

# **Disaster and Demography**

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This unpublished paper reviews the demographic history of Tobi Island up to 1968.

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Most students of atoll life seem to divide the demographic history of atolls into two parts, the aboriginal and the post contact. This is not surprising since a glance at the statistics available for any atoll invariably shows a sharp decline in population in the early contact period which may or may not be offset by a later period of recovery. An assumption which is common in most of the literature on atolls is that prior to contact the atolls had managed to achieve a demographic balance at a relatively high density, and that the west disrupted that balance. This paper is being written partly to show that the assumption, at least for isolated atolls, may be false, and that most precontact populations probably did not reach a balance of births and deaths at a high density. It will be argued that certain phenomena to which atolls are subject make for a fluctuation in the amount of resources available to their inhabitants and that it is more plausible to argue that prior to contact any balance reached at a high population density was

at best precarious. Among these phenomena are typhoons, tidal waves, and drought.

### **Acts of God and Man**

It is difficult to imagine the destructive power of a full-fledged typhoon. Several hours of winds in excess of 200 knots, lashing rains, and inundating waves can combine to devastate an atoll totally, denuding it of almost all flora and fauna, of its soil, of all but the sturdiest structures, and in extreme cases covering it over with a layer of gravel debris from the reef and beach. Even winds of “only” 70 knots can cause great damage, uprooting trees, demolishing buildings, flooding taro pits with salt water.<sup>1</sup>

The effects of “tidal waves” (a misnamed phenomena since they are swells associated with earthquakes—a better term is the Japanese word tsunami) are similar to those of a typhoon, and like typhoons they may vary in the damage they do.

Both tsunami and typhoons are particularly destructive because of the small size and low elevation of atolls. Porous soils, another common feature of the low islands, make them vulnerable to drought.

The life cycle of which atoll man is a part could not exist without fresh water. Since the soils are porous there is little or no surface water. The fresh water which is absolutely necessary for the existence of all but the most primitive vegetation is held under the surface in what is known as a Ghyben-Herzberg lens. This lens is a double convex shaped body of soil saturated with fresh water “floating” on a base of salt-water-saturated soil and rock.<sup>2</sup> The lens is maintained

by rainfall. Thus a decrease or cessation in precipitation will reduce the amount of fresh water available to the plants on the island.

The fresh water lens is vulnerable not only to drought but also to the action of man. Any tampering with the lens may lead to penetration of the bottom layer and the mixing of the saline base with the fresh water. If this occurs on a large enough scale it will lead to the destruction of the lens.

As Barrau points out (1965) the cultivation of the plant *Cyrtosperma chamissonis*, or “wet taro,” on atolls commonly involves the recreation by man of the Southeast Asian swamps where the plant was originally domesticated. This is done by the excavation of large pits down through the upper level of the fresh water lens. Similarly well digging also involves the penetration of the upper layer of the lens. It seems reasonable to suggest that both techniques could lead to the disruption of the lens and the “death” of the island.

Another common practice on atolls is the replanting of large areas with coconut trees. The value of the coconut tree to atoll dwellers in providing food, utensils, and shelter is well known.<sup>3</sup> It is less well known that the coconut may have long term deleterious effects on soil fertility through depletion of potash and other nutrients if it is overplanted (Wiens 1962:456). A decrease in the fertility of already infertile soils would obviously have the effect of decreasing the ability of the ecosystem to support life.<sup>4</sup>

All the above factors—typhoons, tsunami, drought, and the impact of man result in a decrease in the resources available for man’s utilization. The hypothesis I wish to put forward is that such a decrease will be accompanied by

negative trends in human demography. In extreme cases the typhoons and tsunami can act directly on the demography of an atoll by killing large numbers of people. The following passage from Wiens (1962:476) speaks for itself.

June 30, 1905 (typhoon) center passed through Jaluit and Mili atolls (in the Marshalls) and affected many other atolls; barometer fell to 27.6 inches and storm waves rose to 46 feet at Mili, where entire southern islands were inundated. Knox islands adjoining southern Mili were completely washed away—in their place only a sand bank with a few tree trunks remaining. Only 2 of the 70 inhabitants survived after being washed to Mili on a breadfruit tree. Arno was equally hard hit with a loss of 8 lives; three-fourths of the land in the southeast was swept away by waves reported to reach to the tops of coconut palms. At Majuro two stretches totaling three miles of narrow land were swept away. Three women lost their lives here. At Jaluit an enormous sea wave swept across much of the land but fortunately occurred during low-tide stage; the eastern islands were almost entirely swept away and 73 people lost their lives.

More typical was typhoon Lola which struck Pingelap atoll in 1957. Wiens gives the following quotation from a 1957 report by the United States Trust Territory.

The large taro field was inundated. What taro was not immediately dug up and dried was unfit for consumption. The soil in the field would require 6 months of normal rainfall to be washed free of salts. All bearing breadfruit trees were badly damaged or blown down, while pandanus and banana trees were badly affected. About 30% of the coconut palms were blown down and otherwise badly damaged, and survivors had their crowns badly mauled. About 25% of homes and canoes were destroyed or damaged. (Wiens 1962:476)

It is obvious from the Pingelap data that although the typhoon did not kill anyone, it did reduce by a considerable amount the coconuts, breadfruit, pandanus, banana, and taro available to the people. A similar reduction would be brought about by the other disasters mentioned above; destruction of the fresh water lens, drought<sup>5</sup>, and tsunami.<sup>6</sup>

A significant reduction in the amount of food available would have a negative impact on the population of the island. If the pre-disaster trend was one of growth, it would be leveled off or reversed and if the trend was already downward it would be accelerated. Other variables besides the pre-disaster demographic trends would be the density of population in relation to available foods, and the severity of the disaster.

### **Depopulation**

During the course of a rather extensive review of the literature related to depopulation, it became apparent that there was no single satisfactory theory of population decline capable of dealing with the phenomenon in a general manner. There are many explanations put forward for the decline of particular populations, most of these deal with the fate of primitive peoples overwhelmed by the west. One of the few coherent theories dealing with post contact population collapse and certainly the most influential is found in G.H.L. Pitt-Rivers' **Clash of Cultures and Contact of Races** first published in 1927. I was unable to obtain a copy of this book. The discussion which follows is drawn from Robert Maher's **New Men of Papua** (Maher 1961). Apparently Pitt-Rivers draws upon the work of W.H.R. Rivers to formulate a general theory of depopulation. According to Maher, Rivers' basic postulate was that cultures were functionally integrated, so that a change in one aspect would have had an impact on the rest of the culture. Since culture was fundamentally man's way of adapting himself to his environment, it was also connected intricately with his ability to survive. Thus the destruction of one aspect of native culture could have resulted in depopulation.<sup>7</sup>

Rivers theorized that the suppression of those institutions that focused many of a society's values would lead first to a devaluation of life activities then to a devaluation of life itself and a consequent decline in population. Pitt-Rivers adds to this theory his belief that specific psycho-biological reasons can be found for the decline. He states that there is a connection between the apathetic behavior,<sup>8</sup> believed to be typical of people in the throes of demographic collapse, and their infertility. He suggests that the connecting link may be emotional disturbance manifested both in behavior and in physiology.

