. It indicated the more favourable survival in the Islands Regions and the higher fertility among the people of that region.

Elsewhere the epidemiologicaly scene in Tokelau was recently reviewed in depth (Prior, 1980).

2.2.2 Intervention and Evaluation

Over the 1970s many studies were done on medical and other aspects of demography. (Scragg 1968; Biddulph 1972; Sturt 1972; Bell 1973; Malcolm 1973 and Campbell 1974). These related levels of mortality to services or costs or both and helped to evaluate the interventions under way and planned by the national government. They culminated in the National Health Plan (1974).

The thoughts within these studies and current experience have been

consolidated in a monograph covering all aspects of population in Papua New Guinea published by the United Nations and the South Pacific Commission (1982). With this report demography has come of age in Papua New Guinea. Using it in conjunction with the provincial results from the 1980 census planners of all disciplines will be able to make more rational decisions than any of their predecessors.

2.2.3 Transition

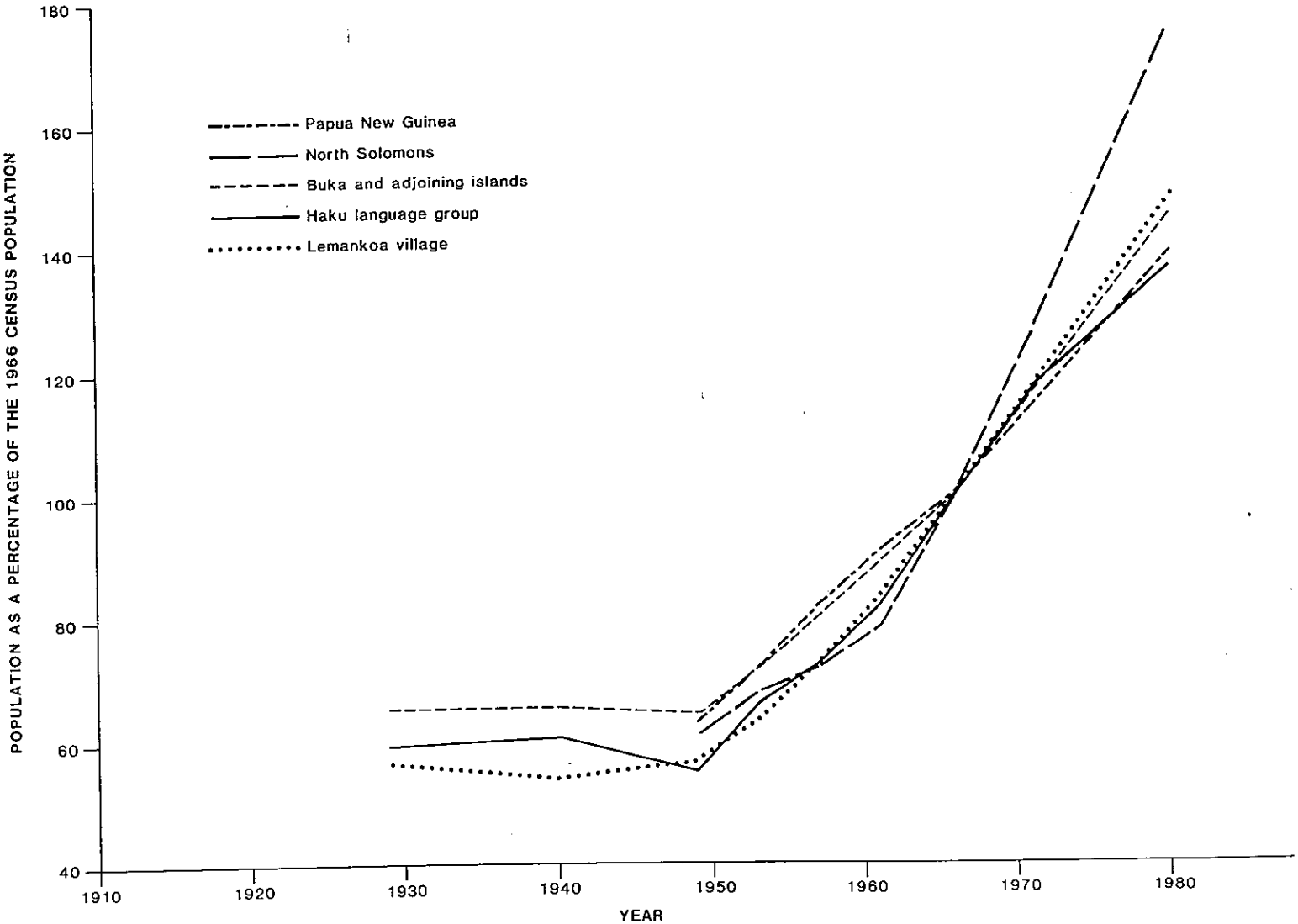
The relative value of health interventions and social change in improving demographic indicators has been under discussion for many years (Fredrickson 1960, Sheps and Ridley 1965).

Most studies have related to countries with an established social structure within which many variables were affected by interventions other than in health. Demographic change in rural south India, in a more sophisticated society than Lemankoa, has been studied in depth (Caldwell 1982).

At a more theoretical level Marshall discounts health interventions and considers that the population growth in developing countries is mainly due to the improved distribution of food with resultant better nutrition (1974). On the other hand Poikolainen argues for health interventions as the major factor and the only one that would adequately explain the exponential growth rate in many societies (1976). Oechsli and Kirk have related birth and death rates to changes in development and per capita Gross National Product (1975).

Taking a more theoretical stance Omran (1971) sets out a series of ages relevant to epidemiologic transition against which the Lemankoa changes can be considered. Johnston (1977) looks into strategies that might accelerate transition and suggests new interventions, particularly in rural health and agricultural development.

Fig 3.1 **POPULATION CHANGE IN PAPUA NEW GUINEA, BOUGAINVILLE, BUKA AND ISLANDS, HAKU GROUP AND LEMANKOA OVER TIME,** EXPRESSED AS A PERCENTAGE OF THE POPULATION AT THE FIRST P.N.G. CENSUS IN 1966.



3. DEMOGRAPHY

3.1 POPULATION CHANGE

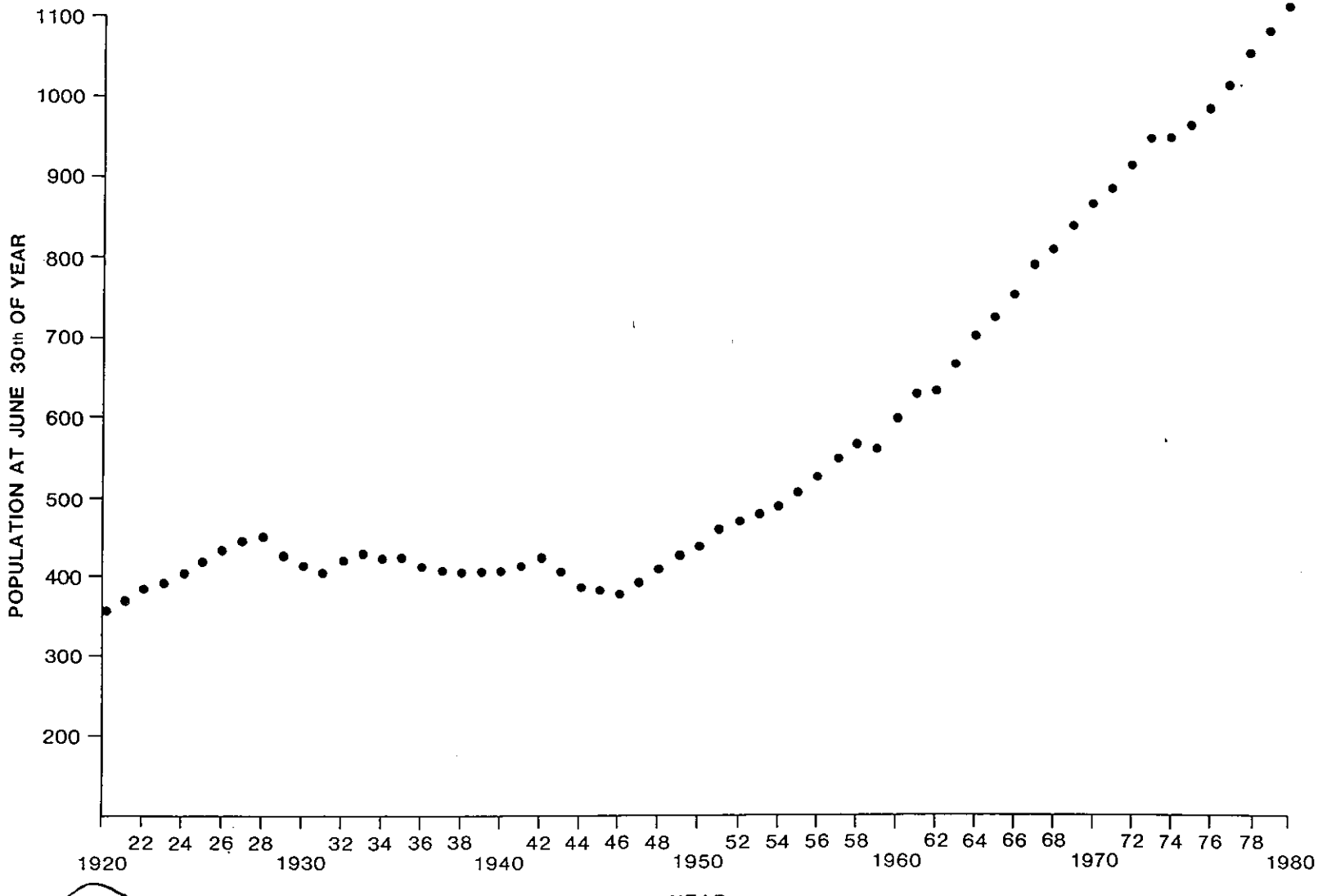
3.1.1 Trends

The precontact population of Lemankoa is unknown. Buka Island was well known to blackbirders and later to recruiters. The Haku coastal villages were sheltered from the south east trade winds and easy to contact to satisfy the increasing demand for plantation labour. Lemankoa village, on a narrow coastal beach in the centre of the language group, would have been protected from direct attack by other tribal groups. As part of the Haku linguistic group on Buka Island, North Solomons Province, Papua New Guinea, its population has been related to these four other larger units. The comparison is shown in Table 3.1. Buka and adjoining islands show a stationary population with small rises and falls for 35 years to 1949 then a rapid increase. Lemankoa population fell then rose pre war as did Haku. Records for the north Solomons Province and Papua New Guinea are available only for the post war period.

Figure 3.1 uses the population at the first census in 1961 as a bench mark. Lemankoa, Haku and North Solomons increased at a greater rate than Buka and Papua New Guinea up to 1961. Lemankoa has continued to stay above the others listed except for North Solomons where the effect of the copper mine development has been exponential. Clearly Lemankoa does not reflect what is happening in New Guinea as a whole. Lemankoa would be close in performance to other areas such as the Bismarck Archipelago where malaria control and social change are well established.

The population of Lemankoa was 358 in 1920 and increased steadily through to 451 in 1928. Over the 8 years to June 1927 there were only 29 deaths recorded and 12 of these occurred in 1926. This is well below the number expected for that time, and therefore these years, just after the mission moved into the area have been disregarded. However, births recorded over this period matched the pattern of later years and may have been more accurately recorded.

Fig 3.2 POPULATION OF LEMANKOA 1920 TO 1980



The background pattern of this is shown in Table 3.2. Over the years of population decline from 1927 deaths exceeded births in all years from 1929 to 1944 except in 1932, 1933, 1935, 1940, 1941 and 1942. The crude death rate exceeded 5% in 1929, 1930, 1931, 1943 and 1944.

3.1.2 Migration

Migration out due to census adjustments was the cause of the notch in the gradient of population in 1959, 1962 and 1974 (Figure 3.2).

	To 1947	1948 Onwards	Total
Migrations In	34	97	131
Migrations Out	75	220	296

Nett migration out exceeded 1% in 1940, 1945, 1949, 1958, 1961, 1964, 1970, 1973, 1974 and 1975. Migration in exceeded 1% in 1948 only and was associated with the postwar marriage catch up. Migrants are in the main young men and women moving in association with marriage and older persons returning to their village of birth after the death of their spouse. In addition some young children move with their widowed parent.

A consistent increase from 1947 has been maintained in spite of a net migration out of 123 persons. Thus the growth shown is less than the actual growth performance of the resident families of Lemankoa.

3.1.3 Eras

Figure 3.2 shows four differing periods of population change.

1927-1942 - Plateau - epidemic era

1942-1947 - Decline - war era

1947-1960 - Steady increase - curative era

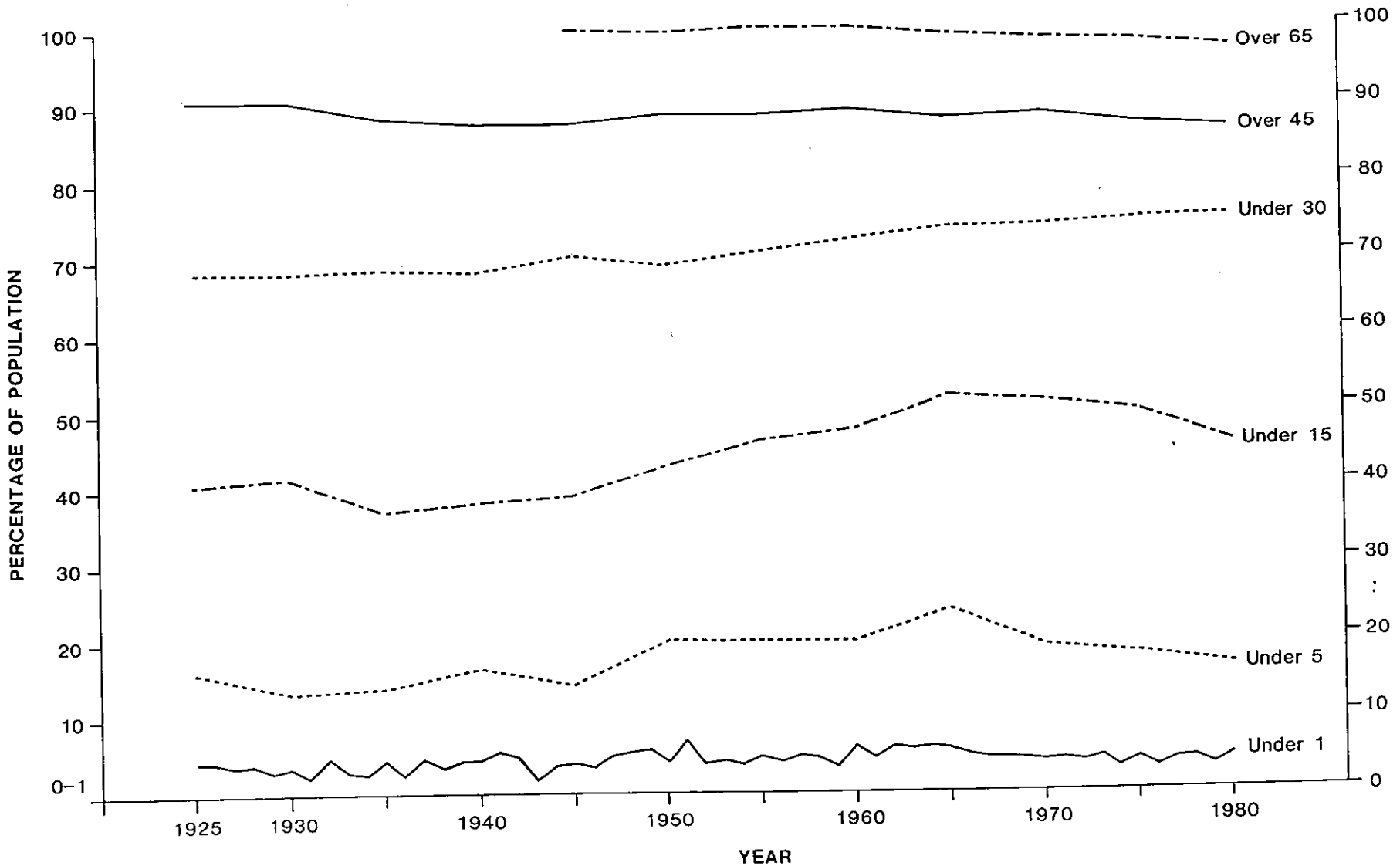
1960-1980 - Rapid increase - preventive era

These eras have been named to match the health situation over each period and have been used in the demographic analysis to simplify discussion and improve comparison.

3.2 POPULATION DISTRIBUTION

The age distribution of the population varies at different times during the period the the study. Age distribution for sexes combined at 5

Fig 3.3 PROPORTION IN BROAD AGE GROUPS SEXES COMBINED 1925-1980



year intervals and 5 year age groups is compared in Table 3.3. Figure 3.3 shows the distribution by broad age group at 5 year intervals.

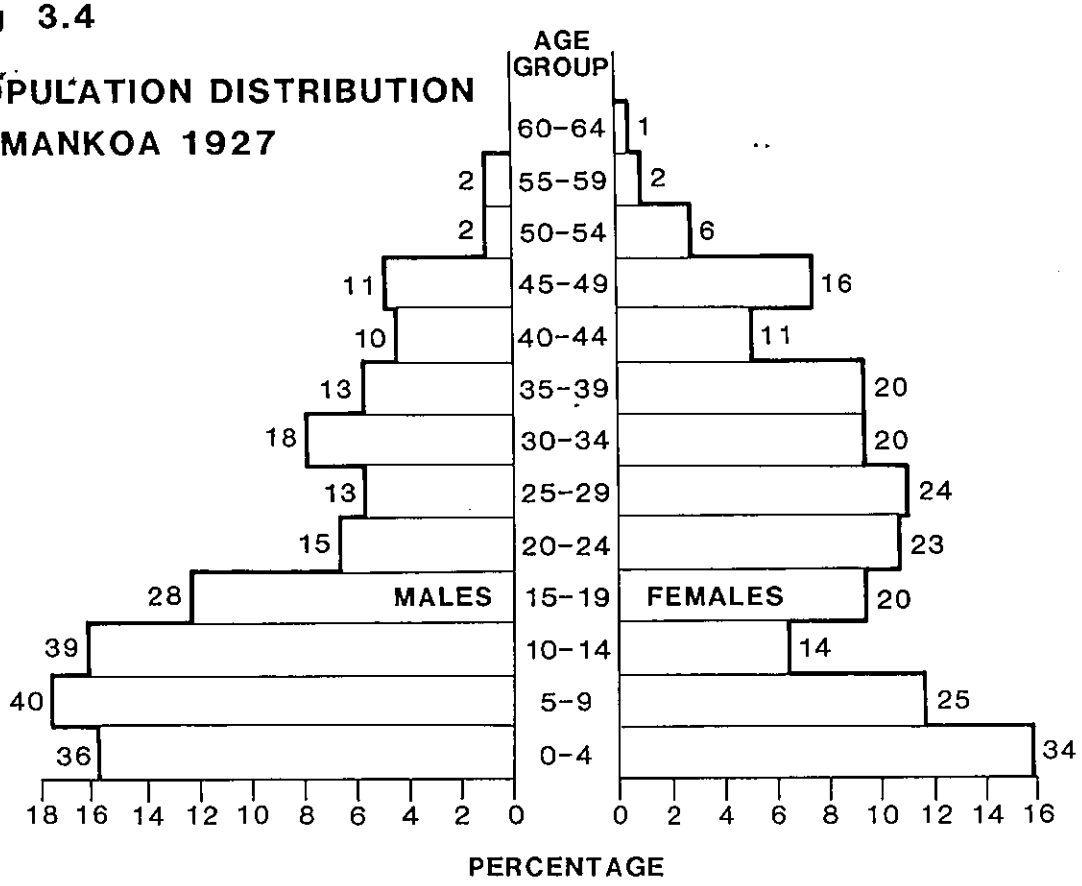
Pre-war the proportions remain stable. The post war period shows little change in the proportion aged 0-1 but large increases in that from 1-4, 5-14 and over 65 and a large and continual decrease in that from 30-44. The proportion from 15-19 falls during the 1950s and early 1960s then increases markedly as the survivors of childhood enter this age group in the late 1960s and 1970s.

