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Nutrition and Physical Degeneration

A Comparison of Primitive and Modern Diets and Their Effects

BY

WESTON A. PRICE, MS., D.D.S., F.A.G.D.
Member Research Commission, American Dental Association
Member American Association of Physical Anthropologists
Author, "Dental Infections, Oral and Systemic"

WITH 134 FIGURES

TO THAT KINDRED SOUL

My Wife

who has assisted me so greatly
on these difficult expeditions,
this book is lovingly dedicated.

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PREFACE

THE gracious reception given to my several reports of field studies among primitive racial groups and the many requests for copies of those brief reports and for further data, together with the need for providing interpretations and applications of the data, have induced me to consolidate my investigations. There have also been many requests from my patients and from members of the medical and dental professions for concise statements as to what I have found that would be useful as preventive procedures. In addition I have been conscious of an opportunity for helpfulness to the members of the various primitive races that I have studied and who are so rapidly declining in health and numbers at their point of contact with our modern civilization. Since they have so much accumulated wisdom that is passing with them, it has seemed important that the elements in the modern contacts that are so destructive to them should be discovered and removed.

There has been a deep sense of obligation to the officials of many countries for the great kindness and assistance that they have so cheerfully given by providing the opportunity for these investigations. The list of these individuals is much too long to mention them all by name. One of the joys of my work has been the privilege of knowing the magnificent characters that are at the outposts earnestly striving to better the welfare of the natives whom they are ministering to, but who are distraught with the recognition that under the modernization program the natives decline in health and become afflicted by our modern types of degenerative diseases. It would be fortunate if each of these field workers could be provided with a copy of this report which they have helped to make possible.

In order to make this information available to as wide a group as possible, I have avoided technical language and will ask the indulgence of professional readers.

There are some individuals whose assistance I must acknowledge specifically: Reverend Father John Siegen and Doctor Alfred Gysi of Switzerland; Mrs. Lulu Herron and Doctor J. Romig of Alaska; the Indian Department at Ottawa; the Department of Indian Affairs at Washington, D. C.; the officials of the eight archipelagos studied in the Pacific; Colonel J. L. Saunders of New Zealand; the Minister of Health, New Zealand; Dr. W. Stewart Ziele of Sydney, Australia; Sir Herbert Gepp of Melbourne, Australia; Doctor William M. Hughes, Minister of Health, Canberra; Dr. Cummiston, Director-General of Health, Australian Commonwealth, Canberra; Doctor Rapael Cilento of Queensland, Australia; Mr. E. W. Saranealis, Thursday Island; the Department of Health of Kenya, Africa; the Department of Health for Belgian Congo, Brussells; the Department of National Parks, Belgian Congo; Minister of the Interior, Peru; Doctor Albert Giesecke and Esther Giesecke of Peru; the Directors of Museums in Sydney and Canberra, Australia; Auckland, New Zealand; Vancouver, and Toronto, Canada; Washington, New York and Chicago, the United States; Juneau, Alaska; Rome, Italy; and Cairo, Egypt; the publishers of the Ohio State Medical Journal, the Journal of the American Dental Association, the Dental Digest and the Dental Items of Interest; my faithful secretary, Mrs. Ruth MacMaster; Professor W. G. Garnett who so kindly provided the critical reading of the manuscript, and the publishers who furnished constructive suggestions and cooperation. To these and a host of others I am deeply indebted and profoundly grateful.

WESTON A. PRICE

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INTRODUCTION

THIS text provides a new approach to some problems of modern degeneration. Instead of the customary procedure of analyzing the expressions of degeneration, a search has been made for groups to be used as controls who are largely free from these affections.

After spending several years approaching this problem by both clinical and laboratory research methods, I interpreted the accumulating evidence as strongly indicating the absence of some essential factors from our modern program, rather than the presence of injurious factors. This immediately indicated the need for obtaining controls. To accomplish this it became necessary to locate immune groups which were found readily as isolated remnants of primitive racial stocks in different parts of the world. A critical examination of these groups revealed a high immunity to many of our serious affections so long as they were sufficiently isolated from our modern civilization and living in accordance with the nutritional programs which were directed by the accumulated wisdom of the group. In every instance where individuals of the same racial stocks who had lost this isolation and who had adopted the foods and food habits of our modern civilization were examined, there was an early loss of the high immunity characteristics of the isolated group. These studies have included a chemical analysis of foods of the isolated groups and also of the displacing foods of our modern civilization.

These investigations have been made among the following primitive racial stocks including both isolated and modernized groups: the Swiss of Switzerland, the Gaelics in the Outer and Inner Hebrides, the Eskimos of Alaska, the Indians in the far North, West and Central Canada, Western United States and Florida, the Melanesians and Polynesians on eight archipelagos of the Southern Pacific, tribes in eastern and central Africa, the Aborigines of Australia, Malay tribes on islands north of Australia, the Maori of New Zealand and the ancient civilizations and their descendants in Peru both along the coast and in the Sierras, also in the Amazon Basin. Where available the modernized whites in these communities also were studied. There have been many important unexpected developments in these investigations. While a primary quest was to find the cause of tooth decay which was established quite readily as being controlled directly by nutrition, it rapidly became apparent that a chain of disturbances developed in these various primitive racial stocks starting even in the first generation after the adoption of the modernized diet and rapidly increased in severity with expressions quite constantly like the characteristic degenerative processes of our modern civilization

of America and Europe. While tooth decay has proved to be almost entirely a matter of the nutrition of the individual at the time and prior to the activity of that disease, a group of affections have expressed themselves in physical form. These have included facial and dental arch changes which, heretofore, have been accounted for as results of admixtures of different racial stocks. My investigations have revealed that these same divergencies from normal are reproduced in all these various racial stocks while the blood is still pure. Indeed, these even develop in those children of the family that are born after the parents adopted the modern nutrition.

Applying these methods of study to our American families, we find readily that a considerable percentage of our families show this same deterioration in the younger members. The percentage of individuals so affected in our American communities in which I have made studies varies through a wide range, usually between 25 per cent to 75 per cent. A certain percentage of this affected group has not only these evidences of physical injury, but also personality disturbances, the most common of which is a lower than normal mental efficiency and acuteness, chiefly observed as so-called mental backwardness which includes the group of children in the schools who are unable to keep up with their classmates. Their I.Q.'s are generally lower than normal and they readily develop inferiority complexes growing out of their handicap. From this group or parallel with it a certain percentage develop personality disturbances which have their expression largely in unsocial traits. They include the delinquents who at this time are causing so much trouble and concern because of evidence of increase in their numbers. This latter group has been accounted for largely on the basis of some conditioning experience that developed after the child had reached an impressionable age. My investigations are revealing a physical structural change and therefore, an organic factor which precedes and underlies these conditioning influences of the environment. The fact that a government survey has shown that 66 per cent of the delinquents who have been treated in the best institutions and released as cured, later have developed their unsocial or criminal tendencies, strongly emphasizes the urgent necessity that if preventive methods are to be applied these must precede and forestall the primary injuries themselves.

While it has been known that certain injuries were directly related to an inadequate nutrition of the mother during the formative period of the child, my investigations are revealing evidence that the problem goes back still further to defects in the germ plasms as contributed by the two parents. These injuries, therefore, are related directly to the physical condition of one or of both of these individuals prior to the time that conception took place.

A very important phase of my investigations has been the obtaining of information from these various primitive racial groups indicating that they were conscious that such injuries would occur if the parents were not in excellent physical condition and nourishment. Indeed, in many groups I found that the girls were not allowed to be married until after they had had a period of special feeding. In some tribes a six months period of special nutrition was required before marriage. An examination of their foods has disclosed special nutritional factors which are utilized for this purpose.

The scope of this work, accordingly, becomes of direct interest in many fields including the various branches of the healing arts, particularly medicine and dentistry, and the social organizations that are concerned with betterment of the racial stock. Similarly, the educational groups are concerned directly since, if we are to stem the tide by passing new information on to the parents of the new generation, it must be done prior to the time the emergency shall arise. This involves a

system of education directed particularly to the high school age pupils.

The data that are being presented in the following chapters suggest the need for reorientation in many problems of our modern social organization. The forces involved in heredity have in general been deemed to be so powerful as to be able to resist all impacts and changes in the environment. These data will indicate that much that we have interpreted as being due to heredity is really the result of intercepted heredity. While great emphasis has been placed on the influence of the environment on the character of the individual, the body pattern has generally been supposed to require a great number of impacts of a similar nature to alter the design. The brain has been assumed to be similarly well organized in most individuals except that incidents in the life of the individual such as disappointments, fright, etc., are largely responsible for disturbed behavior. Normal brain functioning has not been thought of as being as biologic as digestion. The data provided in the succeeding chapters indicate that associated with disturbances in the development of the bones of the head, disturbances may at the same time occur in the development of the brain. Such structural defects usually are not hereditary factors even though they appear in other members of the family or parents. They are products of the environment rather than hereditary units transmitted from the ancestry.

In the light of these data important new emphasis is placed on the quality of the germ cells of the two parents as well as on the environment provided by the mother. The new evidence indicates that the paternal contribution may be an injured product and that the responsibility for defective germ cells may have to be about equally divided between the father and mother. The blending of races has been blamed for much of the distortion and defects in body form in our modern generation. It will be seen that these face changes occur in all the pure blood races studied in even the first generation, after the nutrition of the parents has been changed.

The origin of personality and character appear in the light of the newer data to be biologic products and to a much less degree than usually considered pure hereditary traits. Since these various factors are biologic, being directly related to both the nutrition of the parents and to the nutritional environment of the individuals in the formative and growth period any common contributing factor such as food deficiencies due to soil depletion will be seen to produce degeneration of the masses of people due to a common cause. Mass behavior therefore, in this new light becomes the result of natural forces, the expression of which may not be modified by propaganda but will require correction at the source. Nature has been at this process of building human cultures through many millenniums and our culture has not only its own experience to draw from but that of parallel races living today as well as those who lived in the past. This work, accordingly, includes data that have been obtained from several of Nature's other biologic experiments to throw light on the problems of our modern white civilization.

In presenting the evidence I am utilizing photographs very liberally. A good illustration is said to be equivalent to a thousand words of text. This is in keeping too with the recent trend in journalism. The pictures are much more convincing than words can be, and since the text challenges many of the current theories, the most conclusive evidence available is essential.

Owing to the many requests received for slides or the loan of my negatives, provision is being

made for supplying a limited number of slides of the illustrations in either black and white or in color. Slides of other subjects are available.

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Chapter 1

WHY SEEK WISDOM FROM PRIMITIVE PEOPLES

SOME of the primitive races have avoided certain of the life problems faced by modernized groups and the methods and knowledge used by the primitive peoples are available to assist modernized individuals in solving their problems. Many primitive races have made habitual use of certain preventive measures in meeting crucial life problems.

Search for controls among remnants of primitive racial stocks has been resorted to as a result of failure to find them in our modernized groups or to find the controlling factors by applying laboratory methods to the affected clinical material. Only the primitive groups have been able to provide adequate normal controls.

In the following chapters, I have presented descriptions of certain peoples and their environments in primitive state, and, for comparative study, descriptions of members of the primitive tribes who have been in contact with modernized white races. I have recorded the effects of that contact as expressed in physical and character changes, and have given a survey of the factors in the environment which have changed. It has been necessary to study in this way a wide variety of primitive groups and physical environments. It will, accordingly, be advisable for the reader to keep in mind the comparative effects of different altitudes, latitudes, temperatures and races, and to note the similarity of the reactions of these primitive groups when contact is made with our modern civilization. The purpose is to glean data that will be applicable for use in correcting certain tragic expressions of our modern degeneration, including tooth decay, general physical degeneration, and facial and dental-arch deformities, and character changes. These data will be useful in preventing race decay and deformities, in establishing a higher resistance to infective diseases, and in reducing the number of prenatal deficiency injuries. These latter include such expressions as mental deficiencies caused by brain defects in the formative period, which result in mental disturbances ranging from moderate backwardness to character abnormalities.

The data presented show the level of susceptibility to dental caries (tooth decay) in each isolated

primitive group and, contrasted with that, the level of susceptibility in the modernized natives of the same stock. A résumé of the changes in the environment that are associated with the changes in immunity and susceptibility will be presented. These data reveal an average increase in susceptibility of thirty-five fold. Similar contrasts are shown in relation to the relative incidence of facial and dental arch deformities among primitive natives and modernized natives.

It will be easy for the reader to be prejudiced since many of the applications suggested are not orthodox. I suggest that conclusions be deferred until the new approach has been used to survey the physical and mental status of the reader's own family, of his brothers and sisters, of associated families, and finally, of the mass of people met in business and on the street. Almost everyone who studies the matter will be surprised that such clear-cut evidence of a decline in modern reproductive efficiency could be all about us and not have been previously noted and reviewed.

It is important to preface the observations by constructing a mental pattern of physical excellence from the pictures of the various primitive groups and, with this yardstick or standard of normalcy, observe our modern patterns. Certain preconceived ideas may have to be modified, as for example, that based on the belief that what we see is due to heredity or that deformity is due to mixing of races. If so, why should the last child in a large family generally suffer most, and often be different in facial form; or why should there be these changes in the later children, even in pure racial stocks, after the parents have adopted our modern types of nutrition? Although the causes of physical degeneration that can be seen easily have been hard to trace, the defects in the development of the brain, which affect the mind and character, are much more obscure, and the causes of mental degeneration are exceedingly difficult to trace. Much that formerly has been left to the psychiatrist to explain is now rapidly shifting to the realm of the anatomist and physiologist.

Those contributions of the past cultures which have blended agreeably into our modern experience have been accepted with too little questioning. Much ancient wisdom, however, has been rejected because of prejudice against the wisdom of so-called savages. Some readers may experience this reaction to the primitive wisdom recorded in these chapters.

The writer is fully aware that his message is not orthodox; but since our orthodox theories have not saved us we may have to readjust them to bring them into harmony with Nature's laws. Nature must be obeyed, not orthodoxy. Apparently many primitive races have understood her language better than have our modernized groups. Even the primitive races share our blights when they adopt our conception of nutrition. The supporting evidence for this statement is voluminous and as much of it as space permits is included in this volume. The illustrative material used is taken from the many thousands of my negatives which are available. Photographs alone can tell much of the story, and one illustration is said to be worth as much as one thousand words.

Since the problem of applying the wisdom of the primitives to our modern needs concerns not only health workers and nutritionists, but also educators and social workers, the data are presented without technical details.

While many of the primitive races studied have continued to thrive on the same soil through thousands of years, our American human stock has declined rapidly within a few centuries, and in

some localities within a few decades. In the regions in which degeneration has taken place the animal stock has also declined. A decadent individual cannot regenerate himself, although he can reduce the progressive decadence in the next generation, or can vastly improve that generation, by using the demonstrated wisdom of the primitive races. No era in the long journey of mankind reveals in the skeletal remains such a terrible degeneration of teeth and bones as this brief modern period records. Must Nature reject our vaunted culture and call back the more obedient primitives? The alternative seems to be a complete readjustment in accordance with the controlling forces of Nature.

Thinking is as biologic as is digestion, and brain embryonic defects are as biologic as are club feet. Since both are readily produced by lowered parental reproductive capacity, and since Nature in her large-scale human demonstration reveals that this is chiefly the result of inadequate nutrition of the parents and too frequent or too prolonged child bearing, the way back is indicated. Like the successful primitive racial stocks, we, too, can make, as a first requisite, provision for adequate nutrition both for generation and growth, and can make provision for the regulation of the overloads. We, like the successful primitives, can establish programs of instruction for growing youth and acquaint it with Nature s requirements long before the emergencies and stresses arise. This may require a large-scale program of home and classroom instruction, particularly for the high school girls and boys. This would be in accordance with the practice of many of the primitive races reported upon in the following chapters.

If the individuals in our modern society who are sufficiently defective to require some supervision are in part or largely the product of an injured parentage, who should be held responsible? Is it just for society to consign these unsocial individuals which it has made to a life of hard labor or confinement in depressing environments? Is it just for society to permit production of physical and mental cripples? Many primitive races apparently have prevented the distortions which find expressions in unsocial acts. If so, cannot modern society do this by studying and adopting the programs developed through centuries of experience by the primitives? Nature uses a written language which, without the keys, is made up of meaningless hieroglyphics, but which, with the proper keys, becomes a clear story of racial and individual history. The hieroglyphics indicate racial and individual disaster for modernized groups who heed not the warning story. The primitive races have some of these keys and have used them successfully in avoiding many of the disasters of our modern society. The following chapters record many of the excellent practices of the primitives and they are presented here with the hope that they will be helpful in a program designed to relieve mankind of some of the misfortunes common in the present social order and to prevent disorders for future generations of civilized peoples.

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Chapter 2

THE PROGRESSIVE DECLINE OF MODERN CIVILIZATION

THAT modern man is declining in physical fitness has been emphasized by many eminent sociologists and other scientists. That the rate of degeneration is progressively accelerating constitutes a cause for great alarm, particularly since this is taking place in spite of the advance that is being made in modern science along many lines of investigation.

Dr. Alexis Carrel in his treatise "Man, the Unknown" states:

> Medicine is far from having decreased human sufferings as much as it endeavors to make us believe. Indeed, the number of deaths from infectious diseases has greatly diminished. But we still must die in a much larger proportion from degenerative diseases.

After reviewing the reduction in the epidemic infectious diseases he continues as follows:

> All diseases of bacterial origin have decreased in a striking manner. . . . Nevertheless, in spite of the triumphs of medical science, the problem of disease is far from solved. Modern man is delicate. Eleven hundred thousand persons have to attend the medical needs of 120,000,000 other persons. Every year, among this population of the United States, there are about 100,000,000 illnesses, serious or slight. In the hospitals, 700,000 beds are occupied every day of the year. . . . Medical care, under all its forms, costs about $3,500,000,000 yearly. . . . The organism seems to have become more susceptible to degenerative diseases.

The present health condition in the United States is reported from time to time by several agencies representing special phases of the health program. The general health problem has been thoroughly surveyed and interpreted by the Surgeon General of the United States Public Health Service, Dr. Parran. Probably no one is so well informed in all of the phases of health as is the head of this important department of the government. In his recent preliminary report (1) to state and local officers for their information and guidance, he presented data that have been gathered by a large group of government workers. The report includes a census of the health conditions of all the groups constituting the population of the United States--records of the health status and of the economic status of 2,660,000 individuals living in various sections, in various types of communities, on various economic levels. The data include records on every age-group. He makes the following interpretations based upon the assumption that the 2,660,000 offer a fair sampling of the population, and he indicates the conclusions which may be drawn regarding conditions of status for the total population of some 130,000,000 people.

> Every day one out of twenty people is too sick to go to school or work, or attend his customary activities.

> Every man, woman and child (on the average) in the nation suffers ten days of incapacity annually.

> The average youngster is sick in bed seven days of the year, the average oldster 35 days.
>
> Two million five hundred thousand people (42 per cent of the 6,000,000 sick every day) suffer from chronic diseases-heart disease, hardening of the arteries, rheumatism, and nervous diseases.
>
> Sixty-five thousand people are totally deaf; 75,000 more are deaf and dumb; 200,000 lack a hand, arm, foot or leg; 300,000 have permanent spinal injuries; 500,000 are blind; 1,000,000 more are permanent cripples.
>
> Two persons on the Relief income level (less than $1,000 yearly income for the entire family) are disabled for one week or longer for every one person better off economically.
>
> Only one in 250 family heads in the income group of more than $2,000 yearly cannot seek work because of chronic disability. In Relief families one in every 20 family heads is disabled.
>
> Relief and low-income families are sick longer as well as more often than better-financed families. They call doctors less often. But the poor, especially in big cities, get to stay in hospitals longer than their better-off neighbors.

Concluded Dr. Parran:

> It is apparent that inadequate diet, poor housing, the hazards of occupation and the instability of the labor market definitely create immediate health problems.

It will be seen from this report that the group expressed as oldsters, who spend on an average thirty-five days per year in bed, are sick in bed one-tenth of the time. Those of us who are well, who may have been so fortunate as to spend very little time in bed, will contemplate this fact with considerable concern since it expresses a vast amount of suffering and enforced idleness. It is clear that so great an incidence of morbidity must place a heavy load upon those who at the time are well. The problem of the progressive increase in percentage of individuals affected with heart disease and cancer is adequate cause for alarm. Statistics have been published by the Department of Public Health in New York City which show the increase in the incidence of heart disease to have progressed steadily during the years from 1907 to 1936. The figures provided in their report reveal an increase from 203.7 deaths per 100,000 in 1907 to 327.2 per 100,000 in 1936. This constitutes an increase of 60 per cent. Cancer increased 90 per cent from 1907 to 1936.

That this problem of serious degeneration of our modern civilization is not limited to the people of the United States has been commented on at length by workers in many countries. Sir Arbuthnot Lane, one of England's distinguished surgeons, and a student of public welfare, has made this comment: (2)

> Long surgical experience has proved to me conclusively that there is something radically and fundamentally wrong with the civilized mode of life, and I believe that unless the present dietetic and health customs of the White Nations are reorganized, social decay and race deterioration are inevitable.

The decline in white population that is taking place in many communities throughout several countries illustrates the widespread working of the forces that are responsible for this degeneration. In discussing this matter in its relation to Australia, S. R. Wolstenhole, (3) lecturer in economics at Sydney University, predicts that:

> A decline in Australia's population is inevitable within 40 years because of the absence of a vigorous population policy.

Students of our modern social problems are recognizing that these problems are not limited to health conditions which we have been accustomed to think of as bodily diseases. This is illustrated in a recent discussion by Will Durant: (4)

> The American people are face to face with at least 4 major and militant problems that have to do with the continuity and worthwhile progress of modern civilization:
>
> 1. The threatened deterioration of our stock.
> 2. The purchasing power of our people must rise as fast as the power to procure. . . .
> 3. The third problem is moral. A civilization depends upon morals for a social and governmental order. . . .
> 4. The sources of statesmanship are drying up. . . .

Dental caries or tooth decay is recognized as affecting more individuals throughout the so-called civilized world today than any other affection. In the United States, England and Europe examinations of highly modernized groups, consisting of several million individuals, reveal the fact that from 85 to 100 per cent of the individuals in various communities are suffering from this affection. As a contributing factor to absence from school among children it leads all other affections. From the standpoint of injury to health, it has been estimated by many to be the most serious contributing factor through its involvement of other organs of the body. The Honorable J. A. Young, Minister of Health of New Zealand, strongly emphasized that the insidiousness of the effect of dental disease lies in the fact that it is the forerunner of other far-reaching disturbances and he has referred to the seriousness with which it is viewed in England as follows: "Sir George Newman, Principal Medical Officer of the Ministry of Health in Great Britain, has said that 'dental disease is one of the chief, if not the chief, cause of the ill health of the people.'"

Dr. Earnest A. Hooton, of Harvard University, has emphasized the importance of oral sepsis and the task of stopping tooth decay. In closing Chapter VII of his recent book "Apes, Men and Morons," (5) he states the case as follows:

> I firmly believe that the health of humanity is at stake, and that, unless steps are taken to discover preventives of tooth infection and correctives of dental deformation, the course of human evolution will lead downward to extinction. . . . The facts that we must face are, in brief, that human teeth and the human mouth have become, possibly under the influence of civilization, the foci of infections that undermine the entire bodily health of the species and that degenerative tendencies in evolution have manifested themselves in modern man to such an extent that our jaws are too small for the teeth which they are supposed to accommodate,

> and that, as a consequence, these teeth erupt so irregularly that their fundamental efficiency is often entirely or nearly destroyed.

In discussing the strategic situation of dental science, Dr. Hooton states.

> In my opinion there is one and only one course of action which will check the increase of dental disease and degeneration which may ultimately cause the extinction of the human species. This is to elevate the dental profession to a plane on which it can command the services of our best research minds to study the causes and seek for the cures of these dental evils. . . . The dental practitioner should equip himself to become the agent of an intelligent control of human evolution, insofar as it is affected by diet. Let us go to the ignorant savage, consider his way of eating, and be wise. Let us cease pretending that tooth-brushes and tooth-paste are any more important than shoe-brushes and shoe-polish. It is store food which has given us store teeth.

Students of history have continually commented upon the superior teeth of the so-called savages including the human types that have preceded our modernized groups. While dental caries has been found occasionally in several animal species through the recent geologic ages, the teeth of the human species have been comparatively free from dental caries. Primitive human beings have been freer from the disease than has contemporary animal life. This absence of tooth decay among primitive races has been so striking a characteristic of human kind that many commentators have referred to it as a strikingly modern disease.

Dryer, (6) in discussing dental caries in the pre-historic South Africans, makes this comment:

> In not one of a very large collection of teeth from skulls obtained in the Matjes River Shelter (Holocene) was there the slightest sign of dental caries. The indication from this area, therefore, bears out the experience of European anthropologists that caries is a comparatively modern disease and that no skull showing this condition can be regarded as ancient.

In connection with the studies reported in this volume, it is of particular importance that a desire to find the cause of dental caries was the primary reason for undertaking these investigations. Since it was exceedingly difficult to find in our modern social organization any large group with relatively high immunity to dental caries, a search was made for such control groups among remnants of primitive racial stocks that could also be examined at the point of contact with modern civilization in order that the changes associated with their racial loss of immunity might be noted. Probably few problems with which our modern social groups are concerned have been so inadequately understood not only by the laity, but by the members of the medical and dental professions as has this problem of the cause of dental caries.

The problem of correcting dental arch deformities and thereby improving facial form has developed a specialty in dentistry known as "orthodontia." The literature dealing with the cause of facial deformities is now voluminous. The blending of racial stocks that differ radically in facial form has been said by many to be the chief factor contributing to the creation of deformities of the face. Crowded teeth have been said to be due to the inheritance of the large teeth of one parent and the small bone formation of the other and that such inheritances would provide dental arches that are too

small for the teeth that have been made for them. A more general explanation for certain types of deformity, particularly for the protruding of the upper teeth over the lower, is that they result from thumb sucking, which tends to bring the upper arch forward and to depress the lower. Among the other contributing factors named have been faulty sleeping and breathing habits. To these has been assigned much of the blame. This problem of facial form, as well as that of bodily design, including dental arch design, is so directly a problem of growth, not only of individuals, but of races themselves, that certain laws have been very definitely worked out by physical anthropologists as laws of development. They have assumed that changes in physical type can occur only through the impact of changes in the environment which have affected a great number of generations. It is important to keep this viewpoint in mind as the succeeding chapters are read, for they contain descriptions of many changes in physical form that have occurred routinely in the various racial groups, even during the first generation after the parents have adopted the foods of modern civilization.

Many of our modern writers have recognized and have emphasized the seriousness of mental and moral degeneration. Laird has made a splendid contribution under the title "The Tail That Wags the Nation," (7) in which he states:

> The country's average level of general ability sinks lower with each generation. Should the ballot be restricted to citizens able to take care of themselves? One out of four cannot. . . . The tail is now wagging Washington, and Wall St. and LaSalle Street. . . . Each generation has seen some lowering of the American average level of general ability.

In Laird's analysis of our present situation he has stressed a very important phase. While emphasizing that the degeneration is not limited to restricted areas, he raises the question as to whether local conditions in certain areas play important roles in the rate and extent to which degeneration has taken place. He says further, (7)

> Although we might cite any one of nearly two dozen states, we will first mention Vermont by name because that is the place studied by the late Dr. Pearce Bailey. "It would be," he wrote, "safe to assume that there are at least 30 defectives per 1000 in Vermont of the eight-year-old mentality type, and 300 per 1000 of backward or retarded persons, persons of distinctly inferior intelligence. In other words, nearly one-third of the whole population of that state is of a type to require some supervision."

The problem of lowered mentality and its place in our modern conception of bodily diseases has not been placed on a physical basis as have the better understood degenerative processes, with their direct relationship to a diseased organ, but has generally been assigned to a realm entirely outside the domain of disease or injury of a special organ or tissue. Edward Lee Thorndike, (8) of Columbia University, says that "thinking is as biological as digestion." This implies that a disturbance in the capacity to think is directly related to a defect in the brain.

Another of the distinguished students of mental capacity, J. B. Miner, (9) states:

> If morality and intellect are finally demonstrated to be correlated throughout the whole range of individual differences, it is probably the most profoundly significant fact with which society

has to deal.

The origin of backwardness in a child seems to have been assigned very largely to some experience in that child's life which becomes a conditioning factor and which thereafter strongly influences his behavior. The problem of the relation of physical defects to delinquency in its various phases, including major crime, constitutes one of the most alarming aspects of our modern problems in social degeneration. Chassell (10) has made an exhaustive study of the reports from workers in different fields in several countries and summarizes her finding as follows: "The correlation between delinquency and mental inferiority as found in the case of feeble-minded groups is clearly positive, and tends to be marked in degree."

Burt, (11) who had made an extensive study, over an extended period, of the problems of the backward child and the delinquent child in London, states in his summary and conclusion with regard to the origin of backwardness in the child:

> Both at London and at Birmingham between 60 and 70 per cent belong to the (innately) "dull" category. . . . In the majority the outstanding cause is a general inferiority of intellectual capacity, presumably inborn and frequently hereditary.

In discussing the relationship between general physical weakness and the mentally backward, he writes:

> Old and time-honoured as it must seem to the schoolmaster, the problem of the backward child has never been attacked by systematic research until quite recently. We know little about causes, and still less about treatment. . . . Thirdly, though the vast majority of backward children--80 per cent in an area like London--prove to be suffering from minor bodily ailments or from continued ill-health, nevertheless general physical weakness is rarely the main factor.

Among the many surveys made in the study of the forces that are responsible for producing delinquency and criminality, practically all the workers in this field have testified to the obscure nature of those forces. Burt (12) says that, "it is almost as though crime were some contagious disease, to which the constitutionally susceptible were suddenly exposed at puberty, or to which puberty left them peculiarly prone." He emphasizes a relationship between delinquency and physical deficiency:

> Most repeated offenders are far from robust; they are frail, sickly, and infirm. Indeed, so regularly is chronic moral disorder associated with chronic physical disorder that many have contended that crime is a disease, or at least a symptom of disease, needing the doctor more than the magistrate, physic rather than the whip.
>
> . . . . . .
>
> The frequency among juvenile delinquents of bodily weakness and ill health has been remarked by almost every recent writer. In my own series of cases nearly 70 per cent were suffering from such defects; and nearly 50 per cent were in urgent need of medical treatment. . . . Of all the psychological causes of crime, the commonest and the gravest is usually alleged to be defective mind. The most eminent authorities, employing the most

> elaborate methods of scientific analysis, have been led to enunciate some such belief. In England, for example, Dr. Goring has affirmed that "the one vital mental constitutional factor in the etiology of crime is defective intelligence." In Chicago, Dr. Healy has likewise maintained that among the personal characteristics of the offender "mental deficiency forms the largest single cause of delinquency." And most American investigators would agree.

The assertion of the obscurity of the fundamental causative factors of delinquency constitutes one of the most striking aspects of the extensive literature that has been accumulated through the reporting of intensive studies made by workers in many countries.

Thrasher, (13) in discussing the nature and origin of gangs, expresses this very clearly:

> Gangs are gangs, wherever they are found. They represent a specific type or variety of society, and one thing that is particularly interesting about them is the fact that they are, in respect to their organization, so elementary, and in respect to their origin, so spontaneous.
>
> Formal society is always more or less conscious of the end for which it exists, and the organization through which this end is achieved is always more or less a product of design. But gangs grow like weeds, without consciousness of their aims, and without administrative machinery to achieve them. They are, in fact, so spontaneous in their origin, and so little conscious of the purposes for which they exist, that one is tempted to think of them as predetermined, foreordained, and "instinctive," and so, quite independent of the environment in which they ordinarily are found.

No doubt, many cities have been provided, as has Cleveland, with a special school for delinquent boys. The institution there has been given the appropriate title, the "Thomas A. Edison School." It usually has an enrollment of 800 to 900 boys. Dr. Watson, (14) who has been of outstanding service in the organization of this work, makes an important comment on the origin of the student population there:

> The Thomas A. Edison student population consists of a group of truant and behavior boys, most of them in those earlier stages of mal-adjustment which we have termed predelinquency. . . . In general, they are the products of unhappy experiences in school, home and community. They are sensitive recorders of the total complex of social forces which operate in and combine to constitute what we term their community environment.

It will be seen from these quotations that great emphasis has been placed upon the influence of the environment in determining factors of delinquency.

Hooton, the distinguished physical anthropologist of Harvard, has made important observations regarding our modern physical degeneration. As an approach to this larger problem of man's progressive degeneration, he has proposed the organization and establishment of an Institute of Clinical Anthropology, (15) the purpose of which he has indicated:

> . . . for finding out what man is like biologically when he does not need a doctor, in order to further ascertain what he should be like after the doctor has finished with him. I am entirely serious when I suggest that it is a very myopic medical science which works backward from

the morgue rather than forward from the cradle.

Very important contributions have been made to the forces that are at work in the development of delinquents through an examination of the families in which affected individuals have appeared. Sullenger, (16) in discussing this phase, states:

> Abbott and Breckinridge found in their Chicago studies that a much higher percentage of delinquent boys than girls were from large families. However, Healy and Bronner found in their studies in Chicago and Boston that the large family is conducive to delinquency among children in that the larger the family the greater percentage of cases with more than one delinquent. They were unable to detect whether or not this fact was due to parental neglect, poverty, bad environmental conditions, or the influence of one child on another. In each of the series in both cities the number of delinquents in families of different sizes showed general similarity.

As the investigations outlined in this study are reviewed, many problems not anticipated by the writer when these investigations were undertaken will be presented. These new problems were not, at first, generally thought of as related directly or indirectly to our modern racial degeneration, but have been found recently to be so related.

Since it will be seen that the size and shape of the head and sinuses, including the oral cavity and throat, are directly influenced by forces that are at work in our modern civilization, we shall consider the speaking and singing voice. In traveling among several of the primitive races, one is frequently impressed with the range and resonance of many of the voices--in fact, by almost every voice. We are quite familiar with the high premium that is placed on singing voices of exceptional quality in our modern social order. This is illustrated by the following comment: (17)

> Tip-top Italian-style tenors have always been a scarce commodity, and for the past two decades they have been growing scarcer and scarcer. Opera impresarios count on the fingers of one hand the lust-high-voice Latins. . . . Since the death of Enrico Caruso (1921) opera houses have shown a steady decline.

Important light will be thrown on this phase of the problem--the cause of fewer good voices in Italy today than of old--as we note the narrowing of the face and of the dental arches and as we see the change in the form of the palate of the various primitive races. These changes occur even in the first generation after the parents have adopted the foods of modern white civilizations.

As we study the primitives we will find that they have had an entirely different conception of the nature and origin of the controlling forces which have molded individuals and races.

Buckle, (18) in writing his epoch-making "History of Civilization" about the middle of the last century, summed up his years of historical studies with some very important conclusions, some of which are as follows:

> 2. It is proved by history, and especially by statistics, that human actions are governed by laws as fixed and regular as those which rule in the physical world.

> 3. Climate, soil, food, and the aspects of Nature are the principal causes of intellectual progress.
>
> 6. Religion, literature, and government are, at best, but the products, and not the cause of civilization.

This important view was not orthodox and was met by very severe criticism. The newer knowledge strongly corroborates his view.

My early studies of the relation of nutrition to dental problems were related chiefly to growth defects in the teeth produced long before the eruption of the permanent teeth, chiefly from one year of age to the time of eruption. These often appeared as lines across the teeth. I was able to trace these lines directly to the use of a few highly processed baby foods. I published an extensive report on this phase of the problem, together with illustrations, in 1913. (19) These injuries are disclosed with the x-ray long before the teeth erupt. These disturbances occur much less frequently in connection with the baby foods used today.

The problems of modern degeneration can in general be divided into two main groups, those which relate to the perfection of the physical body and those which relate to its function. The latter include character as expressed in behavior of individuals and of groups of individuals which thus relate to national character and to an entire culture.

In an enumeration of the phases in which there is a progressive decline of modern civilization, it is essential that we keep in mind that in addition to an analysis of the forces responsible for individual degeneration, the ethical standards of the whole group cannot be higher than those of the individuals that compose it. That recent mass degeneration is in progress is attested by daily events throughout the world. The current interpretation for individual character degeneration largely places the responsibility on a conditioning factor which exerts an influence during early childhood and therefore is directly related to the environment of the child. These, therefore, are postnatal conditioning factors. An important contribution to this phase comes directly from the experience of primitive races and indicates that a more fundamental conditioning factor had developed in the prenatal period. If, therefore, large groups of individuals suffer from such a prenatal conditioning influence, new light will be thrown upon the larger problems of group deterioration. History seems to provide records of such mass degeneration as, for example, those which culminated in the so-called "dark ages." That some such mass degeneration is now in progress is suggested by leading students of human welfare. The regius professor of Greek at Oxford in his inaugural lecture in 1937 made the following observation: (20)

> In the revolution of thought through which we are living, the profoundest and most disturbing element is the breakdown of that ethical system which, since the days of Constantine, has imposed upon European culture at least the semblance of moral unity.

In commenting on this important statement Sir Alfred Zimmern in his address on the decline of international standards said that "Recent events should convince the dullest mind of the extent to which international standards have deteriorated and the anarchy which threatens the repudiation of

law and order in favour of brute force."

The problem of progressive decline in individual and group ethical standards is commanding the attention of great international organizations. In discussing this problem before the International Rotary at its meeting in San Francisco in June, 1938, one of the leaders in mass reform, Mayor Harold Burton of Cleveland, stressed very important phases. He stated that the American boys "are making irrevocable choices" between good and bad citizenship which "may make or wreck the nation. It may be on the battlefield of crime prevention that the life of democracy will be saved." He described great industrial cities as battlefields where "the tests of democracy are the newest and sharpest." (21) . . . "For centuries," he said:

> . . . we have fought crime primarily by seeking to catch the criminal after the crime has been committed and then through his punishment to lead or drive him and others to good citizenship. Today the greater range of operation and greater number of criminals argue that we must deal with the flood waters of crime. We must prevent the flood by study, control and diversion of the waters at their respective sources. To do this we must direct the streams of growing boys in each community away from fields of crime to those of good citizenship.

If the "flood waters" that must be controlled lie farther back than the cradle, in order to safeguard individual character and individual citizenship from prenatal conditioning factors which have profound influence in determining the reaction of the individuals to the environment, it is essential that programs that are to be efficient in maintaining national character reach back to those forces which are causing the degeneration of increasing numbers of the population in succeeding generations of our modern cultures.

That the problem of mass degeneration constitutes one of the most alarming problems of our modernized cultures is demonstrated by the urgency of appeals that are being made by students in national and international affairs. The discussion of "An Ethical Declaration for the Times," (22) a declaration of faith, is accompanied by a pledge. This pledge reads:

> I pledge myself to use every opportunity for action to uphold the great tradition of civilization to protect all those who may suffer for its sake, and to pass it on to the coming generations. I recognized no loyalty greater than that to the task of preserving truth, toleration, and justice in the coming world order.

The author emphasizes the great danger of taking for granted that the cultural progress that has been attained will continue. There is probably no phase of this whole problem of modern degeneration that is so brilliantly illuminated by the accumulated wisdom of primitive races as group degeneration. They have so organized the life of the family and the individual that the nature of the forces which established individual behavior and character are controlled.

Our problem of modern degeneration involves both individual and group destiny. Our approach to this study will, accordingly, involve first a critical examination of the forces that are responsible for individual degeneration.

In my search for the cause of degeneration of the human face and the dental organs I have been

unable to find an approach to the problem through the study of affected individuals and diseased tissues. In my two volume work on "Dental Infections," Volume I, entitled "Dental Infections, Oral and Systemic," and Volume II, entitled "Dental Infections and the Degenerative Diseases," (23) I reviewed at length the researches that I had conducted to throw light on this problem. The evidence seemed to indicate clearly that the forces that were at work were not to be found in the diseased tissues, but that the undesirable conditions were the result of the absence of something, rather than of the presence of something. This strongly indicated the need for finding groups of individuals so physically perfect that they could be used as controls. In order to discover them, I determined to search out primitive racial stocks that were free from the degenerative processes with which we are concerned in order to note what they have that we do not have. These field investigations have taken me to many parts of the world through a series of years. The following chapters review the studies made of primitive groups, first, when still protected by their isolation, and, second, when in contact with modern civilization.

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Chapter 3

ISOLATED AND MODERNIZED SWISS

IN ORDER to study the possibility of greater nutritive value in foods produced at a high elevation, as indicated by a lowered incidence of morbidity, including tooth decay, I went to Switzerland and made studies in two successive years, 1931 and 1932. It was my desire to find, if possible, groups of Swiss living in a physical environment such that their isolation would compel them to live largely on locally produced foods. Officials of the Swiss Government were consulted as to the possibility of finding people in Switzerland whose physical isolation provided an adequate protection. We were told that the physical conditions that would not permit people to obtain modern foods would prevent us from reaching them without hardship. However, owing to the completion of the Loetschberg Tunnel, eleven miles long, and the building of a railroad that crosses the Loetschental Valley, at a little less than a mile above sea level, a group of about 2,000 people had been made easily accessible for study, shortly prior to 1931. Practically all the human requirements of the people in that valley, except a few items like sea salt, have been produced in the valley for centuries.

A bird's eye view of the Loetschental Valley, looking toward the entrance, is shown in Fig. 1. The people of this valley have a history covering more than a dozen centuries. The architecture of their wooden buildings, some of them several centuries old, indicates a love for simple stability, adapted to expediency and efficiency. Artistically designed mottoes, many of them centuries old, are carved deep in the heavy supporting timbers, both within and without the buildings. They are always expressive of devotion to cultural and spiritual values rather than to material values. These people have never been conquered, although many efforts have been made to invade their valley. Except for the rugged cleft through which the river descends to the Rhone Valley, the Loetschental Valley is almost completely enclosed by three high mountain ranges which are usually snow-capped. This pass could be guarded by a small band against any attacking forces since artificial landslides could easily be released. The natural occurrence of these landslides has made passage through the gorge hazardous, if not impossible, for months of the year. According to early legends of the valley these mountains were the parapets of the universe, and the great glacier of the valley, the end of the universe. The glacier is a branch of the great ice field that stretches away to the west and south from the ice-cap of the Jungfrau and Monch. The mountains, however, are seldom approached from this direction because of the hazardous ice fields. The gateway to them with which the traveling world is familiar is from Interlaken by way of the Lauterbrunnen or Grindelwald valleys.

Fig. 1. Beautiful Loetschental Valley about a mile above sea level. About two thousand Swiss live here. In 1932 no deaths had occurred from tuberculosis in the history of the valley.

At the altitude of the Loetschental Valley the winters are long, and the summers short but beautiful, and accompanied by extraordinarily rapid and luxuriant growth. The meadows are fragrant with Alpine flowers, with violets like pansies, which bloom all summer in deepest hues.

The people of the Loetschental Valley make up a community of two thousand who have been a world unto themselves. They have neither physician nor dentist because they have so little need for them; they have neither policeman nor jail, because they have no need for them. The clothing has been the substantial homespuns made from the wool of their sheep. The valley has produced not only everything that is needed for clothing, but practically everything that is needed for food. It has been the achievement of the valley to build some of the finest physiques in all Europe. This is attested to by the fact that many of the famous Swiss guards of the Vatican at Rome, who are the admiration of the world and are the pride of Switzerland, have been selected from this and other Alpine valleys. It is every Loetschental boy's ambition to be a Vatican guard. Notwithstanding the fact that tuberculosis is the most serious disease of Switzerland, according to a statement given me by a government official, a recent report of inspection of this valley did not reveal a single case. I was aided in my studies in Switzerland by the excellent cooperation of the Reverend John Siegen, the pastor of the one church of this beautiful valley.

The people live largely in a series of villages dotting the valley floor along the river bank. The land that is tilled, chiefly for producing hay for feeding the cattle in the winter and rye for feeding the people, extends from the river and often rises steeply toward the mountains which are wooded with timber so precious for protection that little of it has been disturbed. Fortunately, there is much more on the vast area of the mountain sides than is needed for the relatively small population. The forests have been jealously guarded because they are so greatly needed to prevent slides of snow and rocks which might engulf and destroy the villages.

The valley has a fine educational system of alternate didactic and practical work. All children are required to attend school six months of the year and to spend the other six months helping with the

farming and dairying industry in which young and old of both sexes must work. The school system is under the direct supervision of the Catholic Church, and the work is well done. The girls are also taught weaving, dyeing and garment making. The manufacture of wool and clothing is the chief homework for the women in the winter.

No trucks nor even horses and wagons, let alone tractors, are available to bear the burdens up and down the mountain sides. This is all done on human backs for which the hearts of the people have been made especially strong.

We are primarily concerned here with the quality of the teeth and the development of the faces that are associated with such splendid hearts and unusual physiques. I made studies of both adults and growing boys and girls, during the summer of 1931, and arranged to have samples of food, particularly dairy products, sent to me about twice a month, summer and winter. These products have been tested for their mineral and vitamin contents, particularly the fat-soluble activators. The samples were found to be high in vitamins and much higher than the average samples of commercial dairy products in America and Europe, and in the lower areas of Switzerland.

Hay is cut for winter feeding of the cattle, and this hay grows rapidly. The hay proved, on chemical analysis made at my laboratory, to be far above the average in quality for pasturage and storage grasses. Almost every household has goats or cows or both. In the summer the cattle seek the higher pasturage lands and follow the retreating snow which leaves the lower valley free for the harvesting of the hay and rye. The turning of the soil is done by hand, since there are neither plows nor draft animals to drag the plows, in preparation for the next year's rye crop. A limited amount of garden stuff is grown, chiefly green foods for summer use. While the cows spend the warm summer on the verdant knolls and wooded slopes near the glaciers and fields of perpetual snow, they have a period of high and rich productivity of milk. The milk constitutes an important part of the summer's harvesting. While the men and boys gather in the hay and rye, the women and children go in large numbers with the cattle to collect the milk and make and store cheese for the following winter's use. This cheese contains the natural butter fat and minerals of the splendid milk and is a virtual storehouse of life for the coming winter.

From Dr. Siegen, I learned much about the life and customs of these people. He told me that they recognize the presence of Divinity in the life-giving qualities of the butter made in June when the cows have arrived for pasturage near the glaciers. He gathers the people together to thank the kind Father for the evidence of his Being in the life-giving qualities of butter and cheese made when the cows eat the grass near the snow line. This worshipful program includes the lighting of a wick in a bowl of the first butter made after the cows have reached the luscious summer pasturage. This wick is permitted to burn in a special sanctuary built for the purpose. The natives of the valley are able to recognize the superior quality of their June butter, and, without knowing exactly why, pay it due homage.

The nutrition of the people of the Loetschental Valley, particularly that of the growing boys and girls, consists largely of a slice of whole rye bread and a piece of the summer-made cheese (about as large as the slice of bread), which are eaten with fresh milk of goats or cows. Meat is eaten about once a week. In the light of our newer knowledge of activating substances, including vitamins, and

the relative values of food for supplying minerals for body building, it is clear why they have healthy bodies and sound teeth. The average total fat-soluble activator and mineral intake of calcium and phosphorus of these children would far exceed that of the daily intake of the average American child. The sturdiness of the child life permits children to play and frolic bareheaded and barefooted even in water running down from the glacier in the late evening's chilly breezes, in weather that made us wear our overcoats and gloves and button our collars. Of all the children in the valley still using the primitive diet of whole rye bread and dairy products the average number of cavities per person was 0.3. On an average it was necessary to examine three persons to find one defective deciduous or permanent tooth. The children examined were between seven and sixteen years of age.

If one is fortunate enough to be in the valley in early August and witness the earnestness with which the people celebrate their national holiday, he will be privileged to see a sight long to be remembered. These celebrations close with the gathering together of the mountaineers on various crags and prominences where great bonfires are lighted from fuel that has been accumulated and built into an enormous mound to make a huge torchlight. These bonfires are lighted at a given hour from end to end of the valley throughout its expanse. Every mountaineer on a distant crag seeing the lights knows that the others are signalling to him that they, too, are making their sacred consecration in song which says one for all and all for one." This motive has been crystallized into action and has become a part of the very souls of the people. One understands why doors do not need to be bolted in the Loetschental Valley.

How different the level of life and horizon of such souls from those in many places in the so-called civilized world in which people have degraded themselves until life has no interest in values that cannot be expressed in gold or pelf, which they would obtain even though the life of the person being cheated or robbed would thereby be crippled or blotted out.

One immediately wonders if there is not something in the life-giving vitamins and minerals of the food that builds not only great physical structures within which their souls reside, but builds minds and hearts capable of a higher type of manhood in which the material values of life are made secondary to individual character. In succeeding chapters we will see evidence that this is the case.

Our quest has been for information relative to the health of the body, the perfection of the teeth, and the normality of development of faces and dental arches, in order that we might through an analysis of the foods learn the secret of such splendid body building and learn from the people of the valley how the nutrition of all groups of people may be reinforced, so that they, too, may be free from mankind's most universal disease, tooth decay and its sequelae. These studies included not only the making of a physical examination of the teeth, the photographing of subjects, the recording of voluminous data, the obtaining of samples of food for chemical analysis, the collecting of detailed information regarding daily menus; but also the collecting of samples of saliva for chemical analysis. The chemical analysis of saliva was used to test out my newly developed procedure for estimating the level of immunity to dental caries for a given person at a given time. This procedure is outlined in following chapters. The samples of saliva were preserved by an addition of formalin equivalent in amount to one per cent of the sample of saliva.

These children will, it is hoped, be reexamined in succeeding years in order to make comparative

studies of the effect of the changes in the local nutritional programs. Some of these changes are already in progress. There is now a modern bakery dispensing white bread and many white-flour products which was in full operation in 1932.

I inquired of many persons regarding the most favorable districts in which to make further studies of groups of people living in protected isolation because of their physical environment, and decided to study some special high Alpine valleys between the Rhone Valley and Italy, which I included in 1932. The Canton of Wallis is bordered by French-speaking people on the west, by Italian-speaking people on the south, and by German-speaking people on the east and north. I had as guides and interpreters in Wallis, Dr. Alfred Gysi and also Dr. Adolf Roos through part of the territory.

Our first expedition was into the valley of the Visp which is a great gorge extending southward from the Rhone River, dividing into two gorges, one going to the Saas Fee country, and the other to the vicinity of the Matterhorn with its almost spirelike pinnacle lifting itself above the surrounding snow-capped mountains and visible from eminences in all directions as one of the mightiest and most sublime spectacles in the world. It was one of the last mountains of Europe to be scaled by man. One has not seen the full majesty of the Alps if he has not seen the Matterhorn.

We left the mountain railroad, which makes many of the grades with the cog system, at the town of St. Nicholas, and climbed the mountain trail to an isolated settlement on the east bank of the Mattervisp River, called Grachen, a five-hour journey. The settlement is on a shelf high above the east side of the river where it is exposed to southern sunshine and enjoys a unique isolation because of its physical inaccessibility. An examination made of the children in this community showed that only 2.3 teeth out of every hundred had been attacked by tooth decay.

The hardihood of the people was splendidly illustrated by a woman of 62 years who carried an enormous load of rye on her back at an altitude of about 5,000 feet. We met her later and talked to her, and found that she was extraordinarily well developed and well preserved. She showed us her grandchildren who had fine physiques and facial developments.

The rye is so precious that while being carried the heads are protected by wrapping them in canvas so that not a kernel will be lost. The rye is thrashed by hand and ground in stone mills which were formerly hand-turned like the one shown in Fig. 2. Recently water turbines have been installed. Water power is abundant and the grinding is done for the people of the mountain side in these water-driven mills. Only wholerye flour is available. Each household takes turns in using the community bake-oven, which is shown in Fig. 2. A month's supply of whole-rye bread is baked at one time for a given family.

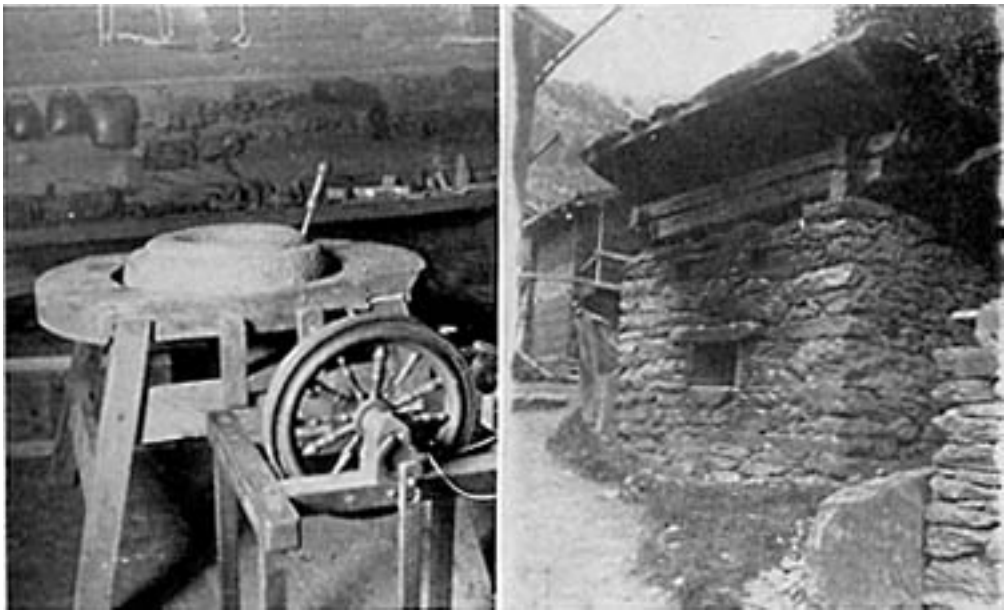

FIG. 2. For centuries the natives ground their rye in this type of hand mill. This community bake-oven for whole rye bread is passing.

Here again the cows were away in the midsummer, pasturing up near the glaciers. Grachen has an altitude of about 5,000 feet. The church at Grachen was built several hundred years ago. We were shown an embossed certificate of honor and privilege extended to a group of about 120 people who had originally built the edifice. We were given valued assistance by the local priest, and were provided with facilities in his spacious and well-kept rooms for making our studies of the children.

From Grachen we returned to St. Nicholas and proceeded from there by train down the valley and up another steep ascent, requiring several hours, to the hamlet of Visperterminen, on the east side of the mountain above the Visp River, and below the junction of the Mattervisp and Saaservisp. This community is made up of about 1,600 people living on a sheltered shelf high above the river valley. The view from this position is indescribably beautiful. It is a little below the timber line of this and the surrounding mountains. Majestic snow-clad peaks and precipitous mountains dot the horizon and shade off into winding gorges which mark the course of wandering streams several thousand feet below our vantage point. It is a place to stop and ponder.

The gradations in climate range in the summer from a tropical temperature in protected nooks during the daytime to sub-zero weather with raging blizzards at night on the high mountains. It is a place where human stamina can be tempered to meet all the vicissitudes of life.

The village consists of a group of characteristically designed Swiss chalets clustered on the mountain side. The church stands out as a beacon visible from mountains in all directions. Visperterminen is unique in many respects. Notwithstanding its relative proximity to civilization--it is only a few hours' journey to the thoroughfare of the Rhone Valley--it has enjoyed isolation and opportunity for maintaining its characteristic primitive social and civil life. We were greeted here by the president of the village who graciously opened the school house and sent messengers to have the children of the community promptly come to the school building in order that we might make such studies as we desired. This study included a physical examination of the teeth and of the general development of the children, particularly of the faces and dental arches, the making of photographic records, the obtaining of samples of saliva, as in other places, and also the making of a detailed study

of the nutrition. In addition, we obtained samples of foods for chemical analysis.

The people of Visperterminen have the unique distinction of owning land in the lower part of the mountain on which they maintain vineyards to supply wine for this country. They have the highest vineyards of Europe. They are grown on banks that are often so steep that one wonders how the tillers of the soil or the gatherers of the fruit can maintain their hold on the precarious and shifting footing. Each terrace has a trench near its lower retaining wall to catch the soil that is washed down, and this soil must be carried back in baskets to the upper boundary of the plot. This is all done by human labor. The vineyards afforded them the additional nutrition of wine and of fruit minerals and vitamins which the two groups we studied at Loetschental and Grachen did not have.

This additional nutrition was of importance because of the opportunity for obtaining through it vitamin C. It is of particular interest in the study of the incidence of tooth decay in Visperterminen that these additional factors had not created a higher immunity to tooth decay, nor a better condition of health in gingival tissues than previously found. In each one hundred teeth examined 5.2 were found to have been attacked at some time by tooth decay. Here again the nutrition consisted of rye, used almost exclusively as the cereal; of dairy products; of meat about once a week; and also some potatoes. Limited green foods were eaten during the summer. The general custom is to have a sheep dressed and distributed to a group of families, thus providing each family with a ration of meat for one day a week, usually Sunday. The bones and scraps are utilized for making soups to be served during the week. The children have goat's milk in the summer when the cows are away in the higher pastures near the snow line. Certain members of the families go to the higher pastures with the cows to make cheese for the coming winter's use.

The problem of identifying goats or cattle for establishing individual ownership is a considerable one where the stock of all are pastured in common herds. It was interesting to us to observe how this problem was met. The president of the village has what is called a "tessel" which is a string of manikins in imitation of goats or cattle made of wood and leather. Every stock owner must provide a manikin to be left in the safekeeping of the president of the village with whom it is registered. It carries on it the individual markings that this member of the colony agrees to put on every member of his animal stock. The marking may be a hole punched in the left ear or a slit in the right ear, or any combination of such markings as is desired. Thereafter all animals carrying that mark are the property of the person who registered it; similarly, any animals that have not this individual symbol of identification cannot be claimed by him.

As one stands in profound admiration before the stalwart physical development and high moral character of these sturdy mountaineers, he is impressed by the superior types of manhood, womanhood, and childhood that Nature has been able to produce from a suitable diet and a suitable environment. Surely, here is evidence enough to answer the question whether cereals should be avoided because they produce acids in the system which if formed will be the cause of tooth decay and many other ills including the acidity of the blood or saliva. Surely, the ultimate control will be found in Nature's laboratory where man has not yet been able to meddle sufficiently with Nature's nutritional program to blight humanity with abnormal and synthetic nutrition. When one has watched for days the childlife in those high Alpine preserves of superior manhood; when one has contrasted these people with the pinched and sallow, and even deformed, faces and distorted bodies that are produced by our modern civilization and its diets; and when one has contrasted the unsurpassed

beauty of the faces of these children developed on Nature's primitive foods with the varied assortment of modern civilization's children with their defective facial development, he finds himself filled with an earnest desire to see that this betterment is made available for modern civilization.

Again and again we had the experience of examining a young man or young woman and finding that at some period of his life tooth decay had been rampant and had suddenly ceased; but, during the stress, some teeth had been lost. When we asked such people whether they had gone out of the mountain and at what age, they generally replied that at eighteen or twenty years of age they had gone to this or that city and had stayed a year or two. They stated that they had never had a decayed tooth before they went or after they returned, but that they had lost some teeth in the short period away from home.

At this point of our studies Dr. Roos found it necessary to leave, but Dr. Gysi accompanied us to the Anniviers Valley, which is also on the south side of the Rhone. The river of the valley, the Navizenze, drains from the high Swiss and Italian boundary north to the Rhone River. Here again we had the remarkable experience of finding communities near to each other, one blessed with high immunity to tooth decay, and the other afflicted with rampant tooth decay.

The village of Ayer lies in a beautiful valley well up toward the glaciers. It is still largely primitive, although a government road has recently been developed, which, like many of the new arteries, has made it possible to dispatch military protection when and if necessary to any community. In this beautiful hamlet, until recently isolated, we found a high immunity to dental caries. Only 2.3 teeth out of each hundred examined were found to have been attacked by tooth decay. Here again the people were living on rye and dairy products. We wonder if history will repeat itself in the next few years and if there, too, this enviable immunity will be lost with the advent of the highway. Usually it is not long after tunnels and roads are built that automobiles and wagons enter with modern foods, which begin their destructive work. This fact has been tragically demonstrated in this valley since a roadway was extended as far as Vissoie several years ago. In this village modern foods have been available for some time. One could probably walk the distance from Ayer to Vissoie in an hour. The number of teeth found to be attacked with caries for each one hundred children's teeth examined at Vissoie was 20.2 as compared with 2.3 at Ayer. We had here a splendid opportunity to study the changes that had occurred in the nutritional programs. With the coming of transportation and new markets there had been shipped in modern white flour; equipment for a bakery to make white-flour goods; highly sweetened fruit, such as jams, marmalades, jellies, sugar and syrups--all to be traded for the locally produced high-vitamin dairy products and high-mineral cheese and rye; and with the exchange there was enough money as premium to permit buying machine-made clothing and various novelties that would soon be translated into necessities.

Each valley or village has its own special feast days of which athletic contests are the principal events. The feasting in the past has been largely on dairy products. The athletes were provided with large bowls of cream as constituting one of the most popular and healthful beverages, and special cheese was always available. Practically no wine was used because no grapes grew in that valley, and for centuries the isolation of the people prevented access to much material that would provide wine. In the Visperterminen community, however, the special vineyards owned by these people on the lower level of the mountain side provided grape juice in various stages of fermentation, and their

feasts in the past have been celebrated by the use of wines of rare vintage as well as by the use of cream and other dairy products. Their cream products took the place of our modern ice cream. It was a matter of deep interest to have the President of Visperterminen show us the tankards that had been in use in that community for nine or ten centuries. The care of these was one of the many responsibilities of the chief executive of the hamlet.

It is reported that practically all skulls that are exhumed in the Rhone valley, and, indeed, practically throughout all of Switzerland where graves have existed for more than a hundred years, show relatively perfect teeth; whereas the teeth of people recently buried have been riddled with caries or lost through this disease. It is of interest that each church usually has associated with it a cemetery in which the graves are kept decorated, often with beautiful designs of fresh or artificial flowers. Members of succeeding generations of families are said to be buried one above the other to a depth of many feet. Then, after a sufficient number of generations have been so honored, their bodies are exhumed to make a place for present and coming generations. These skeletons are usually preserved with honor and deference. The bones are stacked in basements of certain buildings of the church edifice with the skulls facing outward. These often constitute a solid wall of considerable extent. In Naters there is such a group said to contain 20,000 skeletons and skulls. These were studied with great interest as was also a smaller collection in connection with the cathedral at Visp. While many of the single straight-rooted teeth had been lost in the handling, many were present. It was a matter of importance to find that only a small percentage of teeth had had caries. Teeth that had been attacked with deep caries had developed apical abscesses with consequent destruction of the alveolar processes. Evidence of this bone change was readily visible. Sockets of missing teeth still had continuous walls, indicating that the teeth had been vital at death.

The reader will scarcely believe it possible that such marked differences in facial form, in the shape of the dental arches, and in the health condition of the teeth as are to be noted when passing from the highly modernized lower valleys and plains country in Switzerland to the isolated high valleys can exist. Fig. 3 shows four girls with typically broad dental arches and regular arrangement of the teeth. They have been born and raised in the Loetschental Valley or other isolated valleys of Switzerland which provide the excellent nutrition that we have been reviewing. They have been taught little regarding the use of tooth brushes. Their teeth have typical deposits of unscrubbed mouths; yet they are almost completely free from dental caries, as are the other individuals of the group they represent. In a study of 4,280 teeth of the children of these high valleys, only 3.4 per cent were found to have been attacked by tooth decay. This is in striking contrast to conditions found in the modernized sections using the modern foods.

FIG. 3. Normal design of face and dental arches when adequate nutrition is provided for both the parents and the children. Note the well developed nostrils.

In Loetschental, Grachen, Visperterminen and Ayer, we have found communities of native Swiss living almost exclusively on locally produced foods consisting of the cereal, rye, and the animal product, milk, in its various forms. At Vissoie, with its available modern nutrition, there has been a complete change in the level of immunity to dental caries. It is important that studies be made in other communities which correspond in altitude with the first four places studied in which there was a high immunity to dental caries. Modern foods should be available in the new communities selected for comparative study. To find such places one would naturally think of those that are world-famed as health resorts providing the best things that modern science and industry can assemble. Surely St. Moritz would be such a place. It is situated in the southeastern part of the Republic of Switzerland near the headwaters of the Danube in the upper Engadin. This world-famous watering place attracts people of all continents for both summer and winter health building and for the enjoyment of the mountain lakes, snow-capped peaks, forested mountain sides, and crystal clear atmosphere with abundance of sunshine.

The journey from the Canton of Wallis (Valais) to the upper Engadin takes one up the Rhone valley, climbing continually to get above cascades and beautiful waterfalls until one comes to the great Rhone glacier which blocks the end of the valley. The water gushes from beneath the mountain of ice to become the parent stream of the Rhone river which passes westward through the Rhone valley receiving tributaries from snow-fed streams from both north and south watersheds, as it rolls westward to the beautiful Lake Geneva and then onward west and south to the Mediterranean.

It is of significance that a study of the child life in the Rhone valley, as made by Swiss officials and reported by Dr. Adolf Roos and his associates, shows that practically every child had tooth decay and the majority of the children had decay in an aggravated form. People of this valley are provided with adequate railroad transportation for bringing them the luxuries of the world. As we pass eastward over the pass through Andermatt, we are reminded that the trains of the St. Gotthard tunnel go thundering through the mountain a mile below our feet en route to Italy. To reach our goal, the beautiful modern city and summer resort of St. Moritz, we enter the Engadin country famed for its beauty and crystal-clear atmosphere. We already know something of the beauty that awaits us which has attracted pleasure seekers and beauty lovers of the world to St. Moritz. One would scarcely expect to see so modern a city as St. Mortiz at an altitude of a little over a mile, with little else to attract people than its climate in winter and summer, the magnificent scenery, and the clear atmosphere. We have passed from the communities where almost everyone wears homespuns to one of English walking coats and the most elegant of feminine attire. Everyone shows the effect of contact with culture. The hotels in their appointments and design are reminiscent of Atlantic City. Immediately one sees something is different here than in the primitive localities: the children have not the splendidly developed features, and the people give no evidence of the great physical reserve that is present in the smaller communities.

Through the kindness of Dr. William Barry, a local dentist, and through that of the superintendent of the public schools, we were invited to use one of the school buildings for our studies of the children. The summer classes were dismissed with instructions that the children be retained so that we could have them for study. Several factors were immediately apparent. The teeth were shining and clean, giving eloquent testimony of the thoroughness of the instructions in the use of the modern dentifrices for efficient oral prophylaxis. The gums looked better and the teeth more beautiful for having the debris and deposits removed. Surely this superb climate, this magnificent setting, combined with the best of the findings of modern prophylactic science, should provide a 100-per-cent immunity to tooth decay. But in a study of the children from eight to fifteen years of age, 29.8 per cent of the teeth had already been attacked by dental caries. Our study of each case included careful examining of the mouth; photographing of the face and teeth; obtaining of samples of saliva for chemical analysis; and a study of the program of nutrition followed by the given case. In most cases, the diet was strikingly modern, and the only children found who did not have tooth decay proved to be children who were eating the natural foods, whole rye bread and plenty of milk.

In Chapter 15, a detailed discussion of the chemical differences in the food constituents is presented for both the districts subject to immunity, and for those subject to susceptibility.

I was told by a former resident of this upper Engadin country that in one of the isolated valleys

only a few decades ago the children were still carrying their luncheons to school in the form of roasted rye carried dry in their pockets. Their ancestors had eaten cereal in this dry form for centuries.

St. Moritz is a typical Alpine community with a physical setting lar to that in the Cantons of Bern and Wallis (Valais). It is, however, provided with modern nutrition consisting of an abundance of white-flour products, marmalades, jams, canned vegetables, confections, and fruits--all of which are transported to the district. Only a limited supply of vegetables is grown locally. We studied some children here whose parents retained their primitive methods of food selection, and without exception those who were immune to dental caries were eating a distinctly different food from those with high susceptibility to dental caries.

Few countries of the world have had officials so untiring in their efforts to study and tabulate the incidence of dental caries in various geographic localities as has Switzerland. In the section lying to the north and east, and near Lake Constance, there is a considerable district where it is reported that 100 per cent of the people are suffering from dental caries. In almost all the other parts of Switzerland in which the population is large 95 to 98 per cent of the people suffer from dental caries. Of the two remaining districts, in one there is from 90 to 95 per cent and in the other from 85 to 90 per cent individual susceptibility to dental caries. Since in the district in the vicinity of Lake Constance the incidence of dental caries is so high that it is recorded as 100 per cent, it seemed especially desirable to make a similar critical study there and to obtain samples of saliva and detailed information regarding the food, and to make detailed physical examinations of growing children in this community, and through the great kindness of Dr. Hans Eggenberger, Director of Public Health for this general district, we were given an opportunity to do so.

Arrangements were made by Dr. Eggenberger so that typical groups of children, some in institutions, could be studied. He is located at Herisau in the Canton of St. Gall. We found work well organized for building up the health of these children in so far as outdoor treatment, fresh air, and sunshine were concerned. As dental caries is a major problem, and probably nutritional, it is treated by sunshine. The boys' group and girls' group are both given suitable athletic sports under skillfully trained directors. These groups are located in different parts of the city. Their recreation grounds are open lawns adjoining wooded knolls which give the children protection and isolation in which to play in their sunsuits and build vigorous appetites, and thus to prepare for their institutional foods which were largely from a modern menu. Critical dental examinations were made and an analysis of the data obtained revealed that one-fourth of all teeth of these growing boys and girls had already been attacked by dental caries, and that only 4 per cent of the children had escaped from the ravages of tooth decay, which disease many of them had in an aggravated form.

In the Herisau group 25.5 per cent of the 2,065 teeth examined had been attacked by dental caries and many teeth were abscessed. The upper photographs in Fig. 4 are of two girls with typically rampant tooth decay. The one to the left is sixteen years of age and several of her permanent teeth are decayed to the gum line. Her appearance is seriously marred, as is also that of the girl to the right.

Another change that is seen in passing from the isolated groups with their more nearly normal facial developments, to the groups of the lower valleys, is the marked irregularity of the teeth with narrowing of the arches and other facial features. In the lower half of Fig. 4 may be seen two such

cases. While in the isolated groups not a single case of a typical mouth breather was found, many were seen among the children of the lower-plains group. The children studied were from ten to sixteen years of age.

Fig. 4. In the modernized districts of Switzerland tooth decay is rampant. The girl, upper left, is sixteen and the one to the right is younger. They use white bread and sweets liberally. The two children below have very badly formed dental arches with crowding of the teeth. this deformity is not due to heredity.

Many individuals in the modernized districts bore on their faces scars which indicated that the abscess of an infected tooth had broken through to the external surface where it had developed a fistula with resultant scar tissue, thus producing permanent deformity.

Bad as these conditions were, we were told that they were better than the average for the community. The ravages of dental caries had been strikingly evident as we came in contact with the local and traveling public. As we had at St. Moritz, we found an occasional child with much better teeth than the average. Usually the answer was not far to seek. For example, in one of the St. Moritz groups, in a class of sixteen boys, there were 158 cavities, or an average of 9.8 cavities per person

(fillings are counted as cavities). In the cases of three other children in the same group, there were only three cavities, and one case was without dental caries. Two of these three had been eating dark bread or entire-grain bread, and one was eating dark bread and oatmeal porridge. All three drank milk liberally.

When looking here for the source of dairy products one is impressed by the absence of cows at pasture in the plains of Switzerland, areas in which a large percentage of the entire population resides. True, one frequently sees large laiteries or creameries, but the cows are not in sight. On asking the explanation for this, I found that a larger quantity of milk could be obtained from the cows if they were kept in the stables during the period of high production. Indeed, this was a necessity in most of these communities since there were so few fences, and during the time of the growth of the crops, including the stock feed for the winter's use, it was necessary that the cows be kept enclosed. About the only time that cows were allowed out on pasture was in the fall after the crops had been harvested and while the stubble was being plowed.

Among the children in St. Moritz and Herisau, those groups with the lower number of cavities per person were using milk more or less liberally. Of the total number of children examined in both places only 11 per cent were using milk in their diets, whereas 100 per cent of the children in the other districts that provided immunity were using milk. Nearly every child in St. Moritz was eating white bread. In Herisau, all but one of the children examined were eating white bread in whole or in principal part.

Since so many cattle were stall-fed in the thickly populated part of Switzerland, and since so low a proportion of the children used milk even sparingly, I was concerned to know what use was made of the milk. Numerous road signs announcing the brand of sweetened milk chocolate made in the several districts suggested one use. This chocolate is one of the important products for export and as a beverage constitutes a considerable item in the nutrition of large numbers living in this and in other countries. It is recognized as a high source of energy, primarily because of the sugar and chocolate which when combined with the milk greatly reduces the ratio of the minerals to the energy factors as expressed in calories.

It was formerly thought that dental caries which was so rampant in the greater portion of Switzerland was due in part to low iodine content in the cattle feed and in other food because of iodine deficiency in the soil. Large numbers of former generations suffered from clinical goiter and various forms of thyroid disturbances. That this is not the cause seems clearly demonstrated by the fact that dental caries is apparently as extensive today as ever before, if not more so, while the iodine problem has been met through a reinforcement of the diet of growing children and others in stress periods with iodine in suitable form. Indeed the early work done in Cleveland by Crile, Marine, and Kimball was referred to by the medical authorities there as being the forerunner of the control of the thyroid disorder in these communities.

The officials of the Herisau community were so deeply concerned regarding the prevalence of dental caries that they were carrying forward institutional and community programs with the hope of checking this affliction. If dental caries were primarily the result of an inadequate amount of vitamin D, then sunning the patients should provide an adequate reinforcement. This is one of the principal

purposes for getting the growing boys and girls of the community into sunsuits for tanning their bodies.

Another procedure to which my attention was called consisted of adding to the bread a product high in lime, which was being obtained in the foothills of the district. This and other types of bread were studied by chemical analyses. Clinically, tooth decay was not reduced.

I made an effort to establish a clinic in a neighboring town for the purpose of demonstrating with a group of children that dental caries can be controlled by a simple nutritional program. An interesting incident developed in connection with the selection of the children for this experimental group. When parents were asked to permit their children to have one meal a day reinforced, according to a program that has proved adequate with my clinical groups in Cleveland, the objection was made that there was no use trying to save the teeth of the girls. The girls should have all their teeth extracted and artificial teeth provided before they were married, because if they did not they would lose them then.

It is of interest that the southern part of Switzerland including the high Alpine country is largely granite. The hills in the northern part of Switzerland are largely limestone in origin. A great number of people live in the plain between these two geologic formations, a plain which is largely made of alluvial deposits which have been washed down from the upper formations. The soil is extraordinarily fertile soil and has supported a thrifty and healthy population in the past.

When I asked a government official what the principal diseases of the community were, he said that the most serious and most universal was dental caries, and the next most important, tuberculosis; and that both were largely modern diseases in that country.

When I visited the famous advocate of heliotherapy, Dr. Rollier, in his clinic in Leysin, Switzerland, I wondered at the remarkable results he was obtaining with heliotherapy in nonpulmonary tuberculosis. I asked him how many patients he had under his general supervision and he said about thirty-five hundred. I then asked him how many of them come from the isolated Alpine valleys and he said that there was not one; but that they were practically all from the Swiss plains, with some from other countries.

I inquired of several clinicians in Switzerland what their observations were with regard to the association of dental caries and tuberculosis among the people of Switzerland. I noted that the reports indicated that the two diseases were generally associated. We will find a corollary to this in many studies in other parts of the world.

These studies in Switzerland, as briefly presented here, seem to demonstrate that the isolated groups dependent on locally produced natural foods have nearly complete natural immunity to dental caries, and that the substitution of modern dietaries for these primitive natural foods destroys this immunity whether in ideally located elevated districts like St. Moritz or in the beautiful and fertile plains of lower Switzerland. The question seems to answer itself in a general way, without much laboratory data, from the results of a critical examination of the foods. The laboratory analyses, however, identify the particular factors in the foods which are primarily responsible by their presence for establishing immunity, and by their absence in inducing susceptibility to dental caries. These

chemical data are discussed in Chapter 15.

High immunity to dental caries, freedom from deformity of the dental arches and face, and sturdy physiques with high immunity to disease were all found associated with physical isolation, and with forced limitation in selection of foods. This resulted in a very liberal use of dairy products and whole-rye bread, in connection with plant foods, and with meat served about once a week.

The individuals in the modernized districts were found to have widespread tooth decay. Many had facial and dental arch deformities and much susceptibility to diseases. These conditions were associated with the use of refined cereal flours, a high intake of sweets, canned goods, sweetened fruits, chocolate; and a greatly reduced use of dairy products.

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Chapter 4

ISOLATED AND MODERNIZED GAELICS

STORIES have long been told of the superb health of the people living in the Islands of the Outer Hebrides. The smoke oozing through the thatched roofs of their "black houses" has added weirdness to the description of their home life and strange environment. These stories have included a description of their wonderfully fine teeth and their stalwart physiques and strong characters. They, accordingly, provide an excellent setting for a study to throw light on the problem of the cause of dental caries and modern physical degeneration. These Islands lie off the northwest coast of Scotland, extending to a latitude nearly as far north as the southern part of Greenland. A typical view of their thatched-roof cottages may be seen in Fig. 5.

FIG. 5. A typical "black house" of the Isle of Lewis derives its name from the smoke of the peat burned for heat. The splendid physical development of the native Gaelic fisherfolk is characterized by excellent teeth and well formed faces and dental arches.

The Isle of Lewis has a population of about twenty thousand, made up almost entirely of fisher folk and crofters or sheep raisers. This island has so little lime in its soil that it is said that there are no trees in the entire island except a few which have been planted. The surface of the island is largely covered with peat, varying in thickness from a few inches to twenty feet. This is the fuel. Peat contains the rootlets of the plant life which grew many centuries ago. There is so little bacterial growth that vegetable products undergo very slow decay. The pasturage of the island is so poor that exceedingly few cattle are to be found, largely because they do not properly mature and reproduce. In a few districts some highland cattle with long shaggy hair and wide spread horns are found. Almost all of these are imported. The principal herd of cattle on the island consists of a few dozen head on the government experimental farm.

The basic foods of these islanders are fish and oat products with a little barley. Oat grain is the one cereal which develops fairly readily, and it provides the porridge and oat cakes which in many homes

are eaten in some form regularly with each meal. The fishing about the Outer Hebrides is specially favorable, and small sea foods, including lobsters, crabs, oysters and clams, are abundant. An important and highly relished article of diet has been baked cod's head stuffed with chopped cod's liver and oatmeal. The principal port of the Isle of Lewis is Stornoway with a fixed population of about four thousand and a floating population of seamen over week-ends, of an equal or greater number. The Sunday we spent there, 450 large fishing boats were said to be in the port for the week-end. Large quantities of fish are packed here for foreign markets. These hardy fisherwomen often toil from six in the morning to ten at night. The abundance of fish makes the cost of living very low.

In Fig. 5 may be seen three of these fisher-people with teeth of unusual perfection. We saw them at the fish-cleaning benches from early morning till late at night dressed, as you see them pictured, in their oilskin suits and rubber boots. We met them again in their Sunday attire taking important parts in the leading church. It would be difficult to find examples of womanhood combining a higher degree of physical perfection and more exalted ideals than these weather-hardened toilers. Theirs is a land of frequent gales, often sleet-ridden or enshrouded in penetrating cold fogs. Life is full of meaning for characters that are developed to accept as everyday routine raging seas and piercing blizzards representing the accumulated fury of the treacherous north Atlantic. One marvels at their gentleness, refinement and sweetness of character.

The people live in these so-called black houses. These are thatched-roof dwellings containing usually two or three rooms. The walls are built of stone and dirt, ordinarily about five feet in thickness. There is usually a fireplace and chimney, one or two outside doors, and very few windows in the house. The thatch of the roofs plays a very important rôle. It is replaced each October and the old thatch is believed by the natives to have great value as a special fertilizer for their soil because of its impregnation with chemicals that have been obtained from the peat smoke which may be seen seeping through all parts of the roof at all seasons of the year. Peat fires are kept burning for this explicit purpose even when the heat is not needed. This means that enormous quantities of peat are required to maintain a continuous smudge. Some of the houses have no chimney because it is desirable that the smoke leave the building through the thatched roof. Not infrequently smoke is seen rolling out of an open door or open window. Fortunately the peat is so abundant that it can be obtained easily from the almost limitless quantities nearby. The sheep that roam the heather-covered plains are of a small black-faced breed, exhibiting great hardihood. They provide wool of specially high quality, which, incidentally, is the source of the famous Harris Tweeds which are woven in these small black houses chiefly on the Isle of Harris.

We are particularly concerned with the people of early Scotch descent who possess a physique that rivals that found in almost any place in the world. They are descendants of the original Gaelic stock which is their language today, and the only one which a large percentage of them can speak. This island has only one port which means that most of the shore line still provides primitive living conditions as does the central part of the island. It was a great surprise, and indeed a very happy one, to find such high types of manhood and womanhood as exist among the occupants of these rustic thatched-roof homes, usually located in an expanse of heather-covered treeless plains. It would be hard to visualize a more complete isolation for child life than many of these homes provide, and one marvels at the refinement, intelligence, and strength of character of these rugged people. They resent, and I think justly so, the critical and uncomplimentary references made to their homes in attaching to them the name "black-houses." Several that we visited were artistically decorated with clean

wallpaper and improvised hangings.

One would expect that in their one seaport town of Stornoway things would be gay over the week-end, if not boisterous, with between four and five thousand fishermen and seamen on shore-leave from Saturday until midnight Sunday. On Saturday evening the sidewalks were crowded with happy carefree people, but no boisterousness and no drinking were to be seen. Sunday the people went in throngs to their various churches. Before the sailors went aboard their crafts on Sunday evening they met in bands on the street and on the piers for religious singing and prayers for safety on their next fishing expedition. One could not buy a postage stamp, a picture card, or a newspaper, could not hire a taxi, and could not find a place of amusement open on Sunday. Everybody has reverence for the Sabbath day on the Isle of Lewis. Every activity is made subservient to their observance of the Sabbath day. In few places in the world are moral standards so high. One wonders if the bleak winds which thrash the north Atlantic from our Labrador and Greenland coasts have not tempered the souls of these people and created in them higher levels of nobility and exalted human expression. These people are the outposts of the western fringe of the European continent.

Just as one sees in Brittany, on the west coast of France, the prehistoric druidical stone forest marking a civilization which existed so far in the past as to be without historic records except in its monuments; so, too, we find here the forest of granite slabs in which these sturdy prehistoric souls worshipped their divinities before they were crowded into the sea by the westward moving hordes. When one realizes the distance that these heavy stones had to be transported, a distance of probably twenty miles over difficult terrain, we can appreciate the task. Their size can be calculated from the depth to which they must be buried in order to stand erect even to this day.

We are concerned primarily with the physical development of the people, and particularly with their freedom from dental caries or tooth decay. One has only to see them carrying their burdens of peat or to observe the ease with which the fisherwomen on the docks carry their tubs of fish back from the cleaning table to the tiers of packing barrels to be convinced that these people have not only been trained to work, but have physiques equal to the task. These studies included the making of dental examinations, the taking of photographs, the obtaining of samples of saliva for chemical analysis, the gathering of detailed clinical records, and the collecting of samples of food for chemical analysis and detailed nutritional data.

Communication is very difficult among many of these islands. It would be difficult to find more complete isolation than some of them afford. We tried to get to the islands of Taransay and Scarpa on the west coast of the Isle of Harris, but were unable to obtain transportation since the trip can be made only in special, seaworthy crafts, which will undertake the passage only at certain phases of the tide and at certain directions of the winds. On one of these islands, we were told, the growing boys and girls had exceedingly high immunity to tooth decay. Their isolation was so great that a young woman of about twenty years of age who came to the Isle of Harris from Taransay Island had never seen milk in any larger quantity than drops. There are no dairy animals on that island. Their nutrition is provided by their oat products and fish, and by a very limited amount of vegetable foods. Lobsters and flat fish are a very important part of their foods. Fruits are practically unknown. Yet the physiques of these people are remarkably fine.

It was necessary sometimes for us to engage skilled seamen and their crafts to make a special trip to some of these isolated islands. These seamen watch critically the tide, wind and sky, and determine the length of time it will be safe to travel in a certain direction under conditions existing in the speed of the running tide and the periodic change of the wind. Some of the islands are isolated by severe weather conditions for many months of the year.

These islands have been important in the whaling industry, even up to recent years. We visited a whaling station on the Isle of Harris, not active at this time, where monsters of the sea were towed into a deep bay.

In the interior of the Isle of Lewis the teeth of the growing boys and girls had a very high degree of perfection, with only 1.3 teeth out of every hundred examined that had even been attacked by dental caries.

An important part of the study of these islands was the observations made on conditions at the fringe of civilization. A typical cross-section of the residents of the seaport town of Stornoway can be seen assembled on the docks to greet the arrival of the evening boat, the principal event of the community. The group consists largely of adult young people. In a count of one hundred individuals appearing to be between the ages of twenty and forty, twenty-five were already wearing artificial teeth, and as many more would have been more presentable had they too been so equipped. Dental caries was very extensive in the modernized section of Stornoway. Since an important part of these studies involved a determination of the kinds and quantities of foods eaten, it was necessary to visit the sources available for purchasing foods in each town studied. In Stornoway, one could purchase angel food cake, white bread, as snow white as that to be found in any community in the world, many other white-flour products; also, canned marmalades, canned vegetables, sweetened fruit juices, jams, confections of every type filled the store windows and counters. These foods probably made a great appeal both because of their variety and their high sugar content to the pallets of these primitive people. The difference in physical appearance of the child life of Stornoway from that of the interior of the Isle of Lewis was striking. We found a family on the opposite coast of the island where the two boys shown in the upper half of Fig. 6 resided. One had excellent teeth and the other had rampant caries. These boys were brothers eating at the same table. The older boy, with excellent teeth, was still enjoying primitive food of oatmeal and oatcake and sea foods with some limited dairy products. The younger boy, seen to the left, had extensive tooth decay. Many teeth were missing including two in the front. He insisted on having white bread, jam, highly sweetened coffee and also sweet chocolates. His father told me with deep concern how difficult it was for this boy to get up in the morning and go to work.

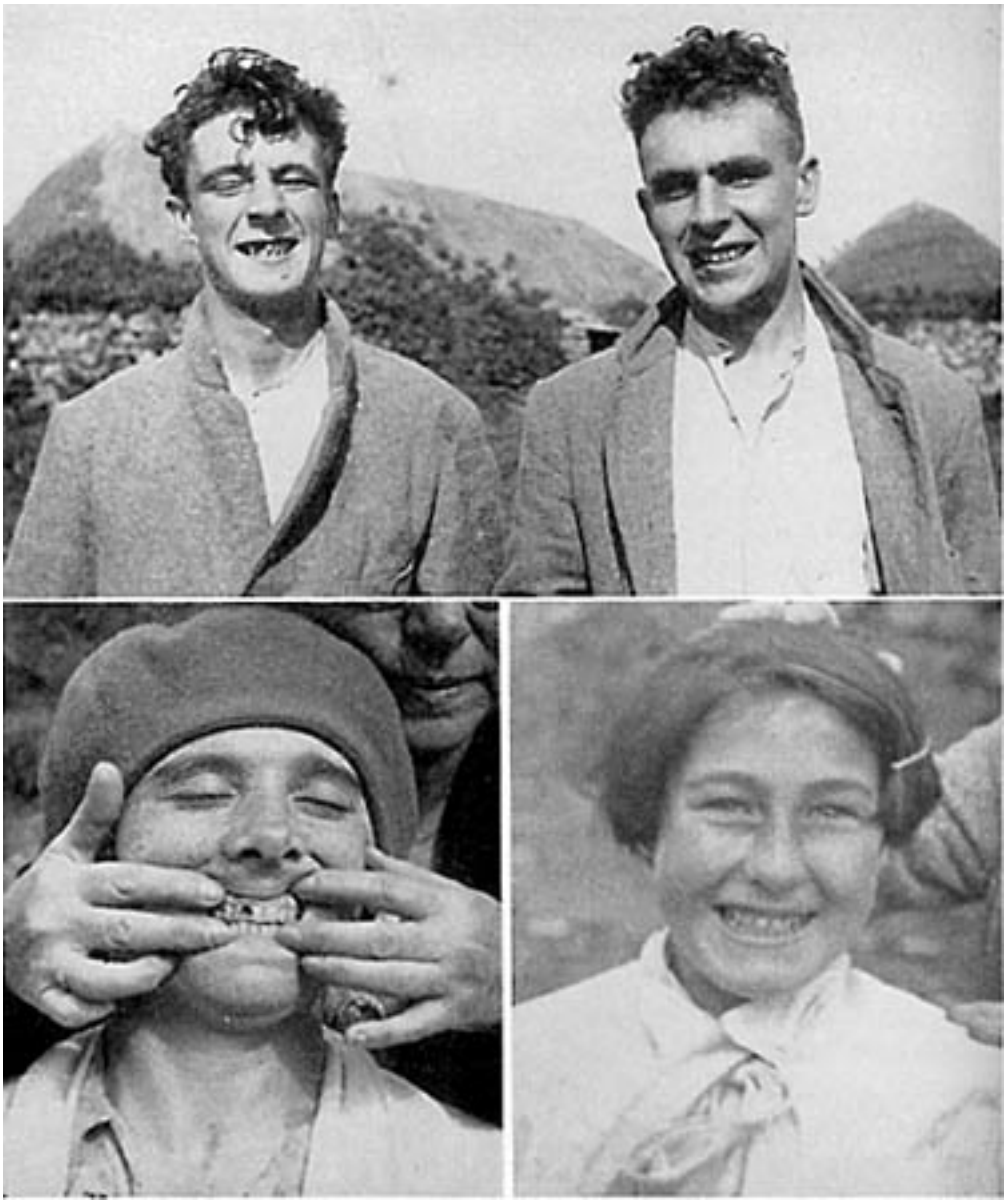

FIG. 6. Above: brothers, Isle of Harris. The younger at left uses modern food and has rampant tooth decay. Brother at right uses native food and has excellent teeth. Note narrowed face and arch of younger brother. Below: typical rampant tooth decay, modernized Gaelic. Right: typical excellent teeth of primitive Gaelic.

One of the sad stories of the Isle of Lewis has to do with the recent rapid progress of the white plague. The younger generation of the modernized part of the Isle of Lewis is not showing the same resistance to tuberculosis as their ancestors. Indeed a special hospital has been built at Stornoway for the rapidly increasing number of tubercular patients, particularly for girls between twenty and thirty years of age. The superintendent told me with deep concern of the rapidity with which this menace is growing. Apparently very little consideration was being given to the change in nutrition as a possible explanation for the failure of this generation to show the defense of previous generations against pulmonary tuberculosis. In this connection much blame had been placed upon the housing conditions, it being thought that the thatched-roof house with its smoke-laden air was an important contributing factor, notwithstanding the fact that former generations had been free from the disease. I was told that the incidence of tuberculosis was frequently the same in the modern homes as it was in the thatched-roof homes. It was of special interest to observe the mental attitude of the native with regard to the thatched-roof house. Again and again, we saw the new house built beside the old one, and the people

apparently living in the new one, but still keeping the smoke smudging through the thatch of the old thatched-roof house. When I inquired regarding this I was told by one of the clearthinking residents that this thatch collected something from the smoke which when put in the soil doubled the growth of plants and yield of grain. He showed me with keen interest two patches of grain which seemed to demonstrate the soundness of his contention.

I was particularly interested in studying the growing boys and girls at a place called Scalpay in the Isle of Harris. This Island is very rocky and has only small patches of soil for available pasturage. For nutrition, the children of this community were dependent very largely on oatmeal porridge, oatcake and sea foods. An examination of the growing boys and girls disclosed the fact that only one tooth out of every hundred examined had ever been attacked by tooth decay. The general physical development of these children was excellent, as may be seen in the upper half of Fig. 7. Note their broad faces.

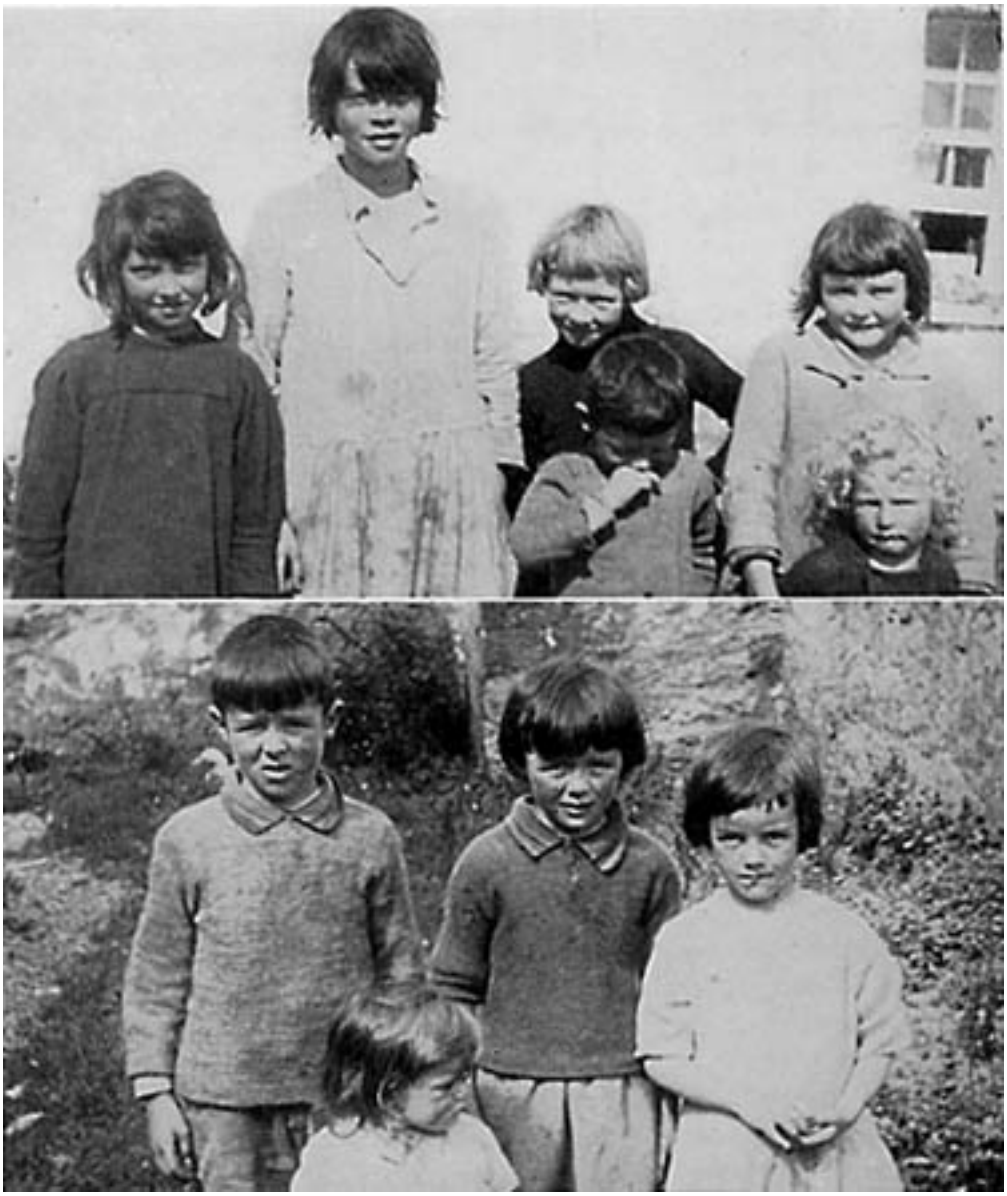

FIG. 7. Above: typical rugged Gaelic children, Isle of Harris, living on oats and sea food. Note the breadth of the faces and nostrils. Below: typical modernized Gaelics, Isle of Bardsey. Note narrowed faces and nostrils.

This is in striking contrast with the children of the hamlet of Tarbert which is the only shipping port on the Isle of Harris, and the place of export of most of the famous Harris tweeds which are manufactured on looms in the various crofters' homes. These Tarbert children had an incidence of 32.4 carious teeth out of every hundred teeth examined. The distance between these two points is not over ten miles and both have equal facilities for obtaining sea foods, being on the coast. Only the latter, however, has access to modern foods, since it supports a white bread bakery store with modern jams, marmalades, and other kinds of canned foods. In studying the tragedy of the rampant tooth decay in the mouth of a young man, I asked him regarding his plans and he stated that he was expecting to go to Stornoway about sixty miles away in the near future, where there was a dentist, and have all his teeth extracted and plates made. He said that it was no use to have any teeth filled, that he would have to lose them anyway since that was everybody's experience in Tarbert. The young women were in just as poor a condition.