The Pitt-Rivers theory is still empirically unconfirmed, but it has enjoyed some popularity.<sup>9</sup> Many writers on atoll depopulation are willing to concede that it is worthy of consideration; both Lessa (1955:174 and 1962:250) and Lambert (1934:1-18) denied its applicability to their studies, while Beaglehole (1957:47) is willing to accept it. The use to which Pitt-Rivers' theory has been put is varied and as Peterson says, "post hoc ergo propter hoc' has seldom been applied so freely to any problem" (1961:334). It would appear to be of limited value in understanding the demographic processes of isolated atolls. Since none of the atolls reviewed (with the possible exception of the Tuamotus (Danielson 1955)) fit the condition necessary for Pitt-Rivers' model—namely having undergone the suppression of an institution or cultural trait on which the society's values had focused. It is possible of course, to imagine a situation in which a typhoon etc. would make the continuance of a particular institution impossible and thus lead to a devaluation of life and the subsequent decline of population.

Raymond Firth, working with the demographer Borrie and the statistician Spillus (Borrie 1957) noted a decline in the population of Tikopia following a typhoon in 1952; the decline was brought about by a combination of disease, increased infant mortality (probably deliberate) and canoe voyages by the men (which may be classified as either suicidal or ill planned depending on the position of the reader regarding the intricate and controversial question of Polynesian navigation). Working from these data Mary Douglas (1969) has put forward the idea that the homeostatic mechanism causing the decrease was the lack of a culturally (rather than biologically) defined valuable. In the Tikopia case the trigger that caused a depression in the population curve was not a total scarcity of food but the lack of “coconut cream” attributed to the typhoon. This condiment was defined by the culture as necessary to make food taste good enough to be consumed in the feasts which were vital to the integration of Tikopia society. The people perceived their situation as being one of starvation, and took what they conceived as appropriate action. In fact, there was no biologically compelling reason to do this, since the total food shortage was not acute. Douglas’ formulation is reminiscent of the Pitt-Rivers hypothesis, in that they both postulate a close connection between the socio-cultural arrangements of people and their demographic trends. Both suggest that a decline in a socio-cultural variable may cause a corresponding decline in population. The difficulty with Pitt-Rivers’ hypothesis has been his concept of the expression of a particular emotional state in both behavior and in fertility. Research has shown that populations of rats, rabbits, and white tailed deer exhibit common symptoms at

abnormally high population densities.<sup>10</sup> This behavior (which we might label pathological) has been explained as resulting from the effect of stress on the endocrine system, particularly the pituitary and adrenal glands. Wynne-Edwards (1965) specifies the stress as social in origin. His study deals with birds and he believes that an increase in the number of interactions related to “social rivalry” in a high density population leads to the adrenal stress syndrome<sup>11</sup> and pathological behavior. The symptoms range from apathy to hyper-sexuality to specific diseases such as arteriosclerosis.<sup>12</sup> I do not claim that a direct application of the results of laboratory experiments on rats and other creatures to a human population is either legitimate or fruitful in every case. The point is that the combined weight of the evidence reviewed in the preceding paragraph is relevant to a discussion of Pitt-Rivers’ theory of a correlation between an emotional state and reproduction in humans. At worst this combined evidence precludes the possibility of rejecting that theory out of hand.

There are many other reasons which have been given for population decline, some of which are more pertinent to atoll demographic processes than others. The remainder of this section will confine itself to a discussion of three of these which seem especially probable as causes of atoll demographic decrease prior to European contact. These are conscious cultural mechanisms of population control, starvation, and disease.

**Conscious cultural mechanisms of population control.** The question of whether isolated atoll populations limited their size by manipulation of birth or death rates is, of course, an empirical one.<sup>13</sup> With the data available it is only



possible to mention some of the factors which must be taken into consideration. The most significant of these factors is the possibility of extremely severe typhoons or tsunamis. Since these disasters act directly on the birth-death ratio, a people who were practicing birth control would take longer to recover from such a disaster than people who were not. The birth limiting people would probably enjoy a distinct advantage if resources were severely limited in the immediate post disaster years when a limitation on the growth of the group would obviously be beneficial. An exception would be the case in which the group had fallen close to the minimum number of people necessary for its survival. In theory this minimum might be biological or sociological. Presumably the biological minimum would be a fetal male and his mother;<sup>14</sup> whether the sociological minimum is more elaborate is an open question.<sup>15</sup> Birth limitation at or close to a minimum figure is obviously dangerous.

A possible phenomenon (with implications for Mary Douglas' homeostasis mentioned above) is that the disaster could trigger temporary population control practices and that with the recovery of the atoll these practices would decrease in importance and frequency.

**Starvation.** The possibility that the atolls were subject to famine has been mentioned by Sahlins (1958), Lessa (1962), Danielson (1955), Sharp (1964), Mason (1968), Hainlane (1965), Cumpston (1923), Denning (1963), Wiens (1962), Wyon (1965), Burrows and Spiro (1953), Alkire (1965), and others. However there is little data on whether starvation was a major factor in controlling population growth on atolls.<sup>16</sup>

That typhoons and tsunami, drought, etc., can severely reduce the amount of food available has already been established. The question of famine involves the determination of the severity of the disaster and the existence of alternatives to coconut, breadfruit, and taro. For our purposes it is sufficient to point out that another possible consequence of disaster could be widespread starvation.

**Disease.** A common theme found in most of the literature on the subject of depopulation is that the diseases introduced by the west were uniquely devastating because of a lack of immunity in the aboriginal population. This certainly seems to have been the case; the evidence is quite strong. Apparently such diseases as measles, chicken pox, and even the common cold are deadly to a population which has not built up some immunity to them. An argument could be made, however, that for some islands at least, this phenomena was not limited solely to contact with the west, but that the intrusion of any outsider could cause a similar epidemic. After all, Melanesia, the Philippines, and Indonesia were close enough to the western islands of Polynesia and Micronesia so that diseases could have spread eastward through the islands. At any rate, the Europeans had been visiting the islands at least since Magellan's voyage in the 16<sup>th</sup> century and it is possible to imagine a chain reaction to diseases introduced by them which would start with the typical decline of a people following contact with European visitors, a gradual build up of immunity, and a slow transmission of the diseases throughout the area by means of the type of voyage mentioned in Sharp (1964) and Golson (1963).<sup>17</sup>

The above discussion is intended as a justification for the addition of the word “disease” to the list of disasters inherent in the atoll situation. The list includes typhoons, tsunamis, drought, and disruption of the fresh water lens. It has been maintained that all of these factors result in a decline in population although it is not possible in most cases to determine the specific mechanism involved, that is whether the disaster acts directly on the population by causing starvation, or indirectly by some sort of feedback mechanism.