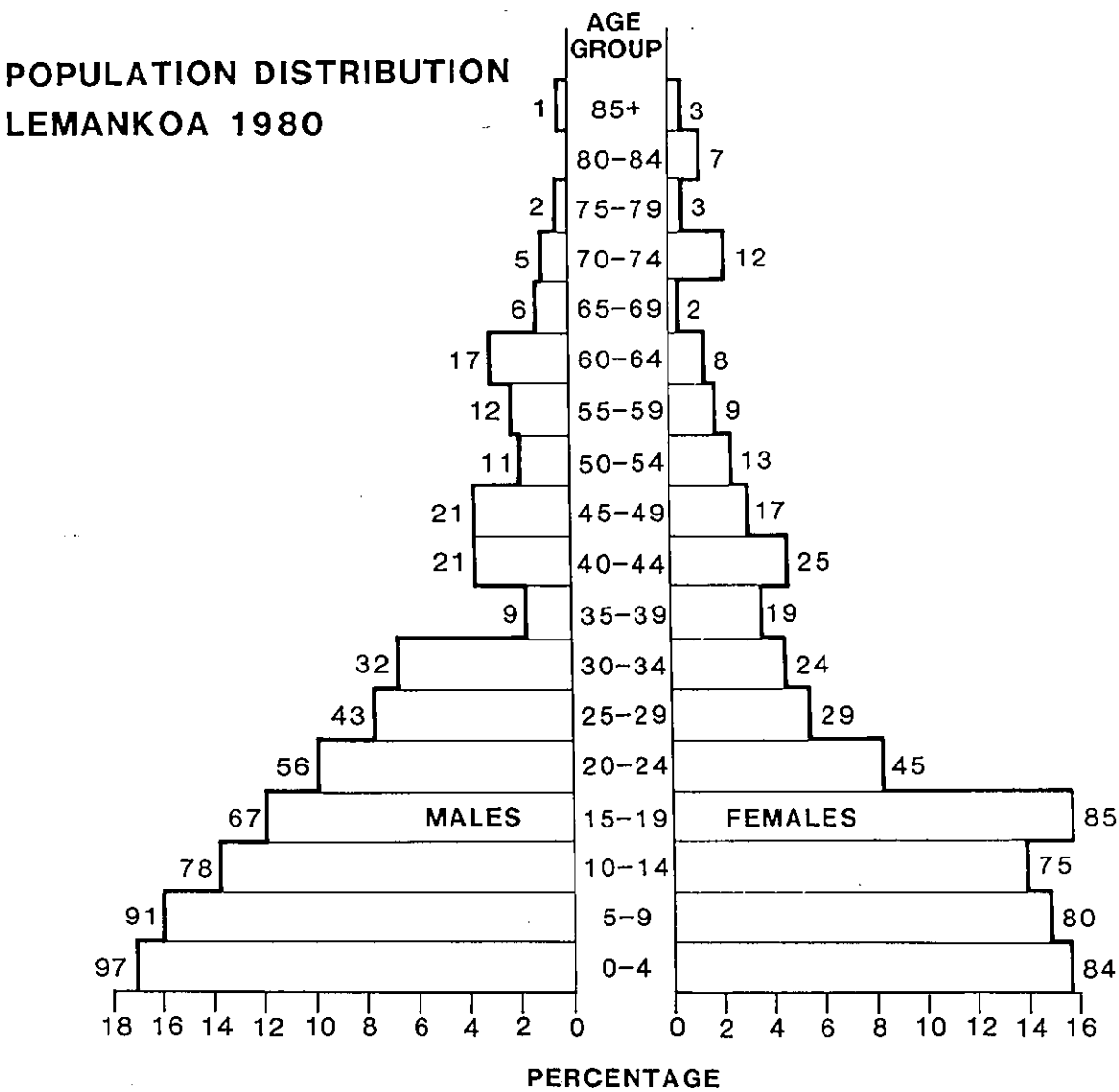
In Table 3.3 cohorts can be followed through on the diagonal. Of note is the excess proportion in the cohorts born from 1910-1915 matching the initial recording of the census and 1920-1925 matching the establishment of the mission at Lemanmanu. The 1940-45 wartime birth cohort shows a falling proportion from migration and mortality in later years. Up to 1940 there was only a rare survivor in any year aged over 65 years but by 1980 there were 3 women and 1 man aged over 85.

Changes in age structure are also shown in the population pyramids for 1927 and 1980 (Figure 3.4). In 1927 there was an excess of males 220 to 196 and a waist in the male distribution at the 20-29 age group. These men born between 1898 and 1907 would have been subject to the aggressive recruiting of the 1910s when Buka was notable as a source of labour. The consolidation of those living in 1922 would have omitted those who appeared to be permanently lost to the village by earlier recruitment but only small numbers are involved. There is waist in the female distribution at both 10-14 and 40-44. In the absence of a matching change on the male side these must relate to the variations within a small population.

The 1980 pyramid shows a significant reduction in the 35-39 year age group for both sexes - those born during the years of the war 1940-45. This pattern is shown in the national census of 1961 and has been noted in other studies (Connell 1977; Scragg 1957). The effect of war with occupation, absence of males, living together in caves, food shortages,

Fig 3.4


POPULATION DISTRIBUTION
LEMANKOA 1927
AGE GROUP
60-64 1
55-59 2 2
50-54 2 6
45-49 11 16
40-44 10 11
35-39 13 20
30-34 18 20
25-29 13 24
20-24 15 23
15-19 28 MALES FEMALES 20
10-14 39 14
5-9 40 25
0-4 36 34
18 16 14 12 10 8 6 4 2 0
0 2 4 6 8 10 12 14 16
PERCENTAGE


POPULATION DISTRIBUTION
LEMANKOA 1980
AGE GROUP
1 85+ 3
80-84 7
2 75-79 3
5 70-74 12
6 65-69 2
17 60-64 8
12 55-59 9
11 50-54 13
21 45-49 17
21 40-44 25
9 35-39 19
32 30-34 24
43 25-29 29
56 20-24 45
67 MALES 15-19 FEMALES 85
78 10-14 75
91 5-9 80
97 0-4 84
18 16 14 12 10 8 6 4 2 0
0 2 4 6 8 10 12 14 16
PERCENTAGE

high infant mortality and absence of health services, adequately explain the shortage in this age group which is more prominent in males than females. The shortage in the age group in adjoining villages also caused a high level of migration from this cohort, accentuating the deficiency as seen in Table 3.3. The excess in age 15-19 would be due to young women migrating in to marry.

By 1980 the tide of high fertility is falling and the percentage aged 0-14 has fallen from over 50% from 1963-1974 to 45.5%. Even so the population is still youthful and rapidly increasing.

3.3 SEX RATIO

Variation in sex ratio must be expected among small populations. As seen in Table 3.4 the secondary sex ratio is masculine except in the period to 1927. Over the entire study there are 107.8 male to every 100 female births.

Over the 60 years of the survey, except for the years between 1940 and 1952, males exceed females in those living. Part of this would be due to the excess of male deaths during the war years.

The sex ratio among those living and calculated at ten year intervals is variable in the 0-14 age group but mainly masculine for the years selected (Table 3.5). Over the reproductive years males generally exceed females except through the years to 1927. This could be linked with the male mortality of contact and recruitment. The years to 1927 had a high proportion of polygamous marriages equating with the shortage of males. Since 1927 the excess of males over the reproductive years would ensure a sufficiency of marital partners for all reproductive women.

In older age groups females consistently predominate and males only reached their number in 1980. Over recent years the more even ratio indicates a more balanced mortality and life style with less risk for the adult male. The pattern differs from that found by Connell (1977) and others, however, in my experience a large proportion of aged females is found in many New Guinea villages.

3.4 MARITAL STATE

In 1927, 80 marriages were recorded and among these 3 men had 3 wives and 18 had 2 wives. The partners in these polygamous marriages were born before the turn of the century. In 1980 the husband and two wives in one of these marriages were still living. There were also three other men who publicly acknowledged two wives. Others may have had similar relationships but there were few unattached mothers. The ages in these four marriages were as follows:

Husbands Age	Wives Age	Number of Children
85	80	6
	77	8
68	73	3
	64	2
44	40	14
	32	5
32	31	2
	30	1

All these men were from the chiefly lines within the village.

The social setting of marriage and reproduction pre war was studied by Blackwood (1935). Ring (1973, p107) has summarised this period as:

"Union arranged by the parents, and betrothal and marriage marked by a series of ceremonial exchanges culminating in the payment of the bride price, and a marriage ceremony occurring soon after the menarche of the bride. The relative youth of the female, the restrictions imposed on the older, prospective husband, and the separation of the adolescent sexes meant that there was little likelihood of pre-marital intercourse."

Today free choice of spouse is usual with most girls completing primary education and some entering professional careers. In 1953, 73% of women aged 15–19 were unmarried while in 1980 the proportion was 84% (Table 3.24). The stress on reproduction for a strong Buka which was part of the Hahalis cult has slowly gone. The mean age of menarche based on

interviews was 15.5 years in 1970 and the age of menopause was 47.29 years (Scragg 1973). Records show no female celibacy. As noted in 1957 divorce was a rare event and only one was recorded in the five years to 1980. Voluntary abstinence based on a fear of danger to the infant was found by Ring (1973, p109) to have been considerably reduced. All reproductive variables were positive favouring biological reproduction and large families.

3.5 MORTALITY

The mortality pattern is the main determinant of the population change mentioned above with significant changes in crude death rates but smaller changes in crude birth rates. Details are presented in Table 3.6 and show the relatively stable population through the epidemic years to 1942, when the birth rate of 41.5 per 1000 just exceeded the death rate of 40.7; the decline in population due to excess war deaths from 1942 to 1947 when the death rate rose to 50.9; the rapidly growing population of the curative era from 1947 associated with a rise in the birth rate to 51.1 and a fall in the death rate to 18.7.

In the preventive era the crude death rate fell further to 5.8 - a level consistent with the proportion aged under 15 while the birth rate fell due to these same non-reproductive children in the population. The average annual change in population varied from a decline of 1.12% in the war years to an increase of 3.24% and 3.76% in the post war eras.

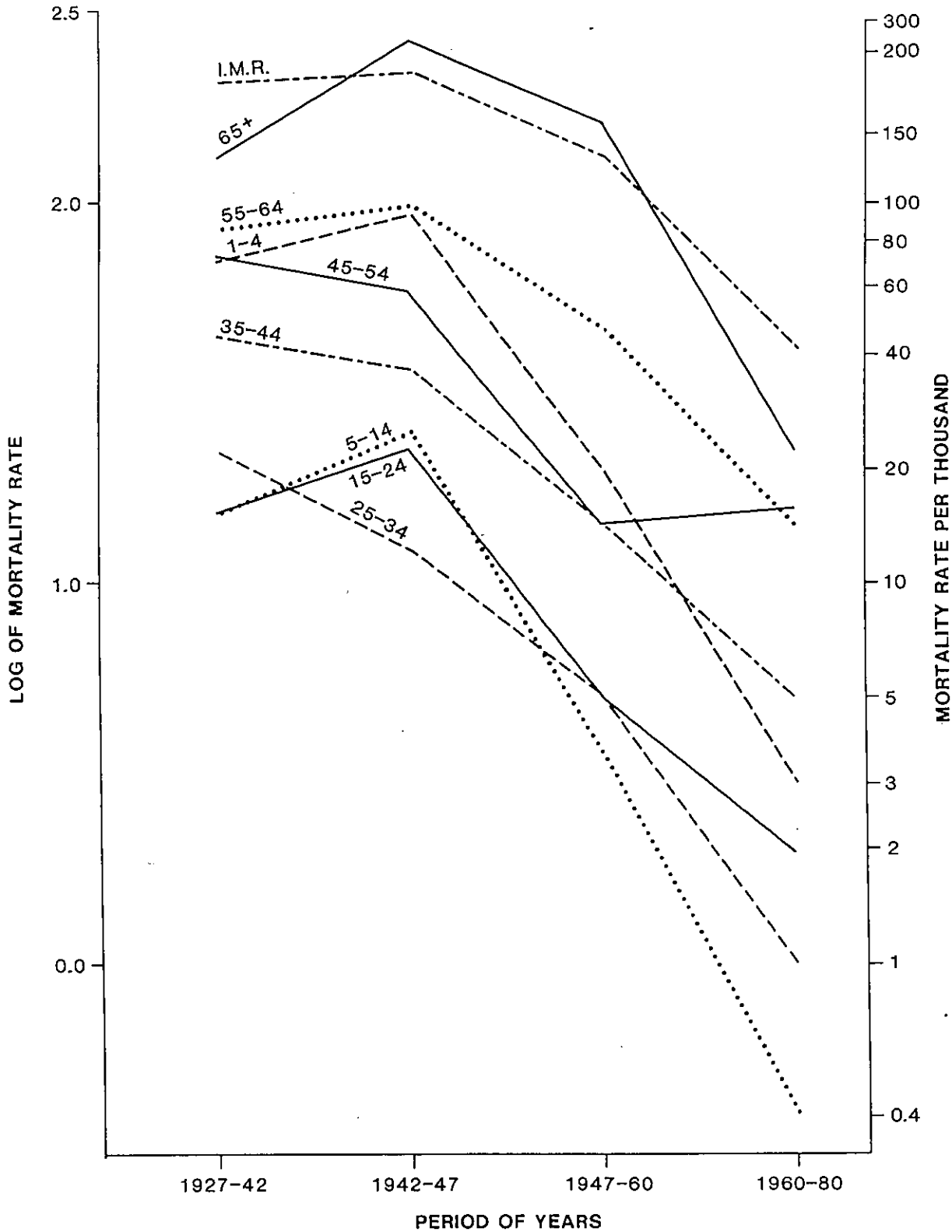
3.5.1 Epidemic Era

The rates for the epidemic era exceed the 32.7 recorded by Bellamy and reported by van de Kaa for the Trobriands of that time but a higher level of 50.4 was recorded for Port Moresby villages (1971, p47).

They are also of a similar order of magnitude to those determined from records in Mekeo and Fuyuge in Papua for the same period (Scragg, 1977). There is no doubt that some births with infant deaths were missed during the early years of contact and smaller deficits in both births and deaths would have been present in all years in all eras. The effect of

Fig 3.5

SEMILOG COMPARISON OF AGE SPECIFIC MORTALITY RATES FOR FOUR PERIODS 1927 TO 1980 IN BROAD AGE GROUPS



these losses, if any, would be to increase both crude birth and death rates to even a higher level with a matching increment.

3.5.2 Post War Rates

There are no comparable rates until after 1960. Those reported after this date are closer to those found in Lemankoa before then (Table 3.7).

Van de Kaa (1971, p206) concluded from the 1966 census that the crude rates for 1961-66 for Papua New Guinea were birth 43.8 and death 20.7 compared with 43.4 and 5.8 for this study. The better performance of Lemankoa matches that of the Bismarck Archipelago (Vines, 1970 p50) with its better environment and greater health interventions compared with the country as a whole.

The rates of 46.6 and 17.0 respectively predicted from the 1971 census for 1971-76 match those of Lemankoa before 1960. The changes found in this study are similar to those reported for French Polynesia (Rallu, 1981).

3.5.3 Age Specific Mortality

The number of persons at risk in each 5 year age group is small except in the preventive era. The number of deaths is irregular and in later periods some age groups have no deaths over an era. Age specific rates are shown in Tables 3.8 to 3.11, and are irregular due to the smallness of the population. However, mortality in all age groups has fallen consistently over the years recorded except for increases in most age groups over the war years. During the war the impact was mainly on the young and the aged. The progressive reduction in age specific mortality in wider age groups is shown within Figure 3.5 and Table 3.12. The small population under study shows visual trends within the four sets of data. Such trends indicate the direction of change which would neither be improved nor more confirmed by statistical testing.

3.5.4 Infant Mortality

The variation in rates by sex is shown in Tables 3.8 to 3.11. At all times the male rate exceeded the female rate but statistical tests show no

significance. The rate for males of 260 for this era approaches that found in Solas for the post war period (Scragg, 1957). Those for the curative era are nearly half those for the earlier periods and the reduction is significant ($p<0.02$). The rate for the preventive era is one fifth of the epidemic era and equivalent to Australia in the 1930s, and the reduction highly significant ($p<0.001$).

Special factors in the reduction are the post war establishment of maternal and child health services. These were as patrolling services from Sohano in 1964 and a fixed clinic and maternity ward at Lemanmanu from one to three miles away in 1955. These services had reduced the number of village births to about 50% of all births by 1972 (Ring 1973).

Over the entire study there were 24 stillbirths recorded from 1545 births - a rate of 16 per 1000 births. A high level of missed events associated with the known practice of infanticide and poor neonatal survival versus intrauterine death would confuse the records. Infants usually die in villages and causes are not determined unless they are accidental in nature. Up to 1947 the ages of deaths were spread across the first year of life (Table 3.13). Half the deaths since the war have been in the first month of life as those after this age have been susceptible to simple curative and preventive measures and more effective infant care.

3.5.5 Child Survival

Deaths for combined sexes over the years 1-4 are an indicator of the health of a village (Sturt, 1972). The rates vary in accord with the crude death rate indicating the community impact of the interventions applied over the last two eras. The changes in each of these reductions are highly significant (Table 3.14).

Child survival to age 5 is the balance after infant and toddler mortalities. The survival pre war matches that found in Solas (Scragg, 1957). The preventive era figure is better than that reported elsewhere in the country (Stanhope, 1968) and for the Buin area (Friedlander, 1975

p61) indicating the major improvement in survival factors in Lemankoa.

3.5.6 Expectation of Life

The exercise of constructing Life Tables is undertaken even though it was realised that the resulting life expectancies would provide only very rough indicators of mortality experience in the four eras. The data lacks numbers to provide expectations that could be compared adequately with outside populations. However, they provide a summation of the quality of the interventions influencing survival. Expectations of life at birth of male 22 and female 25 years in the epidemic era double through the curative interventions to 47 and then to 64 male and 70 female after the preventive attack was applied (Table 3.15). However, expected deaths in this era are absent in some age groups due to the small population size and the actual expectation could be less than calculated.