Through the department of dental inspection for north Scotland, I learned of a place on the Isle of Skye, Airth of Sleat, in which only a few years ago there were thirty-six children in the school, and not one case of dental caries in the group. My examination of the children in this community disclosed two groups, one living exclusively on modern foods, and the other on primitive foods. Those living on primitive foods had only 0.7 carious teeth per hundred, while those in the group living on modern foods had 16.3, or twenty-three times as many.

This community living near the sea had recently been connected with the outside world by daily steamboat service which delivered to the people modern foods of various kinds, and within this community a modern bakery, and a supply house for purchasing the canned vegetables, jams and marmalades had been established. This district was just in the process of being modernized.

I examined teeth of several people in the seventies and eighties, and except for gingival infections with some loosening of the teeth, nearly all of the teeth were present and there was very little evidence that dental caries had ever existed. The elderly people were bemoaning the fact that the generation that was growing up had not the health of former generations. I asked what their explanation was and they pointed to two stone grinding mills which they said had ground the oats for oatcake and porridge for their families and preceding families for hundreds of years. Though they prized them highly, the plea that they would be helpful in educational work in America induced them to sell the mills to me. They told us with great concern of the recent rapid decline in health of the young people of this district.

This one-time well-populated Island, the misty Isle of Skye, still has one of the finest of the famous old castles, that belonging to the Dunvegan clan. It participated in the romantic life of Prince Charlie. The castle equipment still boasts the grandeur of a past glory. Among the relics is a horn which measured the draft to be drunk by a prospective chieftain before he could aspire to the leadership of the clan. He must drink its contents of two quarts without stopping. Again the character of that manhood is reflected in the fact that although a bounty of thirty thousand pounds was placed upon the head of Prince Charlie, none of the many who knew his place of hiding betrayed it.

On my return from the Outer Hebrides to Scotland, I was concerned to obtain information from government officials relative to the incidence of tooth decay and the degenerative diseases in various

parts of north Scotland. I was advised that in the last fifty years the average height of Scotch men in some parts decreased four inches, and that this had been coincident with the general change from high immunity to dental caries to a loss of immunity in a great part of this general district. A study of the market places revealed that a large part of the nutrition was shipped into the district in the form of refined flours and canned goods and sugar. There were very few herds of dairy cattle to be seen. It was explained that even the highland cattle did not do as well as formerly on the same ranges.

As one proceeds from the north of Scotland southward to England and Wales, there is a marked increase in the percentage of individuals wearing artificial restorations or in need of them. In several communities this reached fifty per cent of adults over thirty years of age. An effort was made to find primitive people in the high country of Wales, but without success. We were advised that about the only place that we would be likely to find people living under primitive conditions would be on the Island of Bardsey off the northwest coast of Wales. This is a rock and storm-bound island with the decadent walls of an old castle and a community made up largely of recently imported colonists whom we were advised had been taken to the Island to re-populate it. There is considerable good farm land, but very limited grazing stock. Formerly the Island had produced the foods for its inhabitants with the assistance of the sea. These sources of natural foods have been largely displaced with imported white flour, marmalades, sugar, jams and canned goods. We found the physical condition of the people very poor, particularly that of the growing boys and girls. Tooth decay was so wide-spread that 27.6 out of every hundred teeth examined in the growing boys and girls had already been attacked by dental caries. It was even active in three year olds. From a conference with the director of public health of this district I learned that tuberculosis constituted a very great problem, not only for the people on this island, but for those of many districts of northern Wales. This was ascribed to the lowered defense of the people due to causes unknown. It had been noted that individuals with rampant tooth decay were more susceptible to pulmonary tuberculosis.

While on the Island of Bardsey, I inquired as to what they thought was the cause of such extensive tooth decay as we found, and was told that they were familiar with the cause and that it was due to close contact with the salt water and salt air. When I asked why many of the old people who had lived by the sea all their lives in some districts still had practically all their teeth and had never had tooth decay, no explanation was available. This they said was the reason that had been given in answer to their inquiries.

There is a very remarkable history written in the ruins of the island, and in the faces of the people who live on the Island of Bardsey. The rugged walls of ancient castles bespeak the glory and power of the people who lived proudly in past centuries. They are testified to also by the monuments in the cemeteries; but a new era has come to this island. The director of public health, of this district of Wales, including Bardsey Island, told me the story of the decline and almost complete extinction of the population due to tuberculosis. He also told how the government had re-populated the Island with fifty healthy young families, and then the sad story of how these new settlers were breaking down as rapidly as the former occupants.

The lower photograph in Fig. 7 is of a family of four children in whose faces the tragic story is deeply written. Everyone is a mouth breather and everyone has rampant tooth decay. These people are products of modernization on this island which one time produced vigorous children and stalwart men and women. It is important to compare the faces of the children of the Isle of Bardsey shown in

Fig. 7 below with those shown in Fig. 7 above living in an isolated district in the Isle of Harris. As we will see later, the facial deformity does not reach its maximum severity until the eruption of the second dentition and the development of the adult face, usually at from nine to fourteen years of age. In cases of extreme injury, however, we find it appearing in the childhood face during the period of temporary or deciduous dentition. These children will, doubtless, be much more seriously deformed when their permanent dentitions and adult faces develop. It is important for us to keep this picture in mind in its relation to the high incidence of tuberculosis as we read succeeding chapters and find the part played by modernization in breaking down the defense of individuals to infective processes including tuberculosis.

In Fig. 6 (lower left) is a young girl from the Isle of Bardsey. She is about seventeen years of age. Her teeth were wrecked with dental caries, the disease involving even the front teeth. We ate a meal at the home in which she was living. It consisted of white bread, butter and jam, all imported to the island. This is in striking contrast with the picture of the girl shown in Fig. 6 (lower right) living in the Isle of Lewis, in the central area. She has splendidly formed dental arches and a high immunity to tooth decay. Her diet and that of her parents was oatmeal porridge and oatcake and fish which built stalwart people. The change in the two generations was illustrated by a little girl and her grandfather on the Isle of Skye. He was the product of the old régime, and about eighty years of age. He was carrying the harvest from the fields on his back when I stopped him to take his picture. He was typical of the stalwart product raised on the native foods. His granddaughter had pinched nostrils and narrowed face. Her dental arches were deformed and her teeth crowded. She was a mouth breather. She had the typical expression of the result of modernization after the parents had adopted the modern foods of commerce, and abandoned the oatcake, oatmeal porridge and sea foods.

FIG. 8. From left to right. These pots of soil growing oats contained decreasing

amounts of smoke-thatch. Only the first produced mature grain. This is in accord with the belief and practice of the native Gaelics.

Since a fundamental part of this study involves an examination of the accumulated wisdom of the primitive racial stocks, it is important that we look further into the matter of the smoked thatch. I was advised by the old residents that a serious conflict existed between them and the health officials who came from outside to their island. The latter blamed the smoke for the sudden development of tuberculosis in acute form, and they insisted that the old procedure be entirely discontinued. For this purpose the government gave very substantial assistance in the building of new and modern homes. The experienced natives contended that the oat crop would not mature in that severe climate without being fertilized with the smoked thatch. While they were willing to move into the new house, they were not willing to give up the smoking of the oat straw used for the thatch to prepare it for fertilizing the ground. I brought some of this smoked thatch with me both for chemical analysis and for testing for the influence on plant growth. This was done by adding different quantities of the smoked thatch to a series of pots in which oat seeds were planted. In Fig. 8 will be seen the result. The pot to the right shows the result of planting the oats in a sandy soil almost like that of the Islands of the Outer Hebrides. The oats only grew to the fuzzy limited condition shown. As increasing amounts of this thatch were added to the soil, there was an increase in the ruggedness of the plants so that in the last pot to the left tall stalks were developed heavily loaded with grain which ripened by the time the growth shown in the other pots had occurred. The chemical analysis of the thatch showed that it contained a quantity of fixed nitrogen and other chemicals resulting from the peat smoke circulating through the thatch. This explains the confidence of the hardy old natives who insisted on being permitted to continue the smoking of the thatch even though they did not live in the house.

A dietary program competent to build stalwart men and women and rugged boys and girls is provided the residents of these barren Islands, with their wind and storm-swept coasts, by a diet of oats used as oatcake and oatmeal porridge; together with fish products, including some fish organs and eggs. A seriously degenerated stock followed the displacement of this diet with a typical modern diet consisting of white bread, sugar, jams, syrup, chocolate, coffee, some fish without livers, canned vegetables, and eggs.

Key to Location of Indian and Eskimo Groups Examined in Canada

1. (Cleveland, Ohio)	21. Bethel Island, Alaska
2. Six Nation Indian Reservations, Ontario	22. Holy Cross, Alaska
3. Tuscarora Indian Reservations, New York	23. McGrath, Alaska
4. No. Vancouver Indian Reservation, British Columbia	24. Eklutna, Alaska
5. Craigflower Indian Reservation, Victoria, British Columbia	25. Telegraph Creek, British Columbia
6. Skeena River, British Columbia	26. Dease Lake Indian Reservation, British Columbia
7. Ketchikan, Alaska	27. McDames, British Columbia
8. Wrangell, Alaska	28. Liard, British Columbia, Yukon Border
9. Juneau, Alaska	29. Edmonton, Alberta
10. Sitka, Alaska	30. Winnipeg, Manitoba
11. Cordova, Alaska	31. Broken Head Indian Reservation, Manitoba
12. Valdez, Alaska	32. Sioux Lookout, No. Ontario
13. Seward, Alaska	33. Ombabika, No. Ontario
14. Anchorage, Alaska	34. Toronto, Ontario
15. Stoney River, Alaska	35. Loretteville Reservation, Quebec
16. Sleet Mute, Alaska	36. Caughnawaga Reservation, Quebec

17. Crooked Creek, Alaska
18. Napaimute, Alaska
19. Bethel, Alaska
20. Kokamute, Alaska
37. Vergennes, Vermont
38. Saranac Tuberculosis Sanitarium, New York
39. Mohawk Reservation, Ontario

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Chapter 5

ISOLATED AND MODERNIZED ESKIMOS

DURING the rise and fall of historic and prehistoric cultures that have often left their monuments and arts following each other in succession in the same location, one culture, the Eskimo, living on until today, brings us a robust sample of the Stone Age people. The Maya race is gone, but has left its monuments. The Indian race is rapidly changing or disappearing in North America. The Eskimo race has remained true to ancestral type to give us a living demonstration of what Nature can do in the building of a race competent to withstand for thousands of years the rigors of an Arctic climate. Like the Indian, the Eskimo thrived as long as he was not blighted by the touch of modern civilization, but with it, like all primitives, he withers and dies.

In his primitive state he has provided an example of physical excellence and dental perfection such as has seldom been excelled by any race in the past or present. We are concerned to know the secret of this great achievement since his circumscribed life greatly reduces the factors that may enter as controlling units in molding this excellence. While we are primarily concerned in this study with the characteristics of the Eskimo dentition and facial form and the effect upon it of his contact with modern civilization, we are also deeply concerned to know the formula of his nutrition in order that we may learn from it the secrets that will not only aid the unfortunate modern or so-called civilized races, but will also, if possible, provide means for assisting in their preservation.

It is a sad commentary that with the coming of the white man the Eskimos and Indians are rapidly reduced both in numbers and physical excellence by the white man's diseases. We have few problems more urgent or more challenging than that means shall soon be found for preventing the extermination of the primitive Americans. Many reports have been made with regard to the condition of the teeth of the Eskimos. Doubtless, all have been relatively authentic for the groups studied,

which have been chiefly along the routes of commerce. Clearly those people would not represent the most primitive groups, which could only be located beyond the reach of contact with modern civilization. The problems involved strongly suggested the desirability of locating and studying Eskimos in isolated districts. While dog teams could furnish means of approach in the winter season, they would not be available for summer travel.

Through the kindness of Dr. Alexis Hrdlicka, who has made anthropological studies of the Eskimos in many of the districts of Alaska, I learned that the most primitive groups were located south of the Yukon in the country between it and Bristol Bay including the Delta and mouth of the Kuskokwim River. A government station has been established on the Kuskokwim River for which a government boat enters the mouth of the Kuskokwim to deliver supplies. It carries officials, but not passengers. This contact with civilization has made available modern foods for a limited district, chiefly at the point at which the boat lands, namely, Bethel. A portion of these supplies is transported by a stern-wheel river boat to settlements farther up the river. A great number, however, of Eskimos live between the mouth of the Kuskokwim and the mouth of the Yukon River, on the mainland and islands, a distance of several hundred miles, and have little or no contact with this food.

Accordingly, our program for making these field studies among the Eskimos in 1933 required transportation over long distances and into districts where travelling facilities were practically non-existent by other means than by modern aeroplane. Mrs. Price accompanies and assists me with my records. Our itinerary included steamship service to Seward in western Alaska and railway to Anchorage, where an aeroplane was chartered which carried us to various districts in western and central Alaska. This plane carried our field equipment, and travelled to the points selected. The great Alaska mountain range, culminating in the magnificent Mt. McKinley, stretches across Alaska from the Aleutian Peninsula at the southwest far into the heart of this vast territory. The highest mountain in the United States proper is Mt. Whitney, 14,502 feet. The highest mountain in Canada is Mt. Logan, 19,539 feet. Alaska, however, boasts many mountains that are higher than any of these, many of which are in this range. Mt. McKinley is 20,300 feet. It was necessary for us to surmount this magnificent range to reach the territory in which our investigations were to be made. The special aeroplane selected was equipped with radio for both sending and receiving, and was in touch, or could be in touch at all times, with the Signal Service Corps, as well as with the headquarters and branches of the Company. Owing to clouds in the selected pass, the pilot found it necessary to go one hundred fifty miles out of his course to find one that was clear enough to fly through. Beyond these mountains were vast areas of bare wilderness with no signs of human life. Moose were frequently seen.

Our first objective was to find, if possible, a band of Indians reported to live on Stony River. They had been described as being very primitive. Our pilot, who was well informed about this region, said this was the first time he had even landed in this district. All the people were busy catching and storing the running salmon. After drying the fish they are smoked for a few hours and then stored for winter use. These thrifty people have physical features quite unlike the Indians of central, southern and eastern Alaska. Of the twelve individuals studied here, ten had lived entirely on the native foods or practically so. In their 288 teeth only one tooth was found that had ever been attacked by tooth decay, or 0.3 per cent. Two had come up from the Kuskokwim River, of which the Stony River is a branch. There, they had received a considerable quantity of the "store grub" that had been shipped up the Kuskokwim from Bethel. Twenty-seven per cent of the teeth of these two had been attacked by

dental caries.

We then proceeded to Sleet Mute, on the Kuskokwim River, where three individuals were found who had lived entirely on native foods. None of them had ever had a tooth attacked by tooth decay. Seven others had lived partly on native foods and partly on "store grub," and they had dental caries in 12.2 per cent of their teeth.

At Crooked Creek, the next settlement, eight individuals were examined and of their 216 teeth forty-one, or 18.9 per cent, had caries. All but one of these were living in considerable part on "store grub," and this individual had no dental caries.

At Napimute, 16 per cent of the teeth had been attacked by dental caries, but no individuals studied here were living entirely on native foods.

Bethel is the largest settlement on the Kuskokwim, and contains in addition to the white residents many visiting Eskimos from the nearby Tundra country surrounding it. Eighty-eight individuals studied here were largely Eskimos and mixed bloods. Of their 2,490 teeth, 11.6 per cent, or 281 teeth, had been attacked by tooth decay. Of these eighty-eight individuals twenty-seven with 796 teeth had lived almost exclusively on natural foods, and in this group only one tooth was found with dental caries, or 0.1 per cent. Forty individuals were living almost exclusively on modern foods as shipped in by the government supply boat. Of their 1,094 teeth, 252, or 21.1 per cent, had been attacked by tooth decay. Twenty-one individuals were living partly on native foods and partly on "store grub," and of their 600 teeth thirty-eight, or 6.3 per cent, had been attacked by tooth decay.

At Kokamute, on the Bering Sea at the mouth of the Kuskokwim River, a large band of very primitive Eskimos was studied. They had come from the vicinity of Nelson Island, a district which has had exceedingly little contact with modern civilization. In this group twenty-eight individuals with 820 teeth showed only one tooth, or 0.1 per cent, that had ever been attacked by dental caries.

Bethel Island is situated in the Kuskokwim River. It is visited in the summer by Eskimos from the Tundra Country for laying in their store of fish for winter use. Of fifteen individuals here, thirteen, with 410 teeth, had lived exclusively on native foods, and not a single tooth had been attacked by dental caries. Two had come from Bethel, and of their sixty teeth twenty-one or 35 per cent had been attacked by tooth decay.

In the various groups in the lower Kuskokwim seventy-two individuals who were living exclusively on native foods had in their 2,138 teeth only two teeth or 0.09 per cent that had ever been attacked by tooth decay. In this district eighty-one individuals were studied who had been living in part or in considerable part on modern foods, and of their 2,254 teeth 394 or 13 per cent had been attacked by dental caries. This represents an increase in dental caries of 144 fold.

It next became desirable to study a district that had been in contact with the foods of modern commerce for many years, and for this Holy Cross was selected. This community is located on the Yukon River above the Arctic Circle. It has been in contact with the summer commerce of the Yukon for several decades. It has one of the oldest and best organized Catholic Missions of Alaska. The

individuals studied were all in the school connected with the Mission. The students had come from as far north as Point Barrow on the Arctic Ocean and west to the Bering Straits. All but one had been in contact with and had used modern foods before coming to the Mission, and were using them while there. This one individual had lived exclusively on native foods before coming to the Mission and he had no carious teeth. In eight individuals with 224 teeth, who had lived very largely on modern foods, forty-two teeth or 18.7 per cent had been attacked by tooth decay. Four individuals had lived partly on native foods and partly on modern foods, and of their 112 teeth four, or 3.5 per cent, had been attacked by tooth decay.

It is of interest that while the Eskimos and Indians have lived in accord, they have not intermarried. The Eskimos occupy the lower section of the Yukon and Kuskokwim Rivers, and the Bering Sea frontier. The Indians have occupied the Upper waterways of both these rivers. The next place selected for study was McGrath, which is on the Upper Kuskokwim not far distant from the McKinley Mountain Range. It is the upper terminus of navigation on the Kuskokwim River for the stern-wheel river boats. Its chief importance lies in the fact that it is the division point on the Cross Alaska Aeroplane Routes from Anchorage or Fairbanks to Nome and other western points. Its population consists of several white prospectors and miners who have stayed in the country following the gold rush. Some of them have married Indian and Eskimo women. Of twenty-one individuals only one had lived almost exclusively on native foods and she had no dental caries. Twenty had lived chiefly on imported foods, and of their 527 teeth 175, or 33.2 per cent, had been attacked by tooth decay.

Among the residents of McGrath there is a remarkable family. The father is an American mining engineer who has spent much of his life in that country. His wife is a charming Eskimo woman of splendid intelligence and fine personality. She had come originally from the lower Kuskokwim and was one of the primitive Eskimo stock. While mining interests had provided food supplies for the family, shipped from the United States, she followed her early training and insisted on catching and storing salmon in season as an important part of her own dietary. The salmon were dried and smoked as was the custom of her people. She is the mother of at least twenty children, for she could give the names of that many. Only eleven were living, however, several having died from tuberculosis. Notwithstanding her many overloads, not a single tooth had ever been attacked by tooth decay. A lower anterior tooth had been broken. A picture of this woman is shown in Fig. 9 (upper, left). There has been extensive wear of the teeth, as is characteristic of the teeth of many of the Eskimos, a matter which we will presently discuss. It is of interest to note the splendid symmetry of her dental arches. Her children and husband and son-in-law had lived very largely on modern foods and in these eight individuals with 212 teeth eighty-seven, or 41 per cent, had been attacked by tooth decay. Her oldest living daughter is twenty-two years of age. She has a narrowing of the upper arch and extensive tooth decay. Another daughter, sixteen, is a beautiful girl except for her narrow dental arches. She was reported by our pilot to have become so deeply interested in the engines of the aircrafts as they stopped at this point for servicing and fuel that she had become expert in tuning up and conditioning aeroplane motors. She, doubtless, inherited some of the genius of her father, who is a mining engineer. Twelve of her teeth had been attacked by dental caries.

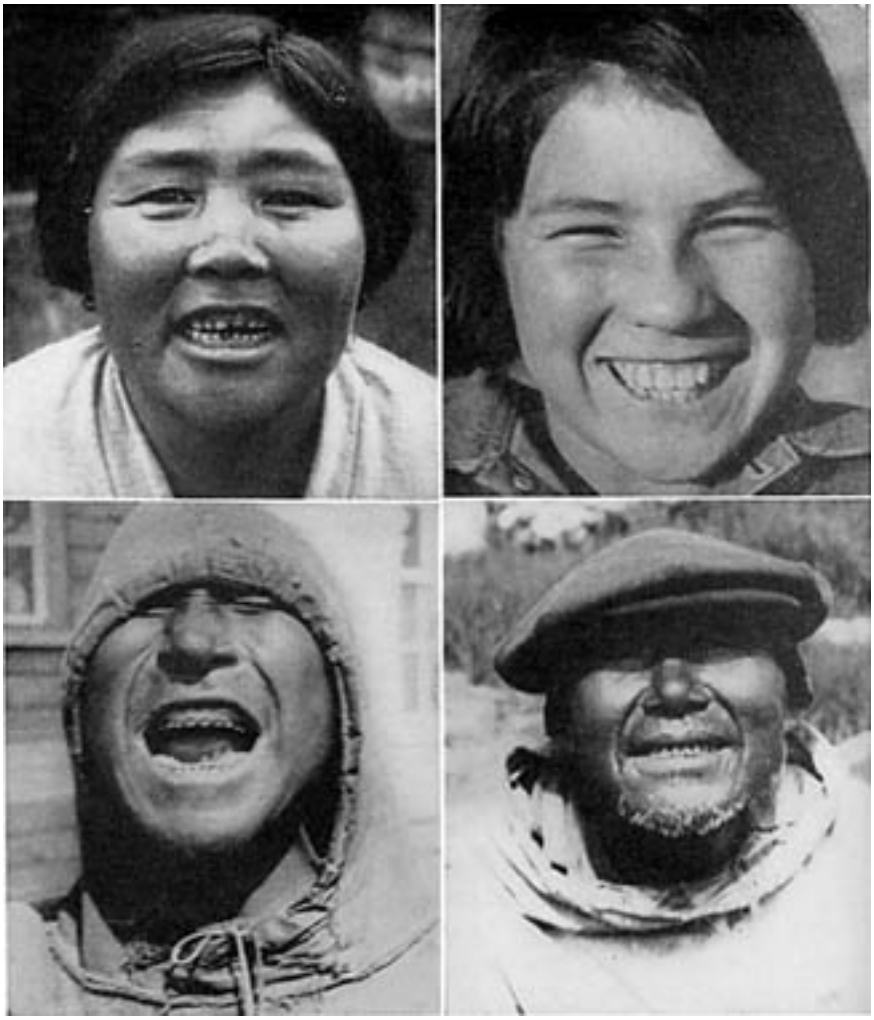

FIG. 9. Typical native Alaskan Eskimos. Note the broad faces and broad arches and no dental caries (tooth decay). Upper left, woman has a broken lower tooth. She has had twenty-six children with no tooth decay.

One does not get a conception of the magnificent dental development of the more primitive Eskimos simply by learning that they have freedom from dental caries. The size and strength of the mandible, the breadth of the face and the strength of the muscles of mastication all reach a degree of excellence that is seldom seen in other races. This is typically illustrated in Fig. 9. I was told that an average adult Eskimo man can carry one hundred pounds in each hand and one hundred pounds in his teeth with ease for a considerable distance. This illustrates the physical development of other parts of the body as well as the jaws, and suggests that the exercising of the jaws is not the sole reason for their very fine teeth, since the superb development of the musculature includes all parts of the body. It has also been suggested that chewing of tough foods, by building teeth of exceptionally fine quality, has been an important factor in the establishment of immunity to caries. As will be shown presently, the teeth of these individuals with their excellent physical development and fine tooth structure develop caries when they depart from their native foods and adopt our modern foods.

Much has been reported in the literature of the excessive wear of the Eskimos' teeth, which in the case of the women has been ascribed to the chewing of the leather in the process of tanning. It is of interest that while many of the teeth studied gave evidence of excessive wear involving the crowns to a depth that in many individuals would have exposed the pulps, there was in no case an open pulp chamber. They were always filled with secondary dentin. This is important since our newer

knowledge indicates that with the chemical characteristics of their food we might expect that secondary dentin would be readily formed within the pulp chambers by a process similar to that which occurs in many individuals under a diet reinforced with mineral and activator-providing foods. One old Eskimo had a scar on his lower lip, which was the result of perforations for carrying a decoration as practiced by his tribe. I have found primitive tribes in several parts of the world with this marking.

The principal outer garment worn by the Eskimo for the more primitive groups consists of a parka carrying a hood which is pulled over the head and closed around the neck with a shirr string, while another shirr string controls the size of the face opening in the hood when it is up. In the summer this is made of cloth or of skin without the fur. A typical case is shown in Fig. 9. It will again be noted that the teeth are excessively worn.

FIG. 10. These primitive Alaskan mothers rear strong, rugged babies. The mothers do not suffer from dental caries.

Owing to the bleakness of the winds off the Bering Sea, even in the summer many of the women wear furs. A typical mother and child dressed in their warm clothing are shown in Fig. 10. The Eskimo women are both artistic and skillful in needle work. They use fur of different colors for decorating their garments. These women make artistic decorations by carving ivory from walrus teeth and from the buried tusks of the hairy mammoth that wandered over the Tundra tens of thousands of years ago. The ear decoration of this Eskimo woman is a typical design. This mother's teeth are literally "two rows of pearls." It is important to note the width of the arches. One is continually impressed with the magnificent health of the child life which is illustrated in Fig. 10. In our various contacts with them we never heard an Eskimo child crying except when hungry, or frightened by the presence of strangers. The women are characterized by the abundance of breastfood which almost always develops normally and is maintained without difficulty for a year. The mothers were completely free of dental caries, and I was told that the children of the Eskimos have no difficulties with the cutting of their teeth.

FIG. 11. When the primitive Alaskan Eskimos obtain the white man's foods, dental caries become active. Pyorrhea also often becomes severe. In many districts dental service cannot be obtained and suffering is acute and prolonged.

The excellence of dentitions among the Eskimos has been a characteristic also of the skulls that have been excavated in various parts of Alaska.

It might be expected that such wonderfully formed teeth would maintain so high an immunity to dental caries that their proud possessors would never be troubled with tooth decay. This, unfortunately, is not the case, a fact of great significance in evaluating our modern theories of the causes of dental caries. When these adult Eskimos exchange their foods for our modern foods, which we will discuss in Chapter 15, they often have very extensive tooth decay and suffer severely. This is clearly illustrated in Fig. 11, for these Eskimos' teeth had been seriously wrecked by tooth decay. They had been living on modern foods and were typical of a large number who are in contact with the Bering Sea ports. Their plight often becomes tragic since there are no dentists in these districts.

A typical effect of modernization on a growing girl was shown in a case in which the central incisors and 16 other teeth were attacked by dental caries. Sixty-four per cent of her teeth had tooth decay.

There are no dentists in western Alaska, north or west of Anchorage, which is near the southern

coast, except at Fairbanks which, like Anchorage, is many hundreds of miles from these Eskimos. It would take months for them to make the journey in winter by dog team, and it would be practically impossible to make it in the summer season by any means of travel except by aeroplane, which clearly these people could not afford. Their dilemma is, accordingly, most tragic when they suddenly become victims of diseases which require hospitalization or skilled medical or dental service. One mining engineer in the interior told me that he had spent two thousand dollars to have a dentist brought in by aeroplane to render dental service. On my examination of his mouth I found twenty-nine of his thirty-two teeth had been attacked by dental caries.

One important phase of modern degeneration, namely, change in facial and dental arch form and other physical expressions, is of interest. It is a matter of great significance that the Eskimos who are living in isolated districts and on native foods have produced uniformly broad dental arches and typical Eskimo facial patterns. Even the first generation forsaking that diet and using the modern diet, presents large numbers of individuals with marked changes in facial and dental arch form. In Fig. 12 will be seen four Eskimo girls who are of the first generation following the adoption of modernized foods by their parents. All have deformed dental arches. It is important to note the pattern of the settling inward of the lateral incisors and the crowding outward of the cuspids. This facial design is currently assigned to a mixing of racial bloods. These girls are pure-blooded Eskimos whose parents have normally formed dental arches.

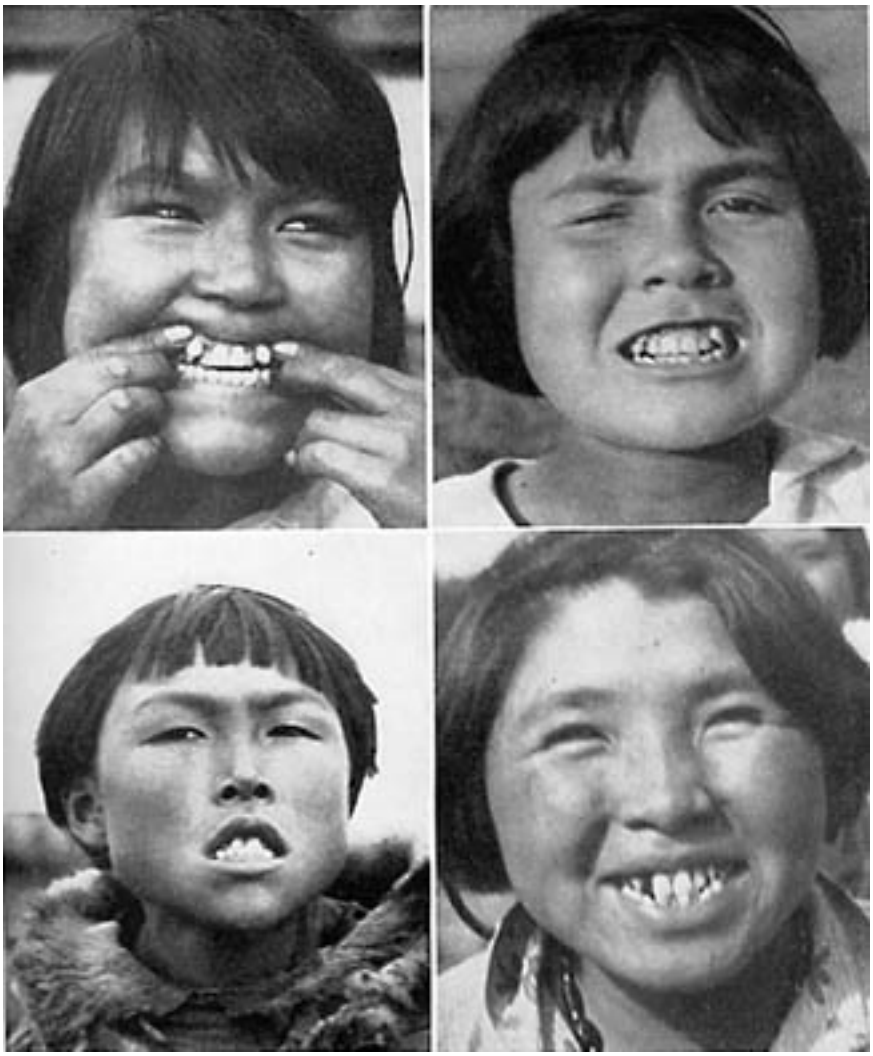

FIG. 12. While dental arch deformities or crowded teeth are practically unknown among many of the primitive groups of

Eskimos, they occur frequently in the first generation of children born after the parents have adopted the white man's foods. Note the narrow nostrils and changed facial form of these children. This is not due to thumb sucking.

We are particularly concerned with the foods used by these primitive Eskimos. They almost always have their homes on or near deep water. Their skill in handling their kayaks is most remarkable. During the salmon running season they store large quantities of dried salmon. They spear many of these fish from their kayaks; even young boys are very skillful. They land salmon so large that they can hardly lift them. They are expert in spearing seals from these light crafts. Seal oil provides a very important part of their nutrition. As each piece of fish is broken off, it is dipped in seal oil. I obtained some seal oil from them and brought it to my laboratory for analyzing for its vitamin content. It proved to be one of the richest foods in vitamin A that I have found.

The fish are hung on racks in the wind for drying. Fish eggs are also spread out to dry, as shown in Fig. 13. These foods constitute a very important part of the nutrition of the small children after they are weaned. Naturally, the drifting sands of the bleak Bering Straits lodge upon and cling to the moist surfaces of the fish that are hung up to dry. This constitutes the principal cause for the excessive wear of the Eskimos' teeth in both men and women.

FIG. 13. The eggs of the salmon are dried and stored as an important item of nutrition for both children and adults. They are also used to increase the fertility of the women. From a chemical standpoint they are one of the most nutritious foods I have found anywhere.

The food of these Eskimos in their native state includes caribou, ground nuts which are gathered by mice and stored in caches, kelp which is gathered in season and stored for winter use, berries including cranberries which are preserved by freezing, blossoms of flowers preserved in seal oil, sorrel grass preserved in seal oil, and quantities of frozen fish. Another important food factor consists of the organs of the large animals of the sea, including certain layers of the skin of one of the species of whale, which has been found to be very high in vitamin C.

Since contact with our modern civilization, the Eskimo population for Alaska is very rapidly

declining. One authority has quoted the reduction of 50 per cent in population in seventy-five years.

An important observation has been made relative to the rapid shortening of the average life by Dr. V. E. Levine and Professor C. W. Bauer, of Creighton University, Nebraska, who reported:

> Cordova, Alaska, Oct. 26, 1934--Due to susceptibility to tuberculosis and other diseases the average life span of the Eskimo of Alaska is only 20 years and their race is doomed to extinction within a few generations unless modern medical science comes to their aid.

Unless a very radical change is made in the interference with the native supply of game and sea foods, the Eskimo population seems destined to have a rapid decline and an early extinction. Their primitive fish foods have been largely curtailed by the encroachment on their salmon streams made by modern canneries.

It is of interest to discuss in connection with the Alaskan Eskimo two white boys (one is shown in Fig. 14), who were sons of a mining engineer. They had been born and raised in a mining camp in Alaska, where their foods had been almost entirely shipped in. I travelled with the mother of these two boys who was bringing them to the United States for operations on their noses, because they were mouth-breathers. It is important to observe the marked underdevelopment of both the middle third and lower third of the face of the boy shown in Fig. 14. The nutrition of the family during their development and growth had been largely provided in package form shipped in from the United States. Their disfiguration is typical of that of large numbers that are developing in our highly modernized communities, and is similar, in general, to the deformities which develop in the primitive races after they adopt the modernized nutrition.

FIG. 14. This white boy was born and raised in Alaska on imported foods. His facial deformity includes a lack of development of the air passages, so that he breathes through his mouth. Lack of bone development creates the crowded condition of the teeth. Note his narrow nostrils.

Notwithstanding the very inhospitable part of the world in which they reside, with nine or ten months of winter and only two or three of summer, and in spite of the absence for long periods of plant foods and dairy products and eggs, the Eskimos were able to provide their bodies with all the

mineral and vitamin requirements from sea foods, stored greens and berries and plants from the sea.

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Chapter 6

PRIMITIVE AND MODERNIZED NORTH AMERICAN INDIANS

NATURE seems to have made one of her large scale demonstrations in the Americas of the power of adaptation of a single racial stock to the scale of climates ranging from torrid jungles of the tropics to the Arctics. The various members of the American Indian race seem clearly to have come from a common origin. The route by which they reached America from Asia as suggested by anthropologists was by way of the Bering Strait. Within a decade a Russian engineer has crossed from Asia to America on the pack ice of the Bering sea, a distance of ninety miles. If this is possible now, how much more likely is it that it has been possible in earlier periods of the world's history, as, for example, during or following the last ice age, or at the time of an earlier ice age. The American Indian, therefore, provides a very remarkable opportunity to study both the capacity for adaptability to different environments and the variations that different environments can produce in a single racial stock. That the Indian of today is not in general a counterpart of the native resident at the time of the discovery of America by Columbus is clearly demonstrated both by the skeletal material and by the early records.

Our problem involved the location and study of groups of the original stock, if such were to be found, who were living in accordance with the tradition of their race and as little affected as might be possible by the influence of the white man. At first thought it might seem impossible that such groups can exist, but as a matter of fact there are still great areas of the American continent inhabited by the original stock living in areas still unexplored. In order to find Indians as little changed as possible by reason of their contact with the white man, particularly with the white man's foods, I went to northern Canada to the region inside the Rocky Mountain range to study the Indians of Northern British Columbia and the Yukon territory. Since an aeroplane could not be used, owing to the lack of a base of supplies for fuel for the return trip; and since the MacKenzie water route was impracticable (an expedition could not go up the waterways through Canada on the MacKenzie River and its branches and return the same season), the route selected was that which enters that territory from Alaska on the large waterway of the Stikine River. This river has cut its channel through the Coast and Cascade Ranges of mountains and has its origin in the high western watershed of the Rockies. It was particularly desirable to reach a group of Indians who could not obtain the animal life of the sea, not

even the running salmon. These fish do not enter the waterways draining to the Arctic. We used a high-powered river transport specially designed for going up rapids on the Stikine River to the end of navigation at Telegraph Creek. At this point large quantities of modern foods are stored during the short open navigation season of the summer to be exchanged for furs during the long winter. A Hudson Bay Post has been established at this point. Here a truck was chartered which took us over a trail across the Rocky Mountain Divide to the headwaters of the rivers flowing north to the Arctic. At this outpost two guides were engaged and a high powered scow chartered to make the trip down the waterways toward the Arctic on the Diese and Liard Rivers. This made it possible, in the summer of 1933, to make contact with large bands of Indians who had come out of the Pelly mountain country to exchange their catch of furs at the last outpost of the Hudson Bay Company. Most of the Indians of Canada are under treaty with the Canadian Government whereby that government gives them an annual per capita bounty. This arrangement induces the Indians in the interior to come out to the designated centers to obtain the bounty. Since it is based on the number in the family, all of the children are brought. This treaty, however, was never signed by the Indians of the British Columbia and Yukon Territory. And, accordingly, they have remained as nomadic wandering tribes following the moose and caribou herds in the necessary search to obtain their foods.

The rigorous winters reach seventy degrees below zero. This precludes the possibility of maintaining dairy animals or growing seed cereals or fruits. The diet of these Indians is almost entirely limited to the wild animals of the chase. This made a study of them exceedingly important. The wisdom of these people regarding Nature's laws, and their skill in adapting themselves to the rigorous climate and very limited variety of foods, and these often very hard to obtain, have developed a skill in the art of living comfortably with rugged Nature that has been approached by few other tribes in the world. The sense of honor among these tribes is so strong that practically all cabins, temporarily unoccupied due to the absence of the Indians on their hunting trip, were entirely unprotected by locks; and the valuables belonging to the Indians were left in plain sight. The people were remarkably hospitable, and where they had not been taken advantage of were very kind. Many of the women had never seen a white woman until they saw Mrs. Price. Their knowledge of woodcraft as expressed in skill in building their cabins so that they would be kept comfortably warm and protected from the sub-zero weather was remarkable. Their planning ahead for storing provisions and firewood strongly emphasized their community spirit. When an Indian and his family moved to a camp site on a lake or river, they always girdled a few more trees than they would use for firewood so that there would be a plentiful supply of dry standing timber for future visitors to the camp.

They lived in a country in which grizzly bears were common. Their pelts were highly prized and they captured many of them with baited pitfalls. Their knowledge of the use of different organs and tissues of the animals for providing a defense against certain of the affections of the body which we speak of as degenerative diseases was surprising. When I asked an old Indian, through an interpreter, why the Indians did not get scurvy he replied promptly that that was a white man's disease. I asked whether it was possible for the Indians to get scurvy. He replied that it was, but said that the Indians know how to prevent it and the white man does not. When asked why he did not tell the white man how, his reply was that the white man knew too much to ask the Indian anything. I then asked him if he would tell me. He said he would if the chief said he might. He went to see the chief and returned in about an hour, saying that the chief said he could tell me because I was a friend of the Indians and had come to tell the Indians not to eat the food in the white man's store. He took me by the hand and led me to a log where we both sat down. He then described how when the Indian kills a moose he

opens it up and at the back of the moose just above the kidney there are what he described as two small balls in the fat. These he said the Indian would take and cut up into as many pieces as there were little and big Indians in the family and each one would eat his piece. They would eat also the walls of the second stomach. By eating these parts of the animal the Indians would keep free from scurvy, which is due to the lack of vitamin C. The Indians were getting vitamin C from the adrenal glands and organs. Modern science has very recently discovered that the adrenal glands are the richest sources of vitamin C in all animal or plant tissues. We found these Indians most cooperative in aiding us. We, of course, had taken presents that we thought would be appreciated by them, and we had no difficulty in making measurements and photographs, nor, indeed, in making a detailed study of the condition of each tooth in the dental arches. I obtained samples of saliva, and of their foods for chemical analysis. A typical Indian family in the big timber forests in shown in Fig. 15.

FIG. 15. This typical family of forest Indians of Northern Canada presents a picture of superb health. They live amidst an abundance of food in the form of wild animal life in the shelter of the big timber.

The condition of the teeth, and the shape of the dental arches and the facial form, were superb. Indeed, in several groups examined not a single tooth was found that had ever been attacked by tooth decay. In an examination of eighty-seven individuals having 2,464 teeth only four teeth were found that had ever been attacked by dental caries. This is equivalent to 0.16 per cent. As we came back to civilization and studied, successively, different groups with increasing amounts of contact with modern civilization, we found dental caries increased progressively, reaching 25.5 per cent of all of the teeth examined at Telegraph Creek, the point of contact with the white man's foods. As we came down the Stikine River to the Alaskan frontier towns, the dental caries problem increased to 40 per cent of all of the teeth.

Careful inquiry regarding the presence of arthritis was made in the more isolated groups. We neither saw nor heard of a case in the isolated groups. However, at the point of contact with the foods of modern civilization many cases were found including ten bed-ridden cripples in a series of about twenty Indian homes. Some other affections made their appearance here, particularly tuberculosis which was taking a very severe toll of the children who had been born at this center. In Fig. 16 are seen two typical cases of tubercular involvement of glands of the neck. The suffering from tooth

decay was tragic. There were no dentists, no doctors available within hundreds of miles to relieve suffering.

FIG. 16. At the point of modernization including the use of the foods of modern commerce, the health problem of the Indians is very different. These modernized Indian children are dying of tuberculosis which seldom kills the primitives.

The physiques of the Indians of the far north who are still living in their isolated locations and in accordance with their accumulated wisdom were superb. There were practically no irregular teeth, including no impacted third molars, as evidenced by the fact that all individuals old enough to have the molars erupted had them standing in position and functioning normally for mastication. The excellence of the dental arches is shown in Fig. 17. Where the Indians were using the white man's food tooth decay was very severe, as shown in Fig. 18. In the new generation, after meeting the white civilization and using his foods, many developed crooked teeth, so-called, with deformed dental arches, as seen in Fig. 19.

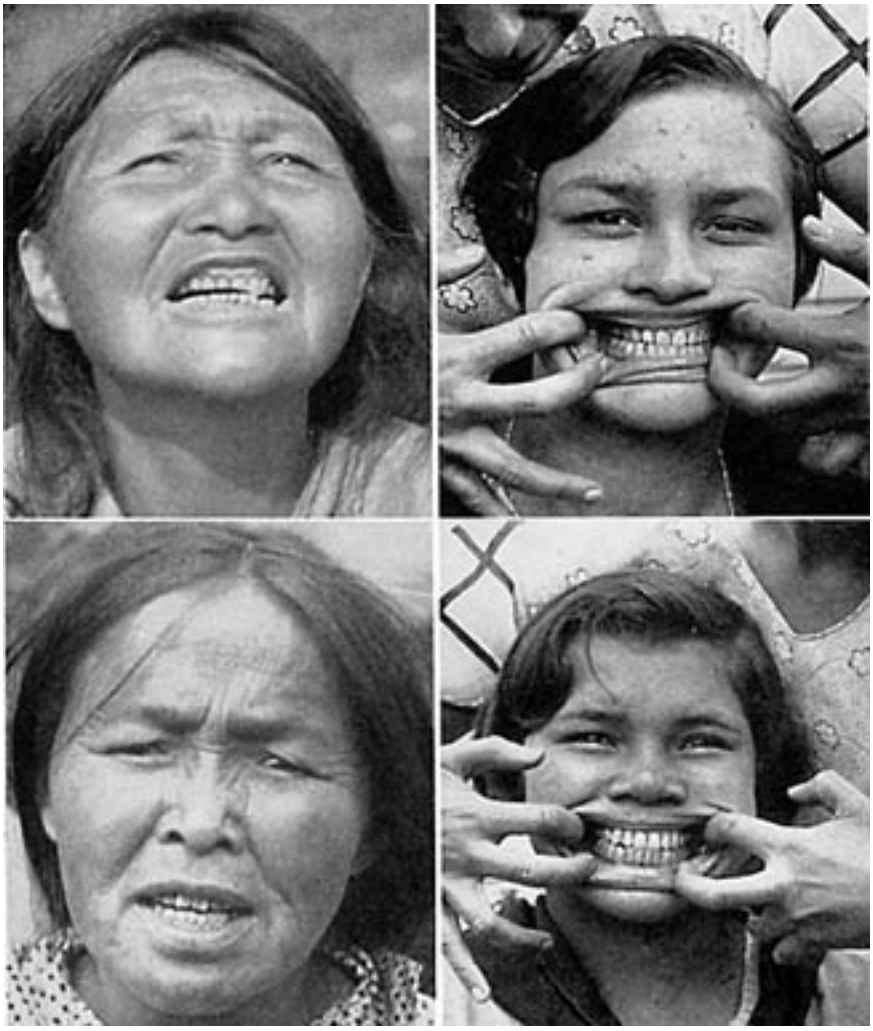

FIG. 17. Wherever the Indians were living on their native foods, chiefly moose and caribou meat, their physical development including facial and dental arch form was superb with nearly complete immunity to dental caries. These two women and two girls are typical.

FIG. 18. Wherever the Indians had access to the modern foods of commerce the dental conditions were extremely bad. These four individuals are typical.

FIG. 19. The blight of the white man's commerce is seen everywhere in the distorted countenances of even the first generation after the adoption by the parents of the foods of modern commerce. These young people with their deformed dental arches are typical. Note the faulty development of the facial bones as evidenced by the narrow nostrils and crowded teeth.

Contact was also made with representatives of relatively isolated primitive Indian stocks in the district south of Hudson Bay. These groups were reached by a newly projected railroad extending eastward and northward from Winnipeg, Manitoba, and we were thus brought into contact with the Indians that had come out of the waterways draining the Hudson Bay and from as far north as James Bay. They had come down to dispose of their furs in exchange for ammunition, blankets, etc. Since this contact was made only once or twice a year, it was quite impossible for the Indians to carry back a sufficient quantity of the foods of the white man to have great influence on their total diet for the year. They still lived on the wild animal game of the land. As in the northern country just reviewed, their principal large animal was the moose. These are treaty Indians, and many of them come out to this frontier to obtain the government bounty and, accordingly, were obliged to bring their families. The bounty here amounted to five dollars per head, a considerable income in exchange for blankets and other equipment. Some of these contact points were at the height of the land dividing the waters running north and east to James Bay and Hudson Bay, or south to Lake Superior. This was historic country that had been the meeting ground of the tribes of the northern waters with the tribes of the Great Lakes district. Many battles had been fought there. For comparison with these more primitive

groups from the Hudson and James Bay watershed, I had the opportunity here of studying families that had taken up residence along the railroad or in its vicinity in order that they might have the advantage of exchanging furs for the modern white man's foods. This gave us an excellent opportunity to study the effects of the modern dietary, of which an example is shown in Fig. 20. This Indian and his wife had built their bodies before the contact with the white man. He is about six feet tall. Both the parents had splendid dental arches and well formed faces. His teeth are shown in Fig. 20 (upper, left). Their two children shown in the photograph were born after the adoption of the white man's foods brought in by the railroad. Both are mouth-breathers and both have narrow dental arches and marked underdevelopment of the middle third of the face. The older girl has tuberculosis. Another adult man is shown in Fig. 20 (upper, right). He, like the generation he represents, has exceptionally fine dental arches and well developed face.

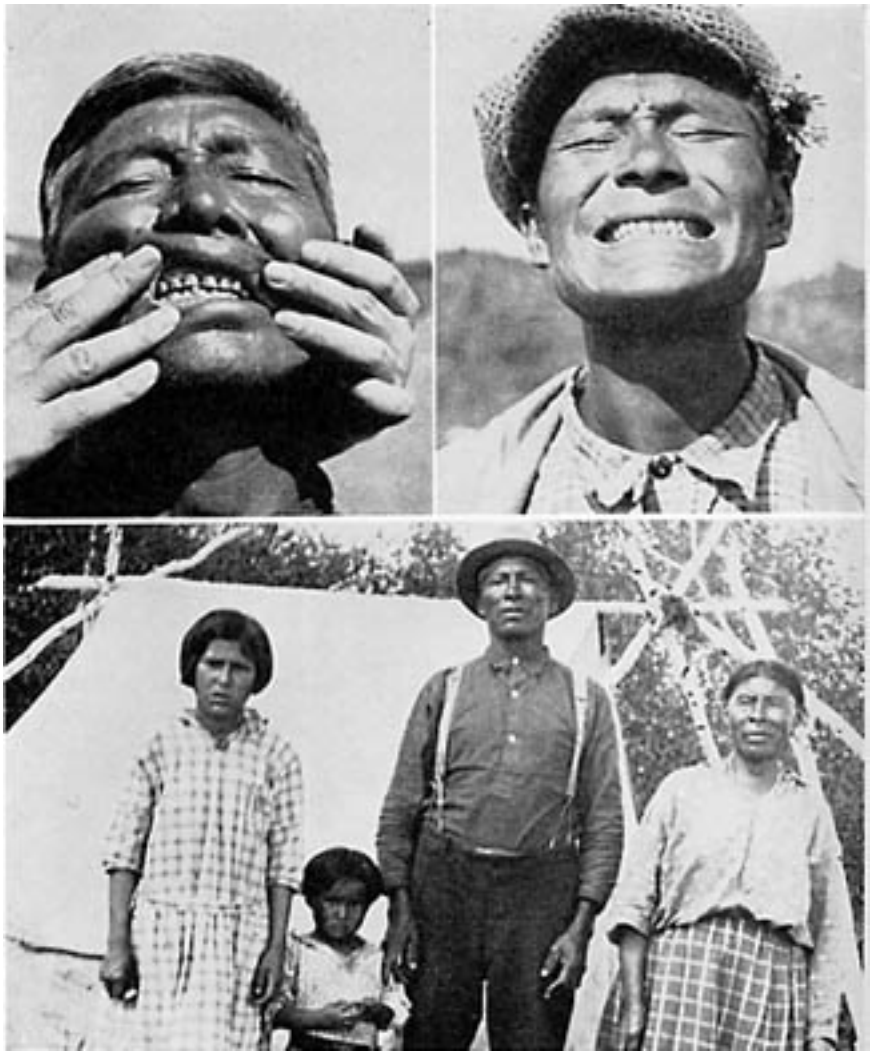

FIG. 20. These primitive Indians are in central Canada. The three parents were developed before their district was reached by modern civilization. Note their good physical and facial form in contrast with the pinched nostrils of the two children. The oldest girl has tuberculosis. They are the product of civilization's contact with their primitive parents.

At this point we again found many of the younger generation ill with tuberculosis or crippled with arthritis. Two of these are shown in Fig. 21.

FIG. 21. These are typical cripples met at the point of contact of our modern civilization with the primitive Indians. The boy at the left has arthritis in nearly all of his joints. He has several abscessed teeth. The boy at the right has tubercul sis of the spine.

For further comparison of the more isolated and more highly modernized groups a study was made of the Indians in the largest single Indian Reservation in Canada, which is located at Brantford, Ontario. In this group there are about 4,700 Indians living under highly modernized conditions provided by the Canadian Government. They live on very fertile land and in close proximity to a modern Canadian city. Each head of a family is provided with a tract of land from which he usually has an income sufficient to permit him to have an automobile. They were able to buy not only necessities and comforts according to the modern standards of the white man, but many of the luxuries as well. The government provides a well administered hospital and staff. When I asked the Director of this hospital, Dr. Davis, what the principal use of the hospital was at that time (1933), he said that the demand for beds had completely changed in the twenty-eight years he had been there. The principal services requested at the hospital in 1933 related to the problems of maternity. He stated that in his period of contact he had seen three generations of mothers. The grandmothers of the present generation would take a shawl and either alone or accompanied by one member of their family retire to the bush and give birth to the baby and return with it to the cabin. A problem of little difficulty or concern, it seemed. He stated that today the young mothers of this last generation are brought to his hospital sometimes after they have been in labor for days. They are entirely different from their grandmothers or even mothers in their capacity and efficiency in the matter of reproduction. He stated that that morning he had had two cases in which surgical interference was necessary in order to make birth possible.

We had an opportunity here to study the effects of modernization. Indians are great lovers of sports, particularly of their own national game which is lacrosse. We were able to witness one of these contests with a team from another reservation. Indian families came in modern automobiles dressed in modern clothes and purchased pop and candy and modern confections at typical confection stands. These were highly modernized Indians.

The group on this reservation, comprising approximately four thousand seven hundred Indians,

belong to the following tribes: Mohawks, Onondagas, Cayugas, Senecas, Oneidas and Delawares making up the Six Nation or Iroquois group. A later addition to this group has been the Tuscaroras from the Carolinas. While there were many mixed bloods, there were also a goodly number of full-blooded Indian families, so that there was an opportunity to study comparatively the effects of intermingling of the Indians with the whites. As in previous investigations, a special effort was made to study the children from eight to sixteen years of age. Typical cases were selected from different environments. For example, boys and girls selected from a training school called Mohawk Institute, which was near the city of Brantford, represented one type of environment. There are approximately one hundred and sixty students under training here, and we were informed that they study half a day and work half a day. The boys are taught craftsmanship and farming, the girls, home economics and garment making, and such practical training as would prepare them for later home building. While most of the boys and girls come from that reservation, a few are accepted from other reservations. It is of interest that 77 per cent of the children in this Institution had suffered from earlier dental caries and that 17 per cent of all the teeth examined had already been attacked by dental caries. But this had occurred apparently before their entrance to the Institute, for we did not find a single case of active caries among those examined, and this is particularly important in connection with their excellent nutrition. The Institute maintained a fine dairy herd and provided fresh vegetables, whole wheat bread, and limited the sugar and white flour.

The children of this group were compared with children of approximately the same age in a public school of the reservation where it was found that 90 per cent had had dental caries, and that at present in 70 per cent of the cases the caries was apparently active. It is important to note that in this group 28.5 per cent of all the teeth examined had already been attacked by tooth decay.

A study was made of patients at the reservation hospital where free service of all kinds is provided. We found that 83 per cent had suffered from dental caries, and that 23.2 per cent of all teeth had already been attacked by caries.

We were particularly interested in the conditions obtaining in the homes, especially with the mothers. A typical young mother had approximately half her teeth attacked by dental caries, as had also her son, aged seven. The middle third of his face was underdeveloped and all of his upper anterior teeth were decayed to the gum line.

A study was made of an Indian reservation in New York State for comparison and for making an estimate of typical modern American Indian life with regard to dental caries and nutrition. For this study a band of 450 in the Tuscarora Reservation northeast of Niagara Falls was visited. Here again we were fortunate to see the people in holiday mood since the study was made on Decoration Day and events of the year had been scheduled, a lacrosse match and a baseball game, between the Indians' teams and white teams from adjacent towns. Several hundred Indians were congregated to exhibit their best in wearing apparel, transportation equipment, and physical prowess. There was evidence of a similarity of features in the older Indians who had not been highly modernized, and a striking deficiency in the facial development of many of the moderns.

A typical mother was studied at her home. She had four children. Her teeth were ravaged by dental caries. She was strictly modern, for she had gold inlays in some of her teeth. The roots of the missing

teeth had not been extracted. Twenty of her teeth had active dental caries. Her little girl, aged four, already had twelve very badly carious teeth. Another daughter aged eight had sixteen carious teeth, and her son aged ten had six. The husband was in bed from an acute lung involvement, doubtless tuberculosis. The children were eating their noon day meal when we arrived, which consisted of a white bread and some stewed vegetables. Milk was available for only the small baby in arms. In this Tuscarora group 83 per cent of those examined had dental caries and 38 per cent of all teeth had already been attacked by dental caries. Every one studied in this reservation was using white-flour products, none were using milk liberally, and only a few in even limited amounts. I was told that in both reservations a few years ago the Indians grew wheat and kept cows to provide a liberal supply of natural cereal and milk for their families, but of late this practice had been discontinued. They were now buying their wheat in the form of white flour and their vegetables largely put up in cans. In both reservations they were using commercial vegetable fats, jams and marmalades, sweetened goods, syrups and confections very liberally. It is remarkable how early the child life adopts modern civilization's confections.

In order to provide a further cross section of the modernized Indians of North America, I made a study in a reservation on Winnipeg Lake in Manitoba. This reservation lies north and east of Winnipeg and is quite highly modernized.

These people were reached with much difficulty because of the natural protection provided by the location of their reservation at the mouth of Brokenhead River. They had been provided with fertile lands and taught modern methods of farming. Their proximity to a great body of water fairly well-stocked with fish gave them an opportunity to secure fish, if they were disposed to make the effort to do so, as their ancestors had done through previous centuries. Their homes were found to be in a dilapidated condition, and while their lands were stocked with cattle and horses, such as we found were in poor condition, and limited in number. The people had been provided with a government school and a government agent to assist in providing for their needs and in giving material assistance when needed. They were within fairly easy distance of hospitals, and had available modern medical service. Notwithstanding all these advantages, their physical condition was very poor. Dental caries was so wide-spread that 39.1 per cent of all teeth studied were found to be affected. They were living almost entirely on modern foods, imported white flours, jams, canned vegetables and liberal quantities of sugar. Over 90 per cent of the individuals had rampant dental caries. Their physical condition and their supply of necessities was very much lower than was that of either of the two preceding groups. Distress was evident even in late summer.

The Indians so far reported were living inland with access to inland foods only. The Pacific Coast Indians were examined to determine the effect of sea foods. To find evidence relating to the physical, and particularly to the dental condition of the Indians who inhabited the Pacific slope a thousand or more years ago, a visit was made to the Vancouver Museum at Vancouver which fortunately possesses splendidly preserved specimens of prehistoric periods. Some of these skulls were uncovered while cutting through a hill for a street extension in the city of Vancouver. Above was a virgin forest of large size green firs and underneath them in the soil there were preserved fallen trunks of other large trees. Several feet below these, burials were uncovered containing skeletons of an early Indian race. This collection contains also skulls from several places and from prehistoric periods. The teeth are all splendidly formed and free from dental caries. The arches are very symmetrical and the teeth in normal and regular position.

It was important to study the conditions of their successors living in the same general community. Accordingly, we examined the teeth and general physical condition of the Indians in a reservation in North Vancouver, so situated that they have the modern conveniences and modern foods. In this group of children between eight and fifteen years of age, 36.9 per cent of all the teeth examined had already been attacked by dental caries. No people were found in this group who were living largely on native foods.

Vancouver Island with its salubrious climate is one of the most favored places of residence on the Pacific Coast. It was of particular interest to study the Indians near Victoria on this island in the Craigflower Indian Reservation. Indeed, the city of Victoria has been partly built on the original Craigflower Indian Reservation. As the need became acute for the territory reserved for them, an arrangement was consummated whereby the Indians were induced to exchange that land for new land in an adjoining district in which a new house was built free for each family. Besides a house, an allotment of land and a sum of money, reported to be ten thousand dollars, was given to each family. This allowed them to become very modern, and, accordingly, many of them owned automobiles and other modern luxuries. The physical effects of the use of food luxuries, resulting from ample funds for purchasing any foods that they might desire, was marked. They were in close proximity to skilled dental service and had practical training in oral prophylaxis. Notwithstanding this, 48.5 per cent of all teeth examined had already been attacked by dental caries. Every individual examined was suffering from tooth decay. The original diet of the Indians of the Pacific Coast was, as we shall see, very largely sea foods, which are probably as abundant today as ever before. It would require a real urge to go to catch the fish since they can now be purchased canned in the open market. Like most modern people, they were living on white-flour products, sweet foods and pastries.

Probably few cities of the Pacific Coast have had a greater abundance and variety of edible sea foods, particularly the various kinds of salmon, than Ketchikan. It is beautifully located on an island, and is the most southerly city in Alaska. Among the many fish that are abundant along this part of the Pacific Coast is the oolachan or candle fish. It is a small fish, but very rich in oil; so much so that it gets its name from being burned as a candle for light. This oil is collected in large quantities and used as a dressing for many of their sea foods. It is also traded with the Indians of the interior for furs and other products. An Indian settlement in this city was studied and it was found that 46.6 per cent of all teeth examined had already been attacked by tooth decay. In many of the homes individuals were ill with tuberculosis or arthritis. Tuberculosis had robbed many of the homes of one or more of its children.

At Juneau, the capital of Alaska, two groups were studied; one in the government hospital, and the other in an Indian settlement. In the hospital were both Indians and Eskimos, chiefly the former. Seventy-five per cent of the patients were reported to have been brought because they had tuberculosis, and some who had come because of accident and other conditions were reported to have tuberculosis also. Approximately 50 per cent of the total hospital enrollment was under 21 years of age. The dental conditions were bad, for 39.1 per cent of all the teeth examined had been attacked by tooth decay.

In the Indian settlement, a group of elderly primitives was found, every one of whom had complete

dentitions in normal arrangement of the arches and without dental caries. In a settlement of modern Indians living principally on modern foods 40 per cent of all teeth had been attacked by tooth decay.

At Sitka, the former capital, two important groups were studied. Located here is the Sheldon Jackson School for Eskimos and Indian boys and girls, chiefly Indians. They have come from widely scatterd territory throughout Alaska, and represent the finest physical specimens that can readily be secured for giving the advantages of an education. Of necessity they came very largely from the modernized districts. In this group 53.7 per cent of all the teeth examined had already been attacked by tooth decay. This gives an indication of the dental conditions in the large number of modernized districts which they represented.

In a settlement at Sitka, a group of Indians of various ages were studied, and it was found that 35.6 per cent of all their teeth had already been attacked by dental caries. A well preserved native Indian, seventy years of age, was found who had come into town from another district. He stated that his diet had consisted chiefly of fish, fish eggs, seaweed and deer. His teeth were of very high excellence and were entirely free from past or present dental caries. He is a splendid example of the product of the native dietary provided for the Pacific Coast people of any period or stage of civilization.

The local physician at Sitka kindly gave very valuable information relative to the attitude of the native Indians in the matter of obtaining fresh sea foods when foods that were very satisfying could be so easily obtained in concentrated form at the various stores. They could go to one of the piers at almost any time of the year and catch fish or secure them as they had been accustomed to do before the arrival of modern foods, but there is a constant striving to be like and live like the white people. They seem to think it is a mark of distinction to purchase their foods and that it is degrading to have to forage for one's foods. They very readily come to depend on white flour and sugar, jams and canned vegetables; and much prefer to have the government or charitable organization supply these when they cannot purchase them, rather than go out and secure their own nutrition. This physician stated that there were about 800 whites living in the town and about 400 Indians, and that notwithstanding this difference in numbers there were twice as many Indian children born as white children, but that by the time these children reached six years of age there were more white children living than Indian and half-breed children. This he stated was largely due to the very high child mortality rate, of which the most frequent cause is tuberculosis. While it does not take many decades to record a distinct physical deterioration, a deteriorating parenthood greatly speeds up this process. While physical defects acquired by the parent will not be transmitted as such, prenatal deficiencies may be established because of the physical defects of the mother resulting from her faulty nutrition, and these deficiencies, together with disturbed nutrition of infancy and early childhood will go far in determining whether there will be for the child a physical breakdown or whether the normal defense of the body will be adequate to protect it from various infections to which it may later be exposed.

Sitka has furnished the longest history of contact with white men of almost any community on the Pacific Coast. Indeed, it was a famous seaport long before any United States Pacific Coast communities had been established. It is of much interest that it was a shipbuilding center for vessels in the Russian trade. Its foundries were developed so efficiently that the bells of the early monasteries of California were cast in this town by the Russians. It contains some of the best examples of the early Russian architecture, particularly in its cathedral.

Anchorage is the principal city of western Alaska, since it is not only a base for the railroad running north to Fairbanks, but a base for aeroplane companies operating throughout various parts of Alaska. It is accordingly a combination of a coast city with its retail activities and a wholesale base for outfitters for the interior. It has an excellent government hospital which probably has been built around the life of one man whom many people told us was the most beloved man in all Alaska. He is Dr. Josef Romig, a surgeon of great skill and with an experience among the Eskimos and Indians, both the primitives and modernized, extending over thirty-six years. I am deeply indebted to him for much information and for assistance in making contacts. He took me, for example, to several typically modernized Indian homes in the city. In one, the grandmother, who had come from the northern shore of Cook Inlet to visit her daughter, was sixty-three years of age, and was entirely free from tooth decay and had lost only one of her teeth. Her son, who had accompanied her, was twenty-four years of age. He had only one tooth that had ever been attacked by tooth decay. Their diet had been principally moose and deer meat, fresh and dried fish, a few vegetables and at time some cranberries. Recently the son had been obtaining some modern foods. Her daughter, twenty-nine years of age, had married a white man and had had eight children. She and they were living on modern foods entirely. Twenty-one of her thirty-two teeth had been wrecked by dental caries. Their diet consisted largely of white bread, syrup and potatoes. Her children whom we examined ranged from five to twelve years of age, and in that family 37 per cent of all the teeth have already been attacked by dental caries, notwithstanding the young age of the children. The mother of this family is shown in Fig. 18 (upper, left). It is of great importance that not only was dental caries rampant, but that there were marked deformity of the dental arches and irregularity of teeth in the cases of the children.

Among the many items of information of great interest furnished by Dr. Romig were facts that fitted well into the modern picture of association of modern degenerative processes with modernization. He stated that in his thirty-six years of contact with these people he had never seen a case of malignant disease among the truly primitive Eskimos and Indians, although it frequently occurs when they become modernized. He found similarly that the acute surgical problems requiring operation on internal organs such as the gall bladder, kidney, stomach, and appendix do not tend to occur among the primitive, but are very common problems among the modernized Eskimos and Indians. Growing out of his experience, in which he had seen large numbers of the modernized Eskimos and Indians attacked with tuberculosis, which tended to be progressive and ultimately fatal as long as the patients stayed under modernized living conditions, he now sends them back when possible to primitive conditions and to a primitive diet, under which the death rate is very much lower than under modernized conditions. Indeed, he reported that a great majority of the afflicted recover under the primitive type of living and nutrition.

The institutions that have been organized for the care of orphans and for the education of Eskimo and Indian boys and girls provide an opportunity to study conditions. A particularly favorable institution is located at Eklutna on the railroad north of Anchorage. Many of the individuals in the school had come from districts so remote from transportation facilities that their isolation had compelled them to live mostly on native foods, at least during their early childhood. They had come from districts very widely distributed throughout the Alaskan peninsula. Credit is due to the management of this institution for preparing and storing dried salmon for use throughout the winter. The beneficial effects of their good nutritional program were evident. The percentage of teeth attacked by dental caries was 14.6. A large percentage of these pupils were of mixed blood of native

Eskimos or Indians with whites. The white parent had probably been largely responsible for their attendance at this training school. There were several full-blooded Eskimos and Indians from modernized communities where they had been living on modern foods throughout their entire lifetime. This gave an opportunity to study the rôle of nutritional deficiencies in the development of deformities and irregularities in the facial features, in the arrangement of the teeth, and in the inter-relationship between the dental arches. The typical irregularities and divergencies from normal were present in the full-blooded Eskimo and Indian boys and girls in as high percentage as in the mixed bloods. Some of the young people with parentage of mixed blood have beautiful features.

Another important institutional group was studied at Seward in the Jesse Lee Home which had first been established at Nome and had been moved to Seward to avoid the extreme isolation of that district. This institution is located at Resurrection Bay which is one of the most beautiful harbors in the world. It gives shelter and educational opportunities to Eskimos and Indians, chiefly of mixed blood, from a large area of Alaska, and particularly from the Aleutian Peninsula, the Aleutian Islands and the Bering Sea. These individuals, whether of mixed or pure blood, had come chiefly from homes that were in large part modernized. The incidence of dental caries found here was 27.5 per cent for all teeth examined. Here again all individuals were affected. Notwithstanding the unusually fine hygienic conditions and highly trained dietitians of this institution, a medical ward and trained nurses, tuberculosis was reaping a heavy toll. I was told that 60 per cent of all those students who had moved with the school from Nome to this location were already dead from tuberculosis. It is common knowledge that tuberculosis has played a very important rôle in decimating the Indian and Eskimo population in the Pacific Coast towns and villages. A very important phase of these investigations is the development of new light on the rôle of nutrition in lowering the defense of these individuals so that with their low inheritance of defensive factors they rapidly become susceptible to tuberculosis.

The problem of evaluating the influence of a particular environment on racial and tribal development is relatively simple when studying contemporary remnants of primitive racial stocks. However, groups that have lived and disappeared in the past do not permit of so simple a procedure for making physical estimates. Fortunately, we have in the burial grounds not only the skeletons, but also many of the implements used in daily life. Sometimes these contain samples of the foods. We may find also their art ware and hunting equipment. While the period may not be definitely recorded, the knowledge of the history of the pottery of the tribe often gives an important clue to the dates as will also the method of burial. Burials made before the advent of the Christian era will in many groups show the bodies in a flexed position with the arms in the lap, whereas in the Christian burials the bodies have been laid prone and the arms crossed on the chest. By this sign the pre-Columbian burials can readily be separated from the post-Columbian.

Using these guides, a study of the Indians of Florida, past and present, permits of comparing the pre-Columbians with those living today in that same territory. We will, accordingly, consider the dental caries problem and that of facial and dental arch form in the Florida Indians by comparing three groups: namely, the pre-Columbian, as evidenced from a study of the skull material in the museums; the tribes of Indians living in as much isolation as is possible in the Everglades and Cypress Swamps; and the Indians of the same stock that are living in contact with the foods of modern civilization. This latter group lives along the Tamiami trail and near Miami. In a study of several hundred skulls taken from the burial mounds of southern Florida, the incidence of tooth decay was so low as to constitute an immunity of apparently one hundred per cent, since in several hundred

skulls not a single tooth was found to have been attacked by tooth decay. Dental arch deformity and the typical change in facial form due to an inadequate nutrition were also completely absent, all dental arches having a form and interdental relationship such as to bring them into the classification of normal. These are illustrated in Figs. 22 and 23. The problem of reaching the isolated groups living in the depth of the Cypress Swamps was complicated by the fact that these people had a dread of all whites growing out of their belief that they had been grossly taken advantage of in some of their early efforts to make a treaty with the whites. With the assistance of three guides, one, an Indian of their own group, another, a white man whom they trusted, and the third, a government nurse who had been very helpful in case of sickness, we were able to take the desired measurements and records and photographs. A group of these more primitive representatives is shown in Fig. 24. While their hunting territory had been grossly encroached upon by the white hunters, they were still able to maintain a very high degree of physical excellence and high immunity to dental caries. Only four teeth in each hundred examined were found to have been attacked by tooth decay.

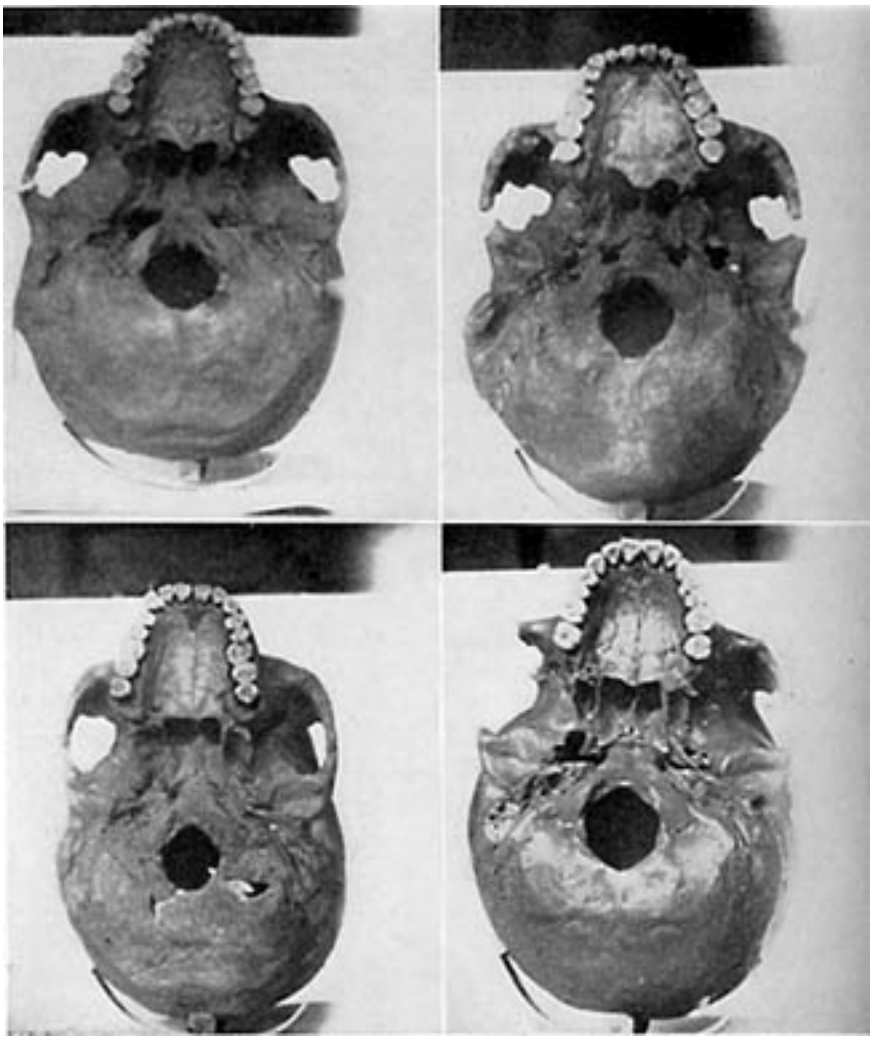

FIG. 22. Skulls of primitive Indians showing superb dental arches typical of Nature's normal plan. Note the splendid position of the third molars which are so frequently defective in position and quality in our modern white civilization. In many districts where I have made studies among primitive Indians and in many collections of their skulls close to a hundred per cent of the teeth have been free from dental caries or faulty position.

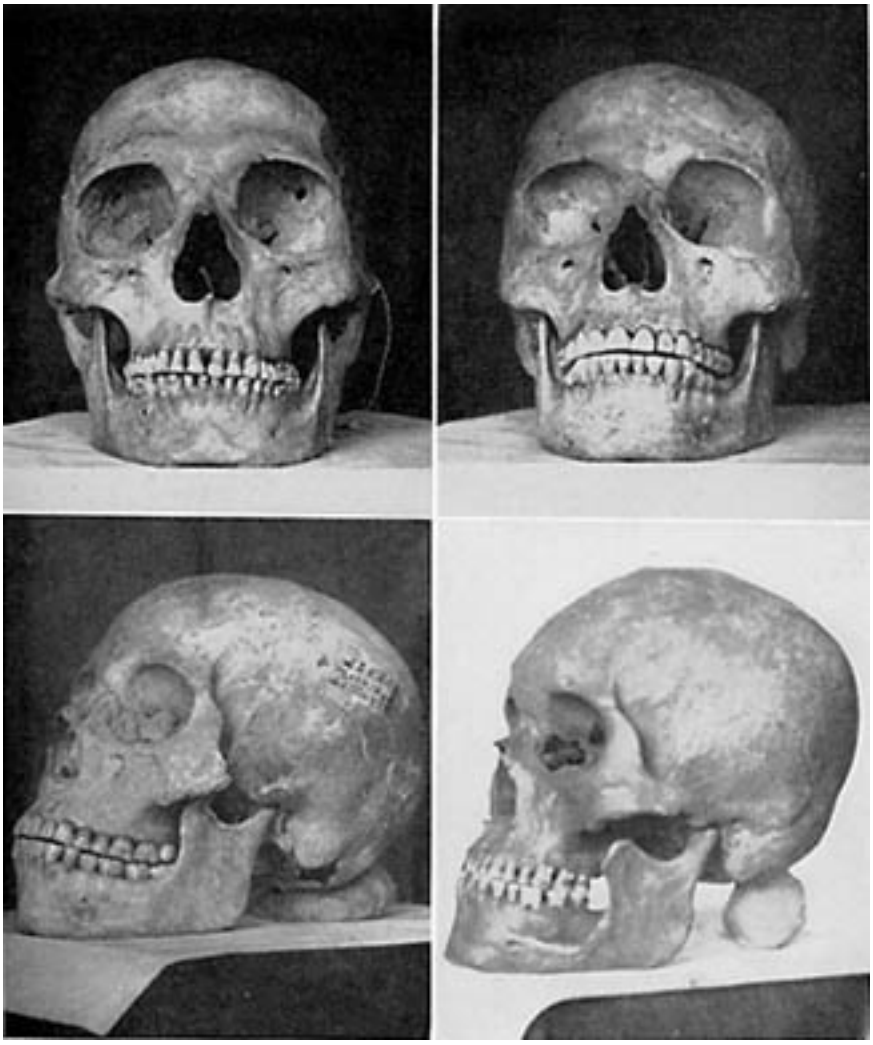

FIG. 23. The Indian skulls that have been uncovered in many parts of the United States and Canada show a degree of excellence comparable to those seen in this Figure. These levels of excellence were the rule with them, not the exception as with us. The parents of these individuals knew what they and their children should eat!

FIG. 24. The Seminole Indians living today in southern Florida largely beyond contact with the white civilization still produce magnificent teeth and dental arches of which these are typical. They live in the Everglade forest and still obtain the native foods.

Practically all of the dental arches were normal in contour with freedom from facial distortion. In contrast with this, the Indians of Florida who are living today in contact with modern civilization present a pathetic picture. Forty out of every hundred teeth examined were found to have been attacked by tooth decay, typically illustrated in Fig. 25. In the latest generation, many dental arches showed a typical deformation with crowding of the teeth and narrowing of the face, conditions that have been found in all human stocks when on an inadequate nutrition during the formative and early growth period. A group of these is typically illustrated in Fig. 26.

FIG. 25. The Seminole Indians of Florida who are living in contact with our modern civilization and its foods suffer from rampant dental caries.

FIG. 26. Seminole Indians. Note the change in facial and dental arch form in the children of this modernized group. They have a marked lack of development of the facial bones with a narrowing of the nostrils and dental arches with crowding of the teeth. Their faces are stamped with the blight which so many often think of as normal because it is so common with us.

It is of interest that the quality of the skeletal material that is taken from the mounds showed unusually fine physical development and freedom from joint involvements. In contrast with this, many of the individuals of the modernized group were suffering from advanced deformities of the skeleton due to arthritic processes.

The effects of the excellent nutrition of the pre-Columbian Indians is indicated in the comparative thickness of the skulls. In Fig. 27 are shown two pieces of a pre-Columbian skull in contrast with a modern skull. The specimen of a trephined lower jaw, shown in Fig. 27 (right) indicates a knowledge of surgery that is very remarkable. The margins show new bone growth. The operation opened a cyst.

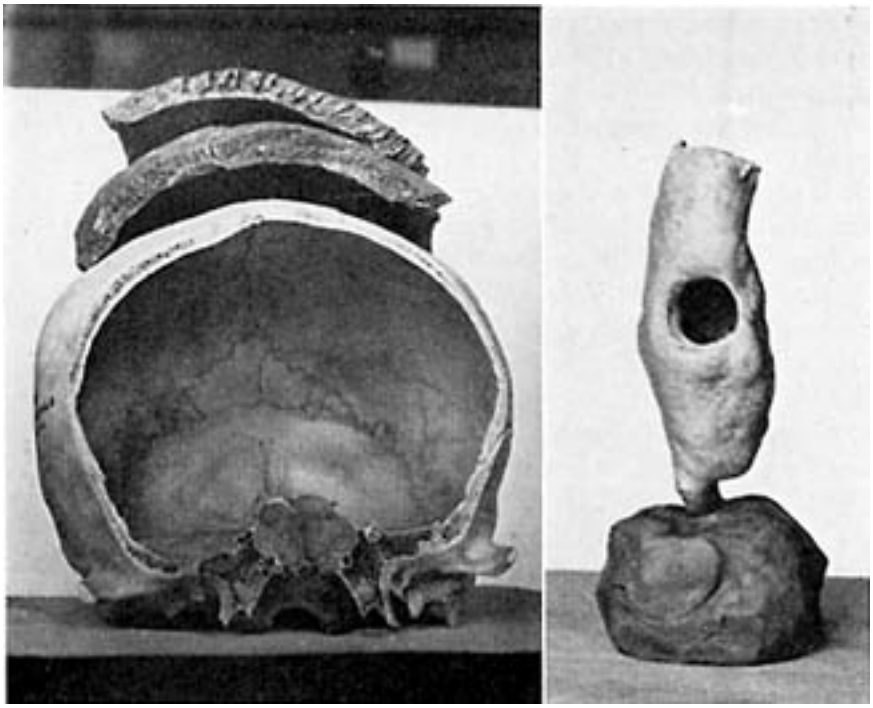

FIG. 27. Left: Example of greater thickness of pre-Columbian Indian skulls in Florida than modern skulls. Right: Illustration of bone surgery of ancient Florida Indians. Note healing of margins of trephined opening into a cyst, of the lower jaw. This is typical of the advanced surgery of the Peruvian Indians.

For the study of a group of Indians now living in a high western state, Albuquerque, New Mexico, was visited.

Several other Indian studies have been made including studies of living groups, recently opened burials and museum collections, all of which support the findings recorded here. I am indebted to the directors and to the staffs of these institutions for their assistance.

Notwithstanding the wide range of physical and climatic conditions under which primitive Indians had been living, their incidence of tooth decay while on their native foods was always near zero; whereas, the modernized Indians of these groups showed very high incidence of dental caries. A summary of percentages follows: *Primitive Indians:* Pelly Mountain, 0.16 per cent; Juneau, 0.00 per cent; Florida Pre-Columbian, 0.00 per cent; Florida Seminoles, 4.0 per cent. *Modernized Indians:* Telegraph Creek, 25.5 per cent; Alaska Frontier, 40.0 per cent; Mohawk Institute, 17 per cent; Brantford Reservation Public School, 28.5 per cent; Brantford Reservation Hospital, 23.2 per cent, Tuscarora Reservation, 38.0 per cent; Winnipeg Lake Reservation, 39.1 per cent; North Vancouver Reservation, 36.9 per cent; Craigflower Indian Reservation, 48.5 per cent; Ketchikan, 46.6 per cent; Juneau Hospital, 39.1 per cent; Sheldon Jackson School, 53.7 per cent; Sitka, 35.6 per cent; Eklutna, 14.6 per cent; Jessie Lee Home, Seward, 27.6 per cent, and Florida Seminoles, 40.0 per cent.

The foods used by the primitives varies according to location and climate. The foods of the modernized groups in all cases were the typical white man's foods of commerce.

While the primitive groups constantly presented well-formed faces and dental arches reproducing

the tribal pattern, the new generation, after the adoption of white man's foods, showed marked changes in facial and dental arch form.

The Indians like several primitive races I have studied are aware of the fact that their degeneration is in some way brought about by their contact with the white man. The dislike of the American Indian for the modern white civilization has been emphasized by many writers. In my studies among the Seminole Indians of Florida I found great difficulty in communicating with or making examination of the isolated Seminoles living deep in the Everglades and Cypress Swamp. Fortunately, I had the able assistance of one of their own tribe, a government nurse who had been very helpful to them and also a white man who had befriended them and whom they trusted. With their assistance I was able to carry out very detailed studies. It was of interest, however, that when we arrived at a settlement in the bush we practically always found it uninhabited. Our Indian guide would go into the surrounding scrub and call to the people assuring them it was to their advantage to come out, which they finally did. I was told that this attitude had grown out of the belief on their part that their treaties had been violated. These isolated Seminole Indian women had the reputation of turning their backs on all white men.

A United States Press report (1) provides an article with the heading *"Tribes 'Fed Up' Seek Solitude, Indians Dislike Civilization, Ask Land Barred to White Men."* The article continues:

> The Bureau of Indian Affairs revealed today that five Indian tribes in Oklahoma are "fed up" with white civilization and want new, secluded tribal lands.
>
> So widespread is the discontent among the 100,000 Indians living in Oklahoma, officials said, that serious study is being given to the possibility of providing new lands where the redman may hunt and fish as his ancestors did.
>
> Dissatisfaction has been brewing for a long time as a result of an increasing Indian population, decreasing Indian lands and unsatisfactory economic conditions. It was brought officially to the notice of bureau officials several days ago when a delegation, headed by Jack Gouge, a Creek Indian from Hanna, Okla., told Indian Commissioner John Collier that most of the Oklahoma Indians wanted new tribal lands away from white civilization.
>
> So anxious are his people to escape from the white man and his influences, Jack Gouge said, that an organization of about 1000 Indians has been formed to press the demands. It is known as the "Four Mothers," apparently representing four of the "civilized tribes"--the Creeks, Choctaws, Cherokees and Chickasaws.
>
> The fifth civilized tribe, the Seminoles of Oklahoma, are negotiating with the Mexican government for tribal lands in that country.
>
> These tribes are described as "civilized" because of the high degree of culture they attained in their original tribal lands along the eastern coast. As their eastern lands became valuable the Indians were moved to the area which is now Oklahoma. At the turn of the century, however, with the discovery of oil there the new tribal lands were broken up. The Indians were forcibly removed to small tracts despite their desire to remain together. Indian Bureau officials do not conceal their bitterness over the white man's "treachery." One official pointed out that about

300 treaties have been signed with the Indians and that practically every one has been violated.

It will be most fortunate if in the interest of science and human betterment such a program as this will be carried out in order to permit these Indians to live in accordance with the accumulated wisdom of their various tribes. Their preservation in isolation would preserve their culture. The greatest heritage of the white man today is the accumulated wisdom of the human race.

REFERENCE

1. Tribes "Fed Up" Seek Solitude. *Cleveland Press*, June 19, 1938.

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Chapter 7

ISOLATED AND MODERNIZED MELANESIANS

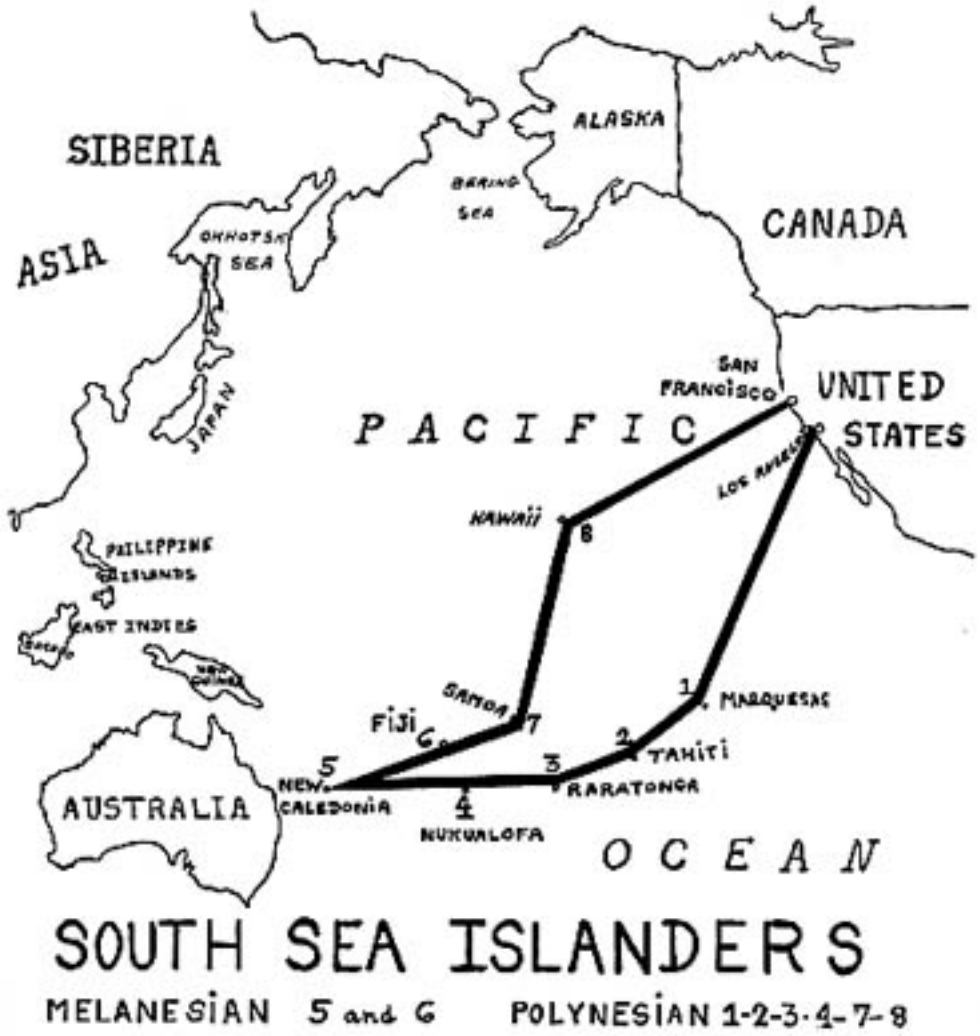
SINCE our quest was to gather data that will throw light upon the cause of modern physical degeneration among human racial stocks in various parts of the world, it became necessary to include for study various groups living in the hot sultry climates of the tropics. Again it was desirable to obtain contact with both highly isolated and, therefore, relatively primitive stocks for comparison with modernized groups of the same stock. In order to accomplish this an expedition was made in 1934 to eight archipelagos of the Southern Pacific to study groups of Melanesians and Polynesians. The Melanesians described here were living in New Caledonia and the Fiji Islands.

If the causative factors for the physical degeneration of mankind are practically the same everywhere, it should be possible to find a common cause operating, regardless of climate, race, or environment.

Owing to the vast extent of the Pacific waters and the limited number of transportation lines, it became very difficult to arrange a convenient itinerary. This, however, was finally accomplished satisfactorily by going southward through the more easterly archipelagos; namely, the Marquesas Islands, Society Islands and Cook Islands, then westward to the Tongan Islands in the southern central Pacific near New Zealand, and then westward to New Caledonia near Australia. From this group we went northward to the Fiji Islands, also in the western Pacific, then to the Samoan Islands

in the central Pacific south of the equator, and then to the Hawaiian Islands north of the equator. These island groups were all populated by different racial stocks speaking different languages. The movements from archipelago to archipelago were made on the larger ships, and between the islands of the group in small crafts, except in the Hawaiian Islands where an aeroplane was used.

The program in each group consisted in making contact with local guides and interpreters. They had generally been arranged for in advance by correspondence with government officials. By these means we were able to reach isolated groups in locations quite distant from contact with trade or merchant ships. To reach these isolated groups often required going over rough and difficult trails since most of the islands being of volcanic formation are mountainous.



On reaching the isolated groups our greetings and the purpose of the mission were conveyed by our interpreters to the chiefs. Much time was often lost in going through necessary ceremonials and feasting. In every instance we received a very cordial reception and excellent cooperation. In no instance was there antagonism. Through the underground telegraph they always seemed to know we were coming and had prepared for us. When these formalities were once over and our wishes made known, the chiefs instructed the members of their tribes to carry out our program for making examinations, recording personal data, making photographs, and collecting samples of foods for chemical analysis. The food samples were either dried or preserved in formalin.

The detailed records for every individual included data on the tribe, village and family, his age, previous residence, physical development, the kinds of foods eaten, the physical condition of every tooth, including presence or absence of cavities; the shape of the dental arches; the shape and development of the face; and detailed notes on divergencies from racial type. Special physical characteristics were photographed. A comparsion was made of these factors for each of the more isolated members of the same tribe and those in the vicinity of the port or landing place of the island. Through the government officials detailed information was secured, usually in the form of the annual government statistical reports, showing the kind and quantity of the various ingredients and articles that were imported, and similarly those that were exported. Contact was made in each island group with the health officers, and the studies were usually made with their assistance. In many instances the only contact with civilization had consisted of the call of a small trading ship once or twice a year to gather up the copra or dried coconut, sea shells and such other products as the natives had accumulated for exchange. Payment for these products was usually made in trade goods and not in money. The following articles consisted nearly always of 90 per cent of the total value: white flour and sugar. Ten per cent consisted of wearing apparel or material for that apparel.

While the missionaries have encouraged the people to adopt habits of modern civilization, in the isolated districts the tribes were not able to depart much from their native foods because of the infrequency of the call of the trader ship. Effort had been made in almost all of the islands to induce the natives to cover their bodies, especially when in sight of strangers. In several islands regulatory measures had been adopted requiring the covering of the body. This regulation had greatly reduced the primitive practice of coating the surface of the body with coconut oil, which had the effect of absorbing the ultra-violet rays thus preventing injury from the tropical sun. This coating of oil enabled them to shed the rain which was frequently torrential though of short duration. The irradiation of the coconut oil was considered by the natives to provide, in addition, an important source of nutrition. Their newly acquired wet garments became a serious menace to the comfort and health of the wearers.

The early navigators who visited these South Sea Islands reported the people as being exceedingly strong, vigorously built, beautiful in body and kindly disposed. There were formerly dense populations on most of the inhabitable islands. In contrast with this, one now finds that on many of the islands the death rate has come to so far exceed the birth rate that the very existence of these racial groups is often seriously threatened.

The Island of New Caledonia is one of the largest of the Pacific. It is situated in the vicinity of 23 degrees south latitude and 165 degrees east longitude. The New Caledonians are pure Melanesian stock. They are broad shouldererd, very muscular and in the past have been very warlike. These Islands are under French control. The foreign population is chiefly French, and limited mainly to the vicinity of the one port of Noumea. The subjugation of these people has been very difficult and as recently as 1917 a band from the interior in protest against efforts to establish a white colony and sugar plantation on a desirable section of coastal land swept down on the French colony in the night and massacred almost the entire population. Their contact with the required foods from the sea had been cut off. They believe they require sea foods to maintain life and physical efficiency. The physical development of the primitive people including their teeth and dental arches is of very high order. A comparison of the individuals living near the ports with those living in the isolated inland locations shows marked increase in the incidence of dental caries. For those living almost exclusively

on the native foods the incidence of dental caries was only 0.14 per cent; while for those using trade foods the incidence of dental caries was 26 per cent. The splendid facial and dental arch development of these quite primitive Caledonians is shown in Fig. 28. Note also their kinky hair and strong neck and face muscles.

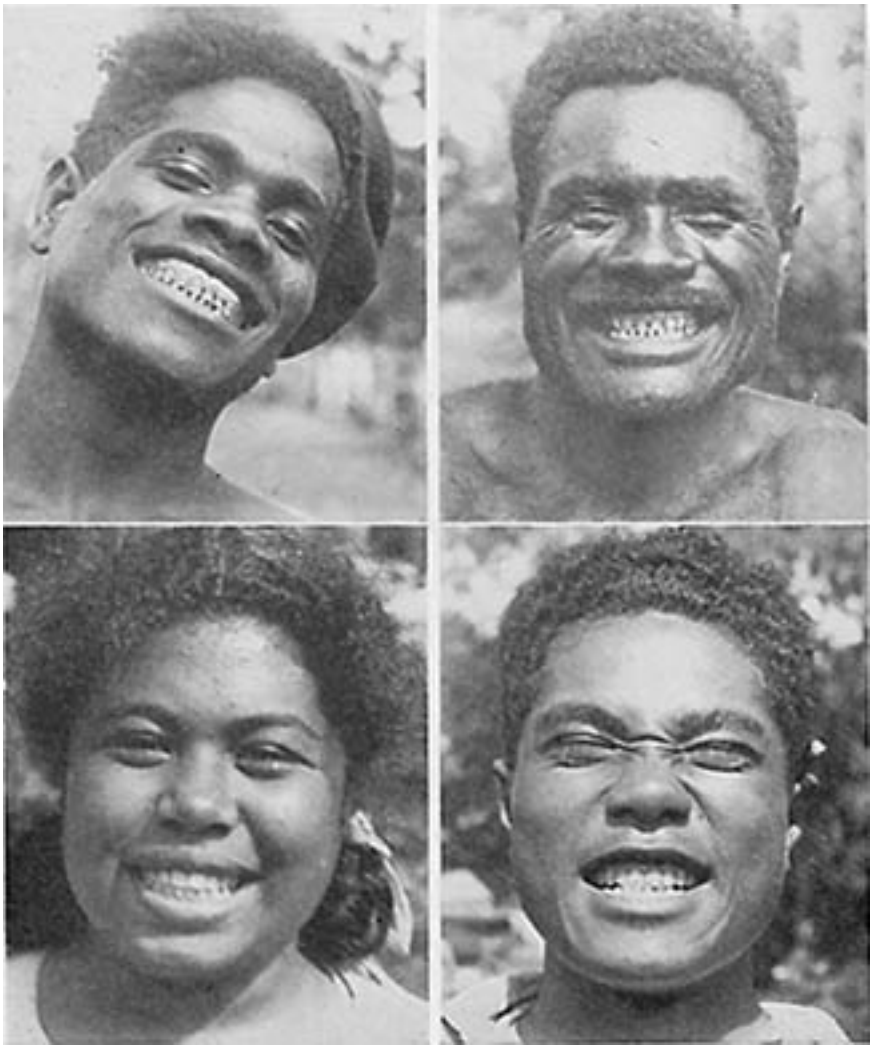


FIG. 28. These Melanesians are typical in general physical build and facial and dental arch form of their race which is spread over a wide area of Islands in the southeastern Pacific. The nutrition of all is adequate for them to develop and maintain their racial pattern.