At this point we shall turn our attention to a concrete example in the island of Tobi. This has two functions; on the one hand, the demographic data available over time from Tobi tends to support the hypothesis that population fluctuations is a constant phenomenon on isolated atolls. These data and supporting arguments are found in Appendix A. On the other hand, the consideration of a specific case, with real people invites certain questions about the kinds of social structure which might be found among peoples whose population is subject to the type of fluctuation discussed in the preceding pages. It is my intention, after giving a brief introduction to the island to present the types of questions which the first section of the paper enables us to ask. The formulation of these questions will involve a certain degree of speculation.

### **Tobi Island**

Tobi Island, located in the extreme southwest of the United States Trust Territory of the Pacific Islands, is a small, low, isolated atoll.<sup>18</sup> Its area is only .228 square miles (Hainline 1965:1133), its highest elevation is only 12 feet, and it is 180 miles from the nearest inhabited island (which is a near-replica of Tobi),

and about 400 miles from the nearest population center—being equidistant from Mindanao and Palau. G.P. Murdock classifies Tobi with the three other southwest islands of Palau District as one of the 15 subareas of Micronesian culture because of the strong Papuan influence (Murdock 1953:216).<sup>19</sup> The language spoken on Tobi is, according to Capell (1969:1) one of the four dialects spoken in the southwest islands, which are more or less closely related to the language of the western Carolines. From my personal experience it is apparent that it is mutually intelligible with the language of at least some of the Caroline islands to the east. Tobi does not have a lagoon, the reef is contiguous with the island.<sup>20</sup>

Both “wet” and “dry” taro is grown, the former in pits in the interior of the island. Sweet potatoes are cultivated as are bananas, papayas, breadfruit, and, of course, coconuts. That the soil is infertile is graphically illustrated by the Tobi method of cultivating papaya, which is valued as food for old, toothless people. The method involves scraping the soil out of the root systems of the huge trees that drift up onto the beach from the Philippines and Indonesia and placing that soil in a loosely woven palm frond basket out in the open where the rains can wash it clean of salt since the people consider the water in the five wells on the island to be too saline for this purpose. After a month or so in the open, this “clean” soil is placed in a hole, and a papaya seed is planted in it. The Tobi people feel that this is the only way a papaya can be grown on their island.<sup>21</sup>

I am not prepared to give a detailed list of the structural components of Tobi society. The general outline seems to be very similar to that given by Alkire (1965:73) for Lamotrek:

The kinship and political organization . . . emphasizes a system of . . . matrilineal clans which can be divided into component subclans, lineages and descent lines each with particular rights to land . . . . Territorial ties—descent and homestead—are of equal importance in the regulation of political activities.”

This quotation has been edited to make it conform with what I believe to be the situation on Tobi. I have deleted Alkire’s references to ranked matrilineal clans since I am not aware of a ranking principle among the clans of Tobi.

At this point I feel it is wise to warn the reader that while I feel the concepts presented in the first portions of this paper do give rise to interesting questions and perhaps allow us some degree of speculative freedom, the following section is to be considered as only an approximation of the type of speculation which is possible because of those concepts and the data in the appendices.

### **Some Questions and Speculations About the Social Consequences of Population Fluctuation**

The first set of questions that arise relate to the type of inter-island system<sup>22</sup> described by Alkire (1965) and Lessa (1968). Following a consideration of the differential effects of disaster and population collapse on islands which are part of such a system and those which are not, I will examine the effects of population fluctuation on rules of land acquisition and utilization.

It is necessary at this point to distinguish between fluctuation of groups and fluctuation of total population. I shall refer to the former as micro fluctuation<sup>23</sup> and the latter as macro fluctuation.

**Inter-island systems.** Clearly membership in a larger system does not decrease the likelihood of an atoll being struck by the type of disaster discussed in the first papers of this paper. In fact it could be argued that being a member of a system increases its chance of being struck by certain disasters. Disease is one example that comes to mind. Since such atolls are in two-way contact with other islands, it would appear that the transmission of disease within the system will be faster than between atolls which are in only a sporadic, unplanned, one-way contact. Of course the possibility that the system as a whole will be struck by disease, typhoon, tsunami or drought is greater than the chances of an isolated island, only in as much as the system covers a greater geographic area and thus presents a bigger “target.”<sup>24</sup>

The adaptive advantage of the system seems to lie in its relative invulnerability, by virtue of internal variation<sup>25</sup> and size, to typhoons and disruption of the fresh water lens.<sup>26</sup> Alkire shows that the Lamotrek system is used as insurance against macro fluctuation caused by typhoons. The mechanism for dealing with the typhoon related depopulation of one of the islands in the system is similar to that used for compensating for micro fluctuation within any individual island and will be discussed in the following section. For the purposes of this section it is sufficient to say that in the same way that an island population as a whole can cushion the effects of micro fluctuation on resource

utilization and ownership, the inter-island system will cushion typhoon related decline in the population of one of its component islands. After a typhoon the survivors will get from the other islands material aid and also replacements for its dead. The question of the strength of the disaster becomes crucial.<sup>27</sup> If there are no resources left on the island after the typhoon then the remaining population, if any, will take refuge on the other islands (assuming they can get there).

However if the island is still habitable then: one, fewer people will die of starvation, and two, most of those that are killed by the typhoon or starve to death will be replaced by people from other islands. In a system containing five islands each with a population of 200 in which island "A" suddenly loses 50 people due to a typhoon and receives only 10 people from each of the other four islands as replacements, then all five islands will have a new population of 190. A near recovery to the pre-typhoon level has been effected for island "A." The time necessary for a similar recovery on an isolated island would be much longer since the population would only have biological means available for increasing its size.

However the possibility that an island's population will reach zero may also be greater in the system than on an isolated island. If disaster so damaged an island that its population was existing at a near starvation level then perhaps it would be abandoned even if it was still possible, by staying, to eke out an existence.<sup>28</sup>

The expectation is that with an increase in population or decrease in resources on the other islands of the system, the empty island will eventually be repopulated.