The highest expectation of life is normally at age five but for the three earlier periods it is at age 10. This arises from the high level of mortality over the childhood years. The impact of low survival is shown in the population distributions where no persons were recorded aged over 70 in the 1920s.

Of note also is the level of female expectation. This matches the lower female crude death rates discussed earlier. Buka has always been a fertile island surrounded by a plentiful supply of fish with no potential for undernutrition at any period provided there was no over population. Accordingly, the female was well protected from the ageing effects disclosed in the Abelam (Schofield, 1962).

The recognised factors of higher male mortality - violence, vehicles (canoes or cars) and alcohol - would all operate against male survival over the entire survey period.

3.6 FERTILITY

Crude birth rate for each period is shown in Table 3.6. The main variation in the rate is over the curative era when it reached 51.1. The high pre war rate matched the mortality for that period.

3.6.1 Age Specific Fertility

Age specific fertility rates were determined for Lemankoa and Solas combined for five year periods from 1947 to 1967 and are used for these years (Table 3.17) (Ring, 1973). These periods had fertility levels as high as that found elsewhere in the world. Rates have been prepared from 1927 to 1947 and 1967 to 1980, (Tables 3.16 and 3.18) and all eleven periods are compared in Figure 3.6. The diagonals in these tables show cohort fertility experience.

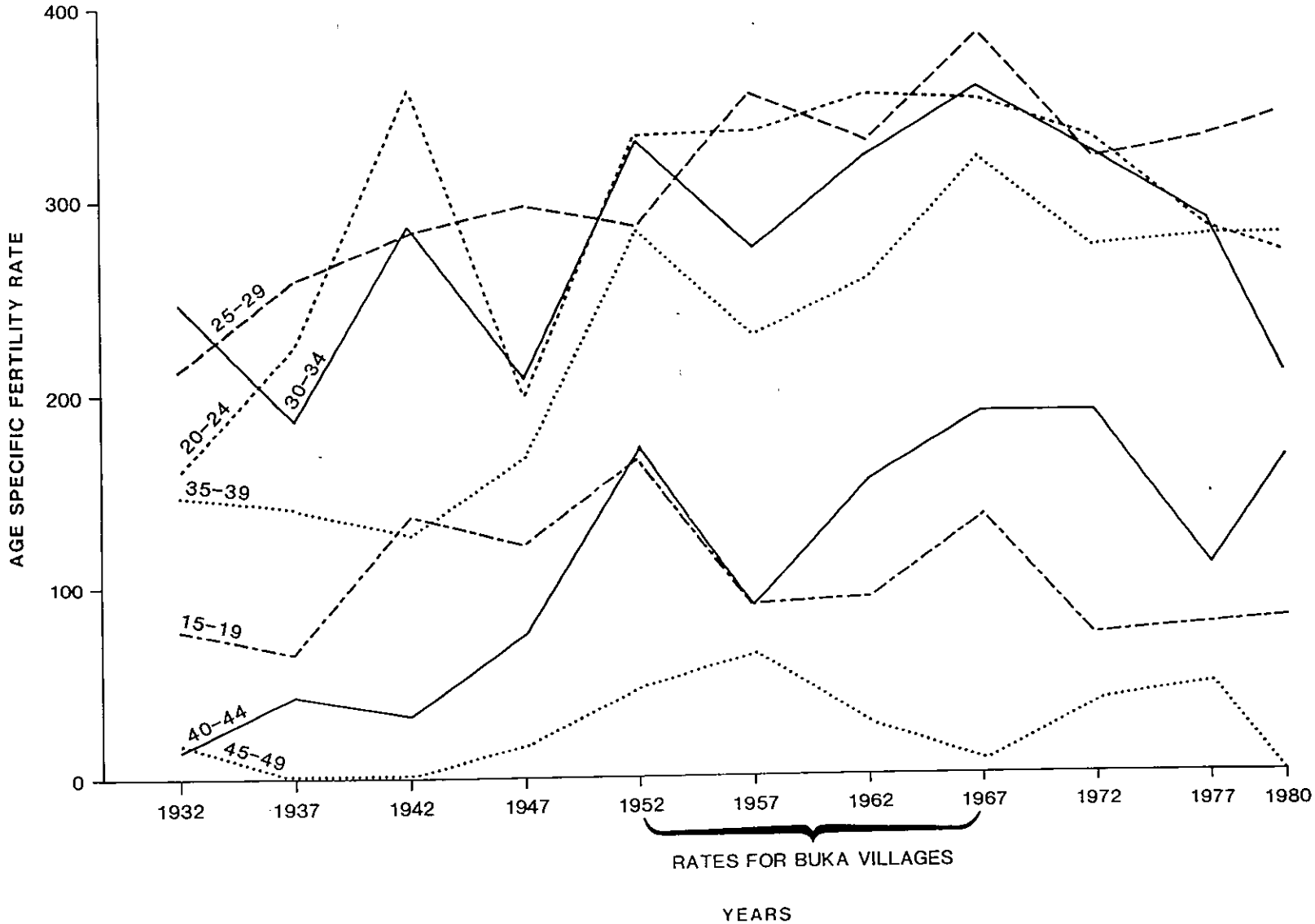
The ages specific fertility rate shows considerable change over time. The initial lowest rates from 1927 to 1937 may be due in part to non-recording of births except that the mortality would become even more excessive if the births were increased. The rate at that time could well be close to the traditional level.

The ratio of births at mother's age 30-39 over those 20-29 is 105 for the years 1927-32 and well in excess of any listed by Henri (1961). It is possible that the ages of some women could have been underestimated in the original census. Such an underestimation would increase the proportion of births in supposedly older women. By 1932 this abnormality has disappeared.

Using 1966 census date van de Kaa (1971, p173) considered that fertility had changed little from 1941 to 1966. However, the current study shows an increase in the 1937-42 period when culture change was starting to trigger a transition in fertility. The total fertility for that period of 6115 matches the rate calculated from the 1966 census of 6225.

In the privation of the war fertility fell to 5410. There was a post war reaction to this fall then a settling back into a pattern of increasing fertility peaking from 1962-67. The Hahalis philosophy of independent government of Buka, a new religion and a strong Buka with many children was no doubt part of this as women 15-19 have twice their expected level of fertility.

Fig 3.6 COMPARISON AGE SPECIFIC FERTILITY RATES LEMANKOA



Since 1967 the fertility has slowly fallen associated with the movement of young women in large numbers into higher education with delays in marriage (Table 3.25). There has also been increased availability of family planning advice. The transition into a lower fertility pattern has commenced. This change appears to be slow, unlike the rapid fall in fertility noted for some countries by Johnston (1977 p5).

The 55 years of fertility study permit cohort analysis of fertility experience (Table 3.24). The rates of the adjoining cohort has been added in as shown to give 7 cohorts. The movement from 5,607 to 8,440 is consistent with the trends noted in the 5 year fertility experience. The final figure of 7,920 indicates that the women now aged 45-49 have not changed their behaviour relevant to family size.

For Papua New Guinea the 1971 census (Agyei, 1979 p28) showed a total fertility of 6159 or 7600 using the Brass method. This latter level is consistent with that found in Lemankoa for that period.

3.6.2 Personal Fertility

3.6.2.1 Cohort Analysis

Ravenholt (1968) has developed a method to analyse fertility in contemporary societies which looks at excess fertility arising from both frequency of birth and age of mother. This current study includes the life experience of several cohorts of women of which two have been selected for analysis. Twenty three women born from 1895 to 1900 were young women of childbearing age when the first census was taken in 1915 and so their ages would be fairly accurate. This cohort is compared in Tables 3.19, 3.20 and 3.21, with the cohort of 21 women born from 1930 to 1935 the youngest of whom would have reached 45 in 1980.

Mothers in the cohort from 1895-1900 have nearly twice the percentage of first births, a higher median age of first birth, far fewer children born before 20 years of age, a lower median parity and half the percentage of births beyond the age of 40 and over the number of four children limits. In addition the completed family size is 3.91 compared with 7.90

for the 1930-35 cohort. Under-recording of births may be a factor but not to such an extent as to make these parameters equal.

3.6.2.2 Birth Interval

A limited analysis has been made of birth intervals beginning or ending between 1930 and 1935. These are compared in Table 3.22 with similar figures for Buka villages after 1947. The mean interval of 2.74 years is similar for both periods and indicates that the reduction of birth intervals and increase in community fertility was probably in effect by 1930. The birth interval for societies with less western contact varies from 3 to 5 years (Becroft 1967, Smythe 1966).

3.6.2.3 Family Size 1953 and 1965

Table 3.23 shows average pregnancies by age of mother based on the experience of women living in Lemankoa and Solas. The receding wave of increase in the mean number of children is shown in the women who were aged 20 and over in 1965 and 35 and over in 1980.

These values indicate a major change in fertility and must be linked back into changes in intercourse variables as noted by Ring (1973). The society drew selectively on various aspects of the introduced culture: "towards a decline or rejection of customs and beliefs that maintained the birth interval and have established maximum biological exposure with fecundability and frequency at a level consistent with the highest biologically possible.

"However, in Buka the effect has been gradual as women were not directly subject to Western influence. Initially their contact was second-hand, through the men who, in turn, were influenced by the European and Chinese settlers who came at the beginning of this century. Boys were encouraged to go to school but the girls did not go, though sought. Since 1950, however, women have been under direct Western influence and the gradual change can be measured in part by their ability to speak English or Pidgin, their dress and cooking utensils. Culture contact and improved health services have produced something close to the idealised situation

described by Freedman (1963) in which 'free and unrestrained sexual unions beginning at an early age produce very high fertility as an incidental result without deliberate intent and without much individual or social concern about family size'". (Ring, 1973 p117)

3.6.2.4 Family Size 1980

The average number of full term pregnancies for 1980 is also shown in Table 3.23. These have fallen for all age groups up to 30-34 years and families of most ages were active in restricting the number of children. The fall is greatest in the 15-19 age and indicates a moved towards reduced personal fertility reversing the changes that have been found at least since the war. The change in family size is definite evidence of the commencement of transition of fertility back to levels closer to mortality rates.

In 1980, 46% of women aged 15-19 were delaying marriage for education or employment, as were 48% of their brothers and 13% and 39% respectively in the next age group (Table 3.25).

In 1965 14 of 72 (19.4%) women aged 15-19 from the survey villages had had children while in 1980 only 6 out of 85 (7.1%) from the same group from Lemankoa had had children (p 0.05).

These same young women when they marry will make decisions that will further restrict average family size and cause a significant reduction in overall fertility.

3.6.3 Reproduction Rates

The gross reproduction rate (G.R.R.) is the number of female children each woman can be expected to produce if she survives to 50 years of age. Over the period 1927-47 the G.R.R. was 2.645 compared with 3.741 for the post war years. Using L28 from the relevant calculated life table (See appendix) to allow for female mortality the net reproduction rate is 1.234 indicating 23.4% increase per generation from 1927-47 compared with 154% in the post war period.

4. HEALTH

4.1 UNDER THE GERMANS

Very little has been written about the medical state of the people of Buka over the years from first contact to the end of German administration in 1915. Visiting boats made contact with men only. Many were recruited for Samoa and Queensland, and in later years for the southern Solomons and for other districts of New Guinea.

Guppy did not visit Buka but reported ulcers and tinea circinata in all areas he visited. He noted:

"An epidemic catarrhal disease, which is allied to influenza, is very prevalent amongst the natives of these islands. It is commonly followed by lung-complications, which not infrequently cause the death of the sufferer. Such an epidemic in running through a village sometimes carries off several of the inhabitants. The elderly natives are, in fact, very liable to pulmonary affections; such diseases usually terminate their lives." (1887 p176)

Kieta District had no station until 1905 and only a mission station at Buka Passage in 1910. Over this period recruiters were continuously in contact with Buka villages and the men of Buka on their part actively sought contact with Germans. Persons aged over 12 were considered adult and thus subject to recruitment (Firth, 1982). Travel between stations was slow and contact with Australian endemic and epidemic diseases minimal. However, introduced upper respiratory infections were almost an annual hazard.

The most significant variation from the historical pattern would have been a higher mortality among these recruits replacing deaths in inter-tribal fighting. Firth (1982) has studied the health risk of labourers over this period and has produced evidence that between 1887 and 1930 2410 persons from Buka were recruited mainly to work in the Gazelle Peninsula. Of these 378 died - 15.7%. This rate is below the average for recruits from all areas. More were recruited from Buka than Bougainville

even though the population of the latter was at least three times as great. The recruits from Buka were mainly men who came eagerly from coastal villages. The German policy was that all unmarried men should work in the plantation system at some time.

Bougainville-Buka was the most densly populated area of the protectorate. The Kieta district officers in 1911 sought a doctor to prevent loss of people by disease from the "very productive recruiting areas" of Buka and north Bougainville (Firth, 1982 p127). In 1913 female recruitment was banned in all districts. By this time there was little recruitment to work outside the district as many new plantations were being developed in the Kieta District.

Children were also involved as almost all the school children at Poporang Mission School in the Shortlands came from the north of the Kieta District until the government stepped in in 1970 (Frith, 1982 p155). In 1910 the Marist Mission was established on Buka and gifts were made to attract students. The relevance of this period to that under study is in the possible permanent loss of young men and others from village life.

In summary, while contact over the German period was intermittent it was persistent. The mortality pattern in the villages is uncertain but that among labourers varied from 1%-2% per year. This rate was a matter of concern to the German administration but there was little more that the contemporary medical care could do and in the developing economy, money was not available to improve the labourers environment.

4.2 AUSTRALIAN ARMY TAKEOVER - 1915-1921

The Australian takeover of New Guinea would have meant little to the people of Buka and less to those at Lemankoa. However, the Marist Mission in the same year established a mission station at Hetau and made their first census visit to Lemankoa. This was the start of real contact. The population of Buka and adjacent islands at that time was 6810.

Rowley (1957) writing on this period found evidence that the demands of the indentured labour associated with these poor conditions absorbed

most of the time of the limited numbers of medical personnel. In summary he states that "the general impression gained from the evidence is that some ground was lost; and at least that no progress was made, between 1914 and 1921, in the campaign to improved native health." (p399)

Any major change in administration causes some breakdown in services and New Guinea was no exception. Mortality in labourers from Buka would have been at least at the level recorded in German times. The effect of this on Lemankoa would have been a continued loss of young unmarried men.

The gap in the 1927 population distribution of males born from 1898-1907 is consistent with recruitment of youths from 1910 to 1921 and the higher mortality of the labourer group.

At the end of army administration a report to the League of Nations and a commission of inquiry looked into health matters over that period. Sixty percent of the troops had malaria or dysentery. The health of those not favoured with medical attention would have been far worse than either the privileged labour or army.

On Bougainville there was only one hospital at Kieta. At that time a survey of Buka children showed 92 enlarged spleens among 136 persons indicating an endemic malaria situation.

4.3 AUSTRALIAN ADMINISTRATION TO 1927

Annual reports to the League of Nations mention major events within the relevant year and those that relate to this study at either the country or district level are listed against the year shown.

1921/22:

- A medical officer was posted to Kieta.
- A police post was opened at Buka Passage.
- Influenza was epidemic in November and December near Kieta and over 1000 died.
- Measles was reported with a low level of mortality.
- The expenditure of health for the whole territory was £22,526.

1922/23:

- Buka population 7738.
- Tuberculosis incidence high in Rabaul.
- Mortality rate of pneumonia in Rabaul 18.2%.

1923/24:

- Buka population 6,206 with special patrols enquiring into causes of large decreases in the population of Buka and adjacent islands.
- 69 medical tul tuls in Kieta District.
- Tuberculosis recognised as coming from Asian migrants.
- No resistance of native people to pneumonia.

1925/26:

- This year's report includes a detailed overview by Dr. R.W. Cilento, Director of Public Health.
- Measles mentioned as epidemic since 1902 with minimum mortality and in this year removed from the quarantine list.
- Whooping cough reported with no deaths.
- Annual recurrent pneumonia.
- Dysentery in Rabaul since 1885 with many deaths.
- Buka Island completely under control with a road to the north western corner.
- Death rate of indentured labour 2.2%.
- Spleen rate in Buka 75%.
- Yaws rare, 10% infected.
- Milk was made available to the Christian missions.

1926/27:

- Small Buka listed to receive special attention as it has the densest population.
- Of 2261 indentured labour from Kieta District 2139 were employed in that district.

In summary the years to 1927 appear to feature repeated epidemic situations such as pneumonia with high mortality. A key to the scene is

described in the 1922 report as:

"Disconcerting reports of the presence of influenza epidemics accompanied by pneumonia were received from time to time." (p86)

4.4 1927-1942 - THE EPIDEMIC ERA

These years are a continuation of those discussed and are best described as the epidemic era. However, the demographic data from the study allows some matching of epidemics with mortality peaks and a better understanding of the health scene.

4.4.1 Health Interventions

1929 - Clearing station at Buka.

- Permission required from the District Officer to wear clothes.

1930 - Medical assistant at Buka.

1931 - 98 medical tul tuls in Buka subdistrict.

1932 - Recruitment prohibited from Buka and adjoining islands of Matsungan, Petats, Pororan and Hetau.

1933 - Milk (condensed) given to the Catholic Mission at Soraken.

1936 - European children given anti-whooping cough injections.

1937 - Novarsenobillon campaign against yaws with 91,622 injections in whole territory.

- Maternal and infant welfare clinic on Buka (?Haheila)

May 1939

- Experimentation with use of sulphapyridine in Rabaul.

- Pneumonia mortality reduced from 20-30% of cases to 8 only among 109 cases (7.3%).

1940 - Two medical assistants at Buka.

No reports after this year due to the war.

4.4.2 Health Reports and Indicators

In 1938 the first report of the Buka Hospital lists:

Admissions 247	Septic Infections 15
Tropical Ulcer 198	Dysentery 10
Yaws 59.	

During the year 11,855 persons were inspected being 97% of the population of the subdistrict.

Yaws 5.2% Spleens enlarged 16%

Tropical Ulcer 7.6% Infant Survival 80%.

The Administrator after a visit to Buka in 1930 reported that "the infant mortality rate among these natives is a problem which has received the attention of the administration for the last few years but which with the co-operation of the Missions is slowly being overcome." (p122)

In 1931 he also reported that "natives living in Buka purchase considerable quantity of tinned meat for their own requirements." (p114)

In 1932 and 1935 there were outbreaks of cargo cult at Lontis, the village adjoining Lemankoa. An earlier outbreak had occurred in the village in 1913.

Over the years the number of indentured labourers slowly increased from 2408 in 1928 to 2919 in 1938. These came more and more from Bougainville island and worked mainly within the district. The death rate among labourers was 1.73% in 1928, and 2.05% in 1929. In 1933 it was the highest reported at 2.5% and had fallen to 1.5% by 1940.