The Fiji Island group lies between 15 and 22 degrees south latitude and between 177 degrees west and 175 degrees east longitude, thus straddling the international date line. The Fiji Islanders are similar in physical development and appearance to the New Caledonians, and like them are largely, if not wholly, Melanesian in racial origin. The men have kinky hair and broad shoulders. In the past, they have been excellent warriors. They are not as tall as their hereditary enemies, the Tongans, to the east, and in order to make themselves look equally tall, they have adopted the practice of training their kinky hair straight out from the head to a height often reaching six or more inches. Typical facial and dental arch forms are shown in Fig. 29. They are British subjects, and where they have had supervision, in the districts near the ports and on those islands on which sugar plantations have been established, they have suffered very greatly from the degenerative diseases.

FIG. 29. The development of the facial bones determines the size and shape of the palate and the size of the nasal air passages. Note the strength of the neck of the men above and the well proportioned faces of the girls below. Such faces are usually associated with properly proportioned bodies. Tooth decay is rare in these mouths so long as they use an adequate selection of the native foods.

Since Viti Levu, one of the islands of this group, is one of the larger islands of the Pacific Ocean, I had hoped to find on it a district far enough from the sea to make it necessary for the natives to have lived entirely on land foods. Accordingly, with the assistance of the government officials and by using a recently opened government road I was able to get well into the interior of the island by motor vehicle, and from this point to proceed farther inland on foot with two guides. I was not able, however, to get beyond the piles of sea shells which had been carried into the interior. My guide told me that it had always been essential, as it is today, for the people of the interior to obtain some food from the sea, and that even during the times of most bitter warfare between the inland or hill tribes and the coast tribes, those of the interior would bring down during the night choice plant foods from the mountain areas and place them in caches and return the following night and obtain the sea foods that had been placed in those depositories by the shore tribes. The individuals who carried these foods were never molested, not even during active warfare. He told me further that they require food from the sea at least every three months, even to this day. This was a matter of keen interest, and at the same time disappointment since one of the purposes of the expedition to the South Seas was to find, if possible, plants or fruits which together, without the use of animal products, were capable of

providing all of the requirements of the body for growth and for maintenance of good health and a high state of physical efficiency. Among the sources of animal foods was the wild pig from the bush. These were not native, but imported into nearly all of the islands, and they have become wild where there is an abundance of food for them. Another animal food was that from coconut crabs which grow to a weight of several pounds. At certain seasons of the year the crabs migrate to the sea in great numbers from the mountains and interior country. They spend about three days in the sea for part of their reproductive program and return later to their mountain habitats. Their routes of travel are as nearly as possible in straight lines. At the season of migration, large numbers of the crabs are captured for food. These crabs rob the coconut trees of fruit. They climb the trees during the darkness and return to the ground before the dawn. They cut off the coconuts and allow them to drop to the ground. When the natives hear coconuts dropping in the night they put a girdle of grass around the tree fifteen or twenty feet from the ground, and when the crabs back down and touch the grass they think that they are down on the ground, let go their hold and are stunned by the fall. The natives then collect the crabs and put them in a pen where they are fed on shredded coconut. In two weeks' time the crabs are so fat that they burst their shells. They are then very delicious eating. Fresh water fish of various kinds are used where available from the mountain streams. Land animal foods, however, are not abundant in the mountainous interior, and no places were found where the native plant foods were not supplemented by sea foods.

Our first visit to the Fiji Islands was in 1934, and the second in 1936. On our first trip we had much personal assistance from Ratu Popi, hereditary king. His residence was on the royal island reserved exclusively for the king and his retinue. His picture is shown in Fig. 30 with that of Mrs. Price. He was very solicitous for the welfare of his people whom he recognized to be rapidly breaking down with modernization. The council house is also shown in Fig. 30. He gave us very important information regarding the origin of cannibalism, relating it to a recognition of special food values of special organs, particularly the livers.

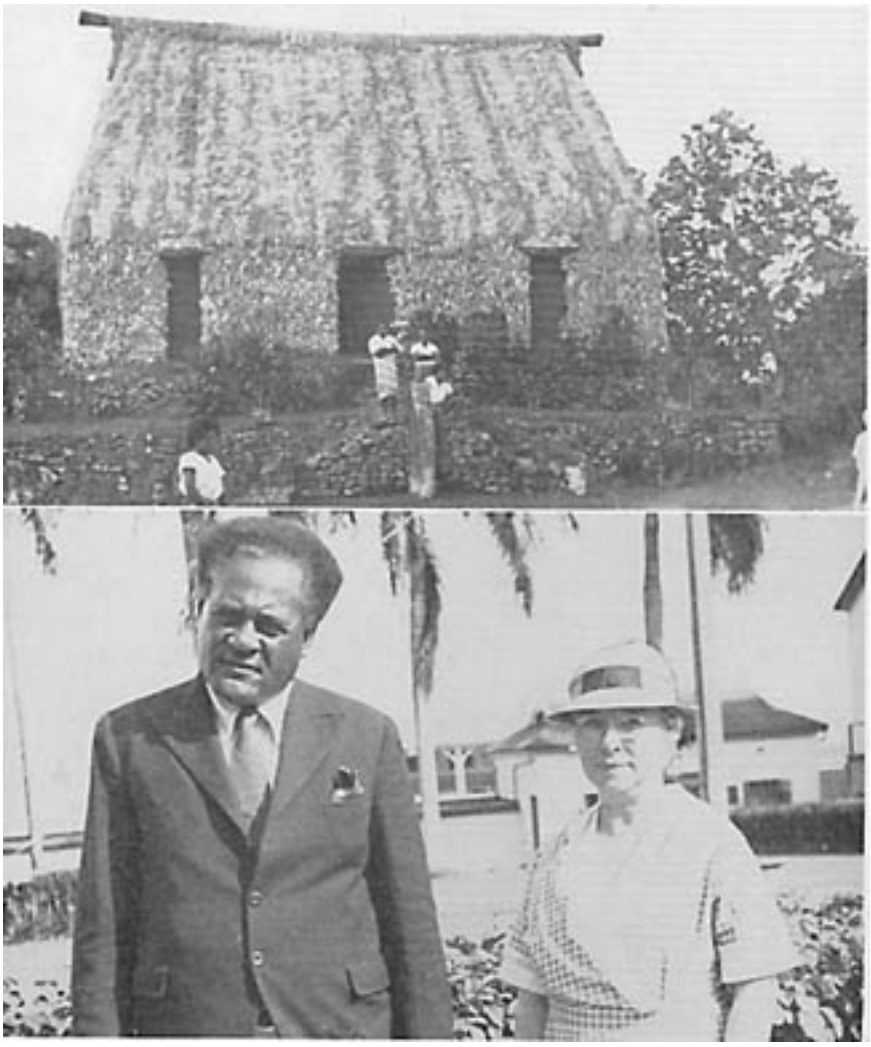


FIG. 30. The building above is the Fiji Council house and shows the typical form of native architecture; no nails or bolts are used. It is located on the King's Island Mbau. The hereditary monarch, Ratu Popi is seen with Mrs. Price. Note his splendid features. Beneath his coat he wears a native skirt and is barefooted.

There has been a very extensive development of sugar plantations on the larger islands of several of the Pacific archipelagos. The working of these plantations has required the importation of large numbers of indentured laborers. These have been brought chiefly from India and China. Since they are nearly all men, those who have married have obtained their wives from among the natives. This, the Chinese have done quite frequently. Since they are excellent workers they provide good homes and are good business men. They are, in many districts, rapidly becoming the landowners and are men of influence. This influx of Asiatics, together with that of Europeans, has had an important influence upon the purity of the native race around the ports and provided an opportunity to study the effect of intermingling of races upon the susceptibility to dental caries. No differences in extent of tooth decay due to ancestry were disclosed. The incidence of dental caries at the points of contact with imported foods was 30.1 per cent of teeth examined as compared with 0.42 for the more isolated groups living on the native foods of land and sea.

The physical changes which were found associated with the use of the imported foods included the loss of immunity to dental caries in practically all of the individuals who had displaced their native foods very largely with the modern foods. Dental caries was much worse, however, in the growing

children and motherhood group due to the special demands of these individuals. These conditions are illustrated in Figs. 31 and 32. The boy shown in Fig. 32 (upper, left) typifies the suffering brought by modernization. Abscessed teeth often cause suicide.

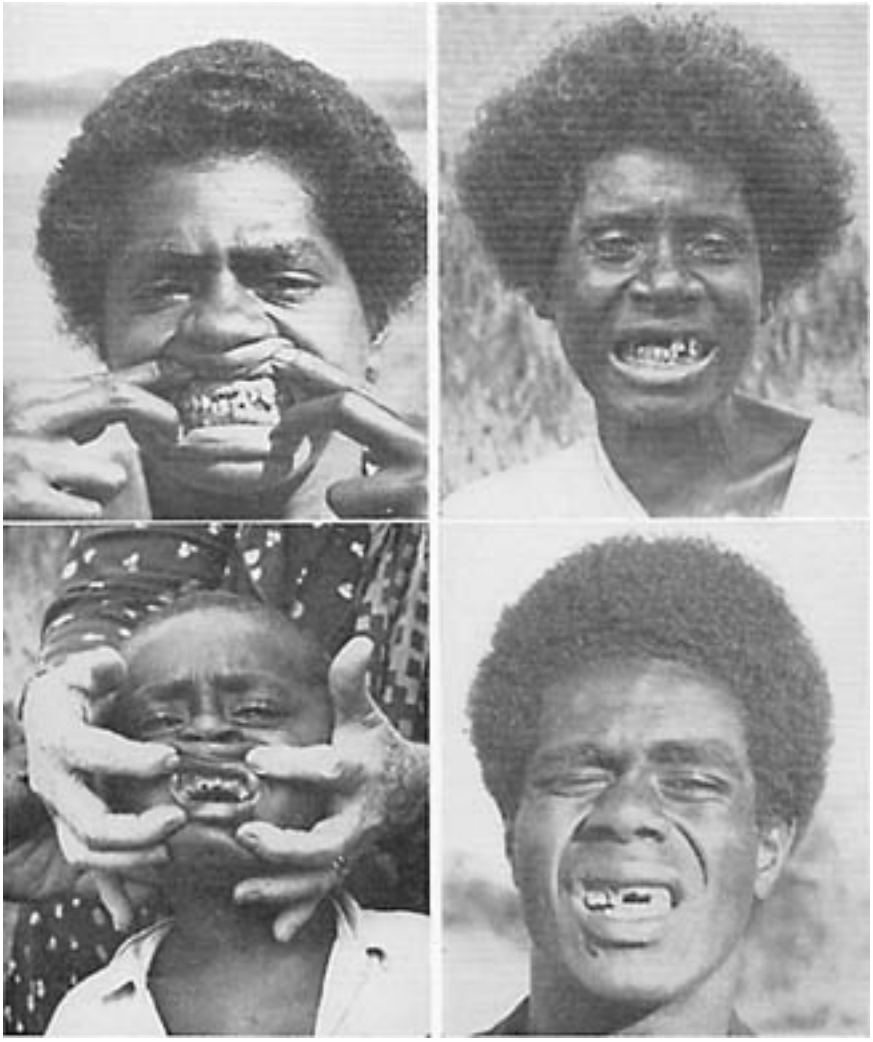


FIG. 31. These natives of the Fiji Islands illustrate the effect of changing from the native food to the imported foods of commerce. Tooth decay becomes rampant and with it is lost the ability to properly masticate the food. Growing children and child bearing mothers suffer most severely from dental caries.

FIG. 32. No dentists or physicians are available on most of these islands. Toothache is the only cause of suicide. The new generation born after the parents adopt the imported modern foods often have a change in the shape of the face and dental arches. The teeth are crowded as shown below.

Another important phase of the studies included a critical examination of the facial form and shape of the dental arches which include very definite and typical changes represented by the narrowing of the features and the lengthening of the face with crowding of the teeth in the arch. These are illustrated in the lower half of Fig. 32.

The members of the Melanesian race living on the Fiji Islands of the Pacific, whether volcanic or coral in origin, have developed a very high immunity to dental caries and well formed faces and dental arches. Their native foods consisted of animal life from the sea eaten with plants and fruits from the land in accordance with a definite program of food selection. In their primitive state only 0.42 per cent of their teeth were attacked by tooth decay. In the modernized groups this incidence increased to 30.1 per cent. The change in the nutrition included a marked reduction in the native foods and their displacement with white-flour products, sugar and sweetened goods, canned foods and polished rice. In the succeeding generations after the parents had adopted the modern foods, there occurred distinct change in facial form and shape of the dental arches.

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Chapter 8

ISOLATED AND MODERNIZED POLYNESIANS

THE characteristics of the Polynesian race included straight hair, oval features, happy, buoyant dispositions and splendid physiques. When the Pacific Islands were discovered the Polynesians were found inhabiting the Hawaiian Islands, the Marquesas Islands, the Tuamotu group including Tahiti, the Cook Islands, the Tongan Islands and the Samoan group.

The first group studied was made up of the people of the Marquesas Islands which are situated 9 degrees south latitude and 140 degrees west longitude, about 4,000 miles due west of Peru. Few, if any, of the primitive racial stocks of the South Sea Islands were so enthusiastically extolled for their beauty and excellence of physical development by the early navigators. Much tooth decay prevails today. They reported the Marquesans as vivacious, happy people numbering over a hundred thousand on the seven principal islands of this group. Probably in few places in the world can so distressing a picture be seen today as is found there. A French government official told me that the native population had decreased to about two thousand, chiefly as a result of the ravages of tuberculosis. Serious epidemics of small-pox and measles have at times taken a heavy toll. In a group of approximately one hundred adults and children I counted ten who were emaciated and coughing with typical signs of tuberculosis. Many were waiting for treatment at a dispensary eight hours before the hour it opened. In the past some of the natives have had splendid physiques, fine countenances, and some of the women have had beautiful features. They are now a sick and dying primitive group. A trader ship was in port exchanging white flour and sugar for their copra. They have largely ceased to depend on the sea for food. Tooth decay was rampant. At the time of the examination, 36.9 per cent of the teeth of the people using trade food in conjunction with the land plants and fruits had been attacked by tooth decay. The individuals living entirely on native foods were few. Some early navigators were so highly impressed with the beauty and health of these people that they reported the Marquesas Islands as the Garden of Eden. Tahiti is the principal island of the Society group. It is situated 17 degrees south of the equator, 149 degrees west longitude. Fortunately degeneration has not been so rapid nor so severe here. The Tahitian population, however, has reduced from over two hundred thousand as early estimated, to a present native population estimated at about ten thousand. These islands are also a part of French Oceania. Many of the able bodied men were taken from these French Islands to France to fight in the World War. Only a small percentage, however, returned, and they were mostly crippled and maimed. The Tahitians are a buoyant, light-hearted race, fully conscious, however, of their rapid decline in numbers and health. Many of the more primitive are very fine looking and have excellent dental arches, as seen in Fig. 33.

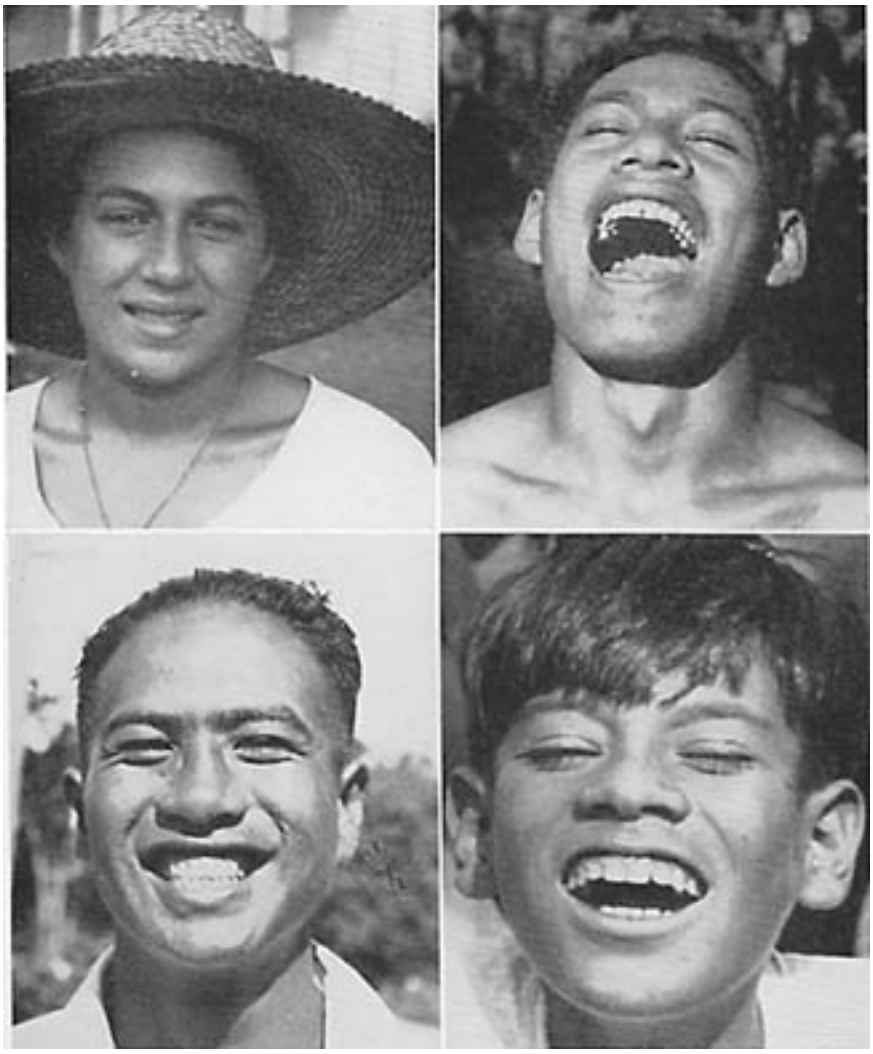

FIG. 33. Polynesians are a beautiful race and physically sturdy. They have straight hair and their color is often that of a sun tanned European. They have perfect dental arches.

The capital of Tahiti, Papeete, is the administrative center for the French Pacific possessions. It has a large foreign population, and there is considerable commerce in and out of this port. Much imported food is used. Like on the Marquesas Islands, it was difficult to find large numbers of individuals living entirely on the native foods. Those that were found had complete immunity to dental caries. For the natives living in part on trade foods, chiefly white flour, sugar and canned goods, 31.9 per cent of the teeth were found to be attacked by tooth decay. Typical extensive destruction of the teeth amongst the modernized Tahitians is shown in Fig. 34. There is a large colony of Chinese in Tahiti, brought there as indentured laborers. They have not returned. When the Tahitian men did not return from the war, their wives married the Chinese, who are good workers.

FIG. 34. Wherever the native foods have been displaced by the imported foods, dental caries becomes rampant. These are typical modernized Tahitians.

The Cook Islands are British and under the direct guidance of the New Zealand Government. Rarotonga is the principal island. It is situated in the Pacific Ocean in the vicinity of 21 degrees south latitude and 160 degrees west longitude. It has a delightful climate the year around. Racially according to legend, the Maori tribe, the native tribe of New Zealand, migrated there from the Cook Islands. In addition to being similar in physical development and appearance, their languages are sufficiently similar so that each can understand the other, even though their separation occurred probably over a thousand years ago.

It is a matter of great importance that the inhabitants of these South Sea Islands were skillful navigators and boat builders. It was a common occurrence for expeditions both peaceful and aggressive to make journeys of one and two thousand miles in crafts propelled by man power and wind and carrying in addition an adequate supply of water and food for their journey.

A large number were found in Rarotonga living almost entirely on native foods, and only 0.3 per cent of the teeth of these individuals have been attacked by dental caries. In the vicinity of Avarua, the principal port, however, the natives were living largely on trade foods, and among these 29.5 per cent of the teeth were found to have been attacked by dental caries. In Fig. 35 (top) are seen typically fine faces and teeth. However at the lower left is shown a child at the port whose parents were living

on the imported food. This boy's upper lateral teeth are erupting inside the arch. In the lower right is a child with normal spacing of the deciduous teeth.

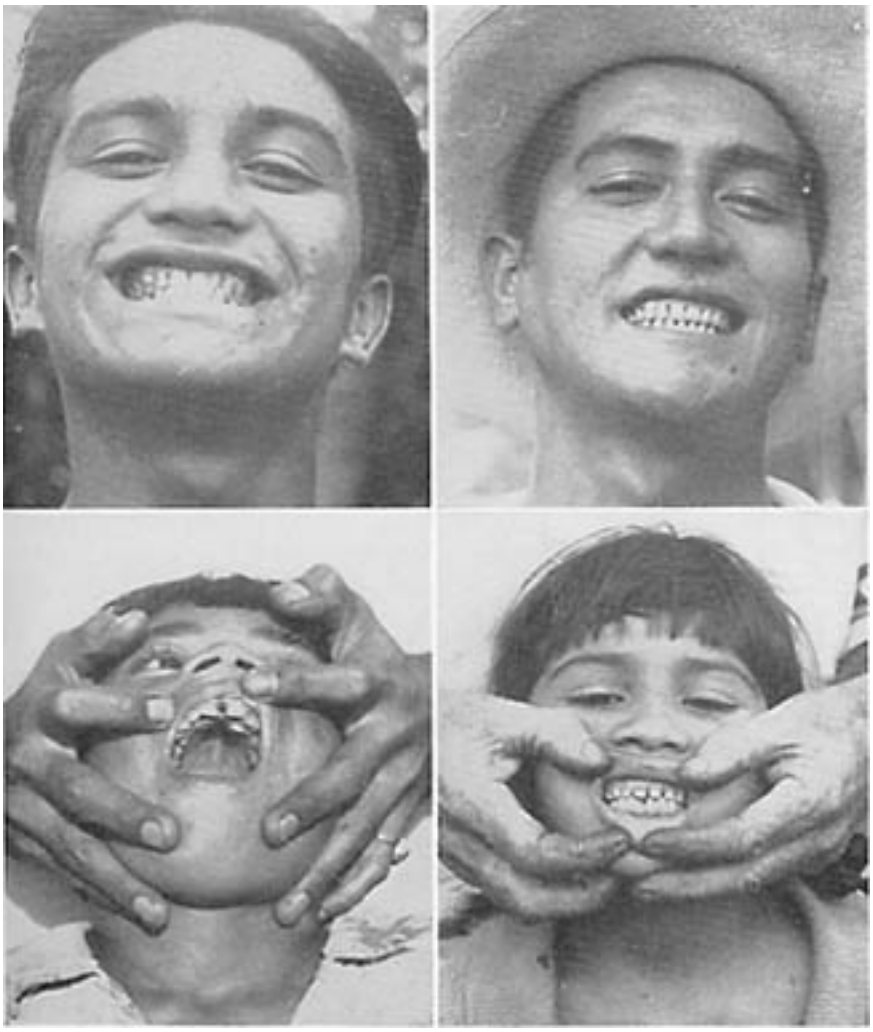

FIG. 35. These Polynesians live on the island of Rarotonga. At the top are two examples of typically fine faces and teeth. Below, at left, is seen a full blood Polynesian child with the dental arch so small that the permanent laterals are developing inside the arch. His parents used imported food. At the right below is a mixed blood of white and Polynesian. Note the normal spacing of the temporary teeth before the permanent set appears. Parents used native foods.

Under British guidance the Cook Islanders have much better health than the Marquesans or the Tahitians. Their population is not seriously decreasing, and is untroubled except for the progressive development of the degenerative diseases around the port. They are thrifty and happy, and are rapidly developing a local culture including a school system supported by natives.

The inhabitants of the Tongan Islands, the principal of which is Tongatabu, are Polynesian. This group, containing over 100 islands, is situated between 18 and 22 degrees south latitude and between 173 and 176 degrees west longitude, and has a native population of about 28,000. They have the distinction of being one of the last absolute monarchies of the world. While they are under the protection of Great Britain, they largely manage their own affairs. Their isolation is nearly complete except for a call from an infrequent trader. They seem to be credited by the inhabitants of the other

islands as being the greatest warriors of the Pacific. The Tongans at least acknowledge that they are the greatest warriors, and indeed the greatest people of the world. They will not step aside to allow anyone to pass since they say that when the world was created and populated they were the first to be made, next was the pig, and last the white man. Ethnologically, they are said to be a mixture of the darker Melanesians with their kinky hair, and the fairer Polynesians of the eastern archipelagos with straight hair. It is said they have never been defeated in battle. For centuries they and the Fijian tribes 700 miles to the west have frequently been at war. The British government has very skillfully directed this racial rivalry into athletics. While we were in the Fiji Islands the British government provided a battle cruiser to carry the football team from Fiji to Nukualofa for the annual contest of strength.

These islanders have practiced eugenics by selecting tall strong mates. The queen of the islands was six feet three inches in height.

The limited importation of foods to the Tongan Islands due to the infrequent call of merchant or trading ships has required the people to remain largely on their native foods. Following the war, however, the price of copra went up from $40.00 per ton to $400.00, which brought trading ships with white flour and sugar to exchange for the copra. The effect of this is shown very clearly in the condition of the teeth. The incidence of dental caries among the isolated groups living on native foods was 0.6 per cent, while for those around the port living in part on trade foods, it is 33.4 per cent. The effect of the imported food was clearly to be seen on the teeth of the people who were in the growth stage at that time. Now the trader ships no longer call and this forced isolation is very clearly a blessing in disguise. Dental caries has largely ceased to be active since imported foods became scarce, for the price of copra fell to $4.00 a ton. The temporary rise in tooth decay was apparently directly associated with the calling of trader ships.

The Samoan Islands are located in the vicinity of 14 degrees south latitude and between 166 and 174 degrees west longitude. The native population of the Samoan Islands is Polynesian. The control of the Islands is divided between two governments. The eastern group is American. The western group is British since the World War, before which it was under German control. The western group is now under a mandate to New Zealand. Through the kindness of the Governor and Naval Officers of American Samoa transportation was provided on an auxiliary craft to the various islands of the American Samoan group. We were particularly indebted to Commander Stephenson, Director of Health, whose guests we were, for continued personal assistance in making favorable contacts in nearly all villages of the American Samoan group. In no islands of the Pacific did we find so excellent an organization for health service. Dispensaries have been established within reach of nearly all the villages besides hospital service at Pago Pago, the port of Tutuila. This is the finest port in the Pacific Ocean. Notwithstanding the regular monthly contact through merchant ships to and from America and Australia, many isolated groups were found living largely on the native foods. A dental survey had recently been made of this group by Lieutenant Commander Ferguson. (1)

The excellent facial and dental arch development of the Samoans is illustrated in the upper half of Fig. 36. The change in facial and dental arch form which follows the use of modern food by the parents is shown in the lower half of Fig. 36. Note the marked irregularity of the teeth. This is one of the few groups of islands in which the population is not rapidly decreasing, indeed there is some increase. The Navy personnel includes one dentist. Practically all his time is required for the

personnel and families of the Navy at this station. Accordingly, he can do only a limited amount of emergency service such as extractions for the natives. About 90 per cent of the inhabitants of American Samoa are on the largest island, Tutuila, and due to the development of roads, a considerable number of the people have access to the main port, to which several of them come on ship days to sell their wares and to buy provisions to augment their native foods. The incidence of dental caries among those individuals living in part on imported foods at the port as compared with those in remote districts living on native foods was as follows: Those almost exclusively on native foods had 0.3 per cent of the teeth attacked by dental caries, and for those on trade foods, 18.7 per cent. Sea foods used here include many shell fish which are gathered and sold largely by the young people. The octopus, the sea crab and the beche-de-mere eaten raw were used.

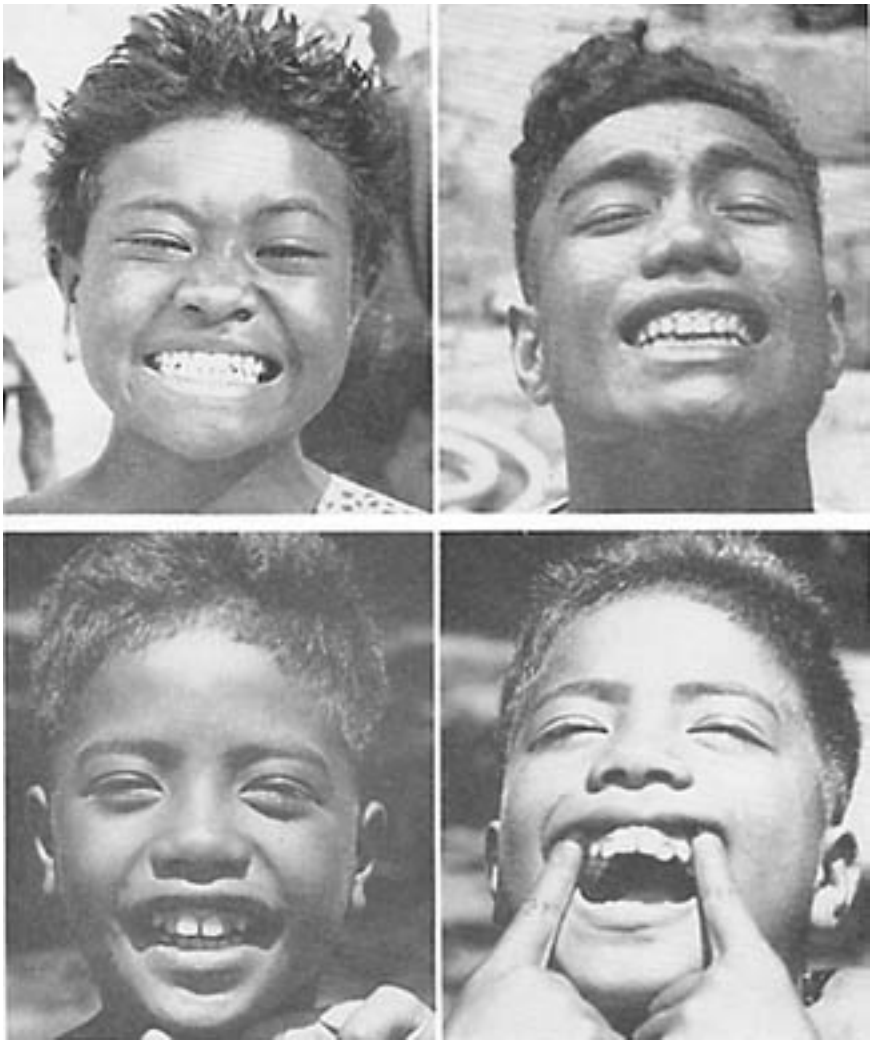

FIG. 36. Note the marked difference in facial and dental arch form of the two Samoan primitives above and the two modernized below. The face bones are underdeveloped below causing a marked constriction of the arches with crowding of the teeth. This is a typical expression of inadequate nutrition of the parents.

The Hawaiian Islands lie between 18 and 22 degrees north latitude and between 154 and 160 degrees west longitude. These Islands are quite unlike any of the other Pacific Island groups previously discussed. Sugar and pineapple plantations cover vast areas and together constitute by far the most important industries of these Islands. In many districts the population is almost entirely foreign or of various blends, chiefly of Filipinos and Japanese with Hawaiians. There is a large

American population and a considerable European. These different racial groups have largely brought their own customs which are rapidly submerging the native customs. Since the native population is so greatly reduced in comparison with the foreign population, and because intermarrying has been so general, it was difficult to find large groups of relatively pure-blooded Hawaiians either living almost entirely on native foods or on modernized foods. Though the number of the individuals in these groups is accordingly not large, important data were obtained for comparing the relative incidence of dental caries and other degenerative processes. While the preparation of foods on the various Pacific Islands has many common factors, all natives using the underground oven of hot stones for cooking, the Hawaiian Islands present one unique difference in the method of preparation of their taro. They cook the root as do all the other tribes, but having done so they dry the taro, powder it and mix it with water and allow it to ferment for several hours, usually twenty-four or more. This preparation called "poi" becomes slightly tart by the process of fermentation and has the consistency of heavy strap molasses or a very heavy cream. It is eaten by rolling it up on one or two fingers and sucking it from them. It accordingly offers no resistance to the process of mastication. In the districts where the natives are living on native foods the incidence of dental caries was only 2 per cent of the teeth, whereas among those natives who are living in large part on the imported foods, chiefly white flour and sweetened goods, 37.3 per cent of the teeth had been attacked by tooth decay. Typical Hawaiian faces are seen in Fig. 37. Typical modern tooth decay is shown in Fig. 38. This girl has tuberculosis also.

FIG. 37. Wherever the Polynesians are being modernized a change is occurring in facial form which is progressively

more severe in the younger members of the family. These girls of an Hawaiian family demonstrate this. Note the change in facial form in the sister to the right. The face is longer and narrower, the nostrils pinched and the chin is receding. The tribal facial pattern is lost.

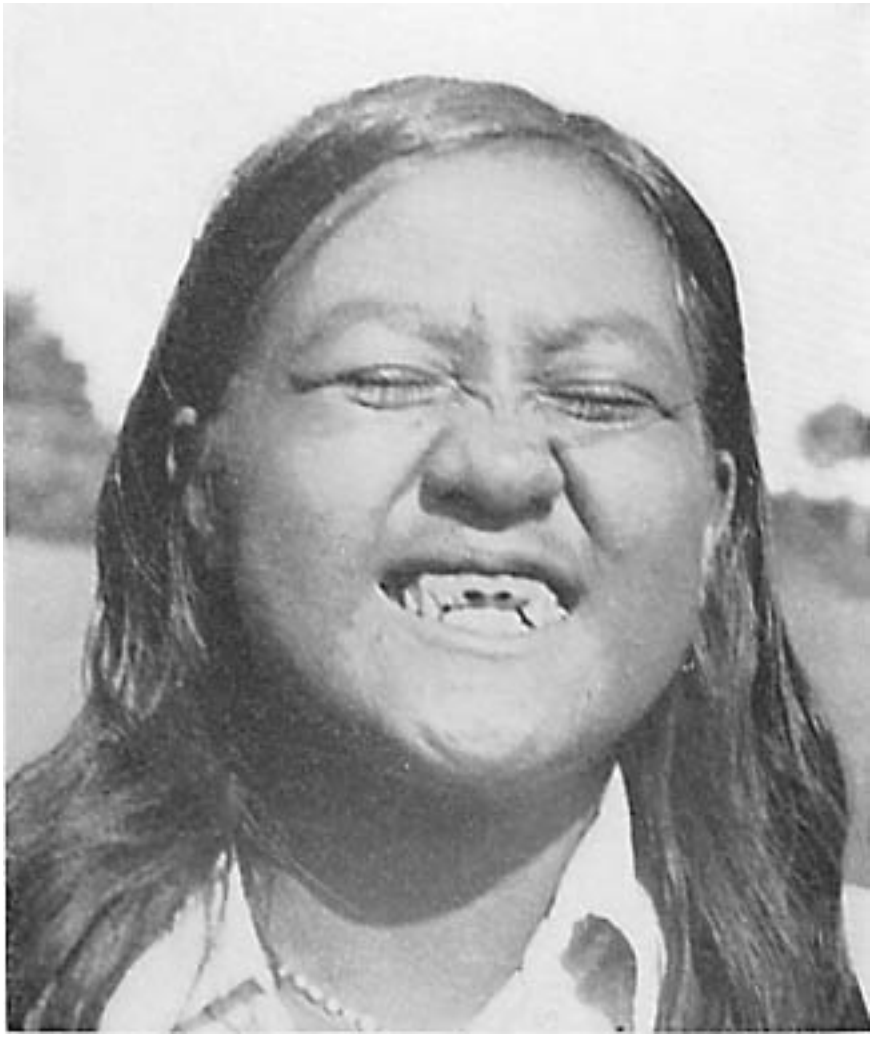

FIG. 38. The Polynesian race is rapidly disappearing with modernization. Tooth decay becomes extreme as shown in the girl above. This girl has tuberculosis, one of the physical injuries which accompany modernization. This is one of the bodily injuries as we will see later.

The study of the incidence of dental caries in these various South Sea Island groups in its relation to diet was only one of several of the problems investigated. Since nutrition is the principal factor that has been found related to the r6le of immunity and susceptibility to dental caries in my previous field studies, the collection of foods for chemical analysis and the gathering of detailed data regarding the articles of diet have been very important phases of the activities of this group of studies.

Data were collected for relating the incidence of irregularities of the teeth and dental arches to the types of nutrition. Similarly, studies were made of the individuals who had been hospitalized, in the few places where hospitals existed, chiefly to obtain data regarding the classification of the individuals who were suffering from tuberculosis. These were similar to the studies that I have made among the Eskimos and Indians of Alaska and northern and central Canada.

If one will picture a community of several thousand people with an average of 30 per cent of all the teeth attacked by dental caries and not a single dentist or dental instrument available for assistance of the entire group, a slight realization is had of the mass suffering that has to be endured. Commerce and trade for profit blaze the way in breaking down isolation's barriers, far in advance of the development of health agencies and emergency relief unwittingly made necessary by the trade contact.

While dental caries was most active in the periods of systematic overloads, such as growth, gestation and lactation, even the splendidly formed teeth of the adult men were wrecked by dental caries when the native foods were displaced with modern foods. In all of the groups living on native foods with a liberal intake of animal life of the sea, the health of the gums was generally excellent. When, however, the sea foods were quite limited in the dietary, heavy deposits formed and often were associated with a marked destruction of the supporting tissues with gingival infection. This condition was particularly prevalent among all groups near the ports, when the groups were displacing part of their native foods with imported foods.

In American Samoa through the cooperation of the educational authorities and the Director of the Department of Health, Commander Stephenson, and under the direct supervision of Lieutenant Commander Lowry, the dental surgeon, a group of four young men of the native teaching staff was selected and given instructions for the removal of the deposits. Equipment in the form of instruments has since been provided, in part through the kindness and generosity of some dental manufacturers. This probably constitutes the only native dental service that has ever been available in any of the Pacific Island groups. The intelligence and aptness with which these men were able to learn the fundamental principles, and their skill in carrying out a highly commendable prophylactic operation was indeed remarkable. I gave them pieces of soap and asked them to carve a reproduction of an extracted tooth which was given as a model and in which they were required to increase all diameters to a given amount. Their work would probably equal if not exceed in excellence that of the first effort of 90 per cent of American dental students. Many of these natives are very dexterous with their fingers and are skilled artists in carving wood and other material.

A great service could be rendered to these people who are in the process of modernization, but who have no opportunity for dental assistance, by teaching some of the bright young men certain of the procedures for rendering first aid. They could be compensated by contributions of native foods and native wares much as our itinerant dentists were in earlier days. The people would not have money to pay an American or European dentist for his service until trade is carried on with currency.

Nearly all these racial stocks are magnificent singers for which Nature has well-equipped them physically. Their artistry can be judged by the fact that they sing very difficult music unaccompanied and undirected. A large native chorus at Nukualofa, in the Tongan Group, sang without accompaniment "The Hallelujah Chorus" from Handel's Messiah with all the parts and with phenominal volume and modulation. Much of their work, such as rowing their largest boats, and many of their sports are carried out to the rhythm of hilarious music.

Many of the island groups recognize that their races are doomed since they are melting away with degenerative diseases, chiefly tuberculosis. Their one overwhelming desire is that their race shall not

die out. They know that something serious has happened since they have been touched by civilization. Surely our civilization is on trial both at home and abroad.

The nutrition of the primitive Polynesians is continually reinforced with animal life from the sea which includes both soft- and hard-shell forms. The incidence of tooth decay varied from 0.6 per cent for the most isolated groups to 33.4 per cent for the modernized groups. Those individuals living in their native environment on their native foods have universally normal facial and dental arch form reproducing the characteristics of the race. Those living on the normal environment except for using the imported foods of white flour, sugar, sugar products, syrup, polished rice, and the like, have in the succeeding generations marked changes in facial and dental arch forms.

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Chapter 9

ISOLATED AND MODERNIZED AFRICAN TRIBES

AFRICA has been the last of the large continents to be invaded and explored by our modern civilization. It has one of the largest native populations still living in accordance with inherited traditions. Accordingly, it provides a particularly favorable field for studying primitive racial stocks.

This study of primitive racial stocks, with the exception of some Indian groups, has been largely concerned with people living under physical conditions quite different from those which obtain in the central area of a large continent.

Sea foods are within reach of the inhabitants of islands and coastal. regions regardless of latitude. The inhabitants of the interior of a continent, however, have not access to liberal supplies of various forms of animal life of the sea. It was important, therefore, in the interest of the inhabitants of the United States, Canada, Europe, and other large continental interiors, to study primitive people living under environments similar to theirs. Africa is one of the few countries that can provide both

primitive living conditions and the modern life of the plains and plateau country in the interior. The great plateau of eastern and central Africa has nurtured a score of tribes with superb physiques and much accumulated wisdom. We are concerned to know how they have accomplished this, and whether they or any other people can survive in that environment after adopting the formulas of our modern civilizations. Considering that the most universal scourge of modern civilization is dental caries, though it is only one of its many degenerative processes, it is important that we study these people to note how they have solved the major problems of living in so severe and disciplining an environment as provided in Africa.

This was done during the summer of 1935. Our route took us through the Red Sea and down the Indian Ocean to enter the African continent at Mombasa below the equator and then across Kenya and Uganda into Eastern Belgian Congo, and thence about 4,000 miles down the long stretch of the Nile through Sudan to the modernized civilization of Egypt. This journey covered most of the country around Ethiopia and gave us contact with several of the most primitive racial stocks of that country. These people are accordingly the neighbors of the Abyssinians or Ethiopians. Since the various tribes speak different languages and are under different governments, it was necessary to organize our safari in connection with the local government officials in the different districts.

During these journeys in Africa which covered about 6,000 miles, we came in contact with about

thirty different tribes. Special attention was given to the foods, samples of which were obtained for chemical analysis. Over 2,500 negatives were made and developed in the field. If any one impression of our experiences were to be selected as particularly vivid, it would be the contrast between the health and ruggedness of the primitives in general and that of the foreigners who have entered their country. That their superior ruggedness was not racial became evident when through contact with modern civilizations degenerative processes developed. Very few of the many Europeans with whom we came in contact had lived in central Africa for as much as two years without serious illness or distinct evidence of physical stress. That the cause was not the severity of the climate, but something related to the methods of living, was soon apparent. In all the districts it was recognized and expected that the foreigners must plan to spend a portion of every few years or every year outside that environment if they would keep well. Children born in that country to Europeans were generally expected to spend several of their growing years in Europe or America if they would build even relatively normal bodies.

One exacting condition of the environment that we encountered was the constant exposure to disease. Dysentery epidemics were so severe and frequent that we scarcely allowed ourselves to eat any food that had not been cooked or that we had not peeled ourselves. In general, it was necessary to boil all drinking water. We dared not allow our bare feet to touch a floor of the ground for fear of jiggers which burrow into the skin of the feet. Scarcely ever when below 6,000 feet were we safe after sundown to step from behind mosquito netting or to go out without thorough protection against the malaria pests. These malaria mosquitoes which include many varieties are largely night feeders. They were thought to come out soon after sundown. We were advised that the most dangerous places for becoming infected were the public eating houses, since the mosquitoes hide under the tables and attack the diner's ankles if they are not adequately protected. We rigidly followed the precaution of providing adequate protection against these pests. Disease-carrying ticks were so abundant in the grass and shrubbery that we had to be on guard constantly to remove them from our clothing before they buried themselves in our flesh. They were often carriers of very severe fevers. We had to be most careful not to touch the hides with which the natives protected their bodies from the cold at night and from the sun in the daytime without thorough sterilization following any contact. There was grave danger from the lice that infected the hair of the hides. We dared not enter several districts because of the dreaded tsetse fly and the sleeping sickness it carries. One wonders at the apparent health of the natives until he learns of the unique immunity they have developed and which is largely transmitted to the offspring. In several districts we were told that practically every living native had had typhus fever and was immune, though the lice from their bodies could transmit the disease. One also wonders why people with such resistance to disease are not able to combat the degenerative diseases of modern civilization. When they adopt modern civilization they then become susceptible to several of our modern degenerative processes, including tooth decay.

Dr. Anderson who is in charge of a splendid government hospital in Kenya, assured me that in several years of service among the primitive people of that district he had observed that they did not suffer from appendicitis, gall bladder trouble, cystitis and duodenal ulcer. Malignancy was also very rare among the primitives.

It is of great significance that we studied six tribes in which there appeared to be not a single tooth attacked by dental caries nor a single malformed dental arch. Several other tribes were found with nearly complete immunity to dental caries. In thirteen tribes we did not meet a single individual with

irregular teeth. Where the members of these same tribes had adopted modern civilization many cases of tooth decay were found. In the next generation following the adoption of the European dietaries dental arch deformities frequently developed.

We are concerned to know something of the origin of these people including the Ethiopians and to what extent racial ancestry has protected them. If we refer to an ethnographic map of African races we find there is evidence of a great movement northward from South Africa. These people had some things in common with the Melanesians and Polynesians of the South Pacific whom we studied the year previously. Their language carries some words of similar meaning. While there are many tribes existing today, it is of significance that they each possess some identifying characteristics of language, dress and food habits. Another great racial movement has apparently moved southward from Northern Africa. These tribes are of Hamitic origin and include Nilotic tribes and Abyssinians. The Nilotic tribes have a distinct physical pattern and mode of life. These great racial movements have met in the Upper Nile region of Eastern Africa near the equator, and have swayed back and forth with successive obliteration or absorption of those tribes that were least sturdy. The negro race occupied an area across Africa from the West to Central Africa. They were exposed to the aggression and oppression of these two great racial movements, resulting often in intermingling in various proportions of racial bloods. The Semitic race, chiefly Arabs, occupied Arabia and a great area in Northern Africa.

In this bird's eye view we are observing changes that have been in progress during many hundreds or thousands of years. The Arabs have been the principal slave dealers working in from the east coast of Africa. They have maintained their individuality without much blending except on the coast. They have not become an important part of the native stock of the interior. These primitive native stocks can be largely identified on the basis of their habits and methods of living. The Nilotic tribes have been chiefly herders of cattle and goats and have lived primarily on dairy products, including milk and blood, with some meat, and with a varying percentage of vegetable foods. It was most interesting to observe that in every instance these cattle people dominated the surrounding tribes. They were characterized by superb physical development, great bravery and a mental acumen that made it possible for them to dominate because of their superior intelligence. Among these Nilotic tribes the Masai forced their way farthest south and occupy a position between two of the great Bantu tribes, the Kikuyu and the Wakamba. Both of these latter tribes are primarily agricultural people.

Masai Tribe. The Masai are tall and strong. Fig. 39 shows a typical belle, also a Masai man who is much taller than our six-foot guide. It is interesting to study the methods of living and observe the accumulated wisdom of the Masai. They are reported to have known for over two hundred years that malaria was carried by mosquitoes, and further they have practiced exposing the members of their tribes who had been infected with syphilis by the Arabs to malaria to prevent the serious injuries resulting from the spirochetal infection. Yet modern medicine boasts of being the discoverers of this great principle of using malaria to prevent or relieve syphilitic infections of the spinal cord and brain.

FIG 39 These members of the Masai tribe illustrate the splendid nutrition provided by their diet of cattle products namely: meat, milk and blood. The chief beside our guide is well over six feet. This Masai belle wears the customary decorations of coils of copper wire bracelets and anklets which largely constitute the attire of the girls.

I saw the native Masai operating on their cattle with skill and knowledge. The Masai have no currency and all their transactions are made with cows or goats. A valuable cow was not eating properly, and I observed them taking a thorn out of the inside of her mouth. The surgical operation was done with a knife of their own making and tempered by pounding. The wound was treated by rubbing it with the ashes of a plant that acted as a very powerful styptic. Their knowledge of veterinary science is quite remarkable. I saw them treating a young cow that had failed to conceive. They apparently knew the cause and proceeded to treat her as modern veterinaries might do in order to overcome her difficulties. For their food throughout the centuries they have depended very largely on milk, meat and blood, reinforced with vegetables and fruits. They milk the cows daily and bleed the steers at regular intervals by a unique process. In Fig. 40 we see a native Masai with his bow and arrow, the latter tipped with a sharp knife which is guarded by a shoulder to determine the depth to which the arrow may enter the vein. If the animal is sufficiently tame, the blood is drawn while it is standing. If the animal is frightened it is quickly hobbled, as shown below. In this figure the stream of blood may be seen spurting from the jugular vein into a gourd which holds about a gallon. A torque is placed around the neck before the puncture is made. The animals did not even flinch when struck by the arrow, the operation is done so quickly and skillfully. When sufficient blood was drawn, the torque was removed and the blood immediately stopped flowing. A styptic made of ashes referred to above was used. This serves also to protect the wound from infection. The blood is defibrinated by whipping in the gourd. The fibrin is fried or cooked much as bacon or meat would be prepared. The defibrinated blood is used raw just as the milk is, except in smaller quantities. When available, each growing child receives a day's ration of blood as does each pregnant or lactating woman. Formerly, the warriors used this food exclusively. These three sources, milk, blood and meat provide them with liberal supplies of body-building minerals and the special vitamins, both fat-soluble and water

soluble. Their estimate of a desirable dairy stock is based on quality not quantity. They judge the value of a cow for keeping in their herd by the length of time it takes her calf to stand on its feet and run after it is born, which is only a very few minutes. This is in striking contrast with the practice of our modern dairymen who are chiefly concerned with the quantity of milk and quantity of butter fat rather than with its value as a source of special factors for nutrition. Many of the calves of the modern high-production cows of civilized countries are not able to stand for many hours after birth, frequently twenty-four. This ability to stand is very important in a country infested with predatory animals; such as lions, leopards, hyenas, jackals and vultures.

FIG. 40. An important source of fat soluble vitamins during the drought period is the blood of the steers which is drawn about every thirty days. Above shows the lance tipped arrow being shot into the neck vein. If the animal is wild it is hobbled as shown below where the stream of blood is seen spurting into the gourd. The flow ceases when the compress is removed.

This reminded me of my experience in Alaska in studying the reindeer of the Eskimos. I was told that a reindeer calf could be dropped in a foot of snow and almost immediately it could run with such speed that the predatory animals, including wolves, could not catch it. And, moreover, that these fawns would go almost immediately after their birth with a herd on a stampede and never be knocked down.

The problem of combating the predatory animals, particularly the lions, calls for greater skill and bravery than is required by other tribes in Africa. The lions live on the large grazing animals, particularly the cattle, from which they select the strongest. In driving over the veldt we frequently saw one or two men or boys guarding an entire herd with only their spears. Their skill in killing a lion with a spear is one of the most superb of human achievements. I was interested to learn that they much prefer their locally made spears to those that are manufactured outside and brought in, because of their certainty that they will not break, will withstand straightening regardless of how much they are bent and because due to the process of manufacture will take a very sharp edge.

On one occasion, after we had been kept awake much of the night by the roaring of the lions and neighing of the zebras that were being attacked by the lions, we visited a Masai manyata nearby in the morning to learn that when they let their cattle and goats out of the corral of acacia thorns, three or four spearsmen went ahead in search of the lions that might be waiting to ambush the cattle. They apparently did not have the slightest fear. The lions evidentally had made a kill nearby. This the natives determined by the number of coyotes.

The heart and courage of these people has been largely broken by the action of the government in taking away their shields in order to prevent them pillaging the surrounding native tribes as formerly. They depended upon their shields to protect them from the arrows of the other tribes. The efforts to make agriculturists of these Masai people are not promising.

In a typical manyata the chief has several wives. Each one has a separate dwelling. Timber and shrubbery are so scarce in this vicinity that the dwellings are built of clay mixed with cow dung which is plastered over a framework of twigs. Many chiefs are over six feet in height.

The Masai live in a very extensive game preserve in which hundreds of thousands of grazing animals enjoy an existence protected from man since even the natives are not allowed to kill the animals as formerly. They seemed to be preserved for the numerous lions which occasionally become very bold since they have an abundance of food and no enemies. Recently the local government authorities found it necessary to shoot off eighty of the lions in a particular district because of their aggressiveness.

In the Masai tribe, a study of 2,516 teeth in eighty-eight individuals distributed through several widely separated manyatas showed only four individuals with caries. These had a total of ten carious teeth, or only 0.4 per cent of the teeth attacked by tooth decay.

Kikuyu Tribe, Kianzbu, Kenya. In contrast with the Masai, the Kikuyu tribe, which inhabits a district to the west and north of the Masai, are characterized by being primarily an agricultural people. Their chief articles of diet are sweet potatoes, corn, beans, and some bananas, millet, and Kafir corn, a variety of Indian millet. The women use special diets during gestation and lactation. The girls in this tribe, as in several others, are placed on a special diet for six months prior to marriage. They nurse their children for three harvests and precede each pregnancy with special feeding.

The Kikuyus are not as tall as the Masai and physically they are much less rugged. Like many of the central African tribes, they remove some lower incisors at the time these permanent teeth erupt.

This custom is reported to have been established for the purpose of feeding the individuals in case of lock-jaw. One of the striking tribal customs is the making of large perforations in the ears in which they carry many metal ornaments. A typical Kikuyu woman is shown in Fig. 41 (upper right). Typical Kikuyu men are also shown in Fig. 41. Note their fine teeth and dental arches.

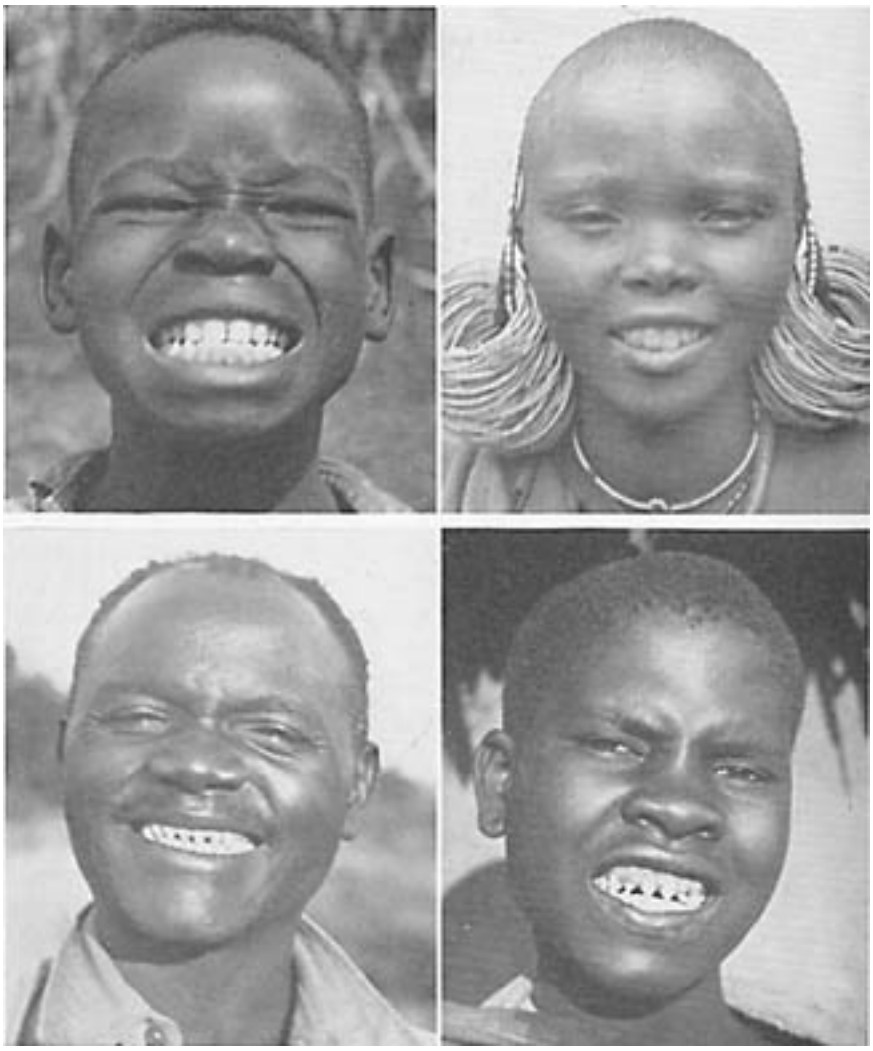

FIG. 41. The development of the faces and dental arches in many African tribes is superb. The girl at the upper right is wearing several earrings in the lobe of each ear. The Wakamba tribe points the teeth as shown below. This does not cause tooth decay while they live on their native food.

A study of 1,041 teeth in thirty-three individuals showed fifty-seven teeth with caries, or 5.5 per cent. These were 36.4 per cent of the individuals affected.

Much of the territory occupied by the Kikuyu tribes was formerly forest. Their practice has been to burn down a section of forest in order to get new lands for planting. As soon as the virgin fertility is exhausted, which is usually in three to five years, they burn down another section of forest. By this process they have largely denuded their section of Kenya of its timber. This has resulted in a great waste of building material. There are few stands of native forest within easy reach of transportation.

Wakamba Tribe, Kenya. The Wakamba tribe point their teeth as shown in Fig. 41. They occupy the territory to the east of the Masai, who in past centuries have driven themselves as a wedge between

the Kikuyu and the Wakamba tribes. The Masai until checked carried on a relentless warfare, consisting largely of raids, in which they slaughtered the men and carried off the women and children and drove away the cattle or goats. The Wakambas are intellectually superior to the Kikuyus and have distinct artistic skill in the carving of art objects. They are mechanical and like machinery. Many of them have important positions in the shops of the Kenya and Uganda railway.

An examination of 1,112 teeth of thirty-seven individuals showed sixty-nine teeth with caries, or 6.2 per cent. Twenty-one and six-tenths per cent of the individuals studied had dental caries.

Jalou Tribe, Kenya. This tribe occupies the territory along Lake Victoria and Kisumu Bay. They are one of the most intelligent and physically excellent native tribes. They were studied in two groups, one at Maseno, and the other at Ogado.

The group studied at the Maseno school were boys ranging from about ten years to twenty-two, totaling about 190 in all. The principal of the school presented the boys in military formation for inspection. Through him as interpreter I asked that all boys who had ever had toothache hold up their hands, and nineteen did so. Of the nineteen only one individual was found to have caries; two of his teeth were involved, which, out of 546 teeth for these individuals, gives 0.4 per cent of the teeth with caries.

In the Ogada Mission a study of 258 teeth for ten individuals revealed no teeth affected with dental caries.

Jeannes School, Kenya. This school is located at Kabete. It is an institution where young married couples are trained in domestic science, agriculture, and similar subjects.

In 388 teeth of thirteen individuals, thirty-one teeth were found to have been attacked by dental caries, or 7.9 per cent. These were in six individuals.

Pumwani Mission School, Kenya. This is a native suburb of Nairobi, and there the people have come under the influence of recent European contact.

In an examination of 588 teeth of twenty-one individuals twenty-six teeth had caries, or 4.4 per cent.

C. M. S. School, Nukuru, Kenya. The children of this school belong to several tribes, chiefly Jalou. In a study of 312 teeth of eleven individuals, only one tooth was found to have been attacked by tooth decay, or 0.3 per cent.

Chewya at Kisurnu, Kenya. The natives of this district belong to the Maragoli tribe. They are very strong and physically well developed. They live within easy reach of Lake Victoria from which they obtain large quantities of fish which constitutes an important part of their diet, together with cereals and sweet potatoes.

A study of 552 teeth of nineteen individuals revealed only one tooth with dental caries, or 0.2 per

cent.

Muhima Tribe or Anchola, Uganda. This tribe resides in southern Uganda. They, like the Masai, are primarily a cattle raising people and live on milk, blood and meat. The district in which they live is to the east of Lake Edward and the Mountains of the Moon. They constitute one of the very primitive and undisturbed groups. While the Masai raise chiefly the hump-backed cattle, the herds of this Muhima or Anchola tribe are characterized by their large wide-spread horns. Like the Masai, they are tall and courageous. They defend their herds and their families from lions and leopards with their primitive spears. Like the other primitive cattle people, they dominate the adjoining tribes.

In a study of 1,040 teeth of thirty-seven individuals, not a single tooth was found with dental caries. This tribe makes their huts of grass and sticks.

Watusi Tribe. This is a very interesting tribe living on the east of Lake Kivu, one of the headwaters of the West Nile in Ruanda which is a Belgian Protectorate. They are tall and athletic. Their faces differ markedly from those of other tribes, and they boast a very noble inheritance. According to legend, a Roman military expedition penetrated into central Africa at the time of Anthony and Cleopatra. A phalanx remained, refusing to return with the expedition. They took wives from the native tribes and passed laws that thereafter no marriage could take place outside their group. They have magnificent physiques. Many stand over six feet without shoes.

Several of the tribes neighboring Ethiopia are agriculturists and grow corn, beans, millet, sweet potatoes, bananas, Kafir corn, and other grains, as their chief articles of food. Physically they are not as well built as either the tribes using dairy products liberally or those using fish from the fresh water lakes and streams. They have been dominated because they possess less courage and resourcefulness.

The Government of Kenya has for several years sponsored an athletic contest among the various tribes, the test being one of strength for which they use a tug-of-war. One particular tribe has carried off the trophy repeatedly. This tribe resides on the east coast of Lake Victoria and lives very largely on fish. The members are powerful athletes and wonderful swimmers. They are said not to have been conquered in warfare when they could take the warfare to the water. One of their methods is to swim under water to the enemy's fleet and scuttle their boats. They fight with spears under water with marvelous skill. Their physiques are magnificent. In a group of 190 boys who had been gathered into a government school near the east coast of Lake Victoria only one boy was found with dental caries, and two of his teeth had been affected. The people dry the fish which are carried far inland.

Uganda which lies to the north and west of Lake Victoria and west of Kenya, is high and although on the equator, has an equitable climate with an abundance of native foods. Two crops per year are produced, and many varieties of bananas grow wild. The Buganda Tribe, Uganda, is the chief tribe of this region. Uganda has been called the Garden of Eden of Africa because of its abundance of plant foods, chiefly bananas and sweet potatoes, and because of its abundance of fresh water fish and animal life. The natives are thrifty and mentally superior to those of most other districts. They have a king and a native parliament which the British Government recognizes and entrusts with local administrative affairs. A typical group was studied in a mission at Masaka. An examination of 664 teeth of twenty-one individuals revealed only three teeth with caries, or 0.4 per cent.

West Nile Laborers from the Belgian Congo. The West Nile Laborers studied at Masaka represent a very strong and dependable group. They come from districts north of Lake Albert in Belgian Congo. They are much sought for in industrial enterprises and are often moved in groups for a considerable distance.

A study of 984 teeth of thirty-one individuals revealed that only three teeth had ever been attacked by tooth decay, or 0.3 per cent. Only one individual had dental caries.

As one travels down the West Nile and later along the western border of Ethiopia many unique tribes are met. A typical negroid type of the upper Nile region is shown in Fig. 42. Members of these tribes wear little or no clothing. They have splendid physiques and high immunity to dental caries.

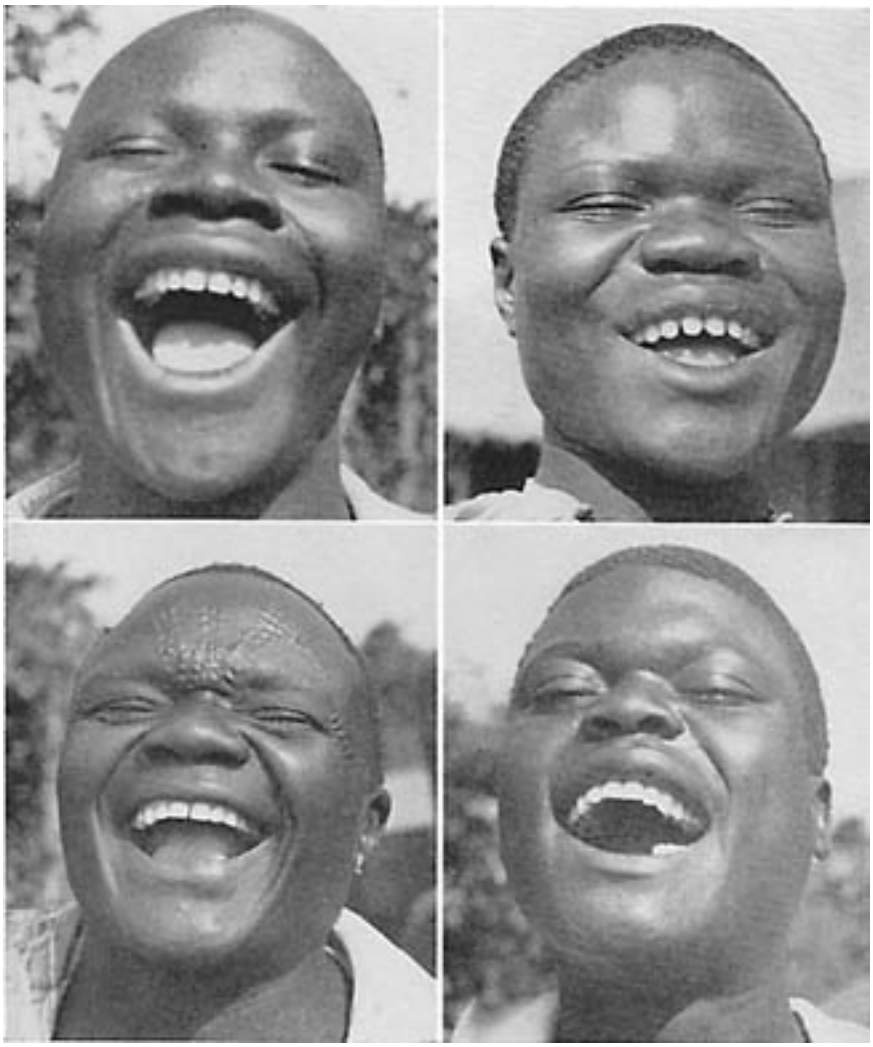

FIG. 42. The reward of obeying nature's laws of nutrition is illustrated in this west Nile tribe in Belgian Congo. Note the breadth of the dental arches and the finely proportioned features. Their bodies are as well built as their heads. Exceedingly few teeth have been attacked by dental caries while on their native foods.

After the confluence of the White Nile and West Nile, the former draining Lake Victoria and the Uganda lakes through Uganda, and the latter, Lakes Kivu, Edwards and Albert and eastern Belgian Congo, the volume of water moving northward is very large. A unique obstruction to navigation has

developed due to the fact that the Nile runs underground for a considerable distance. In this district vegetation is rank and prolific, including large quantities of water plants which form islands that are often attached temporarily to the shore. The water carries large quantities of alluvia which furnish an abundance of nutriment to the floating plant life. Accordingly, in many of these floating islands a large quantity of soil is enmeshed in the plant roots. At some period in the past the river became bridged across in upper Sudan near its southern border. With the progressive addition of new material a large natural bridge has been raised on which trees are now growing, and across which are elephant trails. This and a series of rapids require a detour of over a hundred miles.

The elephants are so plentiful in this district that both in Uganda and Sudan the governments have been required to send in special hunters to reduce the herds. In one district in Uganda two hundred were said to have been slaughtered. They are very destructive to banana plantations. They break the banana trees over or pull them up by the roots and eat the succulent heart as well as the fruits. In a night a herd may destroy an entire plantation. The only people in the districts who are permitted to kill the elephants without license are the pygmies. They are also the only ones not required to pay a head tax. There are many tribes of them in the great forest area in Belgian Congo and Uganda. Their skill with spears is remarkable and they are able to kill an elephant while the animal remains unaware of his danger. It takes them one to two days to hamstring an elephant by working stealthily from behind, always keeping out of the elephant's sight. Although an elephant can scent a human for a long distance, these pygmies can disguise themselves so completely that the elephant is unaware of their presence. After disabling him by cutting the tendons of both hind legs, they attack him openly and, while one attracts his attention, the other slowly but progressively hacks off his trunk. In this manner he bleeds to death. They are particularly fond of elephant meat and a slaughter means a great feast. While we were in one of the pygmy colonies two of them brought in the tusks of an elephant they had just killed. We had the rare opportunity of witnessing the celebration in the colony, which included the special reproduction in pantomime of the attack and method of killing the elephant. The pygmy mother of these two men is shown in Fig. 43 (lower half). It will be noticed that she is a full head shorter than Mrs. Price, who is five feet three inches tall. This rugged, though small, woman is the mother of five grown men, two of whom are shown in Fig. 43 with the tusks of the elephant. Note their homemade spears. As marksmen with bows and arrows and as trappers, these pygmies have wonderful skill. Their arrows are tipped with iron of their own manufacture and have receptacles for carrying drugs which they extract from plants. These drugs temporarily paralyze the animals. For animals which they wish to destroy the arrows carry a poison which rapidly produces death. The home life of the pygmies in the forest is often filled with danger. Just before our arrival two babies had been carried off by a leopard. This stealthy night prowler is one of the most difficult animals to combat and probably has been one of the reasons the pygmies build cabins in the trees. Ordinarily their homes are built on the ground in a little clearing in the big forest. They consist of low shelters covered with banana leaves and other plants, built over a frame work. The native missionary dispensed our gift of salt which is one of their most prized gifts. They put on a dance for us.

FIG. 43. The Pygmies of Belgian Congo are expert hunters. The two young men in the center above have slain single handed the large bull elephant whose tusks they are holding. The spears used are shown. They are two of five grown sons of the pygmy mother standing next to Mrs. Price in the lower picture. Their teeth are excellent and their knowledge of foods unique.

Pygmies, Ituru Forest, Belgian Congo. These people are said to have originally lived in the trees and they were exceedingly shy and difficult to contact. We were taken to several of their villages in the heart of the dense Ituru forest. We found them very well disposed through the confidence that has been established by the mission workers. Their shyness, however, together with the difficulty of making them understand through two transfers of languages, made an examination of their teeth very difficult.

A study of 352 teeth of twelve individuals revealed eight teeth had been attacked by tooth decay, or 2.2 per cent.

The native tribes of Africa have depended to a great extent on fresh water fish from the numerous lakes and rivers for certain of their essential food factors. After being dried in the sun these fish are carried long distances into the interior. The Nile perch grows frequently to a weight of 150 pounds. The natives of Africa know that certain insects are very rich in special food values at certain seasons, also that their eggs are valuable foods. A fly that hatches in enormous quantities in Lake Victoria is

gathered and used fresh and dried for storage. They also use ant eggs and ants.

Nyankunde Mission, Iruinu, Belgian Congo. This group is made up of members of the Bahema, Babira, Alur and Balendu tribes. We will consider the representatives of these different tribes collectively since they live largely on a common dietary consisting chiefly of cereals. Only the Bahemas of this group have small herds of cattle. Some of the others have a few goats. This district is located southwest of Lake Albert.

A study of 6,461 teeth of 217 individuals revealed 390 teeth with dental caries, or 6 per cent. Thirty-eight and seven-tenths per cent of the individuals suffered from dental caries.

Bogora Mission, Belgian Congo. This mission is located west of Lake Albert and includes members of the Bahema and Balendu tribes. While the Bahema tribe originally lived very largely on cattle products, milk, blood and meat, in this district, the herds were small and they were using a considerable quantity of cereals, chiefly corn and beans, some sweet potatoes and bananas. These latter were the chief foods of the other tribes, in addition to goats' milk.

An examination of 2,196 teeth of seventy-seven individuals revealed 160 teeth with caries, or 7.2 per cent. Fifty-three per cent of the individuals had caries.

Kasenyi Port, Lake Albert, Belgian Congo. These natives were members of several tribes surrounding this district who were for the most part temporary residents as laborers. The people had been living largely on a cereal diet and now during their temporary residence at the port had had fish.

An examination of 1,940 teeth of sixty-three individuals revealed 120 teeth with dental caries, or 6.1 per cent of the teeth. Fifty and eighttenths per cent of the individuals had dental caries.

Wanande Tribe, Belgian Congo. This tribe is located at Lubero in Belgian Congo. Their diet consists largely of bananas, sweet potatoes, cereals and goats' milk.

In an examination of 368 teeth of thirteen individuals, there were eight teeth with caries, or 2.2 per cent. Fifteen and four-tenths per cent of the individuals were affected.

Baitu Tribe, Nyunge, Ruanda, Belgian Protectorate. This district lies south of Uganda and east of Belgian Congo proper, northwest of Tanganyika. It lies just east of Lake Kivu. When we learn that Lake Kivu was only discovered in 1894, even though it is one of the important sources of the Nile waters, we realize the primitiveness of the people of this and adjoining districts. This group lives largely on dairy products from cattle and goats, together with sweet potatoes, cereals and bananas.

In a study of 364 teeth of thirteen individuals, not a single tooth was found to have been attacked by dental caries.

Native Hotel Staff at Goina, Belgian Congo. This group consisted of the inside and outside servants of a tourist hotel on Lake Kivu.

An examination of 320 teeth of ten individuals revealed twenty teeth with caries, or 6.3 per cent. It is significant that all of these carious teeth were in the mouth of one individual, the cook. The others all boarded themselves and lived on native diets. The cook used European foods.

Where the members of the African tribes had attached themselves to coffee plantations aad were provided with the imported foods of white flour, sugar, polished rice and canned goods, tooth decay became rampant. This is typically illustrated in Fig. 44.

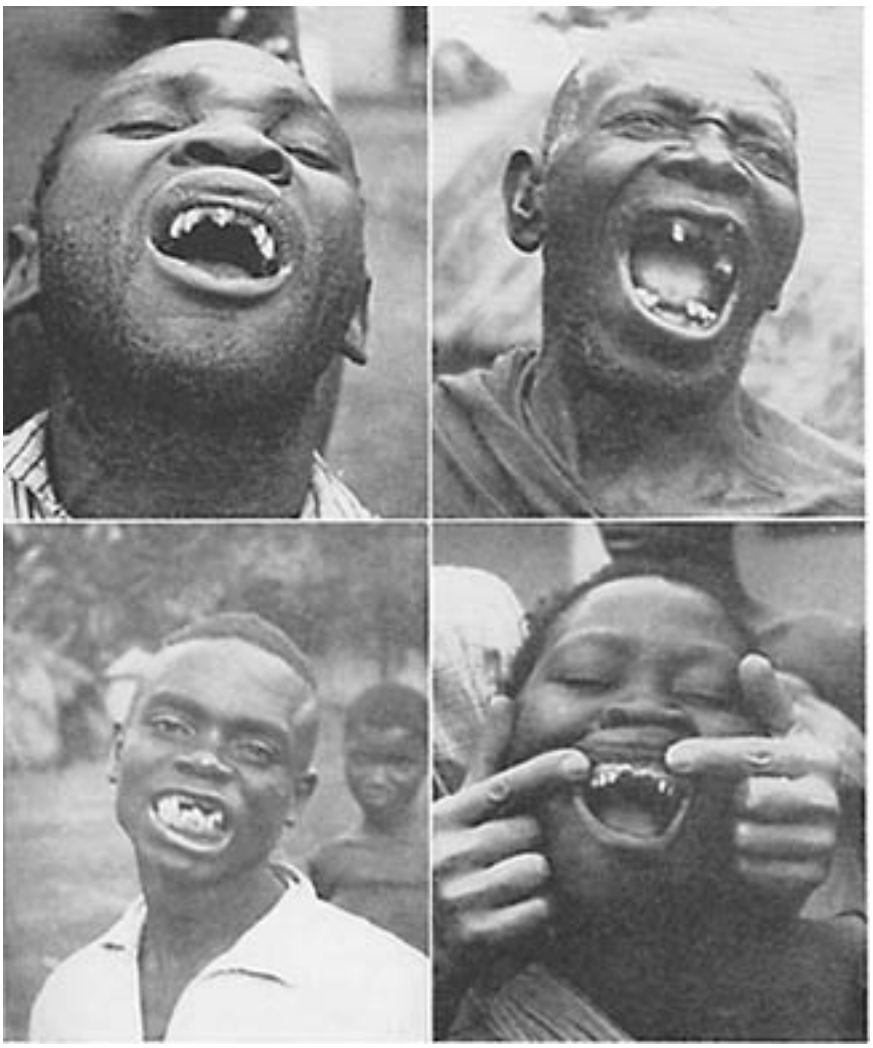

FIG. 44. Wherever the Africans have aidopted the foods of modern commerce, dental caries was active, thus destroying large numbers of the teeth and causing great suffering. The cases shown here are typical of workers on plantations which largely use imported foods.

Anglo-Egyptian Sudan has an area approximately one-third that of the United States. It is traversed throughout its length from south to north by the Nile. There are several tribes living along this great waterway, which are of special interest now owing to their close proximity to Ethiopia. There are wonderful hunters and warriors among them. In hunting they use their long-bladed spears almost entirely. The shores of the Nile for nearly a thousand miles in this district are lined with papyrus and other water plants to a depth of from several hundred yards to a few miles. Back of this area the land rises and provides excellent pasturage for the grazing cattle. These tribes, therefore, use milk, blood and meat from cattle and large quantities of animal life from the Nile River. Some of the tribes are

very tall, particularly the Neurs. The women are often six feet or over, and the men seven feet, some of them reaching seven and a half feet in height. I was particularly interested in their food habits both because of their high immunity to dental caries which approximated one hundred per cent, and because of their physical development. I learned that they have a belief which to them is their religion, namely, that every man and woman has a soul which resides in the liver and that a man's character and physical growth depend upon how well he feeds that soul by eating the livers of animals. The liver is so sacred that it may not be touched by human hands. It is accordingly always handled with their spear or saber, or with specially prepared forked sticks. It is eaten both raw and cooked.

Many of these tribes, like the Neurs, wear no clothing and decorate their bodies with various designs, some of them representing strings of beads produced by putting foreign substances under the skin in definite order. They have maintained a particularly bitter warfare against the Arab slave dealers who have come across from the Red Sea coast to carry off the women and children. In isolated districts even to this day they are suspicious of foreigners. We were told that in one district adjoining Ethiopia all light skinned people are in danger and cannot safely enter that territory without a military escort.

Terraizeka, Upper Nile, Sudan. These people are tall and live largely on fish and other animal life. This part of Sudan consists of many districts of great marshland called the sudd. It is covered with rank papyrus to the height of fifteen to thirty feet. This jungle of rank marsh growth swarms with a wide variety of animal life, large and small.

An examination of 548 teeth of eighteen individuals revealed that not a single tooth had been attacked by dental caries, or 100 per cent immunity.

Neurs, Malakal, Sudan. The Neurs at Malakal on the Nile River are a unique tribe because of their remarkable stature. Many of the women are six feet tall and the men range from six feet to seven and a half feet in height. Their food consists very largely of animal life of the Nile, dairy products, milk and blood from the herds.

A study of 1,268 teeth of thirty-nine individuals revealed only six teeth with dental caries, or 0.5 per cent. Only three individuals had caries, or 7.7 per cent.

Dinkas, Jebelein, Sudan. This tribe lives on the Nile. Its members are not as tall as the Neurs. They are physically better proportioned and have greater strength. They use fish from the Nile and cereals for their diet. They decorate their bodies profusely with scars.

An examination of 592 teeth of twenty-two individuals revealed only one tooth with caries, or 0.2 per cent.

Arab Schools at Khartoum and Omdurman, Sudan. The Arabs are the chief occupants of the territory of Northern Sudan. Omdurman on the west bank of the White Nile opposite Khartoum is the largest purely Arab city in the world. It has been but slightly influenced by modern civilization. Khartoum, on the contrary, just across the river from Omdurman and the capital of Anglo-Egyptian

Sudan, has districts which are typically modern. These include the government offices and administration organization. The Arab section of Khartoum has been definitely influenced by contact with the Europeans. This makes possible a comparative study of similar groups in the two cities-modernized Khartoum and primitive Omdurman.

A study of 1,284 teeth of fifty-two individuals in an Arab school at Khartoum revealed that 59 teeth or 4.7 per cent had been attacked by dental caries, or 44.2 per cent of the individuals studied.

In Omdurman a study of 744 teeth in thirty-one individuals, revealed only nine teeth that had been attacked by tooth decay, or 1.2 per cent. In this group only two or 6.4 per cent of the individuals had dental caries.

The groups examined were selected with the assistance of the government officials and consisted of the higher grade pupils in two advanced native schools, one in Khartoum and one in Omdurman.

It is of interest that of the two boys in the Arab school at Omdurman with dental caries one was the son of a rich merchant and used liberally sweets and European foods.

Native Hospital, Khartoum, Sudan. The individuals studied in this institution were from quite remote areas distributed through Sudan. Some had traveled many days on camels to obtain the help that the hospital provided.

A study of 288 teeth of ten individuals revealed that thirteen had been attacked by tooth decay, or 4.5 per cent.

Ikhlas School, Cairo, Egypt. This is a native school in which the individuals are comparable in many respects to those in the native schools at Khartoum and Omdurman. Their nutrition is highly modernized by living in a modern city.

A study of 2,092 teeth of eighty-five individuals revealed that 353 teeth or 12.1 per cent had been attacked by tooth decay. Seventy-five per cent of the individuals of this group had dental caries.

The total number of teeth examined in the preceding groups was 28,438. Of this number, 1,346 were found with dental caries or 4.7 per cent. This represents a total of 1,002 individuals examined, of whom 300 had one or more carious teeth, or had lost teeth by caries, making 29.9 per cent of the individuals with dental caries. Of this total number of individuals studied in twenty-seven groups, there were several groups with practically complete immunity to dental caries, while other groups had relatively high incidence of that disease.

Facial and Dental Arch Deformities. The purpose of these studies has included the obtaining of data which will throw light also on the etiology of deformities of the dental arches and face, including irregularity of position of the teeth.

A marked variation of the incidence of irregularities was found in the different tribes. This variation could be directly associated with the nutrition rather than with the tribal pattern. The lowest

percentage of irregularity occurred in the tribes living very largely on dairy products and marine life. For example, among the Masai living on milk, blood and meat, only 3.4 per cent had irregularities. Among the Kikuyu and Wakamba, 18.2 and 18.9 per cent respectively had irregularities. These peap! e were largely agriculturists living primarily on vegetable foods. In the native Arab school at Omdurman, among the pupils living almost entirely according to the native customs of selection and preparation of foods, 6.4 per cent had irregularities, while in the native school at modernized Khartoum 17 per cent had irregularities. In the Ikhlas school at Cairo, under modern influence, 16.5 per cent had irregularities. In the native hospital at Khartoum, 70 per cent had irregularities. In the Pygmy group 33.3 per cent had irregularities, and among the grain eaters of the west Nile, 25.5 per cent had irregularities. The Jeannes School had 46.1 per cent and the Ogada mission 30 per cent.

While the primitive racial stocks of Africa developed normal facial and dental arch forms when on their native foods, several characteristic types of deformity frequently developed in the children of the modernized groups. One of the simplest forms, and one which corresponds with a very common deformity pattern in the United States, involves the dropping inward of the laterals with narrowing of the upper arch making the incisors appear abnormally prominent and crowding the cuspids outside the line of the arch. Typical illustrations of this are shown in Fig. 45. Where the nutritional deficiency is very severe, as at Mombasa on the coast, more severe changes in facial form are found.

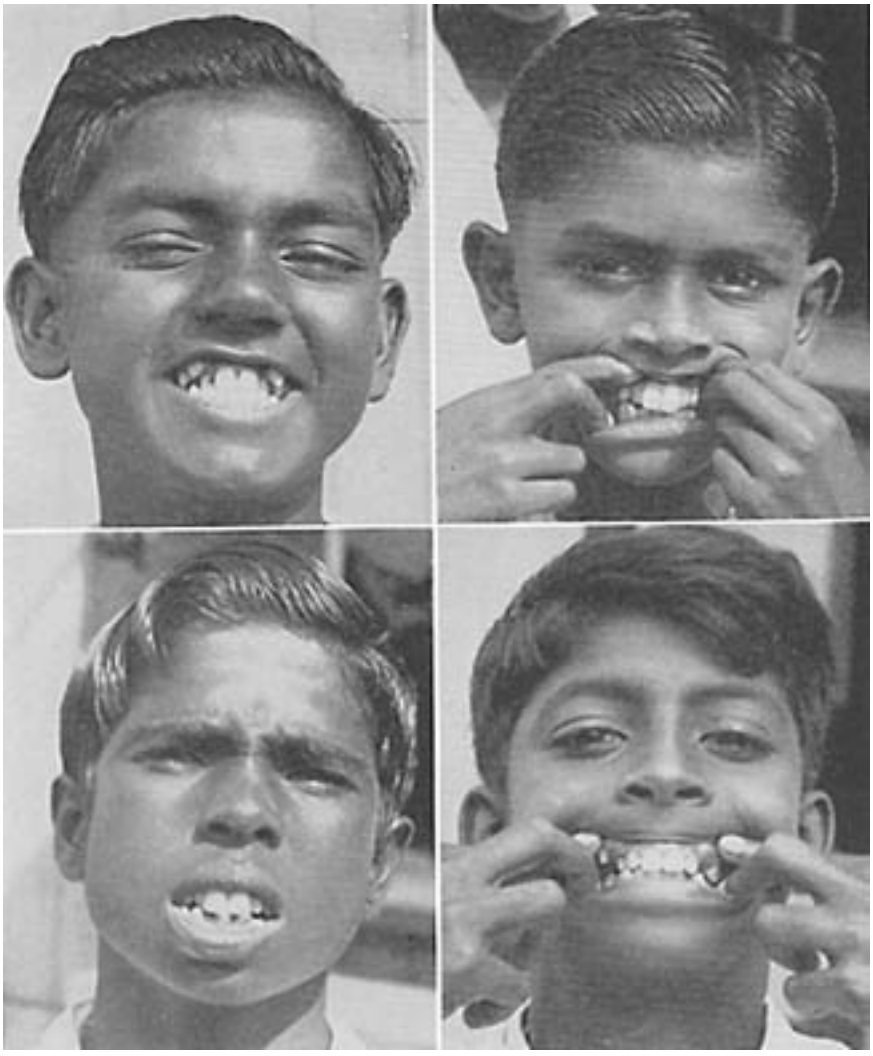

FIG. 45. In the new generations, born after the parents had adopted typical modernized diets of Europeans, there was a marked change in the facial and dental arch forms of the

adolescent children. Note the narrowing of the nostrils and dental arches and the crowding of the teeth in these four typical young men.

Among the deformity patterns a lack of development forward of the middle third of the face or of the lower third of the face often appeared in the more highly modernized groups. An illustration of the former is seen in Fig. 46 (upper left), and of the latter in Fig. 46 (lower left and right). In the girl at the upper left, the upper arch tends to go inside the lower arch all around. This girl is of the first generation, in a mission in Nairobi, following the adoption of the modernized foods by the parents.

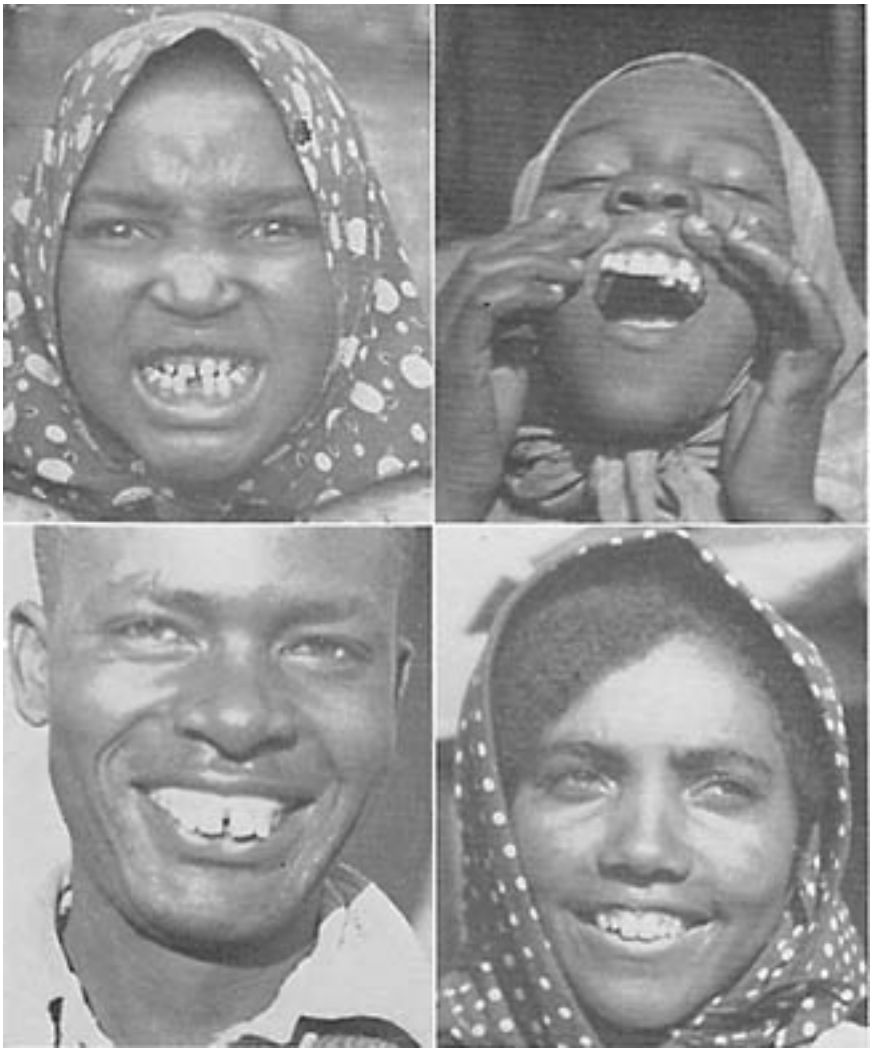

FIG. 46. Disturbed nature may present a variety nf deformity patterns. In the upper left the upper arch is much too small for the lower and nearly goes inside it. The upper right is narrowed with crowding of the teeth. Both lower cases demonstrate an underdevelopment of the mandible of the lower jaw.

A more extreme and severe type of facial change involves an abnormal narrowing with marked distortion of both upper and lower arches. This is shown typically in Fig. 47.

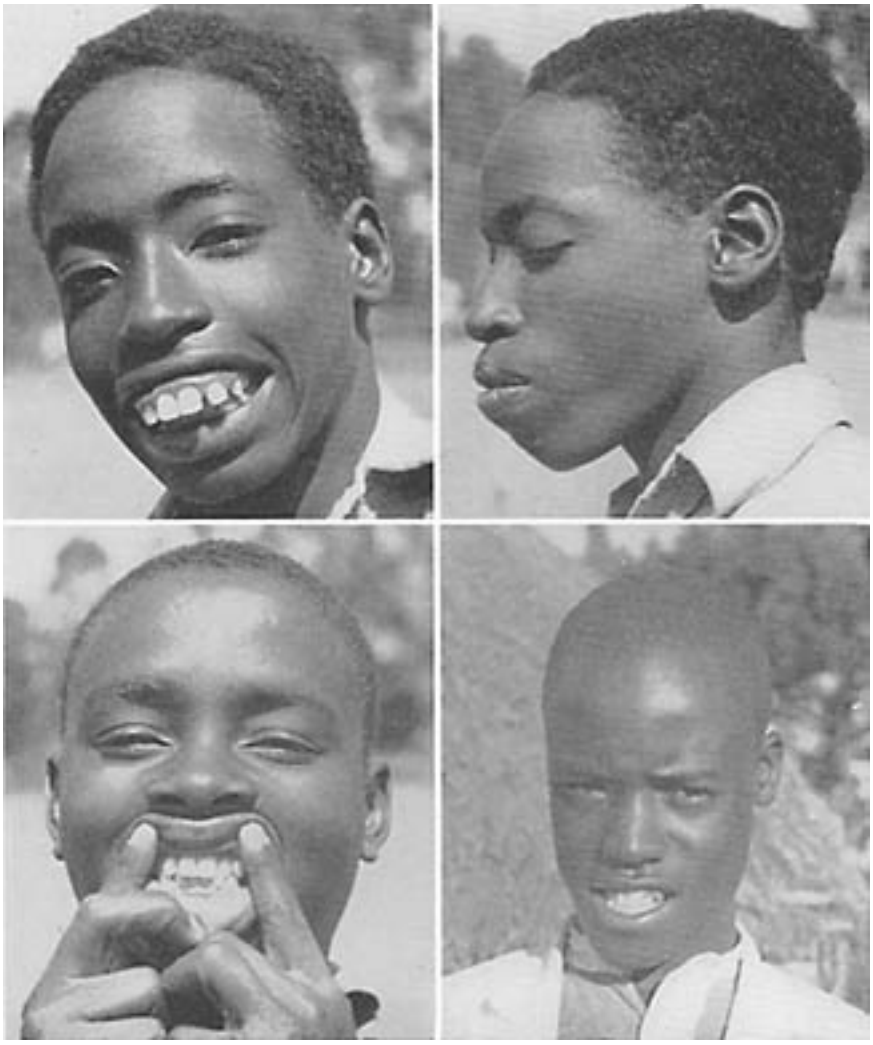

FIG. 47. As in our civilization, even the first generation, after the adoption of modernized foods may show gross deformities. Note the extreme protrusion of the upper teeth with shortening of the lower jaw in the upper pictures and the marked narrowing with lengthening of the face in the lower views. The injury is not limited to the visible structures.

These extreme deformities often produce facial expressions that are suggestive of the faces of some of the monkeys. This is illustrated by the three boys shown with the monkey in Fig. 48.

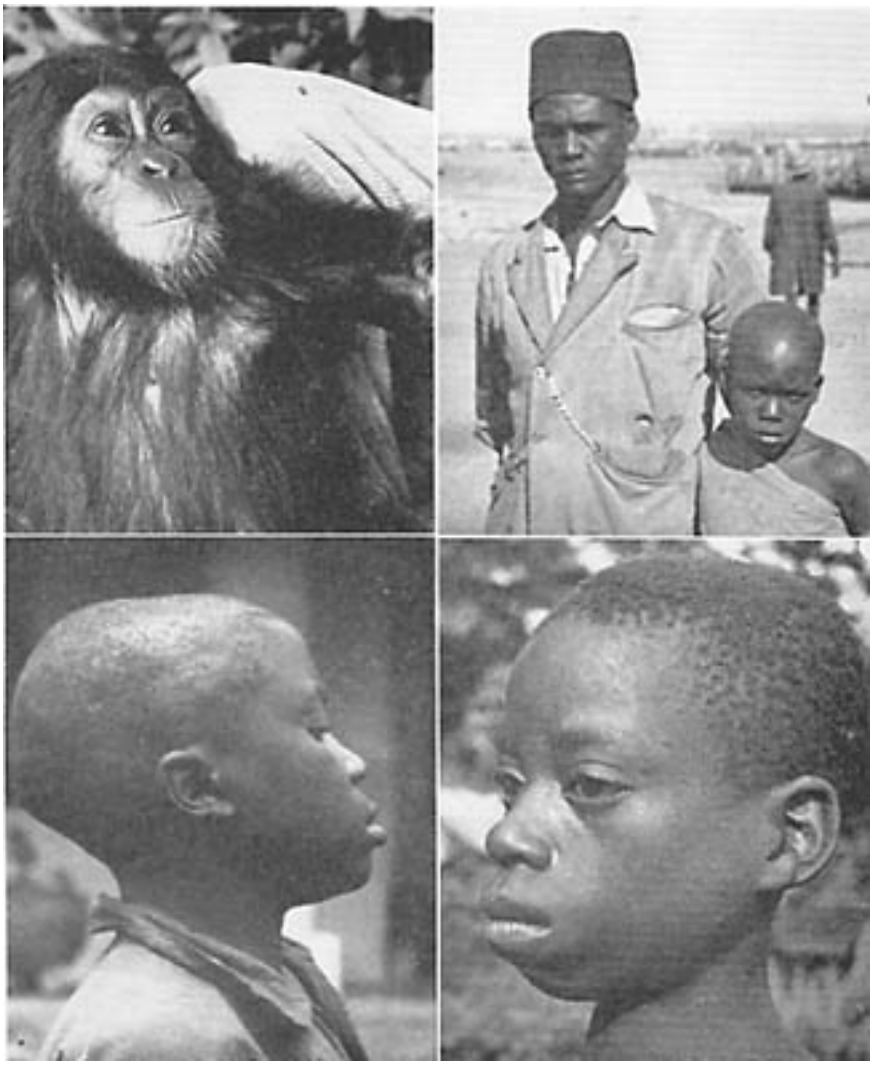

FIG. 48. A very frequent injury apearing in the offspring after the adoption of less efficient foods often involves a marked depression of the middle third of the face as illustrated in the three boys in this view. Note the comparison with the chimpanzee face.