From a consideration of the above it would seem that a comparison of the chart of the Tobi population given in Appendix A with a chart drawn from diachronic population figures for an atoll which is a member of a Lamotrek type system would show the following:

- (a) A similar initial decline following a typhoon, but a much more rapid recovery.
- (b) Sudden small decline after typhoons on other islands in the system.
- (c) Perhaps period of no population at all.<sup>29</sup>

**Land rights.** (a) It is possible to imagine a state of complete demographic stability (defined by the absence of both micro and macro fluctuations). This state defines one end of a continuum. The other end is a situation of complete demographic instability in which both the size and relative strength of groups would change from moment to moment and in which the total size of the population would also change.

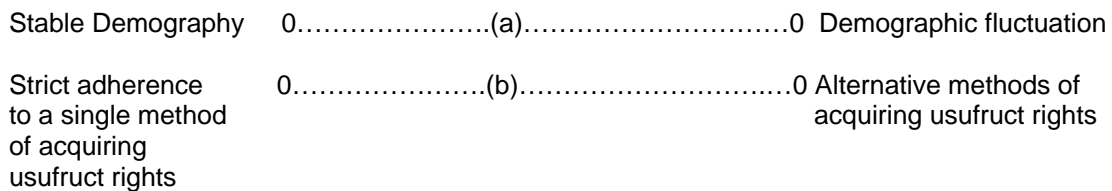
(b) It is also possible to imagine another continuum. It is defined at one end by complete conformity to a single method for the acquisition of usufruct rights so that each resource holder can have one, and only one, discretely defined replacement.<sup>30</sup> The other end of this continuum is defined by the use of many such methods<sup>31</sup> and thus the existence of alternative ways of replacing each resource holder.<sup>32</sup>

Stable demography by definition means both that the necessary people will be available for replacing the resource-holder, and that there will be no



surplus population to exert “illegitimate” pressure on those resources.

Demographic instability means that it is impossible to apply rigorously a single method for acquiring resources, since the “correct” replacement will not always be found and inequities in resource distribution become more severe. As demography becomes less and less stable, more and more alternative methods of obtaining rights are involved. If this is so, then it can be argued that the two continua co-occur as shown in the diagram below.



It could be also argued that stable demography is approximated by atoll populations in as much as they reach their maximum densities. Micro fluctuation is less significant during periods of maximum density. The extreme pressure on resources would probably bring about some method of limiting the growth of groups. This would cut the “normal” micro fluctuation by approximately one half. Macro fluctuation would only be downward, and would probably be brought about by the type of disasters discussed in this paper. Further any attempt to claim resources by “illegitimate” methods would be rebuffed since high density implies greater absolute size of groups and thus greater pressure on resources held by them.

Following a disaster however, in which groups suffer differential numerical decline and loss of usable resources, it can become necessary for survival to re-assign the rights to the resources that are left. The probability is that alternative methods of assigning those resources will become necessary. As Alkire says:

Western Caroline atoll populations are small (usually less than 500). Kinship and territorial distinctions subdivide the population into smaller component units which are liable to extinction through natural processes and disasters. A means of adjusting to the eventuality of losing significant structural units is necessary if the system (is to survive). This means that the matrilineal organization must be supplemented by alternative means of transferring land ownership . . . . On Lamotrek these alternatives are based on patrilineal and adoptive kin ties. . . ." (1965:73)

These alternative rules are also used between islands which are members of a system in the aftermath of a typhoon. The point here is that the chances of losing structural components are greater both immediately following a typhoon and during a period of low population than during a time when the population has peaked. Therefore the need to use alternative rules<sup>33</sup> is also greater at those times. During a period of low population even with a stable total population, "normal" micro fluctuations would ensure that resources would not be equally distributed between the groups. Even though there might be a surplus of resources on the macro level, some groups would not have enough of these resources, some resources would be more valuable, and of course, the groups themselves are more liable to extinction since the loss of one or two people has much greater impact on a group when its size is small than when it is large. For these reasons the use of alternative methods would be greater when populations were relatively small than during periods of high population.

An increase in total population will have the effects of reducing the amount of surplus resources available and thus the opportunity to use alternative rules. As pressure on the resources gets greater, groups will resist the encroachment of non-members who try to claim usufruct rights through the alternative rules.

The argument is that both the opportunity and the necessity for deviation away from a strict adherence to a single method of acquiring use of resources increases as a population moves away from a situation of high density. It can be related to the material covered in this paper by the following hypothesis:

On Tobi, as on Ifaluk and Lamotrek, deviation from strict matriliney in acquiring rights to land co-varies with demographic fluctuation. The greater the degree of demographic stability, the higher the degree of matriliney. Investigation should show that high density population on those islands adhere more closely to matriliney in the acquisition of rights to land than the same population in periods of decline or at a low level. It should also show that an increase in population will be accompanied by an increase in reliance on matriliney in acquiring land.

It is not my intention to pursue this hypothesis further.<sup>34</sup> I believe it serves its purpose if it shows some of the possibilities arising out of a consideration of long term demographic trends on atolls.

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<sup>1</sup> For a detailed account of typhoons, their origin, frequency, distribution, and effects see Wiens (1962:162-186); see also his appendix C, Records of Destructive Typhoon Effects, 174-8.

<sup>2</sup> More detailed accounts of the lens are available in Thomas (1965:26-27) and in Wiens op. cit. 318-326. See also Wiens (1963) for a discussion of rainfall as a crucial variable in the comparative fertility of atolls.

<sup>3</sup> Indeed Sahlins suggests that the existence of the coconut tree is the reason that atolls could support the high population densities which he believes were typical in pre-European times (1958:235).

<sup>4</sup> Wiens (1962:456) further points out that the removal of human waste from the ecosystem by the "flushing" action of the waves through the common practice of using the lagoon or beach below the high tide mark as a latrine can have a similar result.

<sup>5</sup> "What happened during a prolonged drought may be seen from the history of Ocean Island, where Webster recorded in 1850 a population of 2000 to 3000 whereas the scientist Finsch found 35 left in 1880, and those were half starved" Meade (1965:174).

<sup>6</sup> Of course a basic assumption underlying all this is that man cannot live by fish alone; in other words the existence of human life on atolls is dependent on the vegetable productivity of the atoll.

<sup>7</sup> Maher's book (1961) is an application of a reformulation of Rivers' theory to a group of Papuan tribes which have suffered depopulation following the imposition of western contact. His results can be regarded as only partial confirmation of Rivers' theory.

<sup>8</sup> The apathy noted by Pitt-Rivers is not uncommon in a population that is rapidly diminishing. The British anthropologist, A.B. Deacon, writing about the Malekula of the New Hebrides related the following incident.