4.4.3 Epidemics

Those reported below were within Kieta Distrct only or indicated in reports as affecting all districts:

1928 --Epidemic influenzal bronchopneumonia near Buin.

1929 - Influenza near Kieta.

- Whooping cough endemic.

1930 - Acute anterio-poliomyelitis attacked all districts except Kieta.

1931 - Influenza all districts. In Rabaul June to August with 60% affected. 388 deaths in 9787 cases - mortality 4%.

1933 - 88 cases of whooping cough in Buka. Report says none fatal.

1934 - 1% mortality in mild influenza near Kieta.

1936 - Dysentery and whooping cough in Kieta and district.

1938 - Influenza worst for many years with many deaths at Rabaul - small amounts of prontosil tried.

- Whooping cough sporadic in Buka.

1939 - Epidemic influenza at Rabaul August to November 1938 - 75 died in Rabaul Hospital - more than any other year - Sulphahyridine was not tried until the epidemic was over.

1940 - Influenza Gazelle Peninsula.

4.4.4 Epidemic Matching

The recorded deaths showed peaks within individual years. In each year over this period births averaged 1.46 a month while deaths were 1.44 per month. The decline in population over these years was due to a nett migration of 29 persons.

The detailed studies of the Mekeo and Fuyuge epidemics in the Central Province showed that many crisis years were missed at the time and that at least twice the average number of deaths was needed to arouse an awareness in the health system (Scragg, 1977).

Based on the above an arbitrary figure for recognised excess deaths in any month is 4 or more deaths. This level of nearly three times the average would be significant for the residents of any village of just over 400 persons.

Epidemic months are listed in Table 4.1 with age of deaths. In 1928 influenza can be blamed as the main factor. The other epidemic months cannot be matched with a particular disease. The main reason for the absence of matching information is the insensitivity of the base health services, the resident missionaries and the village officials to variations in the number of deaths against time.

It is also probable that Lemankoa in a relatively isolated situation could miss out on some of the epidemics. The severe influenza in Papua and Rabaul in 1938 to 1940 appears to have had no impact on Lemankoa itself. However, the crude death rate for the Haku area as a whole shows a definite epidemic in 1939 with a crude death rate of 42/1000.

Infant and toddler deaths average 7 per year over the era. There were excess numbers from 1928 to 1931 and in 1934 (Table 4.2). Whooping cough was endemic over most of the time. The annual reports state that mortality from whooping cough was negligible but this is inconsistent with the experience of Catholic Mission sisters of that time who recall that all infants aged under one who contracted the disease died.

In summary, the epidemic era was a continuum with the high recruitment years earlier in the century. The population changed little due to a balance between births and deaths plus net out migrants. There was no effective intervention in health of Lemankoa. The limited value of curative all services is indicated by the high mortality among indentured labour.

4.5 THE WAR YEARS

There are no annual reports for this period and war records relate to the forces not the people. Lemankoa was occupied and the village destroyed. One woman who was fishing was killed by gun fire from an aircraft. The people lived in caves and the increase in death rate reflects the privation of life style, poor nutrition and absence of health services. An increased mortality over these years was also reported in the Mekeo even though the area was not actually occupied by either army.

Health services were re-established after the defeat of the Japanese in 1945. In November 1946 an epidemic of dysentery killed over 5% of the population of Buka Island but not this proportion in Lemankoa. The effects of the war were still evident in 1947 when the local hospital on Sohano had over 500 patients mainly with tropical ulcers and similar problems needing treatment with inpatient care and a good diet.

The fall in fertility also relates to the destruction of the family units by communal living and absence of males on duties for either side in the conflict.

4.6 1947-1960 - THE CURATIVE ERA

This period was notable for the introduction of the effective

curative medicines developed during the war years. When the Japanese left, Sohano in Buka Passage was made the district centre and Lemankoa was thus nearer to a centre of medical care.

4.6.1 Health Interventions

1948 - First medical officer at Sohano.

1949 - Native hygiene assistant posted to Lemankoa in addition to the medical tul tul. NAB available in the village.

- Pooled human serum used to abort whooping cough.
- Sulphetrone introduced for treatment of leprosy.
- Only restricted stocks of penicillin available for use in meningoccal meningitis.

1950 - Penicillin available at all hospitals.

1951 - Whooping cough vaccine available for clinic use.

1955 - Triple antigen used for prevention of tetanus, whooping cough and diptheria.

- Penicillin available at aid posts.
- Nurse resident at Lemanmanu three miles from Lemankoa.
- Chloroquin available from all health units.

1956 - Country wide penicillin injections eradicated yaws.

1957 - Salk vaccine used to prevent epidemic poliomyelitis.

1959 - Tuberculosis survey, vaccination and case finding in Bougainville District.

- School health services in Bougainville.

1960 - Spraying of Bougainville houses with DDT commenced.

4.6.2 Health Reports and Indicators

1949 - Sohano Hospital 535 beds - 760 inpatients, 1394 outpatients.

- 4,653 seen on patrol with 132 treatments.

1953 - 2,721 indentured labourers from Bougainville.

- National mortality among labourers 0.31%.

4.6.3 Epidemics

1949 - Influenza Buka.

- Whooping cough Buka.

4.6.4 Summary

There is no significant change in mortality from year to year, the excess deaths over the war years were followed by an immediate fall in the number of deaths. The use of effective medicine enabled the reduction to be maintained for the whole period.

The era was one of rapid social advancement with the establishment in 1959 of a high school for boys and girls at Hutjena, near Sohano on Buka.

4.7 1960-1980 - THE PREVENTIVE ERA

The key to this era was the commencement in 1960 of residual spraying of residences in Buka against malaria. Social change was facilitated by the development of community education through radio and of health education by departmental officers. Independence for Papua New Guinea was achieved.

4.7.1 Health Interventions

1962 - Maternal and Child Health training began at the Catholic Mission, Tearouki Bougainville.

- B.C.G. vaccine provided to new born children in Bougainville.

1963 - Sabin vaccine for poliomyelitis available from M.C.H. Clinics.

- TB survey of Bougainville.

1964 - Health education seminars introduced for field staff.

- Introduction of mass drug administration of choroquine and pyramethamine in an endeavour to achieve malaria eradication.

- Maternal and child health clinic opened at Sohano.

1965 - Aid Post Orderlies trained to undertake domicilliary care of leprosy and tuberculosis patients.

- Hahalis Cult centered in Lemankoa and Hahalis.

1966 - Nursing aid training commenced at Kieta.

1967 - Family planning advice available from government M.C.H. Centres.

1968 - District centre transferred from Sohano to Kieta.

1969 - Bougainville copper mine development nearing completion.

1972 - Routine distribution of antimalarials limited to persons with malaria.

1975 - Papua New Guinea became independent.

4.7.2 Health Reports and Indicators

1960 - Malaria parasite rate Buka - 21.78%.

1964 - Infant mortality in Island Region under 50 per 1000 births.

- Malaria incidence now 5 per 1000 persons in active surveys.

1969 - Country wide influenza epidemic.

1972 - Malaria parasite rate Bougainville - 3.0%.

1973 - 40 family planning acceptors for Bougainville District.

- Unprecedented resistence to DDT/Malathion spraying in areas where malaria has been controlled and cases are rare.

1976 - Malaria parasite rate - 11%

- Family planning acceptors in North Solomons 371.

1978 - National health budget K43,401,000.

1979 - 1 hospital, 24 rural health centres and 80 aid posts in province.

4.7.3 Epidemics in North Solomons

1969 - Influenza epidemic severe in highlands but minimal in Buka.

1975 - 321 cases of pertussis.

--215 cases of yaws.

- 1,332 cases of influenza.

- 207 cases of measles.

4.7.4 Summary

The era started with an assault on malaria but the failure to achieve eradication in Buka and elsewhere first caused the community administration of drugs then locking of houses against spraying. However, there has been no real increase in death rate indicative of the low rate of malaria transmission in the healthy environment of Lemankoa.

4.8 CAUSES OF DEATH

A combined report covering four areas in the Bismarck Archipelago was made in 1969 (Scragg). This included deaths from Lemankoa from 1949 to 1967. There was no noticeable difference between the areas included except that malaria and gastro-intestinal deaths in infants were higher in the inland villages of Buka.

This report showed large reductions between 1952-1957 and 1962-1967 in mortality from malaria, tuberculosis, pneumonia and childbirth. Small increases occurred in mortality from bowel infections and accidents and violence and a large increase in that from neoplasms (Table 4.3).

The effective reduction was in diseases where either prevention or cure is simple. Conditions where death is inevitable or expert care is needed were little changed. Those where community awareness was needed increased in incidence (Table 4.4).

The 58 deaths recorded after 1967 are not sufficient to indicate any changes compared with 1962-67. The analysis in Tables 4.3 and 4.4 shows that the reduction in mortality from 11.14 to 4.69 per 1000 is spread across all the disease groups and disease types.

5. NUTRITION

5.1 MEASUREMENTS

Diet and foods consumed have never been measured and the only indicators of past and present nutrition are height and weight. These and abdominal and chest girths were measured in 1948 and 1949 and repeated from time to time.

In both 1972 and 1980 triceps skin fold measurements were also taken.

The quality of measurement improved over the years and after 1953 a fixed stadiometer was used and a balance scales.

5.2 1949 AND 1980 RESULTS

The 1949 results were used to prepare the height-for-age table included in the study of "Depopulation in New Ireland" (Scragg, 1957).

The 1980 results have been collated in part (Table 5.1). Those results that have been analysed show a secular change for both mean heights and mean weights for the majority of ages and age groups. The results are not presented in full but will be published at a later date.

To enable an assessment to be made of nutrition and possible secular changes, the values for males and females aged 17-19 as groups are presented below. This age group should indicate adult trends in later years.

5.3 MALES

5.3.1 Height

On a smaller number of observations the mean height has increased by 61mm in 31 years to 1.674m (SD < 0.5). The main change is that the range of results shows a shift of the lowest observed value from 1.402 to 1.639m - in all 237mm. The highest value has hardly moved.

In 1882 Guppy (1887, p104) reported the measurement of 72 adult males from St. Christoval and Bougainville Straits. The mean height observed was 1.617m. Oliver reported a 20 year height of 1.62m for 1939 and Friedlander of 1.64m for 1967 (1925, p119) for the Buin area. Malcolm (1970, p76) reported the Kaiapit males as the tallest studied to that date

at 1.661m while 20-29 year adults in Lemankoa were 1.703m in 1980 Table 5.2).

5.3.2 Weight and Body Mass

A similar change has occurred with weight. In 1980 the men weighed 61.4kg, an increase of 8.8kg. Within the distribution the heaviest was lighter but the lightest was 2.22kg heavier. Guppy reported a mean weight of 57.9kg in 12 males in 1882 a value inconsistent with the Lemankoa value and the individuals weighed may have been selected.

Quetelet's Index (Weight/Height^2) is below the accepted level at 20.2 for males of medium frame in 1949 and within that range in 1980 at 21.9 (DHSS/MRC 1976).

Triceps skin fold was not recorded in 1949. In 1980 at 7.3mm it is 60% of the standard for males (Jelliffe, 1966 p 242).

5.4 FEMALES

5.4.1 Height

The situation is the same as with the males. The lowest observed value has increased from 1.377m to 1.540m with a fall in the highest value. The mean has increased by 58mm to 1.589m. Guppy (p115) reported a mean height of 6 adults of 1.488m. Kaiapit females height, again the highest, was 1.568m.

5.4.2 Weight and Body Mass

Again the range of results has moved but here at both top and bottom level, and the mean has increased by 6.7kg to 57.8kg.

Quetelet's Index at 22 in 1949 is within the range for persons of medium frame and above the range at 22.9 in 1980.

Triceps skin fold of 10.5mm is 65% of the standard for females (Jelliffe, 1966).

5.5 OTHER NUTRITIONAL INDICATORS

5.5.1 Menarche

Malcolm has used adult height to determine the age of menarche (1970, p52).

The formula 62.71 - (.303 x adult height in cm) using the 1949 height gives a menarchal age of 15.96 years while the 1980 height indicates a menarchal age of 14.56 years. The mean value by interview in 1970 was 15.5 years and further interviews are now needed to determine the extent of any secular trend in Buka women.

5.5.2 Birthweights at health centres on Buka have been recorded since the centres opened in the 1950s. The average weight of male children over 1969 to 1972 was 3.4kg. This weight approximates that found in Europeans and indicates adequate maternal nutrition.

5.5.3 Menopause

Age of menopause varies inversely with age at menarche as shown by Scragg (1973). The age of menopause in Buka was 47.29 years in 1972 when females aged 20-25 years had a mean height of 1.547m. This compares with 43.57 years in the Fane women who had a mean height of 1.435m.

5.6 DISCUSSION

The state of nutrition of the people of Lemankoa has appeared to be adequate since recovery from the privations of the 1942-45 war. The war was a period of hunger that may have permanently effected those who went through it. From visits and enquiries there have been no other periods of hunger and at other times of crisis, food in adequate quantities has always been available.

The people of Lemankoa, like all Buka people, have fertile easy to garden land with few non-arable areas. Permanent nut trees are common. Coconuts had been extensively developed since contact. Sweet potato is the staple with fish, molluscs and pig readily available in adequate quantities. Their nutritional level in 1947 would have been above that of the Trobriand Islanders at the time of the 1947 nutrition survey (Hipsley, 1950). In addition, they have long had access to and used imported foods (4.4.2). Breast feeding of infants is still usual.

Illness, particularly repeated infections or chronic conditions, affect growth, both height and weight (Tanner, 1979 p9; Scragg, 1955).

Lower values of body build record throughout life the history of the individual's survival against infections that killed other contemporaries in infancy and childhood. The fact that the highest values have moved little relates the higher means to the more consistent health of the village rather than to improved nutrition alone.

In summary, Lemankoa is a village with minimal morbidity, adequate food and stable adequate nutrition. All these conditions have applied since at least 1960. The improvement in the range of heights and weights seen in adolescents will, in due course, cause a secular change in adult height.

6. TRANSITION

The most significant change in Lemankoa over the years has been the exponential natural increase in population in spite of measurable out migration. This increase has been noted in many other countries as a modern phenomena. The time of onset and the rate has varied from group to group and from country to country but did not reach Papua New Guinea until the 1960s and then only in selected areas.

An argument exists as to the extent to which socio-economic change, improved nutrition or health intervention have been responsible. As these factors must vary in impact from place to place, it is important, as far as Lemankoa is concerned, to define their relative significance in that village.

6.1 FERTILITY DECREASE

Fertility rates have always been high in Lemankoa when compared with modern western society. Social change initiated the pre war increase and has maintained this increase until recently. High fertility requires, and is aided by, good nutrition, which lowers the age of menarche, increases the age of menopause and allows biological fertility without damage to the mother.

The down trend shown in the 1980 fertility appears to be limited to younger mothers. Lemankoa is relatively isolated and access to family planning interventions is limited. There was no evidence of personal action in family limitation using modern techniques at the 1980 visit. However, this may be occurring within some families.

Child survival has been maximal since at least 1960 but the effect on fertility tables appears to have been minimal.

Deferral of marriage from the early post pubertal years into the twenties is clearly evident. Many women are presently at high school, college and university and usually only marry in their early career years.

Within these institutions they are subject to all the modern concepts

of the role of women as well as advice on family planning. The educative process external to the formal family planning service has the innate ability to achieve major changes in attitude. In marriage the male who has undergone similar attitude changes confirms the new approach to family size. The Lemankoans, either in their village or in their careers, have a high economic expectation. This also favours smaller families.

The prime causes of the decrease are within the formal and informal educational process linked to the economic state of this micro community. The change is consistent with the findings of Oechsli (1975) that the birth rate relates to the level of socio-economic development and that the "development and modernisation, processes which include demographic change, have become much more rapid." (p415)

6.2 MORTALITY DECREASE

6.2.1 Epidemic Era

In the late 1930s there was a trend toward a lower mortality. Up to that date the community had been establishing its immunity against viral and bacterial diseases that centuries of isolation had kept from its people. The decrease in epidemics and deaths was in no way related to health interventions as there were none of any significance that were applied in rural areas.

The war reversed that situation temporarily and can be looked on as an epidemic among the young and the aged.

6.2.2 Curative Era

The rapid fall was linked with a limited community interest in health and health interventions. A similar change has been noted in the Mekeo (Scragg, 1977 p104) - a larger population subject to similar health endeavours. Neither in Mekeo nor in Lemankoa was there a local hospital. The death rate in Mekeo from 1947 to 1960 was 18.97 in 60, 170 person years compared with 18.7 for Lemankoa.

The health interventions were many and assiduously applied regardless of what the community thought or wished by a benevolent health service

working through village health workers.

Most communities under regular government control had aid posts bringing sulphonamides, penicillin and chloroquine and maternal and child health field service immunisations.

6.2.3 Preventive Era

Prevention had started well before 1960 with immunisation but was not universal. By 1960 only one in every five children aged 0-4 was enrolled in the maternal and child health clinics. The effect of these services did not mature until well into the preventive era.

Environmental services were, and still are, minimal. Community water supply programmes were limited in area of application and few were permanent. There were few latrines in rural areas, only one in a village as sophisticated as Lemankoa.

Malaria control started in Buka in 1960 but not in Mekeo. The death rate in Mekeo for 1960-72 was 8.37 per 1000 compared with 5.8 in Lemankoa. Thus the value of malarial intervention applied in Buka was a 2.57 per 1000 fall in mortality. High levels of mortality are easy to reduce but as mortality falls any further reduction is more and more difficult and more costly. For example, the 2.57 reduction related to malaria control is an achievement costing more than the earlier reductions of ten times that amount.

In comparison to both Lemankoa and Mekeo, the Fuyuge had little nutritional change, health services reduced by the absence of roads and less social change. The death rate remained higher at 12.5 per 1000 (920 deaths in 73,540 persons from 1960-72). The factors behind these differences are summarised in Table 6.1.

6.3 DISCUSSION

There are many theories of epidemiologic transition.

Omran (1971) defines four ages of pestilence and famine, receding pandemic - early and late phases - and degenerative and man-made disease. Over the last 100 years Lemankoa has come through the early pandemic age

and with the rest of Papua New Guinea is within the late pandemic phase with low mortality and high fertility - both varying from area to area.

Marshall (1974) considers nutritional improvement as the main factor in mortality decline. He discounts the value of malaria eradication, immunisation programmes, improved sanitation and antibiotics. Lemankoa and Mekeo received their main advantage from antibiotics and immunisation programmes against the background of a good cash economy. Good nutrition was always present in both societies. Malaria control gave an added benefit when applied in Lemankoa.

Poikolainen (1976) argues for preventive campaigns supported by use of antibiotics as the main factors in the mortality decline. In Lemankoa with a relatively safe environment, interventions in sanitation and malaria played a smaller role.

Johnston (1977) considers the provision of rural health services has been a problem in rural development as they need qualified medical personnel. In Lemankoa qualified medical or paramedical personnel were only indirectly related to the mortality decline in the years since the war. They were centrally responsible for planning and personnel, drugs and preventive campaigns, but orderly personnel provided the primary contact and intervention. This is consistent with the concept that spraymen and other orderlies using simple health interventions can achieve miracles (Scragg, 1968).