The Arabs in several districts use camels' milk extensively. It is nutritious, and in much of the desert country constitutes the mainstay of the nomads for months at a time. The primitive Arabs studied had fine dental arches with very little deformity. Even the horses ridden by the Arab chiefs in moving their camel herds across the desert are often dependent, sometimes for as long as three months, upon the milk of the camels for their nutrition. Typical Arab faces and a camel caravan at rest are shown in Fig. 49. The primitive Arab girls have splendidly developed faces and fine dental arches. Their natural beauty, however, is rapidly lost with modernization, as illustrated in Fig. 50.

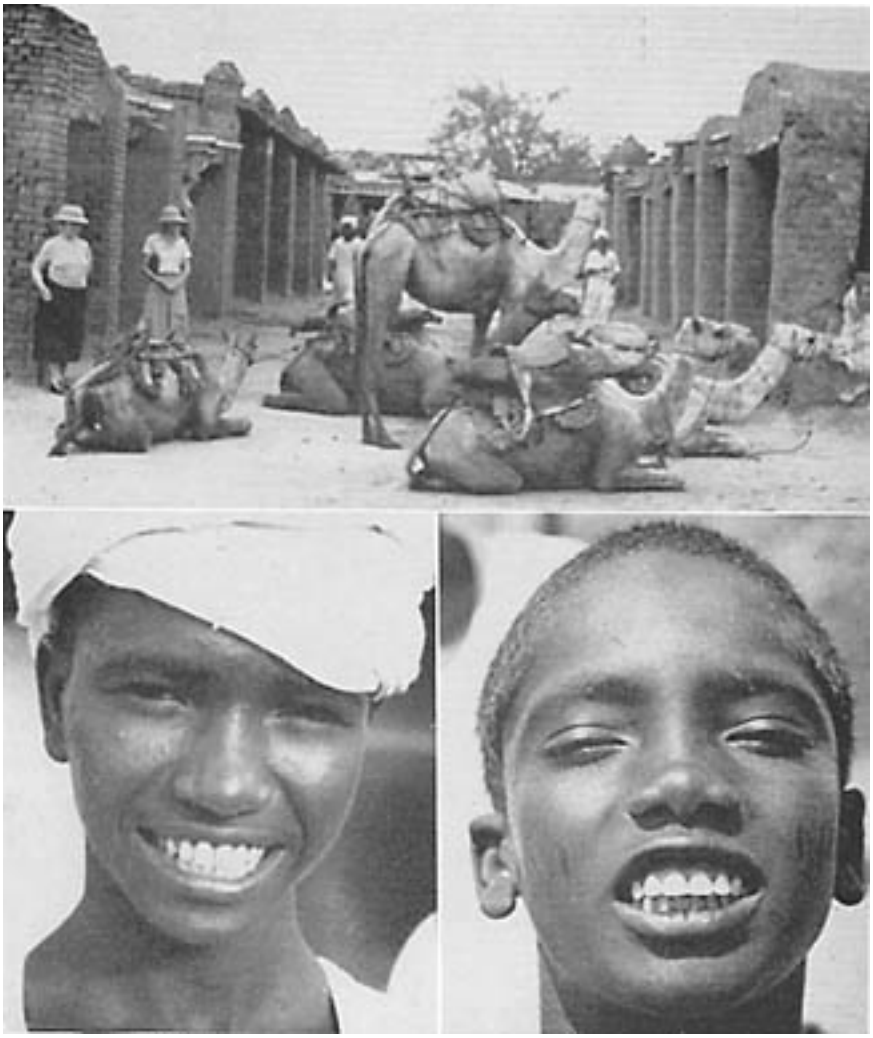

FIG. 49. In the hot desert countries of Asia and Africa camel's milk is an important item of human nutrition. The teeth of the Arahs, as illustrated helow, are excellent. Large areas could not maintain human life without the camel and its milk.

FIG. 50. Both girls and boys in the modernized colonies in Cairo showed typical deformity patterns in faces and dental arches. The health of these groups is not comparable to that of those living on the native dietaries. Reproductive efficiency in these generations is greatly reduced.

Dr. Hrdlicka has called attention to the occasional development in several racial stocks of individuals who travel on all fours instead of upright. I saw several individuals of this type in Africa scooting around about as rapidly as the dogs. They were, accordingly, difficult to photograph. Two are shown in Fig. 51.

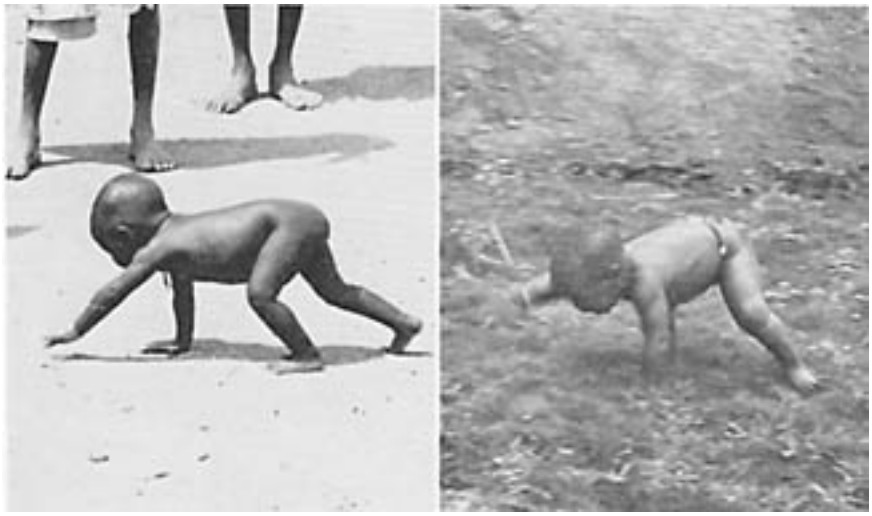

FIG. 51. These two native African children scooted around on all fours so swiftly that it was difficult to take their pictures. We did not see them stand up. They behaved very much like tame chimpanzees.

While slavery of the old form no longer exists in the so-called civilized countries, in its new form it is a most tragic reality for many of the people. Taxes and the new order of living make many demands. For many of these primitive tribes a new suit of clothes could formerly be had every day with no more trouble than cutting a new banana leaf. With the new order they are requested to cover their bodies with clothing. Cloth of all kinds including the poorest cotton has to be imported. They must pay an excessive charge due to the long transportation cost for the imported goods, a charge which often exceeds the original cost in the European or American markets by several fold. In order to pay their head tax they are frequently required to carry such products as can be used by the government officials, chiefly foods, over long distances and for part of each year. These foods are often those which not only the adults, but particularly the growing children sorely need for providing body growth and repair. This naturally has produced a current of acute unrest and a chafing under the foreign domination.

As we encircled Ethiopia we found the natives not only aware of what was going on in that border country, but deeply concerned regarding the outcome. From their temper and sympathetic attitude for the oppressed Ethiopians, it would not be surprising if sympathizers pass over the border into that country to support their crushed neighbors. The problem is accordingly very much larger than the interest of some particular foreign power. It deals directly with the future course of events and the attitude of the African natives in general toward foreign domination. The native African is not only chafing under the taxation by foreign overlords, but is conscious that his race becomes blighted when met by our modern civilization. I found them well aware of the fact that those of their tribes who had adopted European methods of living and foods not only developed rampant tooth decay, but other degenerative processes.

In one of the most efficiently organized mission schools that we found in Africa, the principal asked me to help them solve a serious problem. He said there was no single question asked them so often by the native boys in their school as why it is that those families that have grown up in the mission or government schools were physically not so strong as those families who had never been in contact with the mission or government schools. These young men were thinking. I was even asked several times by them whether or not I thought that the native Africans must go the way of the Red Indians of America.

The happiness of the people in their homes and community life is everywhere very striking. A mining prospector who had spent two decades studying the mineral deposits of Uganda was quoted to me as stating that if he could have the heaven of his choice in which to spend all eternity it would be to live in Uganda as the natives of Uganda had lived before modern civilization came to it.

While inter-tribal warfare has largely ceased, a new scourge is upon them, namely the scourge which comes with modern civilization. As in the primitive racial stocks previously studied and reported, we found that modernizing forces were often associated with a very marked increase of the death rate over the birth rate. In some districts in Africa a marked degeneration is taking place.

Geoffrey Gorer in his book, "Africa Dances," (1) which was written after making studies in West Africa, discusses this problem at length.

He quotes figures given by Marcel Sauvage (2) in his article on French Equatorial Africa: "'In 1911 French Equatorial Africa had twenty million negro inhabitants; in 1921 there were seven and a half million; in 1931 there were two and a half million.'"

He states regarding the quotation: "These figures were given in a responsible French conservative paper and have not been denied." Major Browne, a high official of the British Government Administrative Department of Kenya, with long experience, states in the closing paragraph of his book entitled, "The Vanishing Tribes of Kenya," (3) the following:

> It must also be remembered that the "blessings of civilization" are not in practice by any means as obvious as some simple-minded folk would like to believe. It can be said with fair accuracy that among the tribes with which we have been dealing there is, in their uncontaminated society, no pauperism, no paid prostitution, very little serious drunkenness, and on the whole astonishingly little crime; while practically everyone has enough to eat, sufficient clothing, and an adequate dwelling, according to the primitive native standard. Of what civilized community can as much be said?

Civilizations have been rising and falling not only through all the period of recorded history, but long before as evidenced by archeological findings. If we think of Nature's calendar as one in which centuries are days and civilizations are years, the part current events are playing in the history of a great continent like Africa may be mere incidents.

This much we do know that throughout the world some remnants of several primitive racial stocks have persisted to this day even in very exacting environments and only by such could they have been protected.

In my studies of these several racial stocks I find that it is not accident but accumulated wisdom regarding foods that lies behind their physical excellence and freedom from our modern degenerative processes, and, further, that on various sides of our world the primitive people know many of the things that are essential for life-things that our modern civilizations apparently do not know. These are the fundamental truths of life that have put them in harmony with Nature through obeying her nutritional laws. Whence this wisdom? Was there in the distant past a world civilization that was better attuned to Nature's laws and have these remnants retained that knowledge? If this is not the explanation, it must be that these various primitive racial stocks have been able through a superior skill in interpreting cause and effect, to determine for themselves what foods in their environment are best for producing human bodies with a maximum of physical fitness and resistance to degeneration.

Primitive native races of eastern and central Africa have in their native state a very high immunity to dental caries, ranging from 0 to less than 1 per cent of the teeth affected for many of the tribes. Where modernized, however, the incidence increased to 12.1 per cent.

In the matter of facial deformity thirteen tribes out of twenty-seven studied presented so high a

standard of excellence that not a single individual in the group was found with deformed dental arches.

Their nutrition varied according to their location, but always provided an adequate quantity of body-building and repairing material, even though much effort was required to obtain some of the essential food factors. Many tribes practiced feeding girls special foods for an extended period before marriage. Spacing of children was provided by a system of plural wives.

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Chapter 10

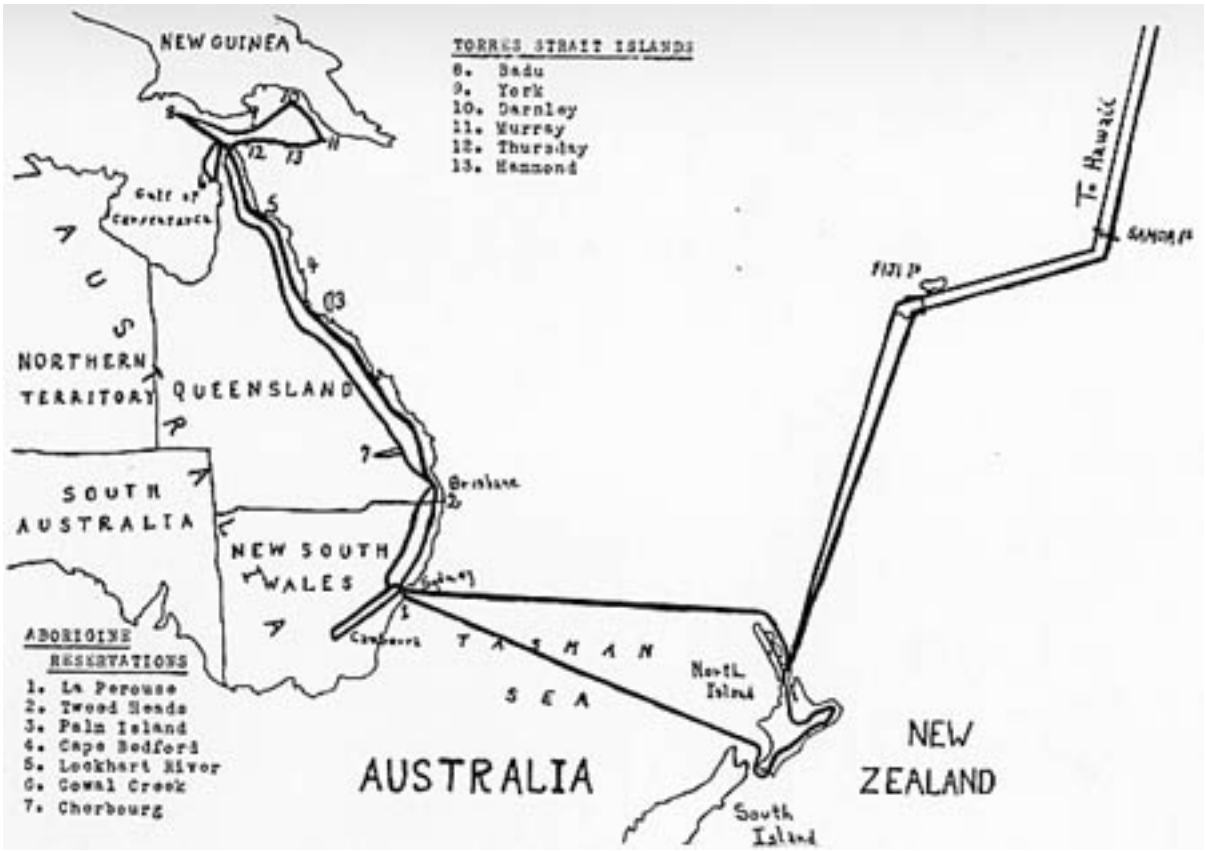
ISOLATED AND MODERNIZED AUSTRALIAN ABORIGINES

OUR problem of throwing light upon the cause of the physical breakdown of our modern civilization, with special consideration of tooth decay and facial deformity, requires a critical examination of individuals living in as wide a range of physical conditions as may be possible. This requires that the Aborigines of Australia be included in this examination of human reactions to physical environments. These were studied in 1936.

In selecting the individuals in the various groups special effort was made to include children between the ages of ten and sixteen years in order to have an opportunity to observe and record the condition of the dental arches after the permanent teeth had erupted. This was necessary because the deciduous dentition or first set of teeth may be in normal position in the arches with a correct relationship between the arches, and the permanent dentition show marked irregularity. The shape of the dental arches of the infant at birth and the teeth that are to take their place in the arches have considerable of their calcification at birth. The development of the adult face, however, does not occur until the permanent teeth have erupted. The general shape or pattern is largely influenced by the position and direction of the eruption of the permanent teeth. These studies, accordingly, have included a careful, detailed record of the shape of the dental arch of each individual.

The Australian Aborigines constitute one of the most unique primitive races that have come out of the past into our modern times and they are probably the oldest living race. We are particularly concerned with those qualities that have made possible their survival and cultural development.

The Aborigines are of special interest because they have come out of a very distant past and are associated with animal life which is unique in being characterized as a living museum preserved from the dawn of animal life on the earth. Many of the animal species that are abundant in Australia are found only in fossil form on other continents. The evidence indicates that they crossed on a land bridge which connected Australia with Asia. After the bridge was submerged the animals persisted in that protected island continent which never has known any of the animal species of later development. Among these animals the marsupials play an important role and constitute a large variety. The American continent has only one or two of the many forms found in Australia. These are the opossum of the marsupial family and the sloth. One of the most curious animals living on the earth today, or that has left its remains in the petrified skeletons of early periods of the earth's history, is the duckbill platypus. It has the unique distinction of having the characteristics of several animal species. It lays eggs like a bird and hatches them with the heat of its body in its pouch. It has webbed, five-toed feet, like the water birds, a bill like a duck and hair and tail like a beaver. The typical marsupial pouch for carrying its young, is another characteristic of this strange animal. Like other mammals it provides milk for its young. Its milk is similar in chemical constituents to that of other mammals. Most rudimentary in form are the mammary glands of the platypus. The young, when hatched in the pouch, nuzzle the lining membrane of the pouch and the milk exudes through minute openings. There is no nipple. The animal lives chiefly in the water. Its home is built above the water level on the bank, but the entrance to it is underneath the water. They are exceedingly playful creatures, apparently more at home in the water than on land. They live on both animal life and plant food found under the water. They seem to be related to an early era of differentiation of animal species.



The Aborigines are credited with having the most primitive type of skeletal development of any race living today. The eyes are very deep set, the brows very prominent giving them an expression that identifies them as a distinct racial type. See Fig. 52. Professor Weidenreich has shown that they resemble in this regard the recently discovered ancient Peking man. While they are still in the Stone Age stage in their arts and crafts, they have developed further in some respects than has any other ancient race. Their skill in tracking and outwitting the fleet and very cunning animal life of their land is so remarkable that they have been accredited with a sixth sense. They have been able to build good bodies and maintain them in excellent condition in a country in which the plant life, and consequently the lower animal life can be maintained at only a very low level because of the absence of rain. Over half of Australia has less than ten inches of rain a year. It is significant that the natives have maintained a vigorous existence in districts in which the white population which expelled them is unable to continue to live. Among the white race there, the death rate approaches or exceeds the birth rate.

FIG. 52. The Aborigines of Australia are recognized to be the oldest living race of mankind. Note the prominent eyebrows and deep set eyes. The man at the upper right is holding his spears and wamara, or spear thrower. They are very fond of decorations on their bodies. Little baldness was seen even in the very old.

They have developed a device for throwing spears, which makes them more deadly than any in the world. I witnessed a group of the present-day natives throwing their spears at a target which consisted of a banana stalk much smaller than a man's body. They threw the spears from a distance which I estimated to be seventy-five yards. About thirty spears were thrown and several pierced the banana stalk and the others were stuck in the ground close around it. This was accomplished by means of a wamara or throwing stick approximately as long as the arm, with a strong hand grip at one end and a device on the other end for engaging in a depression in the butt of the spear. This was thrown by poising the spear about the level of the shoulder, the spear supported by the fingers of the hand which swung the throwing stick. The latter extended back over the shoulder. The impact of their spears has often been demonstrated to be sufficient to completely penetrate a man's body. Their method of tempering wood for the points of the spears was such that the spearheads offered great resistance. A throwing stick is shown in Fig. 52 (upper right).

These natives decorate their bodies with paints for dances and sports. They know the habits of all of the animals and insects so well that they are able to reproduce the calls of the animals and thus

decoy them into traps. Some of the water birds maintain sentinels at lookout points to guard those in the water. The Aborigines are able to decoy these birds by most ingenious methods. They travel with their bodies disguised by grass and shrubbery and enter the water with a headgear made from feathers of one of the birds. Once in the water, they then maneuver in a manner similar to that of the birds and go among the flock of wild ducks or swans. Working entirely under water, they draw the birds under one by one and take load after load to shore without raising the suspicion of the flock. When working among the kangaroos they are so skilled in preparing movable blinds that they can kill many in a grazing wild pack without alarming the rest, always striking when the animal is grazing. Their skill at fishing probably exceeds that of any other race. They are so highly trained in the knowledge of the habits of the fish and the type of movement that the fish transmits to the water and to the reeds in the water, that one of their important contests between tribes is to see how many fish can be struck in succession with a spear, the fish never being seen, their only information as to its whereabouts being the change in the surface of the water and movement of grasses that are growing in the water as the fish moves. The fish are started by the umpire's striking the water. The experts bring up a fish six times out of eight. These fishing contests are held along the banks of lakes and rivers where the water is deep enough for some of the reeds and grasses to come to the surface. The contestants travel in canoes.

The native canoe is cut in one piece from the side of a tree, the cutting being done with stone axes. The canoe offers an exceedingly treacherous platform from which a standing man must throw his spear. For some of the contests the canoe carries a paddler, but in the most exacting contests the spear man must manage his own flat-bottomed canoe.

The skill of the Aborigines in tracking is so phenomenal that practically every large modern town or city in Australia has one or more of these men on its police staff today to track criminals. For weeks, they carry the detailed information about the characteristics of the prisoner's foot across the desert, and when they come across the man s foot print they recognize it among all others in the same path. Every leaf that is turned over or grain of sand on bare rocks has meaning for them.

Their social organization is such that almost every person who had been in intimate contact with them, testified that they had never known any of the Aborigines to be guilty of the theft of anything. Even where partly modernized, as they are in the large government reservations they are trustworthy. A nurse in an emergency hospital told me that she continually left her money, jewelry and other objects of personal property freely exposed and available where many of the hundreds of primitives passing could pick them up, and that she had never known them to take anything. The other nurses had had the same experience.

Every boy and girl among these Aborigines must pass many examinations. Their early schooling includes the tracking of small animals and insects. The small boys begin throwing spears almost as soon as they can stand up straight. No young man can even witness a meeting of the council, let alone become a member of it, until he has passed three supreme tests of manhood. First, he is tested for his ability to withstand hunger without complaint. The test for this is to go on a march for two or three days over the hot desert and assist in preparing the meals of roast kangaroo and other choice foods and not partake of any himself. He must not complain. If he becomes too weak, he is given a small portion. There are tests for fear in which he is placed under the most trying ordeals without knowing that it is part of his examination, and he must demonstrate that he will accept death rather than flee.

No member of their society would be allowed to continue to live with the tribe if he had defied the ideals of the group. Immorality is cause for immediate death.

The growing boys among the Aborigines are taught deference and esteem for their elders in many impressive ways. A boy may not kill or capture a slow moving animal. That is left for the older men, whom he must call. He must limit his hunting primarily to the fast fleeing and canny kangaroos and wallabies, whom even a man on horseback cannot outdistance. Racketeers and such unsocial beings could not exist in this type of civilization.

Marriages are arranged according to very distinct tribal patterns and every girl is provided with a husband at a time decided by the council. Their code of ethics is built around the conception of a powerful Supreme Force that is related to the sun. They believe that there is an after-existence in which the myriads of stars represent the spirits of the Aborigines that lived before. The boys and girls are taught the names of the great characters that make up the different constellations. These were individuals who had conquered all of the temptations of life and had lived so completely in the interest of others that they had fulfilled the great motivating principle of their religion, which is that life consists in serving others as one would wish to be served. The seven stars of Pleiades were seven beautiful maidens that had surpassed most other girls in their devotion and service in the interest of their tribe. It is most remarkable how closely this concept is related to the classical myth regarding the seven daughters of Atlas and the nymph, Pleione.

A part of a young men's examination to determine his ability to withstand pain and his power of self-control consists in performing an operation at the time of his graduation. This operation is at the same time calculated to provide him with his badge of attainment. It consists of the boy's lying on his back and allowing the appointed operator to knock out one of his front upper teeth. This is done by putting a peg against the tooth and hitting it a series of sharp blows with a stone. He must endure this without flinching. We saw scores that carried this diploma. Prior to this, other very severe tests of physical endurance had been successfully completed.

The marvelous vision of these primitive people is illustrated by the fact that they can see many stars that our race cannot see. In this connection it is authoritatively recorded regarding the Maori of New Zealand that they can see the satellites of Jupiter which are only visible to the white man's eye with the aid of telescopes. These people prove that they can see the satellites by telling the man at the telescope when the eclipse of one of the stars occurs. It is said of these primitive Aborigines of Australia that they can see animals moving at a distance of a mile which ordinary white people can not see at all.

While these evidences of superior physical development command our most profound admiration, their ability to build superb bodies and maintain them in excellent condition in so difficult an environment commands our genuine respect. It is a supreme test of human efficiency. It is doubtful if many places in the world can demonstrate so great a contrast in physical development and perfection of body as that which exists between the primitive Aborigines of Australia who have been the sole arbiters of their fate, and those Aborigines who have been under the influence of the white man. The white man has deprived them of their original habitats and is now feeding them in reservations while using them as laborers in modern industrial pursuits. This contrast between the primitive Aborigines

as they still exist in isolated communities in Australia and the modern members of the clans is not, however, much greater than that between these excellent primitives and the whites, near whom they are living.

In my comparative study of primitive races in different parts of the world, of modernized members of their groups and of whites who have displaced them, as well as in my study of our typical modern social organization, I have seldom, if ever, found whites suffering so tragically from evidence of physical degeneration, as expressed in tooth decay and change in facial form, as are the whites of eastern Australia. This has occurred on the very best of the land that these primitives formerly occupied and becomes at once a monument to the wisdom of the primitive Aborigines and a signboard of warning to the modern civilization that has supplanted them. Their superb physical excellence is demonstrated in every isolated group in the primitive stocks with which we came in contact. For tribes that have lived along the coast and had access to the sea foods, their stature was large and well formed.

When living in the Bush they are largely without clothing. Where they are congregated in the reservations they are required to wear clothing. It is important to note in these people the splendid proportions of the faces, all of which are broad, with the dental arches wide and well contoured. This is Nature's normal form for all humans and is shown in Figs. 53 and 54 (upper right). The person in Fig. 53 (upper left) is a woman.

FIG. 53. No other primitive race seems to deserve so much

credit for skill in obeying nature's laws as these primitive Aborigines because of the perpetual drought hazards of much of the land they live in. Half of Australia has less than ten inches of rain per year. Note the magnificent dental arches and beautiful teeth of these primitives. Tooth decay was almost unknown in many districts.

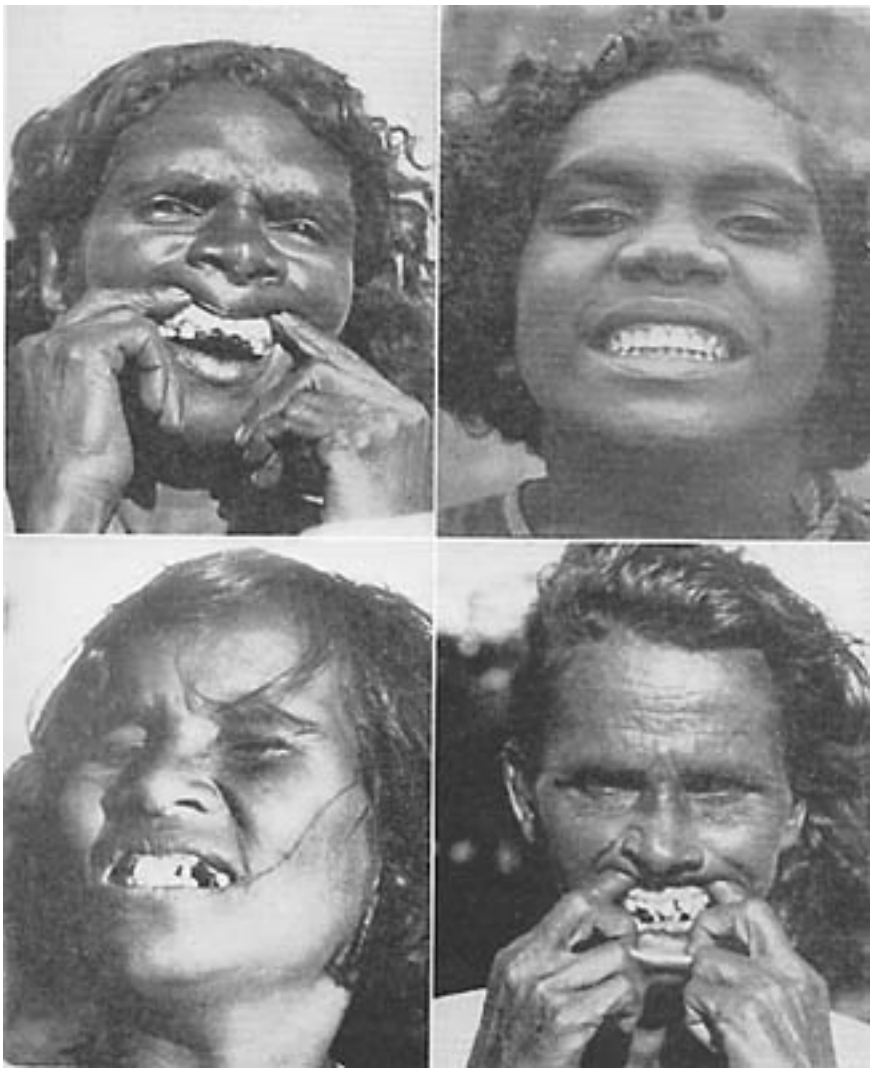


FIG. 54. Wherever the primitive Aborigines have been placed in reservations and fed on the white man's foods of commerce dental caries has become rampant. This destroys their beauty, prevents mastication, and provides infection for seriously injuring their bodies. Note the contrast between the primitive woman in the upper right and the three modernized women.

Various factors in the changed environment were studied critically. Samples of foods were gathered for chemical analysis; and the changes in the modern diet from that which was characteristic of the primitives were studied. When the teeth of the primitives and the teeth found in the skulls that had been assembled in the museums were examined, it was found that dental caries or tooth decay was exceedingly rare among the isolated groups. Those individuals, however, who had adopted the foods of the white man suffered extremely from tooth decay as did the whites. Where they had no opportunity to get native food to combine with the white man's food their condition was desperate and extreme. This is readily disclosed in Fig. 54. Note contrast with upper right. It is quite impossible

to imagine the suffering that these people were compelled to endure due to abscessing teeth resulting from rampant tooth decay. As we had found in some of the modernized islands of the Pacific, we discovered that here, too, discouragement and a longing for death had taken the place of a joy in living in many. Few souls in the world have experienced this discouragement and this longing to a greater degree.

One of the most important phases of our special quest was to get information that would throw light on the degeneration of the facial pattern that occurs so often in our modern civilization. This has its expression in the narrowing and lengthening of the face and the development of crooked teeth. It is most remarkable and should be one of the most challenging facts that can come to our modern civilization that such primitive races as the Aborigines of Australia, have reproduced for generation after generation through many centuries-no one knows for how many thousands of years-without the development of a conspicuous number of irregularities of the dental arches. Yet, in the next generation after these people adopt the foods of the white man, a large percentage of the children developed irregularities of the dental arches with conspicuous facial deformities. The deformity patterns are similar to those seen in white civilizations. Typical illustrations of this will be seen in Figs. 55 and 56. Severe deformities of the face were frequently seen in the modernized groups, as evidenced in Fig. 57.

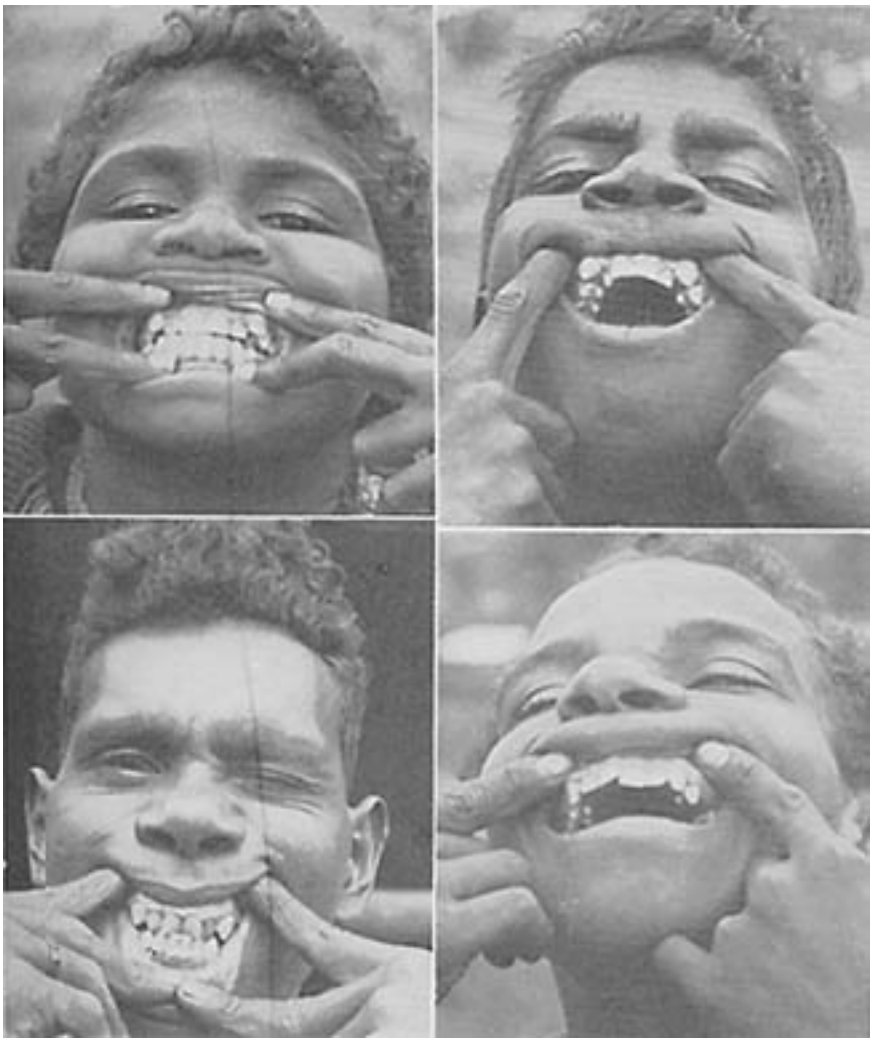


FIG. 55. It is remarkable that regardless of race or color the new generations born after the adoption by primitives of deficient foods develop in general the same facial and dental arch deformities and skeletal defects. Note the characteristic

narrowing of the dental arches and crowding of the teeth of this modernized generation of Aborigines and their similarity to the facial patterns of modern whites.

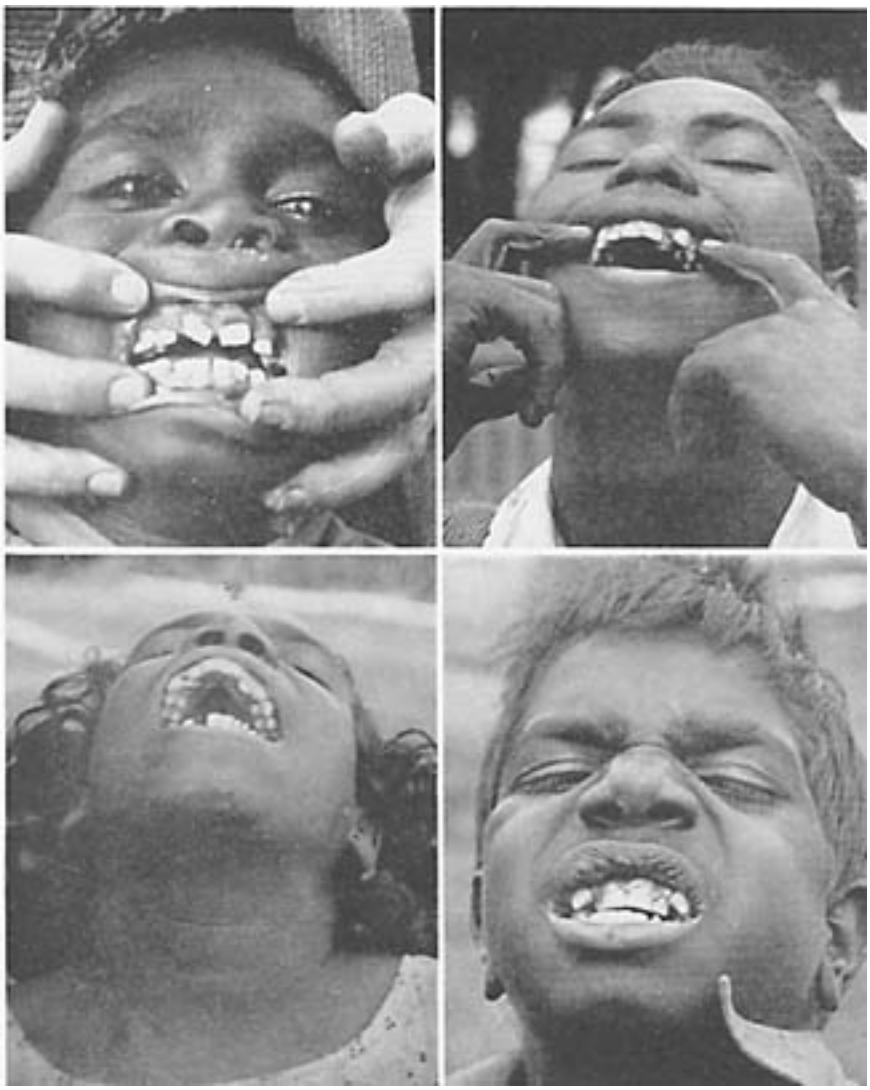


FIG. 56. The disturbance in facial growth is often so serious as to make normal breathing through the nose very difficult. This is primarily due to faulty development of the maxillary bones.

FIG. 57. Deformity patterns produced in the modernized Aborigines of Australia by white men's food. Note the undershot mandible, upper left, the pinched nostrils and facial deformity of all four.

The data obtained from a study of the native Australians who are located in a reservation near Sydney, at LeParouse, revealed that among the Aborigines 47.5 per cent of the teeth had been attacked by dental caries, and 40 per cent of the individuals had abnormal dental arches. For the women of this group, 81.3 per cent of all the teeth had been attacked by dental caries, and for the men, 60.4 per cent, and for the children, 16.5 per cent. In this group 100 per cent of the individuals were affected by dental caries.

Palm Island is a government reservation situated in the ocean about fifty miles from the mainland, off the east coast of Australia, about two-thirds of the way up the coast. It was reached by a government launch. Included in the population of this reservation are a large number of adults who have been moved from various districts on the mainland of Central and Eastern Australia and many children who were born either before or after their parents were moved to this reservation. The food available on the Island is almost entirely that provided by the government. Of ninety-eight individuals examined and measured, 53.1 per cent of them had dental caries. For the group as a whole, 8.9 per cent of all of the teeth were affected; for the women, 21.2 per cent; for the men, 14.2 per cent; and for the children, 5.8 per cent. Fifty per cent of the children had deformed dental arches, which occurred in only 11 per cent of the adults.

Cape Bedford is situated about three-fourths of the way up the east coast and is so isolated that it was necessary for us to use a special aeroplane to reach it. Landing was made on the beach. This group of people is under the management of a German Lutheran missionary. They are dependent almost entirely on the food provided by the mission and the government. The official in charge had spent fifty years in devoted service to these native people. We found him exceedingly sad because of the very rapid breakdown that was in progress among the natives in his care. The dental caries for the group of eighty-three individuals studied was 12.4 per cent of their 2,176 teeth examined. For the women, this amounted to 37.2 per cent of the teeth; for the men, 8.4 per cent; and for the children, 6.1 per cent. Of the eighty-three individuals, 48.1 per cent had been affected by dental caries. Many of the adults in this group had been born on plantations under the influence of the modern nutrition, and many of the children had been born in the mission. For the adults, 46 per cent had abnormally formed dental arches, and for the children, 41.6 per cent. We were advised that deaths occurred very frequently from tuberculosis. This reservation does not provide the natives with natural hunting grounds capable of providing the people with animal life for food. The coast for some distance inland is a series of sand dunes which are slowly being transferred over the vegetation by wind, completely smothering it. While the coast is well supplied with a variety of deep-water fish the natives have practically no equipment for obtaining them, a condition which restricts them very largely to the use of the imported foods supplied by the officials.

Our next stop, using the special aeroplane, was at Lockhart River, which is about four-fifths of the way up the east coast of Australia. Here again we were able to land on the beach near a large group of primitive Aborigines. The isolation here is so nearly complete that they are dependent upon the sea and the land for their foods. This part of Australia, namely, the York Peninsula, is still so primitive that there has been very little encroachment by the white population. It will be remembered that in this area there are no roads, the country being a primitive wilderness. Of fifty-eight individuals examined, their 1,784 teeth revealed that only 4.3 per cent had been attacked by dental caries. For the women, this amounted to 3.4 per cent; for the men, 6.1 per cent; and for the children, 3.2 per cent. Some of these men had at some time worked on cattle ranches for the white men. Of the children, only 6.3 per cent had abnormal dental arches, and of the adults, 8.7 per cent. In this group, therefore, 91.4 per cent of all ages had reproduced the typical racial pattern as compared with 56 per cent of the group at Cape Bedford, 62 per cent of the group at Palm Island, and 60 per cent at LeParouse. At Lockhart River, 32.7 per cent of the individuals had dental caries.

A reservation called Cowall Creek on the west side of York Peninsula situated on the Gulf of Carpenteria, was reached by flying our special plane to Horn Island in the Torres Strait north of Australia and proceeding from there by boat to Thursday Island, and on, by boat, to Cowall Creek. In this reservation thirty-five individuals were studied and found to be in a very pathetic condition. We were told that deaths occurred frequently. Of the 976 teeth examined, 24.6 per cent had been attacked by tooth decay. For the women, this amounted to 60.7 per cent; for the men, 30.4 per cent; and for the children, 8.9 per cent. Forty-nine and six-tenths per cent of the individuals studied had abnormal dental arches. Of the children 66.6 per cent had deformed dental arches, and 9 per cent of the adults. Many of these adults had been raised in the bush. Of the individuals studied, 68.6 per cent had had dental caries. One can scarcely visualize, without observing it, the distress of a group of primitive people situated as these people are, compelled to live in a very restricted area, forced to live on food provided by the government, while they are conscious that if they could return to their normal habits

of life they would regain their health and again enjoy life. Many individuals were seen with abscessing teeth. One girl with a fistula exuding pus on the outside of her face is shown in Fig. 58 (upper right). In their native life where they could get the foods that keep them well and preserve their teeth, they had no need for dentists. Now they have need, but have no dentists. It is easy to chide and blame the officials who provide them with the modernized foods under which they are breaking, but it must be remembered that practically all modern civilizations are more or less in the same plight themselves.

FIG. 58. Aborigines in Australia living on a reservation. The boy at the upper left has suppurating tubercular axillary glands. The girl at the upper right has pus running to the outside of her face from an abscessed tooth. The boy whose legs are shown at the lower left has a badly deformed body from malnutrition. The girl at the lower right has tubercular glands of the neck.

An opportunity was provided for examining a group of the native Aborigines of Australia who made up the crew of eighteen for a pearl-fishing boat. Of this group, 5.7 per cent of their 554 teeth had been attacked by tooth decay. These individuals could be readily divided into two groups; namely, those who had been raised in the Bush and those who had been raised in missions. For the thirteen raised in the Bush, not a single tooth of their 364 teeth had ever been attacked by tooth decay and not a single individual had deformed dental arches. In contrast with this, of the five raised in the mission, 19.3 per cent of their 140 teeth had been attacked by tooth decay and 40 per cent of these

individuals had abnormal dental arches.

The cook on the government boat was an aboriginal Australian from Northern Australia. He had been trained on a military craft as a dietitian. Nearly all his teeth were lost. It is of interest that while the native Aborigines had relatively perfect teeth, this man who was a trained dietitian for the whites had lost nearly all his teeth from tooth decay and pyorrhea.

In the group of Aborigines so far reported, there were many who had come from the interior districts of Australia and many who had always lived near the coast. These two types of districts provided quite different types of foods. Those near the coast were able to obtain animal life from the sea, including fish, dugong or sea cow, a great variety of shell fish, and some sea plants. Those from the interior districts could not obtain animal life of the sea, but did obtain animal life of the land which was eaten with their plant foods in each case. It was quite important to reach a group of Aborigines who had always lived inland and who were on a reservation inland. This contact was made with the group at a government reservation called Cherbourg. A typical group of individuals was examined. Of forty-five individuals with 1,236 teeth, 42.5 per cent of the teeth had been attacked by tooth decay. For the women, this constituted 43.7 per cent; for the men, 64.6 per cent; and for the children, 5.6 per cent. Of all of the individuals here examined 64.5 per cent had dental caries. It is of interest that many of these men had worked on white men's cattle ranches. While the adults showed 11.7 per cent to have deformed dental arches, this rose to 50 per cent for the children of the group. We were informed that in all of these groups tuberculosis was taking a very heavy toll. In Fig. 58, upper left, will be seen a boy with a superating tubercular gland of the axilla; at the right, a girl with a fistula draining pus onto the outside of the face from an abscessed tooth; below, deformed legs and a girl with tubercular glands of the neck.

A reservation situated on the coast where sea foods were available might be expected to make available a particular type of nutrition through sea foods. The individuals in a reservation for the Aborigines at Tweed Heads, which is so situated, were studied. Of the twenty-seven individuals examined, 89 per cent had dental caries. Of their 774 teeth, 39.7 per cent had been attacked by dental caries. For the women, this amounted to 62.5 per cent; for the men, 70.9 per cent; and for the children, 20.8 per cent. Most of these children had been born in this environment while their parents were being fed, largely, the foods provided by the government and mission. In this group, 83.4 per cent of the children had deformed dental arches, and 33.3 per cent of the adults.

An interesting incident was brought to my attention in one of the Australian reservations where the food was practically all supplied by the government. I was told by the director in charge, and in further detail by the other officials, that a number of native babies had become ill while nursing from their mothers. Some had died. By changing the nutrition to a condensed whole milk product, the babies recovered. When placed back on their mother's breast food they again became ill. The problem was: Why was not their mothers' milk adequate? I was later told by the director of a condition that had developed in the pen of the reservation's hogs which were kept to use up the scraps and garbage from the reservation's kitchens. He reported that one after another the hogs went down with a type of paralysis and could not get up. The symptoms were suggestively like vitamin A deficiency in both the babies and the hogs, and indicated the treatment.

The rapid degeneration of the Australian Aborigines after the adoption of the government's modern foods provides a demonstration that should be infinitely more convincing than animal experimentation. It should be a matter not only of concern but deep alarm that human beings can degenerate physically so rapidly by the use of a certain type of nutrition, particularly the dietary products used so generally by modern civilization.

The child life among the Aborigines of Australia proved to be exceedingly interesting. Children develop independence very young and learn very early to take care of themselves. Mothers are very affectionate and show great concern when their children are not thriving. Two typical mothers with their children are shown in Fig. 59. These children, as suggested in the picture, were keenly interested in everything that I did, but were not alarmed or frightened.

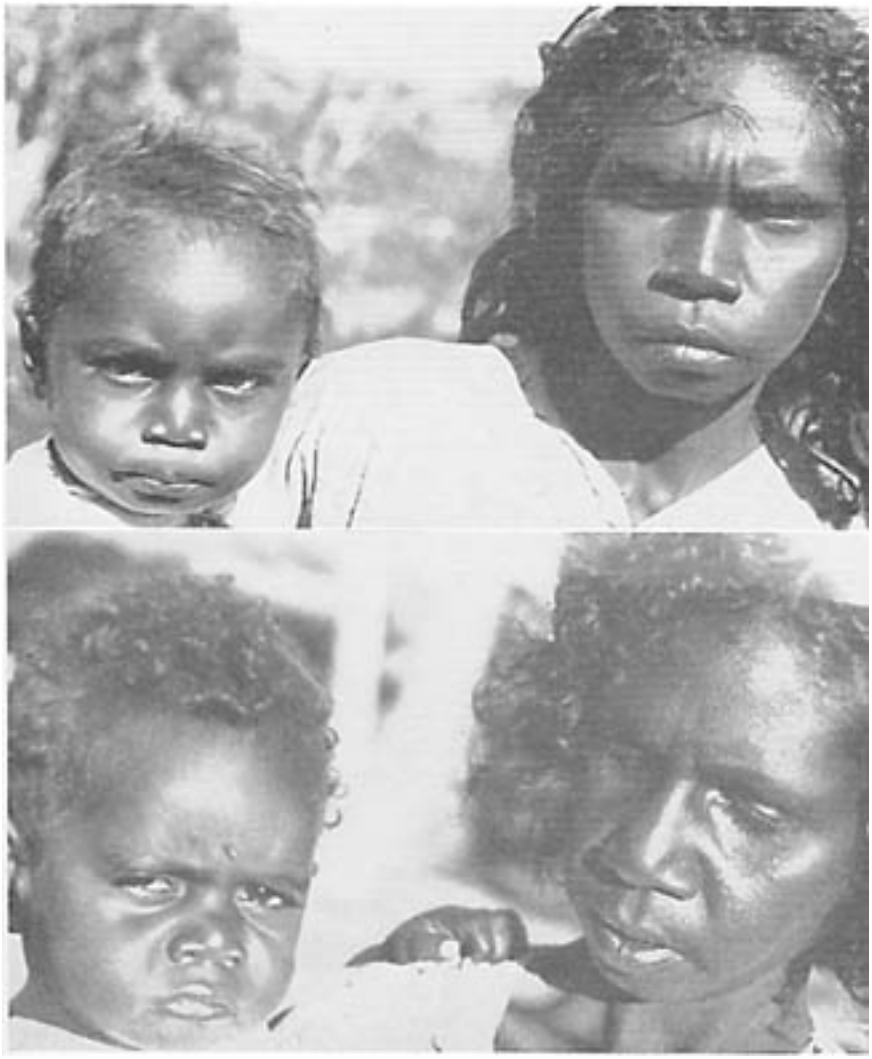


FIG. 59. Typical Aborigine mothers with their children.

The wonderful wisdom of these primitive people was attested by the principal of the public school at Palm Island. A mother died and her nursing infant was taken care of by its maternal grandmother, who had not recently given birth to a child. She proceeded to carry out the primitive formula for providing breast food by artificial means. Her method was to make an ointment of the fresh bodies of an insect which made its nest in the leaves of a certain tree. This she rubbed on her breast and in a short time produced milk liberally for this foster child. I was shown the type of insect, photographed its nest and the colony inside when the nest was opened. The people who vouched for this circumstance declared that they had seen the entire procedure and knew the facts to be as stated. They

further stated that this was common knowledge among the Aborigines.

Another important source of information regarding the Aborigines of Australia was provided by a study of the skeletal material and skulls in the museums at Sydney and Canberra, particularly the former. I do not know the number of skulls that are available there for study, but it is very large. I examined many and found them remarkably uniform in design and quality. The dental arches were splendidly formed. The teeth were in excellent condition with exceedingly little dental caries. A characteristic of these skulls was the evidence of a shortage of material for those that had been transferred to a museum from the interior arid plains country. Those skulls, however, that had come from coastal areas where sea foods were available, show much more massive dimensions of the general pattern. In Fig. 60 will be seen typical skulls showing the normal dental arches and general design of the head. It is of interest to note the very heavy orbital ridges which characterize this race.

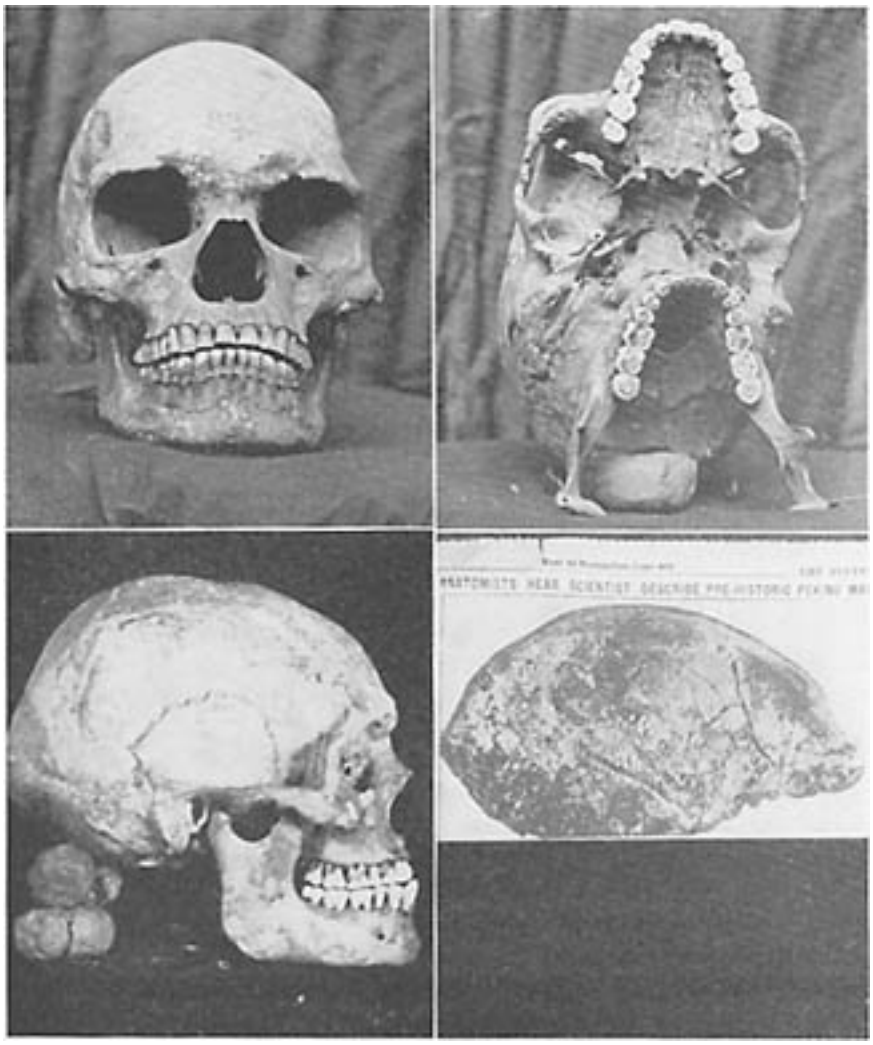


FIG. 60. The buried skulls throughout Australia provide a dependable record of their physical excellence and splendid facial and dental arch forms. In the lower pictures are shown the skull dome of a typical Australian Aborigine for comparison with that of the recently discovered Peking man who possibly lived a million years ago.

I have previously referred to a report by Professor Weidenreich regarding the resemblance of the Australian native's skulls to those of the recently discovered Peking man in the caves of China. In Fig. 60 are two views for comparison. The skull at the left is that of an Australian primitive

photographed in a museum in Sydney, and an outline of the Peking skull is shown at the right. Professor Weidenreich has emphasized the observations that when three skulls are put in series, namely, the Australian primitive, the Peking skull and a chimpanzee skull, the Peking skull appears to be about half way between the two in design and developmental order. The Australian primitive's skull is higher in the crown, showing much greater brain capacity. The supra-orbital depressions are less deep in the Peking than in the chimpanzee, and still less deep in the Australian primitive. The supra-orbital ridges which produce the prominent eyebrows are less pronounced in the Australian primitive than in the Peking man, and still more prominent in the chimpanzee. The prominent supra-orbital ridges of the chimpanzee face are shown in Fig. 48.

The age of the Peking skulls has been variously placed from several hundred thousand to a million years. A distinguished anthropologist has stated that the Australian primitives are the only people living on the earth today that could be part of the first race of mankind. It is a matter of concern that if a scale were extended a mile long and the decades represented by inches, there would apparently be more degeneration in the last few inches than in the preceding mile. This gives some idea of the virulence of the blight contributed by our modern civilization.

The foods available for these people are exceedingly limited in variety and quantity, due to the absence of rains, and unfertility of the soil. For plant foods they used roots, stems, leaves, berries and seeds of grasses and a native pea eaten with tissues of large and small animals. The large animals available are the kangaroo and wallaby. Among the small animals they have a variety of rodents, insects, beetles and grubs, and wherever available various forms of animal life from the rivers and oceans. Birds and birds' eggs are used where available. They are able to balance their rations to provide the requisites for splendid body building and body repair. In several parts of Australia, which originally supported a large population of the primitives, none are left except a few score in reservations. These also are rapidly disappearing. Their fertility has been so greatly reduced that the death rate far exceeds the birth rate.

This group provides evidence of exceptional efficiency in obeying the laws of Nature through thousands of years, even in a parched land that is exceedingly inhospitable because of the scant plant foods for either men or animals. While the Aborigines are credited with being the oldest race on the face of the earth today, they are dying out with great rapidity wherever they have changed their native nutrition to that of the modern white civilization. For them this is not a matter of choice, but rather of necessity, since in a large part of Australia the few that are left are crowded into reservations where they have little or no access to native foods and are compelled to live on the foods provided for them by our white civilization. They demonstrate in a tragic way the inadequacy of the white man's dietary programs.

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Chapter 11

ISOLATED AND MODERNIZED TORRES STRAIT ISLANDERS

IN STUDYING the relationship between nutrition and physical characteristics, it is important to make observations at the point of contact with civilization where as few factors as possible in the environment have been modified by that contact. My previous studies have shown that wherever groups of people were utilizing sea foods abundantly in connection with land plants including roots, greens and fruits, they enjoyed fine physical development with uniform reproduction of the racial pattern and a very high immunity to dental caries. For this particular study we wished to select a racial group living on islands in tropical or subtropical climate, whose ancestral stocks differed from those previously observed, and which was located at points of contact with modern civilization. A high level of excellence might be expected among the groups who were in process of being modernized but were still utilizing the native foods.

For this study the inhabitants of islands north of Australia were chosen in order to record the effect on the Asiatic and Malay stocks at the points of contact of the north with the south and of the east with the west. In the Torres Strait there are a number of fertile islands supporting populations of from several hundred to a few thousand individuals each. These groups are in an area of the sea that is well stocked with sea animal life, and during the past they have been sufficiently isolated to provide protection. The racial stocks have retained their identities and include Papuans, New Guineans, Mobuiags, Arakuns, Kendals and Yonkas. The splendid dental arches of these groups will be seen in the various illustrations. Many of the girls are quite prepossessing, as may be seen in Fig. 61.

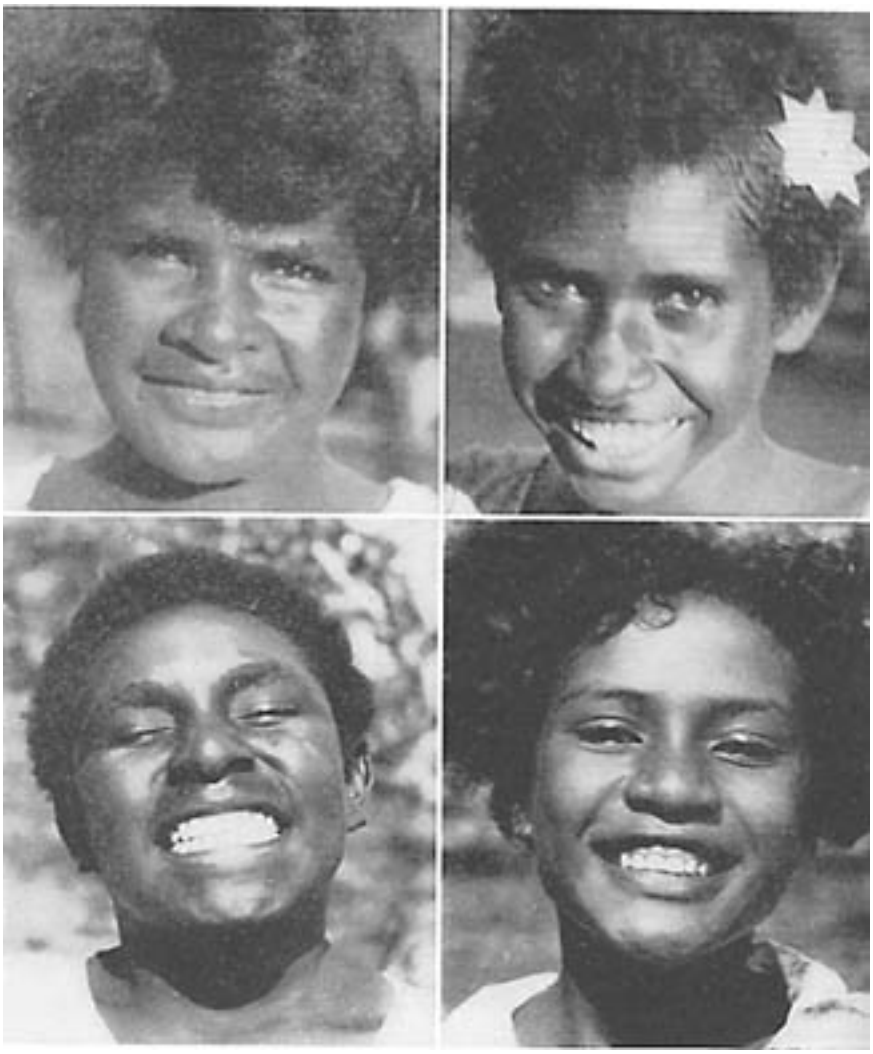

FIG. 61. The inhabitants of the islands north of Australia have splendidly built bodies with fine facial and dental arch form.

With the valuable assistance of the officials of the Australian Government we were able to make investigations on several islands in the Torres Strait. The local administrator provided us with a government boat and personal introductions to the local chief and local representatives of the government. We were accompanied by the administrator and by the general manager of the government stores. These stores have been located on the various islands, and the profit derived from them is used for administrative expenses of the government. They provide modern clothing in addition to foods, chiefly white flour, polished rice, canned goods, and sugar. Studies were made on the various islands in the order in which the stores had been installed on them. It is important to have in mind the nature of these islands. Some are of volcanic origin and have rugged interiors with deep bays; others are of coral origin. All are in a zone that is abundantly supplied with sea animal life, this being the scene of the richest pearl fishing industry in the world.

Badu Island had had the store for the longest period, namely twenty-three years. Of the 586 teeth of twenty individuals examined, 20.6 per cent had been attacked by tooth decay. Of the individuals examined 95 per cent had dental caries. Unfortunately, our stay at this island was accompanied by a torrential downpour which made it very difficult for us to carry forward our investigations. Had we been able to examine the mothers the figures doubtless would have been much higher. The children were examined at the school and showed 18.8 per cent of the teeth to have been attacked by tooth decay. The men examined showed 21.9 per cent. Figures given me by Dr. Gibson, who had been

taken by the government to the island to make extractions, showed that he found as high as 60 per cent of the teeth had been attacked by tooth decay. For the children of this group, 33.3 per cent had abnormal dental arches, whereas only 9.1 per cent of the adults' arches were abnormally formed.

On York Island, 1,876 teeth of sixty-five individuals showed that 12.7 per cent had been attacked by tooth decay. For the women, this was 20.2 per cent; for the men, 12.1 per cent; and for the children, 7 per cent. For the children, 47.1 per cent had abnormal dental arches; for the adults, 27 per cent were affected. The individuals on this island had been in contact with the pearl fisheries industry for several years. Several of the men had been working on the fishing boat. Of the sixtyfive individuals examined, 67.6 per cent had dental caries.

On Darnley Island, thirty-three individuals showed that of their 900 teeth 5.7 per cent had been attacked by tooth decay. The store had been established on this island recently. For the women, 16.6 per cent of the teeth had been attacked; for the men, 6.3 per cent; and for the children, 4.1 per cent. On this island, 29.6 per cent of the children showed abnormal dental arches, and 14.3 per cent of the adults. Of the whole group, 46.1 per cent had been attacked by dental caries.

On Murray Island where a store had recently been established, of the 1,074 teeth examined for 39 individuals, only 0.7 per cent of the teeth had been attacked by tooth decay. For the women, this amounted to 2 per cent; for the men, 1.7 per cent; and for the children, 0.26 per cent. Only 12.8 per cent of the group had dental caries. It is significant that the natives were conscious of a danger from the presence on the island of a store providing imported foods. This had been so serious a problem that there was a question whether it would be safe for us to land, since on the last visit of the government officials, blood was almost shed because of the opposition of the natives to the government s program. The result of our examination indicates that dental caries on these islands shows an incidence which has an apparent direct relationship to the length of time government stores have been established there. The immunity to dental caries on this island is nearly 100 per cent. Of the adults, 14.3 per cent had abnormal dental arches, and of the children, 34.4 per cent.

Thursday Island is the location of the administrative center for the group. Although it is the best sheltered harbor and affords protection for small boats in the Torres Strait, it was not originally inhabited by the natives. They considered it unfit for habitation because the soil was so poor that it could not provide the proper plant foods to be eaten with the sea foods which are abundant about all of the islands. Nearly all of the whites inhabiting the islands of this district live on this island. They are the families of the administrative officers and of merchants who are engaged in the pearl industry. Owing to the infertility of the soil, practically all of the food has to be shipped in except the little that the whites obtain from the sea. On the island there were many native families, with children attending the native school, while their fathers worked in the pearling fleets. Thirty individuals in three fleets were examined, and of their 960 teeth only thirty-five had been attacked by dental caries, or 3.6 per cent. Of these thirty individuals, five, or 16.3 per cent had abnormal dental arches. The men who had teeth attacked by dental caries informed me that this had happened after they had engaged on the pearling vessels and began to use the foods provided there. In the native school on Thursday Island twenty-three children were examined. They were living in homes in which a considerable part of the food was purchased at the company stores. The incidence of tooth decay was 12.2 per cent of their 664 teeth. Many of these Thursday Island children had been born since their parents had begun using the commercial foods provided to the islanders. Among twenty-three individuals, 43.5 per cent had

abnormal dental arches.

While these investigations were planned and carried out primarily to obtain data on the condition of the native races in contact with modern white civilization, wherever possible, data were obtained on the whites also. In a school for whites on Thursday Island, fifty children were examined with regard to their dental arches, but an embarrassing situation was encountered with regard to the sensitiveness of the whites in the matter of having their children examined for dental caries. Figures were obtained for the facial development which reveal that, out of the fifty children examined, 64 per cent had irregularities of facial and dental arch development. In the upper half of Fig. 62, will be seen a group of children photographed in the native school, and in the lower a group of white girls photographed at the white school. The difference in their facial development is readily seen. The son of the white teacher (Fig. 66, left) had marked under development of his face. The white population lived largely on canned food.

FIG. 62. School children from the two groups on Thursday Island. Note the beautifully proportioned faces of the natives, and the pinched nostrils and marked disturbance in proportions of the faces of the whites. The dental arches of the natives are broad, while many of the whites have very crowded teeth. The parents and children of the natives used native foods while the parents and children of the whites used the modern imported foods of commerce.

Hammond Island adloins Thursday Island sufficiently close by to be easily reached in small boats. Accordingly, the people of this island have access to the stores of the white settlement on Thursday Island. Unlike Thursday Island, Hammond Island is quite fertile. Of twenty-seven individuals, all of native stock, 16.5 per cent of their 732 teeth had been attacked by dental caries, and 40 per cent of the individuals showed some deformity of the dental arches. After examining the children at the mission school, I inquired whether there were not families on the island that were living entirely isolated from contact with modern influences. I was taken to the far side of the island to an isolated family. This family had continued to live on their own resources. They were raising vegetables including bananas, pumpkins, and pawpaws. In the cases of the three girls in the family, one with a child five months of age, only six of their eighty-four teeth had been attacked by tooth decay, or 7.1 per cent, as compared with 16.5 per cent for the entire group on this island. These three girls all had normally developed dental arches and normal features. Three of the girls are shown in Fig. 63. We inquired about the mother and were told that she was out fishing, notwithstanding the fact that the sea was quite rough. While we were there, she came in with two fish (Fig. 63). Here was one of the principal secrets of their happiness and success in life. The Catholic priest who had charge of the mission on this island told me that this family practically never asked for assistance of any kind, and was always in a position to help others. They were happy and well nourished. It is important to note that the progressive degeneration in facial form which occurred in many of the families on the other islands was not found in this family.

FIG. 63. These pictures tell an interesting story. The

grandmother shown in the lower right knew the importance of sea food for her children and grandchildren and did the fishing herself. Note the beautiful teeth and well formed faces of her daughters.

The incidence of dental caries ranged from 20.6 per cent of all of the teeth examined for the various age groups on Badu Island to 0.7 per cent, on Murray Island. A group of individuals from this island will be seen in Fig. 64. Note the remarkable width of the dental arches. Note also in this connection that the natives of this island are conscious of the superior food of their locality and wish that their people were not required to purchase food from the government store. The island is situated on the Barrier Reef and has an abundant supply of small fish. The swarms of fish are often so dense that the natives throw a spear with several prongs into the school of fish and when the spear is drawn back, there are several fish on it. This condition provides abundant food for sharks many of which could be seen surrounding the schools of small fish. Encircling the group, they dashed in, mouths open and gorged themselves with the mass of fish from the water. It seemed quite remarkable that the people were willing to go into the water to spear the fish within the zone frequently approached by the sharks, but I was told by the natives that when the fish are so abundant the sharks never attack human beings. One of the natives rowed me in his canoe to a point where I could photograph the sharks at close range. To show his disdain for the shark, he had no hesitancy in standing up in the end of the canoe and hurling his spear into the side of the monster. The spear was immediately thrown out by the shark, which had not been frightened sufficiently to make it leave the scene of action. The sharks in my pictures were swimming so close to the shore that the upper part of the tail was forced out of the water, also the back fin, in order to clear the bottom. It was a great revelation to watch the movement of the tail. Instead of swinging it from side to side like other fish, with which I was familiar, the shark would rotate its tail half or three quarters of a turn in a motion like that of a propeller of a boat, then reverse the motion for the return trip. By a sudden increase of speed in this motion, the shark could dart ahead at a rapid rate, corral the small fish by encircling them, and finally make a dash through the school with its mouth open. Hundreds of the small fish, in order to escape, dart out of the water into the air. This exposes them to the birds, a flock of which follows the sharks when they are feeding on the fish. The birds dive down at the time they see the shark making his raid and catch the small fish as they dart out of the water. It is by the birds of prey that the native fishermen from their lookout locate the schools of fish. While there is a difference of opinion as to whether some species of shark will attack human beings, we saw one pearl diver who bore enormous scars received from the jaws of a shark.

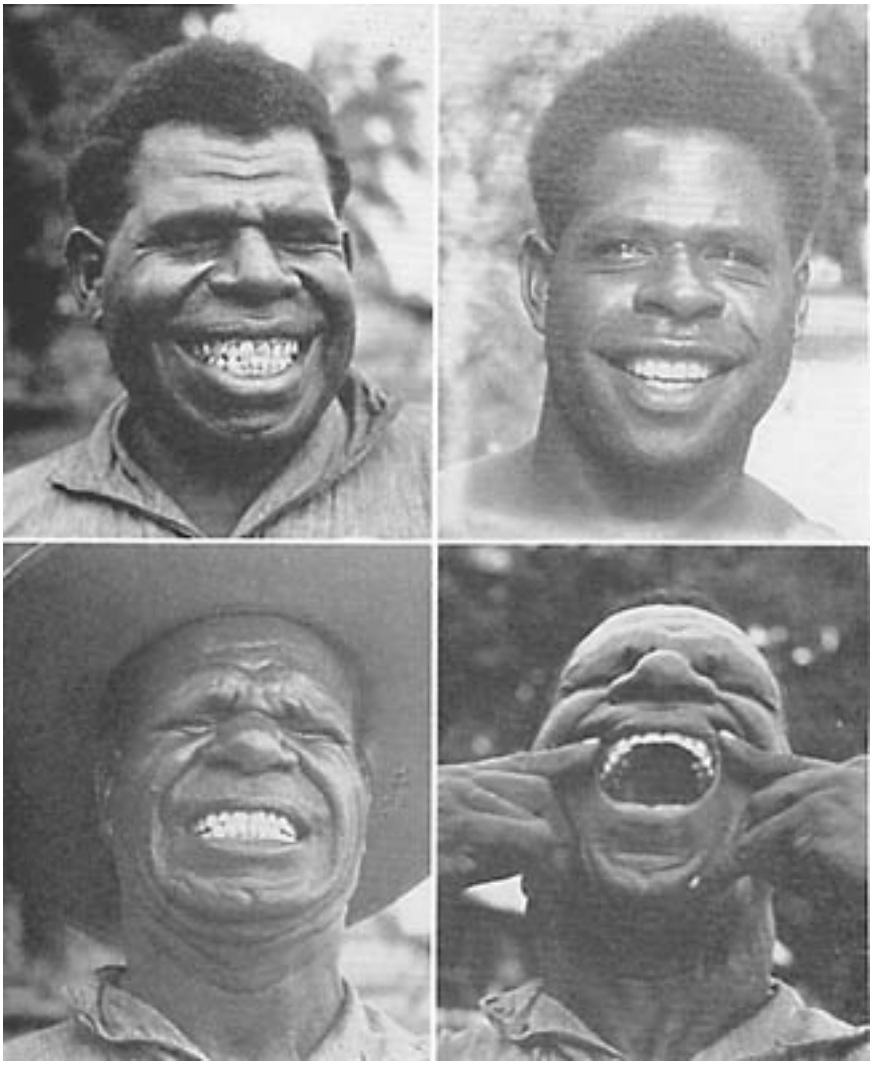

FIG. 64. Natives on the islands of the Great Barrier Reef. The dental arches here teach a high degree of excellence.

The procedure on one island is to snare the sharks by calling them by means of special sounds made by clapping together two large half shells on the surface of the water. This attracts the shark, and then the men one at a time go into the water with a sharp stick with which they guard themselves against attack. A noose made of rope of coconut fiber is slipped over the shark's head and over the back fin. It is then allowed to tire out and is brought to shore. It was not unusual in a good season for the shark fishers to bring in three or four in a night's fishing. The strength of the native swimmers is almost beyond belief. The pearling boats are frequently in great danger of being dashed to pieces on a coral reef, since in those waters gales of fifty miles an hour are frequent. We experienced some such gales. On one occasion, when a pearling boat was wrecked some distance from an exposed rock, one strong swimmer rescued and helped two dozen of the crew to the rock, and was himself rescued after being in the water continuously for thirty-two hours. The pearling boats feed their crew largely on commercial provisions. When the men have been continuously on the boats for one or two years, or often when they have been at sea using this food for six months, they have rampant tooth decay. When the cavities approach or reach the pulp chambers the pain produced in the teeth by the high pressure in deep water produces such agony that they often have to give up pearling.

Physical characteristics of all these residents of the Torres Strait Islands, regardless of their tribal group, were, sturdy development throughout their bodies, broad dental arches, and for all of those who had always lived only on their native food, a close proximity to one hundred per cent immunity

to dental caries. These men are natural mariners. They do not hesitate to make long trips even in rough seas in their homemade crafts. They have an uncanny skill in determining the location of invisible coral reefs. They relate the height of the swell as it rolls over the reef to particular color tones in the water, all of which were too vague for me to see even when they were pointed out.

Among the inhabitants of the Torres Strait Islands, almost all individuals who had been born before the foods of modern civilization had become available were found to have dental arches normal in form. In many families, however, living on islands where a store had been established for some time, and on Thursday Island where imported foods had been available for several decades, many individuals were found who had been born since the use of imported foods. They had gross deformities of the dental arches. This fact is illustrated in Fig. 65 in which typical depression of the laterals and narrowing of the upper arch and abnormal prominence of the cuspids due to the lack of space for the normal eruption may be seen. The facial deformity in two white boys is seen in Fig. 66. Rampant tooth decay in white children is shown in Fig. 67.

FIG. 65. The contrast between the primitive and modernized natives in facial and dental arch form is as striking here as elsewhere. These young natives were born to parents who had adopted our modern foods of commerce. Note the narrowed faces and dental arches with pinched nostrils and crowding of the teeth. Their magnificent heredity could not protect them.

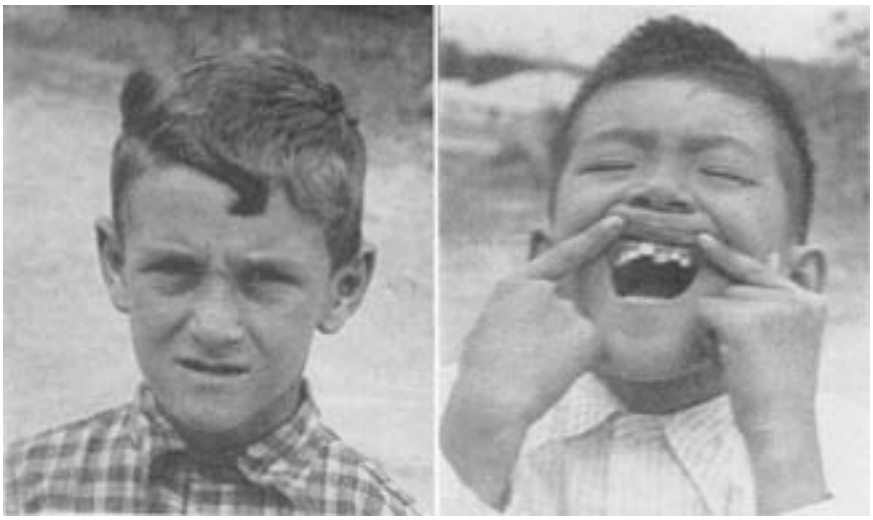

FIG. 66. These children are from the white colony on Thursday Island. Note the pinched nostrils and deformed dental arches with crowding of the teeth. The boy at the left is a mouth breather.

FIG. 67. As everywhere these whites prefer the modernized foods and pay the penalty in rampant tooth decay. They are in pathetic contrast with the superb unspoiled natives. They are within reach of some of the best foods to be found anywhere in the world and yet do not use them; a typical characteristic of modern whites.

We are particularly concerned with data that will throw light on the nature of the forces responsible for the production of these deformities. Since they do not appear to their full extent until the eruption of the permanent teeth as part of the development of the adult, it is easy for the abnormality to be ascribed to the period of child growth. As a result, it has been related to faulty breathing habits, thumb sucking, posture, or sleeping habits, of the child.

It would be difficult to find a more happy and contented people than the primitives in the Torres Strait Islands as they lived without contact with modern civilization. Indeed, they seem to resent very acutely the modern intrusion. They not only have nearly perfect bodies, but an associated personality and character of a high degree of excellence. One is continually impressed with happiness, peace and health while in their congenial presence.

These people are not lazy, but they do not struggle over hard to obtain food. Necessities that are not readily at hand they do not have. Their home life reaches a very high ideal and among them there is practically no crime.

In their native state they have exceedingly little disease. Dr. J. R. Nimmo, the government physician in charge of the supervision of this group, told me in his thirteen years with them he had not seen a single case of malignancy, and had seen only one that he had suspected might be malignancy among the entire four thousand native population. He stated that during this same period he had operated several dozen malignancies for the white population, which numbers about three hundred. He reported that among the primitive stock other affections requiring surgical interference were rare.

The environment of the Torres Strait Islanders provides a very liberal supply of sea foods and fertile islands on which an adequate quantity of tropical plants are readily grown. Taro, bananas, papaya, and plums are all grown abundantly. The sea foods include large and small fish in great abundance, dugong, and a great variety of shellfish. These foods have developed for them remarkable physiques with practically complete immunity to dental caries. Wherever they have adopted the white man's foods, however, they suffer the typical expressions of degeneration, such as, loss of immunity to dental caries; and in the succeeding generations there is a marked change in facial and dental arch form with marked lowering of resistance to disease.

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Chapter 12

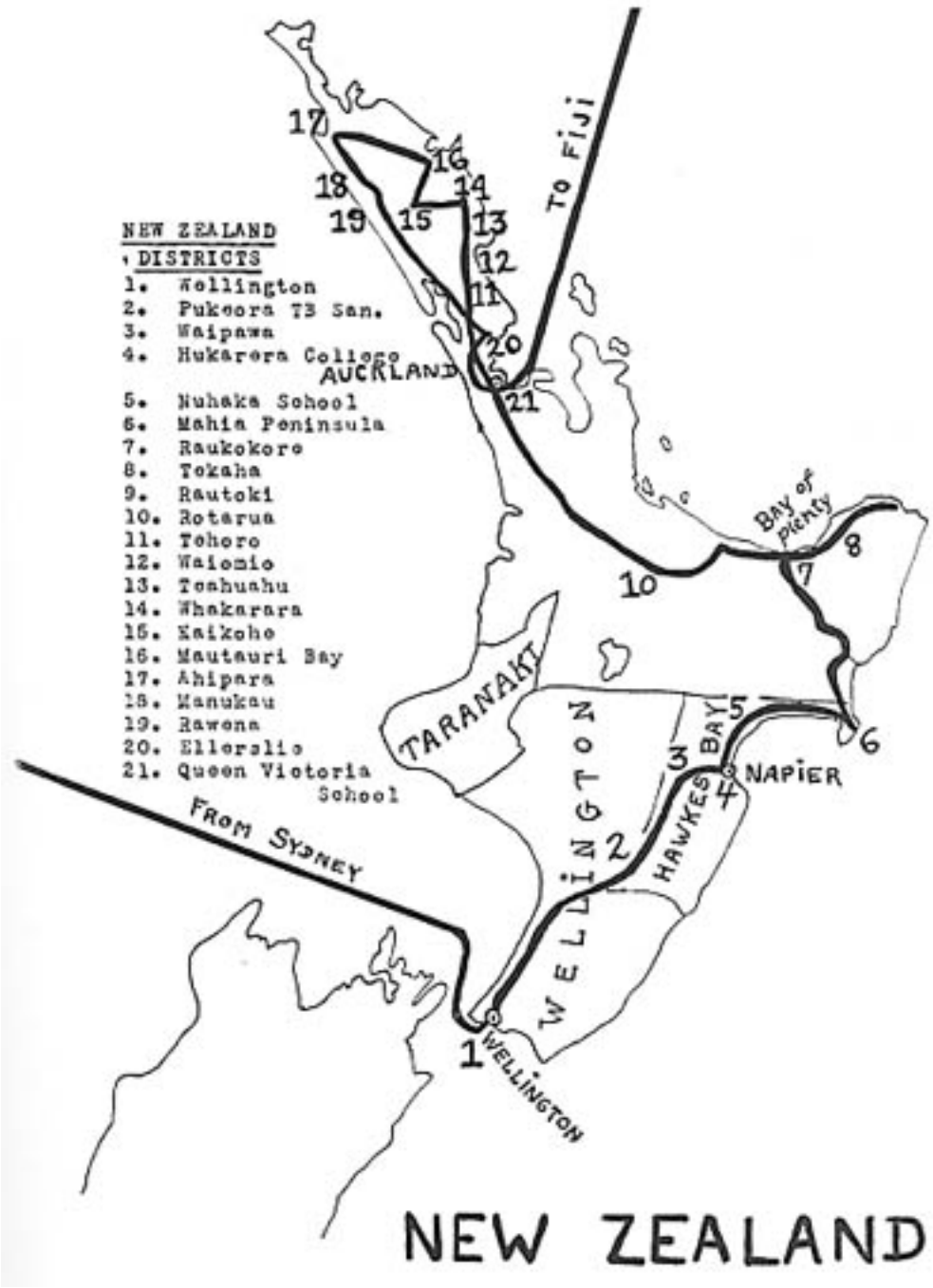
ISOLATED AND MODERNIZED NEW ZEALAND MAORI

BECAUSE of the fine reputation of the racial stock in its primitive condition, it was with particular interest that studies were made in New Zealand. Pickerill (1) has made a very extensive study of the New Zealand Maori, both by examination of the skulls and by examination of the relatively primitive living Maori. He states:

> In an examination of 250 Maori skulls--all from an uncivilized age--I found carious teeth present in only two skulls or 0.76 per cent. By taking the average of Mummery's and my own investigations, the incidence of caries in the Maori is found to be 1.2 per cent in a total of 326 skulls. This is lower even than the Esquimaux, and shows the Maori to have been the most immune race to caries, for which statistics are available.
>
> Comparing these figures with those applicable to the present time, we find that the descendants of the Britons and Anglo-Saxons are afflicted with dental caries to the extent of 86 per cent to 98 per cent; and after examining fifty Maori school children living under European conditions entirely, I found that 95 per cent of them had decayed teeth.

It will be noted that the basis of computation in the above is percentage of individuals with caries. I am using in addition to these figures the percentage of teeth attacked by dental caries. Expressed in percentage of teeth affected the figure for Pickerill's group would be 0.05 or 1 in 2,000 teeth.

We were deeply indebted to the government officials in New Zealand for their invaluable assistance. In anticipation of making these studies I had been in correspondence with the officials for over two years. When we arrived at Auckland, New Zealand, on our way to Australia, our ship was in port for one day. We were met by Colonel Saunders, Director of Oral Hygiene in the New Zealand Department of Public Health who had been sent from the capitol at Wellington to offer assistance. A personal representative of the Government was sent as guide, and transportation to the various Maori settlements in which we wished to make our studies was provided.



New Zealand is setting a standard for the world in the care of growing children as well as in many other health problems. A large percentage of the schools in New Zealand are provided with dental service. A specially trained woman was in charge of the work in each school under Colonel Saunders' supervision. The operations performed by these young women on children far exceeded in quality the average that I have seen by dentists in America. Their plan gives dental care to children twelve years of age and under, provided the parents express a wish that their children receive that care. The service was being extended rapidly to all communities. Since my return, I have learned that the work is being organized to provide for every community of New Zealand. The art of the Maori gives evidence of their great ability and skill in sculpturing. Boys and girls do beautiful carving and weaving. All native buildings and structures are embellished with carvings often in fine detail.

It was most gratifying to find neat and well-appointed dental office buildings for both natives and whites, located beside a large number of the public schools throughout New Zealand. In many communities two or three schools were served by the same operator. Children were either brought to

the central dental infirmary or provision was made for an operating room in the vicinity of each school. The operator went from district to district. A typical dental infirmary is shown in Fig. 68, with Colonel Saunders and one of his efficient women operators in the foreground. I had suggested that I should be glad to have observers from the Department of Health accompany us or arrange to be present at convenient places to observe the conditions and to note my interpretations of them. From two to five such observers were generally present, including the official representative of the department. The planning of the itinerary was very greatly assisted by a Maori member of Parliament, Mr. Aparana Ngata.

FIG. 68. The New Zealand government provides nearly universal free dental service for the children, regardless of color, to the age of twelve years. This is a typical dental clinic maintained in connection with the school system. They are operated by trained dental hygienists. The director of the system, Colonel Saunders, is seen in the picture.

Although New Zealand is a new country with a relatively small population, there being approximately only a million and a half individuals, the building of highways has rapidly been extended to include all modernized sections. In order to reach the most remote groups it was often necessary to go beyond the zone of public improvements and follow quite primitive trails. Fortunately this was possible because it was the dry season. Even then many streams had to be forded, which would have been quite impossible at other seasons of the year. We were able to average approximately a hundred miles of travel per day for eighteen days, visiting twenty-five districts and making examinations of native Maori families and children in native schools, representing various stages of modernization. This included a few white schools and tubercular sanitariums.

Since over 95 per cent of the New Zealanders are to be found in the North Island, our investigations were limited to this island. Our itinerary started at Wellington at the south end of the North Island and progressed northward in such a way as to reach both the principal centers of native population who were modernized and those who were more isolated. This latter group, however, was a small part of the total native population. Detailed examinations including measurements and photographic records were made in twenty-two groups consisting chiefly of the older children in public schools. In the examination of 535 individuals in these twenty-two school districts their 15,332

teeth revealed that 3,420 had been attacked by dental caries or 22.3 per cent. In the most modernized groups 31 to 50 per cent had dental caries. In the most isolated group only 2 per cent of the teeth had been attacked by dental caries. The incidence of deformity of dental arches in the modernized groups ranged from 40 to 100 per cent. In many districts members of the older generations revealed 100 per cent normally formed dental arches. The children of these individuals, however, showed a much higher percentage of deformed dental arches.

These data are in striking contrast with the condition of the teeth and dental arches of the skulls of the Maori before contact with the white man and the reports of examinations by early scientists who made contact with the primitive Maori before he was modernized. These reports revealed only one tooth in 2000 teeth attacked by dental caries with practically 100 per cent normally formed dental arches.

My investigations were made in the following places in the North Island. The Pukerora Tubercular Sanatorium provided forty native Maori for studies. These were largely young men and women and being in a modern institution they were receiving the modern foods of the whites of New Zealand. Their modernization was demonstrated not only by the high incidence of dental caries but also by the fact that 90 per cent of the adults and 100 per cent of the children had abnormalities of the dental arches.

The Hukarera College for Maori girls is at Napier. These girls were largely from modernized native homes and were now living in a modern institution. Their modernization was expressed in the high percentage of dental caries and their deformed dental arches.

At the Nuhaka school an opportunity was provided through the assistance of the government officials to study the parents of many of the children. Tooth decay was wide-spread among the women and active among both the men and children.

The Mahia Peninsula provided one of the more isolated groups which showed a marked difference between the older generation and the new. These people had good access to sea foods and those still using these abundantly had much the best teeth. A group of the children who had been born and raised in this district and who had lived largely on the native foods had only 1.7 per cent of their teeth attacked by dental caries.

The other places studied were Raukokore, Tekaha, Rautoki, Rotarua, Tehoro, Waiomio, Teahuahu, Kaikohe, Whakarara, Mautauri Bay, Ahipara, Manukau, Rawena, Ellerslie, Queen Victoria School at Auckland and Waipawa.

New Zealand has become justly famous for its scenery. The South Island has been frequently termed the Southern Alps because of its snow-capped mountains and glaciers. Of the 70,000 members of the Maori race living in the two islands, about 2000 are on the South Island and the balance on the North Island. While snow is present on many of the mountains of the North Island in the winter season, only a few of the higher peaks are snow capped during the summer. Most of the shoreline of the seacoast of the South Island is very rugged, with glaciers descending almost to the sea. The coastline of the North Island is broken and in places is quite rugged. The approach to the

Mahia Peninsula is along a rocky coast skirting the bay. The most important industries of New Zealand are dairy products, and sheep raising for wool.

The reputation of the Maori people for splendid physiques has placed them on a pedestal of perfection. Much of this has been lost in modernization. However, through the assistance of the government, I was able to see many excellent physical specimens. In Fig. 69 will be seen four typical Maori who retained much of the tribal excellence. Note their fine dental arches. A young Maori man who stands about six feet four inches and weighs 230 pounds was examined. The Maori men have great physical endurance and good minds. Many fine lawyers and government executives are Maori. The breakdown of these people comes when they depart from their native foods to the foods of modern civilization, foods consisting largely of white flour, sweetened goods, syrup and canned goods. The effect is similar to that experienced by other races after using foods of modern civilization. Typical illustrations of tooth decay are shown in Fig. 70. In some individuals still in their teens half of the teeth were decayed. The tooth decay among the whites of New Zealand and Australia was severe. This is illustrated in Fig. 71. Particularly striking is the similarity between the deformities of the dental arches which occur in the Maori people who were born after their parents adopted the modern foods, and those of the whites. This is well illustrated in Fig. 72 for Maori boys. In my studies among other modernized primitive racial stocks, there was a very high incidence of facial deformity, which approached one hundred per cent among individuals in tuberculosis sanatoria. This condition obtained also in New Zealand.

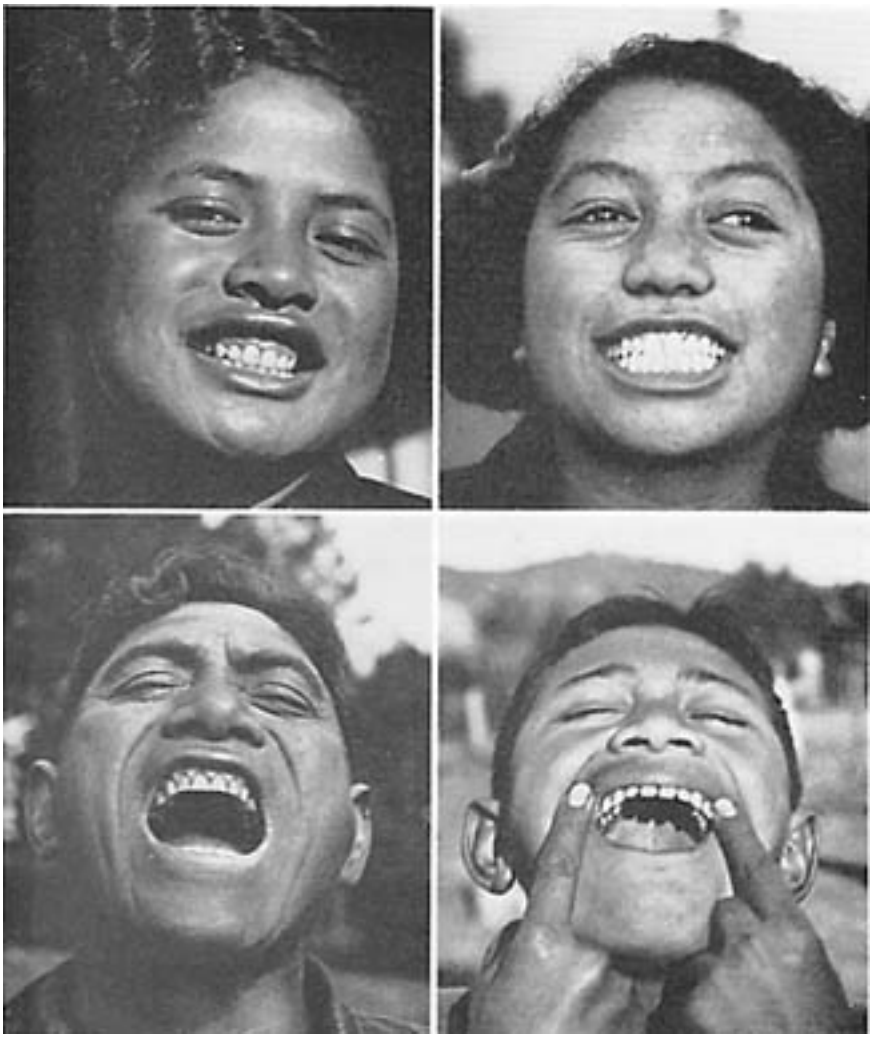


FIG. 69. Since the discovery of New Zealand the primitive

natives, the Mann, have had the reputation of having the finest teeth and finest bodies of any race in the world. These faces are typical. Only about one tooth per thousand teeth had been attacked by tooth decay before they came under the influence of the white man.

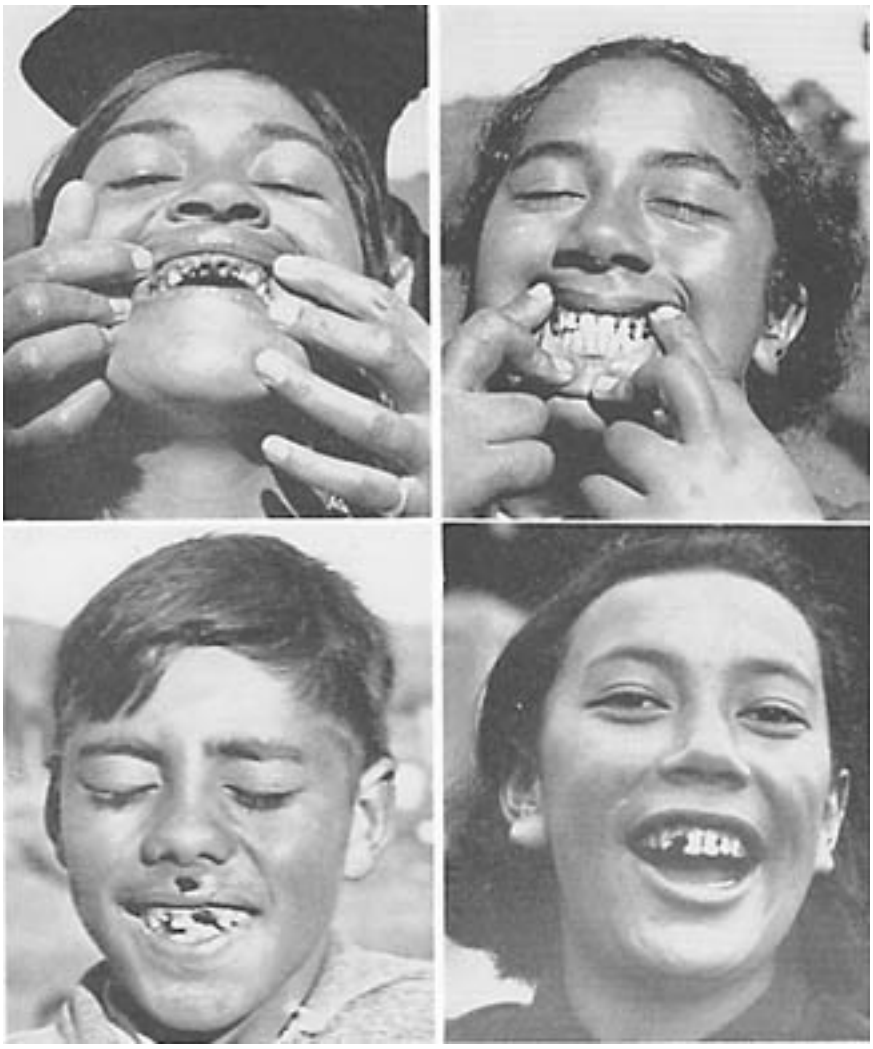


FIG. 70. With the advent of the white man in New Zealand tooth decay has become rampant. The suffering from dental caries and abscessed teeth is very great in the most modernized Maori. The boy at the lower left has a deep scar in his upper lip from an accident.