Among these people there is a hopeless, fantastic apathy. I was asking for skulls the other week and received the ironic reply, "In a little while the white man will be able to take all of ours" (Deacon 1934).

Among others who have recorded this apathy are R. Firth, among the Maoris (1929:280), A.P. Elkin, among the Australian Aborigines (1953), and E.L. Piese, among the "Papauans" of New Guinea (1923). However this apathy is in no sense a universal phenomena. Both Schneider and Lessa, who studied depopulation in Yap and Ulithi Island, respectively, found no sign of it (Hunt Kidder and Schneider (1954) and Lessa (1955)).

<sup>9</sup> H.P. Murray, a high official in the administration of New Guinea justified the imposition of forced labor on the Papuans by claiming that if the natives lost interest in life they would die off and without something to live for (forced labor) they would lose interest. Murray (1923:238).

<sup>10</sup> See Calhoun (1962) for a graphic description of the pathological behavior of rats in a situation of abnormal density.

<sup>11</sup> Hoagland (1963:15) calls the syndrome "Han Seyle's Acute Adrenal Stress Syndrome" after the well known Austrian doctor currently doing research in this area at McGill University. This article is an excellent review of what might be called experimental demography.

<sup>12</sup> One symptom which may be involved in the syndrome is the inhibition of spermatogenesis. Wynne-Edwards (1963:1547).

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<sup>13</sup> The demographer Irene Taeuber finds what she considers good evidence for “widely held ramified fertility controls in Micronesia.” She lists marriage taboos, abortion, infanticide, and “reportedly” contraception (Taeuber and Han 1961:95). However she does not correlate this evidence with the different island types in Micronesia, so that it is impossible to tell to what extent these practices were ever typical of atolls. In a sense what we are doing here is modifying her statement that in precontact times among island people “the natural ecosystem was a limiting or stimulating but not determinative factor in the demographic processes of Micronesia.” (Taeuber 1965:248). I would argue that an exception to this statement has to be made for isolated atolls subject to sudden or long term decreases in ability to support man.

<sup>14</sup> An example of the genesis of a population from an initial group close to the biological minimum is given in Parsonson (1963:50):

A father and a young family, a son and three daughters, were caught in a gale in a small canoe and were swept away to Hereheretua in the Tuamotus, an unoccupied and infertile islet where for lack of suitable timber they were obliged to remain. As each child reached puberty the son took his sisters to wife and raised a family by them all.

<sup>15</sup> For some highly unsatisfactory thoughts on this matter see Livi (1949), Dahlberg (1948), and Levi-Strauss (1967:285).

<sup>16</sup> An interesting study has been made by Birdsell. He found that the population of Tristan da Cuñha, Pitcairn, and Cape Barren Islands followed an intrinsic rate of increase in which the population doubled in each generation. The rate continued essentially unchanged until the population reached a point at which the food resources of the environment exerted a marked depressant effect. (Birdsell 1958:192). From my reading of the Pitcairn material, however, I would suggest that the shortage of such items as wood played an equally important role in the curtailment of an upward population trend on that island. (Barrow 1883, Shapiro 1962, and Silverman 1967).

<sup>17</sup> This opens the whole question of what is meant by the term “initial contact.” Is it the first landing of a European on an island, the first time a ship is sighted from the shore, or possibly the first time a disease which is European in origin decimates a population, even though the disease was introduced by other “aboriginal” people?

<sup>18</sup> Coulter (1957:163) says that there are 17 single low islands in Micronesia.

<sup>19</sup> I am not aware of the data used by Murdock in his classification. I do believe that, whatever the other influences, the culture of the southwest islands is recognizably Carolinian.

<sup>20</sup> A further refinement of the analysis given in the first half of this paper would be to try to deduce the effects of disaster on atolls with or without lagoons. However I feel that the connection of the analysis with empirical data is already tenuous when dealing with atolls as a single phenomena, and I do not feel it would be wise at this point to stretch that connection further.

<sup>21</sup> Of course without experiment it is impossible to use this practice as proof of anything more than the existence of certain attitudes and beliefs of the Tobi people.

<sup>22</sup> For evidence that this type of system did not exist on Tobi see Appendix B.

<sup>23</sup> Micro fluctuation or the change in the size of particular groups throughout time, rather than total or macro fluctuation has been the concern of Sahlins (1958) and Alkire (1965). Other writers on atolls (Brooks (1968) and Danielson (1955) and Lessa (1955, 1962, 1968)) seem to give more consideration to macro fluctuation in as much as they deal with the effects of demographic changes at all. Nowhere have I found as clear a separation between macro and micro fluctuation as I would have wished. The phenomena are, of course, related; a total decrease in population

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necessarily implies a decrease in the average number of people in each group. However, it is possible to conceive of a total population balance in which the decrease in one group will be offset by increases in other groups. Further, it should be noted that my use of the word "fluctuation" does not necessarily imply that what goes down must come up. See Tindale (1961) for an instance of complete depopulation. The idea that human populations have an inherent tendency to increase can be seen in studies of population from Malthus to Peterson (1961) and Wyon (1963).

<sup>24</sup> There is also the possibility that atolls within systems are open to disasters which are attributes of the system itself. However since none of the disasters we have examined are restricted to systems, we shall not go into the question of system-specific disasters.

<sup>25</sup> If an internally varied system is adaptively advantageous then it seems that a system with a high island as a member should be more stable demographically than a system which is composed of only low atolls. That this is manifestly not the case for the Ulithi-Yap system described by Hunt, Kidder, and Schneider (1954) and Lessa (1962) as compared with the Lamotrek-Ifaluk system, makes it possible to add a new dimension to the discussion of depopulation in Yap and Ulithi. (Schneider (1967) and Lessa and Meyers (1962)).

<sup>26</sup> The occurrence of any of the rest of the disasters on our list, tsunami, droughts, and epidemics, would probably not give the system this adaptive advantage since they are not localized. The chances for some of the atolls in the system escaping a tsunami, a drought, or an epidemic are much less than in the case of typhoons and disruption of the fresh water lens. One set of questions, which will not be considered here, would consist of inquiries into demographic effects of non-localized disasters on inter-island systems as opposed to the effects of the same type of disaster on isolated atolls.

<sup>27</sup> For a discussion of an aerial system temporarily overwhelmed by disasters related to European contact see T. Schwartz (1963).

<sup>28</sup> Merir, one of the other southwest islands of Palau, is now uninhabited. In 1968 the last few people left on the government ship. The reason the people gave was that the island had become uninhabitable due to the huge swarms of mosquitoes. If there was no way off the island it would still be inhabited, mosquitoes notwithstanding.