Oechsli provides the concept of a new transition where "mortality decline proceeds so rapidly that it has reached an exceedingly low level before the natality decline begins" (1975 p416). Natural increase can be from 30-35 per 1000. The pace of modernisation, development and fertility decline are also speeded up.

According to Oechsli mortality decline requires social and economic development and all three of these will at a certain balancing point initiate fertility decline.

This balancing point is postulated to be the presence of both a crude death of 10 per 1000 and a per capita GNP of US$500 at 1970 prices.

In Lemankoa the death rate fell below 10 per 1000 in the 1960s. There is no value for the per capita GNP for Lemankoa but the national figure had only reached US$510 in 1977 at 1977 prices - well below the US$500 at 1970 prices.

However, Lemankoa is at an economic level well above the national average. The fall in fertility occurring in the 1970s is consistent with the people of the village achieving both of these targets at about that time. Oechsli also noted that fertility decline could occur without large scale family planning programmes and this has happened in Lemankoa (p416).

Lemankoa appears to be following the accelerated model but many areas in the country may follow the delayed model. It is important to note the changes and interventions that have caused Lemankoa to take the rapid course.

Socio-economic	Health
High economic development.	Adequate nutrition.
Universal primary education.	Child health services.
Modern communications.	Rural health service.
Informed community.	Malaria control.

These factors have not been individually weighted nor do they exclude others that have been part of the change but they are the main factors.

6.4 THE FUTURE

Lemankoa still has adequate land and an income to support its ever growing population. Decline in growth will be slow and the population that has doubled in the last 25 years will no doubt do so again in about 35 years if the fall in fertility is maintained. Lemankoa is part of Papua New Guinea and out migration to the rest of the country is increasing. Migration will be more difficult as other areas have a similar rate of growth and as the national population increases.

At home, Buka land also has a limit for exploitation. Short term, everything should be done to facilitate fertility transition throughout the country in order to maintain a rising standard of living for all Papua New Guineans.

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TABLE 3.1: Comparison of populations 1914 - 1980

	Papua New Guinea	Nth Solomons	Buka and Adjacent Islands	Haku	Lemankoa
1914			6810		
1921			7176		
1926			7548		437
1929			7570	1897	428
1940			7608	1600	409
1949	1,346,464[+]	43,868[+]	7480	1725	429
1953	1,536,273[+]	48,758	8286	2075	477
1957	1,756,570[+]	51,608		2266	549
1961	1,947,031[+]	56,330		2561	628
1966	2,150,317[×]	71,761[×]	11601	3141	755
1971	2,435,409[×]	90,382[×]		3660	881
1980	2,978,057[×]	125,506[×]	16797[×]		1110[×]

[+]Includes estimated population for some areas.

[×]Data from national census.

TABLE 3.2 : Population of Lemankoa including live births, deaths and migrations at 5 year intervals 1922 - 1980.

To Year Ending June 30	Population	Live Births	Deaths	In Migrants	Out Migrants
1922*	383	29	4	1	1
1927	443	83	24	2	1
1932	424	87	104	2	4
1937	412	80	81	4	15
1942	419	97	74	7	23
1947	392	78	100	21	26
1952	470	125	37	6	16
1957	550	120	48	15	7
1962	629	151	43	27	56
1967	778	192	32	9	20
1972	911	179	25	15	36
1977	1010	176	18	15	74
1980	1109	124	15	7	17
Totals July 1920 - June 1980		1521	605	131	296

*Less than 2 years.

TABLE 3.3 : Lemankoa percentage population distributions for combined sexes at 5 yearly intervals and by 5 year age groups.

AGE GROUP	YEAR												
	1922	1927	1932	1937	1942	1947	1952	1957	1962	1967	1972	1977	1980
0-4	17.5	15.7	13.7	13.6	18.4	14.6	22.3	18.5	22.2	22.4	18.5	17.0	16.2
5-9	13.6	14.7	11.6	10.7	11.9	14.5	11.3	17.5	13.8	17.5	18.4	15.8	15.4
10-14	12.8	12.0	14.4	10.7	9.8	11.0	11.9	9.3	13.5	11.2	14.4	15.5	13.8
15-19	10.4	10.8	12.5	14.1	9.3	9.9	8.1	11.1	6.2	10.7	9.1	12.5	13.7
20-24	9.9	8.6	10.8	10.4	11.9	9.2	8.5	7.3	9.7	4.4	8.7	7.1	9.1
25-29	9.9	8.4	6.8	9.7	8.1	10.2	7.7	7.5	6.8	7.2	4.0	7.1	6.5
30-34	9.4	8.6	8.5	6.8	8.1	7.1	8.1	6.2	6.5	5.8	6.0	2.9	5.0
35-39	5.7	7.4	7.3	7.8	5.7	7.4	5.5	6.5	4.5	5.3	4.4	4.9	2.5
40-44	7.1	4.7	5.0	6.3	5.3	5.4	5.1	4.4	5.1	3.5	4.2	3.8	4.1
45-49	2.1	6.1	3.8	3.9	4.1	3.1	4.3	4.2	2.9	3.9	2.9	3.5	3.4
50-54	1.0	1.8	3.8	2.7	2.9	3.1	2.1	3.6	2.9	1.7	3.0	2.2	2.2
55-59	.3	.9	1.4	2.2	2.1	2.6	2.3	1.6	2.9	2.3	1.4	2.7	1.9
60-64	.3	.2	.5	1.0	1.4	1.0	1.7	1.8	1.4	1.9	1.8	1.3	2.3
65-69				.2	1.0	.8	.6	.5	1.4	1.2	1.5	1.4	.7
70-74						.3	.4		.2	1.2	.9	1.3	1.5
75-79											.8	.7	.5
80-84												.6	.6
85+													.4
Total Population	383	443	424	412	419	392	470	550	629	778	911	1010	1109

TABLE 3.4 : Sex ratio of births Lemankoa 1920 - 1980

Years	Male	Female	Males per 100 females
1920-1927	55	57	96
1927-1937	84	84	100
1937-1947	91	87	108
1947-1957	130	115	113
1957-1967	176	167	105
1967-1980	252	227	111
Live births	788	734	107.4
Still births	14	10	140
All births	802	744	107.8

TABLE 3.5 : Tertiary sex ratios by broad age groups Lemankoa 1922 to 1980.

Year	AGE GROUPS									TOTAL		
	0-14			15-44			45 & over					
	M	F	Ratio	M	F	Ratio	M	F	Ratio	M	F	Ratio
1922	108	60	180	85	116	73	5	9	56	198	184	108
1927	115	73	158	97	118	82	15	25	60	227	215	106
1937	70	74	95	124	103	120	16	25	64	210	202	104
1947	75	82	91	104	89	117	14	28	50	193	199	97
1957	132	117	113	119	117	102	26	39	67	277	273	101
1967	207	191	108	147	139	106	46	48	96	400	378	106
1980	266	239	111	228	227	100	75	74	101	569	540	105

TABLE 3.6: Crude birth and death rates for four periods.

Period	Population at risk	Deaths	Crude sex death rate	Combined rate	Births	Crude Birth rate
1927-42	M 3260	132	40.5	40.7	264	41.5
	F 3106.5	127	40.9			
1942-47	M 967.5	55	56.8	50.9	78	39.7
	F 996.5	45	45.2			
1947-60	M 3229.5	61	18.9	18.7	329	51.1
	F 3202.5	59	18.4			
1960-80	M 8767.5	56	6.4	5.8	738	43.4
	F 8219	42	5.1			

TABLE 3.7: Comparative birth and death rates for Preventive Era 1960-1980.

Place	Author	Period	Crude birth rate	Crude death rate	Natural increase
Papua New Guinea Census	van de Kaa	1961-66	43.8	20.7	23.1
South Bougainville	Friedlander	1960-66	60-36	17-5	69-32
Siwai	Connell	1961 & 1971		20 & 12	
Bismark Archipelago	Vines	1966	50.5	10.1	40.4
Mainland New Guinea	Vines	1965	32.4	21.0	11.4
Highlands New Guinea	Vines	1963	21.6	16.1	5.6
Papua New Guinea Census	Skeldon	1971-76	46.6	17.0	29.4
Curative Era		1947-60	51.1	18.7	32.4
Preventive Era		1960-80	43.4	5.8	37.6

TABLE 3.8: 1.7.1927 - 30.6.42
Combined age and sex specific mortality rates per 1000 lives at risk.

	MALES			FEMALES			SEXES COMBINED		
Age Group	Population	Deaths	Rate	Population	Deaths	Rate	Population	Deaths	Rate
Birth	129	33	258	136	22	162	265	55	207
1-	88	5	57	107.5	10	93	195.5	15	77
2-	84	6	71	94	9	96	178	15	84
3-	80	7	88	84	6	71	164	13	79
4-	77	2	26	76.5	4	52	153.5	6	39
1-4	329	20	61	362	29	80	692	49	71
5-9	397.5	7	18	344	7	20	741.5	14	19
10-14	445	5	11	312	3	10	757	8	10
15-19	483.5	5	10	280.5	3	11	764	8	10
20-24	391.5	12	31	265.5	1	4	657	13	20
25-29	241	8	33	246.5	3	12	487.5	11	22
30-34	192	3	16	280.5	7	25	472.5	10	21
35-39	191	5	26	258.5	12	46	449.5	17	38
40-44	158	12	76	223.5	8	35	381.5	20	52
45-49	133	7	53	153	14	91	286	21	73
50-54	102	9	88	121	7	57	223	16	71
55-59	48	5	104	74.5	8	107	122.5	13	106
60-64	17	-		36.5	2	55	53.5	2	37
65-69	2.5	1	400	12.5	1	80	15.0	2	133
TOTAL	3260	132	40.5	3106.5	127	40.9	6366.5	259	40-7

TABLE 3.9: 1.7.1942 - 30.6.47
Combined age and sex specific mortality rates per 1000 lives at risk.

	MALES			FEMALES			SEXES COMBINED		
Age Group	Population	Deaths	Rate	Population	Deaths	Rate	Population	Deaths	Rate
Births	46	12	260	32	5	156	78	17	217
1	30.5	6	196	29.5	6	203	60.0	12	200
2	25.5	2	78	29.5	1	34	55	3	54
3	24	2	83	30.5	3	98	54.5	5	92
4	21.5	1	47	35	-	-	56.5	1	18
1-4	101.5	11	108	124.5	10	80	226	21	93
5-9	117	3	27	154.5	3	19	271.5	6	22
10-14	102	3	29	102	3	29	204	6	29
15-19	94.5	2	21	83	2	24	177.5	4	22
20-24	108.5	2	18	99.5	3	30	208	5	24
25-29	127.5	4	31	67.5	4	59	195	-	-
30-34	79.5	3	39	57.5	1	17	137	4	29
35-39	69.5	-	-	72	2	28	141.5	2	14
40-44	28.5	5	175	53	1	19	81.5	6	74
45-49	25.5	-	-	64	3	47	89.5	3	33
50-54	28.5	5	175	35.5	1	28	64	6	94
55-59	14.5	2	137	26	1	38	40.5	3	74
60-64	15	3	200	16	1	62	31	4	129
65-69	7	-	-	8.5	4	47	15.5	4	258
70-74	2.5	-	-	1	1	1000	3.5	1	285
TOTALS	967.5	55	56.8	996.5	45	45.2	1964	100	50.9

TABLE 3.10: 1.7.47 - 30.6.60
Combined age and sex specific mortality rate per 1000 lives at risk.

	MALES			FEMALES			SEX COMBINED		
Age Group	Population	Deaths	Rate	Population	Deaths	Rate	Population	Deaths	Rate
Births	183	27	147	146	17	116	329	44	133
1	146.5	2	14	117	5	43	263.5	7	26
2	131	3	23	114	5	44	245	8	32
3	126.5	1	8	104.5	2	19	231	3	13
4	120.5	1	8	95.5	2	21	216	3	14
1-4	524.5	5	9	431	14	32	955.5	19	20
5-9	476.5	2	4	437.5	2	4	914	4	4
10-14	325	-	-	364	2	5	689	2	3
15-19	272.5	3	11	333.5	1	3	706	4	6
20-24	253.5	-	-	270.5	2	7	524	2	4
25-29	248	1	4	243.5	-	-	491.5	1	2
30-34	270	2	7	194	2	10	464	4	9
35-39	234.5	3	13	166.5	3	18	401	6	15
40-44	177.5	1	6	139.5	3	21	317	4	13
45-49	110	1	9	129.5	-	-	239.5	1	4
50-54	61	3	49	131.5	2	15	192.5	5	26
55-59	36	3	83	100	1	10	136	4	29
60-64	28	4	142	73	3	41	101	7	69
65-69	13	1	77	36	3	83	49	4	81
70-74	6.5	2	308	6.5	4	612	13	6	461
75-79	2	1	500	-					
TOTAL	3229.5	61	18.8	3202.5	59	18.4	6432	120	18.7

TABLE 3.11: 1.7.60 - 30.6.80
Combined age and sex specific mortality rate per 1000 lives at risk.

	MALES			FEMALES			SEX COMBINED		
Age Group	Population	Deaths	Rate	Population	Deaths	Rate	Population	Deaths	Rate
Births	375	17	45.3	363	15	41.3	738	32	43.4
1	350.5	5	14.3	318.5	1	3.1	669	6	8.9
2	343.5	2	5.8	316.5	1	3.1	660	3	4.5
3	331.5	2	6.0	310.5	2	6.4	642	4	6.2
4	316	-	-	305.5	-	-	621.5	-	-
1-4	1341.4	9	6.7	1251	4	3.2	2592.5	13	5.0
5-9	1443.5	1	0.7	1373.5	-	-	2817	1	0.3
10-14	1225.5	1	0.8	1104.5	-	-	2330	1	0.4
15-19	949.5	3	3.2	784	2	2.6	1733.5	5	2.9
20-24	701	1	1.4	597.5	-	-	1298.5	1	0.7
25-29	543.5	-	-	482	-	-	1025.5	-	-
30-34	400.5	2	5.0	468.5	-	-	869	2	2.3
35-39	366	1	2.7	413.5	4	9.6	779.5	5	6.4
40-44	372.5	1	2.7	307	1	3.3	679.5	2	2.9
45-49	341.5	6	17.6	241	2	8.3	582.5	8	13.7
50-54	247	5	20.2	168.5	3	17.8	415.5	8	19.3
55-59	210.5	2	9.5	152	-	-	362.5	2	5.5
60-64	121.5	3	24.7	152	4	26.3	273.5	7	25.6
65-69	69.5	2	28.7	151	1	6.6	220.5	3	13.6
70-74	36.5	-	-	124.5	3	24.1	161	3	18.6
75-79	13	1	76.9	63.5	2	31.5	76.5	3	39.2
80-84	8	1	125	32.5	1	30.8	40.5	2	49.4
85-89	0.5	-	-	3.5	-	-	4	-	-
TOTAL	8767.5	56	6.4	8219	42	5.1	16986.5	98	5.8

TABLE 3.12: Crude death rates for each era 1927-1980 for combined sexes and broad age groups.

	1927-1942	1942-1947	1947-1960	1960-1980
0 - 1	207	217	133	43
1 - 4	71	93	20	3
5 - 14	15	25	36	0.4
15 - 24	15	23	5	2
25 - 34	22	12	5	1
35 - 44	45	36	14	5
45 - 54	73	59	14	16
55 - 64	85	98	46	14
65 & over	133	263	161	22

TABLE 3.13: Still births and infant mortality rates per 1000 by period for combined sexes.

	Still Births	Rate	Live births	0-30 days	Rate	1-5 months	Rate	6-12 months	Rate	Total	Rate
1927-1942	4	15	264	16	61	21	80	18	68	54	205
1942-1947	2	26	76	7	92	5	66	5	66	17	224
1947-1960	8	24	329	22	67	11	33	11	33	44	134
1960-1980	10	13	738	16	22	4	5	12	16	32	43

TABLE 3.14: Toddler mortality per 1000 for combined sexes for each period.

	Population at risk	Deaths	Rate	L_5 life table survivors
1927-1942	691	49	71	5952
1942-1947	226	21	93	5295
1947-1960	955.5	21	22	7898
1960-1980	2592.5	13	5	9372

TABLE 3.15: Expectation of Life Lemankoa based on mortality experience for each era.

	Expectation at birth		Expectation at age 10	
	Male	Female	Male	Female
1927-42	22	25	32	34
1942-47	16	22	27	29
1947-60	44	44	49	52
1960-80	64	70	64	68

TABLE 3.16: Births and age specific fertility rates for all women in Lemankoa for four periods 1927 - 1947.

	1927-32		1932-37		1937-42		1942-47	
Age Group (years)	Births/ Women	Rate	Births/ Women	Rate	Births/ Women	Rate	Births/ Women	Rate
15-19	6/77.5	77	6/93	65	15/110	136	10/83	120
20-24	18/77.5	160	17/75.5	225	28/78.5	356	19/95.5	199
25-29	18/84.5	213	25/97	258	19/67	283	20/67.5	296
30-34	30/122	246	14/75	187	24/83.5	287	12/57.5	209
35-39	13/88.5	146	15/107	140	8/63	127	12/72	167
40-44	1/67	15	3/68.5	44	3/88	34	4/53	75
45-49	1/57.5	17	-/48.5	-	-/44	-	1/61	16
Total Fertility		4370		4595		6115		5410

TABLE 3.17: Births and age specific fertility rates, for all women for Buka areas for four periods.

	1947-52		1952-57		1957-62		1962-67	
Age Group (years)	Births/ Women	Rate	Births/ Women	Rate	Births/ Women	Rate	Births/ Women	Rate
15-19	57/348	164	38/432	88	34/371	92	47/348	135
20-24	88/265	332	111/333	333	141/402	351	112/322	348
25-29	56/196	286	88/250	352	106/322	329	143/373	383
30-34	67/203	330	51/186	274	70/218	321	106/299	355
35-39	41/145	283	42/184	228	39/152	256	65/203	320
40-44	22/129	171	11/125	88	27/176	153	25/133	188
45-49	4/88	46	7/112	63	3/113	27	1/154	7
Total Fertility		8060		7130		7645		8680

TABLE 3.18 : Births and age specific fertility rates for all women in Lemankoa for three periods 1967 - 1980.

Age Group (years)	1967-72		1972-77		1977-80	
	Births/ Women	Rate	Births/ Women	Rate	Births/ Women	Rate
15-19	12/170	71	14/212	66	17/213.5	80
20-24	41/125	328	45/160	281	32/118.5	270
25-29	37/115.5	320	37/112	330	31/90.5	342
30-34	44/137	321	31/112	277	14/67.5	207
35-39	30/110	272	36/130	277	19/68	279
40-44	13/69	188	10/92.5	108	11/67	164
45-49	2/54.5	37	3/64	47	-/52.5	-
Total Fertility		7680		6930		6710

TABLE 3.19: Fertility experience of cohort of 23 women born 1895 to 1900.