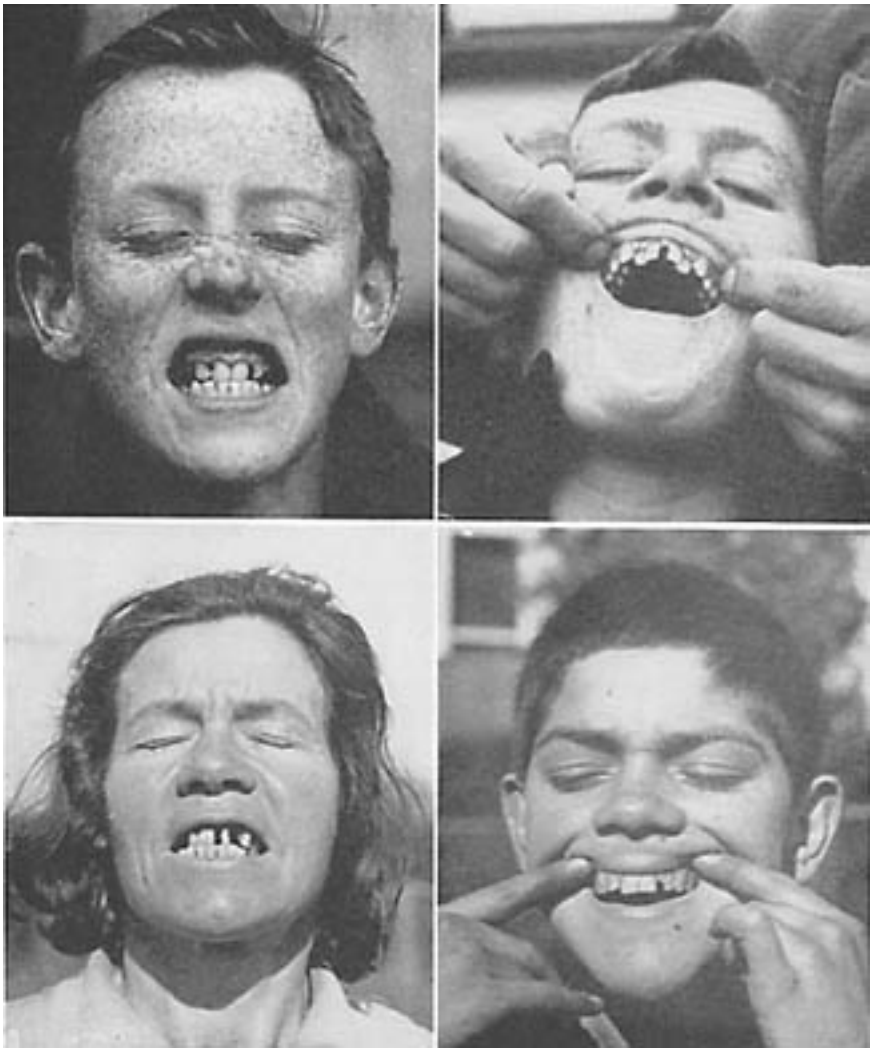


FIG. 71. Whereas the original primitive Maori had reportedly the finest teeth in the world, the whites now in New Zealand are claimed to have the poorest teeth in the world. These individuals are typical. An analysis of the two types of food reveals the reason.

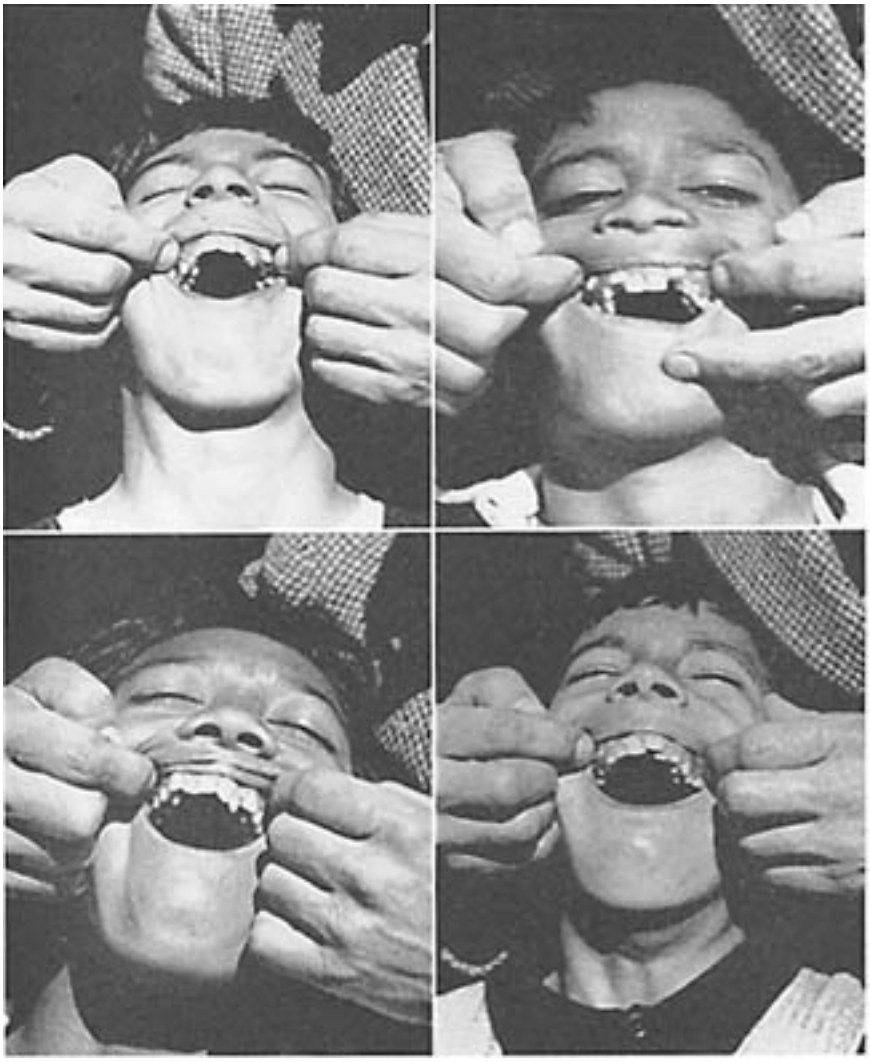


FIG. 72. In striking contrast with the beautiful faces of the primitive Maori those born since the adoption of deficient modernized foods are grossly deformed. Note the marked underdevelopment of the facial bones, one of the results being narrowing of the dental arches with crowding of the teeth and an underdevelopment of the air passages. We have wrongly assigned these distorted forms to mixture of racial bloods.

Through the kindness of the director of the Maori Museum at Auckland, I was able to examine many Maori skulls. Two views are shown in Fig. 73. The skulls belong in the pre-Columbian period. Note the splendid design of the face and dental arches and high perfection of the teeth.

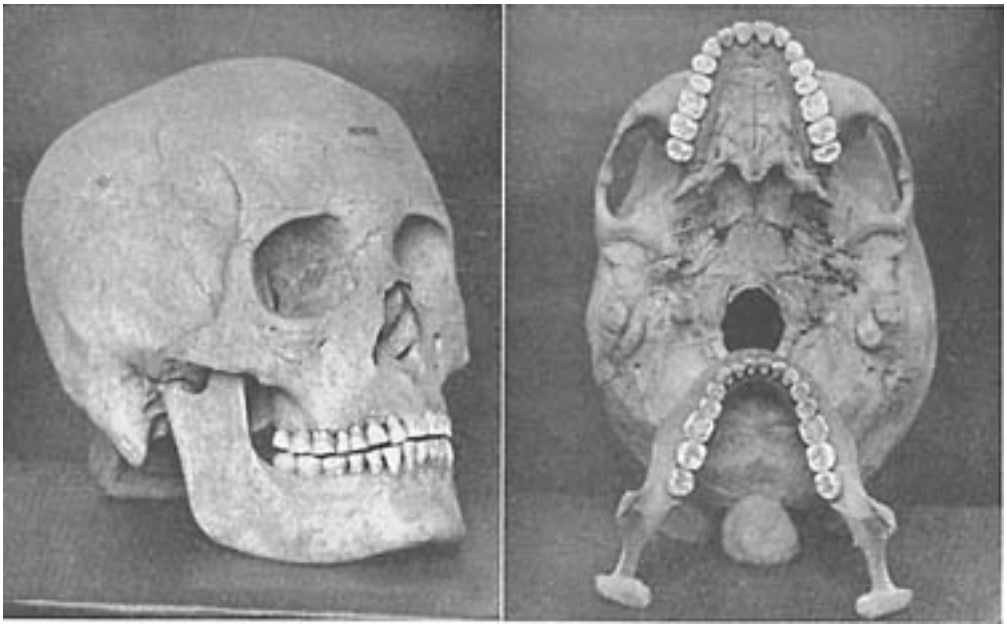


FIG. 73. The large collections of skulls of the ancient Mann of New Zealand attest to their superb physical development and to the excellence of their dental arches.

One of the most important developments to come out of these investigations of primitive races is the evidence of a rapid decline in maternal reproductive efficiency after an abandonment of the native foods and the substitution of foods of modern civilization. This is discussed in later chapters.

It was particularly instructive to observe the diligence with which some of the isolated Maori near the coast sought out certain types of food in accordance with the tradition and accumulated wisdom of their tribes. As among the various archipelagos and island dwellers of the Pacific, great emphasis was placed upon shell fish. Much effort was made to obtain these in large quantities. In Fig. 74 (lower), will be seen two boys who have been gathering sea clams found abundantly on these shores. Much of the fishing is done when the tide is out. Some groups used large quantities of the species called abalone on the West Coast of America and paua in New Zealand. In Fig. 74 (upper), a man, his wife and child are shown. The father is holding an abalone; the little girl is holding a mollusk found only in New Zealand, the toharoa; the mother is holding a plate of edible kelp which these people use abundantly, as do many sea bordering races. Maori boys enjoy a species of grubs which they seek with great eagerness and prize highly. The primitive Maori use large quantities of fern root which grows abundantly and is very nutritious.

FIG. 74. Native Maori demonstrating some of the accessory essentials obtained from the sea. These include certain sea weeds and an assortment of shell fish. It is much easier for the moderns to exchange their labor for the palate tickling devitalized foods of commerce than to obtain the native foods of land and sea.

Probably few primitive races have developed calisthenics and systematic physical exercise to so high a point as the primitive Maori. On arising early in the morning, the chief of the village starts singing a song which is accompanied by a rhythmic dance. This is taken up not only by the members of his household, but by all in the adjoining households until the entire village is swaying in unison to the same tempo. This has a remarkably beneficial effect in not only developing deep breathing, but in developing the muscles of the body, particularly those of the abdomen, with the result that these people maintain excellent figures to old age.

Sir Arbuthnot Lane (2) said of this practice the following:

> As to daily exercise, it is shown here that every person capable of movement can benefit by it, and I am certain that the only natural and really beneficial system of exercise is that developed through long ages by the New Zealand Maori and their race-brothers in other lands.

The practical application of their wisdom is discussed in Chapter 21.

The Maori race developed a knowledge of Nature's laws and adopted a system of living in harmony with those laws to so high a degree that they were able to build what was reported by early scientists to be the most physically perfect race living on the face of the earth. They accomplished this largely through diet and a system of social organization designed to provide a high degree of perfection in their offspring. To do this they utilized foods from the sea very liberally. The fact that they were able to maintain an immunity to dental caries so high that only one tooth in two thousand had been attacked by tooth decay (which is probably as high a degree of immunity as that of any contemporary race) is a strong argument in favor of their plan of life.

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2. LANE, A. Preface to Maori Symbolism by Ettie A. Rout. London, Paul Trench, Trubner, 1926.

Key to Route Followed in Peru

1. Panama
2. Buenaventura
3. Manta
4. Guayaquil
5. Talara
6. Trujillo
7. Callao
8. Lima
9. Huacho
10. Huaura
11. Chimbote
12. Santa Island
13. Chiclayo
14. Eten
15. Huaraz
16. Arequipa
17. Lake Titicaca
18. Juallanca
19. San Rosa
20. Cuzco
21. Calca
22. Manchu Piccu
23. Huancayo
24. Oroya
25. Perene

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Chapter 13

ANCIENT CIVILIZATIONS OF PERU

IN THE foregoing field studies among primitive races we have been dealing chiefly with living groups. Since the West Coast of South America has been the home of several ancient cultures, it is important that they be included with the living remnants of primitive racial stocks, in order to note the contributions that they may make to the problem of modern degeneration. The relationship between the Andes Mountain Range and the coast and the sea currents is such that there has been created a zone, ranging from forty to one hundred miles in width between the coast and the mountains, which for a distance of over a thousand miles is completely arid. The air currents drifting westward across South America from the Atlantic carry an abundance of moisture. When they strike the eastern foothills of the Andes they are projected upward into a region of constant cold which causes the moisture to be precipitated as rain on the eastern slopes, and as snow on the eastern

Cordillera Range. Hence the name of the eastern range is the White Cordillera, and that of the western range, which receives little of this rain, is the Black Cordillera. Between these two ranges is a great plain, which in the rainy season is well watered. The great civilizations of the past have always utilized water from the melting snow through irrigation ditches with the result that a vast acreage was put to agricultural uses.

The Humboldt Current which sweeps northward from the southern ice fields and carries its chilly water almost to the equator has influenced the development of the West Coast of South America. The effect of the current on the climate is generally noticeable. One of the conspicuous results is the presence of a cloud bank which hovers over the coastal area at an altitude of from one thousand to three thousand feet above sea level for several months of the year. Back from the coast these clouds rest on the land and constitute a nearly constant fog for extended periods. When one passes inland from the coast up the mountains he moves from a zone which in winter is clammy and chilly, into the fog zone, and then suddenly out of it into clear sky and brilliant sunlight. It is of interest that the capital, Lima, is so situated that it suffers from this unhappy cloud and fog situation. When Pizarro sent a commission to search out a location for his capital city the natives commented on the fact that he was selecting a very undesirable location. Either on the coast or farther inland than Lima the climate is much more favorable, and these were the locations in which the ancient civilizations have left some very elaborate foundations of fortresses and extended residential areas. The great expanse of desert extending from the coast to the mountains, with its great moving sand dunes and with scarcely a sign of green life, is one of the least hospitable environments that any culture could choose. Notwithstanding this, the entire coast is a succession of ancient burial mounds in which it is estimated that there are fifteen million mummies in an excellent state of preservation. The few hundred thousand that have been disturbed by grave robbers in search of gold and silver, have been left bleaching on the sands. Where had these people come from and why were they buried here? The answer is to be found in the fact that probably few locations in the world provided such an inexhaustible supply of food for producing a good culture as did this area. The lack of present appreciation of this fact is evidenced by the absence of flourishing modern communities, notwithstanding the almost continuous chain of ancient walls, fortresses, habitations, and irrigation systems to be found along this coast. The Humboldt Current coming from the ice fields of the Antarctic carries with it a prodigious quantity of the chemical food elements that are most effective in the production of a vast population of fish. Probably no place in the world provides as great an area teeming with marine life. The ancient cultures appreciated the value of these sea foods and utilized them to the full. They realized also that certain land plants should be eaten with the sea foods. Accordingly, they constructed great aqueducts used in transporting the water, sometimes a hundred miles, for the purpose of irrigating river bottoms which had been collecting the alluvial soil from the Andes through past ages. These river beds are to be found from twenty to fifty miles apart and many of them are entirely dry except in the rainy season in the high Andes. In the river bottoms these ancient cultures grew large quantities of corn, beans, squash, and other plants. These plant foods were gathered, stored, and eaten with sea foods. The people on the coast had direct communication with the people in the high plateaus. It is of more than passing interest that some twenty-one of our modern food plants apparently came from Peru.

Where there is such a quantity of animal life in the sea in the form of fish one would expect to find the predatory animals that live on fish. One group of these attack the fish from the air and they constitute the great flock of guanayes, piqueros and pelicans. For a thousand miles along the coast,

these fish-eating birds are to be seen in great winding queues going to and fro between the fishing grounds and their nesting places. At other times they may be seen in great clouds, beyond computation in number, fishing over an area of many square miles. On one island I was told by the caretaker that twenty-four million birds had their nests there. We passed through a flock of the birds fishing, which the caretaker estimated to contain between four and five million birds. On one island I found it impossible to step anywhere, off the path, without treading on birds' nests. It is of interest that a product of these birds has constituted one of the greatest sources of wealth in the past for Peru, namely, the guano, which is the droppings of the birds left on the islands along the coast where they have their nests. Through the centuries these deposits have reached to a depth of 100 feet in places. When it is realized that only one-fifth of the droppings are placed on the islands, it immediately raises the great question as to the quantity of fish consumed by these birds. As high as seventy-five fish have been found in the digestive tract of a single bird. The quantity of fish consumed per day by the birds nesting on this one island has been estimated to be greater than the entire catch of fish off the New England coast per day.

In addition to the birds, a vast number of sea lions and seals live on the fish. The sea lions have a rookery in the vicinity of Santa Island, which was estimated to contain over a million. These enormous animals devour great quantities of fish. It would be difficult to estimate how far the fish destroyed by this one group of sea lions would go toward providing excellent nutrition for the entire population of the United States. The guano, consisting of the partially digested animal life of the sea, constitutes what is probably the best known fertilizer in the world. It is thirty-three times as efficient as the best barnyard manure. At one time it was sent in shiploads to Europe and the United States, but now the Peruvian Government is retaining nearly all of it for local use. They have locked the barn door after the horse was stolen, figuratively speaking, since the accumulation of ages had been carried off by shiploads to other countries before its export was checked. At the present time all islands are under guard and the birds are protected. They are coming back into many of the islands from which they had been driven and are re-nesting. Birds are given two or three years of undisturbed life for producing deposits. These are then carefully removed from the surface of the islands and the birds are allowed to remain undisturbed for another period.

A very important and fortunate phase of the culture of the primitive races of the coast has been their method of burial. Bodies are carefully wrapped in many layers of raiment often beautifully spun. With the mummies articles of special interest and value are usually buried. Implements used by the individuals in their lifetime were also put in the grave. With a fisherman there were placed his nets and fishing tackle. Almost always, jars containing foods to supply him on his journey in the transition to a future life were left in the tomb. In some of the cultures the various domestic and industrial scenes were reproduced in pottery. These disclosed a great variety of foods which are familiar to us today. Even the designs of their habitations were reproduced in pottery. Similarly their methods of performing surgical operations, in which they were very skillful, were depicted. Fortunately, the different cultures had quite different types of pottery as well as quite different types of clothing. This makes it possible to identify various groups and indicate the boundaries of their habitations.

Their engineering feats disclosed skill in planning fortresses. Their forts were probably impregnable from assault in that day. The materials used for building their temples, abodes, and fortifications differ somewhat in various locations. Throughout the greater extent of the coast of Peru, the walls of buildings were made of adobe often many feet thick and sometimes sixty feet high. They

had walled cities protected by inner and outer lines of fortifications. It is particularly significant that the hardest metals that they are known to have had were copper and bronze. Silver and gold were quite plentiful. Their surgical instruments were flints and the operations that they were able to perform with these instruments were very remarkable. An important instrument in warfare consisted of a club with a star on the end made of copper or stone. With this the opponent's skull was crushed in. One of the amazing features in the various collections of skulls is the large number that show the results of surgical operations. These operations were apparently done for the purpose of saving the life of the individual. The procedure was to remove a section of bone in the center of the depressed area and raise the depressed edges surrounding that area. The fact that a large number of these show abundant evidence of healing and repair clearly indicates that the individual lived for an extended period following the operation. In some cases, the opening is apparently entirely closed in with new bone. Some of these trepanning operations removed a quantity of bone over an area large enough for a human hand to pass through. A group of these operated skulls are shown in Fig. 75. The owner of the one on the lower row, left, probably died following the operation, as there is no evidence of repair. The others show good healing, which in some is very extensive. A study of these trephined skulls reveals that 62 per cent lived for months or years. In Fig. 75 (lower right), is seen a skull which shows a large operation. A part of the surgical procedure was to place a plate of gold over the opening in the skull for protection. One of these is shown in the upper half of Fig. 76. Below is shown the healed scar after removal of the gold plate.

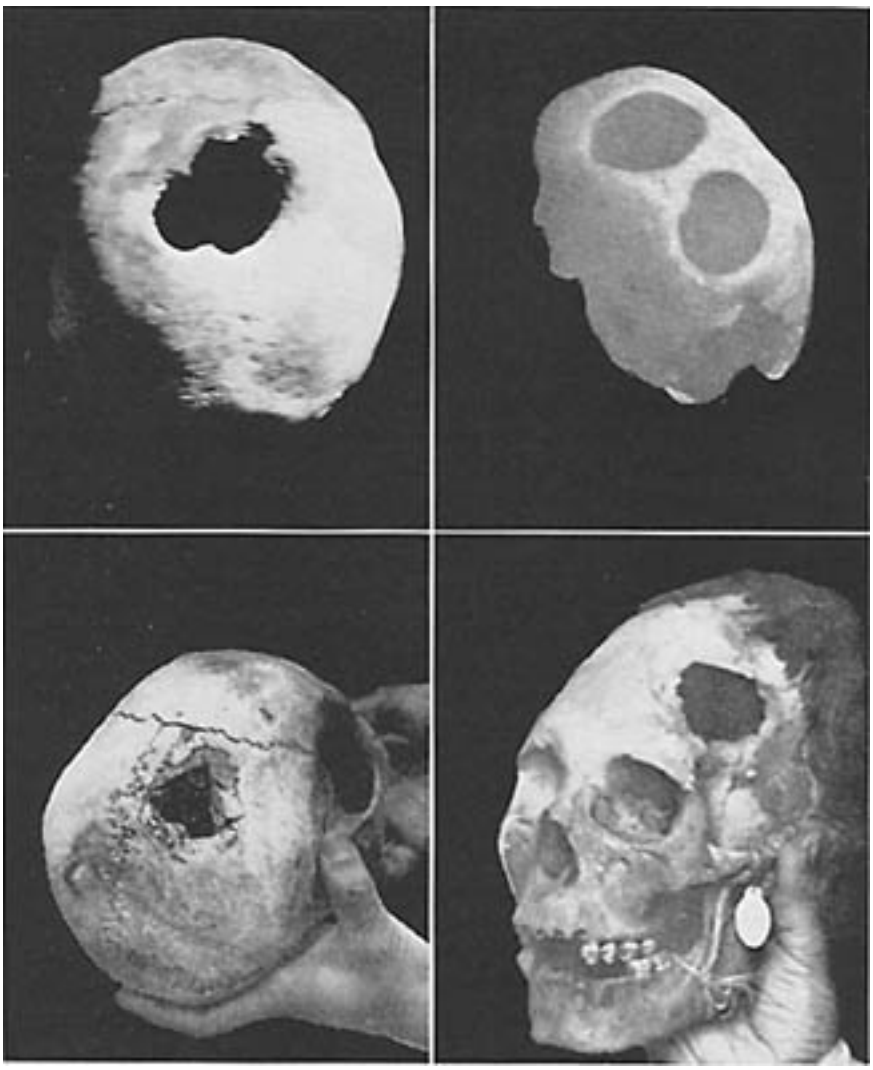

FIG. 75. Trephined skulls of the ancient peoples of Peru.
Their war weapons were designed to produce skull fractures.

Their surgeons trephined the skulls, thus removing the depressed area. The large percentage of operated skulls showing extensive healing indicates a large percentage lived for months and years afterwards. Their surgical flesh cutting knives were made of copper and bronze, the bone cutting of mounted crystals. They used cocoa leaves (cocaine) as a sedative as the natives do today.

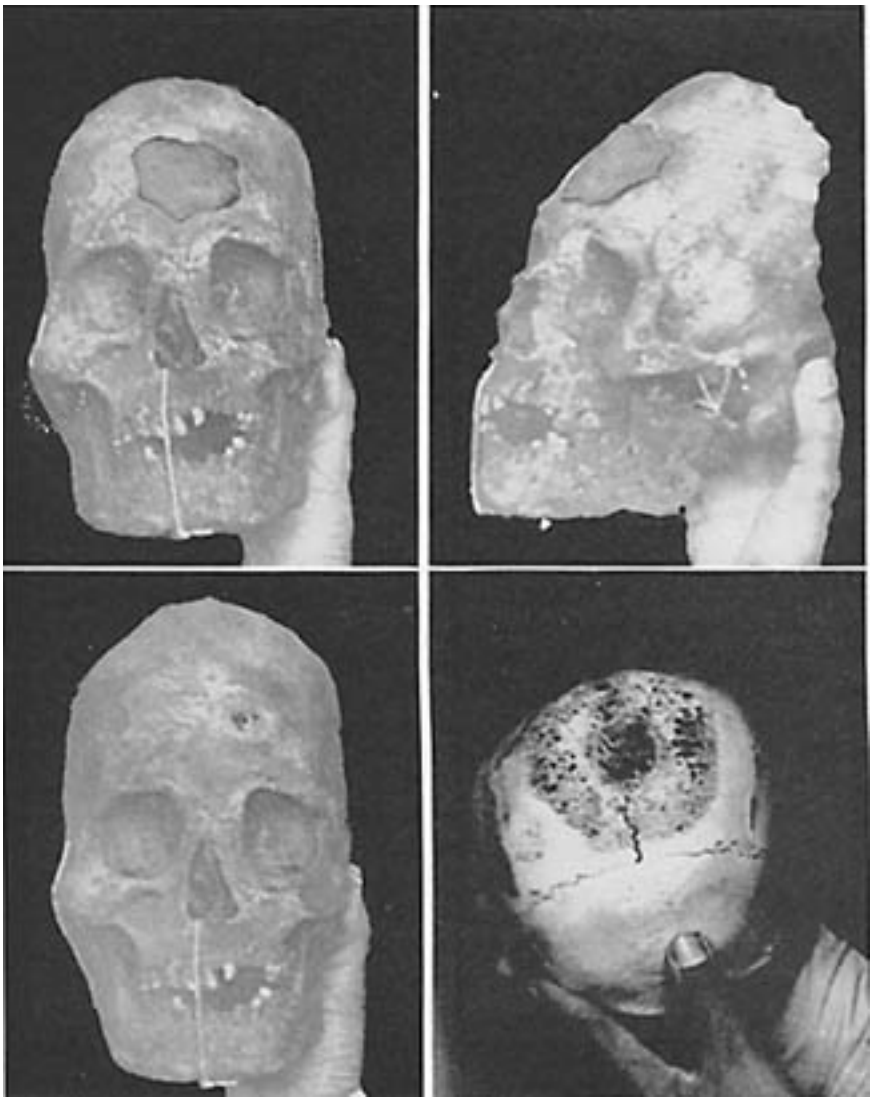

FIG. 76. These ancient surgeons placed a gold plate over the skull opening beneath the scalp to protect the brain. Above, two views are shown of a skull with a gold plate in position and below the same skull with the gold plate removed. Note that the skull opening is nearly healed in. To the right below an extensive operation is shown.

The skill of the surgeons in amputations is illustrated by the pottery reproductions of amputated parts. One of these, for example, shows a man with an amputated foot holding the stump of his leg with one hand while putting on a sock over the end of the stump with the other hand. The technic of amputation is shown in pottery form in Fig. 77. A serious disease of the foot is suggested, requiring amputation of the leg, high up. Note how the thigh bone was cut so as to provide a fleshcovered stump. Below in Fig. 77 is shown a healed oblique fracture with good adaptation.

FIG. 77. The skill of the ancient surgeons in plastic and bone surgery is illustrated in the pottery jar above. In order to provide flesh for a pad over the amputated bone stump the flesh is cut lower than the bone by pushing the flesh up at the time the bone is cut. In the lower view good healing is shown of a difficult oblique fracture.

When the Spaniards arrived to carry forward the conquest of Peru they found the entire coastal area and upper plateaus under the control of a culture organized under the Inca rulers. Prior to the domination of that culture, which had its origin in the high plateau country, several other cultures had developed along the coast in succeeding eras of domination. In northern Peru the Chimus developed a great culture that extended over a long period of time. Their capital city was at Chan Chan, inland from the present coastal port of Saliverry and near Trujillo. This city is estimated to have contained a million people. The argument is sometimes presented that at the time these ancient cultures lived the coastal areas were not arid desert but well supplied with rain. That this was not so is clearly evidenced by the fact that the walls were built of stucco made by mixing water with the available sand and rubble either in continuous molds or in blocks that were built into the fort. Since these blocks were only sun-dried they had very little resistance to rain. In this rainless desert land they have continued to stand through many centuries, many of them probably through several thousand years. There has been a vast change in the walls of the ruined city of Chan Chan within a decade and a half.

In 1925 this district was visited by a heavy downpour of rain which apparently exceeded any precipitation, not only through historic times, but for many centuries preceding. Temples, courtyards

and military defenses which were in splendid preservation before that downpour were reduced to a mere semblance of their former structure. Clearly these great cities and their defenses could not have been built of this material in the period when downpours were even occasional, let alone frequent.

It was, of course, the wealth of the ancient cultures that spurred on the conquistadors. It is very difficult to estimate the per capita quantity of gold available in those early cultures. That gold and silver were abundant is evidenced by the extensive use that was made of these metals for covering the walls of rooms and decorating public buildings with massive plates, sometimes entirely encircling a building and the walls of its various rooms. A considerable quantity of gold and silver has been taken from the burial mounds. One burial mound is reported to have yielded between six and seven million dollars worth of gold. So great has been the activity of the grave robbers that the Peruvian Government has placed a ban on this enterprise though for a period it was allowed on condition that a stated percentage was given to the Government.

One of the principal characteristics of the Chimu culture of the coastal area of northern Peru is shown in the type of pottery they produced. All articles were realistic in design. The pots show hunting scenes, fishing and domestic scenes, as illustrated above. They were very skillful in reproducing features in nearly natural size. Many thousands of these portrait jars have been taken from the mounds of this district. The local museum in the vicinity of Chan Chan, under the skillful direction of Mr. Larco Herrera at Chiclyan was reported to contain over twenty thousand jars and specimens taken from the mounds.

To the south of the domain of the Chimu culture, a very strong culture was built up with very different characteristics known as the Naska. While many of their habits of life, including their methods of providing food, were similar to those of the Chimu culture, they were unique in the designs of their pottery, which were characterized by being allegorical. They used elaborate color designs and fantastic patterns. Very little is known as yet of the meaning of much that they have left. While sundials of ancient design and build have been found in many parts of Peru, it is not known to what extent they developed a knowledge of astronomy. The pilot of the plane that flew us from Lima to Arequipa took us over some very strange architectural designs of geometrical patterns which he had discovered and which he suggested had not been reported upon nor interpreted. I photographed some of these from the air. The straight lines constituting the sides of some of the geometric figures are over a thousand feet long and reveal a precision of the angles and a straightness of the ground structures which indicate the use of competent engineering equipment and a high knowledge of surveying.

One of the principal purposes of my trip to Peru was to study the effect of the Humboldt Current, with its supply of human food, on the ancient cultures which were buried along the coast. In other parts of the world, where Nature had provided the sea with an abundance of sea life which was being utilized by native races, I found quite routinely excellent physical development with typical broad, well-developed facial forms and dental arches with normal contours. In each of these groups, the people have reproduced quite closely the racial type in practically all members of the group. I have emphasized with illustrations this fact in connection with the Melanesians and Polynesians on eight archipelagos of the Pacific Ocean, the Malay races on the islands north of Australia, the Aborigines of Australia along the east coast; also the Gaelics in the Outer Hebrides, and the Eskimos of Alaska.

The activity of grave robbers in the ancient burial mounds has left skeletons strewn helter skelter where many of them have been weathering, probably for years. While many of these had apparently been deliberately smashed, large numbers were intact, and in a good state of preservation. Some of the ancient cemeteries apparently extended over areas covering a square mile; and as far as the eye could see the white bleaching bones, particularly the skulls, dotted the landscape. Since there were several distinct cultures, I endeavored to make a cross section study of a number of these burial grounds in order that a fair average of specimens might be obtained. The skulls were handled by me, personally, and large numbers of them were photographed. As I have mentioned, it was the ancient custom when making the burials to inter objects that were of special interest to the individuals, including the implements with which he had worked. Fishermen's skulls are shown in Fig. 78 with their nets. It will be noted that all these arches are broad and wide, that the third molars are well formed and almost always well developed, and in good masticating position. Notwithstanding the long period of interment the fabrics buried with these people were often in a remarkably good state of preservation. Even the hair was well preserved. A characteristic of the method of preparation for burial involved placing over the teeth a preparation that was held in position by a strip of cloth which cemented the teeth quite firmly to this strip with the result that when the mummy cases were torn open the removal of this bandage removed the straight rooted teeth, and therefore large numbers of the skulls that were bleaching on the sandy wastes were without the straight rooted teeth. Of course, these would readily tumble out at the slightest jar, after the mummified tissues had decomposed from exposure. The teeth lost in this way would include practically all of the upper and lower incisors, some of the bicuspids and third molars.

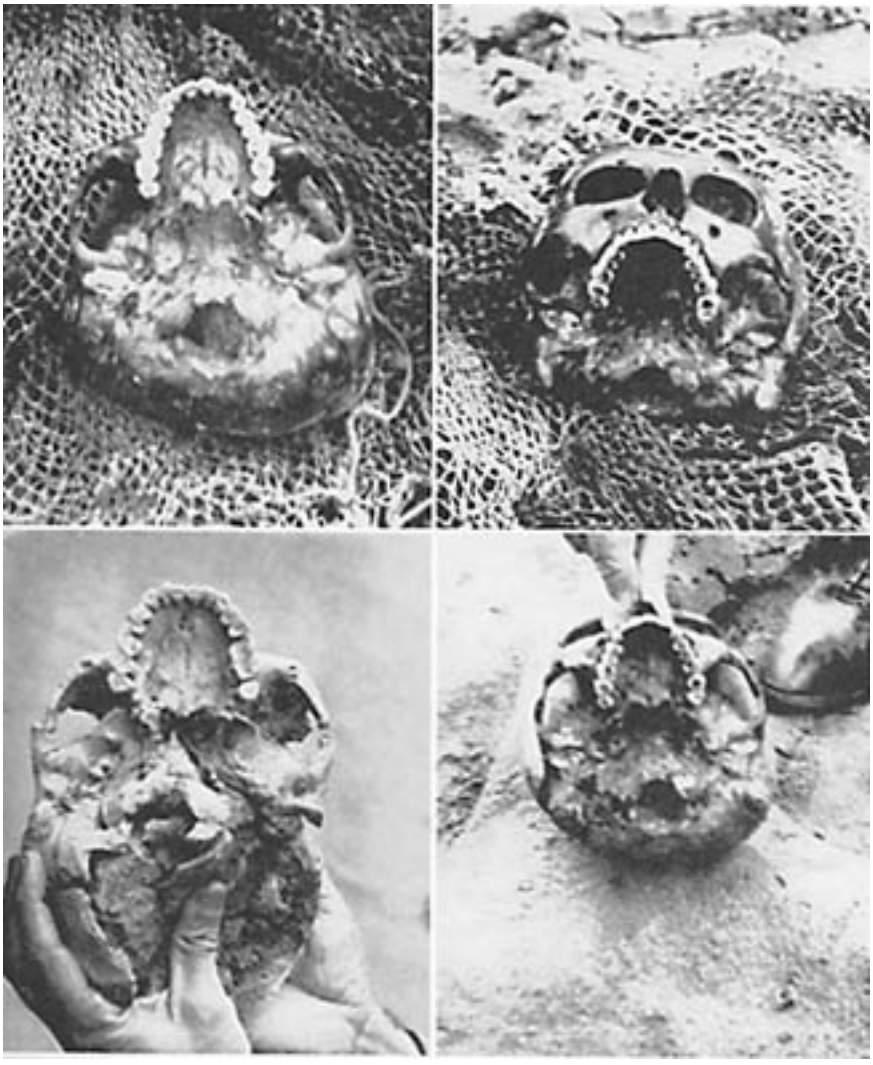

FIG. 78. The two skulls in the upper photograph apparently belonged to fishermen of the Chimu culture as evidenced by the flattened back of the head. Note the splendidly formed dental arches. In an examination of one thousand two hundred and seventy-six skulls in succession I did not find one with the typical deformities of our moderns.

Since our study was primarily concerned with the shape of the dental arches and facial form, these characteristics could be studied and recorded with the straight rooted teeth removed. Fortunately, there are some excellent collections of skulls in museums in Peru, with the skulls in position where they can be readily studied for the shape of the dental arches. When we have in mind that from 25 to 75 per cent of individuals in various communities in the United States have a distinct irregularity in the development of the dental arches and facial form, the cause and significance of which constitutes one of the important problems of this study, the striking contrast found in these Peruvian skulls will be seen to constitute a challenge for our modern civilizations. In a study of 1,276 skulls of these ancient Peruvians, I did not find a single skull with significant deformity of the dental arches.

Since these investigations have apparently established the fact that this problem is related directly to nutrition, and chiefly to nutrition in the formative period, and, as we shall see, to a very early part of the formative period, we have here evidence of a system of living that is very closely in accord with Nature's fundamental laws of reproduction. Several studies have been made dealing with the incidence of dental caries or tooth decay among these ancient cultures. The author of "Bird Islands of Peru" (1) states that in his examination of fifty mummies in succession he found only four with a tooth with dental caries. This again is in striking contrast to our modernized communities in which from 95 to 100 per cent of all the members of a community group suffer from dental caries. I have shown in connection with the Indians of the western coast of Canada that in six highly modernized communities where the Indians were using white man's foods, 40 per cent of all the teeth had been attacked by dental caries. A similar high percentage was found in the Indians now living in Florida. The ancient burials in southern Florida revealed apparent, complete immunity. These were pre-Columbian burials.

The skill of the primitive cultures of Peru in engineering as evidenced by the irrigation systems has always been a subject of amazement to modern engineers. I visited in a valley fifteen miles from the Santa River an ancient aqueduct which was said to be a hundred miles long. Our guide informed me that he had walked in it for thirty-five miles. With its even grades, overflows and auxiliary channels for distribution, its adaptation to the area to be watered, and the skill with which it was cut through rock shoulders and its retaining walls built, it constitutes a monument to engineering ability. Modern engineers have estimated that this aqueduct could deliver sixty million cubic feet of water a day. In Fig. 79 will be seen a section where it has been carried through a rock cutting and beyond will be seen a retaining wall used to carry the flume along the sheer face of a rock. The modern inhabitants of this community have carried away this retaining wall for use in the foundations of their huts. Below, in Fig. 79, will be seen a district of many hundreds of acres, possibly a thousand, where the fields are laid out just as they were left hundreds of years ago when the primitive people were driven from this habitat. All this valley needs is water.

FIG. 79. The ancient civilizations of Peru had skilled engineers. In the upper view is seen one of the ancient aqueducts still intact for thirty-five miles which modern scientists estimate was capable of delivering sixty million cubic feet of water per day. They had no hardened tools or blasting powder, yet they cut this channel through boulders and rocks. Below is seen a valley covering thousands of acres once made fertile by irrigation but now an arid desert.

In order to reach the burial places it was necessary to drive many hundreds of miles over the arid desert inland from the coast. We were exceedingly fortunate in having as our interpreter and guide Dr. Albert Giesecke, who for fourteen years was the Chancellor of Cuzco University. With his excellent knowledge of the country and its languages, with the credentials which gave us entry to the secluded places, together with the kindness and helpfulness of the Peruvian Government officials in almost all localities, we were able to obtain much valuable information. In an estimate of this culture not only their arts, but their scientific skill should be included.

Since the primary object of this quest was to learn of the efficiency of these primitive people in the art of living in harmony with Nature's laws and their methods for accomplishing this, it was desirable to find, if possible, some living descendants of these people to gain from them the information that had been handed down. We were told that there were a few villages in an isolated section of the coast in northern Peru where the inhabitants claimed descent from the ancient Chimu cultures of that area. This group was characterized by a flattening of the skull at the back which classified them as short

heads and is readily identified. We were very fortunate in having the assistance of Commander Daniel Matto of the Peruvian Army. He was able to utilize the police facilities for locating typical old residents who could tell us much of the story of their race and its recent history as it had been handed down by word of mouth. In Fig. 80 will be seen one of these nonagenarians. He told us of incidents that had been related to him by his great-greatgrandfather and by the old people of that area, of the coming of Pizarro four hundred years ago. The height of this man can be judged as he is seen standing beside Mrs. Price, who is five feet three. His head is shown both front and side view, revealing the flattened surface at the back. An ancient skull with typical flattening is also shown. Fortunately these people are living very closely in accordance with the customs of their ancestors. They are fisherfolk, with a hardihood and skill that is in striking contrast with the lethargy of the modernized groups. Their fine physical development, the breadth of their dental arches and the regularity of their facial features are in striking contrast to the characteristics noted among individuals in the modernized colonies. In Fig. 81 will be seen typical members of these colonies.

FIG. 80. The ancient Chimus flattened the back of the head, as shown in the lower left, by placing the infant on a board. A descendant of the Chimus is shown in the upper left with Mrs. Price, and in front and side views at the right. Note that the back of his head is similarly flattened.

FIG. 81. Some descendants of the ancient Chimu culture are still living in a few fishing villages in the north of Peru. They live, as did their ancestors, largely on the sea food. Typical faces of this native stock are shown in this photograph. Note the breadth of the dental arches and full development of the facial bones.

The skill with which these men manage their fishing boats is inspiring. Even though the surf was rolling in great combers they did not hesitate to go out in either their small crafts carrying one individual or in their large sailboats carrying a dozen men. The abundance of the fish in this district is demonstrated by the large catch that each succeeding boat brought to shore.

At the time the Spanish Conquistadors arrived in Peru one of the most unique of the ancient cultures held sway over both the mountain plateaus and the coastal plains from Santiago of Chile northward to Quito, Equador, a distance of about 1200 miles. This culture took its name from the ruling emperors called Incas. The capital of their, great kingdom was Cuzco, a city located between the East and West Cordillera Ranges of the Andes. These parallel ranges are from fifty to two hundred miles apart. Between them is situated a great plateau ranging from 10,000 to 13,000 feet above the sea. The mountain ranges are snow-capped and include in Peru alone fifty peaks that are over 18,000 feet in altitude, ranging up to 22,185 feet in Mount Huascaran. Only Mount Aconcagua in Chile is higher. It is 23,075 feet--the highest mountain in the Americas. The air drift is across South America from east to west, carrying vast quantities of water received by evaporation from the

Atlantic Ocean. This moisture is precipitated rapidly when the clouds are forced into the chill of the higher Andes. In the rainy season the great plateau area is frequently well watered, though not in sufficient quantity to meet the needs of agriculture for much of the territory. In the past the precipitation has been supplemented by vast irrigation projects using the water from the melting snows. It is estimated that the population ruled over by the reigning Incas at the time of the coming of the Spaniards reached five millions.

It is probable that few, if any, of the ancient or modern cultures of the world have ever attained a more highly perfected organization of society than had this Inca culture. The ruling Inca was a benevolent despot, and according to history unique in that he practiced most diligently all of the laws he promulgated for his people. There was no poverty, want or crime. Every man, woman and child was specifically provided with all necessities. The entire amount of tillable land was divided so that every man, woman and child had his assigned parcel. Everyone worked as assigned by the proper official. While it is not appropriate here to go into details, it is important that we have a bird's eye view of this great culture for which I will quote a paragraph from Agnes Rothery's "South America, The West Coast and The East." (2)

> The people who erected this temple lived in order and health, under the most successful communism the world has ever seen. Their land was divided into three portions--one portion for the Inca, one for the Sun, and one for the people, with seventy square meters for every boy and thirty-five for every girl. The live stock and implements were similarly apportioned and the land was ploughed, planted, and the crops gathered in strict rotation. First the fields of the Sun were cultivated, and then the land of the aged, the sick, widows, and orphans was tended; then the lands of the people, neighbors assisting one another; and last of all the lands of the Inca, with songs of praise and joy, because this was the service of their King. To every living soul was given his tasks, according to his physical and mental capacities. He was prevented from overwork, prohibited from idleness, cared for in illness and old age. Children were taken by the Government when they were five and trained to the profession where they were most needed. There was no hunger, no crime in the whole empire.
>
> The Inca held his kingly office over the docile, industrious, and contented mass not only through his royal blood, but through his wisdom and kindness in caring for and guiding his subjects, his bravery in war, and his statesmanship at home. Although he set an example to his subjects by following every law which he promulgated (astonishing idea to our modern lawmakers!), he lived, as became his rank, in luxury. In his garden were rows of corn moulded from pure gold with leaves of pure silver, and a tassel of spun silver, as fine as silk, moving in the air. Llamas and alpacas, life-sized and cunningly fashioned from the same metal, stood upon his lawns, as they did in the courts of the Temple of the Sun.

Cuzco, the capital, is reported to have housed about two hundred thousand people at the time of the Spanish Conquest. It is situated on a branch of the Urabamba River in a beautiful valley surrounded by fertile mountain sides and towering snow-capped pinnacles. The Urabamba River drains a large area of the plateau lying to the south of Cuzco and has cut a magnificent gorge through the southern range of the Andes where it passes from the plateau to the eastern watershed and thence to the Amazon. A little to the south of Cuzco the eastern and the western ranges of mountains approach and combine in a cluster of magnificent pinnacles and intervening valleys and gorges, that are to be equalled by no mountain scenery in the world. Today, almost all travel from the Andean Plateau

north of this region, as well as from all areas along the coast, must proceed to the coast, thence down the coast by boat to the port of Mollendo which is often dangerous or impossible of approach because of the heavy seas. The journey is made by train up through Arequipa and over the western Cordillera Range of the Andes into the plateau country and from there northward to Cuzco. So great is this natural barrier that the detour requires many days, and the crossing of several divides ranging from fourteen to sixteen thousand feet above the sea. This was not necessary for the Incas who had built roads and suspension bridges through these mountains from Cuzco to all parts of the great empire. It is in this mountain vastness that the Inca rulers had constructed their most superb fortresses. While the early Spanish conquerors of the country knew that the nobility had great defenses to which they might retreat, the location of the fortresses was not known. Their greatest fortress was discovered and excavated by Professor C. W. Bingham of Yale, under the auspices of Yale University and the American Museum of Natural History. This fortress and retreat is now world famous as Macchu Piccu, and probably represents the highest development of engineering, ancient and in some respects modern, on the American continent.

We are particularly concerned with the type of men that were capable of such great achievement, since they were required to carry forward their great undertakings without the use of iron or the wheel. While the great Inca culture dominated the Sierras and the coast for several centuries prior to the coming of the Spanish, and while they had their seat of government and vast agricultural enterprises in the high Sierras, it is of special interest that many of the most magnificent monuments remaining today in stone were not constructed by the Inca culture, but by the Tauhuanocan culture which preceded the Inca. The Incas were a part of the Quechu linguistic stock, while the Tauhuanocans were a part of the Aymara linguistic stock. The Incas had their capital in the high plateau country about the center of Peru. The earlier Tauhuanocan culture centered in southern Peru near Lake Titicaca where their most magnificent structures are to be found today. One of the largest single stones to be moved and put into the building of a great temple in the history of the world is to be found near Lake Titicaca. According to engineers, there is no quarry known in an easily reached locality where such a stone could be quarried. It is conjectured that it was brought two hundred miles over mountainous country. It is important to note that many magnificent structures, evidently belonging to this ancient Tauhaunocan culture, are found distributed through the Andean Plateau from Bolivia to Equador. Their masonry was characterized by the fitting together of large stones faced so perfectly that in many of the walls it was difficult to find a crevice which had enough space to allow the passage of the point of my pen knife, notwithstanding that these stones were many-sided with some of them fifteen to twenty feet in length. In Figure 82 above will be seen a section of wall of the great fortress Sacsahuaman overlooking Cuzco. Modern engineers seem unable to provide a satisfactory answer as to how these people were able to cut these stones with the limited facilities available, nor is it explained how they were able to transport and hoist some of their enormous monoliths. The walls and fortress of Macchu Piccu, as well as the residences and temples, were built of white granite which apparently was taken from quarries in the bank of the river Urabamba, two thousand feet below the fortress. Without modern hoisting machinery, how did they raise those mammoth stones? In Fig. 82 below is shown a typical section of wall. One stone shown has twelve faces and twelve angles, all fitting accurately its boundary stones. It is as though the stones were plastic and pressed into a mould.

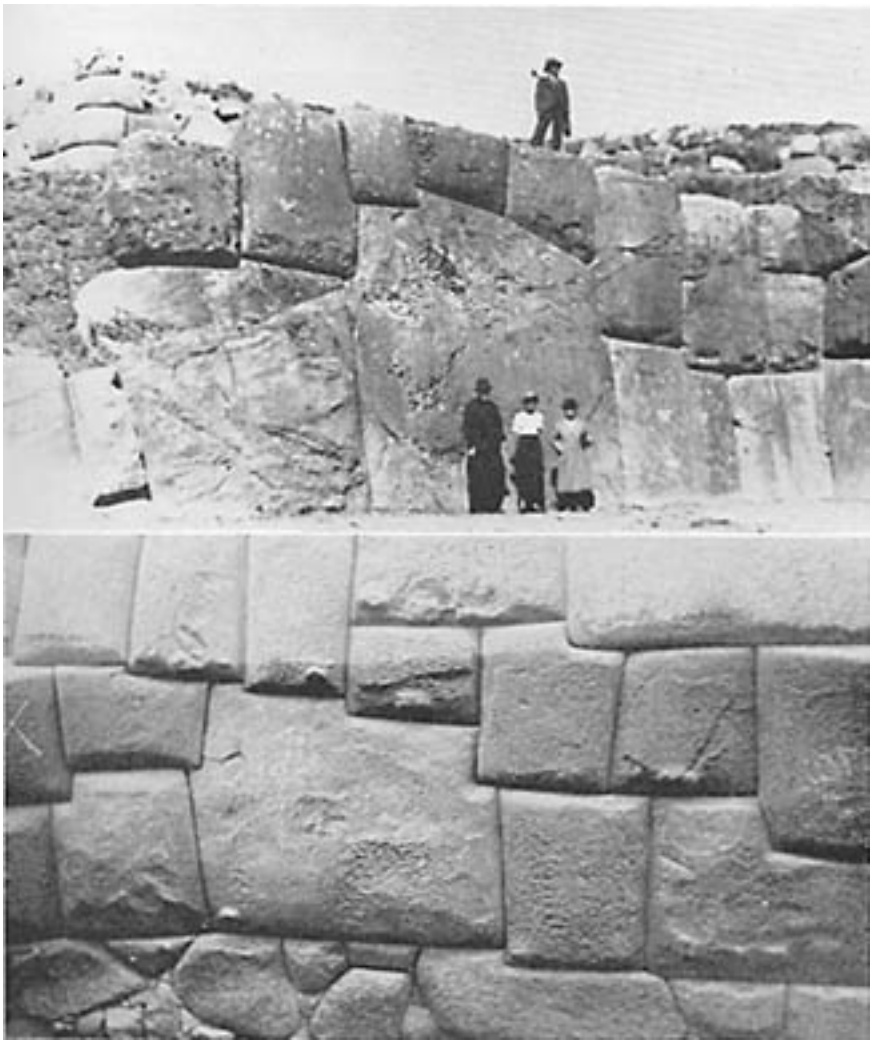

FIG. 82. The primitive peoples of the Andean Sierra built wonderful fortresses and temples of cut stones which are assembled without mortar and cut to interlock. The central stone, above, is estimated to weigh one hundred and forty thousand pounds. Below the largest stone has twelve faces and twelve angles.

The country is rugged. Over it passes the highest standard-gage railroad in the world,--about 16,000 feet above sea level. The banks of this river are protected for long distances by ancient stone retaining walls. The native Indians live and herd their flocks of llamas and alpacas up near the snow line, largely between 15,000 and 18,000 feet. The Incas and their descendants now occupying the high Sierras in the Andes have been thrifty agriculturists. They turn the soil with a very narrow, long, slender bladed spade which they force into the ground, and with which they pry the ground up in chunks. They then break up the chunks. These spades were originally made of copper which they mined themselves. Cuzco is the archeological capital of South America, but its glory is in the ancient fortresses and temples, rather than in the modern structures. As one passes through the streets, he will note that in many instances the foundations and parts of the walls of many of the modern Spanish cathedrals and public buildings are of old Inca construction, of fine stone work surmounted by cheap rubble work and mortar superstructure. Whereas the original Cuzco had running water and an excellent sanitation system, modern Cuzco has deplorable sanitary conditions. The following is quoted from the West Coast Leader, published in Lima, dated July 20, 1937: "Of a total 3,600 houses in the city of Cuzco 900 are without water or drainage; 2,400 are without light (windows) and 1,080 completely lack any sanitary systems. It is not surprising, therefore, that in some years the death rate

exceeds the birth rate.

We are particularly concerned in studying these people to know the sources of their great capacity for developing art, engineering, government and social organization. Can such a magnificent culture be brought about unless founded on a superb physical development resulting from purely biologic forces?

Earthquakes are very frequent in the Andes. We experienced several while in Peru. One of these opened up a cave in the mountainside in the Urabamba Valley near which we were making studies. The cave had just been explored and a number of ancient burials found. I was able to examine a number of skulls from this cave which apparently represented a pre-Spanish period. The date of the burials could not be determined. The skulls were interpreted as belonging to an early Indian period. In Fig. 83 may be seen two typical skulls. Note the broad sweep of the dental arches and freedom from tooth decay. The third molars (wisdom teeth) are well developed and in normal position for mastication. These are typical of the entire group found in this burial place. It is very evident that these individuals were provided with an adequate nutrition throughout the formative and growth periods, as well as during their adult life. This is significant because of the limited variety of foods easily obtainable for the people in the high plateau country of the Andes.

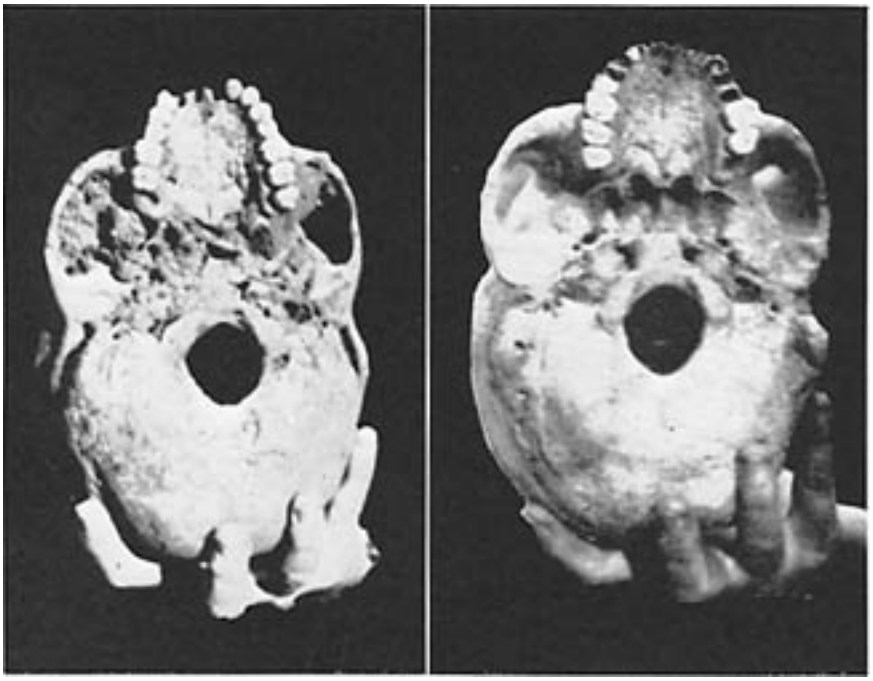

FIG. 83. Typical skulls of High Sierra Indians from a recently opened burial cave. Note the breadth of the dental arches provided by excellent development of the bones of the head.

The ancient Peruvians of both the coastal area and high plateau country had developed superb physical bodies in each of the several cultures. This development had been brought about in spite of the bad conditions prevailing with arid desert land extending from the coast to the mountains, and in spite of the severe climate of the high Sierras. The people utilized the wide variety of animal life from the sea in conjunction with the excellent plant foods grown in the river basins with the aid of irrigation. Over twenty of our common plants had their origin in ancient Peru. In the high Sierras, their animal foods were largely limited to the llama, alpaca and wild animals. Each household,

however, maintained a colony of guinea pigs. Owing to the difficulty of boiling in the high altitudes, they found it necessary to roast their cereals and meats. Their vegetable foods included potatoes, which were preserved in powder form by freezing and drying and pulverizing. Corn and several varieties of beans and quinua were their principal cereals. The latter is a small seed of very high nutritive value.

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Chapter 14

ISOLATED AND MODERNIZED PERUVIAN INDIANS

IN ORDER to understand the living descendants of the ancient residents of the high Andes it is essential that we know their environment. Their climate is cold at night the year around. While during the winter the snow is deep in the high mountains, there is very little on the plateau, since Peru is near the equator extending from 5 to 16 degrees south latitude. The sunshine is bright and warm even in winter. Consequently they have pasturage for their animals the year around.

The only native domesticated animals of the Andean Plateau are the llama and the alpaca. Both of these belong to the camel species, as does the vicuna. The llama is the Indians' beast of burden in the Andes. Only the males are used. The animals are very docile and respond with gentleness when treated with kindness. One continually marvels at the ease with which the Indian guides his loaded caravan with soft words or motions, never with harshness. The llama has many unique features as a beast of burden. It forages as it moves along and consequently must be driven very slowly. Each animal will carry a burden not exceeding a hundred pounds, and if more is placed on its back it will immediately lie down until the extra burden is removed. The llama has broad doubletoed feet like the camel which make it very sure-footed. It requires no shoeing and exceedingly little care. It can thrive, however, only in the high altitudes. The wool of the llama is coarse and is used for heavy, rough garments. The alpaca is a little smaller than the llama and produces a very heavy wool of fine quality. Accustomed as this animal is to the severe cold and the high altitudes, as well as to the rain and sun,

its fleece is both durable and warm. It is used extensively throughout the world for suits for aviators. The native colors vary from white to bluish tints and from light to very dark browns. It accordingly provides very stable colors for weaving directly into ponchos and native apparel. The vicuna is a much smaller animal than either the llama or alpaca. It has one of the most highly prized coats of fur produced anywhere in the world. This animal has never been domesticated; vast herds have lived wild on the high slopes of the Andes mountains. The demand for vicuna fur became so great that a million and a half of these animals were slain in one year to obtain their fur pelts. The result is that the Peruvian Government has now completely forbidden their destruction. The garments of the ruling class of the Incas were made of the vicuna wool.

One of the important objectives of my trip to Peru was to find and study, if possible, some descendants of these Andean stocks. Fortunately, large numbers of the Aymara linguistic stock, the descendants of the Tauhuanocan culture, are still residing in southern Peru and Bolivia where they are said to retain the essentials of their ancient methods of living. They constitute the principal native populations in the vicinity of Lake Titicaca and the high mountain plateaus of southern Peru and northern Bolivia. I have always encountered difficulty in persuading the native peoples to allow themselves to be photographed in their primitive costumes. They are usually willing to be photographed provided one will wait for them to put on some modern garment.

I am reminded of an experience on one of the South Sea Islands where there was need for roads, but no money with which to build them. Laws were passed by the chiefs that anyone approaching a highway in native garb where he might be seen by a foreigner was subject to arrest and to payment of a fine which had to be worked out as labor in building roads. Of course, on that island no one would allow himself to be photographed without some modern clothing. One boy presented himself wearing a single garment, a man's full dress vest, which had evidently reached the island in a missionary barrel.

The hats in the pictures in Fig. 84 are of native design and manufacture. They are made of fur and are like our modern derbies in construction.

FIG. 84. Descendants of the Tauhuanocans who were the most famous ancient workers in stone. They live in the high Sierras of southern Peru and northern Bolivia. They belong to the Aymara linguistic division. They make fur felt hats and are skilled agriculturists.

It is important to note the roundness of the features of the Aymaras, the wide development of the nostrils for air intake and the breadth of the dental arches. Many of them had been transported several hundreds of miles to a coffee plantation because of their adeptness and skill in sorting imperfect coffee beans from the run. As I watched them I found it difficult to move my eyes fast enough to follow their fingers and pick out from the moving run the undesired or imperfectly formed kernels. This revealed a superb development of coordination. The wisdom of these Aymaras is discussed in Chapter 21.

I was very anxious to study the Incas in different parts of the high Andes, particularly some of the original type in the vicinity of Cuzco, their ancient capital. Throughout the Andean Plateau, the Indians from the higher elevations bring down their wares on market days to exchange with Indians from other localities, as well as to meet and visit with their friends. They are very industrious and one seldom sees a woman, either shepherding the stock or carrying a burden, who is not busily engaged in spinning wool. While their wool is obtained in part from sheep that have been imported, a great deal of it is obtained from the alpacas which, like the llamas, are raised in the high altitudes where the Indians always prefer to live. I was fortunate in making contact with several groups of Indians in high

altitudes through the kindness of the prefects. A group of Indians from the high mountains of the Urabamba Valley near Cuzco is shown in Fig. 85. An examination of this group of twenty-five revealed the fact that not one tooth had been attacked by dental caries and that, at all ages, the teeth normally due were present.

FIG. 85. The Quichua Indians living in the high Andes are descendants of the Incas. They live at high elevations, up to 18,000 feet, where they raise herds of llamas and alpacas. They weave their own garments and have great physical endurance. They can carry over 200 pounds all day at high altitudes in the manner shown at the lower right.

In Fig. 85, lower right, may be seen a typical Indian of the Andes carrying a heavy load. The Indians of this region are able to carry all day two hundred to three hundred pounds, and to do this day after day. At several of the ports, these mountain Indians have been brought down to the coast to load and unload coffee and freight from the ships. Their strength is phenomenal.

In approaching the study of the descendants of the Inca culture, it is important to keep in mind a little of their history and persecution under the Spanish rule. To this day they are bitter against the white man for the treachery that has been meted out to them on many occasions. Their leader was seized under treachery. The agreement to free him, if the designated rooms were filled with gold as high as a man could reach, was broken and their chief killed after the gold was obtained. It is

recorded that some six million of them died in the mines under forced labor and poor foods under the lash of their Spanish oppressors. In many places they still keep themselves aloof by staying in the high mountains of the Andes with their flocks of llamas and alpacas. They come down only for trading. As in the past, they still weave their own garments. Indeed, they provide practically all of their necessities from the local environment. Their capacity for enduring cold is wonderful. They can sleep comfortably through the freezing nights with their ponchos wrapped about their heads and with their legs and feet bare. They wear two types of head cover, one inside the other. Several individuals are seen in Fig. 85. Many of them have faces that show strong character and personality.

The women of this district wear felt hats which can be turned up or down according to the weather. Fine examples of weaving were worn by the women.

In Fig. 86 will be seen two young men who had just come down from the high mountains to a government school. The one in the lower photograph is still wearing his native costume. The one in the upper has discarded his native costume for white man's trousers. Note the fine development of his chest, the splendid facial development and fine teeth and dental arches. It is important to keep in mind that these people are living in a rarified atmosphere and that, because of the high altitude, they need greater lung capacity and stronger hearts than do the people living at sea level. The ratio of oxygen content is reduced about half at 10,000 feet.

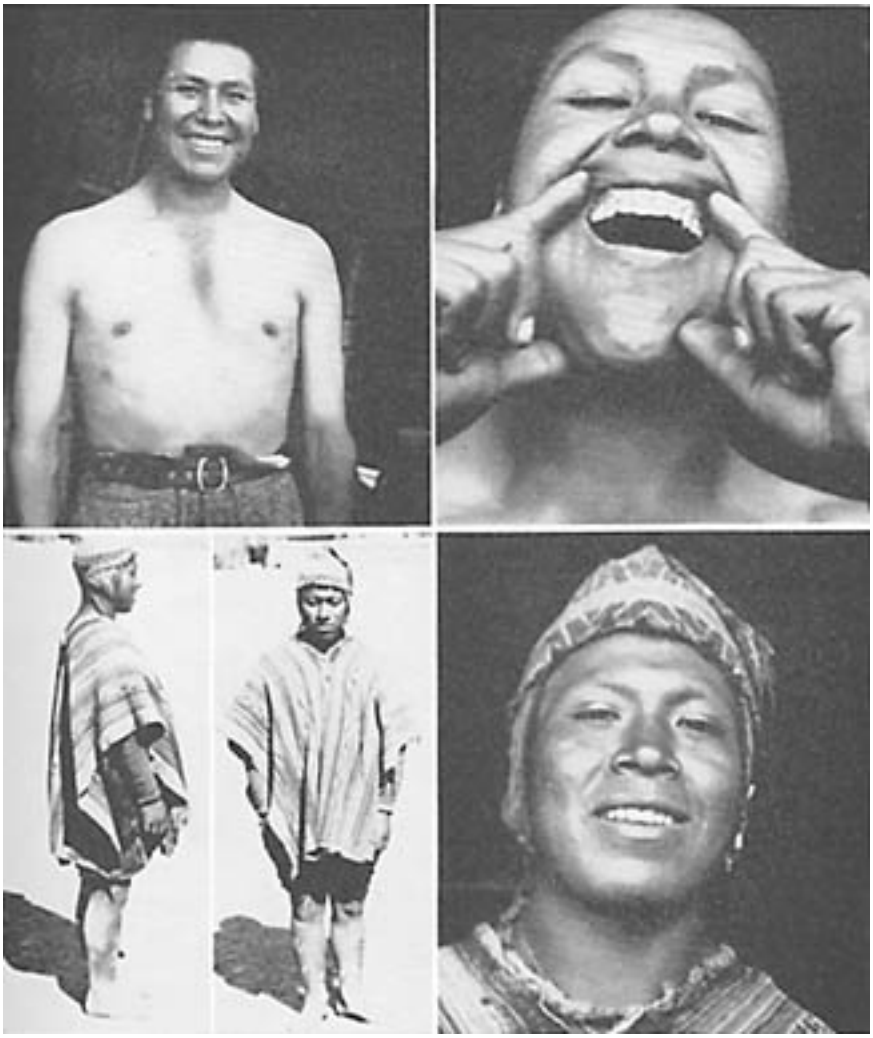

FIG. 86. The chest development, of necessity, must have large lung capacity for living in the rare atmosphere of the

high Andes. The boy shown above has a magnificent physique, including facial and dental arch development. Below is seen the typical clothing worn up among the snows. Even in frosty weather they are bare below the knees.

The broad dental arches of these Indians are shown in Fig. 87. Note the extensive wear of the teeth at the upper left. Much of the food is eaten cold and dry as parched corn and beans. Such rough foods as these wear the teeth down.

FIG. 87. The superb facial and dental arch development of these high Andean Indians is shown above. The man at the upper left was said to be very old yet he climbs the mountains up into the snows herding the llamas and alpacas. The teeth have a very high state of perfection. Long and vigorous use has worn the teeth of the old people.

Market days which usually occur on Sunday present an interesting scene. The Indians travel long distances with their wares for exchange. They have no currency and exchanges are made by bargaining.

Where these Indians have become modernized, the new generation shows typical changes in facial and dental arch form as reported for the other groups. There is also a marked character reaction which

will be discussed in detail in Chapter 19. In Fig. 88 are shown four typical modification patterns due to the influence of modernization after the foods of the white man have displaced the native dietary.

FIG. 88. The modernization of the Sierra Indians through the introduction of foods of modern commerce has produced a sad wreckage in physique and often character. The boy at the upper left is a mouth breather because his nostrils are too small to carry sufficient air. The girl at the upper right has a badly underdeveloped chin and pinched nostrils. Both boys below have badly narrowed arches with crowding teeth.

An important item in the life of the Andean Indians is the satisfaction they get from chewing cocoa leaves from which is made our modern cocaine. In order to extract the alkaloid they chew with these leaves the ash produced by the burning of a particular plant. This drug is chewed as tobacco, one large quid will last for several hours. Practically every Indian carries in a little pouch a quantity of these leaves in dried form. The effect of this drug is to increase their capacity for endurance. It makes them unconscious of hunger and fatigue. Through our interpreter we frequently asked them regarding the comfort or nourishment they obtained from the leaves and were told that they often preferred these leaves to food when they were on a journey and carrying heavy loads. I was informed that they can increase the quantity of the drug used to a point at which they are quite unconcious of pain and able to endure injuries without suffering, and operations without discomfort. Since packets of these leaves were found in the burials near the coast, it is clear that the drugs were used throughout Peru in early times. It is also of interest that several of the skulls taken from the cave in the high Andes, were

found with trephine operations in the skulls similar to those found in the burials along the coast.

The physical perfection and development of the present and past Andean population has been accomplished in spite of the difficulty of building and maintaining good bodily structure at the high altitude where dairy products have not been and are not at present a large part of the nutritional program. In this regard the ancient and contemporary peoples of the Andes differ radically from the present and past groups of people who live in the high valleys of Switzerland and Tibet where milk is plentiful. The cow, sheep, horse and pig have been imported into the high Andean countries during the last four hundred years since the Spanish Conquests, but they have not acclimatized easily. The earlier cultures were of course, dependent upon the llama, alpaca, wild deer, birds and guinea pig for animal foods. While there have been vast burial mounds built and preserved in the coastal regions where the absence of rain and the dry sand have added materially to their preservation, the rainy seasons have established very different conditions for skeletal preservation in the high altitudes. Nevertheless, a large number of skeletons in good state of preservation have been recovered.

The high Andean plateau extends throughout the length of Peru between the mountain chains. The present Indian stock was studied in four different places in the high plateau country, the farthest north being Huaras. In this area we were materially assisted by the governor of the province who very kindly sent messengers and brought down Indian families from high altitudes to the police headquarters at Huaras. This place is at an elevation of about 11,000 feet. We had an opportunity to study also many who had come from the higher altitudes to the markets to sell their wares. Huaras lies in a fertile valley that has been in contact with modern civilization for many decades. This vicinity, therefore, provided a wide range in classes of people, from Indians who are isolated to those who are living in highly modernized groups. In addition to the opportunity for studying the older people there were opportunities for studying adolescents in the two high schools, one for girls and one for boys. Some were pure-bloods who had been highly isolated in their formative and childhood periods. The mixed-bloods had been considerably modernized. There were some whites. I was told by the prefect and others who were well informed that there was quite a distinct difference between the Indians who were living in the high northern Cordillera, the western Andean range called the Black Mountains, and those living in the eastern range or White Mountains. The latter were physically much better built and were least modernized. Typical low immunity to caries and changes in facial and dental arch form were found in these modernized groups.

Another important area in which the native Indians were studied was Chiclayo. This district is unique in large part because of the influence of the modern civilization at Lima with which it is connected by the railroad. The native market here is very large and occupies about a mile of the main street of the town, through which no traffic except pedestrian traffic can pass while the market is in session. The town has been under the influence of the Spanish since the time of the Conquest. It has many colonial buildings and a large cathedral. It has not, however, accommodations for the influx of tourists who come out of curiosity for the purchase of Indian wares. With the aid of the prefect, even though no public accommodations were available, we were made very comfortable in the soldiers' barracks. As the Indians came down from the mountains to display and sell their wares, they were brought to us at the barracks. Since this district has been in quite intimate contact with the nutrition of the modernized capital, we found here many individuals showing typical degeneration of the teeth and dental arches.

The adaptation of racial characteristics to the environment in which they have developed is very strikingly illustrated in the Indian cultures of the Amazon jungle district. We were very fortunate in being able to make studies of some groups living at present as did their ancestors through countless centuries in the Amazon basin. We were greatly pleased and impressed with the splendid physiques and fine personalities of many of the individuals of the groups.

The abundance of rain, the fertility of the soil and the warm climate make plant growth most luxuriant on the eastern slopes of the Andes. It is of interest that in passing from the capital, Lima, across the desert stretch between the ocean and the mountains and then up the wall of the Andes to an altitude of sixteen thousand feet and then down to the plateau at about twelve thousand feet and up again over the eastern range and down into the Amazon basin, one has passed through the tropics, temperate zone and sub-arctic zones with varieties of plant life corresponding to each. A distance of a few hundred yards will often divide the limits of particular birds and flowers. When one reaches the foothills of the Andes on the eastern side, he is in a region of rushing streams teeming with fish, a region of tropical fruits and vegetables. It is in this setting that some of the finest Indians we have seen were enjoying life in its fullness. The type of shelter is very simple, indeed, consisting as it does of a framework covered with banana and palm leaves. We were privileged to meet by special arrangement about thirty of this tribe who had been brought from some distance by the officials of the Perene Colony, owned and operated by the Peruvian Corporation. In Fig. 89 will be seen the chief and one of the noble women of his retinue. They understood that they would have their pictures taken and came dressed in royal regalia. Typical countenances are seen in Figs. 90 and 91. These people have very kind faces with broad dental arches, and a high sense of humor. They decorated their faces especially for their photograph. In the entire group associated with this chief I did not find a single tooth that had been attacked by dental caries. The fine dental arches are illustrated in Figs. 90 and 91. Many of these young men had really noble countenances, such as would rate them as leaders in modern science and culture.

FIG. 89. Jungle Indians from the Amazon. This is the chief of a tribe who came prepared to have their pictures taken in their tribal regalia. Note the splendid features of both and the noble

carriage of the woman.

FIG. 90. The facial and dental arch development of the jungle Indians was superb and the teeth were excellent and free from dental caries. Note the complete development of the dental arches and nostrils.

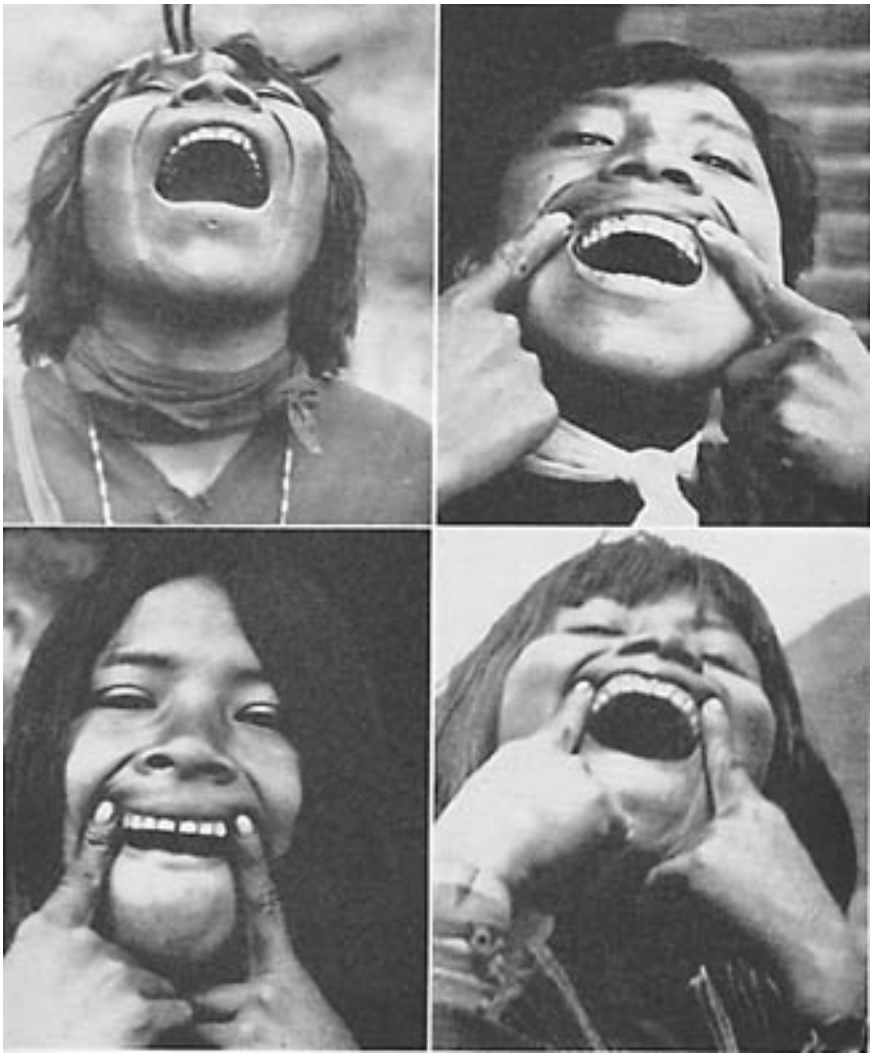

FIG. 91. The excellence of skeletal development of the jungle Indians as expressed in the faces and dental arches, is illustrated in these views. Their foods were selected from the animal life of the streams and the bush together with native plants.

In another tribe, however, of the same racial stock, efforts to modernize had been in operation for some time by a mission. The food of this latter group had been distinctly affected by their contact with the modern group. By reducing the animal foods, the change in physical efficiency, and appearance of tooth decay, is most marked. In Fig. 92 above will be seen typical cases of rampant tooth decay with extensive loss of the teeth. In Fig. 92 below are shown two of the first generation following the adoption of the modernized type of diet in this group. Note the narrowing of the faces with crowding of the teeth. Note the deformed dental arches.

FIG. 92. At the point of contact of these jungle Indians with modernization where it included a change from their native diet tooth decay became rampant as shown. A marked change in facial form occurred accompanied by crowding of the teeth in the new generation.

The native foods of these Amazon Jungle Indians included the liberal use of fish which are very abundant in both the Amazon and its branches, particularly in the foothill streams; animal life from the forest and thickets; bird life, including many water fowl and their eggs; plants and fruits. They use very large quantities of yucca which is a starchy root quite similar to our potato in chemical content. This is not the yucca of North America.

The Peruvian Indians, in the highlands and in the eastern watershed of the Andes, and also in the Amazon Basin, have built superb bodies with high immunity to dental caries and with splendidly developed facial and dental arch forms while living on the native foods in accordance with their accumulated wisdom. Whenever they have adopted the foods of modern civilization and have displaced their own nutrition, dental caries has been found to be wide-spread; and in the succeeding generations following the adoption of modern foods, a change in facial and dental arch forms has developed. The modernized foods which displaced their native foods were the typical white man's dietary of refined-flour products, sugar, sweetened foods, canned goods, and polished rice.

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Chapter 15

CHARACTERISTICS OF PRIMITIVE AND MODERNIZED DIETARIES

IF PRIMITIVE races have been more efficient than modernized groups in the matter of preventing degenerative processes, physical, mental and moral, it is only because they have been more efficient in complying with Nature's laws. We have two procedures that we can use for evaluating their programs: first, the interpretation of their data in terms of our modern knowledge; and second, the clinical application of their procedures to our modern social problems. Specifically, since the greater success of the primitives in meeting Nature's laws has been based primarily on dietary procedures, it becomes desirable first, to evaluatetheir dietary programs on the basis of known biologic requirements for comparison with the foods of our modern civilization; and second, to test their primitive nutritional programs by applying their equivalents to our modern families.

The advance in our knowledge of body-building and body-repairing materials from a biochemical standpoint makes it possible even with our limited knowledge of organic catalysts, to draw comparisons between the primitive and modernized dietaries. If we use the generally accepted minimal and optimal quantities of the various minerals and vitamins required, as indicated by Sherman, (1) we shall have at once a yardstick for evaluating the primitive dietaries.

Of the eighteen elements of which the human body is composed, all of which are presumably essential, several are needed in very small quantities. A few are required in liberal quantities. The normal adult needs to receive from the foods eaten one-half to one gram of calcium or lime per day. Few people receive more than one-half of the minerals present in the food. The requirements of phosphorus are approximately twice this amount. Of iron we need from one-seventh to one-third of a gram per day. Smaller amounts than these are required of several other elements. In order to utilize these minerals, and to build and maintain the functions of various organs, definite quantities of various organic catalysts which act as activating substances are needed. These include the known and unknown vitamins.

Unlike some experimental animals human beings have not the ability to create some special chemical substances (not elements) such as vitamins within their bodies. Several animals have this capacity. For example, scurvy, which is due to a lack of vitamin C, cannot be produced readily in rats because rats can manufacture vitamin C. Similarly, rickets cannot be produced easily in guinea pigs,

because they can synthesize vitamin D. The absence of vitamin D and adequate minerals produces rickets in young human beings. Neither rickets nor scurvy can be produced readily in dogs because of the dogs' capacity to synthesize both vitamins C and D. We are not so fortunate. Similarly, the absence of vitamin B (B_1) produces in birds and man severe nervous system reactions, such as beri-beri. These symptoms are often less pronounced, or quite different, in other animals.

From our knowledge of the dietaries used by the various primitive racial stocks we can calculate the approximate amounts of the minerals and vitamins provided by those dietaries, for comparison with the amounts provided by modernized foods. Our problem is simplified by the fact that the food of the white man in various parts of the world being built from a few fundamental food factors, has certain quite constant characteristics. Hence the displacing diets are similar for the several modernized groups herewith considered.

As a further approach to our problem, it is important to keep in mind that, in general, the wild animal life has largely escaped many of the degenerative processes which affect modern white peoples. We ascribe this to animal instinct in the matter of food selection. It is possible that man has lost through disuse some of the normal faculty for consciously recognizing body requirements. In other words, the only hunger of which we now are conscious is a hunger for energy to keep us warm and to supply power. In general, we stop eating when an adequate amount of energy has been provided, whether or not the body building and repairing materials have been included in the food. The heat and energy factor in our foods is measured in calories. In planning an adequate diet, a proper ratio between body building and energy units must be maintained. It is important to keep in mind that while the amount of body-building and repairing material required is similar for different individuals of the same age and weight, it is markedly different for two individuals, one of whom is leading a sedentary, and the other, an active life. Similarly, there is a great difference between the amount of body-building and repairing material required by a growing child or an expectant mother and an average adult.

There are certain characteristics of the various dietaries of the primitive races, which are universally present when that dietary program is associated with a high immunity to disease and freedom from deformities. In general, these are the foods that provide adequate sources of body-building and body-repairing material. The use by primitives, of foods relatively low in calories has resulted in forcing them to eat large quantities of these foods, in order to provide the heat and energy requirements of the body. The primitives have obtained, often with great difficulty, foods that are scarce but rich in certain elements. In these rare foods were elements which the body requires in small quantities, including minerals such as iodine, copper, manganese and special vitamins. In connection with the vitamins it should be kept in mind that our knowledge of these unique organic catalysts is limited. The medical profession and the public at large think of vitamin D as consisting of just one chemical factor, whereas, investigations are revealing continually new and additional factors. A recent review (2) describes in considerable detail eight distinct factors in vitamin D and refers to information indicating that there may be at least twelve. Clearly, it is not possible to undertake to provide an adequate nutrition simply by reinforcing the diet with a few synthetic products which are known to represent certain of these nutritional factors. By the mass of the people at large, as well as by members of the medical profession, activated ergosterol is considered to include all that is necessary to supply the vitamin D group of activators to human nutrition.

The various dietary programs of primitive races which appear to be successful in controlling dental caries and deformities may be divided into three groups based upon the sources from which they derive the minerals and fat-soluble activators. I do not use the term vitamins exclusively because as yet little is known about the whole group of organic catalysts, although we have considerable knowledge of the limited number which are designated by the first half dozen letters of the alphabet. Most lay people and members of the medical and dental professions assume that the six or eight vitamins constitute practically all that are needed in an adequate nutrition. These organic activators can be divided into two main groups, water-soluble and fat-soluble. An essential characteristic of the successful dietary programs of primitive races has been found to relate to a liberal source of the fat-soluble activator group.

When we discuss the successful dietary programs of the various groups from the standpoint of their ability to control tooth decay and prevent deformity we find that for the people in the high and isolated Alpine valleys their nutrition is dependent largely on entire rye bread and dairy products with meat about once a week and various vegetables, fresh in the summer season and stored for the winter season. An analysis in my laboratory of the dairy products obtained from the Loetschental Valley in Switzerland through a series of years has shown the vitamin content to be much higher than the average throughout the world for similar foods during the same seasons. The milk in these high valleys is produced from green pasturage and stored green hay of exceptionally high chlorophyll content. The milk and the rye bread provided minerals abundantly.

The diet of the people in the Outer Hebrides which proved adequate for maintaining a high immunity to dental caries and preventing deformity consisted chiefly of oat products and sea foods including the wide variety of fish available there. This diet included generally no dairy products since the pasture was not adequate for maintaining cattle. Oat grain was the only cereal that could be matured satisfactorily in that climate. Some green foods were available in the summer and some vegetables were grown and stored for winter. This diet, which included a liberal supply of fish, included also the use of livers of fish. One important fish dish was baked cod's head that had been stuffed with oat meal and chopped cods' livers. This was an important inclusion in the diets of the growing children. The oats and fish, including livers, provided minerals and vitamins adequate for an excellent racial stock with high immunity to tooth decay.

For the Eskimos of Alaska the native diet consisted of a liberal use of organs and other special tissues of the large animal life of the sea, as well as of fish. The latter were dried in large quantities in the summer and stored for winter use. The fish were also eaten frozen. Seal oil was used freely as an adjunct to this diet and seal meat was specially prized and was usually available. Caribou meat was sometimes available. The organs were used. Their fruits were limited largely to a few berries including cranberries, available in the summer and stored for winter use. Several plant foods were gathered in the summer and stored in fat or frozen for winter use. A ground nut that was gathered by the Tundra mice and stored in caches was used by the Eskimos as a vegetable. Stems of certain water grasses, water plants and bulbs were occasionally used. The bulk of their diet, however, was fish and large animal life of the sea from which they selected certain organs and tissues with great care and wisdom. These included the inner layer of skin of one of the whale species, which has recently been shown to be very rich in vitamin C. Fish eggs were dried in season. They were used liberally as food for the growing children and were recognized as important for growth and reproduction. This successful nutrition provided ample amounts of fat-soluble activators and minerals from sea animal

life.

For the Indians living inside the Rocky Mountain Range in the far North of Canada, the successful nutrition for nine months of the year was largely limited to wild game, chiefly moose and caribou. During the summer months the Indians were able to use growing plants. During the winter some use was made of bark and buds of trees. I found the Indians putting great emphasis upon the eating of the organs of the animals, including the wall of parts of the digestive tract. Much of the muscle meat of the animals was fed to the dogs. It is important that skeletons are rarely found where large game animals have been slaughtered by the Indians of the North. The skeletal remains are found as piles of finely broken bone chips or splinters that have been cracked up to obtain as much as possible of the marrow and nutritive qualities of the bones. These Indians obtain their fat-soluble vitamins and also most of their minerals from the organs of the animals. An important part of the nutrition of the children consisted in various preparations of bone marrow, both as a substitute for milk and as a special dietary ration.

In the various archipelagos of the South Pacific and in the islands north of Australia, the natives depended greatly on shell fish and various scale fish from adjacent seas. These were eaten with an assortment of plant roots and fruits, raw and cooked. Taro was an important factor in the nutrition of most of these groups. It is the root of a species of lily similar to "elephant ears" used for garden decorations in America because of its large leaves. In several of the islands the tender young leaves of this plant were eaten with coconut cream baked in the leaf of the tia plant. In the Hawaiian group of islands the taro plant is cooked and dried and pounded into powder and then mixed with water and allowed to ferment for twenty-four hours, more or less, in accordance with the stiffness of the product desired. This is called poi. Its use in this form was comparable in efficiency with its use on other archipelagos as a boiled root served much as we use potatoes. For these South Sea Islanders fat-soluble vitamins and many of the minerals were supplied by the shell-fish and other animal life from the sea.

The native tribes in eastern and central Africa, used large quantities of sweet potatoes, beans, and some cereals. Where they were living sufficiently near fresh water streams and lakes, large quantities of fish were eaten. Goats or cattle or both were domesticated by many tribes. Other tribes used wild animal life quite liberally. Some very unique and special sources of vitamins were used by some of these tribes. For example, in certain seasons of the year great swarms of a large winged insect develop in Lake Victoria and other lakes. These often accumulated on the shores to a depth of many inches. They were gathered, dried and preserved to be used in puddings which are highly prized by the natives and are well spoken of by the missionaries. Another insect source of vitamins used frequently by the natives is the ant which is collected from great ant hills that in many districts grow to heights of ten feet or more. In the mating season the ants develop wings and come out of the ant hills in great quantities and go into the air for the mating process. These expeditions are frequently made during or following a rain. The natives have developed procedures for inducing these ants to come out by covering over the opening with bushes to give the effect of clouds and then pounding on the ground to give an imitation of rain. We were told by the missionaries that one of the great luxuries was an ant pie but unfortunately they were not able to supply us with this delicacy. Parts of Africa like many other districts are often plagued by vast swarms of locusts. These are gathered in large quantities, to be cooked for immediate use or dried and ground into a flour for later use. They provide a rich source of minerals and vitamins. The natives of Africa used the cereals maize, beans,

linga linga, millet, and Kaffir corn, cooked or roasted. Most of these were ground just before cooking.

Among the Aborigines of Australia we found that those living near the sea were using animal life from that source liberally, together with the native plants and animals of the land. They have not cultivated the land plants during their primitive life. In the interior, they use freely the wild animal life, particularly wallaby, kangaroo, small animals and rodents. All of the edible parts, including the walls of the viscera and internal organs are eaten.

The native Maori in New Zealand, used large quantities of foods from the sea, wherever these were available. Even in the inland food depots, mutton birds were still available in large quantities. These birds were captured just before they left the nests. They developed in the rockeries about the coast, chiefly on the extreme southern coast of the South Island. At this stage, the flesh is very tender and very fat from the gorging that has been provided by their parent. The value of this food for the treatment of tuberculosis was being heralded quite widely in both Australia and New Zealand. In the primitive state of the islands large quantities of land birds were available and because of the fertility of the soil and favorable climate, vegetables and fruits grew abundantly in the wild. Large quantities of fern root were used. Where groups of the Maori race were found isolated sufficiently from contact with modern civilization and its foods to be dependent largely on the native foods, they selected with precision certain shell-fish because of their unique nutritive value.

A splendid illustration of the primitive Maori instinct or wisdom regarding the value of sea foods was shown in an experience we had while making examinations in a native school on the east coast of the North Islands. I was impressed with the fact that the children in the school gave very little evidence of having active dental caries. I asked the teacher what the children brought from their homes to eat at their midday lunch, since most of them had to come too great a distance to return at noon. I was told that they brought no lunch but that when school was dismissed at noon the children rushed for the beach where, while part of the group prepared bonfires, the others stripped and dived into the sea, and brought up a large species of lobster. The lobsters were promptly roasted on the coals and devoured with great relish. Other sea foods are pictured in Fig. 74.

The native diet of the tribes living in the islands north of Australia consisted of liberal quantities of sea foods. These were eaten with a variety of plant roots and greens, together with fruits which grew abundantly in that favorable climate. Few places in the world have so favorable a quantity of food for sea-animal life as these waters which provide the richest pearl fisheries in the world. This is evidence of the enormous quantity of shell-fish that develop there. Here, as off the east coast of Australia, are to be found some of the largest shell-fish of the world. It was a common occurrence to see these shells being used by natives for such purposes as water storage and for bath tubs of a size approximately that of a wash tub. Australia and New Zealand are near enough to the Antarctic ice cap to have their shores bathed with currents coming from the ice fields, currents which abound in food for sea animals. The great barrier reef off the east coast of Australia extends north to within a few leagues of New Guinea. Murray Island is near the north end of this barrier. The fish in the water at times form such a dense mass that they can be scooped into the boats directly from the sea. Fishermen wading out in the surf and throwing their spears into the schools of fish usually impale one or several.

The incidence of tooth decay on this island was less than one per cent of all of the teeth examined. Another important sea food in these waters was dugong, referred to as sea cow in northern waters. This animal is very highly prized but is becoming scarce. We found its meat very much like lamb. It lives on the vegetation of the sea floor in shallow water. As we flew over the bays of Eastern Australia going northward in search of colonies of native Aborigines, we could see these sea animals pasturing in the clear water among the ocean plants.

During these investigations of primitive races, I have been impressed with the superior quality of the human stock developed by Nature wherever a liberal source of sea foods existed. These zones of abundant marine life were largely in the wake of the ocean currents drifting from the ice fields of the poles. The Humboldt Current is probably the most liberal carrier of marine life of any of the ocean currents. It leaves the ice field of the Antarctic and bathes the west coast of South America from its southern tip nearly to the equator, where the coast line changes direction and the Humboldt Current is deflected out into the ocean. It meets here a warm current coming down from the coast of Central America, Panama and Columbia. If the superb physiques that Nature has established among the Maori of New Zealand, the Malays of the Islands north of Australia, the Gaelics of the Outer Hebrides and the natives on several of the archipelagos of the Pacific, owe their superior physical development to sea foods, we should expect to find that the tribes which have had contact with the great Humboldt Current food would also have superb physiques. Unfortunately, very little has been known of the ancient cultures that have developed along the coast of Chile and Peru. It has been reported that of all the Indian tribes of South America, those in Patagonia were the most stalwart. While the west coast of Peru is bathed by the Humboldt Current with its nearly inexhaustible supply of human nutrition, the lands bordering that shore are among the most desolate deserts of the world. The zone between the Andes Mountains and the coast for approximately a thousand miles is utterly barren, consisting of moving sand dunes and jagged promontories. Practically the only break in this waterless, treeless desert is to be found in the few ribbons of water that trickle down from the melting snows of the Andes Coastal Range. This coast has no rainy seasons. Any vegetation grown, now or in the past thousands of years, has had to be watered from the limited supply afforded by these rivers which seem so insignificant when compared with the vastness of the territory. These river bottoms contain the alluvial deposits from the Andes and are very rich when watered. It has been only by means of gigantic engineering undertakings that the water from these rivers has been carried through great irrigation ditches, sometimes fifty to a hundred miles long for the purpose of making it possible to utilize these river bottom lands for agriculture.

In many of the primitive tribes living by the sea we found emphasis on the value of fish eggs and on some animal forms for insuring a high physical development of growing children, particularly of girls, and a high perfection of offspring through a reinforcement of the mother's nutrition. It is also important to note that in several of the primitive tribes studied there has been a consciousness that not only the mother should have special nutrition, but also the father. In this group very great value was placed upon a product obtained from a sea form known locally as the angelote or angel fish, which in classification is between a skate and a shark. The young of the angelota are born alive, ready for free swimming and capable of foraging for themselves immediately at birth. Twenty to thirty young are born in one litter. The eggs of the female before fertilization are about one inch in diameter, slightly oval but nearly spherical. They are used as food by all, but the special food product for men is a pair of glands obtained from the male. These glands weigh up to a pound each, when they are dried. They have a recognized value among the natives for treating cases of tuberculosis, especially for

controlling lung hemorrhages. The sea foods were used in conjunction with the land plants and fruits raised by means of irrigation in the river valleys. Together these foods provided adequate nutrition for maintaining high physical excellence.

In Chapter 13 I have discussed the probable order of these ancient cultures and the possible extent of their duration. Very little is known of their origin. Evidence has recently been discovered in Panama indicating that both the wealth and the culture of Peru were carried northward by maritime conquerors and that the cultures of Central America, including the Maya culture may have had their origins in these ancient cultures of Peru.