<sup>29</sup> See Burrows and Spiro (1953:1) and Lessa (1968) for data which could possibly be used in this way, though I am not prepared to submit the argument to empirical testing. However the following quote from Burrows and Spiro is suggestive. Discussing the reason for a fluctuation in their population figures for the years 1903 to 1914, they makes the following comment, ". . . a result of the typhoon of 1907. Not many lives were lost in that disaster, but, judging by native accounts of all such occasions, the destruction of food-bearing plants probably led to emigration on a considerable scale. By 1914 most of the refugees may have returned." (1953:4)

<sup>30</sup> That is, in this situation there is one and only one "correct" way to acquire the use of resources.

<sup>31</sup> Including completely "unprincipled" acquisition.

<sup>32</sup> That is, in this situation there are many ways of acquiring use of resources.

<sup>33</sup> For an explanation of a process that can help to make the application of these alternative methods possible without inter-group conflict see Spiro (1952).

<sup>34</sup> Further work on this hypothesis could no longer ignore the problems surrounding Malayo-Polynesian land tenure. The hypothesis would have to be considered in the light of the papers by Goodenough (1955 and 1957), Lane (1961), and Firth (1957) among others.

## Appendix A

### Evidence that Tobi experienced population fluctuation before the coming of the European

It is hard to accept literally Holden's statement that the Tobi people were completely unaware of the outside world (Thilenius 1936:12) since it would appear that the presence of strangers on the island was not a rare phenomena.<sup>1</sup> Since 1945, approximately seven groups of people in small, motorless craft have drifted onto Tobi, from such places as the Philippines, "Papua," and Indonesia. Although this number may be high because of some general post war increase in boat traffic in the area, I see no reason not to extend the possibility of accidental contact with other peoples backward in time. The idea that these "drift" voyages by outsiders to Tobi are not totally post-contact phenomena, is of course, related to the discussion of disease presented in the first section of this paper; it also can be used to reinforce the idea of a fluctuating population in another way.

As Vayda and Rappaport (1965) point out, the population of an atoll may be small enough so that accidental voyagers could influence its culture even if the traits the voyagers introduced were not an improvement on the old ways.<sup>2</sup> Of course we must keep in mind that some cultural traits can only be transmitted if the borrowing culture is capable of assimilating them. As Carneiro (1962:166) points out, a primitive tribe may come in contact with a people having great pyramids, but would not become pyramid builders themselves if they did not have the requisite technological and social arrangements to support them.

There are innumerable stories told on the island whose general format is “So and so came to Tobi from X place. He taught us to make our paddles (or nets or houses, etc.) in a new way. That is why we call our paddles (or nets or houses, etc.) X paddles.” The oral history of the island also includes a number of stories about strangers who drifted in and whose magic was strong enough for them to take over the island.<sup>3</sup> One of the seven clans on the island is called Ha-Worei (literally the people [of] Wolei) after the founder who is said to have been a woman who drifted into Tobi from Wolei, a Carolinian island a thousand or more miles to the east. She is said to have come to Tobi long after the original settlement which was by a woman from Fais, a small island near Ulithi. There are songs and dances whose meaning and words no one knows, which are identified as Indonesian or Philippine.

It is possible to see all these memories of strangers as some confirmation of population fluctuation since the impact of strangers would be greater on a small population than on a relatively large one. However, to my knowledge the Tobi people tell no stories which deal directly with long term macro fluctuation. There is general agreement that the island was densely populated before the European came. The stories told concern the scarcity of resources (especially taro and coconut)<sup>4</sup> and the great numbers of people. Disease and the Angaur mines are given as the reason for today’s depopulation. The people believe the Germans removed three shiploads of 500 people each from the island to work in their mines. In no case did I hear stories that the population had ever declined prior to about 1910.



The best evidence of population fluctuation would be in a series of censuses spread out over time. This of course involves a paradox. The only population estimates of which we have any record are those done by Europeans. Yet the point of this paper is that the population fluctuation shown in those estimates and censuses was not simply a post European phenomena, but is inherent in isolated atoll situations. A partial resolution of this paradox was offered in the discussion on the concept of “contact.” It might be noted that this paradox is common to most diachronic studies of non-literate people. On the following pages I have set out as complete a demographic history of Tobi as can be made from the available data.

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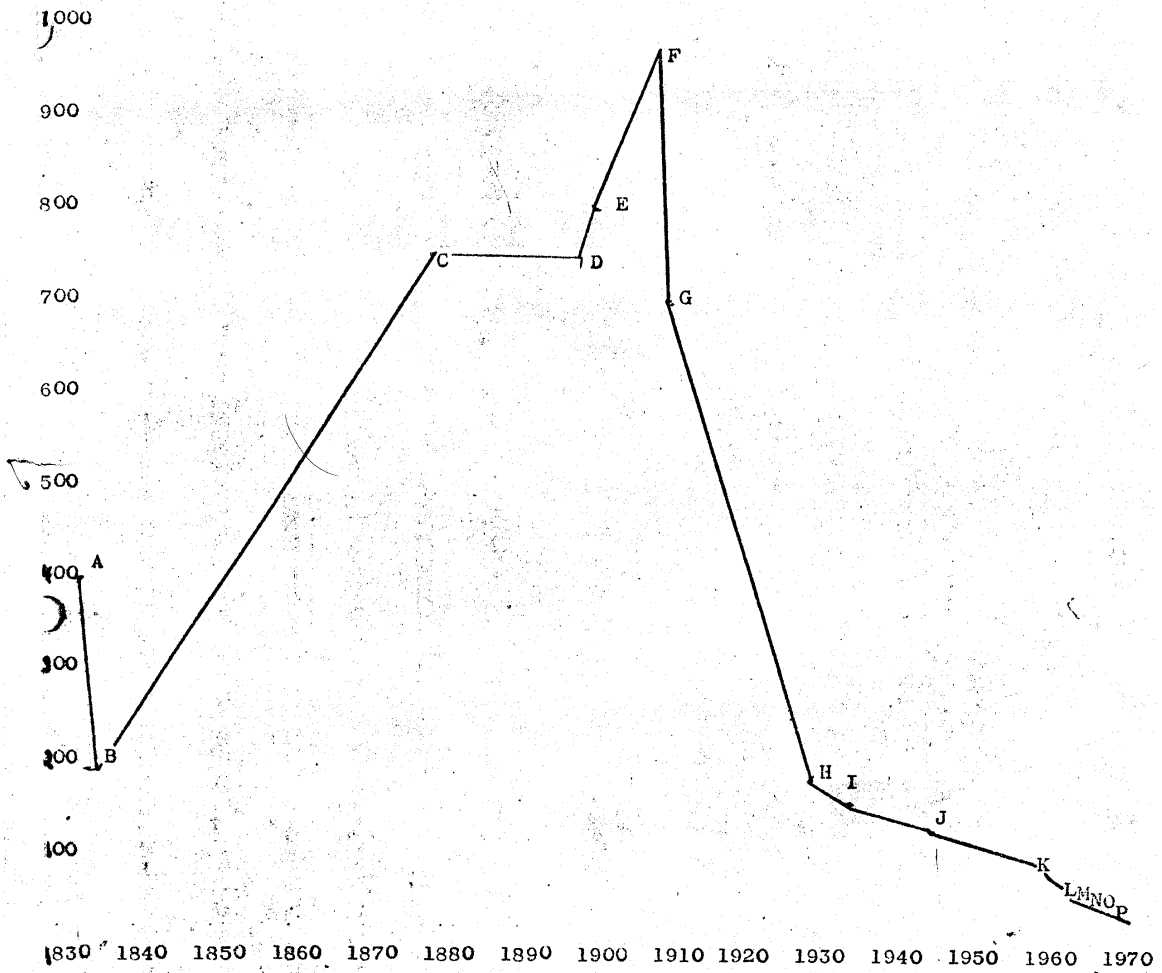
<sup>1</sup> Holden himself drifted in from northern Palau in a jerry built small boat. (Thilenius 1936:12)