Birth number	Age group of births						
	15-19	20-24	25-29	30-34	35-39	40-44	Total
1	2	10	7	2	1		22
2		5	8	7	1		21
3		3	3	7	1		14
4		1	2	6	2	2	12
5			2	3	4	1	10
6			1	1	4	1	7
7				2	1		3
8						1	1
Total births	2	19	23	28	14	5	90
Births per mother still surviving	0.09	0.83	1.00	1.26	0.73	0.28	
Total births all mothers	0.09	0.91	1.91	3.13	3.74	3.91	

TABLE 3.20: Fertility experience of cohort of 21 mothers born 1930-35.

Birth number	Age group of births							
	15-19	20-24	25-29	30-34	35-39	40-44	45-49	Total
1	13	7	0	1				21
2	2	15	3	1				21
3		10	8	-	2			20
4		5	12	1	2			20
5			9	9				18
6			3	14	1			18
7			2	7	6			15
8				4	7	1	1	13
9				2	6	1		9
10					2	3	1	6
11					1	2		3
12					1			1
13						1		1
Total births	15	37	37	39	28	8	2	166
Births per mother still surviving	.71	1.76	1.76	1.86	1.36	.4	.19	
Total births all mothers	.71	2.48	4.24	6.4	7.43	7.81	7.90	

TABLE 3.21: Comparison fertility experience of mothers born 1895-1900 and 1930-1935.

	Birth group of mother	
	1895-1900	1930-1935
Percentage of first births	24.4	12.7
Median age at first birth	23.64	19.58
Percentage births to mothers aged 15-19	2	9
Median age all mothers	30	29.3
Median parity all mothers	3.06	4.87
Percentage births over age 40 and over parity 4	24.4	51
Mothers dead before age 45	4	1
Total births per mother	3.91	7.90

TABLE 3.22: Percentage distribution and duration of birth interval for five periods.

Distribution and mean length	1930-35 Lemankoa	1947-49 Buka	1950-54 Buka	1955-59 Buka	1960-64 Buka
Interval length (years)					
Less than 1.00	2.3	0.9	0	0.9	0.5
1.00 - 1.99	23.0	15.1	16.4	28.6	41.5
2.00 - 2.99	35.6	50.9	53.1	49.8	50.7
3.00 - 3.99	27.6	28.3	22.0	15.4	5.7
4.00 - 4.99	11.5	4.7	8.5	5.3	1.6
No. and mean length					
No.	87	106	177	227	371
Mean	2.74	2.71	2.73	2.46	2.17
SD	0.99	1.37	0.82	0.82	0.66
Intervals over 5 years	5	7	13	8	5

By setting 95% confidence limits on mean birth intervals of 5 years or less a significant difference is found between 1960-64 and other periods.

TABLE 3.23: Average number of full term pregnancies for all Buka women in 1953 and 1965 and Lemankoa women in 1980 by age group.

	Buka		Lemankoa
Age group (years)	1953	1965	1980
15 - 19 (all)	0.25	0.22	0.09
20 - 24	1.74	1.62	0.93
25 - 29	2.91	3.33	2.66
30 - 34	4.84	5.47	4.15
35 - 39	6.15	6.32	6.61
40 - 44	7.48	8.16	8.19
45 - 49	6.50	8.09	8.60
50 and over	5.52	6.33	7.60

TABLE 3.24: Buka and Lemankoa cohort age specific fertility all women born 1902 - 1937.

Year of birth of mother	Total fertility	All reach age 50 by
1902-07	5607[x]	1957
1907-12	5960	1962
1912-17	7175	1967
1917-22	6880[+]	1972
1922-27	8440	1977
1927-32	7805	1982
1932-37	7920*	1987

[x]Includes experience of next cohort for 15-19 age group.

[+]Spent age 20-24 in war years.

*Includes experience of previous cohort for 45-49 age group.

TABLE 3.25: Education and employment of single males and females and married males in the Lemankoa population, 1980.

		Married		Unmarried				
		Living in village	Employed Elsewhere	Living in village	Primary & Secondary Education	Tertiary Education	Employed Elsewhere	Total
15-19	Males	6	3	26	18	4	10	67
	Females	14	-	32	29	2	8	85
20-24	Males	15	7	12	-	3	19	56
	Females	35	-	4	-	1	5	45
25-29	Males	22	10	4	-	1	6	43
	Females	26	-	2	-	-	1	29
30-45	Males	56	6	-	-	-	-	62

TABLE 4.1: Epidemic months, deaths and age.

Year	Month	Number	Age years	Diseases
1928	July	6	1,1,1,2,48,48	
	October	4	0,4,5,7	
	December	4	0,2,38,38	Influenza
1928	May	7	0,7,39,39,39,41,46	Influenza
	October	4	0,1,22,64	Whooping cough
1930	March	4	1,32,45,52	
	December	5	1,17,37,41,51	
1938	May	4	0,27,40,42	

TABLE 4.2: Deaths persons aged 0-4 years 1928 to 1942.

Year	Deaths	Year	Deaths
1928	10×	1936	7
1929	14×	1937	7
1930	10×		
1931	12×	1938	4
1932	1	1939	5
		1940	3
1933	4	1941	6
1934	10×	1942	8×
1935	5		

×Years with above average deaths.

TABLE 4.3: Comparative mortality by disease groups.

	Disease Group	All Survey Areas by Period								Lemankoa Only	
		1949-1952		1952-1957		1957-1962		1962-1967		1967-1980	
		No.	%	No.	%	No.	%	No.	%	No.	%
I	Infective & Parasitic	40	12.9	105	28.7	95	31.3	44	16.9	12	20.8
II	Neoplasms	3	1.0	11	3.0	7	2.3	33	12.7	4	6.9
III	Endocrine & Nutritional	1	0.3	1	0.3	2	0.7				
IV	Blood & Blood Forming			1	0.3	2	0.7	1	0.4		
V	Mental & Psychoneurotic	2	0.6	6	1.6			3	1.2	3	5.2
VI	Nervous System	2	0.6	11	3.0	12	3.9	6	2.3		
VII	Circulatory System	1	0.3	2	.5	2	0.7	5	1.9	6	10.3
VIII	Respiratory System	18	5.8	54	14.8	73	24.0	39	15.0	7	12.1
IX	Digestive System	4	1.3	4	1.1	5	1.6	21	8.1	2	3.4
X	Genito-Urinary System			6	1.6	5	1.6	3	1.2	2	3.4
XI	Pregnancy & Childbirth	5	1.6	6	1.6	3	1.0	4	1.5	1	1.7
XII	Skin & Cellular Tissue	3	1.0	2	0.5			3	1.2		
XIII	Musculo-skeletal										
XIV	Congenital Malformations			2	0.5	1	0.3			2	3.4
XV	Early Infancy	74	23.8	62	16.9	32	10.5	32	12.3	5	8.6
XVI	Symptoms, Senility & Illdefined	141	45.4	83	22.7	47	15.5	47	18.1	11	19.0
XVII	Accidents, Poisoning & Violence	17	5.4	10	2.7	18	5.9	19	7.3	3	5.2
	Total Deaths All Causes	311		366		304		260		58	

TABLE 4.4: Mortality incidence per 100,000 persons by disease group.

Disease Where:-	4 Survey Areas 1952-1962	4 Survey Areas 1962-1967	Lemankoa Only 1967-80
Prevention or Cure Simple	512	170	65
Cure Complex:-			
Prevention by Infection	394	255	89
Community Awareness Absent	128	191	73
Death Inevitable	274	251	121
Expert Care Needed	47	43	40
Not Classified	397	204	81
Total Mortality	1,752	1,114	469

TABLE 5.1: Height, weight and skin folds for males and females aged 17-19 years for 1949 and 1980.

MALES

	Year	No.	Mean	S.D.	Range
Height (metres)	1949	17	1.613	.084	1.402-1.733
	1980	9	1.674	.036	1.639-1.754
Weight (Kg)	1949	16	52.6	8.4	34.3-79.0
	1980	9	61.4	5.2	56.5-72.4
Skin fold (mm)	1980	9	7.3	1.69	5.4-10.3

FEMALES

Height (metres)	1949	21	1.531	.057	1.377-1.660
	1980	16	1.589	.030	1.540-1.636
Weight (Kg)	1949	18	51.1	7.5	41.5-69.2
	1980	16	57.8	7.3	46.5-74.2
Skin fold (mm)	1980	16	10.5	1.53	7.2-11.1

TABLE 5.2: Height of selected groups North Solomons adult males aged 20-29 1882 to 1980.

Population	Researcher	Year	Height in metres age group 20-29
Bougainville* Straits	Guppy	1882	1.617
Buin	Oliver	1939	1.62
Lemankoa	Scragg	1949	1.634
Islands Sample	Vines	1965	1.613
Buin	Friedlander	1967	1.64
Lemankoa	Scragg	1980	1.703

*Age unknown

TABLE 6.1: Factors in the decline in mortality in Lemankoa, Mekeo and Fu yuge 1960 to 1972.

	Lemankoa	Mekeo	Fu yuge
Nutrition	++	++	-
Economy	+++	++	-
Sanitation	±	±	-
Malaria Control	+	-	-
Immunisations	+	+	±
Modern Medicines	+	+	±
Communications	+	+	-
Crude Death Rate	5.8	8.37	12.5

Historical Epidemiology in Papua New Guinea

The study of the history of population is becoming increasingly important in the study of life in pre-industrial societies. Pre-industrial societies in the developing countries have only recently been subjected to the same scrutiny as has occurred in Europe. This study relates to various communities in Eastern Papua New Guinea where first contact with industrial man occurred in the early 19th century and first organised settlements and colonial government in the 1880's. At this time the main island and surrounding archipelagos were divided between Germany, the Netherlands and the United Kingdom. Prior to the development of government, missions established isolated stations. In most cases the missions had total influence over areas and accordingly there was little confusion due to followers of two churches in the area settled. The Catholic Church established the best record of vital events. This study uses records of Catholic mission stations of Yule Island, Mekeo and Fane (Fuyuge) in Southern Papua from 1875, on the north of Buka Island in Bougainville from 1915, and near Aitape on the north west coast from 1911. The location of these areas is shown in Fig. 1.

Records

As far as can be ascertained there were no traditional records of population. People could recall their predecessors but there were no written records. Both government and missions established head counts and recorded vital events. Government records were recorded at best annually and showed numbers of people, births and deaths. Catholic mission records were parish related and accordingly were as comprehensive as the priest could establish. The needs of the Church required that baptisms, confirmations, marriages and burials be undertaken on all Christians, and that as far as possible all people in the parish be Christians at least by the time of their death. These records were established of all people in units of approximately 5,000. Polygamous families were fully recorded and there was no deletion of the heathen. All were destined to become members of the Church if the priest did his work effectively.

The lack of any records within the society meant that the only information was that held by the priest. Accordingly the absence of any community cross-references required more comprehensive records than those of

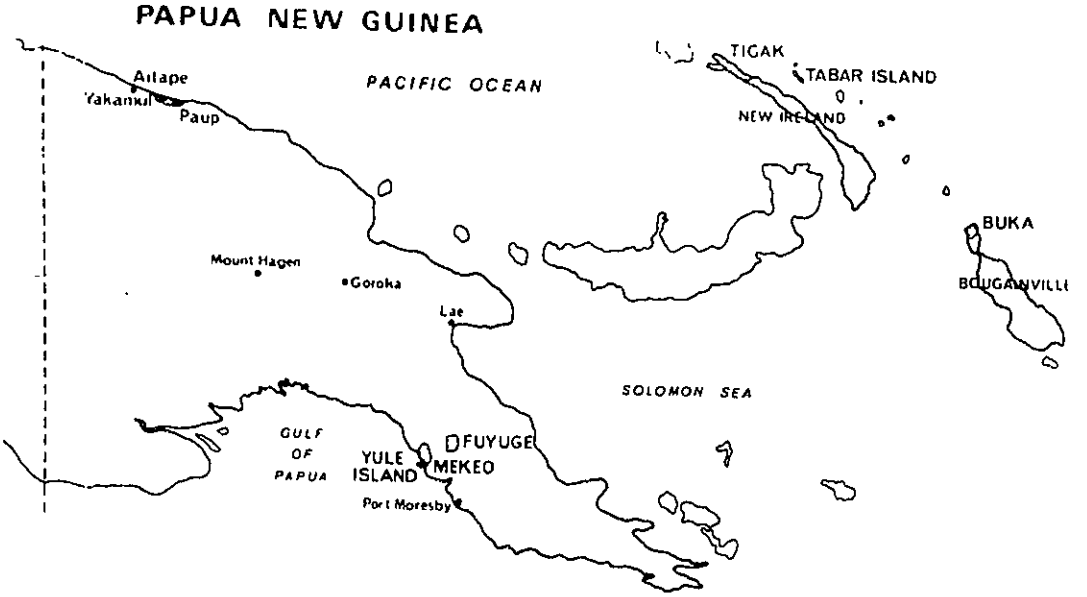

Figure 1. Location of Study Areas.

preindustrial Europe. One important record not normally kept elsewhere was the *status animarum*. This record was rewritten about once in each generation and was continually amended to include new vital events. These records were kept from the date of arrival of the priests in any area, but the majority of those for the north and for the islands were destroyed during the 1942-45 war. Only isolated records and sometimes those for only one series of vital events were saved from destruction. On the whole of the north east coast it was only possible to find records for two village groups even though the earliest Catholic influences in the old German New Guinea was in this area commencing during the 1880's. As opposed to this, complete records exist for the whole of the Mekeo population surrounding Yule Island station. These records were extended as missionaries moved inland and the whole of the area had been recorded prior to 1920.

Method of Study

The existence of a *status animarum* and of population summaries (including lists of numbers of births and deaths from each parish and often each sub-station prepared on a regular annual basis) made it possible to determine both birth and death rates. Over the first five to ten years of contact the record of deaths was poor, with the quality of recording deaths in children better than for adults. From the material available it was possible to determine the age at death and sex of all persons and to relate all deaths to correct months. Some 7,000 deaths were classified by age, sex and date in the Fuyuge area and some 5,000 in the Mekeo area. A study of government annual reports and personal contact with people living in the area, both missionaries and government people, were used in an endeavour to establish the nature of epidemics and other events of importance in mortality.

The Clements Survey

The Yule Island areas were visited in 1935 by Clements and others of the University of Sydney, School of Public Health and Tropical Medicine. (Clements, 1936). Their survey followed on the visual survey of Breinl in 1913. (Breinl, 1915). The survey by Clements was designed "to obtain factors of health and disease amongst a virile vigorous people living in a well populated area." The survey took two months and 5,000 people were seen over 400 miles of tracks. Clements walked through the Mekeo and through the centre of the Fuyuge areas. He wrote in detail on chronic disease in the area, but on epidemic disease concluded: -

Coastal and Subcoastal Districts -

"The population of the coastal and subcoastal districts is increasing. The children and infants number 43% of the total population, a figure also obtained by Dr. Strong. This is due to - (a) a moderately high birth rate (survival rate); (b) a moderately low death rate. The natives are not subjected to the severe onslaught of any particular disease; the general conditions prevailing are those of a normal native population where the average morbidity is due to mild endemic diseases. Malaria undoubtedly influences the death rate, whilst those diseases that might influence the birth rate are absent.

Mountain Districts -

"Population figures are not available for these districts. The natives are exceedingly healthy, the common diseases of the coastal belt being absent or only commencing to make their appearance. Maternal mortality and snake bite still claim a high percentage of deaths, whilst pneumonia is also a serious disease at these high altitudes. Although goitre is an interesting disease, it does not influence the death rate.

"The inner mountain districts (Goilala) are remarkably free from disease, due partly to altitude and partly to isolation. Will the contact associated with the 'opening up' of this territory bring in its train a long list of foreign ailments?"

This quotation relates the medical and mission intelligence on the state of health in these people over the years covered by this study of their mortality. It indicates, as will become clear below, the complete

ignorance on the part of western observers of the real state of health in the pre-industrial society that they served.

Mortality

As indicated earlier, this paper reports mortality from the Mekeo, Fuyuge, Aitape and Buka areas.

Mekeo

The patterns of deaths in the Mekeo area in general and in the individual villages of Inau'aia and Tsiria are shown in Table 1. Most of the years with high mortality in Tsiria and Inau'aia are matched by high mortality in the Mekeo. This linking of mortality shows the sensitive relationships of even small populations to introduced diseases, in that populations of 350 (Inau'aia) and 450 (Tsiria) responded in the same way as a population of over 3,000. It indicates the value of small groups of people in measuring variations in mortality.

The changes in population and crude death rates over the years are shown in Figs. 2 and 3 respectively. These figures

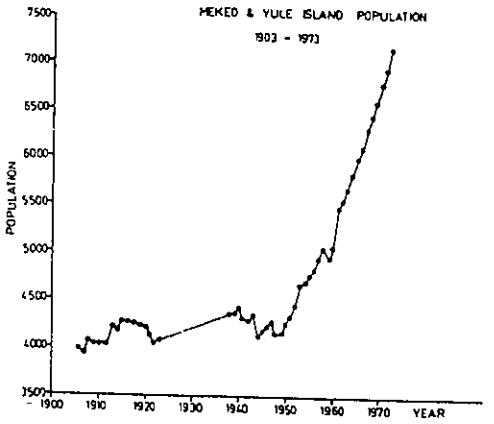

Figure 2. Combined Mekeo and Yule Island Population from Church records begun in 1889. Totals were not available from 1924 to 1937.

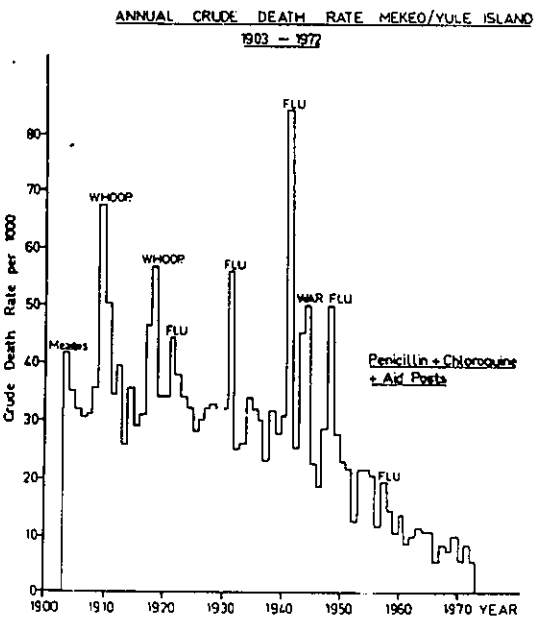

Figure 3. Variation in Mekeo/Yule Island Crude death rates showing cause of epidemics as indicated in historical records.

dated from 1903 as records prior to 1903 were scanty and related to only parts of the area under survey. The population graph shows a rapid take off of the population in 1950 with a doubling in about every 25 years. From a knowledge of medical events of that time this relates fairly precisely to the synchronous availability of penicillin and chloroquine and to the development of aidposts in rural areas.