While the coastal area of Peru saw the development of many magnificent cultures through past ages, the highlands of Peru also have left much evidence of superior attainments and wisdom. The two great Indian linguistic groups of the Andean highlands of today are the Aymara of Southern Peru and Bolivia and the Quichus of central and northern Peru. The Aymara are credited with being the descendants of the Tauhuanocan culture which preceded the Incan culture in the highlands. The Quichu are credited with being the descendants of the Incan culture which had its zenith just prior to the coming of the Spaniards. In Chapter 14 I have shown photographs of these racial stocks as they are found today in the Andean Sierras. It may be possible that in former times the vast mountain ranges provided large herds of grazing wild animals of the deer family. Because of the vastness of the population and the extent to which all available land surfaces were utilized for agriculture, it does not seem possible that wild animal life could have been an adequate source of nutrition. The members of the camel family, the llamas, alpacas, and vicunas were utilized for food. Of these the first two were used to considerable extent as they are today. When it is recognized that in the Sierra the available water is largely that provided to the streams from the melting snows and from rains in the rainy season, it will be realized that these sources of fresh water could not provide the liberal quantity of iodine essential for human growth and development. It was, accordingly, a matter of great interest to discover that these Indians used regularly dried fish eggs from the sea. Commerce in these dried foods is carried on today as it no doubt has been for centuries. When I inquired of them why they used this material they explained that it was necessary to maintain the fertility of their women. I was informed also that every exchange depot and market carried these dried fish eggs so that they were always available. Another sea product of very great importance, and one which was universally available was dried kelp. Upon inquiry I learned that the Indians used it so that they would not get "big necks" like the whites. The kelp provided a very rich source of iodine as well as of copper, which is very important to them in the utilization of iron for building an exceptionally efficient quality of blood for carrying oxygen liberally at those high altitudes. An important part of their dietary consists today as in the past of potatoes which are gathered and frozen, dried and powdered, and preserved in the powdered form. This powder is used in soups with llama meat and other products. Since the vitamin D group of activators is absent from nearly all plant products but must be synthesized in animal bodies from the plant foods, where it is largely stored in organs, an adequate source had to be provided. The Indians of the highlands of Peru maintained colonies of guinea pigs which were used in their stews. The ancient burials also show that the guinea pig was a common source of food since mummified bodies of this animal were found. This is significant since of all the animals that are used for experimental work the guinea pig is probably the most efficient in synthesizing vitamin D from plant foods. They are very hardy. They live on a great variety of green plant foods and twigs and are very prolific. They apparently played a very important part in the physical excellence of the ancient cultures.

It is unfortunate that as the white man has come into contact with the primitives in various parts of the world he has failed to appreciate the accumulated wisdom of the primitive racial stocks. Much valuable wisdom has been lost by this means. I have referred to the skill of the Indians in preventing scurvy and to the many drugs that we use which the white man has learned of from the primitives.

In this connection the Indians of British Columbia, who have been so efficient in preventing scurvy, have a plant product for the prevention and cure of diabetes. This has recently become known to the white man through the experience of a patient who was brought into the hospital at Prince Rupert, British Columbia, as reported in the Canadian Medical Journal, July 1938. Prince Rupert is near the boundary between British Columbia and Alaska on the coast. The patient came to that hospital for an operation and suddenly showed signs of diabetes, which required treatment with large doses of insulin. Dr. Richard Geddes Large asked him regarding the history of his affection and what he had been taking. He was told that for several years he had been using an Indian preparation which was a hot water infusion of a root of devil's-club which is a spiny, prickly shrub. This medicine was in common use by the British Columbia Indians. The material was obtained and used in this hospital for the treatment of diabetes and was found to be quite as efficient as insulin and had the great advantage that it would be taken by mouth whereas the insulin which is destroyed in the stomach by the process of digestion must be injected. They could see very little difference in the efficiency of this preparation whether taken internally or used hypodermically. This promises to be a great boon to a large group of individuals suffering from diabetes. It is also probable that its use will prevent the development of diabetes and since the Indians used it for other affections it may also become a very important adjunct in modern preventive medicine.

One of the sources that I have found to be helpful in studying primitive races is an investigation of knapsacks. I have asked for the privilege of seeing what is carried in their knapsacks. I found dried fish eggs and dried kelp in the knapsacks in the high Andes. It is also of interest that among this group in the Andes, among those in central Africa, and among the Aborigines of Australia, each knapsack contained a ball of clay, a little of which was dissolved in water. Into this they dipped their morsels of food while eating. Their explanation was to prevent "sick stomach." This is the medicine that is used by the native in these countries for combating dysentery and food infections. It is the treatment that was given me when I developed dysentery infection in central Africa while making studies there. The English doctor in Nairobi whom I called in said he would give me the native treatment of a suspension of clay. It proved very effective. An illustration of the way in which modern science is siowiy adopting practices that have been long in use among primitive races, is to be found in the recent extensive use that is made of clay (kaolin) in our modern medicine. This is illustrated in the following: (3)

> In the course of an expedition to Lake Titicaca, South America, financed by the Percy Slade Trustees in which one of us (H.P.M.) took part, an interesting observation was made in regard to the diet of the Quetchus Indians on the Capachica Peninsula near Puno. These people are almost certainly descendants of the Incas and at the present time live very primitively. They exist largely on a vegetable diet of which potatoes form an important part. Immediately, before being eaten, the potatoes are dipped into an aqueous suspension of clay, a procedure which is said to prevent "souring of the stomach."

> We have examined this clay and found it to consist of kaolin containing a trace of organic material, possibly coumarin, and presumably a decomposition product of the grass from underneath which the clay is dug. The local name for the clay is Chacco, and the Indians distinguish between good and bad qualities. This dietetic procedure is universal among the Indians of the Puno district, and is probably of very ancient origin.
>
> Such a practice by a primitive people would appear rather remarkable in view of the comparatively recent introduction of kaolin into modern medicine as a protective agent for the gastric and intestinal mucosa and as a remedy for bacterial infections of the gut.

It is of interest that both the British and American Pharmacopeias have added kaolin to their list during the last two decades.

The Indians of the past buried, with their dead, foods to carry them on their journey. From an examination of these one learns that in many respects the Indians living in the high Sierras are living today very much as their ancestors did during past centuries. Items of importance now and in the past are parched corn and parched beans which are nibbled as the people walk along carrying their heavy burdens. Today these are the only foods eaten on many long journeys. We found the parched beans pleasant to taste and very satisfying when we were hungry.

The Indians of the Amazon Basin have had a history very different from either those of the high Sierras of the Andes or those of the coastal region. The fact that vast areas of the Amazon Basin have not only never been surveyed, but never even penetrated, indicates the nature of the isolation of these groups. Very little progress has been made in the effort to conquer or modernize these Indians. A few explorers have made expeditions into parts of the interior and have reported the characteristics of the plant and animal life, as well as of the native races. Our sole contact was with the tribe which came to the coffee plantation to assist in the gathering and the harvest of the coffee beans. In Chapter 14 I have described these people in considerable detail. Since the Amazon Basin has vast quantities of rain as well as abundant streams from the eastern watershed of the Andes, the tribes live largely in tropical jungles where there is an abundance of water. They are expert, accordingly, in the use of river crafts and in fishing for the various types of marine life. Unlike the Indians of the high Andes or of the coast regions they are not agriculturists. They live on wild native foods almost entirely. They are expert with the blow gun, with the bow and arrow and in snaring with both nets and loops. They use very large quantities of a tuber root called yucca which has many qualities similar to the roots of the edible variety of the lily family. This plant is boiled and eaten much as are potatoes. They use also large quantities of fish from the streams, birds and small animals of the land, together with the native fruits including bananas. Their dietary provides a very liberal supply of minerals and vitamins together with an adequate quantity of carbohydrates, fats and proteins.

In evaluating the nutritive value of the dietary programs of primitive races and our modernized cultures, it is important that we have a yardstick adequately adjusted to make computation in terms of specific body needs for building good bodies and maintaining them in good health. The advance in modern chemistry has gone far toward making this possible.

The problem of estimating the mineral and activator contents, in other words the body-building and repairing qualities of the displacing foods used by the various primitive races, is similar in many

respects to estimating these qualities in the foods used in our modern white civilizations, except that modern commerce has transported usually only the foods that will keep well. These include chiefly white flour, sugar, polished rice, vegetable fats and canned goods.

Very important data for typical American dietaries are now available provided by the Bureau of Home Economics, United States Department of Agriculture, and also by the Bureau of Labor Statistics, United States Department of Labor. These surveys provide a basis of estimating the nutrition of various income groups both with regard to the type of foods selected in our American communities and the quantities of each type used, together with the chemical content of these foods expressed quantitatively. Those who wish to have detailed reports are referred to the bulletins of the above departments. In my clinical studies of the mineral constituents of individuals, affected with dental caries and other disturbances of physical deficiency, I find a wide range of variation in the calcium, phosphorus and fat-soluble activator content of the dietaries used, although in general the calorie content is adequate. This latter factor is controlled by appetite. These computations reveal that the individuals studied have a calcium intake ranging from 0.3 to 0.5 grams; and a phosphorus intake of from 0.3 to 0.6 grams. The minimum adult requirements as provided by such an authority as Sherman, whose figures are used by the United States Department of Labor, are for the average adult 0.68 of a gram of calcium and 1.32 grams of phosphorus per day. It can be seen readily that the amounts given above are far short of the minimum even if individuals absorbed from the foods all of the minerals present. A question arises at this point as to the efficiency of the human body in removing all of the minerals from the ingested foods. Extensive laboratory determinations have shown that most people cannot absorb more than half of the calcium and phosphorus from the foods eaten. The amounts utilized depend directly on the presence of other substances, particularly fat-soluble vitamins. It is at this point probably that the greatest breakdown in our modern diet takes place, namely, in the ingestion and utilization of adequate amounts of the special activating substances, including the vitamins needed for rendering the minerals in the food available to the human system. A recent report by the Council on Foods of the American Medical (4) Association makes this comment on spinach:

> Spinach may be regarded as a rich source of vitamin A and as a contributor of vitamin C, iron and roughage to the diet. It is therefore a valuable food. (But) the iron is not well utilized by infants . . . (and) the feeding of spinach is of no value during early infancy as a source of calcium.

Even though calcium is present in spinach children cannot utilize it. Data have been published showing that children absorb very little of the calcium or phosphorus in spinach before six years of age. Adult individuals vary in the efficiency with which they absorb minerals and other chemicals essential for mineral utilization. It is possible to starve for minerals that are abundant in the foods eaten because they cannot be utilized without an adequate quantity of the fat-soluble activators.

FIG. 93. This figure shows the rapid healing of a fractured femur of a boy four and onehalf years of age suffering from convulsions due to malnutrition. His fracture occurred when he fell in a convulsion. There was no healing in sixty days. After reinforcing his nutrition with butter vitamins the healing at the right occurred in thirty days. Whole milk replaced skim milk and a whole wheat gruel made from freshly ground whole wheat replaced white bread.

This is illustrated in the following case. A minister in an industrial section of our city, during the period of severe depression, telephoned me stating that he had just been called to baptize a dying child. The child was not dead although almost constantly in convulsions. He thought the condition was probably nutritional and asked if he could bring the boy to the office immediately. The boy was badly emaciated, had rampant tooth decay, one leg in a cast, a very bad bronchial cough and was in and out of convulsions in rapid succession. His convulsions had been getting worse progressively during the past eight months. His leg had been fractured two or three months previously while walking across the room when he fell in one of his convulsions. No healing had occurred. His diet consisted of white bread and skimmed milk. For mending the fracture the boy needed minerals, calcium, phosphorus and magnesium. His convulsions were due to a low calcium content of the blood. All of these were in the skimmed milk for the butter-fat removed in the cream contains no calcium nor phosphorus, except traces. The program provided was a change from the white flour bread to wheat gruel made from freshly ground wheat and the substitution of whole milk for skimmed milk, with the addition of about a teaspoonful of a very high vitamin butter with each feeding. He was given this meal that evening when he returned to his home. He slept all night without a convulsion. He was fed the same food five times the next day and did not have a convulsion. He proceeded rapidly to regain his health without recurrence of his convulsions. In a month the fracture

was united. Two views of the fracture are shown in Fig. 93, one before and one after the treatment. Six weeks after this nutritional program was started the preacher called at the home to see how the boy was getting along. His mother stated that the boy was playing about the doorstep, but they could not see him. She called but received no answer. Presently they spied him where he had climbed up the downspout of the house to the second story. On being scolded by his mother, he ran and jumped over the garden fence, thus demonstrating that he was pretty much of a normal boy. This boy's imperative need, that was not provided in white bread and skimmed milk, was the presence of the vitamins and other activators that are in whole milk but not in skimmed milk, and in whole wheat, freshly ground, but not in white flour. He was restored to health by the simple process of having Nature's natural foods restored to him.

This problem of borrowing from the skeleton in times of stress may soften the bones so that they will be badly distorted. This is frequently seen as bow legs. An illustration of an extreme condition of bone softening by this process is shown in Fig. 94, lower section, which is the skeleton of a monkey that was a house pet. It became very fond of sweets and was fed on white bread, sweetened jams, etc., as it ate at the same table with its mistress. Note that the bones became so soft that the pull of the muscles distorted them into all sorts of curves. Naturally its body and legs were seriously distorted. In this condition my patient, whom I was serving professionally, asked me for advice regarding her monkey's deformed legs and distorted body. I suggested an improved nutrition and provided fat-soluble vitamins consisting of a mixture of a high vitamin butter oil and high vitamin cod liver oil with the result that minerals were deposited on the borders of the vertebrae and joints and on the surfaces of the bones as shown in the illustration. This of course, could not correct the deformity and the animal was chloroformed.

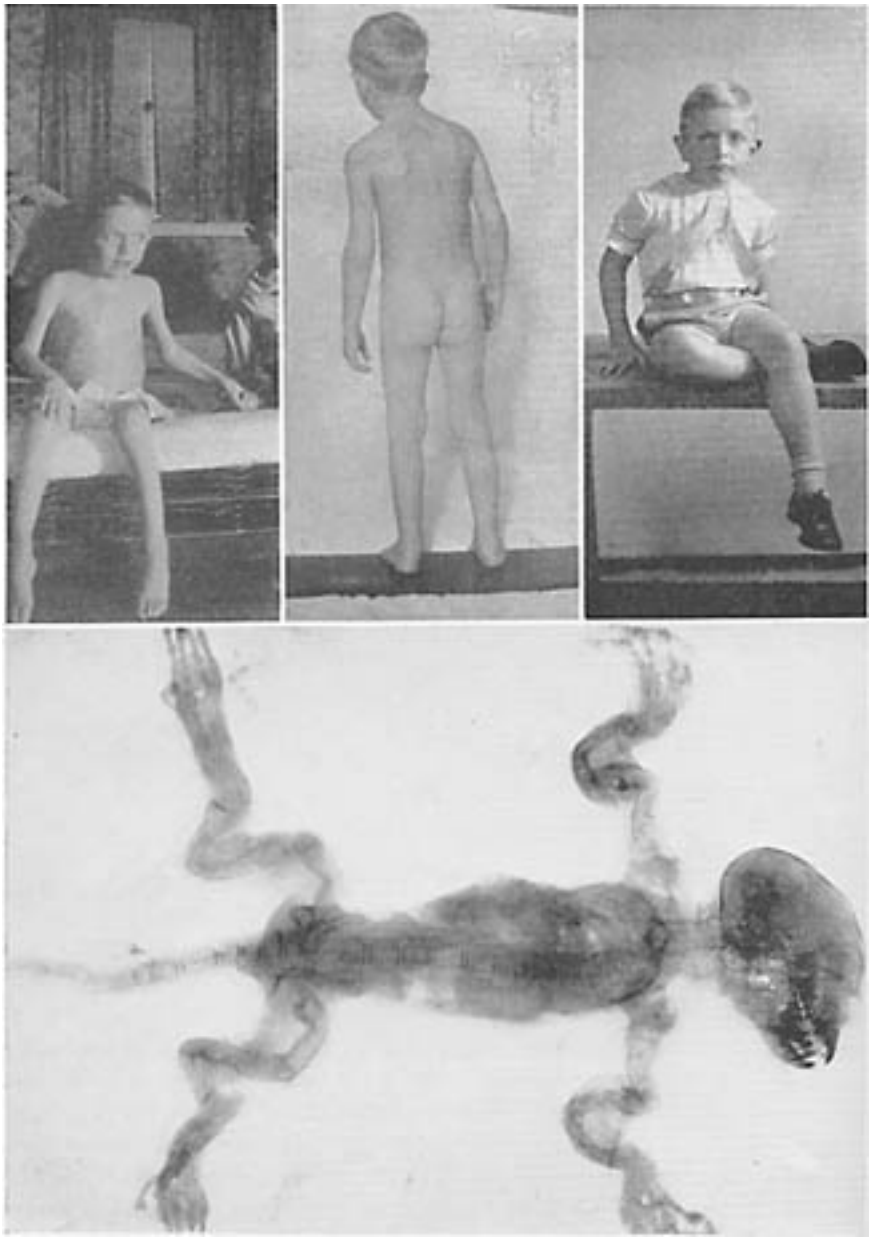

FIG. 94. This boy, age 5, had suffered for two and one-half years from inflammatory rheumatism, arthritis and heart involvement. Upper left shows limit of movement of neck, left wrist, swollen knees and ankles. The middle upper view shows the change in six months after improvement of his nutrition, and at right his change in one year. Below is shown the grossly demineralized and deformed skeleton of a pet monkey being fed on sweets and pastries.

The necessity that the foods selected and used shall provide an adequate quantity of fat-soluble activators (including the known fatsoluble vitamins) is so imperative and is so important in preventing a part of our modern degeneration that I shall illustrate its need with another practical case.

A mother asked my assistance in planning the nutritional program for her boy. She reported that he was five years of age and that he had been in bed in hospitals with rheumatic fever, arthritis and an acute heart involvement most of the time for the past two and a half years. She had been told that her boy would not recover, so severe were the complications. As is so generally the case with rheumatic fever and endocarditis, this boy was suffering from severe tooth decay. In this connection the

American Heart Association has reported that 75 per cent of heart involvements begin before ten years of age. My studies have shown that in about 95 per cent of these cases there is active tooth decay. The important change that I made in this boy's dietary program was the removal of the white flour products and in their stead the use of freshly cracked or ground wheat and oats used with whole milk to which was added a small amount of specially high vitamin butter produced by cows pasturing on green wheat. Small doses of a high-vitamin, natural cod liver oil were also added. At this time the boy was so badly crippled with arthritis, in his swollen knees, wrists, and rigid spine, that he was bedfast and cried by the hour. With the improvement in his nutrition which was the only change made in his care, his acute pain rapidly subsided, his appetite greatly improved, he slept soundly and gained rapidly in weight. In the first view, to the left, in Fig. 94, the boy is shown sitting on the edge of the bed at the end of the first month on this program. His joints were still badly swollen and his spine so rigid that he could not rotate his head farther than shown in the picture. In the center view he is shown about six months later, and in the third view, one year later. This occurred six years ago. As I write this a letter has been received from the boy's mother. She reports that he is taller and heavier than the average, has a good appetite and sleeps well.

In the newer light regarding the cause of rheumatic fever, or inflammatory rheumatism (discussed in Chapter 21) there appear to be three underlying causes: a general lowered defense against infection in which the fat-soluble vitamins play a very important part; minute hemorrhages in joint tissues as part of the expression of deficiency of vitamin C, a scurvy symptom, and a source of infecting bacteria such as streptococcus. This could be provided by his infected teeth. These typical expressions of modern degeneration could not occur in most of the primitive races studied because of the high factor of safety in the minerals and vitamins of their nutrition. It is important to emphasize the changes that were made in our modern dietary program to make this boy's nutrition adequate for recovery. Sugars and sweets and white flour products were eliminated as far as possible. Freshly ground cereals were used for breads and gruels. Bone marrow was included in stews. Liver and a liberal supply of whole milk, green vegetables and fruits were provided. In addition, he was provided with a butter that was very high in vitamins having been produced by cows fed on a rapidly growing green grass. The best source for this is a pasturage of wheat and rye grass. All green grass in a state of rapid growth is good, although wheat and rye grass are the best found. Unless hay is carefully dried so as to retain its chlorophyll, which is a precursor of vitamin A, the cow cannot synthesize the fat-soluble vitamins.

These two practical cases illustrate the fundamental necessity that there shall not only be an adequate quantity of body-building minerals present, but also that there shall be an adequate quantity of fat-soluble vitamins. Of course, water-soluble vitamins are also essential. While I have reduced the diets of the various primitive races studied to definite quantities of mineral and calorie content, these data are so voluminous that it will not be appropriate to include them here. It will be more informative to discuss the ratios of both body-building and repairing material in the several primitive dietaries, in comparison with the displacing foods adopted from our modern civilization. The amount of food eaten by an individual is controlled primarily by the hunger factor which for our modernized groups apparently relates only to need for heat and energy. The dietaries adopted have all been built on the basis of the heat and energy requirements of the body for the groups living in the several districts and under their modes of life. These have been calculated for the principal foods eaten by the various groups. The figures will be published in detail in a more technical report. There are two simple ways in which these comparisons can be made. One is in terms of normal body requirements;

and the other in terms of the ratio between the mineral and the vitamin content of the native foods and the displacing foods. If we use as a basis the ability of individuals to remove half of the minerals present even though their bodies need more than this, we will be more generous than the average individual's capacity will justify. This will require that we double the amount, as specified for minimum body use by the United States Department of Labor, Bureau of Labor Statistics, in their Bulletin R 409, that is, for calcium 0.68 grams; for phosphorus 1.32 grams; for iron 0.015 grams. The figures that will be used, therefore, are for twice the above amounts: 1.36 grams of calcium; 2.64 grams of phosphorus; 0.030 grams of iron.

Few people who have not been in contact with experimental data on metabolism can appreciate how little of the minerals in the food are retained in the body by large numbers of individuals who are in need of these very chemicals. We have seen that infants cannot absorb calcium from spinach. If we are to provide nutrition that will include an adequate excess as a factor of safety for overloads, and for such periods as those of rapid growth (for children), pregnancy, lactation and sickness, we must provide the excess to the extent of about twice the requirements of normal adults. It will therefore, be necessary for an adequate nutrition to contain approximately four times the minimum requirements of the average adult if all stress periods are to be passed safely.

It is of interest that the diets of the primitive groups which have shown a very high immunity to dental caries and freedom from other degenerative processes have all provided a nutrition containing at least four times these minimum requirements; whereas the displacing nutrition of commerce, consisting largely of white-flour products, sugar, polished rice, jams, canned goods, and vegetable fats have invariably failed to provide even the minimum requirements. In other words the foods of the native Eskimos contained 5.4 times as much calcium as the displacing foods of the white man, five times as much phosphorus, 1.5 times as much iron, 7.9 times as much magnesium, 1.8 times as much copper, 49.0 times as much iodine, and at least ten times that number of fat-soluble vitamins. For the Indians of the far North of Canada, the native foods provided 5.8 times as much calcium, 5.8 times as much phosphorus, 2.7 times as much iron, 4.3 times as much magnesium, 1.5 times as much copper, 8.8 times as much iodine, and at least a ten fold increase in fat-soluble activators. For brevity, we will apply the figures to calcium, phosphorus, magnesium, iron and fat-soluble activators in order. The ratio in the Swiss native diets to that in the displacing diet was for calcium, 3.7 fold; for phosphorus, 2.2 fold; for magnesium, 2.5 fold; for iron, 3.1 fold; and for the fat-soluble activators, at least ten fold. For the Gaelics in the Outer Hebrides, the native foods provided 2.1 times as much calcium, 2.3 times as much phosphorus, 1.3 times as much magnesium, and 1.0 times as much iron; and the fat-soluble activators were increased at least ten fold. For the Aborigines of Australia, living along the eastern coast where they have access to sea foods the ratio of minerals in the native diet to those in the displacing modernized foods was, for calcium, 4.6 fold; for phosphorus, 6.2 fold; for magnesium, 17 fold; and for iron 50.6 fold; while for the fatsoluble activators, it was at least ten fold. The native diet of the New Zealand Maori provided an increase in the native foods over the displacing foods of the modernized whites of 6.2 fold for calcium, 6.9 fold for phosphorus, 23.4 fold for magnesium, 58.3 fold for iron; and the fatsoluble activators were increased at least ten fold. The native diet of the Melanesians provided similarly an increase over the provision made in the modernized foods which displaced them of 5.7 fold for calcium, 6.4 fold for phosphorus, 26.4 fold for magnesium, and 22.4 fold for iron; while the fat-soluble activators were increased at least ten fold. The Polynesians provided through their native diet for an increase in provision over that of the displacing imported diets, of 5.6 fold for calcium, 7.2 fold for phosphorus, 28.5 fold for magnesium, 18.6 fold for iron;

and the fat-soluble activators were increased at least ten fold. The coastal Indians of Peru provided through their native primitive diets for an increase in provision over that of the displacing modernized diet of 6.6 fold for calcium, 5.5 fold for phosphorus, 13.6 fold for magnesium, 5.1 fold for iron; and an excess of ten fold was provided for fat-soluble vitamins. For the Indians of the Andean Mountains of Peru, the native foods provided an increase over the provision of the displacing modern foods of S fold for calcium, 5.5 fold for phosphorus, 13.3 fold for magnesium, 29.3 fold for iron; and an excess of at least ten fold was provided for fat-soluble vitamins. For the cattle tribes in the interior of Africa, the primitive foods provided an increase over the provision of the displacing modernized foods of 7.5 fold for calcium, 8.2 fold for phosphorus, 19.1 fold for magnesium, 16.6 fold for iron and at least ten fold for fat-soluble activators. For the agricultural tribes in Central Africa the native diet provided an increase over the provision of the displacing modern diet of 3.5 fold for calcium, 4.1 fold for phosphorus, 5.4 fold for magnesium, 16.6 fold for iron and ten fold for fat-soluble activators. All the above primitive diets provided also a large increase in the water-soluble vitamins over the number provided in the displacing modern diets.

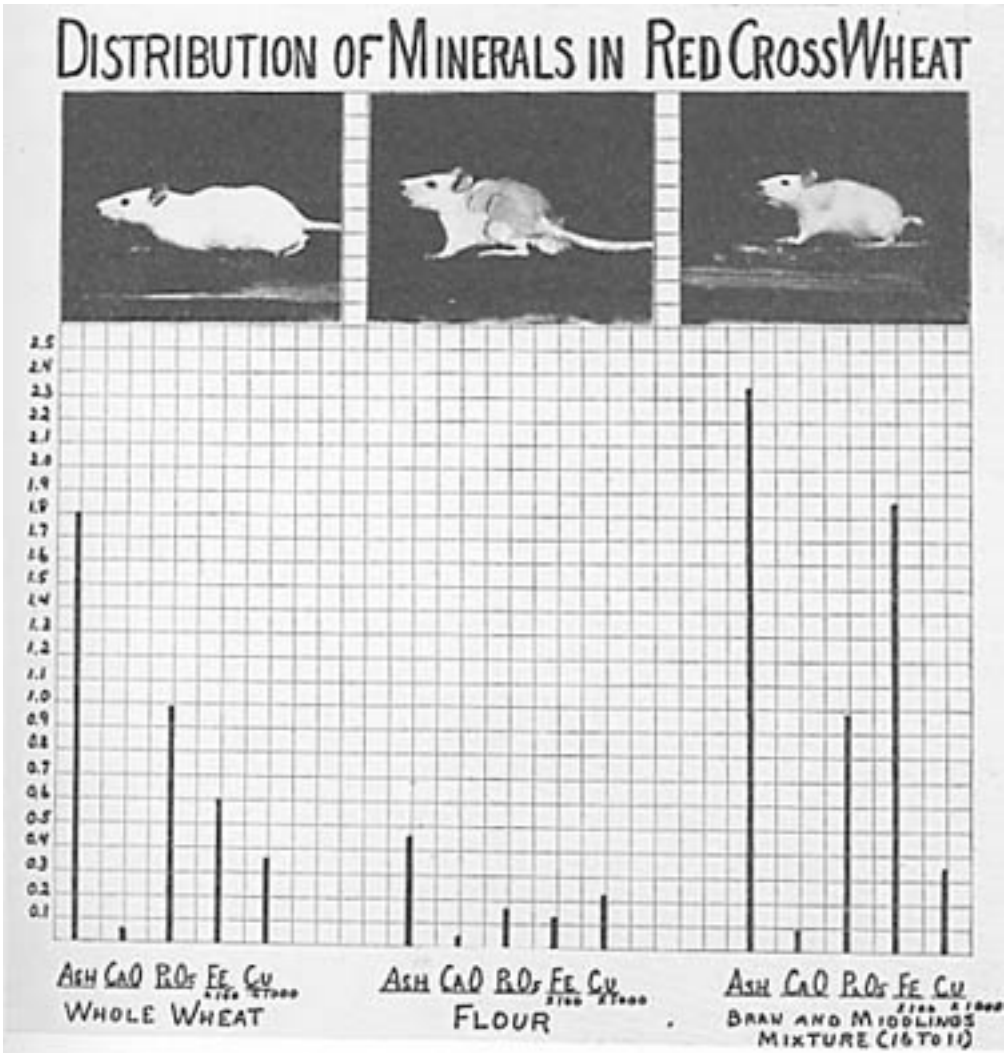

FIG. 95. Effect of different wheat products on rats. Left: whole wheat. Center: white flour. Right: bran and middlings mixture. The graphs record actual amount of indicated minerals present, as milligrams per cent. Only the rats on the whole wheat developed normally without tooth decay. Those on white flour had tooth decay, were underweight, had skin infections and were irritable. They did not reproduce. The third group were undersize. The balance of the ration was the same for all.

From the data presented in the preceding chapters and in this comparison of the primitive and modernized dietaries it is obvious that there is great need that the grains eaten shall contain all the minerals and vitamins which Nature has provided that they carry. Important data might be presented to illustrate this phase in a practical way. In Fig. 95 will be seen three rats all of which received the same diet, except for the type of bread. The first rat (at the left) received whole-wheat products freshly ground, the center one received a white flour product and the third (at the right) a bran and middlings product. The amounts of each ash, of calcium as the oxide, and of phosphorus as the pentoxide; and the amounts of iron and copper present in the diet of each group are shown by the height of the columns beneath the rats. Clinically it will be seen that there is a marked difference in the physical development Qf these rats. Several rats of the same age were in each cage. The feeding was started after weaning at about twenty-three days of age. The rat at the left was on the entire grain product. It was fully developed. The rats in this cage reproduced normally at three months of age. The rats in this first cage had very mild dispositions and could be picked up by the ear or tail without danger of their biting. The rats represented by the one in the center cage using white flour were markedly undersized. Their hair came out in large patches and they had very ugly dispositions, so ugly that they threatened to spring through the cage wall at us when we came to look at them. These rats had tooth decay and they were not able to reproduce. The rats in the next cage (illustrated by the rat to the right) which were on the bran and middlings mixture did not show tooth decay, but were considerably undersized, and they lacked energy. The flour and middlings for the rats in cages two and three were purchased from the miller and hence were not freshly ground. The wheat given to the first group was obtained whole and ground while fresh in a hand mill. It is of interest that notwithstanding the great increase in ash, calcium, phosphorus, iron and copper present in the foods of the last group, the rats did not mature normally, as did those in the first group. This may have been due in large part to the fact that the material was not freshly ground, and as a result they could not obtain a normal vitamin content from the embryo of the grain due to its oxidation. This is further indicated by the fact that the rats in this group did not reproduce, probably due in considerable part to a lack of vitamins B and E which were lost by oxidation of the embryo or germ fat.

There is a misapprehension with regard to the possibility that humans may obtain enough of the vitamin D group of activators from our modern plant foods or from sunshine. This is due to the belief viosterol or similar products by other names, derived by exposing ergosterol to ultraviolet light, offer all of the nutritional factors involved in the vitamin D group. I have emphasized that there are known to be at least eight D factors that have been definitely isolated and twelve that have been reported as partially isolated.

Coffin has recently reported relative to the lack of vitamin D in common foods as follows: (5)

1. A representative list of common foods was carefully tested, by approved technique, for their vitamin D content.
2. With the remote possibility of egg yolks, butter, cream, liver and fish it is manifestly impossible to obtain any amount of vitamin D worthy of mention from common foods.
3. Vegetables do not contain vitamin D.

It will be noted that vitamin D, which the human does not readily synthesize in adequate amounts, must be provided by foods of animal tissues or animal products. As yet I have not found a single

group of primitive racial stock which was building and maintaining excellent bodies by living entirely on plant foods. I have found in many parts of the world most devout representatives of modern ethical systems advocating the restriction of foods to the vegetable products. In every instance where the groups involved had been long under this teaching, I found evidence of degeneration in the form of dental caries, and in the new generation in the form of abnormal dental arches to an extent very much higher than in the primitive groups who were not under this influence.

Many illustrations might be presented showing the special wisdom of the primitives in the matter of reinforcing their nutrition with protective foods.

Few people will realize how reluctant members of the primitive races are, in general, to disclose secrets of their race. The need for this is comparable to the need for secrecy regarding modern war devices.

The Indians of the Yukon have long known the cure for scurvy and history makes an important contribution to their wisdom in treating this disease. It is of interest that W. N. Kemp (6) of Vancouver states:

> The earliest recorded successful treatment of scurvy occurred in Canada in 1535 when Jacques Cartier, on the advice of a friendly Indian, gave his scurvyprostrated men a decoction of young green succulent 'shoots' from the spruce trees with successful results. These happy effects apparently were not appreciated in Europe, for scurvy continued to be endemic.

Since that time untold thousands of mariners and white land dwellers have died with this dreaded disease.

Shortly before our arrival in Northern Canada a white prospector had died of scurvy. Beside him was his white man's packet of canned foods. Any Indian man or woman, boy or girl, could have told him how to save his life by eating animal organs or the buds of trees.

Another illustration of the wisdom of the native Indians of that far north country came to me through two prospectors whom we rescued and brought out with us just before the fall freeze-up. They had gone into the district, which at that time was still uncharted and unsurveyed, to prospect for precious metals and radium. They were both doctors of engineering and science, and had been sent with very elaborate equipment from one of the large national mining corporations. Owing to the inaccessibility of the region, they adopted a plan for reaching it quickly. They had flown across the two ranges of mountains from Alaska and when they arrived at the inside range, i.e., the Rocky Mountain Range, they found the altitude so high that their plane could not fly over the range, and, as a result, they were brought down on a little lake outside. The plane then returned but was unable to reach the outside world because of shortage of fuel. The pilot had to leave it on a waterway and trudge over the mountains to civilization. The two prospectors undertook to carry their equipment and provisions over the Rocky Mountain Range into the interior district where they were to prospect. They found the distance across the plateau to be about one hundred miles and the elevation ranging up to nine thousand feet. While they had provisions and equipment to stay two years they found it would take all of this time to carry their provisions and instruments across this plateau. They

accordingly abandoned everything, and rather than remain in the country with very uncertain facilities and prospects for obtaining food and shelter, made a forced march to the Liard River with the hope that some expedition might be in that territory. One of the men told me the following tragic story. While they were crossing the high plateau he nearly went blind with so violent a pain in his eyes that he feared he would go insane. It was not snow blindness, for they were equipped with glasses. It was xeropthalmia, due to lack of vitamin A. One day he almost ran into a mother grizzly bear and her two cubs. Fortunately, they did not attack him but moved off. He sat down on a stone and wept in despair of ever seeing his family again. As he sat there holding his throbbing head, he heard a voice and looked up. It was an old Indian who had been tracking that grizzly bear. He recognized this prospector's plight and while neither could understand the language of the other, the Indian after making an examination of his eyes, took him by the hand and led him to a stream that was coursing its way down the mountain. Here as the prospector sat waiting the Indian built a trap of stones across the stream. He then went upstream and waded down splashing as he came and thus drove the trout into the trap. He threw the fish out on the bank and told the prospector to eat the flesh of the head and the tissues back of the eyes, including the eyes, with the result that in a few hours his pain had largely subsided. In one day his sight was rapidly returning, and in two days his eyes were nearly normal. He told me with profound emotion and gratitude that that Indian had certainly saved his life.

Now modern science knows that one of the richest sources of vitamin A in the entire animal body is that of the tissues back of the eyes including the retina of the eye.

In Chapter 18 I refer to the work of Wald on studies of vitamin A tissues. He states that extracts of eye tissue (retina, pigment, epithelium, and choroid) show the characteristic vitamin A absorption band and that they are potent in curing vitamin A deficient rats. He shows also that the concentration of vitamin A is constant for different mammals.

I have been impressed to find that primitive racial stocks in various parts of the world are familiar with the fact that eyes constitute an invaluable adjunct for nutrition. Even the one time cannibals of the Fiji Islands, and the hereditary king of the Fiji Islands, told me in detail of the practices with regard to the use of eyes as an adjunct to diet. The chief, his father, and grandfather had the privilege of reserving the eyes of captives for their personal use. When among the natives of the islands north of Australia, I learned to enjoy greatly fish head soup made from certain selected tissues. After the fish had been cleaned the heads were split and the eyes left in.

The space of the entire book might be used for discussing the nutritional wisdom of the various primitive races. It is a pity that so much of their wisdom has been lost through lack of appreciation by the whites who early made contact with them.

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Chapter 16

PRIMITIVE CONTROL OF DENTAL CARIES

THE essential differences in the diets of the primitive races and those of the modernized groups have been discussed in the preceding chapter. We are concerned now with discovering whether the use of foods, which are equivalent in body-building and repairing material to those used by the primitives will, when provided to our affected modernized groups, prevent tooth decay or check it when it is active.

There are two approaches to this problem of the control of tooth decay by nutritional means. One is by the presentation of clinical results and the other by the consideration of the characteristics of those nutritional programs which have been successful in producing a high immunity to tooth decay.

We may divide the primitive racial stocks into groups, classified according to the physical environment in which they are living and the manner in which the environment largely controls their available foods. It is significant that I have as yet found no group that was building and maintaining good bodies exclusively on plant foods. A number of groups are endeavoring to do so with marked evidence of failure. The variety of animal foods available has varied widely in some groups, and been limited among others.

In the preceding chapter we have seen that the successful dietaries included in addition to a liberal source of minerals, carbohydrates, fats, proteins, and water-soluble vitamins, a source of fat-soluble vitamins.

Vitamin D is not found in plants, but must be sought in an animal food. The dietaries of the efficient primitive racial stocks may be divided into groups on this basis: in the first place those obtaining their fatsoluble activators, which include the known fat-soluble vitamins, from efficient

dairy products. This includes the Swiss in the high Alps, the Arabs (using camel's milk), and the Asiatic races (using milk of sheep and musk ox). In the second place there are those using liberally the organs of animals, and the eggs of birds, wild and domesticated. These include the Indians of the far North, the buffalo hunting Plains Indians and the Andean tribes. In the third place there are those using liberally animal life of the sea. These include Pacific Islanders and coastal tribes throughout the world. In the fourth place there are those using small animals and insects. These include the Australian Aborigines in the interior, and the African tribes in the interior.

Many of the above groups use foods from two or more sources. Each of the groups has provided an adequate quantity of body-building material from both animal and plant tissues. It does not matter what the source of minerals and vitamins may be so long as the supply is adequate. In our modern life, the location of a group will determine the most efficient and most convenient source for obtaining the essential foods. Clearly, for those near the coast, the sea may be most convenient, while for those in the interior or in the far North, dairy products or the organs of animals may be the only available source. It would be fortunate indeed, if our problems were as simple as this statement might indicate. We have, however, in the first place, the need for a strength of character and will power such as will make us use the things our bodies require rather than only the foods we like. Another problem arises from the fact that our modern sedentary lives call for so little energy that many people will not eat enough even of a good food to provide for both growth and repair, since hunger appeals are for energy only, the source of heat and power, and not for body-building minerals and other chemicals. Still another problem confronts us, i.e., the sources of fatsoluble activators indicated above, namely: dairy products, organs of animals and sea foods, may vary through a wide range in their content of the fat-soluble activators or vitamins, depending upon the nutrition available for the animals. Cows fed on third grade hay, too low in carotene, not only cannot produce strong calves but their milk will not keep healthy calves alive. (Chapter 18.)

The League of Nations' Committee on Nutrition has estimated the amount of pasture land required per capita to provide adequate milk and meat. Owing to the density of population and cost of land near large cities, it is not possible to provide an adequate acreage for dairy cattle. This results in stall feeding of shipped fodder. Only those cows can be kept in a herd whose production of milk and butter fat can pay in volume for their keep. Unfortunately milk may have a high cream line or butter fat content and still be low in essential fat-soluble vitamins. This constitutes an exceedingly important phase of our modern problem. Butter ships best when hard and this quality can be largely controlled by the fodder given to the cattle and hence becomes an important factor in the wholesale butter industry. Since 1927, I have been analyzing samples of dairy products, chiefly butter, from several parts of the world for their vitamin content. These samples are received every two to four weeks from the same places, usually for several years. They all show a seasonal rise and fall in vitamin content. The high level is always associated with the use of rapidly growing young plant food. This tide in plant life, fluctuating with the seasons, controlled the migration of the buffalo southward in the autumn and winter and northward in the spring. They moved at the rate of about twelve miles per day, travelling with the sun in order to provide the highest-vitamin milk for the young calves born in the south. No doubt these tides in nutrition control also the migration of birds. By far the most efficient plant food that I have found for producing the high-vitamin content in milk is rapidly growing young wheat and rye grass. Oat and barley grass are also excellent. In my clinical work small additions of this high-vitamin butter to otherwise satisfactory diets regularly checks tooth decay when active and at the same time improves vitality and general health.

Similarly the value of eggs for providing fat-soluble vitamins depends directly upon the food eaten by the fowl. The fertility of the eggs also is a direct measure of the vitamin content, including vitamin E.

Since the sea foods are, as a group, so valuable a source of the fatsoluble activators, they have been found to be efficient throughout the world not only for controlling tooth decay, but for producing a human stock of high vitality. Unfortunately the cost of transportation in the fresh state often constitutes a factor limiting distribution. Many of the primitive races preserved the food value, including vitamins, very efficiently by drying the fish. While our modern system of canning prevents decomposition, it does not efficiently preserve some of the fatsoluble activators, particularly vitamin A.

Since the organs, particularly the livers of animals, are storage depots of the vitamins an important source of some of the fat-soluble activators can be provided by extracting the fat of the livers and shipping it as liver oils. Modern methods of processing have greatly improved the quality of these oils. There are some factors, however, which can be provided to great advantage for humans from dairy products of high efficiency.

I have shown in the preceding chapter the quantities of several of the minerals that are essential in suitable chemical form to maintain an adult in good health and make possible tissue repair. The dietaries of the various primitive groups have all been shown to have a mineral content several times higher than that which obtains in the inadequate food eaten by modernized primitives and the people of our modernized cultures.

Modern commerce has deliberately robbed some of nature's foods of much of their body-building material while retaining the hunger satisfying energy factors. For example, in the production of refined white flour approximately eighty per cent or four-fifths of the phosphorus and calcium content are usually removed, together with the vitamins and minerals provided in the embryo or germ. The evidence indicates that a very important factor in the lowering of reproductive efficiency of womanhood is directly related to the removal of vitamin E in the processing of wheat. The germ of wheat is our most readily available source of that vitamin. Its role as a nutritive factor for the pituitary gland in the base of the brain, which largely controls growth and organ function, apparently is important in determining the production of mental types. Similarly the removal of vitamin B with the embryo of the wheat, together with its oxidation after processing, results in depletion of body-building activators.

Refined white sugar carries only negligible traces of body-building and repairing material. It satisfies hunger by providing heat and energy besides having a pleasant flavor. The heat and energy producing factors in our food that are not burned up are usually stored as fat. In the preceding chapter we have seen that approximately half of the foods provided in our modern dietaries furnish little or no body-building or repairing material and supply no vitamins. Approximately 25 per cent of the heat and energy of the American people is supplied by sugar alone which goes far in thwarting Nature's orderly processes of life. This per capita use is unfortunately on the increase. Therefore we must begin by radically reducing the foods that are so deceptive, and often injurious in overloading the

system. Even this much change in our modern nutrition will raise the factor of safety sufficiently to check tooth decay in a large percentage of people. It will not, however, be adequate for most children in whom the additional demands of rapid growth must be satisfied. I have found the highest incidence of tooth decay in the high school and boarding school girls, and the next in the boarding school boys. These groups suffer even more than the childbearing mothers.

In discussing the technical aspects later I shall consider the defensive factors in the saliva as controlled by the nutrition through the blood stream, and also the role of oral prophylaxis.

It is appropriate at this point to note some characteristics of a decaying tooth. The process of tooth decay never starts from within but always from without and is most likely to start at the contact points between the teeth or in the pits and grooves, especially when these are incompletely formed. Teeth never have caries while they are covered with flesh but decay most easily soon after eruption, when conditions are unfavorable. If the saliva is normal the surfaces of the teeth progressively harden during the first year after eruption. While there are many theories regarding the relative importance of different factors in the process of decay practically all provide for a local solution of the tooth substance by acids produced by bacteria. The essential difference in the various theories of tooth decay is the difference in theories relative to the control of these decalcifying organisms, and relative to their quantity and activity. The dental profession has been waiting for decades for this question to be solved before taking active steps to prevent the whole process. The primitive approach has been to provide a program that will keep the teeth well, that is, prevention of dental caries by adequate food combinations. I have just stated that teeth harden after eruption if the saliva is normal. This occurs by a process of mineralization much like the process by which petrified wood is produced.

The tooth is made up of four structures. The first is the pulp within, which carries blood vessels and nerves. This structure is surrounded in both the root and crown by the dentine or tooth bone which is nourished from within. The dentine of the root is covered by cementum which receives nourishment from the membrane which attaches the root to the jaw bone. The dentine of the crown or exposed part of the tooth is covered with enamel. Tooth decay proceeds slowly through the enamel and often rapidly in the dentine, always following the minute channels toward the pulp, which may become infected before the decay actually reaches the pulp to expose it; nearly always the decay infects the pulp when it destroys the dentine covering it. When a tooth has a deep cavity of decay, the decalcified dentine has about the density of rotten wood. With an adequate improvement in nutrition, tooth decay will generally be checked provided two conditions are present: in the first place, there must be enough improvement in the quality of the saliva; and in the second, the saliva must have free access to the cavity. Of course, if the decay is removed and a filling placed in the cavity, the bacteria will be mechanically shut out. One of the most severe tests of a nutritional program, accordingly, is the test of its power to check tooth decay completely, even without fillings. There are, however, two further tests of the sufficiency of improvement of the chemical content of the saliva. If it has been sufficiently improved, bacterial growth will not only be inhibited, but the leathery decayed dentine will become mineralized from the saliva by a process similar to petrification. Note that this mineralized dentine is not vital, nor does it increase in volume and fill the cavity. When scraped with a steel instrument it frequently takes on a density like very hard wood and occasionally takes even a glassy surface. When such a tooth is placed in silver nitrate, the chemical does not penetrate this demineralized dentine, though it does rapidly penetrate the decayed dentine of a tooth extracted when decay is active. This process is illustrated in Fig. 96 which shows two deciduous teeth extracted from

the same child, one before, and the other a few months after improving the nutrition. These deciduous molars were replaced by the bicuspids of the second dentition. The tooth at the left had deep caries and was removed before the treatment was begun. Note that the silver nitrate has blackened the tissue to the depth of the decay. The tooth at the right was removed about three months after the nutrition was changed. Note that the decayed dentine is so dense that the silver nitrate has not penetrated deeply and discolored it.

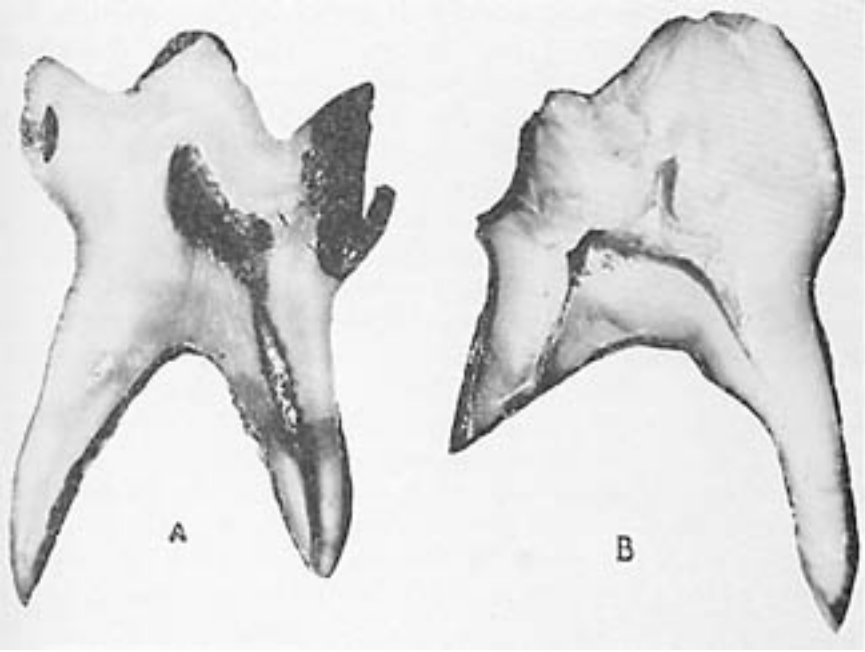

FIG. 96. A, illustrates the permeability of decayed dentin to silver nitrate. B, illustrates the decreased permeability of decayed dentin to silver nitrate due to mineralization, after saliva has been improved by correcting the nutrition.

There is still another test that demonstrates Nature's protective mechanisms. Ordinarily, when the pulp of a tooth is exposed by dental caries, the pulp becomes not only infected, but dies opening up a highway of infection direct from the infected mouth to the inside of the fort at the end of the root. One expression of this is a dental abscess, the existence of which is usually unknown to the individual for sometime and the infecting germs pass more or less freely throughout the body by way of the blood stream and lymph channels. This infection may start the degeneration of organs and tissues of other parts of the body.

Among some of the primitive races, whose nutritional programs provided a very high factor of safety, even though the teeth were worn down to the gum line and into what was formerly the pulp chamber, the pulp was not exposed. Nature had built a protecting zone, not in the cavity of the tooth in this case, but within the pulp chamber. This entirely blocked off a threatened exposure and kept the walls of the fort sealed against bacteria. This process does not occur in many instances in people of our modern civilization. Pulp chambers that are opened by wear provide exposed pulp which becomes infected with subsequent abscess formation. If a reinforced nutrition as efficient as that of many of the primitive races, is adopted, the pulp tissue will seal up the opening made by decalcification of the dentine, by building in a new layer of normal dentine which is vital and quite unlike the petrified decay exposed to the saliva, thus completely walling off the impending danger. This is illustrated in Fig. 97 with three cases. At the left are shown x-rays of teeth of three children in

one of my experimental clinics in a poor district in Cleveland. The pulp chambers and pulp tissues of the root canals are shown as dark streaks in the center of the tooth. The very large cavities which had decalcified the tooth to the pulp chamber are shown as large dark areas in the crown. Temporary fillings had to be placed because of pain produced by the pressure of food on the pulp below the decayed dentine. After the nutrition was improved, the tissues of the pulp built in secondary dentine thus reincasing itself in a closed chamber. This process is shown in each of the three cases presented in Fig. 97, in the views to the right.

FIG. 97. Three cases that illustrate how nature can close an exposure of the pulp due to dental caries by building a protecting wall within the pulp chamber when the nutrition is adequately improved.

Under the stress of the industrial depression the family dietary of the children shown in Fig. 97 was very deficient. They were brought to a mission where we fed them one reinforced meal at noon for six days a week. The home meals were not changed nor the home care of the teeth. The preliminary studies of each child included complete x-rays of all of the teeth, a chemical analysis of the saliva, a careful plotting of the position, size and depth of all cavities, a record of the height, and weight, and a record of school grades, including grades in deportment. These checks were repeated every four to six weeks for the period of the test, usually three to five months. It is important to note that the home nutrition which had been responsible for the tooth decay was exceedingly low in body building and repairing material, while temporarily satisfying the appetite. It usually consisted of highly sweetened strong coffee and white bread, vegetable fat, pancakes made of white flour and eaten with syrup, and doughnuts fried in vegetable fat.

The nutrition provided these children in this one meal included the following foods. About four ounces of tomato juice or orange juice and a teaspoonful of a mixture of equal parts of a very high vitamin natural cod liver oil and an especially high vitamin butter was given at the beginning of the meal. They then received a bowl containing approximately a pint of a very rich vegetable and meat stew, made largely from bone marrow and fine cuts of tender meat: the meat was usually broiled separately to retain its juice and then chopped very fine and added to the bone marrow meat soup which always contained finely chopped vegetables and plenty of very yellow carrots; for the next course they had cooked fruit, with very little sweetening, and rolls made from freshly ground whole wheat, which were spread with the high-vitamin butter. The wheat for the rolls was ground fresh every day in a motor driven coffee mill. Each child was also given two glasses of fresh whole milk. The menu was varied from day to day by substituting for the meat stew, fish chowder or organs of animals. From time to time, there was placed in a two quart jar a helping similar to that eaten by the children. This was brought to my laboratory for chemical analysis, which analysis showed that these meals provided approximately 1.48 grams of calcium and 1.28 grams of phosphorus in a single helping of each course. Since many of the children doubled up on the course, their intake of these minerals was much higher. I have shown in the preceding chapter that the accepted figures for the requirements of the body for calcium and phosphorus are 0.68 grams of calcium and 1.32 grams of phosphorus. It is obvious that this one meal a day plus the other two meals at home provided a real factor of safety. Clinically this program completely controlled the dental caries of each member of the group.

The chemical analysis of the saliva (1, 2) revealed a marked improvement which progressively increased. At the beginning of the test the average for the group showed a very low factor of safety, so low that we should expect tooth decay to be active. In six weeks the average changed to a condition which we should expect would be accompanied by a cessation of tooth decay. The saliva factor of safety continued to improve for five months at which time the special program was discontinued for the summer.

Several incidents of special interest occurred. Two different teachers came to me to inquire what had been done to make a particular child change from one of the poorest in the class in capacity to learn to one of the best. Dental caries is only one of the many expressions of our modern deficient nutritions.

I have referred to the importance of a high vitamin butter for providing the fat-soluble activators to make possible the utilization of the minerals in the foods. In this connection, it is of interest that butter constitutes the principal source of these essential factors for many primitive groups throughout the world. In the high mountain and plateau district in northern India, and in Tibet, the inhabitants depend largely upon butter made from the milk of the musk ox and the sheep for these activators. The butter is eaten mixed with roasted cereals, is used in tea, and in a porridge made of tea, butter and roasted grains. In Sudan Egypt, I found considerable traffic in high vitamin butter which came from the higher lands a few miles from the Nile Basin. This was being exchanged for and used with varieties of millet grown in other districts. This butter, at the temperature of that area, which ranged from 90° to 110° Fahrenheit, was, of course, always in liquid form. Its brilliant orange color testified to the splendid pasture of the dairy animals. The people in Sudan, including the Arabs, had exceptionally fine teeth with exceedingly little tooth decay (Chapter 9). The most physically perfect people in northern India are probably the Pathans who live on dairy products largely in the form of soured curd, together with wheat and vegetables. The people are very tall and are free of tooth decay.

Probably every housewife is familiar with the low melting quality of the butter produced in early summer when the cows have been put on the green pastures. This is particularly true of butter that has the grassy flavor and the deep yellow to orange color. This butter is usually several times as high in fat-soluble activators including vitamins A and D as butter produced from stall fed cattle or cattle on poorer pasturage. In Chapter 15, I have explained why this butter is not favorable for shipping and why dairymen so frequently give the cows a ration that will produce less of these qualities. One of the principal foods used for accomplishing this is made of cotton seed meal and cereals.

There are many illustrations of the low efficiency of this type of fodder for providing vitamins essential for dairy products. In one of the recent severe droughts in the Mississippi Valley several thousand cattle were shipped to Ohio for water and green pasture as a means of saving their lives. They were fed enroute on concentrates said to consist of cotton seed meal and grain. Professor Oscar Erf of the Department of Dairying of Ohio State University has given me the following detailed information:

> With reference to the cattle from the south-western and central-northern states of the drought area which were brought into Ohio in the fall of 1935 on a 600 acre farm north of Delaware, will say that I had the privilege of viewing some of these cattle previous to the time that they

were brought to Ohio in 1935. Because of the extreme drought period and the hot sun, it was rare to see green grass on the prairies. The sedges were nearly all dried up. The tumbleweed was about the only thing that was available for the cattle in some instances. The corn was dried up and very little green was in evidence. In the particular location that I was in we found the cattle suffering terribly. Many had infected eyes.

There were a good many deaths on the plains which were literally dried up. Sometimes there was even a small amount of decomposition after death. In the fall, those that survived on the plains, were loaded up and driven to the corrals, loaded into cars and sent east. Only the good ones were loaded and even a large number of these passed out in transit.

I was informed that the crop of grass the year before was very scant. Consequently, a large number of calves were born with weak eyes and these were the early ones to pass out on the plains. The low vitality of the individuals which I considered was due to the lack of vitamin A or the green grass factors was the cause of the serious infection, however their being secondary to the primary cause.

The first train load of the twenty-eight hundred cattle that were brought to this ranch were fed on green corn stalks. There was a nine acre patch of corn in this area. The fences were taken down one afternoon at 3 o'clock and by 9 o'clock there was no evidence of stubbles or roots. This had all been eaten in a very short space of time. We had quite a time getting hays and green stuff which we demanded because of its carotin content and its green grass factor. There was not enough grass available in the beginning so we had to buy about 400 tons of hay a day to keep the animals fed. They got no grain of any kind because it was a question of bringing the cattle to a more or less normal condition with no intention of fattening the animals.

After they had made arrangements for feeding operations and made feed racks in sufficient numbers, we went over the herd to estimate the numbers that were blind and had sore eyes, which I assume from past experience, was due to a vitamin A deficiency. As near as we can estimate, nearly 8 12 animals were affected (29 per cent). There were 157 calves born and approximately 50 per cent were deformed and not normal. We did not get the complete figures but they probably ranged a little higher than that. The worst infected cows were calves and animals that were 18 to 20 months old. I could not get the story of these individuals but they must have been in the area of dry grass for 2 years. There was a slight improvement in those that were not seriously infected after they were fed here. They improved decidedly in October and November and were practically all slaughtered before the middle of December.

The milk of these vitamin deficient cows would not properly nourish either their calves or human beings.

Many children have tooth decay even while using whole milk, in part because the milk is too low in vitamin content, due to the inadequacy of the food given the cows. The means for improving this condition have been discussed in Chapter 15.

Some of the current theories of the chemistry of tooth decay place the responsibility on the local condition in the mouth as affected by the contributing factors provided by sugars and starches which enhance the growth of acid producing organisms. A phase of this has been closely related to the slogan that a clean tooth cannot decay. Among the difficulties in applying this interpretation is the

physical impossibility of keeping teeth bacteriologically clean in the environment of the mouth. Another difficulty is the fact that many primitive races have their teeth smeared with starchy foods almost constantly and make no effort whatsoever to clean their teeth. In spite of this they have no tooth decay. In many of the primitive groups that I have studied the process of modernization includes teaching oral hygiene and prophylaxis. Yet, even with the addition of this important adjunct to health, they have in most cases lost their immunity to tooth decay and dental caries has become active. This will be seen in many of the illustrations of the primitive races in the preceding chapters. Of course everyone should clean his teeth, even the primitives, in the interest of and out of consideration for others.

In my clinical work I have sought for extreme cases of active tooth decay in order to test the primitive wisdom. Many of these cases have been furnished by members of the dental profession in other cities and states. By the simple procedure of studying the nutrition of the individual, obtaining a sample of saliva for analysis, seeing x-rays of the individual's teeth and supporting bone, and getting a history of the systemic overloads, I have been able to outline a nutritional program which, in well above 90 per cent of the cases has controlled the dental caries. Improvement in the condition of the teeth has been confirmed by later x-rays and reports by the patients' dentists. In a few cases where I had contact with the patients only through correspondence the cooperation was not adequate for accomplishing complete improvement. While it is true that there is a marked difference in the susceptibility of different individuals to dental caries, even those who would ordinarily be classed as highly susceptible, have generally received permanent benefit from the treatment.

These principles of treatment have now been applied to many hundreds of patients as indicated by the fact that over 2,800 chemical analyses of the saliva have been made. The dietary programs that have been recommended have been determined on the basis of a study of the nutrition used by the patient, the data provided by the x-rays, from the saliva analysis and case history. The diets have been found to be deficient in minerals, chiefly phosphorus. Fat-soluble vitamins have been deficient in practically every case of active tooth decay. The foods selected for reinforcing the deficient nutritions have always included additional fatsoluble vitamins and a liberal source of minerals in the form of natural food. Human beings cannot absorb minerals satisfactorily from inorganic chemicals. Great harm is done, in my judgment, by the sale and use of substitutes for natural foods.

One of our greatest difficulties in undertaking to apply the wisdom of the primitives to our modern problems involves a character factor. The Indians of the high Andes were willing to go hundreds of miles to the sea to get kelp and fish eggs for the use of their people. Yet many of our modern people are unwilling to take sufficient trouble to obtain foods that are competent to accomplish the desired results.

Jobbers and middlemen as well as supply depot managers want butter sold in accordance with its label rather than in accordance with its vitamin content. One large distributor whom I asked to cooperate by maintaining a stock of high-vitamin butter to which I could refer people, told me frankly that he wished I would stop telling people about the difference in the vitamins in butter. He did not wish them to think of butter in terms of its vitamin content. Another large concern told me that when I had worked up a sufficiently large market they would become interested in supplying the demand. I counsel people to put in storage some of that butter which has the grassy flavor and which melts

easily and is produced when the cows go onto the rapidly growing young grass. Unfortunately, cows that have been on a stable fodder low in carotene and under the stress of gestation often are so depleted in their own body vitamins that it takes them three or four weeks to replenish their own bodies when they get on good pasture. Then the vitamins will appear in liberal quantity in their milk. This has made it necessary for me to assist many patients in obtaining a supply by analyzing butter for its vitamin content and then putting this material in storage and making it available for special cases as needed.

The program that I have found most efficient has been one which includes the use of small quantities of very high vitamin butter mixed in equal parts with a very high vitamin cod liver oil. A simple method of preparing the butter is by melting it and allowing it to cool for twenty-four hours at a temperature of about 70° F., then centrifugalizing it which provides an oil that remains liquid at room temperature. When this butter oil is mixed in equal parts with a very high-vitamin cod liver oil, it produces a product that is more efficient than either alone. It should be used within a couple of weeks of the time it is mixed. It is desirable that this material be made available in various parts of the country. Even the high-vitamin butter produced on the early summer growth of grass put in storage and used during the winter will go far toward solving our great national problem of shortage of fat-soluble vitamins. The quantity of the mixture of butter oil and cod liver oil required is quite small, half a teaspoonful three times a day with meals is sufficient to control wide-spread tooth decay when used with a diet that is low in sugar and starches and high in foods providing the minerals, particularly phosphorus. A teaspoonful a day divided between two or three meals is usually adequate to prevent dental caries and maintain a high immunity; it will also maintain freedom from colds and a high level of health in general. This reinforcement of the fat-soluble vitamins to a menu that is low in starches and sugars, together with the use of bread and cereal grains freshly ground to retain the full content of the embryo or germ, and with milk for growing children and for many adults, and the liberal use of sea foods and organs of animals, produced the result described.

I have previously reported (3) seventeen cases of extensive dental caries. In these patients there were found 237 open cavities of apparently active caries. Most of the individuals were between twelve and twenty years of age and accordingly had twenty-eight permanent teeth each, or a total of 476. It will be noted that if one cavity is allowed per tooth, approximately half of the total number of teeth were affected, or precisely 49.7 per cent of all the teeth had open cavities. This group includes only persons of whom I have been making critical examination every six to twelve months over a three-year period. In practically all cases, Roentgen-ray examinations were made in addition to clinical examinations of the teeth. While these persons have been on the reinforced nutritional program during the winter and spring months of the past three years, only two new cavities have developed in the group, or 0.4 per cent. The length of time during which the cavities previously found had been developing is not known beyond the fact that all of the patients were receiving frequent and thorough dental service, most of them twice a year and many of them more frequently. It is accordingly probable that the cavities found had developed in less than a year. That dental caries was not a new problem with these persons was indicated by the very extensive and numerous dental restorations that had been made in their mouths. It is, therefore, apparent that 250 times as many cavities developed in the period preceding the starting of the nutritional program as in the three years following its adoption. If these data were reduced to a yearly basis, the comparison would show a much wider variation.

In a group of fifty persons, including the above mentioned seventeen, who had been on the special nutritional program for from one to six years, most of them three years or more, only two new cavities developed. Allowing these persons to have an average of twenty-eight teeth per person, or a total of 1,400 teeth, this would represent an incidence of dental caries in a period of three years of 0.14 per cent. In this group of fifty, there are many instructive and striking cases.

For example, H. F. did not have a single cavity from October, 1932, to June, 1933, while taking additional vitamins and high mineral foods. From June, 1933, to May, 1934, while not taking the special vitamins, she developed ten new cavities.

S. K., prior to 1931 had rampant tooth decay with pulps nearly exposed in all first permanent molars. The remaining deciduous teeth had been reduced to shells. She was on the special nutritional program from December, 1931, to June, 1932, during which time caries was completely arrested. She discontinued taking special oil in June, 1932, and did not take it again until October, 1933, during most of which time she was taking viosterol under a physician's prescription to prevent dental caries. She came in October, 1933, with fourteen new cavities. She was immediately placed again on the special program, from October, 1933, to May, 1934. During this period, the dental caries was completely under control. During the time that she was not on the special program, there developed on many of the surfaces of the permanent teeth white patches of decalcifying enamel. Under the reinforced nutritional program, these largely disappeared, and those that did not regain their translucency turned dark.

Among the group of seventeen J. H., sent in from another city, had thirty-eight open cavities in June, 193 1. In addition to active caries, he had quite disturbing heart symptoms, which curtailed his activity, and he also had a marked sense of lassitude and weariness. He has been on the reinforced nutritional program during the fall, winter and spring of each year since that time. During this time, he has not developed a single new cavity. The density of all the teeth has progressively improved as evidenced by Roentgen-ray records. His physical condition has been greatly improved so that he is able to carry on his college activities and heavy outside work to earn money to maintain his college expenses. He is not conscious of a heart limitation. When asked what the principal change was that he had noticed, he said that in addition to not feeling tired, he was more rested with six hours' sleep than formerly with ten hours'.

A. W. had thirty-two new cavities in the two years previous to beginning the special nutritional reinforcement. She continued this regularly during the winter and spring months for three years and has not had a single new cavity since that time.

In a group of children whose mothers had the special nutritional reinforcement during gestation and lactation and who had been provided with the same dietary adjuncts during the winter and spring months of infancy and early childhood, not a single carious cavity has developed. A number of these children are now in public schools. Their physical development is distinctly above that of the average children of their age, as is also their efficiency in school work.

It is important that I emphasize here some dangers that are not usually recognized or properly emphasized in the literature. When fish oils including cod liver oils are given in too large doses to

some patients they experience quite definite symptoms of depression. The available evidence indicates that fish oils that have been exposed to the air may develop toxic substances. My work and that of others with experimental animals has demonstrated that paralysis can be produced readily by over-dosing. Serious structural damage can be done to hearts and kidneys. I have reported this in considerable detail. (4) My investigations have shown that when a high vitamin natural cod liver oil is used in conjunction with a high vitamin butter oil the mixture is much more efficient than either alone.4 This makes it possible to use very small doses. Except in the late stages of pregnancy I do not prescribe more than half a teaspoonful with each of three meals a day. This procedure appears to obviate completely the undesirable effects. As stated elsewhere fish oils should be stored in small containers to avoid exposure to the air. Rancid fats and oils destroy vitamins A and E, (5) the former in the stomach. (6)

I am frequently reminded that ancient skulls are often found with extensive dental caries thus disproving that the primitive groups were more free from dental caries than the modern groups. It must be kept in mind that the fundamental laws of Nature have been in operation as long as animals and men have been on the earth. In my investigations among primitive races, I have been concerned particularly with the study of changes that have taken place both in immunity to dental caries and in the environment, including the foods used. It has been important that I find large groups with relatively high immunity to dental caries to be used as controls. There is great need, accordingly, that additional data be provided. Fortunately, this need is being met. There have just come to my desk two interesting reports; one, from Dr. Arne Hoygaard (7) and the other from Dr. P. O. Pedersen. (8) These two distinguished scientists have spent a year in East Greenland among the Eskimos in that very barren and isolated region. The percentage of teeth found attacked by dental caries among the isolated Eskimos of East Greenland is exceedingly low, less than 1 per cent. Where the Eskimos were in contact with modernized store foods at the port, tooth decay was active. The conditions which they have found were apparently not quite so favorable as in the groups I studied in Alaska. The Greenland Eskimos apparently are living in a more difficult environment. The data provided by these investigations are in accord with the data I have obtained among isolated Eskimos and other primitive racial stocks. Eastern Greenland, by international agreement, is administered by the Danish Government and no one is permitted even to visit the coast of Greenland without special permission. This permission is very difficult to obtain. Even Danish citizens are not free to travel there. We are, accordingly, very grateful to Dr. Hoygaard and Dr. Pedersen for their contribution from studies made in that protected field. We shall look forward with interest to their detailed reports.

Unfortunately, the public is very much at sea because of the extravagant claims that are made for many of the products advertised over the radio, in journals, and by door to door solicitation. A dependable and helpful booklet on the vitamin content of foods has been published by the United States Department of Agriculture, Miscellaneous Publications, No. 275. The fact should always be emphasized that foods as Nature makes them have much more nutritional value than after they are processed so that insect life cannot live on them. When foods cannot support insect life they cannot support human life.

A report has just appeared in the September number of the New Zealand Dental Journal by H. H. Tocker on behalf of the Hawkes Bay Branch of the New Zealand Dental Association in which he reports the results of the application of my suggestions in the Hukarere School for native Maori girls at Napier. I have reported my studies there in Chapter 12. They used only one part of my suggestions

for checking the activity of dental caries. The diet of both their control group and tested group was the same except for one item, i.e., "one heaped teaspoonful twice daily of malt and cod liver oil." In a group of sixty-six native girls the thirty-three with the best teeth were used as a control group. The remaining thirty-three were given the additional fat-soluble vitamins. In six months' time ~resistance of this group was raised by 41.75 per cent" as compared with the control group. The nutrition of the test group was not adequately reinforced to obtain the best results. There was a marked inadequacy of mineral carrying foods in proportion to the energy and heat providing factors in the foods. An adequate quantity of such efficient foods should be as readily available today as before the white men came to New Zealand.

It is important to summarize at this point some of the data that I have developed in other chapters because of their direct relation to the control of dental caries and other degenerative processes. Since human life like other animal life has been developed in Nature's laboratory to fit Nature's natural foods we run a great risk when we undertake to modify seriously these foods. Bakers' so-called whole wheat bread is not comparable to Nature's foods that provide entire wheat and other cereals, because of the factors that have been removed from the wheat either mechanically or by oxidation. This is so large a problem that adequate changes in the available grain foods cannot be made until there 15 sufficient public demand to produce them through the normal channels of supply and demand. It is primarily a problem for our Federal and State governments. Packaged foods containing dry cereals can undergo important changes, even while the material is being processed or while in packages on the shelves. The determinations of the loss of vitamins in packaged foods as reported in 1938 by the Agricultural Experimental Station of Oklahoma Agricultural and Mechanical College, reveal that a material loss occurs in two weeks' time and a very serious loss in one to two months' time in certain stock rations.

An important source of misapprehension is the literature and teachings of fadists. Such, for example, as the misapprehension of many people that they must use only alkaline producing foods and that a great danger is associated with the use of acid producing foods. In the primitive races I have found practically no difference between the acid balance meat diet of the isolated Eskimos of the far north and the less acid vegetable and milk diet of other groups as efficient factors in control of caries. It is important to keep in mind that our bodies have a mechanism for maintaining proper acid and alkali balance in the blood and this varies through only a very narrow limit whether the balance of the total food eaten is acid or alkaline. It is also important to have in mind that there are certain fat-soluble vitamins provided in dairy products in adequate quantity that cannot all be supplied in fish oils. Also that overdosing with cod liver oil and other fish oils can be definitely detrimental. When packages of cod liver oil are purchased from the trade the material should be received in full containers not exposed to air and when opened should be transferred to small units so it is not progressively oxidized during the period of its use.

The excess of calories over body building minerals is exceedingly high in sweets of various kinds regardless of their special branding and the methods of manufacture and storage. There is very little of the body building minerals in maple syrup, cane syrup from sugar or honey. They can all defeat an otherwise efficient dietary. The problem is not so simple as merely cutting down or eliminating sugars and white flour though this is exceedingly important. It is also necessary that adequate mineral and vitamin carrying foods be made available. It is also necessary to realize that many of our important foods for providing vitamins are very low in body building material. For example, one

would have to eat nearly a bushel of apples a day or half a bushel of oranges to obtain a liberal factor of safety for providing phosphorus; similarly one would be required to eat nine and one half pounds of carrots or eleven pounds of beets each day to get enough phosphorus for a liberal factor of safety, while this quantity would be provided in one pound of lentils or beans, wheat or oats. I have discussed elsewhere the availability of phosphorus depending upon its chemical form. Since the calories largely determine the satisfying of the appetite and since under ordinary circumstances we stop when we have obtained about two thousand to twenty-five hundred very little of the highly sweetened fruits defeats our nutritional program. We would have to consume daily the contents of thirty-two one pound jars of marmalade, jellies or jams to provide a two gram intake of phosphorus. This quantity would provide 32,500 calories; an amount impossible for the system to take care of.

Milk is one of the best foods for providing minerals but it may be inadequate in several vitamins. Of all of the primitive groups studied those using sea foods abundantly appear to obtain an adequate quantity of minerals particularly phosphorus with the greatest ease, in part because the fat-soluble vitamins provided in the sea foods (by which I mean animal life of the sea) are usually high. This enables a more efficient utilization of the minerals, calcium and phosphorus.

As I study routinely the sample dietaries being used by people suffering from dental caries, usually associated with other disturbances, I find large numbers who are not getting in their food even half the minimum requirements of calcium, phosphorus and magnesium and iron and usually only a fraction of the minimum requirements of the fat-soluble vitamins. These latter have a role which in many respects is like the battery of an automobile which provides the spark for igniting the fuel. Even though the tank is filled with gasoline there is no power without the igniting spark.

There are two programs now available for meeting the dental caries problem. One is to know first in detail all the physical and chemical factors involved and then proceed. The other is to know how to prevent the disease as the primitives have shown and then proceed. The former is largely the practice of the moderns. The latter is the program suggested by these investigations. Available data indicate that the blood and saliva normally carry defensive factors which when present control the growth of the acid producing organisms and the local reactions at tooth surfaces. When these defensive factors are not present the acid producing organisms multiply and produce an acid which dissolves tooth structure. The origin of this protective factor is provided in nutrition and is directly related to the mineral content of the foods and to known and unknown vitamins particularly the fat-soluble. Clinical data demonstrate that by following the program outlined dental caries can be prevented or controlled when active in practically all individuals. This does not require either permission or prescription but it is the inherent right of every individual. A properly balanced diet is good for the entire body.

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Chapter 17

ONE ORIGIN OF PHYSICAL DEFORMITIES

FACES are classified on the basis of physical characteristics and appearances which identify them as having a common ancestry. The constant reproduction of ancestral patterns constitutes one of the fundamental laws of heredity. We are concerned here with the divergences from the normal course of reproduction.

The precision with which Nature reproduces widely distributed racial stocks demonstrates how deeply seated and controlling are the Mendelian laws. In Fig. 98 may be seen four young men of the Melanesian race born on four different islands. They have never seen each other, yet they look like brothers. Similarly, in Fig. 99 are shown four Polynesian girls. Here again they look so much alike that they might readily be taken for sisters. Yet, they live in four different groups of Polynesian islands; the Hawaiian, the Samoan, the Tahitian, and the Rarotongan.

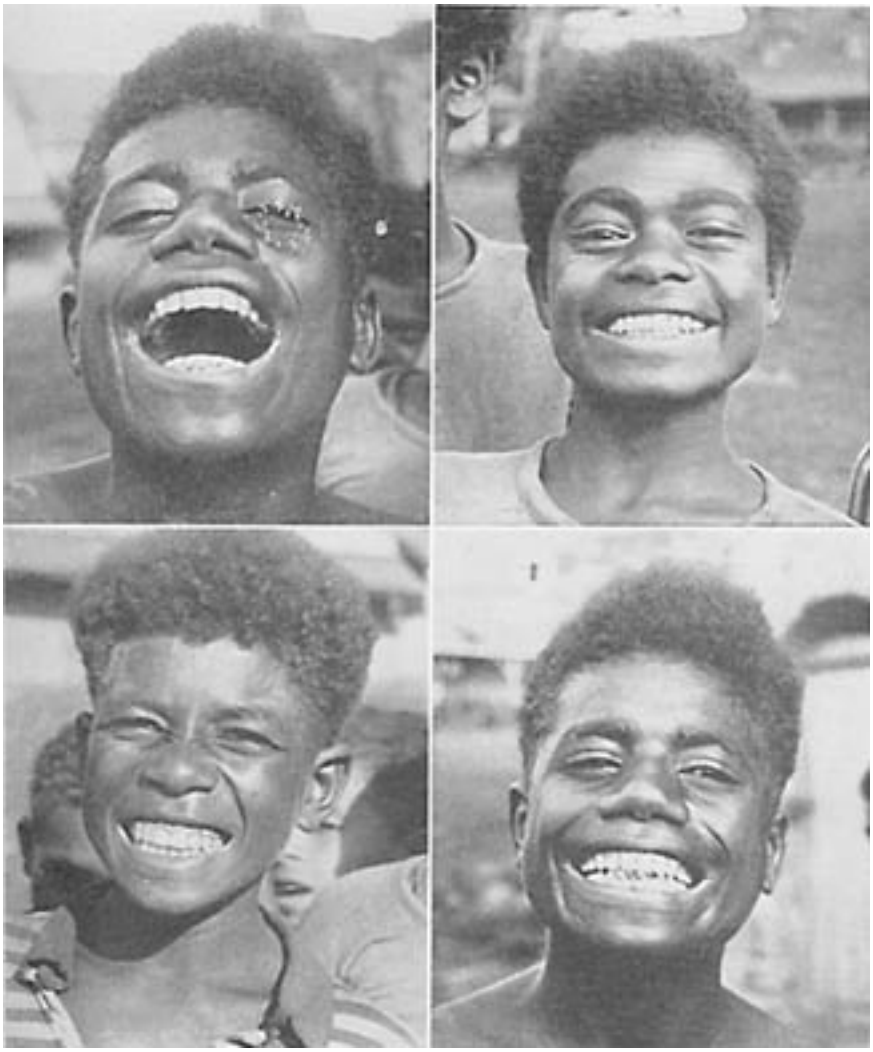

FIG. 98. These four Melanesian boys born on different islands look like brothers but are not blood relations. They illustrate the role of heredity in reproducing racial type. Heredity, however, can only operate normally when the germ cells have not been injured.

99. These four Polynesian girls live on different islands and are not related though they look like sisters. They record their racial type by undisturbed heredity.

The blending of different racial stocks produces typical characteristics of either or both ancestral patterns. When, however, marked divergences appear without mixing of racial stocks, the result is not due to heredity, but occurs in spite of heredity. In the previous chapters, I have shown that in the modernized groups of various primitive racial stocks, ccrtain individuals developed marked changes in facial and dental arch form from the racial pattern. We are interested to know the nature of the forces responsible for this distortion of the ancestral pattern. In a study of 1,276 skulls of the ancient civilizations of Peru, I did not find one with a typical divergence from normal such as we find in modern whites or in children of primitive racial stocks after the parents have adopted the foods of our modern civilization. It is important that we study this phase in further detail.

In Fig. 100 are shown two Indian fathers and their sons, whom we studied in Peru. The father and son shown above lived at Talara, in a highly modernized Indian colony. The father worked in the oil fields on the coast. This district is an arid desert into which practically all food has to be shipped for the large colony engaged in the oil industry. The father was born while his parents were using the native foods of the coast, including an abundance of sea foods. The son was born to his parents after they had adopted the foods of modern civilization. The father and son shown below, lived in the high Sierras. The father is an Indian descendant of the Incas and was born while his parents were living on the native dietary of the high plateau country, near Cuzco. After the adoption of the modern foods by

the parents, the son shown to the right was born. It is important to keep in mind that the marked change in these fathers and sons has occurred in the first generation after the parents have adopted the white man's foods, and has occurred in spite of heredity.

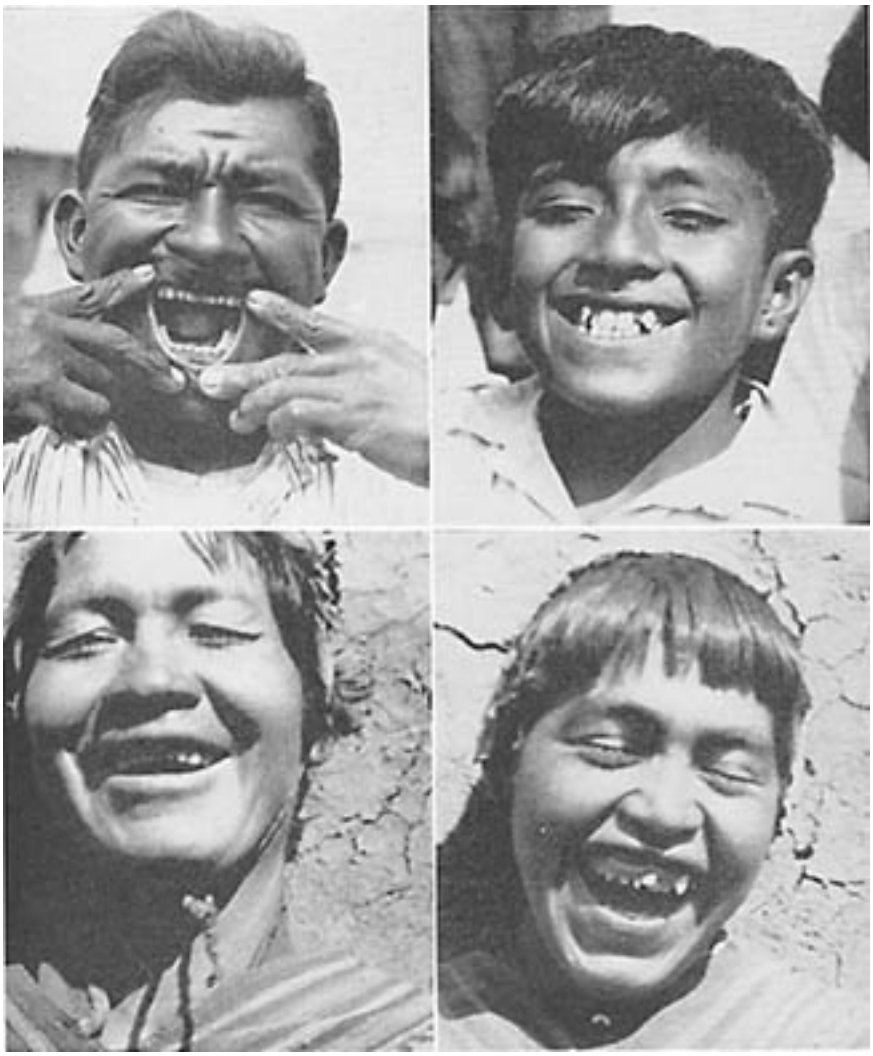

FIG. 100. Disturbed heredity. Above, father a primitive coastal Indian of Peru with normal facial and dental arch development. Son at right presents distortions of both facial and dental arch form. Below, father a primitive Andean Indian with excellent facial and dental arch form. His son at right has not reproduced the racial pattern. Both sons are full blood.

In Fig. 101 above is shown a Wakamba father in central Africa, a man who is working for the railroad company which contributed largely to the food supply for the laborers. The boy shown at the right was born after the parents had adopted the imported foods. In the lower picture, in Fig. 101, is seen a Fiji Islander and his son. The father was born to parents living on the native foods, and his son was born after the adoption of the white man's foods. All these are typical cases of the inhibition of Nature's normal procedure. We have additional data which indicate that our problem is associated with a progressive lowering of reproductive capacity on the part of one or both of the parents.

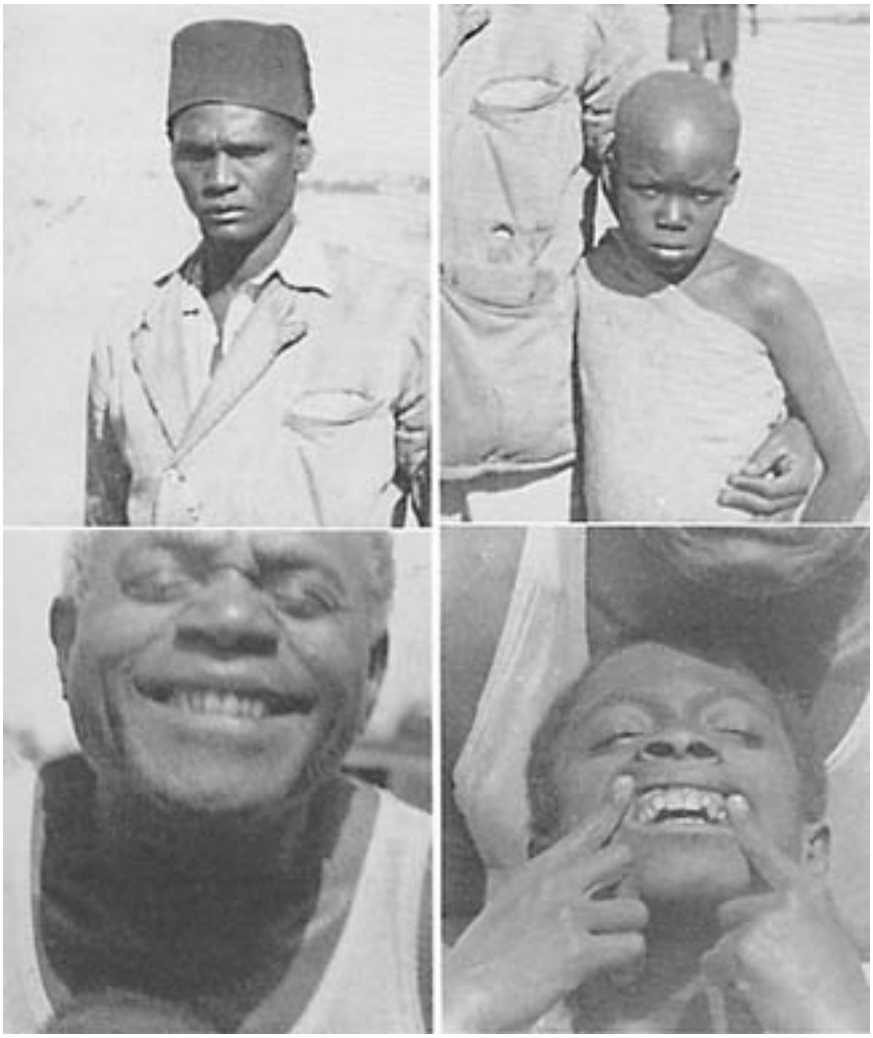

FIG. 101. Disturbed heredity. Above, the father is a primitive Wakamba of Central Africa. His son at right has not reproduced the tribal pattern. Below, the father presents the typical Fijian primitive facial and dental arch form. His son at right has a narrowed arch and change in facial form. Both sons are full blood.

In photographing the members of modernized families, regardless of racial stocks, we frequently find that changes in facial expression appear in the younger members of the family. This change in facial contour within a family does not occur in the primitive races, while on their native dietary.

In contrast with this we see, in Fig. 102, two sisters and two brothers. In each pair there is a marked change in the facial form of the younger. The arches and the nostrils of the younger child are narrower and there is a marked lack of development in both the middle and lower thirds of the face.

FIG. 102. Disturbed heredity. Quichua Indians. Note the marked change in shape of the face and dental arches of the younger sister at the right. Also of the younger brother at the right. These families demonstrate a lowering of reproductive capacity of the parents with the later born children.

Very striking illustrations of this progressive degeneration in the children of a given family were found among the modernized aborigines of Australia. Two views of brothers are shown in Fig. 103 (upper). The father and mother of these two boys were born in the Bush. They were living, when photographed, in one of the reservations, on the imported modern foods which were provided by the government. This is also illustrated in the lower photograph. Note the marked underdevelopment of the middle third of the face of the girl.

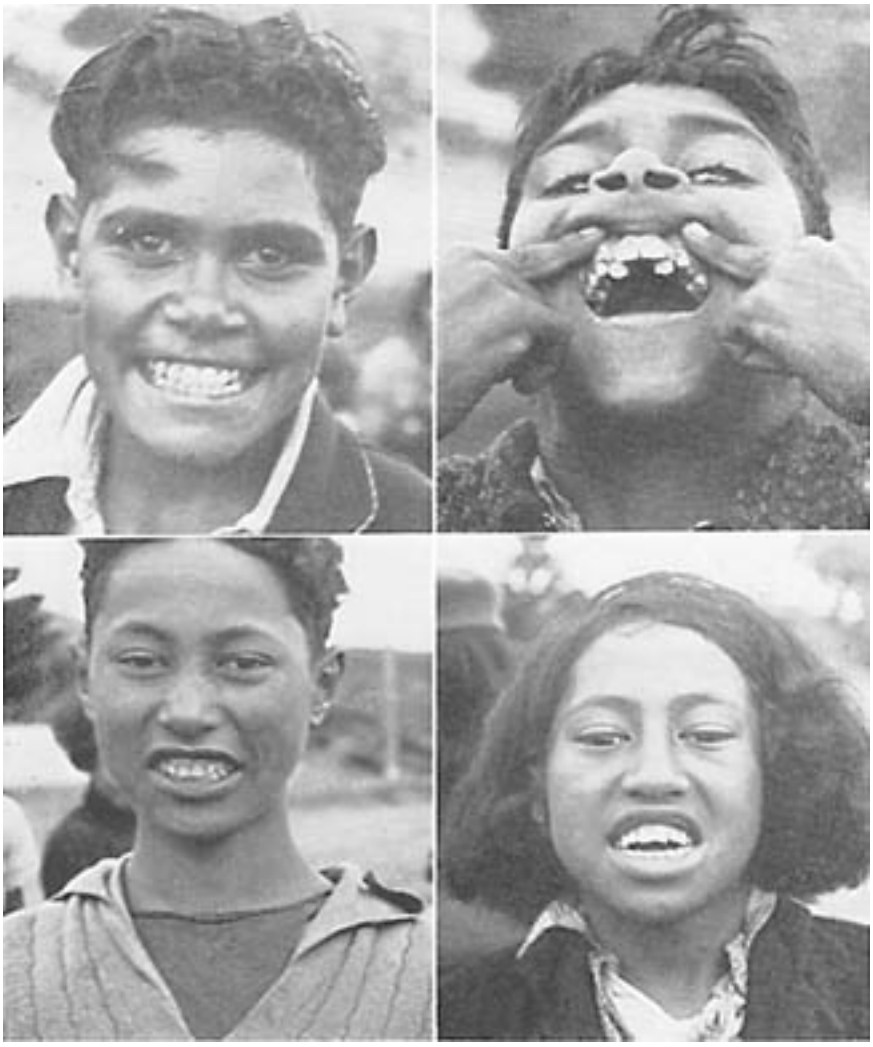

FIG. 103. Disturbed heredity. These children are Australian Aborigines. Note the marked change in facial and dental arch form in the younger child at the right in both families. This is depressed reproductive capacity of the parents.

Striking instances were frequently seen among the modernized Maori of New Zealand. Two sisters presenting two extremes of facial form are shown in the upper section of Fig. 104. The girl to the left is the older. She has the typical tribal pattern which has been completely lost in her younger sister to the right.

FIG. 104. Above, two Maori girls in New Zealand and below, two white girls in Peru. Note the facial change in the girls at the right compared with their older sisters.

If the change in facial form were the result of racial admixture, we should not have the types of deformity patterns that these cases show. Indeed, in the same family we should not find several different deformity patterns. The lack of development downward of the upper anterior incisors and the bone supporting them is illustrated for the younger child, in Fig. 103 lower right. It will be noted that when this girl's molar teeth are in contact her front teeth still miss occluding by a considerable distance.

Members of the white race are affected in a similar manner. In Fig. 104 (lower) are shown two sisters; the younger to the right reveals strikingly the lack of development of the middle and lower third of the face. The fact that this condition so frequently shows a progressively severe injury in the younger members of the family is a matter of great importance in tracing the causative factors. It is important to keep in mind that when the injury shows in the face of the young child it becomes worse when the adult face forms. This increase in deformity occurs at the time of the development of the permanent dentition, at from ten to fourteen years of age.

In the islands north of Australia where contact with modern civilization is just being made, the adult individuals showed a constant reproduction of the tribal pattern, while those born since contact was made, had many divergences from normal. In Fig. 105 will be seen a family of six individuals.

Four were born before the modern store was put on that island and two after the parents had come into contact with the influence of the imported foods. It will be seen that the four older brothers show marked uniformity of facial design, and that all have reproduced the tribal pattern. The two younger members show definite change in facial pattern. This is also illustrated in Fig. 106 above, in which the oldest brother was born before the store was put on Badu Island, and the three younger, after the establishment of the store twenty-three years ago.

FIG. 105. Of these six brothers the four older were born on Badu Island before the white man's store was established. The two younger at right below, after. Note change in facial form.

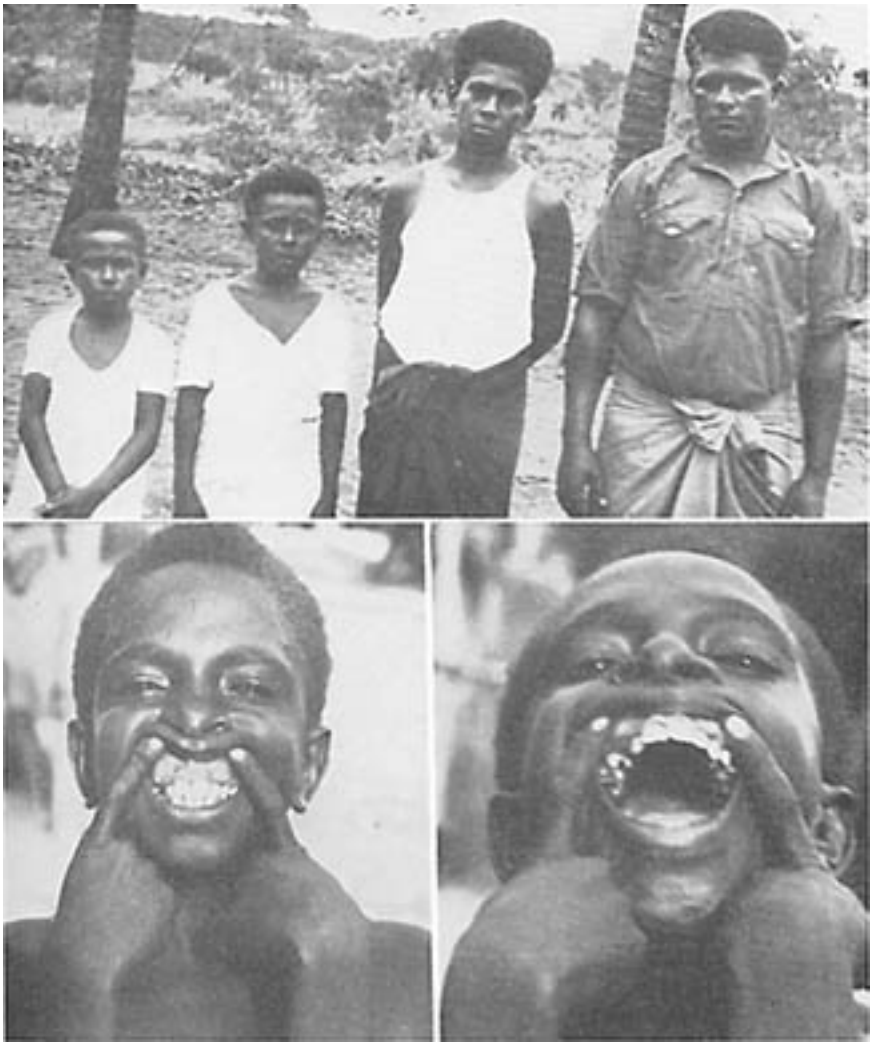

FIG. 106. Above, the brother at the right was born before the store was put on Badu Island, the three younger, after. Note the change in facial form. Below, note that the dental arches are too constricted to provide space for the erupting cuspids. This boy is the one shown at the left in Figure 107.