<sup>2</sup> It is also probable that the borrowing culture will resist acquiring adaptive-negative traits (Vayda 1965). This may explain why Holden could not convince the Tobi people to use fish hooks of western design (Thilenius 1936), since from my experience, they are less useful than fish hooks of Tobi design.

<sup>3</sup> The chieftancy was, it is said, always restored to the correct lineage after a generation or so.

<sup>4</sup> One of the old men still bears scars which he claims are from a shark-tooth trap he stumbled into while stealing taro as a small boy. These are seen by both him and the people as evidence of food shortage from dense population that existed in the “olden times.”

### Population of Tobi Island 1932-1968



It is hardly necessary to caution the reader that almost all the evidence used to construct this graph is extremely tenuous. I do believe that the line does represent the general outline of Tobi demographic history.

## Population of Tobi Island 1832-1968

Point on graph	Source	Date	Number of people	People sq. 1 mile	Comments
A	Ward 1967:419, 434; Thilenius 1936:11	1832	400	1000	A compromise between several conflicting reports made by two U.S. seamen who together with four other sailors and three Palauans were marooned on Tobi. Capt. Bernard, who was rescued after six months, gave a figure of 500 in a deposition made shortly after his rescue. Holden, who spent more than two years on the island, gave a figure of 400 to 500 in a newspaper interview shortly after his return to the U.S. But in a book written about his adventures he gave an estimate of 300 to 400.
B	Thilenius 1936:12	1834	200	800	Holden wrote that following a "great wave that washed over the northern part of the island and ruined the gardens," the population dropped by 50 percent due to "famine and sickness." The question of whether the disease can be linked to the presence of the Americans on the island is interesting. Given the facts that Bernard and his crew had spent approximately one year in Palau and reported no epidemics from that almost equally "uncontacted" place and that they drifted up on the island with the Palauans in the remains of a small boat built from scraps, I find it hard to see their role as disease transmitters as different in any significant way from the Palauans with them.
C	Thilenius 1936:42	1878	750	3,000	A superficial estimate made by a visiting ship captain.
D	Peterson 1961	1898	750	3,000	An estimate extrapolated from a report that in this year 200 men in canoes came out from the island to trade with a ship. The figure of 750 seems to be the minimum with the demographic principles for a functioning society. Even when due weight is given to the type of ratio described by Pitt-Rivers (1923 and 1927), it seems necessary to assume at least 3.5 other people on the island for each man in a canoe. Old people, children, and women would not be part of the estimated 200 men in canoes and it is not clear whether these 200 men were all the able bodied men on the island. If a more realistic approximation is made then the line could have reached the top by this point. The rate of increase between point B and D would be even greater than that required to raise the population by 250



					Yapese is the increase in the occurrence of general infections due to a rise in the number of abortions. The practice of abortions is not limited to peoples in contact with an intruding culture (Devereux 1955). So it is possible to see the danger of a falling birth rate due to reproductive pathologies as one which Pacific peoples faced long before "contact."
J	Lessa 1955	1948	141	564	Lessa gives this figure for Tobi, noting the fact that the number of people under 15 years of age was less than 9.9 percent of the total.
K	U.S. Navy 1964:[illeg]	1962	80	320	The reason for the drop from point J to K is not clear. About 20 people are now living in the Tobi village in Palau.
L	Kahn 1966:88	1964	66	264	
M	U.S. Dept. of State 1965 through 1969	1965	67	268	
N	U.S. Dept. of State 1965 through 1969	1966	67	268	
O	U.S. Dept. of State 1965 through 1969	1967	60	240	
P		1968	53	212	This figure is taken from a simple census which I made during my stay on Tobi, 1967 to 1968. The situation today makes this type of census invalid since the percentage of the total population actually on Tobi at any given time varies widely as the people come and go to Palau.

<sup>1</sup> Hainline's figure (1965:1188) of .228 square miles has been rounded off to .25.

## Appendix B

### Tobi and Inter-Island Ties

Unfortunately it is impossible to state the actual degree of isolation that existed on Tobi prior to the establishment of a regular ship schedule by the Germans in about 1910. The only evidence I have is a statement by Holden that in 1832 the people were unaware of the existence of any other place in the world (Thilenius 1936:12). Since Holden was shipwrecked on the island, it seems reasonable to assume that the geographical knowledge of the people is one area that he would have been interested in and would have investigated thoroughly. The fact that Holden claimed that the Tobians lived in a completely Tobi centered world without the knowledge of the existence of any people besides themselves is less important than the fact that he did not state that they knew how to get to outer islands. During my stay on the island I managed to elicit only two stories indicating deliberate voyaging by the islanders. One of these stories concerned the original settlement of the island and the other the great “hero” of the island, who, as one of the old men told me, “discovered” Indonesia, New Guinea, the Philippines, Malaysia, Taiwan, Japan, and Shanghai. In contrast to Sonsorol, another of the southwest islands, there is no one on Tobi today with any detailed knowledge of navigation.<sup>1</sup>