The epidemic pattern over the years through to 1950 is set against a mean crude death rate over that period of 3.7% (3.1% if epidemic years are excluded). There is a problem in determining what is an epidemic (Schofield, 1972). A doubling of the mean death rate would allow only one epidemic, that of influenza in 1941. An epidemic probably occurred if the crude death rate for a given year exceeds the non-epidemic mean crude death rate by at least one third (i.e. an increase of more than ten deaths per 1,000)

with adequate confirmatory and oral written reports. The presumptive epidemics are listed in Table 2.

The age of deaths in some of the epidemics is shown in Table 3 and compared with the mortality in non-epidemic years. In non-epidemic years about one third of deaths are in persons under the age of five. An outbreak of whooping cough on Yule Island commenced in August 1909 and then spread throughout the rest of the Mekeo over the months until February, 1910. The epidemic peak on Yule Island in September was followed by peaks in other villages in November to January. The annual crude death rate was 6.8% with 205 deaths in the epidemic. Sixty per cent of deaths of known age were in children aged under five and an additional 14% in those between 5 and 10 years as shown in Table 3. The 1918 epidemic has a similar pattern of child deaths.

Age specific mortality rates covering the epidemic deaths have been calculated using Coale and Demeny (1966) Model Life Tables Population North 4 for males with a population showing no growth. This population approximates that known to be living in two individual villages in Aitape in 1940 and Buka in 1928. The model population has a crude birth and death rates of 40 and 41 per 1,000 and expectation of life of 24.7 years. The resemblance is the best that could be found as the Papua New Guinea populations were subject to irregular epidemics and not stable.

Of further interest is the significant adult mortality in the 1931, 1941 and 1948 influenza outbreaks, with 35 to 43% of deaths in those aged 20-49 years. Figure 4 shows the age specific mortality rates up to double the expected in the peak years of 1931 and 1941, and related to the nature of the epidemic. The importance of influenza-pneumonia in the adult years is evident. It appears that community immunity was slow to develop. Serological studies would further define influenza immunity experience.

The 1943-44 epidemic was not associated with any particular disease but appears to be related to the state of emergency in the country. Over this period young men were actively forced to war as either soldiers or

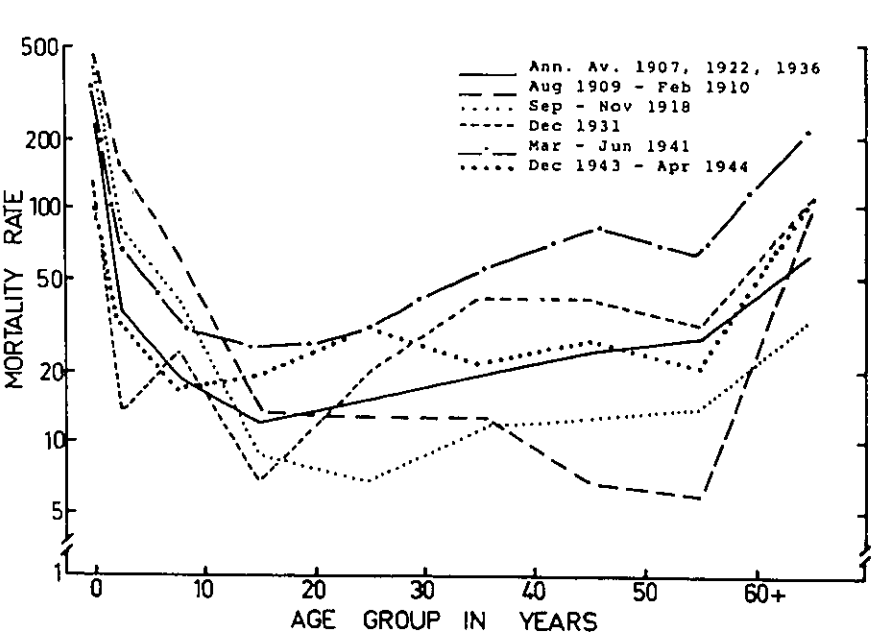

Figure 4. Mekeo/Yule Island age specific mortality rates per 1,000 for certain epidemic periods within epidemic years compared with non- epidemic years. Causes of epidemics shown in Figure 3.

carriers, and the peaking of the mortality in the young adult years is inconsistent with that found in any other of the epidemics or normal mortality years.

Fuyuge

The epidemic pattern in Fuyuge was presented in a previous paper (Scragg, 5). In this area, population (Fig. 5) was static; the non-epidemic background mortality rate (Fig. 6) is about 2%, with epidemics producing excess mortality of up to 8.5% (1939-40 influenza epidemic). The age specific mortality in these epidemic years is shown in Table 4. The massive increase in age specific mortality in all age groups in 1939-40 indicates a different community immunity pattern to Mekeo in 1941 where, what was presumably the same influenza virus had its main effect in persons aged 0-1 and 30-49 years. Of note is the fact that both epidemic and non-epidemic years show high proportions of deaths in infants and the aged. This relates in part to the effects of the cooler average temperatures at 3,000 meters and higher and the greater susceptibility to chest infections under these conditions.

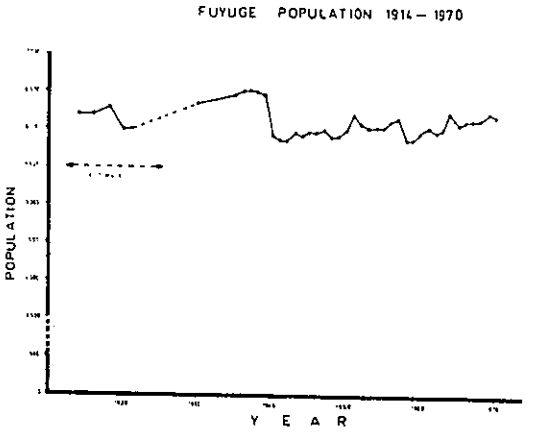

Figure 5. Fuyuge population from Church records begun in 1907.

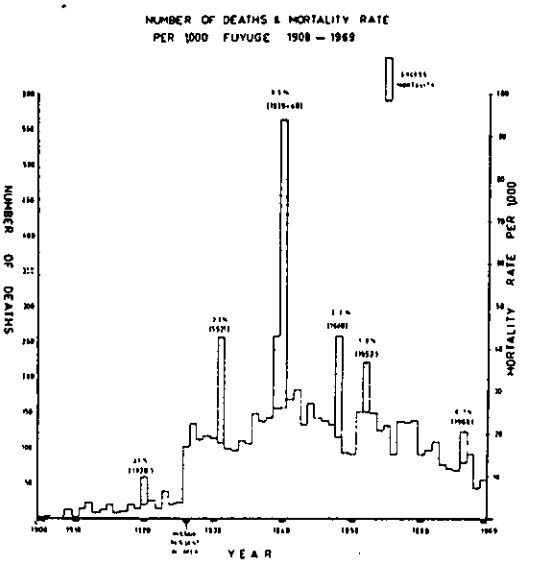

Figure 6. Fuyuge Mortality, epidemic years and excess mortality.

The 1939-40 epidemic preceded that in Mekeo, and even though it appears to have been part of the same epidemic, the story told locally is that it stopped at a river on the border between the Mekeo and Fuyuge. It may have done so and entered the area by a fresh epidemic spreading from Port Moresby along the coast. Also of interest is the absence of any peak in the wartime years. There was no recruiting of labour in the Fuyuge, and these people isolated in their mountain valley would have only seen the aircraft and not participated in the fighting, nor would the women and children have suffered due to the absence of adult men at the front. In Fuyuge we again have a reduction of mortality in the years after 1950, but it is not as immediate, indicating the difficulty in establishing outposts and providing medicines to these isolated mountain people.

At this point it is important to reflect on the state of the health of these people and those of the Mekeo at the time of Clements' visit. Severe epidemics with high mortality had been occurring every few years, and in the Mekeo and Fuyuge the 1931 epidemic

was a notable event with a 2.5% and 2.8% excess mortality respectively.

It was clearly evident that the missionaries and government personnel only knew of deaths that the people wanted them to know on the one hand, and that on the other hand people in the villages did not consider it abnormal to have their death rate doubled in any one year. They did not, however, accept the excess mortality of 1940-41. They themselves and the missionaries vividly recall the extent of this disease.

It is also relevant that a recent Papua New Guinea epidemic (1969) had an excess mortality varying from 5 to 30 per thousand, only a small fraction of that experienced during the 1940-41 epidemic.

Aitape

In Aitape, studies have been made of two village groups totalling 1100 persons prior to 1940. Table 5 and Fig. 7 show a comparison of births and deaths, and birth and death rates, for these people. The mean birth rate was 4.3%, the mean death rate 4.2% which shows clearly the state of affairs in Papua New Guinea in coastal areas from 1917 to 1939. In this area wartime records were lost, but a priest recorded 100 deaths among the 400 people of Paup from 1943 to 1945. In 1918 and 1919, mortality reached 5%. These, in comparison with previous years, would hardly rate as epidemics, but epidemics did occur elsewhere in those years.

In 1924, 1925 and 1936, mortality in epidemics exceeded 5%. The records do not go as far as the 1941 epidemic and the 1931 epidemic is shown by a low peak 4.6%. It is clearly not possible to relate the Aitape epidemics with those on the south coast. At this time air movement was minimal and all diseases entering the country would have come by sea. Also of interest in Fig. 7 is the balancing of mortality, with each epidemic year followed by a year in which the mortality is about 2%. Any persons with poor health in the society, either adults or children, suffered in an epidemic and the year following was usually one of reasonably low mortality.

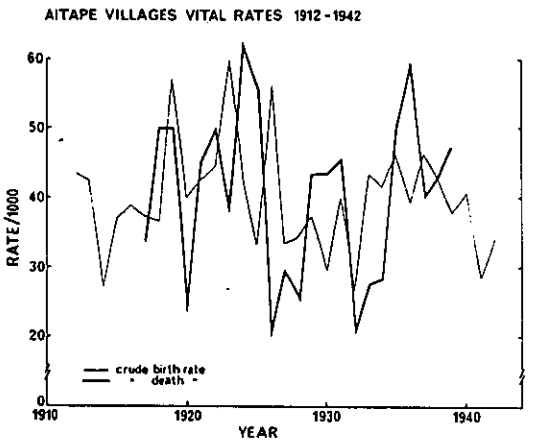

Figure 7. Aitape birth and death rate from Church records. The extreme variation relates to the small number at risk.

Buka

Buka has been included because the area was occupied for several years by the Japanese invaders and there was a direct effect from the war. Fig. 8 shows the death

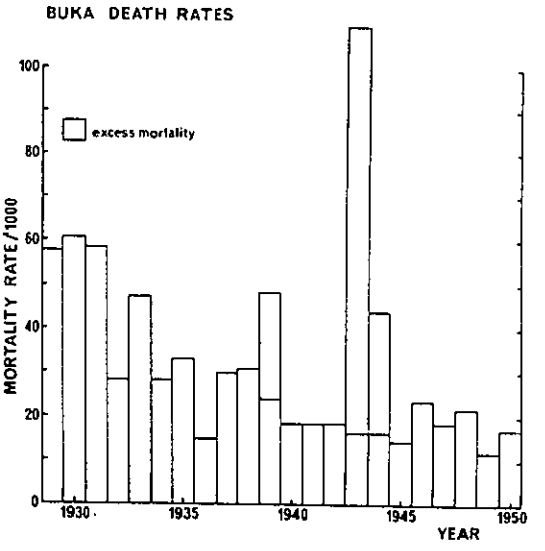

Figure 8. Buka death rates from Church records showing excess mortality.

rate from 1929 to 1968. Relating it to the other records, there was an epidemic in 1939 but the main peak is that from 1943 and 1944. In 1943 there was an excess mortality of 9.5% and in the following year, 2.8%. This was a direct effect of the war. There were few epidemics in the years following the war and this indicates in a way the quality and availability of medical care provided in the areas where war had its greatest effect.

Crisis Years

Schofield (1972) in recent papers had used the word "crisis" as an historian's description of an epidemic. The mortality in Papua New Guinea was at all times high by current standards. In Fuyuge, the mountain people were protected from malaria and could be expected to have a lower mortality through this, but it would hardly be as low as 2%. Bick (1969) has reported on mortality in mountain areas where both malaria and epidemics were present, with deaths exceeding births in all years. The high levels of mortality in the years after contact gives us no indication of what mortality may have been prior to contact. The epidemics of influenza and whooping cough might not have occurred and these appear to have been the main killing diseases. Malaria was endemic. Inter-tribal fighting was present and the limited studies of Barth (1971) indicate the importance of fighting, bowel and chest diseases in pre-contact mortality. It appears that mortality would not have been less than that in the contact years. In the absence of epidemics, births could have exceeded deaths in most years even though the average excess of births might have been very small.

Population Change

Fig. 9 compares the population change in Fuyuge and Buka as well as three other areas in New Ireland and Bougainville where population has been counted for some time. Of significance there was an early decline in population in all areas except Mekeo (seen in Fig. 2). This decline in New Ireland is linked with the introduction of gonorrhoea along with the other epidemic and endemic diseases (Scragg, 1957); however, the popualtion decline in Buka occurred even though gonorrhoea was not present. From the scanty records presented here it appears that the population throughout the country started to decline with contact. Early 20th century concern over decline in population was related only to areas where people could be precisely counted - islands of limited size and villages along precise road links or narrow islands. Other areas were assumed to be static or increasing in numbers. If a deficit was noticed, then it was considered not significant because people were thought to have migrated out of the area into villages not being counted.

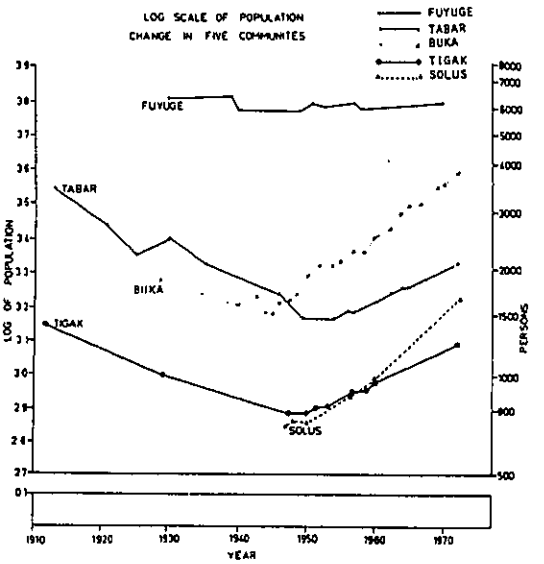

Figure 9. Long-term variation in the population of five communities from Church and personal records.

If the population was declining, how many were there in Papua New Guinea prior to contact? There is no adequate information from studies completed to date, but it does appear that the population in 1970 could have equalled that in 1870 and that over the years from contact it fell in all areas and started to increase in most areas soon after the end of the 1942-45 war. This war caused a decline in all areas as shown by the shortage of people in the age cohort for that year in both the 1966 and

1971 census. The rate of increase since the war has been phenomenal in many areas with population doubling in at least one area in 17 years. (Ring, et. al. 1973).

ROY SCRAGG, M.D.

Professor,
Social and Preventive Medicine,
Univ. P.N.G.
Present Address -
6 Victoria Avenue,
UNLEY PARK. 5061. South Australia

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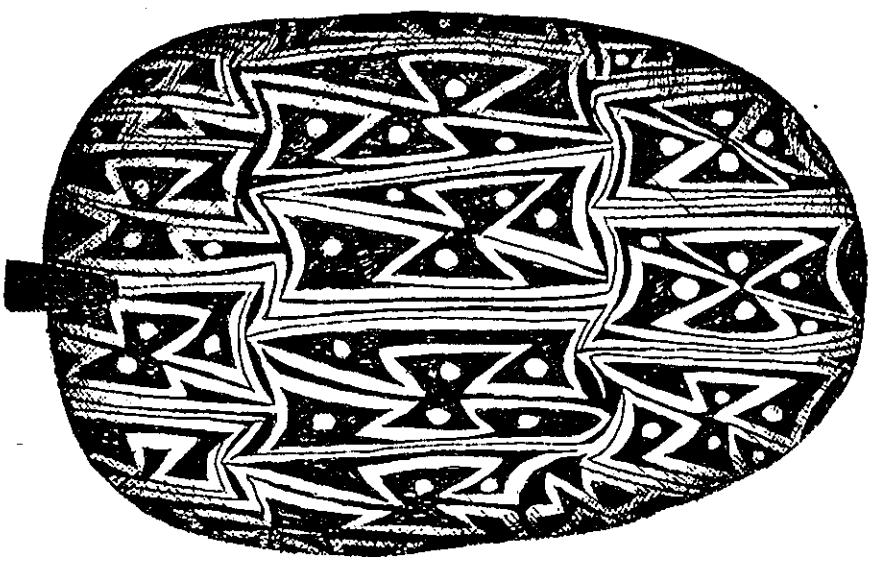

Lemankoa from the sea

Village rest house Lemankoa

Mon and crew ready to leave for Gagan and Sohano

1948 roads were made for bicycles only

Traditional village house

Replacement house 1948 for living and sleeping

Raised house as required by kiaps in 1948
but seldom used at that time

Bomber wreck on the reef between Lemankoa
and Lontis

PERIOD 1.7.27 to 30.6.42

ABRIDGED LIFE TABLE

MALES

AGE(X)	l(X)	1000 q(X)	d(X)	L(X)	P(X)	T(X)	E(X)	AGE()
0	100000.0	259.84	25984.	82350.	0.672908*	2184930.	21.849	0
1	74015.7	217.05	16055.	253604.	0.824786**	2102080.	28.400	1
5	57950.9	84.57	4901.	277503.	0.929683	1848476.	31.897	5
10	53050.2	54.75	2904.	257990.	0.947319	1570973.	29.613	10
15	50145.7	50.49	2532.	244399.	0.904503	1312984.	26.183	15
20	47613.7	142.82	6804.	221059.	0.852043	1068585.	22.443	20
25	40810.0	153.86	6279.	188352.	0.882110	847526.	20.768	25
30	34530.8	75.38	2603.	166147.	0.901608	659174.	19.089	30
35	31928.0	123.36	3936.	149300.	0.784838	493027.	15.442	35
40	27991.8	139.56	3956.	117568.	0.715030	343227.	12.262	40
45	24035.6	230.52	4445.	84065.	0.710814	225659.	11.855	45
50	19590.4	391.81	5279.	59755.	0.618412	141594.	9.705	50
55	12311.4	412.57	3842.	36953.	0.740100	81839.	8.789	55
60	8469.8	0.00	0.	27349.	0.556377	44886.	8.206	60
65	8469.8	827.25	4853.	15215.	0.132353***	17537.	3.206	65
70	3616.7	1000.00	3617.	2321.	0.000000	2321.	3.764	70

*P(BIRTH), **P(0-4), ***T(70)/T(65)