This problem of progressive degeneration in the younger members of the family is again illustrated by the group shown in Fig. 107. The older girl has reproduced the tribal pattern of the race with normal broad, dental arches. The second girl shows marked narrowing and lengthening of the face. The third child, a boy, shows very marked divergence from the tribal pattern. This group is shown below with their teeth exposed. It will be seen that the oldest girl has broad dental arches typical of Nature's normal design. The second girl has a marked depression laterally in the molar and bicuspid region producing a narrowing of the palate. The third child has in addition to the narrowing of the face a marked deficiency in bone growth so that the cuspids both above and below are forced entirely outside the arch. The total circumference as well as the breadth of the upper arch is so reduced that space is not available for the cuspids. They will be seen imbedded high in the tissue, as illustrated in the lower picture of Fig. 106.

FIG. 107. Natives from islands north of Australia. Above, note the progressive facial change in the younger sister and brother with lengthening and narrowing of the face and body. Below, note the broad arches of the oldest girl at the right, lateral depression of the bicuspids and molars of the next girl and inadequate bone development of the boy's face. These are on an island north of Australia.

Fig. 108 shows three white girl scouts in New Zealand. Note that progressive narrowing of the body including both shoulders and hips has occurred in the younger members of the family. This is also shown in Fig. 107.

FIG. 108. White Girl Scouts, New Zealand. Note the progressive lengthening and narrowing of the face and narrowing of the hips in the younger girl at the left.

It would be remarkable if these disturbances in the physical pattern were limited to the face and dental arches. An illustration of other deficiency injuries is shown in Fig. 109, which shows three children in a modernized Maori family. It will be seen that while the oldest girl has the typical Maori racial pattern of face, there is a marked lack of development of the middle third of the face, with progressive severity of distortion in her two younger brothers. On observing the feet it will be seen that she has splendidly formed feet while the second child has flat feet, and the third child has clubbed feet.

FIG. 109. New Zealand Mann. Note the progressive change in facial form of the two younger boys as compared with their older sister. Then note the progressive change in their feet. Normal feet, flat feet and club feet.

I have found similar examples in several of the modernized primitive racial stocks. The severity of the disturbing factors may be different under different circumstances. Drought, industrial depression, unemployment, and the like, all have their influence. In Fig. 110 will be seen three Maori children of New Zealand; the second child is smaller in stature than the third and gives more evidence of facial injury. While his older sister and younger brother have normal feet, his quite severe disturbance in facial growth is associated with club feet.

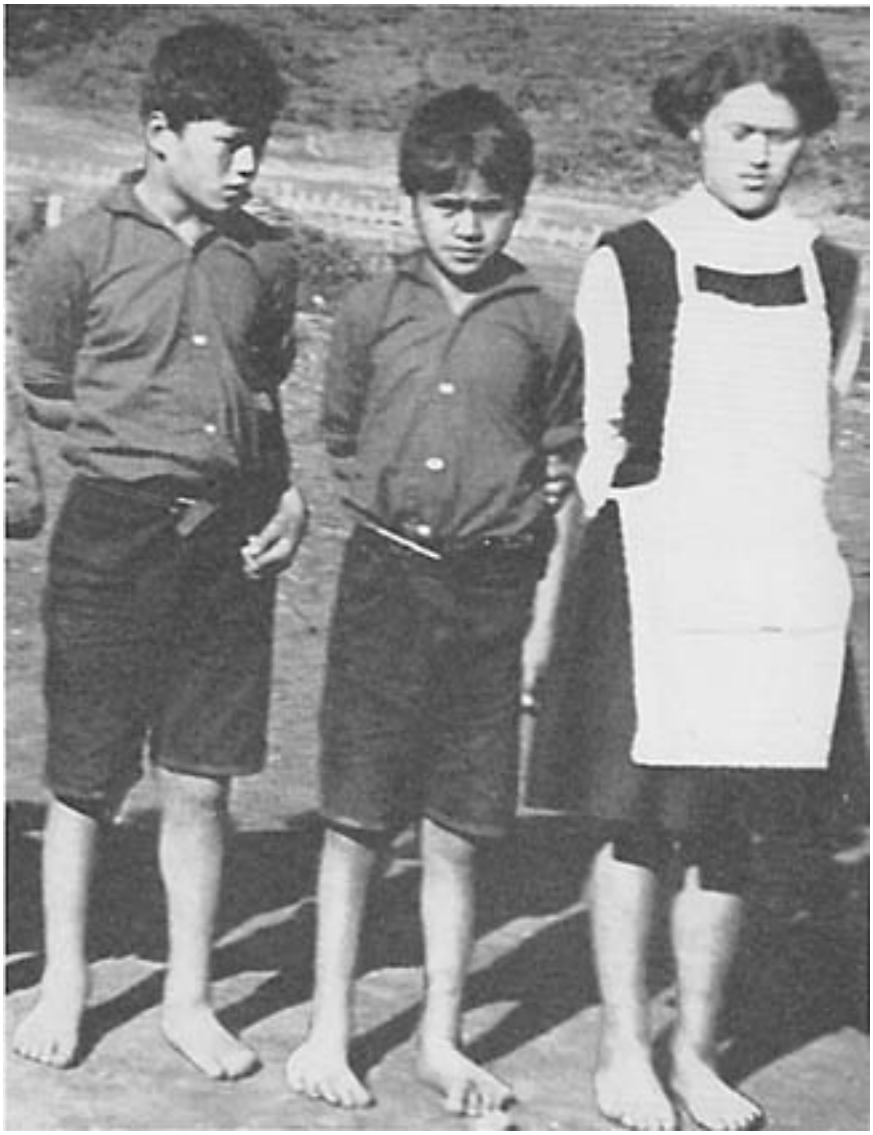

FIG. 110. New Zealand Maori. Note the marked undersize of the second child and underdevelopment of the face associated with marked deformity of the feet.

I have one patient who was the seventh of a family of eleven children. All the children in the family have good facial development, except this patient. She was born in the midst of a severe financial depression when the total amount of money available for the food for the family was reduced to a very low level. The other children were born before or after the depression, and were not injured. In addition to this patient's severe facial deformity, she has had some arthritis and a general rheumatic tendency. Her facial injury is marked and is characterized by a lack of development of the middle third.

Deformities of the feet associated with facial deformity have been found in several modernized groups of primitive racial stocks. A typical case among the modernized Indians of Peru is shown in Fig. 111. The face of this boy shows abnormal development with narrowing of the upper arch and displacement of the teeth. This is associated with gross deformity of one foot and shortening of the leg. He lives in the high country. This phase is strikingly illustrated in Fig. 112 where the face is very badly injured and both feet are seriously clubbed. This boy is a Coastal Indian.

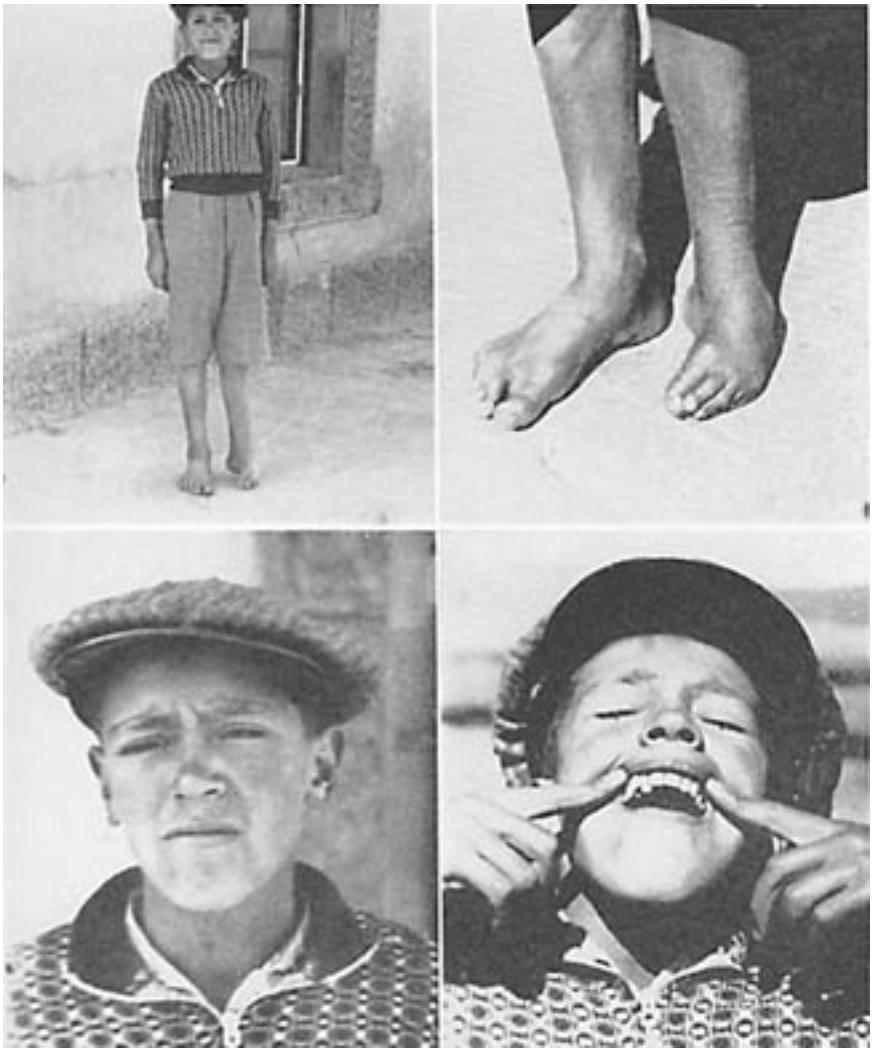

FIG. 111. This boy is a modernized Indian in the high Sierra of Peru. Note the disturbed development of the face associated with the deformity of one foot.

FIG. 112. This is a modernized coastal Indian of Ecuador. Note the serious facial and dental arch distortion associated with club feet.

The serious expressions of physical deformities which we found had occurred in several primitive racial stocks, after they have become modernized sufficiently to be using the foods of our modern civilization, are occurring in our modern American families with equal severity and great frequency.

One method for determining the cause of these deformities is through an examination of birth and death certificates to note the recorded data relative to physical deformities. An outstanding contribution to this approach has been made by Dr. D. P. Murphy, of the University of Pennsylvania. In an examination of 130,132 individual death certificates that have been recorded between 1929 and 1933, he found physical deformities recorded in 1,476 cases. Dr. Murphy sent field workers to make a personal study of the family histories by contacting the mothers or grandmothers, of whom they were able to locate 890. From this group he was able to select 405 with sufficiently complete family histories to allow tabulation in a form that would throw light upon the birth rank and other data. His studies strongly emphasize the presence of a period of low reproductive activity. In concluding one of his reports he states: (1)

Miscarriages, stillbirths, and premature births occurred more often than would be expected by chance in the pregnancies immediately preceding and immediately following the pregnancy

> which resulted in the birth of a defective child, and less often than would be expected by chance in the remaining pregnancies. Miscarriage, stillbirth, and premature birth occurred most often in the pregnancy immediately preceding that of the defective child.
>
> From the above observations, it is concluded that the birth of a congenitally malformed child may be only one expression of a prolonged decrease in functional reproductive activity, the other expressions being miscarriages, stillbirths, and premature births.
>
> It is suggested that the obstetrician has unusual reason to suspect the possible existence of a congenital malformation in the pregnancy which follows immediately after a miscarriage, a stillbirth, or a premature birth.

Shute, of the University of Western Ontario, London, Canada, in a personal communication, states that he has been impressed, in his studies of aborted fetuses, with the large percentage that are malformed. This seems to link the malformations with the causative factors which have resulted in decreased reproductive activity.

In connection with the production of imperfect infants, the period in the formative process at which the injury occurs and also its origin are important. Murphy has thrown important light on this phase in his study of the cause of the defectives in forty families with two or more malformed. (2) He concludes: "Many if not most of the congenital malformations met with in this study resulted from defects in the germ plasm, which were present before fertilization."

Among the important questions that arise is the relative responsibility of the two parents. As an approach to this phase Murphy (2) has made a study which deals with a consecutive series of 884 families in each of which there appeared at least one congenitally malformed child. In forty of these families, there were two or more malformed brothers and sisters. He presents extensive data in tabular form from which he takes examples to illustrate his interpretation. He states under the "Clinical Value of Study" the following:

> It is evident from the above data (tables) that there is a strong tendency for congenital malformations to duplicate in siblings that belong to a consecutive series of families. And also that such defects tend to appear rather frequently among their more distant relatives. This duplication of malformations is to be observed in the case of the more serious types of defects, just as it is noticed in the less serious ones. These findings lend support to the theory that congenital malformations are primarily the result of influences which affect the germ cells prior to, rather than after, fertilization. The validity of this theory is emphasized by three examples taken from Tables I and II. Family 17 in Table I contained 3 children with pyloric stenosis, two of which were twins. Family 6 in Table II possessed 2 siblings with cleft palate, conceived by the same father, but born to different mothers. Family 8 in Table II contained 2 children both exhibiting an absence of the right half of the diaphragm. It does not seem likely that such sequences of events as these could be the result of any forces that did not operate until after fertilization had taken place. . . .
>
> Since, as has been shown in a previous report, congenital malformations are 24 times more common in siblings of defective children than in the population at large, the present observations should be of added clinical interest.

Summary and Conclusions

1. A consecutive series of 40 families having 2 or more congenitally malformed children has been studied with respect to the duplication of defects in siblings.
2. The defect observed in the first malformed child reappeared in a subsequent malformed sibling in about 50 per cent of all cases; the 50 per cent remaining including all other possible defects.
3. In a second group of 39 consecutive families, in which a malformed child possessed a malformed relative, the malformation in the child and in the relative were identical in about 41 per cent of cases.
4. In 19 non-consecutive families with 2 or more malformed children, the defect of the first child repeated in a subsequent child in over half of the families.

It is significant that while these important factors are just coming to light in our modernized civilization, the evidence clearly indicates that several so-called primitive races have been conscious of the need for safeguarding motherhood from reproductive overloads which would reduce the capacity for efficient reproduction. For example, G. T. Baden (3) in his book "Among the Ibos of Nigeria" states:

> It is not only a matter of disgrace but an actual abomination, for an Ibo woman to bear children at shorter intervals than about three years. . . . The idea of a fixed minimum period between births is based on several sound principles. The belief prevails strongly that it is necessary for this interval to elapse in order to ensure the mother being able to recuperate her strength completely, and thus be in a thoroughly fit condition to bear another child. Should a second child be born within the prescribed period the theory is held that it must inevitably be weak and sickly, and its chances jeopardized.

Similarly, the Indians of Peru, Ecuador and Columbia have been familiar with the necessity of preventing pregnancy overloads of the mother. Whiffen (4) in his book "North-West Amazons" states:

> The numbers (of pregnant women) are remarkable in view of the fact that husbands abstain from any intercourse with their wives, not only during pregnancy but also throughout the period of lactation--far more prolonged with them than with Europeans. The result is that two and a half years between each child is the minimum difference of age, and in the majority of cases it is even greater.

It may also be important to note that the Amazon Indians have been conscious of the fact that these matters are related to the nutrition of both parents. Whiffen states that:

> These Indians share the belief of many peoples of the lower cultures that the food eaten by the parents--to some degree of both parents--will have a definite influence upon the birth, appearance, or character of the child.

This problem of the consciousness among primitives of the need for spacing children has been emphasized by George Brown (5) in his studies among Melanesians and Polynesians in which he reports relative to the natives on one of the Solomon Islands as follows:

> After the birth of a child the husband was not supposed to cohabit with his wife until the child could walk. If a child was weak or sickly, the people would say, speaking of the parents, "Ah, well, they have only themselves to blame."

These new data have a very important bearing on the problems of degeneration in our modern civilization. Since it is true that a racial pattern can be changed in a single generation our modern concept and teaching with regard to the role of heredity must be modified, in its relationship to cause and effect. A deformity arising from intercepted heredity is just as truly biologic as a deformity arising from accumulated impacts as expressed in heredity. Instead of blaming the past generations for the distortions or frailties of our modern generation and thus relieving our own generation of responsibility these new data indicate that the social organization that is creating these divergencies from normal must alone accept the responsibility.

This completely changes some aspects of the theories and practice of modern social education. Instead of planning the care and management of distorted personality as though the lesion were the result of environmental influences upon a normally organized individual, it should be looked upon as a distortion affecting one link in the chain of heredity which is neither the result of the distortions of previous links nor a controlling factor for future links in the chain. The prognosis, in other words, while being bad for the individual is not necessarily bad for his or her descendants.

While many of the individuals who have suffered physical distortions have apparently practically normal brain development we shall see in the following chapter that a certain percentage have so great a disturbance in brain organization that they cannot and should not be considered as individually responsible for their behavior.

It is urgent therefore that the data presented in this chapter be looked upon as an important key to the progressive degeneration that is taking place in many parts of the world under the influence of our so-called modern civilization. It is a matter of profound significance that the most primitive races were originally able to avoid the physical degeneration so general in many communities today. It is also a matter of importance that the primitives recognized not only these dangers but were conscious of and practiced adequate means for preventing them. They had sufficient character to achieve the ends which they deemed essential. Weakness in character may constitute the greatest barrier in the reorganization and conservation of our modern civilization.

Two serious defects from which many individuals in our modernized civilization suffer are impacted teeth and the absence of teeth due to their failure to develop. It is significant that in the arches of the primitive races practically all teeth form and erupt normally, including the third molars. In the modernized primitives and among our modern whites with deformed dental arches many teeth are impacted and often several of the permanent teeth have never formed. The evidence indicates that this, like the facial and dental arch deformities is due to an absence of vitamin A in the diet of the mother during the gestation period or of one or both of the parents prior to conception. The cause is discussed in the next chapter.

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Chapter 18

PRENATAL NUTRITIONAL DEFORMITIES AND DISEASE TYPES

A RELATIONSHIP between physical types and certain disease susceptibilities has been recognized by diagnosticians for centuries. The skill of many physicians in reading intuitively and from external signs the nature of their patients' troubles when these could not be classified with precision played an important part in the successful warfare against disease in the period preceding the advance in modern laboratory technique. For many of the old-time physicians, these constitutional qualities were expressed as diathesis. An individual would be recognized as having a phthisical diathesis (a susceptibility to tuberculosis). Similarly, the arthritis group had a rheumatic diathesis. While modern science has undertaken to express its findings numerically, the problem of reducing the diatheses to mathematical formulas has required so many overlappings, that it has been impossible to establish definite limiting boundaries.

In my investigations regarding the types of individuals who develop rheumatic group lesions as a result of dental focal infections, (1) I found that individuals could be divided into very definite groups in which 15.05 per cent with severe lesions belonged to families in which similar disease symptoms had occurred. Evidence was disclosed of a systemic factor that played a controlling role in determining whether or not the individual would be seriously injured from dental focal infections. It became very clear that the soil was quite as important a determining factor as was the type of infection. This finding led me to broaden the scope of my investigations to include a search for control cases that were free from the degenerative processes. I was not able to find these controls in the clinical material afforded by our modern civilization, and therefore extended the search to isolated primitive racial stocks.

Associated with a fine physical condition the isolated primitive groups have a high level of immunity to many of our modern degenerative processes, including tuberculosis, arthritis, heart disease, and affections of the internal organs. When, however, these individuals have lost this high level of physical excellence a definite lowering in their resistance to the modern degenerative processes has taken place. To illustrate, the narrowing of the facial and dental arch forms of the children of the modernized parents, after they had adopted the white man's food, was accompanied by an increase in susceptibility to pulmonary tuberculosis.

In Fig. 113 will be seen four young people, examined in the tuberculosis wards of the Juneau (Alaska) Hospital for Indians and Eskimos. All exhibited marked evidence of prenatal injury. Note the cuspids erupting outside the line of the arch. The teeth of the upper arch of the boy at the upper left, pass inside the teeth of the lower arch. His upper arch is so narrow that even a finger could not be passed between the lateral walls. These pictures had to be taken with short exposures in the poor light of the wards. They reveal, however, the conditions.

FIG. 113. Eskimo children seriously ill in the tuberculosis wards of the government hospital at Juneau, Alaska. They were too ill to be moved to good light for photographing. Every tubercular child in these wards had disturbed facial development and deformed dental arches. The parents were living on modern foods.

In Figs. 114 and 115 are shown several individuals photographed in the tuberculosis hospital in New Zealand. Note the lack of development of the middle third of the face and the narrowing and lengthening of the face. In several individuals the teeth of the upper arch closed inside the teeth of the lower arch, instead of outside, as in normal persons. Here again, 100 per cent of the young people with tuberculosis gave evidence of injury in the formative period, and 91.2 per cent of the total number of patients were found to have disturbed dental arches.

FIG. 114. These are patients in the Maori Hospital for tuberculosis in New Zealand. Note the very marked underdevelopment of the middle third of the face above and of both middle and lower thirds of the face below. Every patient under thirty years of age in these wards had deformed dental arches and disturbed facial development.

FIG. 115. These girls are also in the tuberculosis ward of the New Zealand Hospital for Maori. Note the marked disturbance in development of the face and dental arches. All have pinched nostrils.

In Fig. 116 are shown four typical individuals in the tuberculosis hospitals in Hawaii; one in Hilo and the other in Honolulu. In each of these hospitals 100 per cent of the individuals had abnormal development of the face and dental arches.

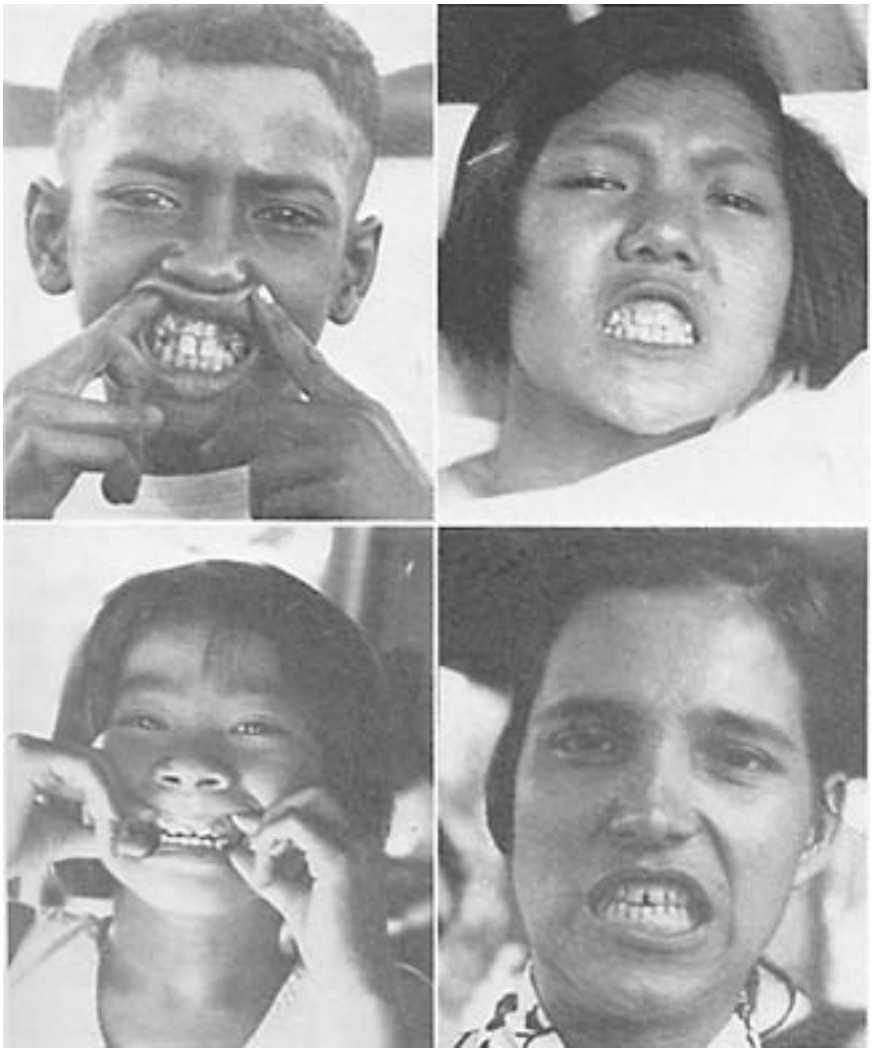

FIG. 116. These are native Hawajians in tuberculosis hospitals. Every child in the wards showed marked disturbance of facial development and dental arch form.

While we know many of the factors contributing to the nature of diatheses, I have found no data dealing with the forces which determine diatheses, except the influence of heredity. The data I am presenting in this volume, deal with forces other than heredity.

An outstanding advance in organizing the data which relate the physical characteristics of individuals to their disease susceptibilities has been made by the Constitutional Clinic of Columbia University and the Presbyterian Hospital of New York, under the able direction of Dr. George Draper. He has found it necessary in order to study man as a whole, to view him from four different angles: "his form, his function, his immunity mechanism and his psychology." These four attributes he has designated as the "four panels of personality." Dr. Draper has published several communications including two textbooks, one entitled, "Human Constitution," (2) and the other, "Disease and the Man." (3) Dr. Draper has approached this problem from the data provided in the medical clinics, and therefore, from the characteristics of affected individuals, whereas my approach has been through a study of the primitive groups and the physical changes and disease susceptibilities which occur as a result of their modernization. The similarity of our conclusions greatly emphasizes the importance of the findings of each. Dr. Draper has emphasized the importance of the face and of the dental arches in the general matter of susceptibility to disease. He closes one of his chapters, entitled *The Relation of Face, Jaws and Teeth to Human Constitution and Its Bearing on Disease*, as

follows:

> The lessons which we have learned from these observations, however, is that the face and jaws hold much information of value to the student of the human being. As clinicians in the field of internal medicine we have been taught to observe the gums and teeth in order to detect possible foci of infection. But for the student of clinical organismalism, the teeth and jaws hold much valuable information about the total personality. For the worker in the dental branch of medicine it would seem that an unusual opportunity is offered for extending such observations and correlations. It may very well be that the dental student who becomes interested in the relation of the mouth to the organism may form a most important link with the responsibilities of internal medicine.
>
> The more we come to view man as a totality, as an organism which functions as a whole and not as a collection of separate elements, the more do all the special branches of medicine become fused with the general concept which forms the basis of this discussion, namely, the relation of the human organism as a whole to those various reactions of maladjustment with environment which we call disease.

It is clear that a definite association of abnormal facial patterns with specific disease susceptibilities exists. From my studies it is also clear that these abnormal facial patterns are associated with influences resulting from a change in the nutrition of the parents of the individual. We are at this point concerned with the forces that underlie these phenomena.

In approaching this problem as it applies to human beings, much can be learned from a study of domestic and wild animals. Until recent years it has been common knowledge among the superintendents of large zoos of America and Europe that members of the cat family did not reproduce efficiently in captivity, unless the mothers had been born in the jungle. Formerly, this made it necessary to replenish lions, tigers, leopards and other felines from wild stock as fast as the cages were emptied by death or as rapidly as new stock should be added by enlargement.

The story is told of a trip to Africa made by a wild animal specialist from the London zoo for the purpose of obtaining additional lions and studying this problem. While in the lion country, he observed the lion kill a zebra. The lion proceeded then to tear open the abdomen of the zebra and eat the entrails at the right flank. This took him directly to the liver. After spending some time selecting different internal organs, the lion backed away and turned and pawed dirt over the carcass which he abandoned to the jackals. The scientist hurried to the carcass and drove away the jackals to study the dead zebra to note what tissues had been taken. This gave him the clue which when put into practice has entirely changed the history of the reproduction of the cat family in captivity. The addition of the organs to the foods of the captive animals born in the jungle supplied them with foods needed to make reproduction possible. Their young, too, could reproduce efficiently. As I studied this matter with the director of a large lion colony, he listed in detail the organs and tissues that were particularly selected by animals in the wilds and also those that were provided for animals reproducing in captivity. He explained that, whereas the price of lions used to be fifteen hundred dollars for a good specimen, they were now so plentiful that they would scarcely bring fifteen cents. If we observe the parts of an animal that a cat eats when it kills a small rodent or bird, we see that it does not select exclusively the muscle meat.

During my biological investigations using animals, I have had barn rats gnaw their way into the room where the rabbits were kept and kill several animals during a night. On two different occasions, only the eyes of the rabbits had been eaten, and the blood may have been sucked. On another occasion the brains had been eaten. It was evident that these rats had a conscious need for special food elements that were provided by these tissues.

No phases of the problem of physical degeneration can be as important as knowledge of the forces that are at work and the methods by which they operate. It is clear from the data presented in previous chapters that these forces can become operative with sufficient speed to make a difference in two generations, one succeeding the other. It is also clear from preceding data that these forces originate in the change of the nutrition of the parents.

A chemical analysis of the food (Chapter 15), discloses a marked reduction in the intake of some of the vitamins and minerals in individuals who are undergoing a degenerative process.

Many investigators have presented important data dealing with the role of vitamin A in prenatal as well as postnatal growth processes. It is known that the eye is one of the early tissues to develop injury from the absence of vitamin A, hence the original name for this vitamin was the xerophthalmic vitamin. The importance of vitamin A to the eye, and the fact that this vitamin is stored in eye tissue have been emphasized by several investigations.

Wald (4) in discussing vitamin A in eye tissues states:

> Extracts of eye tissue (retina, pigment epithelium and choroid) showed the characteristic vitamin A absorption band at 620 mu. with the SbC13 test and were also potent in curing vitamin A deficient rats. The concentration of vitamin A was very constant for different mammals, at about 20 Y per g. dry tissue. Values for frog tissues were much higher.

This comment is of interest in connection with the observation that I have previously quoted regarding the raid of barn rats on the rabbit cages in the stress of deep winter. While it has been shown that vitamin A is essential for the normal function of eyes, its role in the formation of eye tissues has not been clearly understood. Probably the most sensitive procedure for testing the depletion of vitamin A in domestic animals today is by observing their behavior in semi-darkness.

Edward Mellanby (5) has presented important new data dealing with vitamin A deficiency and deafness. He states in an abstract of a paper read before the Biochemical Society, in London in November 1937, the following:

> In previous publications I have shown that a prominent lesion caused by vitamin A deficiency in young animals, especially when accompanied by a high cereal intake, is degeneration of the central and peripheral nervous systems. In the peripheral system it is the afferent nerves which are principally affected, including the eighth nerve, both cochlear and vestibular divisions. It has now been possible to show that vitamin A deficiency produces in young dogs degenerative changes in the ganglia, nerves and organs of both hearing and balance inside the temporal bone. All degrees of degeneration have been produced, from slight degeneration to complete disappearance of the hearing nerve. The nerves and ganglion cells

supplying the organ of Corti are more easily damaged than those of the vestibular division. As might be expected when once the spiral ganglion cells have disappeared, additions of vitamin A to the diet have no effect, and the organ of Corti remains completely denervated. The "inattention" of dogs on these diets which I previously ascribed to cerebral defect is undoubtedly due to deafness. It now remains to determine whether these results may be extended to explain certain forms of deafness in man.

The serious effects of deficiency in vitamin A on pregnant rats has been investigated and reported by Mason (6) as follows:

Abnormalities are described in the pregnancies of rats maintained on diets deficient in vitamin A in varying degree. Prolongation of the gestation period up to 26 days in severe cases and a long and difficult labour which might last 2 days and often resulted in death of both mother and young were characteristic.

Defects due to deficiencies in vitamin A in the diet of dairy animals, (pregnant cows, their offspring and normal calves fed on the milk from those cows) have been reported upon by Meigs and Converse (7) as follows:

In 1932 we reported from Beltsville evidence that farm rations frequently fed to calves may be dangerously low in vitamin A, and that milk produced by cows fed hay which has lost its green color may be an unsafe source of vitamin A in the calf ration. This preliminary paper reported results dealing with four cows which had been fed over two years on a good grain mixture and late-cut low-color timothy hay. Of six calves born of these cows, two were dead, one was unable to stand and died shortly after birth, and three were both weak and blind. The fact that cows so fed were unable to properly nourish their calves before birth led to the question whether the milk from these cows might not be deficient for normal growth of calves from other cows fed on rations adequate in vitamin A. This preliminary report included results on three normal calves fed milk from those cows fed low-color timothy hay. The three calves died at fifty-seven, sixty-two, and seventy-one days of age, respectively.

Since growth, prenatal and postnatal, is related directly to the pituitary body, we are specially interested in the knowledge available on the functioning of this gland.

The work of Barrie (8) throws important light on this subject. He has reported as follows:

Partial deficiency of vitamin E as shown in the female rat fed on a diet containing only a trace of vitamin E but which is otherwise complete, results in the prolongation of gestation, which may be continued as long as 10 days beyond the normal period. The offspring under these conditions are abnormal. These young may develop slowly and be thin and undersized in spite of sufficiently profuse lactation, or they may become extremely fat and develop a leg weakness and carpopedal spasm about 18 days after birth. Animals of both types have thin skulls and short silky fur. Complete E deficiency in the adult also produces the soft fur and imperfectly calcified skull. Partially E deficient animals occasionally give birth to a litter but fail to lactate.

The changes observed are similar in several ways to those produced by hypophysectomy (surgical removal of pituitary gland). Marked degranulation of the anterior pituitary is found in

> both the abnormal young and the adult sterile animals. Lack of vitamin E therefore produces a virtual nutritional hypophysectomy in the young rat.

The inability of various species to complete gestation when vitamin E is not provided in adequate quantity has been reported by many investigators. A. L. Bacharach, E. Allehorne and H. E. Glynn have used their study of this factor as a means of estimating the quantity of vitamin E in the diet. (9) They state:

A diet suitable for work on vitamin E causes female rats, fed on this diet from weaning, to show a gestation-resorption rate not significantly differing from 100 per cent; when the diet is supplemented with adequate amounts of vitamin E, also administered from weaning, the live litter rate does not differ significantly from 100 per cent. It is found that, on such a diet, the percentage of implantations (conceptions) is markedly different between animals that have been submitted to a single gestation-resorption, owing to lack of vitamin E, and animals that are mated for the first time. The authors suggest that the process of undergoing gestation-resorption brings about some deep-seated changes in the reproductive mechanism of the rat, of a kind not hitherto recognized as characterising the vitamin E deficiency syndrome.

One of the outstanding changes which I have found takes place in the primitive races at their point of contact with our modern civilization is a decrease in the ease and efficiency of the birth process. When I visited the Six Nation Reservation at Brantford, Ontario, I was told by the physician in charge that a change of this kind had occurred during the period of his administration, which had covered twenty-eight years and that the hospital was now used largely to care for young Indian women during abnormal childbirth (Chapter 6).

A similar impressive comment was made to me by Dr. Romig, the superintendent of the government hospital for Eskimos and Indians at Anchorage, Alaska. He stated that in his thirty-six years among the Eskimos, he had never been able to arrive in time to see a normal birth by a primitive Eskimo woman. But conditions have changed materially with the new generation of Eskimo girls, born after their parents began to use foods of modern civilization. Many of them are carried to his hospital after they had been in labour for several days. One Eskimo woman who had married twice, her last husband being a white man, reported to Dr. Romig and myself that she had given birth to twentysix children and that several of them had been born during the night and that she had not bothered to waken her husband, but had introduced him to the new baby in the morning.

Sherman, (10) who has made many important contributions to our knowledge of vitamin A, has shown in a recent communication that an amount of vitamin A sufficient to support normal growth and maintain every appearance of good health in animals, may still be insufficient to meet the added nutritive demands of successful reproduction and lactation. With the failure to reproduce successfully, there usually appears in early adult life an increased susceptibility to infection, and particularly a tendency to lung disease at an age corresponding to that at which pulmonary tuberculosis so often develops in young men and women. He states, further, that vitamin A must be supplied in liberal proportions not only during the growth period but during the adult period as well, if a good condition of nutrition and a high degree of health and vigor are to be maintained.

Hughes, Aubel and Lienhardt (11) have shown that a lack of vitamin A in the diets of pigs has resulted in extreme incoordination and spasms. They also emphasize that gilts bred prior to the onset of the nervous symptoms either aborted or farrowed dead pigs.

Hart and Gilbert (12) have shown that the symptoms most commonly seen in cattle having a vitamin A deficiency are the birth of dead or weak calves, with or without eye lesions. They report also a condition of newborn calves which simulates white scours, and the development of eye lesions in immature animals.

Hughes (13 has shown that swine did not reproduce when fed barley and salt, but did so when cod liver oil was added to this food.

Sure (14) has shown that a lack of vitamin A produces in females a disturbance in oestrus and ovulation, resulting in sterility. Further, he states, that resorption of the fetus may be produced by lack of vitamin A, even on a diet containing an abundance of vitamin E, which is known as the anti-sterility vitamin.

One of the most important contributions in this field has been made by Professor Fred Hale, of the Texas Agricultural Experiment Station, at College Station, Texas. He has shown that many physical deformities are readily produced by curtailing the amount of vitamin A in the ration of pigs. He produced fifty-nine pigs (15) that were born blind, every pig in each of six litters-where the mothers were deprived of vitamin A for several months before mating and for thirty days thereafter. In pigs, the eyeballs are formed in the first thirty days. He found, as have several others, that depriving pigs of vitamin A for a sufficient period produced severe nerve involvements including paralysis and spasms, so that the animals could not rise to their feet. He reported that one of these vitamin A deficient pigs that had previously farrowed a litter of ten pigs, all born without eyeballs, was given a single dose of cod liver oil two weeks before mating. She farrowed fourteen pigs which showed various combinations of eye defects, some had no eyes, some had one eye, and some had one large eye and one small eye, but all were blind.

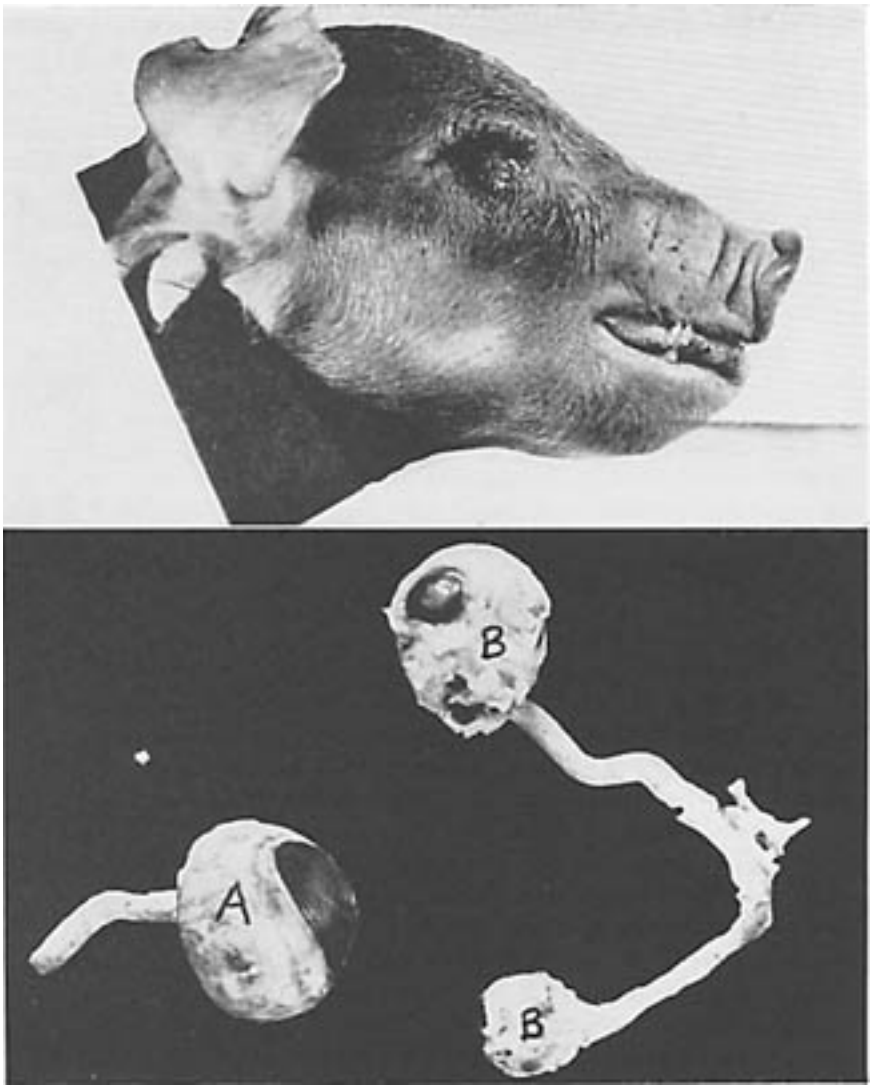

FIG. 117. Above, this pig was one of fifty-nine born without eyeballs and with other serious deformities due to lack of vitamin A in the mother's diet. Offspring of these blind pigs when normally fed had perfect eyes and no deformities. Below, A, at left shows normal eye of a pig at nine months. B, at right shows partial eyeballs and optic nerves produced in offspring when one dose of vitamin A was given two weeks before mating. (Courtesy of Professor Fred Hale.)

In Fig. 117 I am able through Professor Hale's kindness, to show an eyeless pig and a normal eye of a pig (at the left) and (at the right) a pair of incomplete eyes from a pig born in the litter just mentioned. This one dose of vitamin A made possible the partial formation of optic nerves and eyeballs. A typical eyeless pig is shown in Fig. 118 (lower). Note its deformed ears. Among the many physical injuries which develop in the pigs born to sows fed on a diet deficient in vitamin A are serious defects of the snout, dental arches, eyes and feet. This pig was born without eyeballs. It also had club feet and two tumors. In Fig. 118 (upper right) is shown a pig with cleft palate, and in Fig. 119 (upper right) one with double hairlip. In Fig. 118 (upper left) is shown a boy with cleft palate and defective eyes. One of the very important results of Professor Hale's investigations has been the production of pigs with normal eyes, born to parents both of whom had no eyeballs due to lack of vitamin A in their mother's diet. The problem clearly was not heredity. Two litters, one containing nine pigs and the other eight, which were born to mothers that had been deprived of vitamin A before mating and for thirty days thereafter, produced the following lesions: All had complete absence of

eyeballs; some lacked development of the opening of the external ear; others had cleft palate, harelip, displaced kidneys, displaced ovaries, or displaced testes.

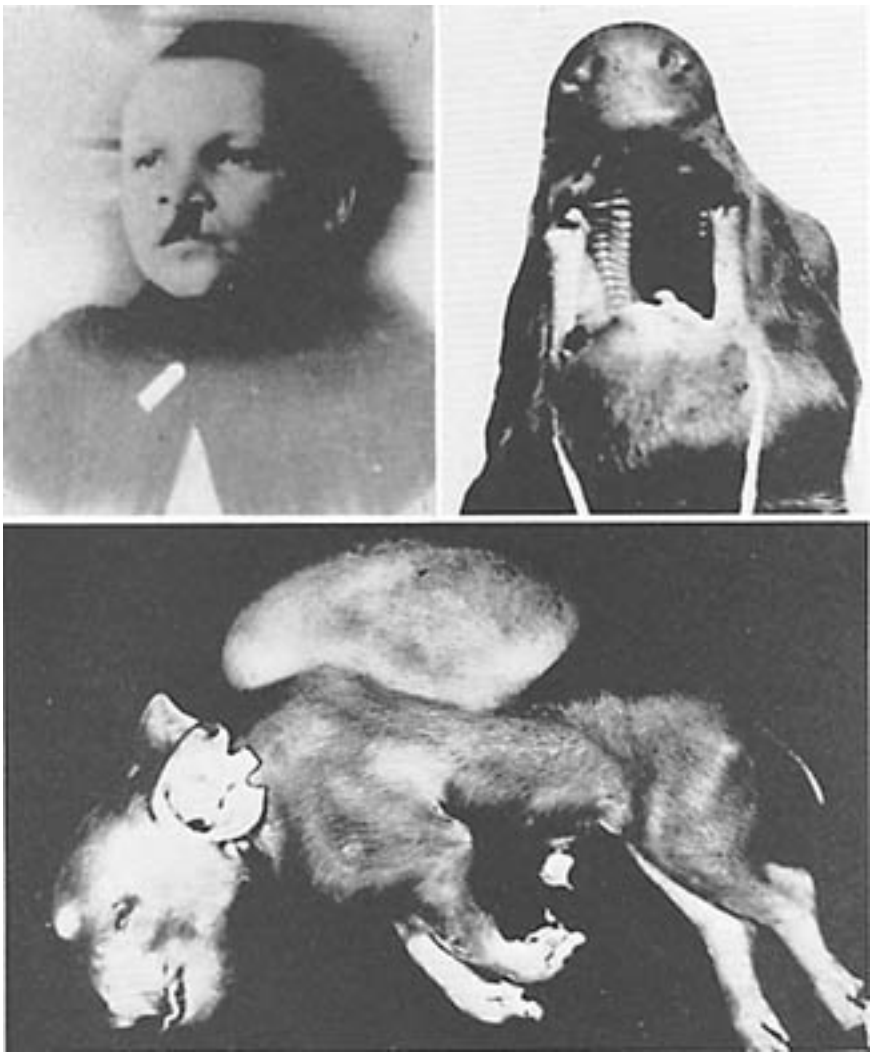

FIG. 118. Upper left: Boy has cleft palate, and harelip. Upper right: Pig has cleft palate, no eyes. Below, Pig has club feet, deformities of the ears, two tumors and no eyeballs due to lack of adequate vitamin A in the mother's diet. (Kindness of Professor Hale.)

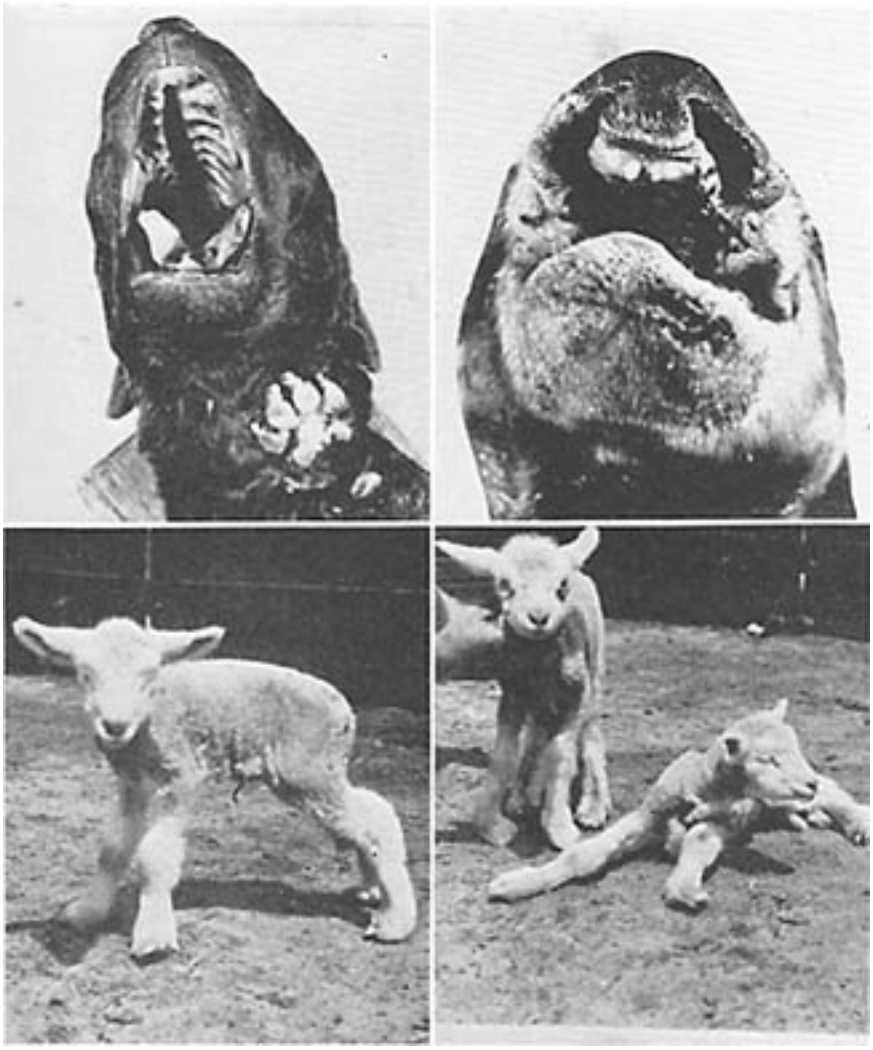

FIG. 119. Many young of modern domestic animals are born with deformities. At the upper left is seen a pup with cleft palate. In two previous litters all the pups were deformed and unable to live. At the upper right is one of Professor Hale's pigs with double harelip. Below two blind lambs and one with club foot.

It is of interest that in October, 1935, Professor Hale reports that the Texas Agricultural Experiment Station was informed that a litter of fourteen pigs had been born blind in June, 1935, on a farm at Ralls, Texas. Of these, six pigs were raised and brought to the Station for further study. The farmer owning the pigs stated that no green feed was available on his farm from March, 1934, until May, 1935. It will be noted that this condition paralleled the experimental conditions at the station under which by restricting vitamin A before and immediately after gestation fifty-nine pigs were produced without eyeballs.

Professor Hale reports that in April, 1935, a litter of seven pigs were born blind at McGlean, Texas, which was suffering from drought conditions, similar to those at Ralls. The litter and dam were purchased by the Experimental Station. Matings were made between blind pigs. These were fed rations containing ample vitamin A, and normal pigs with normal eyeballs were produced. Even the mating of a blind son with his mother who had produced him when on deficient diet, produced only normal pigs when both had ample vitamin A. He states, "If an hereditary factor had been the cause of this congenital blindness, these matings would have produced some blind pigs, even if vitamin A

were present in the ration." The problem of congenital cleft palate has been very embarrassing to those parents whose children have been so afflicted. It is of interest that breeders of fancy dogs are frequently embarrassed by having this problem develop in their kennels or among litters born to parent stock obtained from their kennels.

In Fig. 119 (upper left) I have shown a water spaniel pup with cleft palate. This pup was not able to nurse because of the impossibility of producing suction without a palate. When fed artificially the milk was expelled through the nostrils. The mother had given birth to two previous litters all of which were dead at birth or died soon after. Her diet had been reinforced with mineral calcium phosphate in tablet form hoping to insure normal offspring. This is not nature's method.

I am informed by a veterinary that he has experienced trouble with harelip, cleft palate or serious facial deformities among dogs that are pets in homes where they are lavishly coddled and fed the things they like best. He stated that he has more trouble with head defects in bulldog pups than any other breed.

There are few if any problems connected with modern degeneration on which so much light is thrown as that supplied by recent investigations on the problems of paternal responsibility for defects in the offspring. There are several reasons for this. Because the mother has the sole responsibility for the nourishment of the fetus during the formative period and she alone provides the handicaps incident to the process of birth, it is very natural that defects are practically all interpreted as being associated with these processes. This unfortunately, has been embarrassed further by the fact that since distortions in behavior do not appear until sometime after birth, normality was largely assumed to be present up to the time of their appearance, and therefore of necessity would be contributions from the child's environment. As such they would be subject naturally to treatment by applying influences to change the mental environment. Hence the entire problem of the role of the sex cells through controlling the architecture of the body including the brain has been largely overlooked. Very important light is thrown on this problem in the data provided on the pup shown in Fig. 120. This shows a dachshund pup with cleft palate and a very severe spinal deformity. This is not unlike deformities frequently seen, or unlike that of the pup shown in Fig. 119. The highly significant circumstance is the fact that these same deformities not only appeared also in another pup of this same litter but in one pup in each of three other litters about the same time. While four mothers were involved these four litters were all sired by one father. The paternal responsibility is clearly established.

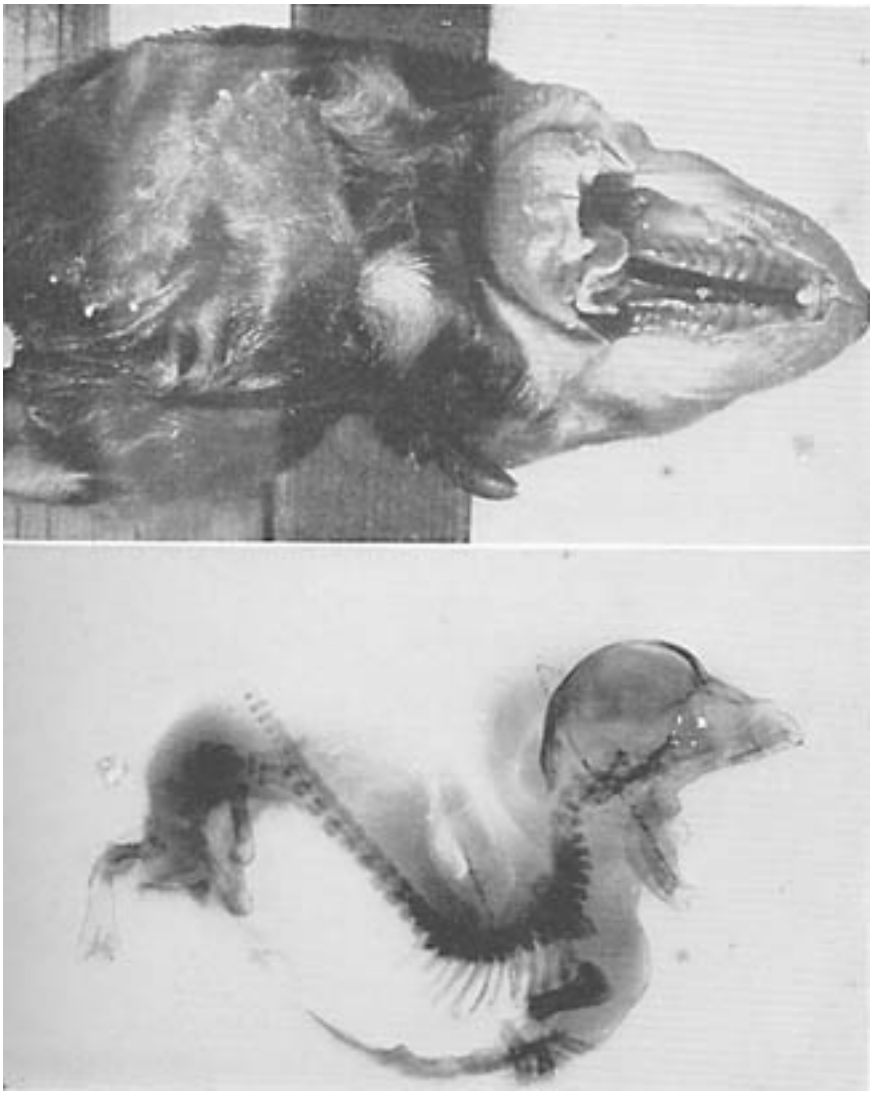

FIG. 120. This pup had cleft palate, as seen above, and grossly deformed spine, as shown below. It was one of two pups born in the same litter with the same defects and one of five pups born in four litters with these same defects. Five different mother dogs were involved but all pups were from the same father dog.

At the right in Fig. 119 a lamb is shown with club feet and two lambs without eyeballs. I am told that in some of the sheep raising states quite a number of deformities occur in lambs at birth. One writer states:

> These deformities may maintain themselves in any number of ways. We have them two-headed, 5 and 6 legs, 2 tails, born without eyes, hermaphrodites, born with ribs on one side and any number of such deformities. A common deformity in sheep is under-shot and over-shot jaws. This simply means that the upper jaw extends farther to the front that the under jaw and the front teeth do not meet. This is called over-shot and the reverse is called under-shot.

It will be noted that a common deformity in sheep relates to an under-development of either the upper or lower jaw which is one of the most common expressions of disturbed development in humans.

Some illustrations of the deformities that may occur in domestic animals are shown in Fig. 121.

Above are seen two cows each with an extra foreleg attached to the shoulder; below, to the left is shown a double-faced calf which also had a cleft palate; to the right a cat with deformed legs.

FIG. 121. Typical deformities in domestic animals. Above, two cows with an extra foreleg hanging from the shoulder. Below, left, double faced calf. Right, cat with deformed legs.

In corresponding with Professor Hale, I inquired whether they had information as to the effect of vitamin A deficiency on the sire. He replied, "If we reduceed the vitamin A content of the body of the sire, he would become sterile and, therefore, we could not try this procedure." The question arises as to what the effect would be of a less severe depletion of vitamin A of both parents.

It is a very easy matter to place the full responsibility on the mother, when defects develop in the children. These data indicate that either parent may contribute directly to certain of the defects of the children, due to defects in the germ plasm.

A practical case from my field studies includes a full-blooded Eskimo woman who was married twice, the second time to a white man, by whom she had several children. She had insisted on selecting and preparing the native foods for herself, though she prepared the white man's imported foods for him. With a total of twenty-six pregnancies she did not have any tooth decay. He had rampant tooth decay, and a marked abnormality in the development of face and of the dental arches. Several of the children had incomplete development of the face and of the dental arches. One of the

girls who was married had very narrow dental arches and nostrils and a typical boyish type of body build. Unlike her mother, this girl had a very severe experience in the birth of her only child and insisted that she would not take the risk of having another. Several daughters have narrow arches. The question arises whether the deficient nutrition of the father may have been the contributing factor in the injury of their children.

New light is being thrown on human problems by animal investigations. One study that is particularly instructive has been conducted by McKenzie and Berliner of the University of Missouri. (Bulletin No. 265.) The experimental animals used were sheep. Their studies indicated to them that they could predict the level of fertility of the sire by studies made on the seminal fluid. They found that the percentage of abnormal spermatozoa increased to 84 per cent under unfavorable conditions and reduced to less than 15 per cent under favorable conditions. When the unfavorable conditions characterized by these abnormal spermatozoa prevailed the females did not conceive. High temperature proved to be an important controlling factor as indicated by variation in percentage of abnormal sperm. In one breed the average variation was from 2.5 per cent in January to 22 per cent defective in August; in another breed from 18 per cent in January to 73 per cent defective in August. They also found that the same result could be produced in the winter by keeping the sires in heated rooms or by applying heat externally. They further found that when the percentage of abnormal sperm was high a condition of sterility was apparently established. In a personal communication from Professor McKenzie he states that their inference is that with a high percentage of abnormal sperm the ova either are not fertilized or that fertilization takes place and that prenatal death occurs in a certain number of the cases, and that there is an appreciable prenatal death loss in sheep, horses, cattle, and swine. I have referred to the data presented by Mall indicating that 15 per cent of human conceptions in England are expelled as deformities in the second and third month of gestation. McKenzie also presents data relating to swine in which a sire that showed a high percentage of abnormal sperm was bred to two groups of sows of similar breed. One was maintained in a barn without access to pasture, the other received similar rations plus access to pasture. The group without pasture produced a high percentage of mummies, small litters, and abnormal pigs (open abdominal walls with viscera protruding and exposed spine in the region of the lumbar vertebrae). The second group on the same food with the addition of pasturage produced normally large-size litters without mummies. The following year this experiment was repeated reversing the groups of sows and using a similar high percentage of defective sperm in the same sire. The same results occurred, with the group maintained without access to pasture. This emphasizes the need for the vitamins and minerals that are provided in natural foods, particularly vitamin A and seems to relate to the studies of Hale in which the absence of vitamin A produced gross defects. These studies on domestic animals strongly emphasize the necessity that both parents shall have adequate nutrition before conception occurs and subsequently for the mother.

Until very recently there has been exceedingly little literature dealing with the factors contributing to the abnormal development of fetuses in either domestic animals or humans. Williams, who is one of the few students of this problem as it relates to domestic animals, in referring to this phase has commented that there is no treatise in the English language on teratology (development of monsters) in domestic animals. (16) He emphasizes that these defects are growing in numbers and economic importance. He refers to Burki's studies in Switzerland indicating that this difficulty has constantly and enormously increased in his territory. This veterinary has asked "Are our cows degenerating?" It is of interest that a type of deformity commonly recognized among veterinaries as a distortion of the

head presenting a lack of development of the bones of the middle part of the face including the upper jaw is commonly called "bull-dog calf." This is particularly important in connection with the frequent human deficiency of lack of development in the middle third of the face. Williams emphasizes the common knowledge that Boston bull-dogs are not prolific and because of the difficulty of giving birth to their young, some veterinarians resort routinely to caesarian section. Fortunately, seriously deformed specimens are seldom born alive and usually do not continue to term. Williams states that Loje has observed ten grossly deformed calves of a particular type that were traced to the same sire; also a series of five with this deformity reported by Hutt were traced to one sire. Among the deformities in domestic animals cleft palate or absence of palate is very common. These studies on domestic animals strongly emphasize two facts; first, that deformities among these animals are very similar to those that develop in humans, and second, that the defects are largely related to the original germ cells and that the male may provide the defect quite as well as the female. Several of the primitive races have understood and provided against these mishaps.

Moench and Holt of the Cornell Medical School and New York Hospital (17) have made important studies on humans and have found a very high incidence of sterility when abnormal forms of spermatozoa reached 25 per cent. Among the abnormal forms they found one particular family with a particular type of abnormal sperm reaching 12 per cent. Their breeding record was decidedly bad and fetal malformations repeatedly occurred. In their group, in 63 sterile matings the men were normal 21 times and abnormal 37 times. They listed over 40 different abnormal or deformed types of sperm. They conclude:

1. In a normal semen the abnormal sperm heads do not exceed 19 to 20 per cent.
2. When the sperm head abnormalities reach 20 to 23 per cent, impaired fertility can be assumed.
3. When the sperm head abnormalities are above 25 per cent, clinical sterility is usually present.

An important contribution to the question of the relation of the germ cells of the father to the type of defects that are prevalent in his family history has been made in recent studies conducted in Germany. (18)

> Two German surgeons concerned with enforcing the sterilization law in Berlin have taken advantage of their opportunities to make an important contribution to the study of fecundity.
>
> Several studies have been published previously, of the spermatozoa of normal men. This book offers a study of the spermatozoa of men who had been diagnosed as hereditarily defective. At the time of the operation, the upper part of the vas deferens was washed out, and the sperm thus obtained were studied in great detail, 20 different types of abnormality being distinguished.
>
> In their control studied, the normal man is found to produce 19 per cent of morphologically defective sperm. By contrast, the chronic alcoholic patient produces 75 per cent of defective sperm.
>
> Previously it has been assumed that as much as 25 per cent or 30 per cent of abnormal

> sperm were a good evidence of lowered fertility if not of sterility. But the fertility of these chronic alcoholics was not diminished, the authors claim.
>
> In cases of inherited mental defect, 62 per cent of abnormal sperm were produced, accompanied by low fecundity,--as is the case generally with the mentally defective male. On the other hand, in hereditary deafness, 62 per cent and in hereditary blindness 75 per cent of defective sperm appeared.
>
> Epilepsy and schizophrenia (dementia praecox) both supposed to be constitutional in origin, show less abnormality of spermatozoa (58 per cent and 54 per cent respectively) than blindness and deafness.

The fact that in the past almost the entire emphasis of change in physical, mental and moral qualities has been assigned to the forces of heredity, strongly emphasizes the lack of information regarding the nature of the forces at work and the points at which their influence constitute the determining factors. The data previously presented in this chapter dealing with the role of vitamins A and E throw valuable new light on this phase. It is important, however, that new data are available dealing with the factors which injure the germ cells and which Tredgold has spoken of as "poisoned germ cells."

In a personal communication received from Professor T. S. Sutton of the College of Agriculture, Ohio State University, he makes the following observation:

> For several years we have been interested in the study of the effects of vitamin A deficiency. Right now our main consideration is the effect of this deficiency on reproduction. We find that a diet low in vitamin A will cause reproductive failure, which seems to be caused chiefly by a degeneration of the germinal epithelium of the gonad. This is particularly true in the case of the male. I think we have rather convincing evidence that this is a direct dietary damage to the gonad (ovary or testis), rather than a disruption of the endocrine balance which might result in sterility as appears to be the case in vitamin B deficiency.

The degenerative processes which occur in nerve tissues due to vitamin A deficiency have been studied by Professor Sutton and his associates. (19) They have been able to show detailed progressive degeneration within nerve fibers as a result of vitamin A deficiency.

In the light of the newer information it is quite clear why we may have anyone of the following distinct expressions in the reproductive process, namely, physical excellence of succeeding generations (such as obtains among many of the primitive races as I have shown); complete reproductive failure or sterility or partial failure resulting in defectives of various types at the borderline between these two phases. It is the rapid and progressive increase in this last group which constitutes the progressive degeneration of our modern civilization.

One of the main problems in this study has to do with the relation of nutrition to the modification of the growth of the child, both in its formative period and in the stage of adolescence. I have shown that in many of these primitive racial stocks there occurs in the first generation after the displacement of native foods by imported foods a marked change in facial and dental arch forms. These changes

happen most frequently in the later children in the families and come about notwithstanding the impact of heredity through all the previous generations of excellent physical development. Clinically, the evidence is abundant, that this change occurs in these primitive racial stocks regardless of color, geographic location, temperature, and climate. We are apparently dealing here with a factor which, while it may be related to the germ plasm and to the prenatal growth period, clearly involves other forces than those that are at work in the case of hereditary defectives. Since these changes have to do directly with disturbances in growth of the head, particularly of the face and of the dental arches, we are concerned with such evidence as may be available as to the nature of the forces that readily affect the anatomy of the skull.

The general architecture of the body is apparently determined primarily by the health of the two germ cells at the time of their union. This architectural design may not be completely fulfilled due to interference with nutritive processes both before and after birth. In this large problem of the relationship between physical design of the body and resistance or susceptibility to disease, we may have determining factors operating at different periods in prenatal and postnatal growth. The accumulating evidence strongly emphasizes that disease susceptibility is a widely variable factor and associated with certain types of developmental disturbances.

In a discussion of tuberculosis susceptibility before a meeting of specialists in that field, emphasis was placed upon the fact that other factors than the bacteria played controlling roles in the matter of susceptibility to tuberculosis.

Weisman has recently made an important contribution to the problem of physical development and susceptibility to tuberculosis. He has presented (20) statistical data indicating the type of chest deformity which predisposes an individual to tuberculosis. He states:

> In a study previously made on the shape of the normal and of the tuberculosis chest, it was found that the average normal chest was flat and wide and that the average tuberculous chest was deep and narrow. It was also shown that the deep chest was an underdeveloped, primitive type of chest, resembling an infant's chest in shape. Later studies on the shape of the chest and on environment showed that children from the poorer socio-economic environments had on the average a deeper chest, weighed less and were shorter than the children from the higher socio-economic levels. An investigation recently made on the incidence of tuberculosis in the various school districts in Minneapolis revealed that there is a very high incidence of tuberculosis among the children from the slums where the deep chest prevails. Ten times as many cases of tuberculosis were reported from a school district which is perhaps the poorest in the city as were reported from the best school districts.
>
> This study, which shows that there is a definite correlation between the deep chest and the positive reaction to tuberculin adds one more link to the chain of evidence supporting the contention that the deep chest is more or less associated with tuberculosis. It also helps to explain why there is such a high incidence of tuberculosis among the poor in the slum districts. The children in the slums are physically underdeveloped. They are not only shorter and lighter but they have on the average a deep, primitive, infantile type of chest, one that has not gone through the normal process of development. Even the new-born and infants are shorter and lighter and have a deeper chest than the average infant from a better environment.

It is important to note that Dr. Weisman associated the type of chest which predisposes the individual to tuberculosis, with a prenatal condition since he states "even the new-born and infants are shorter and lighter and have a deeper chest than an average infant from a better environment." This work throws important light on why in the primitive groups the children born to parents who are living on the imported nutrition lower in vitamins and minerals than the native foods, not only showed a greatly increased incidence of tuberculosis over the children born to parents on the native diet but also proved to be those individuals who, in facial and dental arch form, presented positive evidence of prenatal injury. We also have a direct explanation for the observations that have been emphasized by Dr. George Draper, that physical form has a direct relationship to disease susceptibility of certain types, frequently spoken of as diatheses.

It is important in this connection to call to mind the statement made by some clinicians that tuberculosis patients with narrow nostrils tend to make a poor fight. These narrow nostrils are clearly related to prenatal injury resulting primarily from defective germ cells which determine the architecture, not heredity but intercepted heredity.

It is very easy to understand the effects of gross physical lesions such as the absence of eyeballs, harelip and cleft palate. These defects can readily be seen. The problem is very different, however, when we are dealing with disturbances of function due to minute anatomical lesions in either external or internal organs such as the brain. These latter will be discussed in the next chapter.

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Chapter 19

PHYSICAL, MENTAL AND MORAL DETERIORATION

AFTER one has lived among the primitive racial stocks in different parts of the world and studied them in their isolation, few impressions can be more vivid than that of the absence of prisons and asylums. Few, if any, of the problems which confront modern civilization are more serious and disturbing than the progressive increase in the percentage of individuals with unsocial traits and a lack of irresponsibility.

Laird (1) has emphasized some phases of this in an article entitled, *The Tail That Wags the Nation*, in which he states: "The country's average level of general ability sinks lower with each generation. Should the ballot be restricted to citizens able to take care of themselves? One out of four cannot." He has illustrated the seriousness of this degeneration by presenting details as follows:

> Although we might cite any one of nearly two dozen states, we will first mention Vermont by name because that is the place studied by the late Dr. Pearce Bailey. "It would be," he wrote, "safe to assume that there are at least 30 defectives per 1000 in Vermont of the eight-year-old mentality type, and 300 per 1000 of backward or retarded persons, persons of distinctly inferior intelligence. In other words, nearly one-third of the whole population of that state is of a type to require some supervision.

From a broad view of the problem of modern degeneration it will be helpful to note the observations by Tredgold (2) in mental deficiency. He states:

> It is thus evident that the condition of mental deficiency, whilst presenting many interesting problems to the physician, the pathologist, and the psychologist, has also a much wider interest and importance. Since in Man the predominate feature is Mind, and since it is by its development and evolution that human progress has taken, and must take place, it is clear that the question of its disease, and particularly of its defect, is one of supreme importance to the statesman, the sociologist, the philosopher, and the whole community.

In connection with these investigations among primitive races it is interesting to note that the data are in complete harmony with the data which clinical pathologists, clinicians and anatomists have obtained in their study of the physical and structural characteristics of individuals who make up the deficiency groups. In discussing the problem of the significance of the shape of the palate, Tredgold (2) states:

> Palate--The association of abnormalities of the palate with mental deficiency has long been recognized, and there is no doubt that it is one of the commonest malformations occurring in this condition. Many years ago Langdon Down drew attention to the subject, and more recently Clouston has recorded a large number of observations which show conclusively that, although deformed palates occur in the normal, they are far and away more frequent in neuropaths and the mentally defective. He states that deformed palates are present in 19 per cent of the ordinary population, 33 per cent of the insane, 55 per cent of criminals, but in no less than 61 per cent of idiots. Petersen, who has made a most exhaustive study of this question, and has compiled an elaborate classification of the various anomalies found palatal deformities present in no less than 82 per cent of aments, (mental defectives), in 76 per cent of epileptics, and in 80 per cent of the insane.

Probably every city in the United States has made special provision for both mentally deficient groups and unsocial individuals, either in special schools or in special classes. In Cleveland, we have had a large school devoted to the problems of the so-called pre-delinquent boys, of whom nearly all have been before the courts and are assigned to this institution because they are not well enough adjusted to be kept in their normal school environment. In discussing the characteristics of these boys with the principal of that school, I asked him what the probabilities were that many of these boys would finally become involved in crime. His comment was, in effect, that they were virtually in the vestibule of a penal institute, when judged by the experience of previous boys from that school.

In approaching a study of this group, it is helpful to observe the experience of the well-equipped institutions organized for the correction of the abnormal trend which characterizes these boys. In this connection, there is a helpful report by the United States Dept. of Labor, Publication No. 203, which gives the result of tracing the after careers of 621 boys who were in five of the best-known correctional institutions. It was found that 66 per cent had been arrested and 58 per cent convicted one or more times after having been paroled from the institution. It is apparent from data of this type that probably the forces that produce these abnormal expressions cause irreparable damage in the brain tissue. Practically all recent crime reports are recording an increase in juvenile crime. The Children's Bureau of the Dept. of Labor stated (Nov. 4, 1938): "that juvenile delinquency spurted

during 1937 for the first time since 1930," but it cannot explain why until further study.

Reports to the bureau from 28 courts in 17 states and the District of Columbia showed that they handled 31,038 cases during 1937, an increase of 3,000 over 1936. The report showed that 44 per cent of the cases involved children between 14 and 15 years old; 22 per cent those between 12 and 13 years, and 10 per cent those between 10 and 11. Boys' cases comprised 8 5 per cent of the total.

As an approach to this problem I have made an examination of 189 boys in the Cleveland school for pre-delinquents. I gave particular attention to those physical signs of nutritional injury, which seemed to be definitely assigned to the formative period of the child. We endeavored to obtain detailed information relative to the family history and to the birth of the child. We were fortunate in having the assistance of the officers, and of a nurse in the dental service of the Health Department of the Board of Education, a nurse who made visits to the homes of many of these boys to obtain the information directly from the mothers.

In this group of boys, there were twenty-nine for whom I had not sufficient details to include their cases in the studies. Of the 189 in the group, there were only three with sufficiently normal dental arches to be classified as normal. Accordingly, 98.4 per cent proved to be individuals with more or less marked abnormality. Many of the faces were very badly deformed.

While often it will be difficult to place the responsibility entirely on either parent for the child's abnormal physical development, it is of interest to study the birth rank of these children. The average number of children in the families represented by these 160 children is 4.75. Of these, thirty-five, or 21.9 per cent, are first children in the families represented; thirteen, or 9.1 per cent, are only children; thirty-nine, or 24.4 per cent, are last children; and thirty-six or 22.5 per cent, are fifth children or later. Sixty-two, or 38.7 per cent, are either the first or last child. It will be seen from these data that the first or last child, or even a late child in a large family, tended to have a distinctly poorer chance than the intermediate children in the families in which these studies were made. Statistical data relating the age of the mother and father to prenatal deficiency of their offspring reveal that abnormally young parents have a much higher percentage of defective children than do those in the most favorable child-bearing period of life. The group at the Cleveland school included only those boys who have been before the courts because of more or less serious phases of delinquency. If they are in a considerable part the products of a defective society, it seems quite unfair that they should be held entirely responsible for that delinquency, which has put them in this institution. If they are destined for a penal institute in which they will be held entirely responsible for that abnormality which resulted in their misdemeanor, as has been the procedure in the past, are they receiving just consideration? Society may be justified in protecting itself from their misdeeds by placing restrictions about them, but it does not seem that society is justified in shifting the entire responsibility to the affected individuals.

Recent studies of the mental capacity of felons brought before the Common Pleas Court in Cleveland have shown that of 3,197 convicted felons examined in the medical clinic only 42.3 per cent were classified as normal. Fifty-five and nine-tenths per cent were classed as defective delinquents and only 1.8 per cent as insane. The outgrowth of this study has resulted in the drafting by the Cleveland Bar Association of a new criminal law for Ohio to be presented to the coming State

Legislature. This bill provides for the creation of a new criminal class composed of what are called defective delinquents. This includes morons and others of abnormal mentality but not insane who commit felonies or misdemeanors. The purpose of this legislation is to afford special treatment for law violators falling within the new classification, making it possible to segregate delinquents in separate institutions. The Ohio law like that of most other states now recognizes only two types of criminals, sane and insane, and if not insane they must be punished.

It is proper that we should ask who is to blame for the abnormalities which render these young men incapable of making the necessary adaptation to our environment.

An important characteristic of the boys in the Cleveland school was their low intelligence. Practically all were recorded as retarded or mentally backward prior to their transfer to this institution.

It is important that we note the characteristics of groups that are similarly retarded, but who have not demonstrated sufficiently unsocial characters to have to be placed in the pre-delinquent groups. We shall recognize them as individuals who may never commit unsocial acts sufficient to get them into trouble, though they will doubtless continue in the group of mentally backward persons. Such a group is to be found in the Outwaithe School in Cleveland. The children in this school, which enrolls about one thousand students, were examined in order to ascertain whether there might be groups that are similarly afflicted physically. The school is distinctive because it has a very high percentage of children who are backward mentally. Many of these children have been concentrated there in order to bring them under the influence of special teachers. In an examination of a cross section of the children, almost all were found to have had distinct injury in the formative period, as evidenced by the changes in facial form. A preliminary survey of the backward children of this institution was made by having typical classes selected by an official of the school from ages ranging from eleven to seventeen. I examined the arches and made measurements of the head and face. With the assistance of the school nurse I obtained records of the other children in the families selected. This latter survey was supplemented by field work by the nurse. The intelligence quotients, as reported in the records, were also provided. In the twenty-nine individuals so studied, seven, or twenty-five per cent were first children; fourteen, or fifty per cent last children in the families. Only one individual was found with approximately normal dental arches, that is, approximately three per cent of the individuals. Twenty-eight children, or 97 per cent, had abnormality of one or both dental arches. These children were placed in this institution because they were backward mentally, although as a group they are comparable to the group studied in the Thomas A. Edison School, where the grouping was based on delinquent traits. A cursory examination was made by observing other pupils in this school in their classes and on the grounds. A large percentage of severe facial and dental arch deformities and a very high percentage with definite disturbances in facial growth were evident. These data are presented as applying to a group of individuals characterized by a disturbed mentality, to the extent that they were assigned to special classes for the mentally retarded. While the group constituting the school population at Outwaithe represented the relatively large group of pupils assigned to special classes for backward children and did not carry the stigmata of delinquency carried by those of the Thomas A. Edison School, both groups had many physical defects in common.

We are, accordingly, concerned with the relationship existing among various stages of mental backwardness, pre-delinquency and criminality. To throw light on this subject, I visited our State Penitentiary to observe the characteristics of facial and dental arch development of the individuals

whose unsocial traits had brought them to this institution. I visited the dental clinic with the director, Dr. May, and saw the mouths of typical members of that colony as they were presented for oral examination. I asked the director what, if any, special features of the oral cavity he had observed to be characteristic of this group and different from those he had observed outside the institution in his private practice. He stated that he had noted continually that there was a tendency for the tongue to be too large for the mouth. This is a constant characteristic of another group of mentally injured, namely, the Mongoloid. This institution has a population of approximately four thousand individuals. A high percentage of them gave marked evidence of injury in the prenatal period as expressed in disturbances of facial form and the shape of the dental arches. In observing over half the population at work or exercise, I did not see one with a typically normal facial development. In Fig. 122 will be seen typical examples of this group. These show front and side views (see Hooton's recent book. 15a).

FIG. 122. Criminals. Were their unsocial traits related directly to incomplete brain organization associated with prenatal injury?

Newspaper daily illustrated reports of crimes committed by young criminals show almost continually these evidences of prenatal injury. Note the two characters Bird and Nixon, Fig. 123.

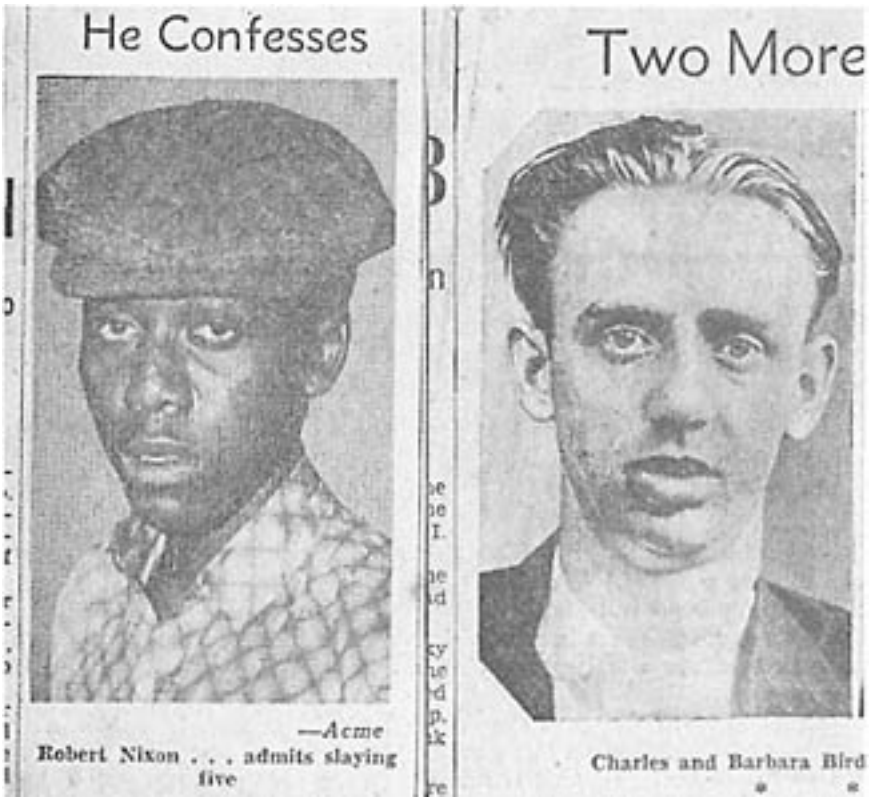

FIG. 123. Note the marked lack of normal facial development of these notorious young criminals. Nixon is only 18. These are typical samples seen frequently in the daily press.

It is important to emphasize the fact that the disturbances in the development of the head, face and brain may have a variety of expressions. In the more severe form characteristic of the Mongoloid group, as seen in Fig. 124 the facial injury is typical and is associated with a mental disturbance which, in turn, has been shown to be associated with typical brain lesions. The individuals of that group, however, do not tend to be criminals. Indeed, their injury is too severe. As a group they are apt to be docile, tractable and happy. Indeed, in the mentally backward and criminal groups in their various stages, we find facial patterns typical of large numbers of individuals we see on the streets, who are in school or in business, and entirely capable of maintaining a respected and honorable position in society. Accordingly, it is not justified, and indeed would be entirely unfair, to associate their disturbed facial and dental arch development with traits that would be normally found in the grossly unsocial groups. We cannot by viewing the face evaluate the kind or extent of brain injury that is associated with prenatal malnutrition of that individual. Indeed, these various divergent facial patterns are accepted by our modern civilization as representative of the many varieties or patterns constituting a normal population. It is not until we see primitive groups living under a controlled natural environment that we see Nature's model and design of the human physiognomy.

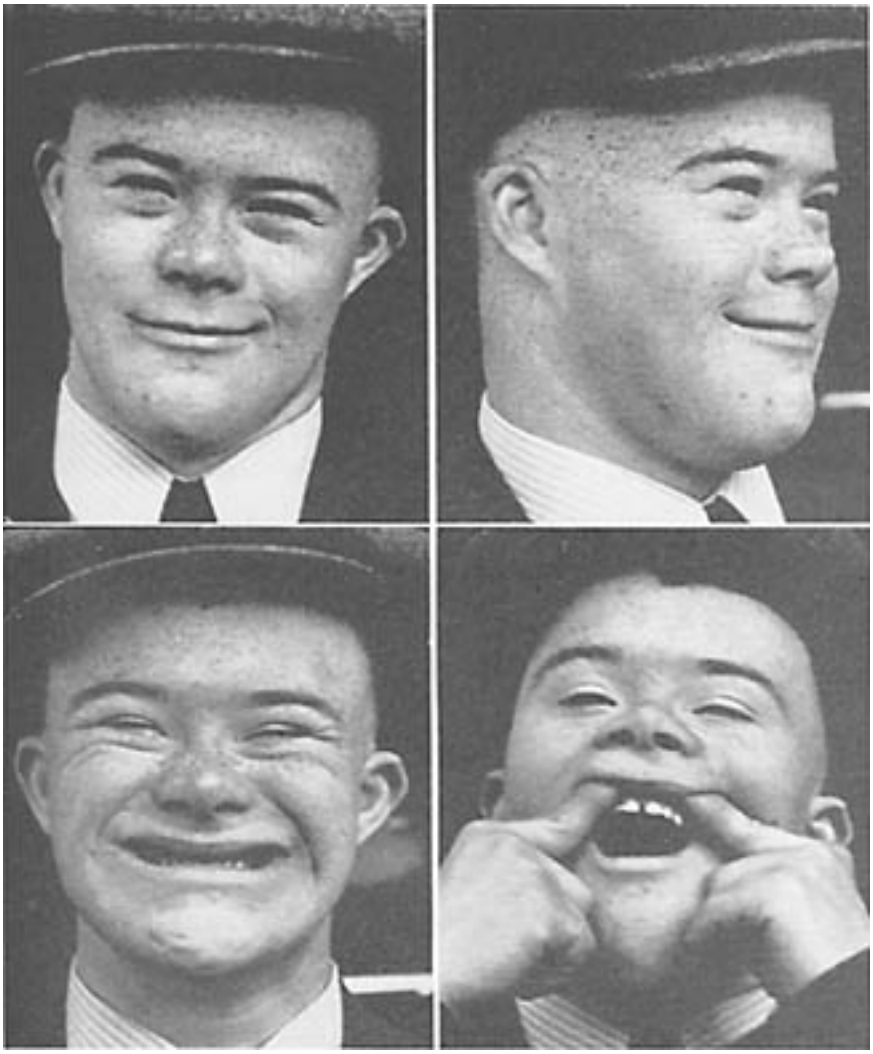

FIG. 124. This is a typical mongoloid defective. Note the marked lack of development of the middle third of the face and nose with the upper arch too small for the lower. Individuals of this type look alike and act alike and all have typical speech and behavior defects. These are now associated with definite defects in the brain. Nearly all are either a first or last child. A large percentage are born to mothers over forty years of age.

We are concerned to know the percentage in any typical colony of our modern civilization that may be placed in the various classifications of normal, mildly backward mentally, severely backward mentally, unsocial, delinquent, criminal, idiots, epileptic and insane. Tredgold (2) reports two surveys in England and Wales which give figures on the proportion of the population that could be identified with definite lesions. It would be fortunate if a survey could be made in the United States that would indicate the extent of the increase in delinquents of various types, including racketeers and criminals. It would be very helpful if these data could be related to the degrees of prenatal injury. There are many phases of modern degeneration which lend themselves to study from the standpoint of the probable role of progressive decline in the efficiency of nutrition to the progressive increase in morbidity, mortality, mental deficiency and delinquency. This is discussed in the next chapter on Soil Depletion, Plant and Animal Deterioration.

From the point of view of this problem the differences between the modern white civilizations and many of the primitive groups is interesting. Criminal tendencies in isolated primitives are so slight

that no prisons are required. I have referred to the Loetschental Valley in Switzerland, which, until recently, has been physically isolated from the process of modernization. For the two thousand inhabitants in that valley, there is no prison. In Uganda, Africa, the Ruanda tribes estimated to number two and a half millions, had no prisons.

Observation of Nature's normal facial patterns in the primitive racial stocks, establishes types within the limits of normality. The readers of this text by observing the individuals in any given families may see in how large a percentage of white families the progressive narrowing and lengthening of the face in the younger members of the family as compared with the older occurs. Further observations will enable one to recognize rapidly, even without experience and special training in anatomy, these evidences of prenatal injury.

I made a survey in the New England States, Quebec and Eastern Ontario, because the United States death rate from heart disease as reported by the American Heart Association was shown to be highest in Vermont and New Hampshire, followed closely by Massachusetts and New York. I first visited the New York State Hospital for tuberculosis patients at Raybrook, near Saranac. With the assistance of a member of the staff, I examined fifty young men and women in the wards. In that group, only three were found with normal facial and dental arch development. These three individuals were marble cutters who were suffering from silicosis. The forty-seven other individuals examined (94 per cent) were found to have marked evidence of injury in the developmental period. At the state fair at Rutland, Vermont, to which residents came from various communities throughout the state, I was able to count, by observing and recording the individuals who passed, that in each 100 people, three out of four gave evidence of injury in the developmental period. Similar studies were made at the State Farm for delinquent boys and girls, almost all of whom had been before the courts. 1 found that a very high percentage, approximating 100 per cent of those observed, had received injuries in the prenatal period. I then went to Quebec and studied groups of school children in the early teens. I observed groups in which a very high percentage gave marked evidence of prenatal injury. This seemed aggravated in districts where the farms had been abandoned, because the land was not producing as well as in the past. I studied Indians in two Indian Reservations, also, and there again found marked evidence of injury typical of our modernized communities. Similarly, a limestone district in Ontario was visited and critical observations were made of the facial form of the new generation, in regions in which the fertility of the soil had been definitely depleted through exhaustion. These again showed evidence of prenatal injury through faulty nutrition. The prisoners in a jail were examined, and all of them except two habitual drunkards showed marked evidence of prenatal injury.

If space permitted, it would be interesting to include here a discussion and illustrations of the physical characteristics of the racketeers and criminals whose pictures are shown in our newspapers almost daily. It is rare that a normal face is depicted in this group.

As an approach to more detailed study of the available information regarding the processes that are involved in the production of facial deformities, it will be helpful to think of the face as constituting the floor of the anterior part of the brain. The pituitary body is situated on the underside of the brain just back of the eyes. It is the governing body for the activity of growth, and largely controls the functioning of several of the other glands of internal secretion. It is, as it were, the master of the ship.

We are, accordingly, primarily concerned with the role that it plays, and the forces which control its own development and function. Its dependence upon vitamin E has been demonstrated by many workers. For example, Dr. M. M. O. Barrie (3) has reported that an inadequate amount of vitamin E produces marked disturbance in the growth of the offspring of rats. He states:

> The changes observed are similar in several ways to those produced by hypophysectomy (removal of pituitary gland). Marked degranulation of the anterior pituitary is found in both the abnormal young and the adult sterile animals. Lack of vitamin E therefore produces a virtual nutritional hypophysectomy in the young rat.

The work recently done in this field by Dr. Hector Mortimer and his associates in McGill University, Montreal, has included studies of skull development of rats. He has shown that the surgical removal of the pituitary body at the base of the brain in very young rats produces regularly a certain type of defect in skull development. This has been characterized by a lack of development forward of the muzzle or face, with a narrowing of the nose and dental arches. He found that by the addition of extracts made from the pituitary glands, which he had removed surgically, he entirely prevented the development of these defects, thereby establishing the relation of the injury to deficiencies of the hormones developed by that organ. Another approach to the problem on which he has expended much fruitful effort, has been in connection with the study of the skulls of individuals who are known to have disturbances in the functioning of the pituitary gland through the interference caused by tumors. Common illustrations are the cases of acromegaly or giantism. By associating these physical changes in bodily form with each x-ray, data obtained from skiagraphs, together with the history and the nature of the tumor, considerable information has been developed. Another important series of studies has included the correlation, by means of the x-rays, of the skulls of individuals suffering from certain types of physical and mental disturbances, with certain abnormalities in the skull as shown by the x-rays. By these various means Dr. Mortimer has been able to divide the various types of skull defects and developmental and growth defects into distinct classifications. With this yardstick he is able to classify individuals from their Roentgenograms. It is of interest that in his work, in association with Dr. G. Levine, Dr. A. W. Rowe and others at the Evans Memorial for Clinical Research and Neuro-Endocrine Research in Boston, important relationships have been established through the examination of over three thousand case histories. X-ray records of the skull are included in the studies. They report that independent and previous physiological investigations gave evidence at the time of the examination of disturbed pituitary function. Dr. Mortimer's excellent investigations seem to indicate clearly that facial and dental arch form are directly related to and controlled by the functioning of the pituitary body in the base of the brain. Dr. Barrie (3) reports that partial deficiency of vitamin E, as shown in the case of the female rat, results in the prolongation of gestation which may be continued as long as ten days beyond the normal period. The offspring under these conditions are abnormal. Further, animals deficient in vitamin E, occasionally give birth to a litter, but fail to lactate.

When we realize that one of the best sources of vitamin E is wheat germ, most of which is removed from white flour, usually along with four-fifths of the mineral, we see one cause of the tragedy that is overwhelming so many individuals in our modern civilization. In many individuals it may be wise to reinforce our modern white bread and starchy dietary with wheat germ, which can be obtained in package form from the manufacturers of flour. As this is put up in cans, all air is displaced with an inert gas when the cans are sealed. While in this way oxidation of the embryo

which is very fragile, is prevented, as soon as the seal is broken, oxidation sets in and progresses rapidly, producing a product that is not comparable to the wheat embryo of freshly cracked whole wheat. My investigations indicate that Nature has put just the right amount of embryo in each grain of wheat to accompany that quantity of food. If the whole wheat is prepared and eaten promptly after grinding and exposing the embryo to oxidation, the effect desired by Nature is adequately provided.

It is important to emphasize in connection with the development of the deformities of the face that other skeletal deficiencies or abnormalities result from the same disturbing factors. One of these is the narrowing of the entire body, with a tendency to increase in height. This is shown in many of the family groups of modernized primitives. The effect of this narrowing of the body, which in girls results in the boyish type of figure due to the narrowing of the hips, introduces an entirely new and serious problem in the experience of our modern civilization when confronted with the problems of childbirth.

Among primitive races living in a primitive state childbirth was a very simple and rapid process, accompanied by little fear or apprehension; whereas, in the modernized descendants, even in the first and second generations of those individuals born to parents after they had adopted the foods of modern white civilizations, serious trouble was often experienced.

We have been considering the changes which take place in the skeletal growth as a result of the disturbances in the functioning of the pituitary body of the individual after birth, or of the mother during the prenatal period. We are also concerned with changes in the soft tissues, particularly the brain. I have presented data indicating that a very large percentage of mentally backward children have disturbances in facial development. The available data also indicate that a large percentage of those who are seriously injured in facial form have some disturbance in their mental or moral character. Whether there is relationship between the processes which develop these physical abnormalities in brain growth and mental efficiency, including emotional states and character traits is now to be considered.

An important contribution has been made to this phase of the problem by Dr. James Papez, Professor of Anatomy at Cornell University, (4) who concludes his report:

> Is emotion a magic product, or is it a physiologic process which depends on an anatomic mechanism? . . . The evidence presented is . . . suggestive of such a mechanism as a unit within the larger architectural mosaic of the brain.

Research data have been presented which deal with the anatomical defects of the brain of individuals suffering from the typical mental and physical patterns of the so-called Mongolian idiot. In these cases the gyrus cinguli of the brain were found to be absent, which indicates the impossibility that these individuals function normally either physically or mentally.

Modern civilization has provided a large group of the defectives known as Mongolian idiots. They have very definite characteristics both physical and mental. Among the former, one of the most universal expressions is a vacant stare associated with a face that is markedly underdeveloped in the middle third, usually accompanied by narrow nostrils and a narrow upper dental arch.

One of the outstanding characteristics of the group is their inability to develop mentally beyond three to eight years of age. Because of the difficulty of building a character and intelligence level beyond infancy, these unfortunates are housed largely in state institutions for feebleminded. Since the physical picture is similar to that which occurs in a much less severe form in a large number of individuals in our modern civilization, it is important that we study this group in the light of the information that is available with regard to their physical, mental and moral characteristics, and in the light of such information as is available regarding their origin.

The surveys that have been made reveal the fact that nearly all of them are born to mothers more than forty years of age, and apparently at a period of very low efficiency in reproductive capacity. While most of the discussion and literature stress the importance of the age of the mother, some data are now available which throw responsibility also on the paternal side.

Korosi, as reported by Tredgold in Mental Deficiency, came to the conclusion as a result of the investigation of 24,000 unselected individuals that the children of fathers below twenty or above forty years of age are weaker than the children of fathers between these ages. Also, the children of mothers over forty years of age are weaker than those born to mothers below this age. Tredgold presents data connecting defective structures in the brain with certain phases of physical behavior and mental deficiencies. He quotes many authors whose data correspond with his own. Much of this material relates to accounts of incomplete prenatal development of nerve structures in the brain.

We are particularly interested in the origin and the nature of the brain lesions. Penrose, (5) in analyzing the relative etiologic importance of birth order and maternal age in Mongolism presents data obtained from an examination of 224 defectives in which the total number of children in all the families involved was 1,013. Accordingly, in these families approximately 20 per cent were so affected. The average number of children per family was five and one-half. He states:

> Mongolian imbeciles are very often born last in a long family. This fact, which was pointed out many years ago by Shuttleworth, has led clinicians to believe that Mongolism is to some extent a product of the exhaustion of maternal reproductive powers due to frequent child bearing. . . . The conclusion is widely accepted with the reservation that the affected child is not necessarily born at the end of the family. Several cases are first-born, in fact, and it is sometimes stated that the conditions occur more frequently in first and last children than in other ordinal positions. There is, however, ample evidence that Mongolian imbeciles have a significantly later birth rank than normal children.

G. Ordahl (6) has reported on a study of ninety-one cases in which he found that fifty-six or 60 per cent were the last born. The families averaged five children. He states that "uterine exhaustion is the most commonly advanced reason for Mongolism." Madge T. Macklin (7) says, "It is usually stated that it (Mongolism) occurs more frequently in the later pregnancies owing either to reproductive exhaustion or to too advanced age of the mother." We are concerned at this point for evidence that will throw light on the relationship between the functioning of the pituitary body in the base of the brain and the development of this type of facial and mental deformity.