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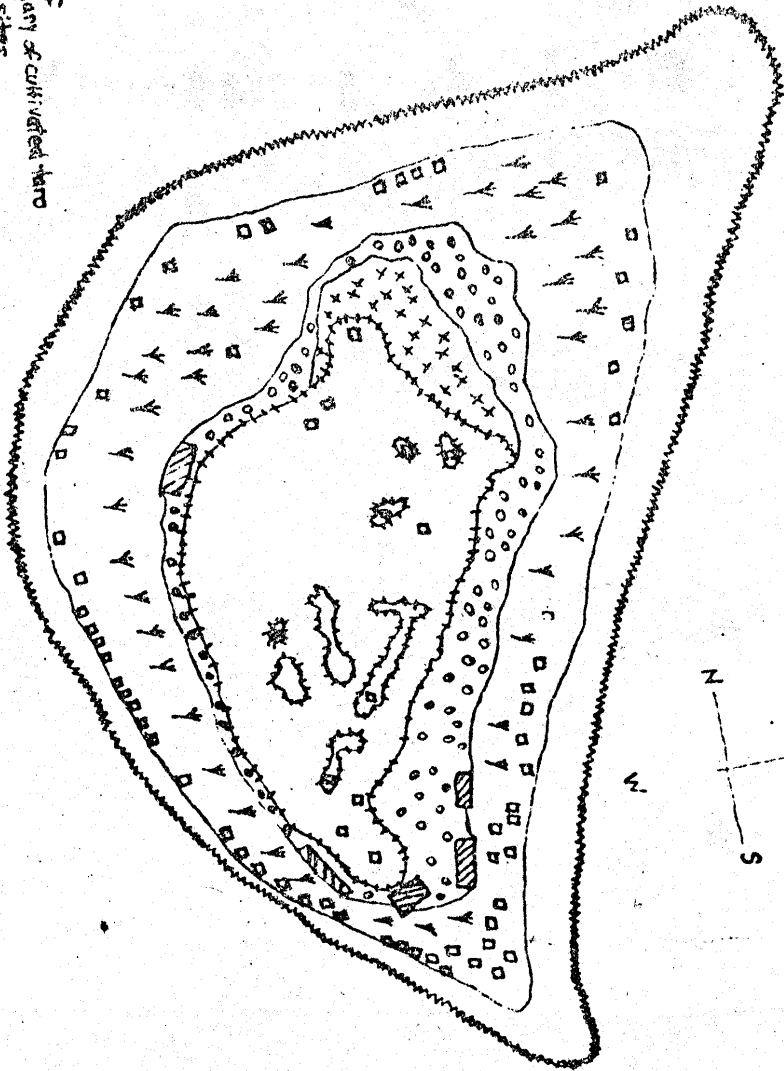
<sup>1</sup> Since no one on Tobi would admit that the Sonsorolese were ever better at anything than the Tobi people, they claimed that the incredibly detailed star knowledge of the Sonsorolese is simply a pack of lies. The lack of navigational knowledge implies that Tobi was not involved in the type of arrangement described by Alkire (1965), who studied Lamotrek, a Carolinian atoll east of Tobi. He found that Lamotrek was involved in a systematic relationship with other atolls in its general vicinity. He also found that the people of those islands were using this system to cushion the effects of disaster. The existence of this kind of system has great implications for the type of problems with which this paper is concerned. Perhaps the discussion presented in this paper can be seen as a necessary first step to a consideration of the type of system Alkire found. By

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starting with an island for which there is no evidence of any systematic relations with the outside world, one could better see the adaptive advantages of the Lamotrek arrangement.

Tobi Island 1909

- reef
- +++++ boundary of cultivated land
- house sites
- ▨ garden
- Y Y coconut palms
- ○ wooded land
- X X waste land



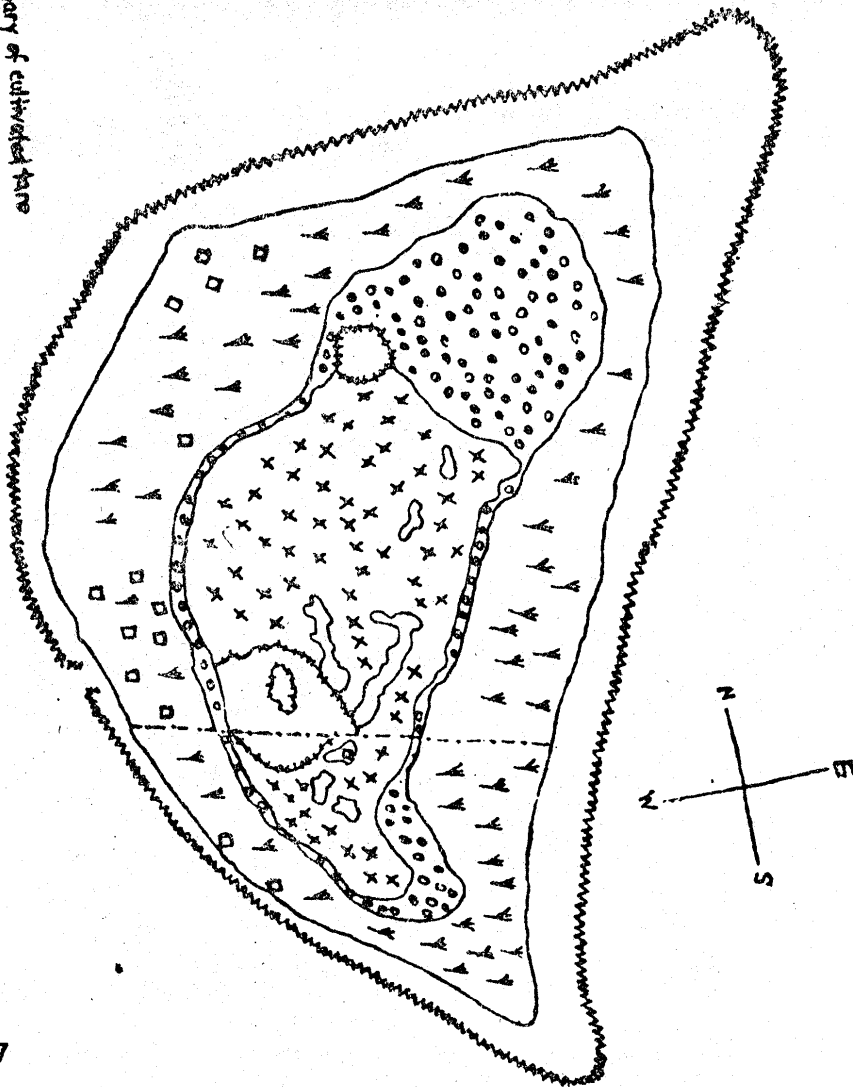
TOBI ISLAND, 1909  
(ADAPTED FROM EILERS)



Tobi Island 1968

- - reef
- - boundary of cultivated zone
- - house sites
- Y - coconut palms
- o - wooded land
- - fallow taro fields (uncultivated)
- - causeway

Tobi Island, 1968



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