PERIOD 1.7.27 to 30.6.42

ABRIDGED LIFE TABLE

FEMALES

AGE(X)	l(X)	1000 q(X)	D(X)	L(X)	P(X)	T(X)	E(X)	AGE(
0	100000.0	157.89	15789.	89579.	0.729731*	2430762.	24.308	0
1	84210.5	276.37	23290.	275286.	0.788813**	2341183.	27.802	1
5	60920.5	110.25	6717.	287311.	0.909628	2065897.	33.911	5
10	54203.8	68.03	3687.	261801.	0.939441	1778086.	32.804	10
15	50516.4	52.54	2654.	245946.	0.963850	1516285.	30.016	15
20	47862.1	18.85	902.	237055.	0.960711	1270339.	26.542	20
25	46960.1	60.12	2823.	227742.	0.911906	1033284.	22.003	25
30	44136.6	117.85	5202.	207679.	0.830233	805542.	18.251	30
35	38955.8	228.62	8901.	172422.	0.798367	597863.	15.355	35
40	30033.8	166.85	5005.	137656.	0.748307	425441.	14.165	40
45	25028.6	353.74	8854.	103009.	0.685532	287786.	11.498	45
50	16175.0	253.70	4104.	70616.	0.674222	184777.	11.424	50
55	12071.4	422.36	5098.	47611.	0.643701	114161.	9.457	55
60	6972.9	241.24	1637.	30647.	0.718352	66550.	9.544	60
65	5335.9	334.03	1766.	22015.	0.386807***	35903.	6.792	65
70	3520.0	1000.00	3520.	13887.	0.000000	13887.	3.945	70

*P(BIRTH), **P(0-4), ***T(70)/T(65)

PERIOD 1.7.27 to 30.6.42

ABRIDGED LIFE TABLE

TOTAL

AGE(X)	l(X)	1000 q(X)	d(X)	L(X)	P(X)	T(X)	E(X)	AGE(
0	100000.0	207.69	20769.	86292.	0.702249*	2299721.	22.997	0
1	79230.8	248.75	19709.	264932.	0.806663**	2213429.	27.936	1
5	59521.7	96.57	5748.	283239.	0.921229	1948597.	32.738	5
10	53773.9	59.07	3177.	250928.	0.944722	1665358.	30.970	10
15	50597.2	51.24	2593.	246504.	0.927505	1404431.	27.757	15
20	48004.5	94.90	4555.	228634.	0.898887	1157926.	24.121	20
25	43449.1	107.98	4692.	205516.	0.895397	929292.	21.388	25
30	38757.4	100.81	3907.	184019.	0.859412	723776.	18.675	30
35	34850.1	124.82	6441.	158148.	0.793066	539758.	15.488	35
40	28409.0	234.06	6649.	125422.	0.737393	381610.	13.433	40
45	21759.6	299.88	6525.	92485.	0.697980	256188.	11.774	45
50	15234.4	305.08	4648.	64553.	0.648400	163703.	10.746	50
55	10586.7	419.54	4431.	41356.	0.672236	99150.	9.366	55
60	6155.7	171.64	1057.	28137.	0.681385	57794.	9.308	60
65	5099.1	496.04	2529.	19172.	0.342456***	29157.	5.718	65
70	2569.8	1000.00	2570.	9985.	0.000000	9985.	3.886	70

*P(BIRTH), **P(0-4), ***T(70)/T(65)

PERIOD 1.7.42 to 30.6.47

ABRIDGED LIFE TABLE

MALES

AGE(X)	l(X)	1000 q(X)	D(X)	L(X)	P(X)	T(X)	E(X)	AGE(X)
0	100000.0	272.73	27273.	32000.	0.599786*	1506028.	15.060	0
1	72727.3	379.85	27626.	217893.	0.706496**	1424028.	19.580	1
5	45101.1	120.90	5453.	211873.	0.871332	1206135.	26.743	5
10	39648.2	137.50	5452.	184612.	0.879488	994262.	25.077	10
15	34196.6	100.31	3448.	162364.	0.905085	809650.	23.676	15
20	30749.1	88.35	2717.	146955.	0.884147	647286.	21.051	20
25	28032.3	146.02	4093.	129229.	0.841496	500333.	17.848	25
30	23939.1	173.13	4144.	109334.	0.905234	370404.	15.473	30
35	19794.6	0.00	0.	98073.	0.701228	261070.	13.189	35
40	19794.6	597.54	11828.	69403.	0.573930	162997.	8.189	40
45	7966.4	0.00	0.	39832.	0.701228	92695.	11.636	45
50	7966.4	597.54	4760.	27931.	0.428106	52863.	6.636	50
55	3206.1	508.16	1629.	11953.	0.445812	24931.	7.776	55
60	1576.9	647.77	1021.	5331.	0.520958	12973.	8.227	60
65	555.4	0.00	0.	2777.	1.000000	7643.	13.760	65
70	555.4	0.00	0.	2777.	0.429205***	4865.	8.760	70
75	555.4	1000.00	555.	2088.	0.000000	2088.	3.760	75

*P(BIRTH), **P(0-4), ***T(70)/T(65)

PERIOD 1.7.42 to 30.6.47

ABRIDGED LIFE TABLE

FEMALES

E(X)	1(X)	1000 Q(X)	D(X)	L(X)	P(X)	T(X)	E(X)	AGE(X
0	100000.0	142.86	14286.	90571.	0.741265*	2170484.	21.705	0
1	85714.3	277.19	23759.	330061.	0.796992**	2079913.	24.266	1
5	61955.0	92.86	5753.	295391.	0.885905	1799851.	29.051	5
10	56201.6	137.50	7728.	261689.	0.874835	1504460.	26.769	10
15	48473.8	110.86	5374.	228934.	0.875085	1242771.	25.638	15
20	43099.9	140.72	6065.	200557.	0.808313	1013837.	23.523	20
25	37034.9	250.99	9295.	161936.	0.815589	813500.	21.966	25
30	27739.5	95.52	2650.	132075.	0.889891	651564.	23.489	30
35	25089.8	106.24	3167.	117533.	0.891967	519491.	20.705	35
40	21922.5	87.20	1912.	104653.	0.851723	401960.	18.336	40
45	20010.9	215.19	4306.	89289.	0.821363	297127.	14.848	45
50	15704.8	132.06	2074.	73339.	0.847444	207838.	13.234	50
55	13630.7	176.17	2401.	62151.	0.780878	134499.	9.867	55
60	11229.5	271.26	3046.	48832.	0.453308	72348.	6.443	60
65	8183.3	924.65	7567.	22000.	0.075089	23816.	2.910	65
70	616.6	928.43	573.	1652.	0.090567***	1816.	2.946	70
75	44.1	1000.00	44.	165.	0.000000	165.	3.728	75

*P(BIRTH), **P(0-4), ***$T(75)/T(70)$

PERIOD 1.7.42 to 30.6.47

ABRIDGED LIFE TABLE

E(X)	1(X)	1000 Q(X)	D(X)	L(X)	P(X)	T(X)	E(X)	AGE(X
				TOTAL				
0	100000.0	215.19	21519.	85797.	0.664514*	1818849.	18.183	0
1	78481.0	325.23	25526.	246459.	0.755046**	1733052.	22.082	1
5	52955.2	105.05	5563.	250869.	0.879626	1486592.	28.073	5
10	47392.5	137.50	6517.	220671.	0.877272	1235723.	26.074	10
15	40875.9	105.60	4317.	193583.	0.890547	1015052.	24.833	15
20	36558.4	113.76	4159.	172400.	0.852919	821464.	22.469	20
25	32400.4	134.63	4364.	147043.	0.833627	649064.	20.033	25
30	28041.7	143.92	4036.	122579.	0.891435	502021.	19.004	30
35	24005.7	97.27	2334.	109271.	0.617779	379442.	16.778	35
40	21671.3	305.47	6621.	89360.	0.755100	270171.	12.808	40
45	15050.6	157.70	2373.	67475.	0.740747	180811.	12.342	45
50	12677.9	379.83	4817.	49982.	0.645621	113336.	9.184	50
55	7860.6	313.35	2463.	32270.	0.616990	63354.	8.278	55
60	5397.4	434.45	2345.	19910.	0.427041	31084.	5.915	60
65	2709.1	744.63	2017.	8502.	0.247852	11174.	4.125	65
70	692.8	781.53	541.	2107.	0.211223***	2672.	3.362	70
75	151.1	1000.00	151.	564.	0.000000	564.	3.734	75

*P(BIRTH), **P(0-4), ***T(75)/T(70)

PERIOD 1.7.47 to 30.6.60

ABRIDGED LIFE TABLE

MALES

(X)	1(X)	1000 Q(X)	D(X)	L(X)	P(X)	T(X)	E(X)	AGE(X)
0	100000.0	148.35	14835.	90209.	0.838120*	4372303.	43.723	0
1	85164.8	52.46	4468.	328351.	0.952724**	4282094.	50.280	1
5	80697.1	21.00	1695.	399243.	0.989387	3953243.	48.989	5
0	79002.2	0.00	0.	395011.	0.973212	3553995.	44.986	10
5	79002.2	53.58	4233.	384429.	0.972475	3158984.	39.986	15
0	74769.6	0.00	0.	373848.	0.990012	2774554.	37.108	20
[illegible]	74769.6	19.98	1494.	370114.	0.971889	2400707.	32.108	25
[illegible]	73276.0	36.41	2668.	359710.	0.950975	2030593.	27.712	30
[illegible]	70607.9	62.12	4386.	342075.	0.954489	1670883.	23.664	35
[illegible]	66222.1	27.81	1841.	326507.	0.963957	1328808.	20.066	40
[illegible]	64380.7	44.52	2866.	314738.	0.869790	1002301.	15.568	45
[illegible]	61514.7	219.90	13577.	273756.	0.725100	687563.	11.177	50
[illegible]	47937.8	345.41	15575.	198501.	0.585184	413806.	8.623	55
[illegible]	31412.5	520.85	16361.	116160.	0.543122	215306.	6.854	60
	15051.3	323.37	4867.	63089.	0.481314	99146.	6.587	65
	10184.2	807.35	8222.	30366.	0.171923	36057.	3.541	70
	1962.0	935.67	1836.	5221.	0.082776***	5692.	2.901	75
	126.2	1000.00	126.	471.	0.000000	471.	3.733	80

*P(BIRTH), **P(0-4), ***T(80)/T(75)

PERIOD 1.7.47 to 30.6.60

ABRIDGED LIFE TABLE

FEMALES

E(X)	1(X)	1000 Q(X)	D(X)	L(X)	P(X)	T(X)	E(X)	AGE(X)
0	100000.0	122.30	12230.	91929.	0.829266*	4397186.	43.972	0
1	87769.8	122.32	10736.	322705.	0.918439**	4305257.	49.052	1
5	77034.2	22.62	1742.	380815.	0.975153	3982552.	51.699	5
10	75291.8	27.13	2042.	371353.	0.978907	3601737.	47.837	10
15	73249.3	14.89	1091.	363520.	0.974463	3230385.	44.101	15
20	72156.7	36.35	2623.	354237.	0.931491	2866865.	39.730	20
25	69536.0	0.00	0.	347680.	0.975143	2512628.	36.134	25
30	69536.0	49.71	3457.	339038.	0.931139	2164948.	31.134	30
35	66079.0	89.01	5882.	315591.	0.903607	1825910.	27.632	35
40	60197.4	104.50	6291.	285261.	0.944871	1510219.	25.088	40
45	53906.9	0.00	0.	269535.	0.964561	1224958.	22.724	45
50	53906.9	70.84	3819.	259988.	0.939359	955423.	17.724	50
55	50088.2	48.63	2436.	244352.	0.883853	695436.	13.884	55
60	47652.5	137.12	6517.	215971.	0.741906	451084.	9.466	60
65	33735.9	345.41	13330.	160230.	0.411505	235113.	6.070	65
70	25396.2	959.85	24338.	55976.	0.077196	74882.	2.953	70
75	1018.0	0.00	0.	5090.	0.431083***	8947.	8.789	75
80	1018.0	1000.00	1018.	3857.	0.000000	3857.	3.789	80

*P(BIRTH), **P(0-4), ***T(80)/T(75)

PERIOD 1.7.47 to 30.6.60

ABRIDGED LIFE TABLE

E(X)	1(X)	1000 Q(X)	D(X)	L(X)	P(X)	T(X)	E(X)	AGE(X
				TOTAL				
0	100000.0	137.07	13707.	90953.	0.833603*	4465648.	44.656	0
1	86292.8	84.72	7311.	325849.	0.937156**	4374695.	50.696	1
5	78981.8	21.78	1720.	390608.	0.981896	4048846.	51.263	5
10	77261.5	14.34	1108.	383537.	0.976653	3658238.	47.349	10
15	76153.2	32.47	2473.	374582.	0.974189	3274701.	43.001	15
20	73679.8	18.92	1394.	364914.	0.985437	2900119.	39.361	20
25	72285.9	10.13	732.	359600.	0.974000	2535205.	35.072	25
30	71554.0	42.04	3008.	350250.	0.942731	2175605.	30.405	30
35	68546.1	73.17	5016.	330192.	0.932270	1825354.	26.630	35
40	63530.6	61.86	3930.	307829.	0.957991	1495163.	23.535	40
45	59600.6	20.85	1243.	294897.	0.930364	1187334.	19.922	45
50	58358.0	119.45	6971.	274361.	0.872312	892438.	15.292	50
55	51386.5	137.03	7042.	239329.	0.789194	618077.	12.028	55
60	44345.0	296.30	13139.	188877.	0.685803	378748.	8.541	60
65	31205.8	339.62	10598.	129533.	0.429242	189871.	6.084	65
70	20607.5	920.76	18975.	55601.	0.078144	60338.	2.928	70
75	1632.9	935.67	1528.	4345.	0.082749***	4737.	2.901	75
80	105.0	1000.00	105.	392.	0.000000	392.	3.731	80

*P(BIRTH), **P(0-4), ***T(80)/T(75)

PERIOD 1.7.60 to 30.6.80

ABRIDGED LIFE TABLE

GE(X)	1(X)	1000 Q(X)	D(X)	L(X)	P(X)	T(X)	E(X)	AGE(X
				MALES				
0	100000.0	45.45	4545.	96272.	0.943483*	6475929.	64.759	0
1	95454.5	26.42	2522.	375470.	0.933290**	6379657.	66.835	1
5	92932.3	3.45	321.	463359.	0.996230	6004187.	64.608	5
10	92611.3	4.09	379.	462110.	0.990122	5540328.	59.823	10
15	92232.7	15.69	1447.	457546.	0.998566	5078218.	55.059	15
20	90735.5	7.11	645.	452314.	0.996433	4620673.	50.897	20
25	90140.1	0.00	0.	450700.	0.987794	4168359.	46.243	25
30	90140.1	24.41	2201.	445199.	0.980948	3717659.	41.243	30
35	87939.5	13.56	1192.	436717.	0.986551	3272460.	37.213	35
40	86747.3	13.34	1157.	430345.	0.951378	2835743.	32.690	40
45	85590.1	84.33	7222.	409995.	0.909765	2404899.	28.098	45
50	78367.9	96.63	7573.	372903.	0.927172	1995004.	25.457	50
55	70795.3	46.48	3291.	345750.	0.919257	1622096.	22.912	55
60	67504.7	116.63	7876.	317833.	0.874357	1276346.	18.908	60
65	59628.5	134.73	8034.	278058.	0.927771	958513.	16.075	65
70	51594.9	0.00	0.	257975.	0.838317	680455.	13.188	70
75	51594.9	323.37	16684.	216264.	0.438103***	422430.	8.188	75
80	34910.9	1000.00	34911.	206216.	0.000000	206216.	5.907	80

*P(BIRTH), **P(0-4), ***T(80)/T(75)

PERIOD 1.7.60 to 30.6.80

ABRIDGED LIFE TABLE

FEMALES

E(X)	l(X)	1000 q(X)	d(X)	L(X)	P(X)	T(X)	E(X)	AGE(X)
0	100000.0	42.13	4213.	96503.	0.953187*	7001086.	70.011	0
1	95786.5	12.71	1218.	380090.	0.992132**	6904583.	72.083	1
5	94568.7	0.00	0.	472844.	1.000000	6524493.	68.992	5
10	94568.7	0.00	0.	472844.	0.993660	6051649.	63.992	10
15	94568.7	12.63	1194.	469846.	0.993619	5578805.	58.992	15
20	93369.6	0.00	0.	466848.	1.000000	5108950.	54.718	20
25	93369.6	0.00	0.	466848.	1.000000	4642112.	49.718	25
30	93369.6	0.00	0.	466848.	0.976348	4175264.	44.718	30
35	93369.6	47.30	4417.	455300.	0.967901	3708416.	39.718	35
40	88952.7	16.14	1436.	441175.	0.971675	3252610.	36.566	40
45	87517.1	40.71	3563.	428678.	0.936897	2811436.	32.124	45
50	83954.3	86.45	7258.	401628.	0.954824	2382757.	28.382	50
55	76696.2	0.00	0.	333484.	0.938053	1981130.	25.831	55
60	76696.2	122.89	9502.	359723.	0.918732	1597646.	20.831	60
65	67194.5	32.61	2191.	330494.	0.927359	1237918.	18.423	65
70	65003.1	114.02	7412.	306486.	0.870698	907424.	13.960	70
75	57591.5	146.55	8440.	266857.	0.555932***	600937.	10.434	75
80	49151.4	1000.00	49151.	334080.	0.000000	334080.	6.797	80

*P(BIRTH), **P(0-4), ***T(80)/T(75)

PERIOD 1.7.60 to 30.6.80

ABRIDGED LIFE TABLE

TOTAL

E(X)	1(X)	1000 Q(X)	D(X)	L(X)	P(X)	T(X)	E(X)	AGE(X)
0	100000.0	43.84	4384.	96384.	0.948164*	6734380.	67.344	0
1	95616.4	19.04	1797.	377695.	0.987555**	6637997.	69.423	1
5	93719.4	1.77	166.	468182.	0.998040	6260299.	66.798	5
10	93553.3	2.15	201.	467264.	0.991767	5792117.	61.913	10
15	93352.3	14.33	1338.	463417.	0.990375	5324853.	57.040	15
20	92014.5	3.84	354.	459183.	0.998074	4861436.	52.833	20
25	91660.9	0.00	0.	458304.	0.994306	4402247.	48.028	25
30	91660.9	11.39	1044.	455695.	0.978573	3943943.	43.023	30
35	90617.0	21.33	1933.	449930.	0.976769	3488248.	38.494	35
40	87755.1	14.61	1282.	435571.	0.959613	3042318.	34.668	40
45	86473.8	36.54	3158.	417982.	0.920907	2606747.	30.145	45
50	80719.4	92.54	7470.	384923.	0.938579	2188765.	27.116	50
55	73249.5	27.13	1987.	361280.	0.926732	1803843.	24.626	55
60	71262.4	120.69	8601.	324810.	0.904926	1442563.	20.243	60
65	62661.4	55.94	4132.	302977.	0.922793	1107754.	17.678	65
70	58529.7	89.27	5225.	279586.	0.867309	804776.	13.750	70
75	53304.6	179.32	9558.	244427.	0.538020***	525190.	9.853	75
80	43746.2	1000.00	43746.	282563.	0.000000	282563.	6.459	80

*P(BIRTH), **P(0-4), ***T(80)/T(75)