A striking case is that of a boy sixteen years of age who was a typical Mongolian idiot. He had two sisters who were much older than he. His mother was a partial invalid when he was born late in her

life. We have no data relative to the details of the children who may have been lost. His father was living and well except for a railroad injury. This boy at the age of sixteen was infantile in many of his characteristics and developments. The genitals were those of a boy eight years old. The facial expression was that of the typical Mongolian idiot. By the Binet test he had a mentality of about four years. Roentgenograms of his hands showed that the epiphyseal bones had not united. He played on the floor with blocks and with rattles like a child. His interest was in children's activities. (Fig. 125.) The outstanding physical characteristic was his maxillary arch which was so much smaller than the mandibular arch that it went entirely inside it. In order to give him a masticating surface, and with the hope of helping him both physically and mentally, since several cases had greatly benefited by such an operation, I determined to widen his arch by moving the maxillary bones apart about one-half inch. The position of his teeth before the moving of the bones is shown in Fig. 126. Roentgenograms showing the opening of the median suture with increase of pressure are also shown in Fig. 126. An important phase of this case was that the left nostril was entirely occluded, and probably had been all his life. A rhinologist spent half an hour trying to shrink the tissue with adrenalin and cocain sufficiently to get air or water through, and was not able to do so. The quantity of air that he was able to inhale through his right nostril was so scant that he continually breathed with his mouth open. At night he was forced to lie with something like his coat rolled into a hard ridge and placed under the back of his neck and his head pushed far back to a position that would open his mouth and retain it so, or he would awaken, strangling because of the closing of his mouth.

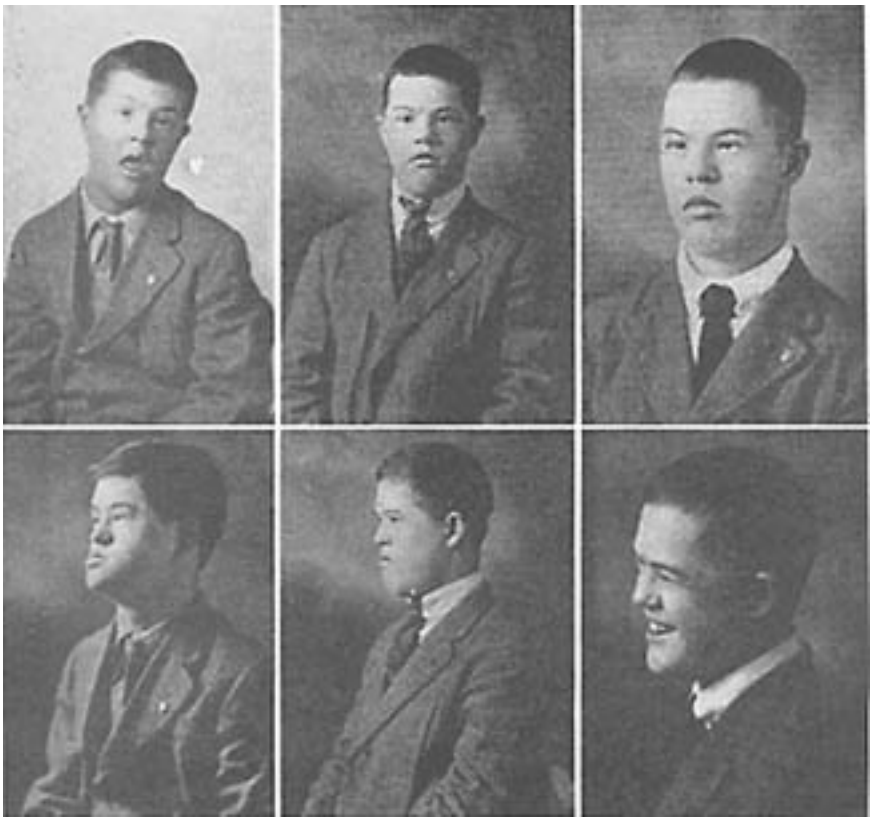

FIG. 125. These views show physical changes in the mongoloid type due to movement of maxillary bones to stimulate the pituitary gland in base of brain. Left, front and side view before, center, front and side view in thirty days. Right, front and side view six months after. Aged sixteen, infantile before, adolescent after operation. While he improved mentally he was harmless before and a sex pervert after operation and had to be placed in an institution.

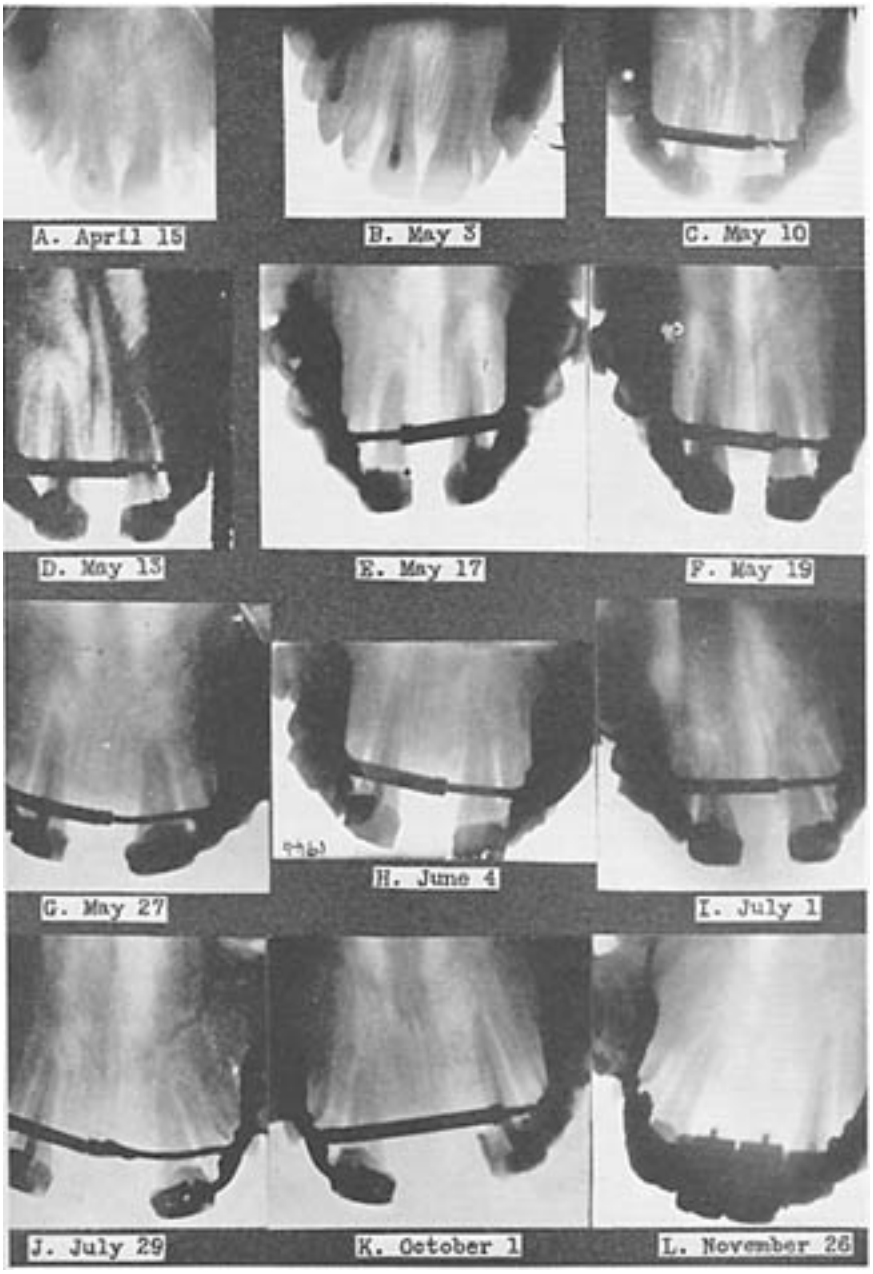

FIG. 126. These x-ray pictures show the position of the teeth before operation to move maxillary bones; and progessively, by the dates shown, the widening of the upper arch. In twelve weeks' time the boy passed through adolescence. New bone rapidly filled in the space between the separated bones. The space was retained with a fixed bridge carrying two additional teeth. His mother was nearly fifty when he was born.

With the movement of the maxillary bones laterally, as shown progressively in Fig. 126, there was a very great change in his physical development and mentality. He grew three inches in about four months. His moustache started to grow immediately; and in twelve weeks' time the genitals developed from those of a child to those of a man, and with it a sense of modesty. His mental change was even more marked. The space between the maxillary bones was widened about one-half inch in about thirty days. This lateral pressure on the maxillary bones was accomplished by rigid attachments to the teeth of the two sides of the upper arch. The outward movement of the maxillary bones (which form the roof of the mouth and sides of the nose) by pressure on the temporal bones produced a

tension downward on the floor of the anterior part of the brain, thus stimulating the pituitary gland in the base of the brain. In a few weeks' time he passed through stages that usually take several years. At first, he got behind the door to frighten us; later, he put bent pins on chairs to see us jump when we sat down, and finally he became the cause of a policeman's coming to the office from where he was conducting traffic on the corner below to find who it was squirting water on him when his back was turned. He developed a great fondness for calling people over the telephone, wanted to borrow my automobile to take his mother for a drive, and with his arm caressingly about the shoulders of one of the secretaries, invited her to go with him to a dance. All this change developed in about twelve weeks.

A most remarkable event happened in connection with this procedure. He lived in another city, and so, while with me, stayed in a boarding house at a little distance from my office in order that he might have frequent, and almost constant attention. On his return to his home town, his efficiency had increased to such an extent that his mother could send him with the money to the grocery store with the order for the day's groceries, and he could bring back the right change and could tell when it was correct. He could also come alone to me ninety miles by railroad and make two changes of trains and the various transfers on the street cars of the city with accuracy and safety.

He wore an appliance in his mouth to keep the bones in position. This appliance became dislodged; the maxillary bones settled together; immediately, or in a day or two, he lapsed into his old condition of lethargy accompanied by an old trouble, which had frequently been distressing, namely, nausea, this sometimes lasting for twenty-four hours. With the readaptation of the separating appliance and the reconstruction of the retaining appliance, he returned rapidly to his improved condition.

But a new problem had developed. We had changed an infant to a potential man with the impulses of a man, but with the mind of a child. With the change in his physical condition he became a menace in his community as a sex pervert. His mother died and his sister married. It became necessary to have him placed in a state institution for defectives. During the period he was in my care, he had learned to read child stories and newspaper headings, and had spent much time doing so. The changes in his physical appearance are shown in Fig. 125, above, front view, and below, side view. The first picture at the left shows his appearance before the operation; the second, thirty days after; and the last, six months later. The opening produced in the upper arch in front of half an inch was filled by supplying two teeth on a restoration, which at the same time held the maxillary bones in their new position. In six months he had developed whiskers and moustache. The progressive changes in the position of the maxillary bones with the opening of the median suture are shown in Fig. 126, together with the mechanical appliance. In the last view, the restoration carrying the porcelain teeth to fill the space is shown.

A very important contribution to our knowledge of the cause of Mongolism has recently been published by Dr. Clemens E. Benda, (8) Clinical Director of the Wrentham State School, Wrentham, Massachusetts, in association with the Harvard Medical School of Boston. He and his group have approached the problem of Mongolism from two different angles; first, as to determine whether it is accidental, and second, whether it is a unit of symptoms which can be related to more essential alteration. Their studies including careful anatomical studies have been made on the basis of an examination of 125 Mongoloids. He states:

> Summarizing our investigations, the pituitary in mongoloids reveals a peculiar and definite pathology. On the basis of fourteen cases we feel justified in emphasizing that in mongolism definite failure of the pituitary development is to be found. Mongolism appears as a hypopituitarism of a specific type, in which the absence or deficiency of basophiles seems to be essential.

The evidence indicates that this severe type of facial and brain injury is related directly to a lowered reproductive capacity of the mother associated with age, since the majority are born to mothers beyond forty years of age, and to an inadequate nutrition of the mother, particularly in vitamin E since this vitamin plays so important a role in the nutrition of the pituitary body.

Important new data have been provided in an analysis of births in the United States in connection with the development of the Mongolian group. Bleyer (9) has reported a study of 2,822 cases. He reports that of the total births in the United States in 1934, of 1,095,939, there were 1,822 reported as Mongoloids. The average age of the mothers of these individuals was forty-one years. He reports data indicating that in the age group of mothers forty to forty-four the chances of the development of a Mongoloid would be seventy-five times as high as normal expectancy, and in the age forty-five to forty-nine the chances are 125 times normal expectancy. In a group of 1,942 Mongoloids, 1,100 or 57 per cent were last children. These data are in keeping with those of several other investigators, and emphasize the problem of depleted reproductive capacity.

The interesting problems involved in the birth of identical twins throw light on the origin of both physical and mental characters. It is a matter of great significance in connection with these studies that anomalies which we can associate with parental deficient nutrition are reproduced in both twins. Important additional light has been thrown on this phase by a family of six pairs of fraternal twins born to the same parents. These are reported by Dr. William W. Greulich, of New Haven. (10) It is significant that nine of these individuals (one of the oldest pair is deceased, and the youngest twins are yet babes in arms) show marked narrowing of the nostrils and lack of development of the middle third of the face, narrowing of the face and tendency to be mouth breathers. Further, the severity of this condition appears to be progressively more severe in the younger pairs of twins, sufficiently grown to show facial development. There is accordingly, evidence here of progressive lowering of reproductive efficiency, and the fact that both individuals are involved similarly has great significance, since they are fraternal twins arising from a single ovum. This seems clearly to relate this disturbance with a deficient germ plasm. Factors that are reproduced in identical twins would include both hereditary characters and those that are produced by a disturbance in environment resulting in an interference with normal hereditary processes. In a case of twins that are not identical, there is significance in the development of similar deformities which are likely to be of acquired origin rather than of hereditary origin. In Fig. 127 is seen a pair of twins. Note that they have similar disturbance in the development of the dental arches with the upper laterals depressed and the cuspids crowded outward in the arch.

FIG. 127. These boys are twins, not identical. Note, however, both have same type of deformity of the dental arch, apparently due to the same cause.

A very important source of information which deals with the relation of disturbances of the physical development of the head and mentality is provided by a study of the members of the teen-age group who are classed as mentally backward. In an examination of a Cleveland school in a colored district that has been set aside largely for boys and girls who are distinctly deficient in their ability to learn, it was disclosed that a very large percentage suffered from gross facial deformities when judged by these standards. Typical individuals in this group are shown in Fig. 128, one is white, lower left. It is clear that these boys were all physically injured in the formative period. Their clinical history indicates that the brain was involved in this disturbed development.

FIG. 128. These four boys are typical of a group of several hundred in a special school for backward children. Practically all showed some evidence of incomplete facial and dental arch development. The range of defects is wide. Blacks are similarly injured as whites. This is inhibited heredity.

One of the problems involved in the development of the group of disturbances having physical and mental expressions, is associated with the sensitiveness of the body during the period of adolescence. Many students of degenerative problems have emphasized various phases of this large problem. Burt" commented: "It is almost as though crime were some contagious disease, to which the constitutionally susceptible were suddenly exposed at puberty, or to which puberty left them peculiarly prone." The age of adolescence is also the period of greatest susceptibility to dental caries. Data derived from chemical studies of the blood and saliva show that in this period of susceptibility to dental caries the supplies of minerals and vitamins are inadequate to meet Nature's demands, and the system borrows minerals from the skeleton to maintain vital processes. Lichtenstein and Brown (12) report data which reveal that educational quotients, like intelligence quotients, fall with increase in age during the years of developing puberty. They show that the educational quotient at nine years of age for the group studied was 100; at eleven years of age, 89; at twelve years, 83; and at thirteen years, 74. The changes in facial and dental arch form, which I have described at length in this volume, develop in this age period also, not as a result of faulty nutrition of the individual but as the result of distortions in the architectural design in the very early part of the formative period. Apparently, they are directly related to qualities in the germ plasm of one or both parents, which

result from nutritional defects in the parent before the conception took place, or deficient nutrition of the mother in the early part of the formative period. Case records show that the first signs of delinquency generally make their appearance during these years. The age reported most frequently was that of thirteen.

One expression of the rate of the progressive degeneration that is taking place in the United States is the increase in delinquency and crime in young people between twelve and twenty years of age, as well as in crime in general. Edgar Hoover, Director of the Bureau of Investigation, has recently published data showing comparative figures for 1936 and 1937, during which time crimes in the United States increased from 1,333,526 to 1,415,816, an increase of six per cent. This increase is occurring in spite of the rapid development of social organizations for improving the environment.

Preventive measures among the unsocial group, who pass through the stages of predelinquency and crime, have been almost entirely confined to improvement in the social surroundings of the growing youth. While, no doubt, individuals with a low factor of safety are less likely to develop serious criminal tendencies under favorable environments, such factors as constitute a first-conditioning force, i.e., injury of the germ plasm, and deficient nutrition in the developmental period are not corrected by these efforts. These new data relating to the nature of the underlying causes strongly emphasize the need for beginning much earlier. Indeed, the preparation for the next generation should begin early in the life of the preceding generation.

Many investigators have emphasized the sensitiveness of the nervous system to disturbances in the formative period. Considerable data have been presented indicating that the tissues of the nervous system are the most easily affected of all the structures of the body. The extent of the injuries to the nervous system vary through a wide range.

Harris in his chapter on "Congenital Abnormalities of the Skeleton" in Blacker's (13) "Chances of Morbid Inheritance" has presented data indicating the sensitive period at which the ovum is most likely to be injured:

> Few normal human embryos have been subjected to careful study. The vast majority of human embryos examined have been abnormal, and it is their abnormality which has led to their abortion between the sixth and thirteenth weeks of embryonic life, a critical period associated with the development of the placenta, during which the death rate is probably in the neighborhood of at least 15 per cent.

In tracing the development of the human embryo, he tells why the growth process is very different from that of the development of embryos of lower forms. He states regarding deformed ova: "Ova that survive the eighth week tend to live on to term, and are born as monsters." I have referred previously to a personal communication from Professor Shute, of the University of Western Ontario, which states that he had been impressed with the high percentage of deformities in aborted fetuses. This seems to be Nature's method of eliminating defective individuals. Harris says further:

> It is sometimes suggested that threatened abortions in early pregnancy should not be treated by rest and quiet, as it is quite possible that the uterus is attempting to rid itself of a pathological ovum which might become a monster in the future.

The available data emphasize strongly that a very small percentage of the total gross deformities ever develop to menace society. Harris quotes Mall: (14)

> He estimated from the records of 100,000 pregnancies that there were 80,572 normal births, 11,765 abortions of normal embryos and early monsters, and 615 monsters born at term. Thus at term 1 child in 132 is born with some anatomical defect. For each such case appearing at term, 12 others died and were aborted during pregnancy.

These data deal with gross defects involving physical deficiencies in the infant and indicate that the defects that are produced in the formative period, which are less severe than the above, are not recognizable at birth and may not be until long afterwards. According to Harris, "During the fourth week of embryonic life the head, brain and spinal cord are most susceptible to adverse conditions." He traces the sensitive areas of the various structures through the various weeks in the embryonic history. The deformities of the face among the primitive races which I have illustrated extensively frequently are not revealed until the eruption of the permanent dentition and the development of the adult features. While it is true that many children show deformity in facial development even in babyhood and childhood, those individuals are usually much more seriously injured when the adult face is developed.

Bloom (15) has presented the anatomical and histological characteristics of a defective born to a mother fifty-one years of age, whose general health was reported as good. The infant's facial pattern was markedly divergent from normal and practically no brain tissues had been formed. This expression of an extreme injury was entirely beyond that with which we are concerned in the study of the mental and the moral cripples who constitute an increasing part of our society. This is presented to emphasize Nature's inexorable requirement that each parent shall be individually physically fit for the responsibility of producing the next generation. Several primitive races studied have realized this responsibility.

There are some phases of modern physical degeneration in which most of us take part with remarkable complacency. We would consider it a great misfortune and disgrace to burn up the furniture in our homes to provide warmth, if fuel were available for the collection. This is precisely what we are doing with our skeletons by a process of borrowing, simply because we fail to provide new body repairing material each day in the food. You are all familiar with the tragic misfortune that overtakes so many elderly people through the accident of a broken hip or other fractured bone. Statistics show that approximately 50 per cent of fractured hips occurring in people beyond 65 years of age never unite. We look upon this as one of the inevitable consequences of advancing age. In Chapter 15 I have referred to the small boy whose leg was broken when he fell in a convulsion while walking across the kitchen floor. That bone did not break because the blow was hard but because the minerals had been borrowed from the inside by the blood stream in order to maintain an adequate amount of the minerals, chiefly calcium and phosphorus in the blood and body fluids. He had been borrowing from his skeleton for months because due to a lack of vitamins he could not absorb even the minerals that were present in the inadequate food that he was eating. The calcium and the phosphorus of the milk were in the skimmed milk that he was using but he needed the activators of the butter-fat in order to use the minerals. Simply replacing white bread with these activators and the normal minerals and vitamins of wheat immediately checked the convulsions.

We have many other expressions of this borrowing process. Much of what we have thought of as so-called pyorrhea in which the bone is progressively lost from around the teeth thus allowing them to loosen, constitutes one of the most common phases of the borrowing process. This tissue with its lowered defense rapidly becomes infected and we think of the process largely in terms of that infection. A part of the local process includes the deposit of so-called calculus and tartar about the teeth. These contain toxic substances which greatly irritate the flesh starting an inflammatory reaction. Many primitive peoples not only retain all of their teeth, many of them to an old age, but also have a healthy flesh supporting these teeth. This has occurred in spite of the fact that the primitives have not had dentists to remove the deposits and no means for doing so for themselves. Note particularly the teeth of the Eskimos. The teeth are often worn nearly to the gum line and yet the gum tissue has not receded. Many of these primitive groups were practically free from the affection which we have included in the general term of pyorrhea or gingivitis. Pyorrhea in the light of our newer knowledge is largely a nutritional problem. While nutrition alone often will not be adequate for correcting it, when established practically no treatment will be completely adequate without reinforcing the nutrition in so far as deficient nutrition has been a contributing factor. Nutrition plus the frequent removal of deposits, plus suitable medication will check and prevent pyorrhea but not correct the damage that has already been done. The elements that are chiefly needed in our nutrition are those that I have outlined as being particularly abundant in the menus as used by several of the primitive races. These are discussed in detail in Chapter 15.

Another important aspect of this problem of borrowing has to do with the progressive shrinking of the skeleton as evidenced by the shortening of the stature. I have measured many individuals who have lost from two to six inches in height in a decade or two. I have seen a few individuals who have lost as much as ten inches of their height by this process of borrowing from the skeleton. Our bodies need a certain amount of fresh minerals every day with which to manufacture blood. The days that these minerals are not provided in the foods they will be taken from our storage depots, the skeleton.

A particularly tragic phase of this problem of borrowing from the bone is seen in growing girls and is chiefly due to their ambition to avoid enlargement of their bodies to keep down their weight. The girls deprive themselves of body building material at a time when their bodies are growing and are requiring considerable new mineral. Forming bone has a prior claim on minerals, which is sufficiently commanding to induce the individual to borrow from bones that are already formed to provide for the necessary lengthening and growth. By this process many of the bones of the body are softened, particularly the bones of the spine. Curvatures develop, one of the expressions of which may be round or stooped shoulders.

Among primitive races this type of girl, so commonly seen in our modern civilization, is absent. Probably not one of these girls has ever suspected the suffering and sorrow that is being stored up for future life as a result of this bad management at a critical time in her development. Fig. 134 illustrates one of the tragedies of this borrowing process. Practically all of these physical evidences of degeneration can be prevented and fortunately many of them can be relieved in large part with an adequate nutrition. Even ununited fractures often can be induced to unite by an adequate reinforcement of the nutrition. This is true not only for young people but for elderly people as well.

In addition to the problems growing out of physical injuries through lack of development before

birth, which express themselves as facial and other deformities, there is increasing need for concern for physical handicaps entailed in underdevelopment of the hips. The difficulty encountered at childbirth in our modern civilization has been emphasized by Dr. Kathleen Vaughan (16) of London. In her book, "Safe Childbirth," she states that faults of development more than race modify pelvic shape. In the Foreword to her book, Dr. Howard A. Kelly, Professor Emeritus of Gynaecological Surgery, Johns Hopkins University, says:

> Dr. Vaughan presents such an array of facts and data that the book must impress every reader. It is of vital importance that her conclusions be considered, for in my opinion our methods of bringing up our girls and the habits of our women with many of the customs of 'civilized' life must be radically readjusted.

This important work should be made available for reference in the school libraries of the United States. Further data from it are presented in Chapter 21.

The great contrast in discomfort and length of time of the labor of modern mothers is to be contrasted with ease of childbirth among primitive mothers. Many workers among the primitive races have emphasized the vigorous health and excellence of the infant at birth. We have here, therefore, emphasis on the need in the interest of the infant that the mother shall have an easy and short labor. Both of these factors are directly influenced by the vitamin content of the mother's body as supplied by her nutrition and also by the physical development of her body if her mother at the time of gestation and prior to conception had adequate vitamins in her food to insure perfect germ cells.

The sensitivity of the brain to injury resulting from medication given the mother has been emphasized by Dr. Frederic Schreiber of Detroit. In his paper before the American Medical Association meeting in San Francisco, June, 1938, he was quoted as saying (17) that the analysis showed that 72 per cent of the children had shown difficulty in breathing at the time of birth or in the first few days following birth. He concluded, therefore, that this difficulty in breathing was the cause of the brain damage.

Difficulty in breathing would lead to a shortage of oxygen. An insufficient supply of oxygen in the blood stream would have serious effects upon the tissues of the brain. In this connection, he cited evidence found in post-mortem examinations that deficiency of oxygen caused microscopic changes in the brain.

X-ray photographs of some of the children examined by Dr. Schreiber showed various degrees of brain atrophy.

The contribution of Dr. Schreiber also emphasizes strongly the susceptibility of the brain tissue to injuries which may handicap the individual throughout life.

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Chapter 20

SOIL DEPLETION AND PLANT AND ANIMAL DETERIORATION

THE data available on the subject of soil depletion and animal deterioration are so voluminous that it would require a volume to present them adequately. When we realize the quantities of many of the minerals which must enter into the composition of the bodies of human beings and other animals, we appreciate the difficulty of providing in pasture and agricultural soils a concentration of these minerals sufficient to supply the needs for plant growth and food production. If we think of growing

plants and grasses in terms of average soil tilled to a depth of seven inches, we are dealing with a total of approximately two million pounds of soil per acre, of which two thousand pounds will be phosphorus in its various chemical forms, some of which will not be readily available for plants. If one-half of this phosphorus were present in an available form, there would be enough for only one hundred poor crops, utilizing ten pounds to the acre for the seed alone; or for forty good crops, taking twenty-five pounds per acre, assuming that the seed were to be removed from that land and not replaced. A sixty-bushel crop of wheat or corn per acre takes twenty-five to twenty-eight pounds of phosphorus in the seed. The soil is depleted of calcium similarly, though that mineral is not usually present in such limited amounts nor so rapidly taken away as is phosphorus. The leaves and stems of rapidly growing young plants and grasses are rich in calcium and phosphorus. As the plants ripen the phosphorus is transported in large amounts to the seed while most of the calcium remains in the leaves. A large part of the commerce of the world is concerned with the transportation of chemical elements as foods, chief of which are calcium and phosphorus. Whether the product of the soil is ultimately used as wheat for bread, milk and meat for foods, or wool and hides for clothing, every pound of these products that is shipped represents a depletion of soil for pasturage or for grain production.

If we think of one hundred good crops constituting the limit of capacity of the best soils, and one-fourth of that for a great deal of the acreage of the tillable soil, we are probably over-generous. This problem of depletion may seem to many people unimportant, either because there has been no consciousness that depletion has been taking place, or because they believe that replenishment is a simple matter.

In correspondence with government officials in practically every state of the United States I find that during the last fifty years there has been a reduction in capacity of the soil for productivity in many districts, amounting to from 25 to 50 per cent. I am informed also that it would cost approximately fifty dollars per acre to replenish the supply of phosphorus.

Many people realize that farms they knew in their childhood have ceased to be productive because they have "run out." The movement of population to cities and towns is, in part, the result of the call of the social center and in part a consequence of the need of forsaking depleted soil. While there are many things that influence the movement from the farms, there is much to be learned from the government census reports which deal directly with farm acreage and values.

If we relate the levels of life of human and domestic animals to the problem of soil depletion, we find two important groups of data. First, there are those which relate to specific land areas, some small and some very large; and second, those which relate to civilizations and groups, both large and small that have passed out of existence or are rapidly deteriorating. A study of the skeletons of the past and present often discloses a progressive breakdown. For example, we may mention the important anthropological findings of Professor Hooton of Harvard, who, in his examinations of various pueblos of the Western Plains, especially at the Pecos Pueblo where the progressive burials have been uncovered, has brought to light the calendar of a civilization extending over a thousand years. These findings show that there has been over the period of years a progressive increase in skeletal deformities, including arthritis and dental caries, together with a reduction in stature, suggesting a direct relationship to progressive depletion of the soil.

In a recent magazine article, I have presented data (1) comparing the mineral content of different pasture grasses, and relating these to deficiencies in cattle. Unfortunately, space does not permit reviewing these data here in detail. They show that calcium varied from 0.17 per cent for a dry pasture grass in Arizona to 1.9 per cent in a Pennsylvania pasturage plant, to 2 per cent in a British Columbia pasturage plant, a range of over ten fold. Similarly, phosphorus was shown to vary from 0.03 per cent to 1.8 per cent, a range of sixty fold. Neither pasture animals nor human beings can eat a sufficient amount of low mineral plant food to provide the total mineral requirements of ordinary metabolism. In cases of overload, such as pregnancy and lactation in adults, and rapid growth in children, the demand is increased greatly. For example, a high-milk-production cow from southern Texas on a certain low mineral pasture will run behind her normal requirements about 60 grams of phosphorus and 160 grams of potassium per day. In that district large numbers of cattle were unable at the time to maintain their own bodies, let alone reproduce or provide milk. Many cattle in the district developed loin disease. It was found that moving them to another plot of ground where the soil was not depleted provided recovery.

About thirty-seven billion dollars, or approximately 40 per cent of the cash income of salaries and wages of the people in the United States, is used for the purchase of foods. When we add to this the expenditure of energy by the people living on the land, it represents a total, probably exceeding fifty billion dollars a year that is spent for the chemicals that are provided in the foods, a large amount of which, perhaps 50 per cent, will have been expended for calcium and phosphorus, perhaps 25 per cent for other chemicals, and 25 per cent for special vitamin or activator carrying foods. Of this enormous transportation of minerals from the soil an exceedingly small proportion gets back to the tillable land in this country. Orr (2) states that "Consumption in the United Kingdom of live stock products mostly derived from grass lands has been estimated at about four hundred million pounds sterling per annum (*nearly two billion dollars*) ." This includes dairy products, meats and hides. Never in the history of the world has there been such a large scale depletion of the soil by transportation away from the tilled and pasturage areas. Sickness in the United States has been calculated to cost nearly half as much as food, and is increasing.

An important discovery has been made with regard to the feeding of dairy cattle and other live stock: the nutritive value of young grass, when in a state of rapid growth, carries not only a very large quantity of minerals, but also digestible proteins in amounts that are approximately equivalent to those provided by the concentrated cereal cattle foods, such as linseed cake. It is observed also that not only do the milk products of such cows remain at a high level while the cows are on the rapidly growing young grass, particularly a rapidly growing young wheat grass or young rye grass, but the animals themselves are in better physical condition than when on grain concentrates. Further, that calves fed on the milk of those cows grow much more rapidly than they do when the cows are on other fodder and have a much higher resistance to disease. Grass, to provide these nutritional factors, must be grown on a very rich, well-balanced soil. A young plant, of necessity, produces a rapid depletion of soil. Minerals and other chemicals are removed and therefore there is need for adequate replacement.

In Chapter 18 I have reported investigations made by Professors Meigs and Converse at the Beltsville Experimental Station, in which they have shown that feeding cattle on a grade of dried hay that was low in chlorophyll resulted in the development of dead or blind calves, and further that when

the milk of these cows was fed to three normal calves they died in fifty-seven, sixty-two and seventy-one days respectively. These calves had been fed on whole milk until twenty days of age. They show that the main deficiency in this ration was vitamin A.

Since mammals require milk in infancy and since it is the most efficient single food known, I have made a special study of milk and its products. The role of the vitamins and other activating substances in foods is quite as important and essential as that of minerals. These activating substances, in general, can be divided into two groups, those that are water-soluble and those that are fat-soluble, the former being much more readily obtained in most communities, than the latter. Since the fat-soluble and also the water-soluble vitamins are essential for mineral utilization and particularly since the fat-soluble activators are so frequently found to be inadequately supplied in diet and are usually more difficult to obtain, a special effort has been made to determine the level of these in dairy products in many different places for different seasons of the year. To accomplish this, I have obtained each year since 1927 samples of cream and butter, mostly butter, for analysis for their activator content. The work has rapidly extended so that for the eleventh year we are receiving now (1939) samples from several hundred places distributed throughout the world, usually once or twice a month throughout the year. Methods used for these studies are both biologic and chemical. These data are used in connection with morbidity and mortality statistics for the same districts.

The progressive changing of the levels of life is shown by the morbidity and mortality statistics of the various areas of the United States and Canada. The American Heart Association publishes, from time to time, very important data relative to the number of deaths from heart disease in the various states of the Union. It is of interest to note that the highest mortality levels that are obtained are found in those states, in general, that have been longest occupied by modern civilizations, namely, the Atlantic States, the New England States, the Great Lakes States and the Pacific States. Their data published in their booklet ~tHeart Disease Mortality Statistics" and based on the United States Registration area reveal that the death rate per 100,000 population was 123 in 1900. The data sent me in November 1937 from the United States Census Bureau, Department of Commerce, in Washington, report the death rate from heart per 100,000 for 1934 as 239.9, in other words an increase of 86.9 per cent in thirty-four years. Figures provided by the Bureau of Census for England and Wales show the death rate per 100,000 to be 269.3; and for Scotland, 232. While the average figure for the United States Registration area of 224 deaths per 100,000 seems very high, it is exceedingly important to note that the New England States were much higher, leading the entire country. Massachusetts reported 307.3; New Hampshire, 323.1; Vermont, 310.8; New York, 302.1; Maine, 297.5. The rate of increase in the decade of 1921 to 1930 was 51.3 per cent for Delaware; 52 per cent for Connecticut, 51 per cent for Pennsylvania, 59.4 per cent for Missouri, 60.0 per cent for Washington; 55 per cent for Wisconsin; 64 per cent for Louisiana; 71 per cent for Florida; 63 per cent for South Carolina; 81 per cent for Montana; 61 per cent for Kentucky; and 51.9 per cent for North Carolina. Such rates of increase as these are cause for alarm.

Sir Arnold Theiler, who spent a quarter of a decade studying the problems of nutritional deficiency diseases among pasture animals in South Africa, has discussed at length the reduction of phosphorus in available quantities for plant development as constituting, by far, the most important mineral deficiency. He reported data obtained from many countries through the world, indicating that the deterioration of cattle and sheep can be directly traced to an inadequate amount of phosphorus in the soil. He states, in discussing the relation of this problem to the conditions as they obtain in Australia,

that: (3)

> Amongst the Australian data the figures showing depletion of phosphorus as a result of sale of products off the farm without adequate replacement by manuring, are interesting. Thus Richardson estimates that it would take two million tons of superphosphate to replace the phosphorus removed in the form of milk, mutton and wool. In the "ranching stage" of the development of a country the fact is often forgotten that the balance of Nature is frequently disturbed to the detriment of generations to come.

It is important to keep in mind that morbidity and mortality data for many diseases follow a relatively regular course from year to year, with large increases in the late winter and spring and a marked decrease in summer and early autumn. The rise and fall of the level of morbidity with the changing season produces curves that are exceedingly regular for the same place from year to year. The distribution, however, is distinctly different for different latitudes and altitudes. It is further of special importance to note that the curves for the Southern Hemisphere, with its opposite seasons, are in reverse of those of the Northern Hemisphere, and have very similar levels for the same seasonal periods. I have obtained the figures for the levels of morbidity for several diseases in several countries, including the United States and Canada. I find that the distribution of the rise and fall in morbidity and mortality does not follow the sunshine curve but does follow the curve of vegetable growth. Accordingly, I have made studies by dividing the United States and Canada into sixteen districts, four from East to West and four from North to South. I have plotted by months the levels of mortality for heart disease and pneumonia in these various districts, from figures obtained from the governments of these two countries. Similarly, I have plotted curves for the vitamin content found in butter and cream samples obtained from these sixteen districts. When these are arranged in accordance with the levels by months they are found, in each case, to be opposite to the mortality from heart disease and pneumonia. It is also important to note that while these curves show a higher midsummer level of vitamins in dairy products in the northern tier of districts, the period of high level is shorter than in the more southern division. Two peaks tend to appear in the summer cycle of curves for the vitamins, one representing the spring period of active growth and the other, the fall period. These peaks are closer together in the north than in the south.

A particularly important phase of this study is the finding of a lower level of vitamins throughout the year in those districts which correspond with the areas of the United States and Canada that have been longest settled, and consequently most depleted by agriculture. A similar study has been made based on the data published in a report by Tisdall, Brown and Kelley, (4) of Toronto. Their figures for children's diseases which included chicken pox, measles, nephritis, scarlet fever, hemorrhage of newborn, tetany and retropharyngeal abscess were arranged according to the incidence for each month. All of these diseases show a relatively high incidence during February and March, rising in December and January, falling during April and May, reaching a very low level in midsummer and then making a rapid increase during the autumn. These are opposite to the vitamin levels found in the dairy products of Ontario for the same months.

In Chapter 3, I discussed data obtained during two summers in the Loetschental and other Swiss valleys. The Loetschental Valley has been isolated from contact with surrounding civilizations by its unique physical environment. For twelve hundred years during which time a written history of the valley has been kept, the people have maintained a high level of physical excellence providing

practically all their food, shelter and clothing from the products raised in the valley. Cattle and goats provided milk, milk products and meat. The stock was carefully sheltered during the inclement weather and great care was used to carry back to the soil all of the enrichment. This, of course, is a process that is efficiently carried out in many parts of the world today. In this manner extensive depletion of the minerals required for food for animals and human beings may be prevented. Their practice is in striking contrast to that in many of the agricultural districts of the United States in which the minerals are systematically shipped from the land to the cities, there to be dissipated to the ocean through the sewerage system. Among many primitive races there is some attempt to preserve the fertility of the soil. For example, in Africa, many of the tribes that depend in part on agriculture, cleared off only a few acres in the heart of a forest and cropped this land for a limited number of years, usually less than ten. Great care was taken to prevent the loss of the humus both through drenching rains and wind erosion. The decaying vegetation and lighter soil that might be dislodged by the water were caught in the entanglement of roots and shrubbery surrounding the agricultural patch. The surrounding trees protect the soil from wind erosion. Care was taken not to form gullies, furrows and grooves that could carry currents of water and thus float away the valuable humus from the soil. This again is in contrast to conditions in other parts of the world, particularly in the United States. Sears (5) has stated that "Bare ground left by the plow will have as much soil washed off in ten years as the unbroken prairie will lose in four thousand. Even so, soil in the prairie will be forming as fast as, or faster than it is lost." In Nature's program, minerals are loaned temporarily to the plants and animals and their return to the soil is essential. To quote again from Sears.

> What is lent by earth has been used by countless generations of plants and animals now dead and will be required by countless others in the future. In the case of an element such as phosphorus, so limited is the supply that if it were not constantly being returned to the soil, a single century would be sufficient to produce a disastrous reduction in the amount of life.

The history of preceding civilizations and cultures of mankind indicate the imbalances that have developed when minerals have been permanently transferred from the soil. There are only a few localities in the world where great civilizations have continued to exist through long periods and these have very distinct characteristics. It required only a few centuries, and in some profligated systems a few decades to produce so serious a mineral depletion of the soil that progressive plant and animal deterioration resulted. In such instances, regular and adequate replenishment was not taking place.

The replenishment may be made, as in the case of the prairie with its plant and animal life, through a replacement in the soil of borrowed minerals, a program carried out efficiently by a few intelligent civilizations. The balance of the cultures have largely failed at this point. Another procedure for the replenishing of the depleted soils is by the annual spring overflow of great water systems which float enrichment from the highlands of the watersheds to the lower plains of the great waterways. This is illustrated by the history of the Nile which has carried its generous blanket of fertilizing humus and rich soil from the high interior of Africa northward over its long course through Sudan and Egypt to the Mediterranean, and thus made it possible for the borders of the Nile to sustain a population of greater density than that of either China or India. The salvation of Egypt has been the fact that the source of the Nile has been beyond the reach of modernizing influences that could destroy Nature's vast stores of these replenishing soil products. Where human beings have deforested vast mountainsides at the sources of the great waterways, this whole problem has been changed.

A similar situation has occurred in China. Her two great rivers, the Yangtze and the Yellow River, having their sources in the isolated vastness of the Himalayas in Tibet, have through the centuries provided the replenishment needed for supporting the vast population of the plains of these great waterways. Together with this natural replenishment the Chinese have been exceedingly efficient in returning to the soil the minerals borrowed by the plant and animal life. Their efficiency as agriculturists has exceeded that of the residents of most parts of the populated world.

The story in Europe and America has been vastly different in many districts. The beds of roots of trees and grasses that hold the moisture and induce precipitation have been rudely broken up. An important function of the plant and tree roots is the entanglement of dead plant life. Vegetation holds back moisture at the time of melting snows and rainy seasons so efficiently that disastrous floods are prevented and a continuing flow of water maintained over an extended period. Under the pressure of population more and more of the highlands have been denuded for agriculture; the forests have often been ruthlessly burned down, frequently with the destruction of very valuable timber. The ashes from these great conflagrations provided fertilizer for a few good crops, but these chemicals were dissipated rapidly in the swift flow of the water in which they were soluble, with the result that vast areas that Nature had taken millenniums to forest have been denuded and the soil washed away in a few decades. These mountainsides have become a great menace instead of a great storehouse of plant food material for the plains country of the streams. Loss of timber which was needed greatly for commerce and manufacture has been another disastrous result. The heavy rains of the spring now find little impediment and rush madly toward the lower levels to carry with them not the rich vegetable matter of the previous era, but clay and rocks which in a mighty rush spread over the vast plains of the lowlands. This material is not good soil with which to replenish and fertilize the river bottoms. On the contrary, it often covers the plains country with a layer of silt many feet deep making it impossible to utilize the fertile soil underneath.

We have only to look over the departed civilizations of historic times to see the wreckage and devastation caused by these processes. The rise and fall in succession of such cultures as those of Greece, Rome, North Africa, Spain, and many districts of Europe, have followed the pattern which we are carving so rapidly with the rise and fall of the modernized culture in the United States.

The complacency with which the masses of the people as well as the politicians view our trend is not unlike the drifting of a merry party in the rapids above a great cataract. There seems to be no appropriate sense of impending doom.

An outstanding example of our profligate handling of soil and watersheds may be seen in our recent experiences in the Mississippi Basin. The Ohio River draining the western slopes of the Allegheny Mountains has gone on rampages almost annually for a decade carrying with it great damage to property and loss of life. Other branches of the Mississippi, particularly the Missouri, draining the eastern slopes of the Rocky Mountains have gone out of control so that vast areas are flooded with silt. There is now a concerted effort to stem this series of cataclysms by building dykes along the great waterways to raise the banks and dams in the higher regions of the watershed to hold back the floods. These artificial lakes become settling pools for the silt and soon lose their efficiency by being filled with the debris that they are holding back from the lower levels. An effort is also being made to reforest which is purposeful, but when we consider the millenniums of time that

Nature has required to build the tanglewood of plant life, shrubbery and trees over the rocks and through the gullies to act as great defenses for holding back the water, these modern programs offer very little assurance for early relief.

Another very destructive force is the wind. When surfaces are denuded either at high or low altitudes the wind starts carving up the soil and starts it on the march across the country. We call the demonstrations dust storms. When we travel through our Western States, it is not uncommon to see buildings and trees partially buried in these rolling dunes of drifting sand. When we were traveling across the desert of Peru in 1937, we saw in many places mountain-like dunes rolling slowly across the country, frequently so completely blocking former traffic routes that long detours were necessary. When we were flying over eastern Australia in search of groups of primitive aborigines, we saw great forests gradually being engulfed with these marching billows of sand so that most of the trees were covered to their tips.

Few people will realize that it is estimated that only about 45 per cent of the land surface of the United States is now available for agricultural purposes and grazing. This includes vast areas that are rapidly approaching the limit of utility.

In one of my trips to the Western States I visited a large ranch of some fifty thousand acres. I asked the rancher whether he was conscious of a depletion in the soil of the ranch in its ability to carry pasture cattle. He said that it was very greatly depleted, that whereas formerly the cows on the ranch were able to produce from ninety-three to ninety-five healthy calves per hundred cows annually, nearly all of sufficiently high physical quality to be available for reproductive purposes, now he was getting only forty to forty-four calves per hundred cows annually and usually only ten or eleven of these were physically fit for reproductive purposes. He stated also that he was able to raise as many calves for restocking the ranch on the plant food produced on the fifty acres to which he was applying a high fertilization program as on the rest of the fifty-thousand-acre ranch. Of late most of the calves for the ranch had to be imported from other states.

In a city in the vicinity I inquired of the director of public health what the death rate was among their children up to one year of age. He stated that the figures were progressively increasing in spite of the fact that they were giving free hospitalization and free prenatal and postnatal care for all mothers who could not afford to pay for the service. This death rate had more than doubled in fifty years. I asked how he interpreted the increasing mortality rate among the infants and mothers. His comment was in effect that they could not explain the cause, but that they knew that the mothers of this last generation were far less fit physically for reproduction than their mothers or grandmothers had been.

To many uninformed people the answer will seem simple. Those who are responsible for these programs, recognize the difficulty in replenishing the exhausted minerals and food elements in adequate quantity. I have been informed by the director of the department of agriculture of the state of Ohio that it would cost fifty dollars per acre to restore the phosphorus alone that has been exhausted during the last fifty to one hundred years. He stated that the problem is still further complicated by the fact that the farmer cannot go to a bank and borrow money to buy this fertilizer. If, however, he buys adjoining acreage to double his own, he can then borrow twice as much money

as he can on his own farm. But this is not all of the difficulty. Recent data indicate that if sufficient phosphorus in a form easily available for plant use were supplied to the land at once, it would kill the plant life; it must be provided in a form in which by a process of weathering it is made slowly available for plant utilization. Phosphorus is only one of the minerals that is readily taken from the soil. Other minerals also are difficult to provide. I have been able practically to double the weight and size of beets in five weeks by the addition of a tablespoonful of ferric ammonium citrate to each square foot of garden soil.

An important commentary on soil depletion is provided by the large number of farms that have been abandoned in many districts throughout the United States. The severe industrial depression which has thrown large numbers of shop and mill workers out of employment, has induced a considerable number of these to return to the land for subsistence. As one drives through farming districts that once were very fertile many farms are seen apparently abandoned insofar as tillage is concerned.

In my studies on the relation of the physiognomy of the people of various districts to the soil, I have found a difference in the facial type of the last generation of young adults when compared with that of their parents. The new generation has inherited depleted soil. In many communities three generations of adults are available for study. The yardstick for these comparisons has been developed in the preceding chapters. It will be of interest for the readers to apply this yardstick to their own brothers and sisters in comparison with the parents and particularly their grandparents. The most serious problem confronting the coming generations is this nearly unsurmountable handicap of depletion of the quality of the foods because of the depletion of the minerals of the soil.

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Chapter 21

PRACTICAL APPLICATION OF PRIMITIVE WISDOM

IF THE observations and deductions presented in the foregoing chapters are exerting as controlling an influence on individual and national character as seems to be indicated, the problem of the outlook for our modern civilization is changed in many important aspects. One of the most urgent changes in our viewpoint should be to look upon the assortment of physical, mental and moral distortions as due, in considerable part, to nutritional disturbances in one or both parents which modify the development of the child, rather than to accepted factors in the inheritance. The evidence indicates that these parental disturbances of nutritional origin may affect the germ plasm, thus modifying the architecture, or may prevent the mother from building a complete fetal structure, including the brain. In other words, these data indicate that instead of dealing entirely with hereditary factors, we are dealing in part with distortions due to inhibitions of normal hereditary processes. This changes the prospects for the offspring of succeeding generations. Atavism will still have plenty to her credit even if she must give up her claim to distortions of individual characteristics.

Jacobson (1) has summarized the determining factors in individuality and personality when he says "The Jekyll-Hydes of our common life are ethnic hybrids." Most current interpretations are fatalistic and leave practically no escape from our succession of modern physical, mental and moral cripples. Jacobson says of our modern young people:

> Very much of the strange behavior of our young people to-day is simply due to their lack of ethnical anchorage; they are bewildered hybrids, unable to believe sincerely in anything, and disowned by their own ancestral manes. To turn these neurotic hybrids loose in the world by the million, with no background, no heritage, no code, is as bad as imposing illegitimacy; their behavior, instead of expressing easily, naturally and spontaneously a long-used credo, will be determined by fears and senseless taboos. How can character be built upon such foundations? There is a ludicrous as well as a pathetic side to the situation presented by a Greek puzzled by his predominantly German children, or by the German woman unable to understand her predominantly Spanish progeny. It is a foolish case over again of hen hatching ducklings, of wolf fostering foundlings.

If our modern degeneration were largely the result of incompatible racial stocks as indicated by these premises, the outlook would be gloomy in the extreme. Those who find themselves depressed by this current interpretation of controlling forces would do well to recall the experiments on pigs referred to in Chapters 17 and 18, in which a large colony all born blind and maimed because of maternal nutritional deficiency--from deficient vitamin A--were able to beget offspring with normal eyes and normal bodies when they themselves had normal nutrition.

Much emphasis has been placed on the incompatibility of certain racial bloods. According to Jacobson, (1)

> Aside from the effects of environment, it may safely be assumed that when two strains of

> blood will not mix well a kind of "molecular insult" occurs which the biologists may some day be able to detect beforehand, just as blood is now tested and matched for transfusion.

It is fortunate that there is a new explanation for the distressing old doctrine which holds that geniuses cannot be born unless there is an abundant crop of defectives. In this connection Jacobson says,

> The genius tends to be a product of mixed ethnic and nervously peculiar stock--stock so peculiar that it exhibits an unusual amount of badness. The human family pays dearly for its geniuses. Just as nature in general is prodigal in wasting individuals for the development of a type, or species, so do we here find much human wastage apparently for a similar purpose. One may think of the insane and the defectives as so many individuals wasted in order that a few geniuses may be developed. It would seem' that in order to produce one genius there must be battalions of criminals, weaklings and lunatics. Nietzsche must have had biologic implications of this sort in mind when he spoke of the masses as merely "fertilizers" for the genius. This is why the genius has been compared to the lily on the dunghill. He absorbs all the energy of his family group, leaving the fertilizing mass depleted.

Our recent data on the primitive races indicate that this theory is not true, since in a single generation various types and degrees of physical, mental or moral crippling may occur in spite of their purity of blood and all that inheritance could accomplish as a reinforcement through the ages.

The extent to which the general public has taken for granted that there is a direct relationship between mental excellence and mental deficiency is illustrated by the commonly heard expression "great wits and fools are near akin" which expresses tersely the attitude of a modern school of psychiatry. This doctrine is not supported by controlled data from scientifically organized investigations. One of the principal exponents quoted is Maudsley who stated "it is not exaggeration to say that there is hardly ever a man of genius who has not insanity or nervous disorder of some form in his family." Many reviews of the lives of great men have been published in support of this doctrine. Havelock Ellis, however, one of the leading psychologists and psychiatrists of our day, has shown that the percentage of cases substantiating this doctrine is less than 2 per cent and less than half that proportion found in the population at large, which in a tested group he found to be 4.2 per cent. East of Harvard in discussing this problem states, after reviewing the evidence pro and con: "Thus it is seen that where one collates the work of the most competent investigators on the possibility of relation between insanity and genius the conclusion is unavoidable that none exists."

Those who still believe in the old fatalistic doctrines may answer the questions why the last child is affected seriously much more often than would be expected through chance; or why the most severe defectives are born after mothers have exceeded forty years of age; and still further why our defectives are found chiefly among the later members of large families. These facts are not explainable by Mendel's laws of heredity.

Professor J. C. Brash, of the University of Birmingham, in his monograph (2) discusses the current theories in detail. He emphasizes the role of heredity as the controlling factor in the origin of divergencies. However, all of the distortions of the face and jaws which he presents as being related to heredity can be duplicated, as I have shown, in the disturbances appearing in the first and second

generation after primitive racial stocks have adopted the foods of our modern civilizations in displacement of their native foods. He emphasizes the importance of an adequate diet during the growth period of the child, and also the fact that malocclusion is not a direct manifestation of rickets. Hellman has emphasized the importance of childhood diseases. The disturbances which we are studying here, however, are not related to these influences.

Two of the outstanding advances in laboratory and clinical approach to this problem of the relation of the structure of the brain to its function as expressed in mentality and behavior have been the work of Tredgold in England, referred to in Chapter 19, and the "Waverly Researches in the Pathology of the Feeble-Minded," in Massachusetts. Tredgold recognizes two sources of brain injury, "germinal blight" and "arrest" and puts particular stress on the former as being pathological and not spontaneous, and related to the germ of either or both parents due to poisoning of the germ cell. The "arrest" problems have to do with intra-uterine environmental disturbances.

The Waverly group have made very detailed anatomical studies, both gross and microscopic, of brains of mental defectives and related these data to the clinical characteristics of the individuals both mental and physical when living. They have reported in detail two groups of studies of ten individuals each. In their summary of the second group they state: (3)

> The provisional conclusions drawn from the second series and the combined first and second series are much in agreement with the original conclusions drawn from the first series which were as follows: First that measurable brain can be correlated with testable mind in the low and high orders with fairly positive results. That is the small simple brains represented the low intellects or idiots and the most complex brain patterns corresponded to the high grade, moronic and subnormal types of feeble-mindedness.

The lessons from the primitive races demonstrate certain procedures that should be adopted for checking the progressive degeneration of our modernized cultures. If, as now seems indicated, mal-development with its production of physical, mental and moral cripples is the result of forces that could have been reduced or prevented, by what program shall we proceed to accomplish this reduction or prevention?

I have presumed in this discussion that the primitive races are able to provide us with valuable information. In the first place, the primitive peoples have carried out programs that will produce physically excellent babies. This they have achieved by a system of carefully planned nutritional programs for mothers-to-be. It is important to note that they begin this process of special feeding long before conception takes place, not leaving it, as is so generally done until after the mother-to-be knows she is pregnant. In some instances special foods are given the fathers-to-be, as well as the mothers-to-be. Those groups of primitive racial stocks who live by the sea and have access to animal life from the sea, have depended largely upon certain types of animal life and animal products. Specifically, the Eskimos, the people of the South Sea Islands, the residents of the islands north of Australia, the Gaelics in the Outer Hebrides, and the coastal Peruvian Indians have depended upon these products for their reinforcement. Fish eggs have been used as part of this program in all of these groups. The cattle tribes of Africa, the Swiss in isolated high Alpine valleys, and the tribes living in the higher altitudes of Asia, including northern India, have depended upon a very high quality of dairy products. Among the primitive Masai in certain districts of Africa, the girls were required to

wait for marriage until the time of the year when the cows were on the rapidly growing young grass and to use the milk from these cows for a certain number of months before they could be married. In several agricultural tribes in Africa the girls were fed on special foods for six months before marriage. The need for this type of program is abundantly borne out by recent experimental work on animals, such as I have reported in Chapters 17, 18 and 19.

Another important feature of the control of excellence of child life among the primitive races has been the systematic spacing of children by control of pregnancies. The interval between children ranged from two and a half to four years. For most of the tribes in Africa this was accomplished by the plural-wife system. The wife with the youngest child was protected.

The original Maori culture of New Zealand accomplished the same end by birth control and definite planning. In one of the Fiji Island tribes the minimum spacing was four years.

These practices are in strong contrast with either the haphazard, entirely unorganized programs of individuals in much of our modern civilization, or the organized over-crowding of pregnancies also current. The question arises immediately: what can be done in the light of the data that I have presented in this volume to improve the condition of our modern civilization? A first requisite and perhaps by far the most important is that of providing information indicating why our present haphazard or over-crowded programs of pregnancies are entirely inadequate. This should include, particularly, the education of the highschool-age groups, both girls and boys.

In the matter of instruction of boys and girls it is of interest that several of the primitive races have very definite programs. In some, childbirth clinics supervised by the midwife are held for the growing girls. With several of these tribes, however, the ease with which childbirth is accomplished is so great that it is looked upon as quite an insignificant experience. Among the ancient Peruvians, particularly the Chimu culture, definite programs were carried out for teaching the various procedures in industry, home-building and home management. This was accomplished by reproducing in pottery form, as on practical water jugs, the various incidents to be demonstrated. The matter of childbirth was reproduced in detail in pottery form so that it was common knowledge for all young people from earliest observation to the time the practical problems arose. Many of the problems related directly were similarly illustrated in pottery forms.

It is not sufficient that information shall be available through maternal health clinics to young married couples. If pigs need several months of special feeding in order that the mothers-to-be may be prepared for adequate carrying forward of all of the inheritance factors in a high state of perfection, surely human mothers-to-be deserve as much consideration. It is shown that it is not adequate that sufficient vitamin A be present to give the appearance of good health. If highly efficient reproduction is to be accomplished there must be a greater quantity than this. There is no good reason why we, with our modern system of transportation, cannot provide an adequate quantity of the special foods for preparing women for pregnancy quite as efficiently as the primitive races who often had to go long distances without other transportation than human carriers.

The primitive care of a newborn infant has been a matter of severe criticism by modernists especially those who have gone among them to enlighten them in modern ways of child rearing. It is

common practice among many primitive tribes to wrap the newborn infant in an absorbent moss, which is changed daily. A newborn infant, however, does not begin having regular all over baths for a few weeks after birth. While this method is orthodox among the primitives it is greatly deplored as a grossly cruel and ignoble treatment by most moderns. Dr. William Forest Patrick of Portland, Oregon was deeply concerned over the regularly occurring rash that develops on newborn infants shortly after they are first washed and groomed. He had a suspicion that Nature had a way of taking care of this. In 1931 he left the original oily varnish on several babies for two weeks without the ordinary washing and greasing. He found them completely free from the skin irritation and infection which accompanies modern treatment. This method was adopted by the Multanomah County Hospital of Oregon which now reports that in 1,916 cases of unwashed, unanointed babies only two cases of pyodermia occurred. They record that each day the clothing was changed and buttocks washed with warm water. Beyond this the infants were not handled. Dr. Patrick states that within twelve hours after birth by Nature's method the infant's skin is clear, and Nature's protective film has entirely disappeared. In my observations of the infant's care among primitive races I have been continually impressed with the great infrequency with which we ever hear a primitive child cry or express any discomfort from the treatment it receives. Of course, when hungry they make their wants known. The primitive mother is usually very prompt, if possible, to feed her child.

Among the important applications that can be made of the wisdom of the primitive races is one related to methods for the prevention of those physical defects which occur in the formative period and which result in physical, mental and moral crippling. When I visited the native Fijian Museum at Suva, I found the director well-informed with regard to the practices of the natives in the matter of producing healthy normal children. He provided me with a shell of a species of spider crab which the natives use for feeding the mothers so that the children will be physically excellent and bright mentally, clearly indicating that they were conscious that the mother's food influenced both the physical and mental capacity of the child. The care with which expectant mothers were treated was unique in many of the Pacific Islands. For example, in one group we were informed that the mother told the chief immediately when she became pregnant. The chief called a feast in celebration and in honor of the new member that would come to join their colony. At this feast the members of the colony pledged themselves to adopt the child if its own parents should die. At this feast the chief appointed one or two young men to be responsible for going to the sea from day to day to secure the special sea foods that expectant mothers need to nourish the child. Recent studies on the vitamin content of crabs have shown that they are among the richest sources available. We have then for modern mothers the message from these primitives to use the sea foods liberally, both during the preparatory period in anticipation of pregnancy and during that entire period. In Fig. 129 will be seen a woman of one of the Fiji Islands who had gone several miles to the sea to get this particular type of lobster-crab which she believed, and which her tribal custom had demonstrated, was particularly efficient for producing a highly perfect infant.

FIG. 129. This Fiji woman has come a long distance to gather special foods needed for the production of a healthy child. These and many primitive people have understood the necessity for special foods before marriage, during gestation, during the nursing period and for rebuilding before the next pregnancy.

For the Indians of the far North this reinforcement was accomplished by supplying special feedings of organs of animals. Among the Indians in the moose country near the Arctic circle a larger percentage of the children were born in June than in any other month. This was accomplished, I was told, by both parents eating liberally of the thyroid glands of the male moose as they came down from the high mountain areas for the mating season, at which time the large protuberances carrying the thyroids under the throat were greatly enlarged.

Among the Eskimos I found fish eggs were eaten by the childbearing women, and the milt of the male salmon by the fathers for the purpose of reinforcing reproductive efficiency.

The coastal Indians in Peru ate the so-called angelote egg, an organ of the male fish of an

ovoviviparous species. These organs were used by the fathers-to-be and the fish eggs by the mothers-to-be.

In Africa I found many tribes gathering certain plants from swamps and marshes and streams, particularly the water hyacinth. These plants were dried and burned for their ashes which were put into the foods of mothers and growing children. A species of water hyacinth is shown in Fig. 130. The woman shown in Fig. 130, with an enormous goiter, had come down from a nine-thousand-foot level in the mountains above Lake Edward. Here all the drinking water was snow water which did not carry iodine. She had come down from the high area to the sixthousand-foot level to gather the water hyacinth and other plants to obtain the ashes from these and other iodine carrying plants to carry back to her children to prevent, as she explained, the formation of "big neck," such as she had. The people living at the six-thousand-foot level also use the ashes of these plants.

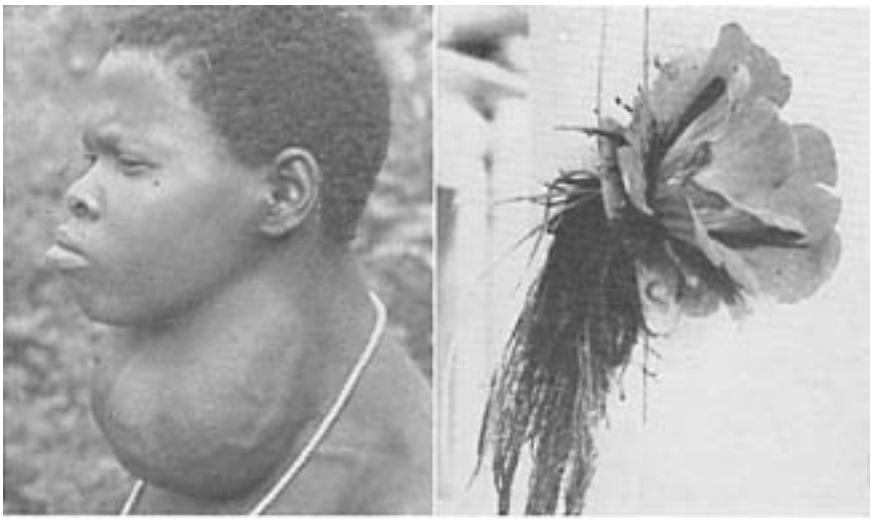

FIG. 130. This African woman with goiter has come down from the 9000 foot level in the mountains in Belgian Congo near the source of the Nile to a 6000 foot level to gather special plants for burning to carry the ashes up to her family to prevent goiter in her children. Right, a Nile plant, a water hyacinth burned for its ashes.

Among many of the tribes in Africa there were not only special nutritional programs for the women before pregnancy, but also during the gestation period, and again during the nursing period.

As an illustration of the remarkable wisdom of these primitive tribes, I found them using for the nursing period two cereals with unusual properties. One, was a red millet which was not only high in carotin but had a calcium content of five to ten times that of most other cereals. They used also for nursing mothers in several tribes in Africa, a cereal called by them linga-linga. This proved to be the same cereal under the name of quinua that the Indians of Peru use liberally, particularly the nursing mothers. The botanical name is quinoa. This cereal has the remarkable property of being not only rich in minerals, but a powerful stimulant to the flow of milk. I have found no record of the use of similar cereals among either the English or American peoples. In Chapter 14, I presented data indicating that the Peruvians, who were descendants of the old Chimu culture on the coast of Peru, used fish eggs liberally during the developmental period of girls in order that they might perfect their physical preparation for the later responsibility of motherhood. These fish eggs were an important part of the

nutrition of the women during their reproductive period. They were available both at the coast market of Peru and as dried fish eggs in the highland markets, whence they were obtained by the women in the high Sierras to reinforce their fertility and efficiency for childbearing. A chemical analysis of the dried fish eggs that I brought to my laboratory from Alaska as well as of samples brought from other places has revealed them to be a very rich source of body-building minerals and vitamins. Here again, I have found no record of their use in our modern civilization for reinforcing physical development and maternal efficiency for reproduction. As I have noted in Chapter 15 special nutrition was provided for the fathers by tribes in the Amazon jungle, as well as by the coastal tribes.

Professor Drummond, a British bio-chemist, in discussing the question of the modern decline in fertility, before the Royal Society of Medicine (4) suggested that the decline in the birth rate in European countries, during the last fifty years, was due, largely, to the change in national diets which resulted from the removal of vitamins B and E from grains when the embryo or germ was removed in the milling process. He called attention to the fact that the decline in the birth rate corresponded directly with the time when the change was made in the milling process so that refined flour was made available instead of the entire grain product.

Of the many problems on which the experience of the primitive races can throw light, probably none is more pressing than practical procedures for improving child life. Since this has been shown to be largely dependent upon the architectural design, as determined by the health of the parental germ cells and by the prenatal environment of the child, the program that is to be successful must begin early enough to obviate these various disturbing forces. The normal determining factors that are of hereditary origin may be interrupted in a given generation but need not become fixed characteristics in the future generations. This question of parental nutrition, accordingly, constitutes a fundamental determining factor in the health and physical perfection of the offspring.

One of the frequent problems brought to my attention has to do with the responsibility of young men and women in the matter of the danger of transmitting their personal deformities to their offspring. Many, indeed, with great reluctance and sense of personal loss decline marriage because of this fear, a fear growing out of the current teaching that their children will be marked as they have been.

On the presumption that all mentally crippled individuals will be in danger of transmitting these qualities to their offspring there is a strong movement continually in operation toward segregating such individuals or incapacitating them by sterilization. Several primitive racial stocks have produced large populations without criminals and defectives by means of an adequate nutritional program which provided normal development and function. May it not be that even our defectives, when they have resulted from poisoning of germ cells or interference with an adequate normal intrauterine environment, may be able to build a society with a high incidence of perfection, that will progressively return toward Nature's ideal of human beings with normal physical, mental and moral qualities? Because of its interpretation of the individual's responsibility for his mental and moral qualities, society has not only undertaken to protect itself from the acts of so-called unsocial individuals but has proceeded to treat them as though they were responsible for the injury that society has done to them. Does it not seem inevitable that this apparently false attitude will change if it be demonstrated that they are the result of a program of inadequate nutrition for the parents.

As we have seen, the children born in many of the families of primitive racial stocks after the parents have adopted our modernized dietary, may have marked changes in the facial and dental arch forms. In our modernized white civilization this change occurs so frequently that in a considerable percentage of the families there is seen a progressive narrowing of the dental arches in the succeeding children of the same family. Since the position of the permanent teeth which erupt at from seven to twelve years of age, can be determined by x-rays early in child life, this procedure provides an opportunity to anticipate deformities that will make their appearance with the eruption of the permanent teeth.

In Fig. 131, may be seen the x-rays of the upper arches of three children. Even under conditions causing the permanent teeth to develop irregularly the deciduous dental arch will not show the deformity that will be expressed later in the permanent dental arch. The abnormal placement of the developing permanent teeth, however, will show the deformity that is later to be produced in the face even though the deciduous arch is normal in design. Both deciduous and permanent teeth can be seen at the same time. In Fig. 131 it will be seen that there is a progressive deformity revealed in the position of the permanent teeth in these three children. (Most severe in the youngest.) This narrowing of the curve made by the permanent teeth is a condition characteristic of a large number of individuals, occurring in at least 25 per cent of the families throughout the United States; in some districts the percentage will reach 50 to 75 per cent.

FIG. 131. X-rays of teeth of three children in one family show in the teeth and upper arch a progressive injury in the younger children as indicated by the progressive narrowing of the placement of the tooth buds of the upper permanent teeth. Note the narrowing curve of the arch.

Another striking illustration of this progressive injury in the younger members of the family, detected early by the x-rays, is shown in Fig. 132. Note the breadth of the arch of the permanent teeth of the oldest child (to the left), and the marked narrowing of the arch of the two younger children (to the right).

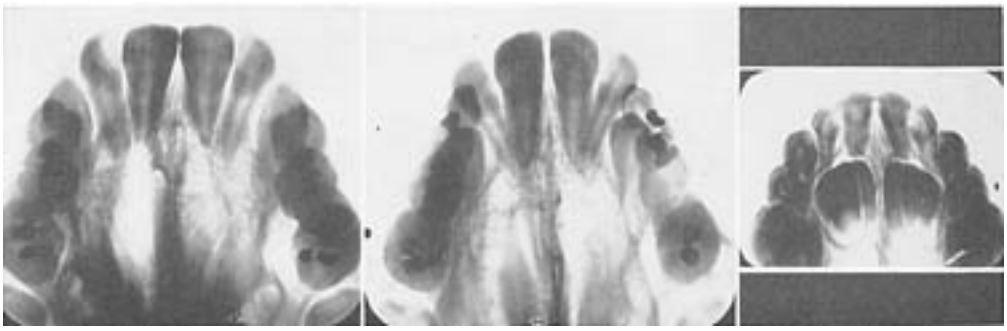

FIG. 132. These x-rays illustrate the progressive injury in the two younger children in this family. Note the progressive narrowing of the permanent arch illustrated by the lapping of the laterals over the centrals in the youngest, and decreasing distance between the cuspids.

While the application of orthodontic procedures for the improve- ment of the facial form and arrangement of the teeth will make a vast improvement in facial expression, that procedure will not modify disturbances in other parts of the body, such as the abnormal underdevelopment of the hips and pelvic bones. If an improvement in nutrition for the mothers-to-be is adequately provided in accordance with the procedures of the primitives, it should be possible to prevent this progressive lowering of the capacity of our modern women to produce physically fit children.

Fig. 133 is another illustration. The oldest child, ten years of age, is shown at the upper left. She has a marked underdevelopment of the width of the face and dental arches. The nostrils are abnormally narrow and she tends to be a mouth breather. She is very nervous and is becoming stooped. In the lower left photograph, is shown an x-ray of the narrowed upper arch. At the right is shown her younger sister, six years of age. It will be seen that the proportions of her face are much more normal and that she breathes with complete ease through her nose. She has none of the nervous trouble of her older sister. In the x-rays, below, at the right, it will be seen that her permanent arch, as indicated by the positions of the permanent teeth, although not so far advanced as that of her sister, has good design. The history of these pregnancies is of interest. The duration of labor for the first child was fifty-three hours and for the second three hours. Following the birth of the first child the mother was a partial invalid for several months. Following that of the second child the experience of childbirth made but slight impression on the strength and health of the mother. During the first pregnancy no special effort was made to reinforce the nutrition of the mother. During the second pregnancy the selection of foods was made on the basis of nutrition of the successful primitives. This included the use of milk, green vegetables, sea foods, organs of animals and the reinforcement of the fat-soluble vitamins by very high vitamin butter and high vitamin natural cod liver oil. It is a usual experience that the difficulties of labor are greatly decreased and the strength and vitality of the child enhanced where the mother has adequately reinforced nutrition along these lines during the formative period of the child.

FIG. 133. In this family the first child to the left was most injured in the formative period as shown in the form of the face and dental arches above and x-rays below. The first child required fifty-three hours of labor and the second three hours, preceded by special nutrition of the mother.

The problem of maternal responsibility with regard to the physical capacity of their offspring to reproduce a healthy new generation comprises one of the most serious problems confronting modern degenerating society. In a previous chapter I have discussed the difficulty that zoological garden directors have had in rearing members of the cat family in captivity. It has been a very general experience until the modern system of feeding animal organs was instituted, that unless the mothers-to-be had themselves been born in the jungle the lack of development of the pelvic arch would frequently prevent normal birth of their young. In the Cleveland Zoo a very valuable tigress, that had been born in captivity, found it impossible to give birth to her young. Although a Caesarian operation was performed, she lost her life. The young also died. One of the veterinaries told me that the pelvic arch was entirely too small to allow the young to pass through the birth canal. Studies of the facial bones of this animal showed marked abnormality in development.

The result of disturbance in the growth of the bones of the head and of the development of general body design is quite regularly a narrowing of the entire body, and often there is a definite lengthening. Statistics have been published relative to the increase in the height of girls in colleges during the last few decades. This is probably a bad rather than a good sign as actually it is an expression of this change in the shape of the body. I am informed by gynecologists that narrowing of the pelvic arch is one of the factors that is contributing to the increased difficulties that are encountered in childbirth by our modern generation.

A typical case illustrating the relationship between the lack of pelvic development and deformity of the face, is presented in Fig. 134. This girl presented a very marked underdevelopment of the lower third of the face which produced the appcarance of protrusion of her upper teeth so that it was quite difficult or impossible for her to cover them with her lips. An operation to improve her appearance consisted in removing the first bicuspid on each side above and then moving the bone carrying the anterior teeth backward with appliances, the width of the two removed teeth. This changed the relationship of the teeth as shown in the two upper views in Fig. 134. The operation greatly improved her facial appearance and she lost the inferiority complex which had prevented her from mingling with young people. When she went to the hospital for her first child, there was special concern because of her weak heart, and every effort was made to obtain a normal birth rather than one by Caesarian section. This proved impossible and the Caesarian operation was done. Great difficulty was experienced in saving the life of the mother and child. Her boyish figure, of which she had been so proud, and which had been a part of her serious deformity, during her formative period had nearly resulted in her undoing. She nursed her baby for some time but the overdraft of reproduction on her frail body was so great that she aged rapidly, her back weakened and she stooped forward as shown in Fig. 134, lower right. In the view at the lower left, it will be seen that the teeth remained in their new position. A point to keep in mind is that her physical deficiency was probably directly caused by an inadequate nutrition of her mother during the intrauterine development and prior to conception. It is, of course, possible that the father also contributed a poisoned germ cell that constituted a disturbance in the architectural design of the offspring. In this connection, it is important to have in mind the tragic influence of a program of deliberate starvation of mothers-to-be in order that the bones of the baby may be soft and thus provide an easy birth. Some literature has been published indicating the foods that would be efficient in accomplishing this. This means almost certain wreckage or handicapping of the child's life.

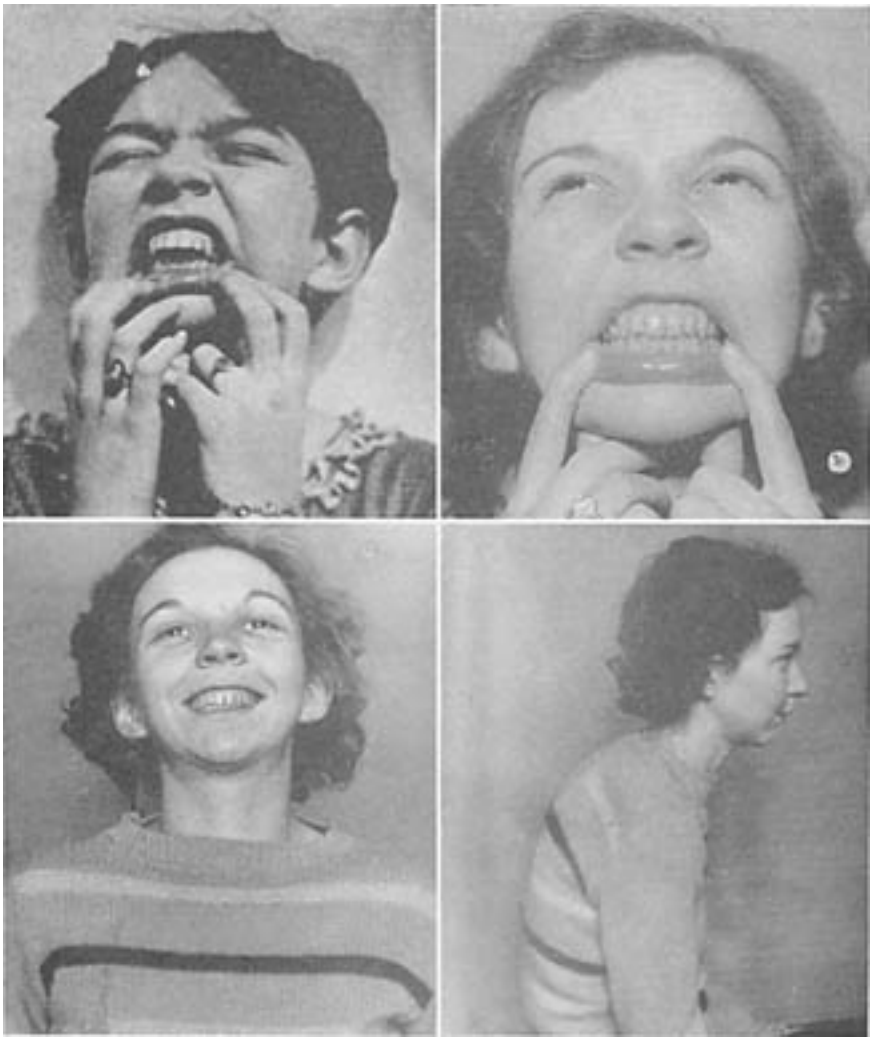

FIG. 134. This girl suffered with a serious deformity of her face. She also had very contracted pelvic arch. The facial deformity was improved as shown. She nearly lost her life with the birth of her first baby which was removed by Caesarian operation. Note her badly deformed back from the overload of reproduction.

Information from many sources may suggest that the expectant mother needs more calcium and more vitamin D. She may go to the pharmacy with a prescription or on her own initiative obtain calcium tablets and so-called vitamin D as a synthetic preparation. We are concerned here with data which will throw light on the comparative value of the treatment the modern mother will thus give herself with that that the primitive mother would provide.

Dr. Wayne Brehm who is associated with two Columbus, Ohio, hospitals has recently published the results (5) of a study of the effect of the treatment received in 540 obstetrical cases divided into six groups of ninety individuals each, on the basis on which their nutrition was reinforced in order to study the comparative effects of the different treatments. The reinforcement of the diet consisted in Group 1 of taking calcium and synthetic vitamin D as viosterol; Group 2, calcium alone; Group 3, viosterol alone; Group 4, calcium and cod liver oil; Group 5, cod liver oil alone and Group 6, no reinforcement. For those receiving the calcium and viosterol there was extensive calcification in the placentae, marked closure of the fontanelle (the normal opening in the top of the infant skull) and marked calcification in the kidneys. For those receiving calcium alone there was no placental calcification, slight closure of the fontanelle and no calcification of the kidneys. Group 3 receiving

viosterol had moderate to marked placental calcification, moderate closure of the fontanelle and no calcification of the kidneys. Those receiving cod liver oil alone had very slight placental calcification, slight fontanelle closure and no calcification in the kidneys. Those receiving no reinforcement had very slight placental calcification, normal fontanelle closures and no calcification of the kidneys. The effect on the mother was a prolonging of labor in Group 1 and at birth the fetal heads were less moulded not being able to adjust their shape to the shape of the birth tube. These infants had a general appearance of ossification or postmaturity. This strongly emphasizes the great desirability of using Nature's natural foods instead of modern synthetic substitutes.

It is a matter of great importance that the most serious disturbances in reproduction and childbirth are occurring in the most civilized parts of the world. In Chapter 19 I have referred to the important work of Dr. Kathleen Vaughan entitled "Safe Childbirth." She has not only had wide experience among several tribes in India and in the British Hospitals but has collected a large quantity of information regarding the experience of many races throughout the world. Her data strongly emphasize the necessity that the growing girl shall be allowed to have an active outdoor life not only until the completion of the building of her body at about fourteen years of age, but through the child-bearing period. In practically all countries a restricted sedentary indoor life greatly increases the complications associated with childbirth. She quotes Whitridge Williams to the effect that: "At the onset of pregnancy the (males) are 125 to 100 (females), and he adds that sex is determined in the germ cells, primarily or immediately after their union, and is immutable by the time segmentation of the ovum begins." Notwithstanding this advantage, prenatal and infant mortality reduces the proportion of boys to a level below that of girls. Dr. Vaughan in her reference to the data on the annual report of the chief medical officer, the Minister of Health, states as follows:

> Our infant mortality returns show that over half the number of infants dying before they are a year old die before they have lived a month (and 6,744 of them before they are twenty-four hours old), strongly suggesting that their vitality was impaired by the process of birth. The figures of those who did not survive one month are 20,060, and of these *more than half are males. So we lose over ten thousand boys every year under a month old!* (Public Health Report, No. 55, British). Hear what Dr. Peter McKinley has to say on the subject. "The death rate of infants in the period immediately subsequent to birth is nine times as high as that which occurs later in the first years of life." He shows how the difficulty experienced by the mothers during parturition leads to the death of infants at and just after birth, and says in this connection, "Infant deaths under a month are significantly associated with the death rates of mothers in childbearing." He quotes Netherland statistics showing that of stillbirths due to difficulty during birth, male stillbirths predominate, and says, "These figures might be taken in support of the view that the greater size of the male head is a cause of some greater difficulty in labour than there is with a female birth." Here, indeed, in civilized childbirth is the laboratory where the sex of the population is finally determined-the actual births of boys and girls are nearly equal in number, but the small ones slip through; the larger children are the ones who are killed during birth, or so damaged that life is heavily handicapped, and we are left with an enormous surplus female population. This destruction of male infants, which goes on day by day and year by year, puts the consequences of the Great War into the shade. Our surplus female population (now reaching over one and a half million in excess of the male) is directly due to it. We have no need of Pharaoh's midwives to kill our boys off at birth (Exodus i. 16). Civilization does it unaided, for all civilized races as they pass their zenith and are on the downgrade have eventually had to face the same problem, the outnumbering of men by women, and most of them have met it as the East does to-day by female infanticide. A more

> intelligent policy would be to prevent the males dying at birth. We see that difficult childbirth leads to a high maternal mortality, but it is also the cause of a high infant mortality falling most heavily upon the male infants, and it is also responsible for the production of mental defectives in ever-increasing numbers.

Dr. Vaughan's work places emphasis on the necessity that the human body be properly built, especially that of the mother-to-be. She shows clearly that the shape of the pelvis is determined by the method of life and the nutrition. In all primitive tribes living an outdoor life childbirth is easy and labor is of short duration. She shows that this is associated with a round pelvis and that the distortion of the pelvis to a flattened or kidney shape, even to a small degree, greatly reduces the capacity and therefore the ease with which the infant head may pass through the birth canal. In Dr. Vaughan's wide experience she has observed two ways by which a rough estimate of the pelvic shape and capacity may be anticipated: first, by the gait of the individual, because the angle of the hips is determined by the shape of the pelvis; and second, by the teeth and jaws. She has recognized an association between facial and dental arch deformities and deformed pelvis.

During my investigations in eastern Australia I was informed that the birth rate among the whites had declined over a large area and to such an extent that many families had no children and many women could produce only one child. The diets used in that district were very largely refined white-flour products, sugar, polished rice, vegetable fats, canned goods and a limited amount of meat. The alarm regarding the declining birth rate in Australia has recently been a matter of discussion by the New South Wales legislature as indicated by an Associated Press dispatch from Sydney, Australia, dated August 1, 1938: "A 'stork derby' with sweepstakes prizes was proposed in the New South Wales Legislature today to boost Australia's falling birth rate."

A report just received from the Bureau of Home Economics, Department of Agriculture, Washington, presents figures for the average amount of the various foods used in different income groups in different parts of the United States. These showed that in general about one-third of the income up to $2500 was spent for food per family; further, that the total flour equivalent ranged from 0.39 to 0.50 pound per capita per day. These quantities will furnish about 829 to 1063 calories per day, per capita. It will be seen at once that this provides a large number of the calories required for growing children and sedentary adults per day. With this number of calories derived from refined flour products there is no adequate provision for a normal amount of such body-building materials as minerals and vitamins. These have been removed, largely, in the milling process, and are largely denied to our modern civilization insofar as the cereal foods are concerned. This includes vitamin E, so essential for the functioning of the pituitary gland, the master governor of the body.

One of the most important lessons we may learn from the primitive cultures is the detail of their procedures for preventing dental caries. Since I have devoted an entire chapter (Chapter 16) to this I will make only a brief comment here. Simply stated, the practical application of the primitive wisdom for accomplishing this would involve returning to the use of natural foods which provide the entire assortment of bodybuilding and repairing food factors. This means the recognition of the fact that all forms of animal life are the product of the food environments that have produced them. Therefore, we cannot distort and rob the foods without serious injury. Nature has put these foods up in packages containing the combinations of minerals and other factors that are essential for nourishing the various organs. Some of the simpler animal forms are able to synthesize in their bodies some of the food

elements which we humans also require, but cannot create ourselves. Our modern process of robbing the natural foods for convenience or gain completely thwarts Nature's inviolable program. I have shown how the robbing of the wheat in the making of white flour reduced the minerals and other chemicals in the grains, so as to make them sources of energy without normal body-building and repairing qualities. Our appetites have been distorted so that hunger appeals only for energy with no conscious need for body-building and repairing chemicals.

A first requisite for the control of tooth decay is to have provided an adequate intake of the body-building and repairing factors by the time the hunger appeal for energy has been satisfied. A sufficient variety of foods must be used to supply the body's demand for those elements which it needs in large quantities, that is, calcium and phosphorus, and the other elements which it needs in smaller quantities, though just as imperatively. One of the serious human deficiencies is the inability to synthesize certain of the activators which include the known vitamins. This makes necessary the reinforcement of the nutrition with definite amounts of special foods to supply these organic catalysts, especially the fat-soluble activators, including the known vitamins, which are particularly difficult to provide in adequate quantities. I have shown that the primitive races studied were dependent upon one of three sources for some of these fat-soluble factors, namely, sea foods, organs of animals or dairy products. These are all of animal origin. I have indicated in Chapter 16 the nutritional programs that have proved in clinical testing adequate for providing the body with nutrition that will not only prevent tooth decay, but check it when it is active. The stress periods of life, namely, active growth in children and motherhood, do not constitute overloads among most of the primitive races because the factor of safety provided by them in the selection of foods is sufficiently high to protect them against all stresses. I have indicated the type of nutrition that is especially needed for these stress periods in our modern civilization. Also, that it is not necessary to adopt the foods of any particular racial stock, but only to make our nutrition adequate in all its nutritive factors to the primitive nutritions. Tooth decay is not only unnecessary, but an indication of our divergence from Nature's fundamental laws of life and health. (See Chapter 16 for primitive menus.) The responsibility of our modern processed foods of commerce as contributing factors in the cause of tooth decay is strikingly demonstrated by the rapid development of tooth decay among the growing children on the Pacific Islands during the time trader ships made calls for dried copra when its price was high for several months. This was paid for in 90 per cent white flour and refined sugar and not over 10 per cent in cloth and clothing. When the price of copra reduced from $400 a ton to $4 a ton, the trader ships stopped calling and tooth decay stopped when the people went back to their native diet. I saw many such individuals with teeth with open cavities in which the tooth decay had ceased to be active.

In undertaking to make practical application of primitive wisdom to our modern problems, the field is so broad that only a limited number of items may be included. It is important to emphasize the difference between the procedures used in the preparation of boys and girls for life in many of the primitive groups, and in our modern social organization. Few people will realize the remarkable training given the primitive children, with the fathers and mothers as tutors. To illustrate, among the Indians of the far North in Canada near the Arctic Circle, the girls rather than the boys select a companion for life. This is done with the help of her parents. Before a boy is considered worthy of consideration he must demonstrate that he can build the winter cabin, provide the firewood for maintaining the home of the parents, and all of the provisions of wild game, during the trial period of several weeks. After an adequate demonstration of bravery as well as of skill, in which the boy must

kill a grizzly bear, he is accepted into the home for a period of trial marriage. The girl has the privilege of making her choice by trial, but when the choice is made there is complete faithfulness on the part of both. Girls are prepared for life's duties by being taught to make clothing, prepare food, care for children and assist in the maintenance of the home. I have seldom, if ever, seen such happy people as these forest Indians of the far North.

In Chapter 10, in discussing the Australian Aborigines, I have similarly described the preparation of boys for the responsibility of manhood. No modern college graduate has to win his spurs under more exacting examinations and tests than do those boys.

In Africa several specialties call for special training. The medicine men spend several years under the training of a tutor. Each boy must provide a specified number of cattle per year which are eaten by the group.

Probably the most indelible impression that is left by my investigations among primitive races, is that which came from examining 1,276 skulls of the people who had been buried hundreds of years ago along the Pacific Coast of Peru and in the high Andean Plateau, without finding a single skull with the typical marked narrowing of the face and dental arches, that afflicts a considerable proportion not only of the residents in modernized districts in Peru, but in most of the United States and many communities of Europe today. I know of no problem so important to our modern civilization as the finding of the reason for this, and the elimination of the cause of error. Perhaps few will recognize the significance of this important point. This may be the reason why the prospect is not encouraging.

One of the important lessons we should learn from the primitive races is that of the need for maintaining a balance beween soil productivity, plant growth and human babies. Even in a country with so low a fertility as obtains in the greater part of Australia, the Aborigines for a very long period were able to maintain this balance. Their system of birth control was very efficient and exacting.

A survey made by a committee appointed by the League of Nations indicates the need per capita of approximately one-half acre of land for wheat, two acres for dairy products, and ten acres for beef producing pasture for the supply of meat. When we realize that Ohio has been occupied by our modern civilization for only one hundred fifty years and that it is estimated that during that time approximately half of the topsoil has been lost through water and wind erosion we realize that Nature's accumulated vegetable enrichment has been greatly reduced in this area within a short time from this one source alone. In Chapter 20 I have shown that there is only enough phosphorus in the top seven inches of agricultural land for approximately fifty crops of high-yield wheat or one hundred crops of moderate-yield. Other grains make similar drafts upon the land. I have given data indicating a relationship between progressive soil depletion and progressive increase in heart disease.

It is apparent that the present and past one or two generations have taken more than their share of the minerals that were available in the soil in most of the United States, and have done so without returning them. Thus, they have handicapped, to a serious extent, the succeeding generations, since it is so difficult to replenish the minerals, and since it is practically impossible to accumulate another layer of topsoil, in less than a period of many hundreds of years. This constitutes, accordingly, one of

the serious dilemmas, since human beings are dependent upon soil for their animal and plant foods, for body-building. The minerals are in turn dependent upon the nutritive factors in the soil for establishing their quality. The vitamin and protein content of plants has been shown to be directly related to availability of soil minerals and other nutriments. A program that does not include maintaining this balance between population and soil productivity must inevitably lead to disastrous degeneration. Over-population means strife and wars. The history of the rise and fall of many of the past civilizations has recorded a progressive rise, while civilizations were using the accumulated nutrition in the topsoil, forest, shrubbery and grass, followed by a progressive decline, while the same civilizations were reaping the results of the destruction of these essential ultimate sources of life. Their cycle of rise and degeneration are strikingly duplicated in our present American culture.

Various therapeutic measures in use today have come to us from primitive peoples. One of the greatest scourges of the world is malaria fever. Everywhere it has been fought successfully with quinine. Indeed, many parts of the world would not have been tenantable for whites without it. Yet few people realize that quinine was the gift of the ancient Peruvian Indians.

In Chapter 15 I presented data regarding the treatment used by several primitive races for preventing and correcting serious disturbances in the digestive tract. This consisted in the use of clay or aluminum silicate which modern science has learned has the important quality of being able to adsorb and thus collect toxic substances and other products. Important new light is now thrown on the probable role of this substance in the primitive diet and its possible application in our modern problems of sensitization reactions or allergies. In the first volume of my work on "Dental Infections," I presented data relating toxic sensitization reactions to dental infections. These were shown in both animals and human beings. I discussed the relation of these reactions to histamine and emphasized their similarity to the effect produced by inocculation with histamine. An important new chapter has recently. been added to this problem by the work of Dr. C. F. Code for which he has received an award by the American Association for the Advancement of Science. He reported his findings before the Association meeting at Richmond, Virginia, in December, 1938. Dr. Code has apparently discovered that histamine is the actual product responsible for the symptoms of the various allergies. Its excess accumulation in the blood is the actual cause of the symptoms whether expressed as asthma, hay fever or skin eruptions such as produced by pollens, various foods, dust and other sensitizing agents. He has shown that the eosinophils, a type of white blood cell, are the source of excess histamine in the blood. It is accordingly indicated that the primitive treatment by the use of kaolin, aluminum silicate, as an adsorbent was used directly for controlling such symptoms. It is now further indicated that this treatment can be helpful for the prevention of modern allergies. Previous investigations have shown that histamine is produced in the alimentary tract as a putrefaction product of proteins by the action of certain micro-organisms of the colon group.

Modern science boasts the discovery of vitamin C, lack of which took its toll of thousands of the white mariners through hundreds of years with scurvy. The first recorded cure of that disease was made by the Indians in Canada when the British soldiers were dying in large numbers. The Indians taught them to use a tea made from the steeped tips of the shoots of the spruce. When I was among the Indians of the far north I asked a chief why the Indians did not get scurvy. He then proceeded, as I have related in Chapter 15, to explain to me how the Indians prevented scurvy by the use of special organs in the animals. While it is true that we have come to associate the absence of vitamin C as the causative factor in scurvy, we do not know how many other affections may be due to its absence in

adequate quantity in our foods. Almost weekly, new diseases are being associated with vitamin deficiencies in our modern dietaries.

One of our modern tendencies is to select the foods we like, particularly those that satisfy our hunger without our having to eat much, and, another is to think in terms of the few known vitamins and their effects. The primitive tendency seems to have been to provide an adequate factor of safety for all emergencies by the selection of a sufficient variety and quantity of the various natural foods to prevent entirely most of our modern affections. Their success demonstrates that their program is superior to ours. An important advance in modern international relationships provides for exchange of professorships and, thus, interchanges of wisdom. We have shown a most laudable and sympathetic interest in carrying our culture to the remnants of these primitive races. Would it not be fortunate to accept in exchange lessons from their inherited knowledge? It may be not only our greatest opportunity, but our best hope for stemming the tide of our progressive breakdown and also for our return to harmony with Nature's laws, since life in its fullness is Nature obeyed.

As I have sojourned among members of primitive racial stocks in several parts of the world, I have been deeply impressed with their fine personalities, and strong characters. I have never felt the slightest fear in being among them; I have never found that my trust in them was misplaced. As soon as they had learned that I was visiting them in their interest, their kindness and devotion was very remarkable. Fundamentally they are spiritual and have a devout reverence for an all-powerful, all-pervading power which not only protects and provides for them, but accepts them as a part of that great encompassing soul if they obey Nature's laws.

Ernest Thompson Seton has beautifully expressed the spirit of the Indian in the opening paragraph of his little book "The Gospel of the Red Man":

> The culture and civilization of the White man are essentially material; his measure of success is, "How much property have I acquired for myself?" The culture of the Red man is fundamentally spiritual; his measure of success is, "How much service have I rendered to my people?"
>
> The civilization of the White man is a failure; it is visibly crumbling around us. It has failed at every crucial test. No one who measures things by results can question this fundamental statement.

The faith of the primitive in the all-pervading power of which he is a part includes a belief in immortality. He lives in communion with the great unseen Spirit, of which he is a part, always in humility and reverence. Elizabeth Odell in the following lines seems to express the spirit of the primitives,

> Flat outstretched upon a mound
> Of earth I lie; I press my ear
> Against its surface and I hear
> Far off and deep, the measured sound
> Of heart that beats within the ground.
> And with it pounds in harmony

The swift, familiar heart in me.
They pulse as one, together swell,
Together fall; I cannot tell
My sound from earth's, for I am part
Of rhythmic, universal heart.

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