

Cor.  
~

165

Lit. Nr.164

(Olt 05.02.2021)

### FIELD STUDIES AMONG SOME AFRICAN TRIBES ON THE RELATION OF THEIR NUTRITION TO THE INCIDENCE OF DENTAL CARIES AND DENTAL ARCH DEFORMITIES\*

By WESTON A. PRICE, D.D.S., M.S., F.A.C.D., Cleveland, Ohio

**T**OOTH decay is one of the modern paradoxes since many primitive races were largely free from it, while modern civilizations are nearly all scourged by it. The purpose of these several field studies among primitive racial stocks is to throw light on the reasons for the present dilemma.

The remnants of primitive racial stocks previously studied and reported all had environments which are quite different from those that are provided in the interior of a large continent. It has, accordingly, been desirable to make investigations among primitive racial stocks situated where physical conditions were more nearly comparable to those which obtain in agricultural areas of Europe and America.

For this purpose, the interior of Africa was selected for the special studies that were made during the summer of 1935. The continent was entered on the east coast at Mombasa. Tribes with differing dietary habits were selected and studied in Kenya, Uganda, Belgian Congo and the Sudan. A study was made of the native life in Port Said, Port Sudan on the Red Sea and Aden, Arabia, en route to Mombasa. The itinerary is outlined on the map shown in Figure 1. In order

\*Read before the Section on Histology, Physiology, Pathology, Bacteriology and Chemistry (Research) at the Seventy-Seventh Annual Session of the American Dental Association, New Orleans, La., Nov. 5, 1935.

to make contact with as nearly primitive groups as were available, assistance was obtained from government officials and missionaries in direct contact with these tribes. Both guides and interpreters were obtained from these sources. By correspondence, special arrangements had been made in advance through high officials. The procedures consisted, as in previous studies of primitive racial groups, in making examinations of the teeth and the form of the dental arches and recording these data both in photographs and in clinical records. Over 2,500 negatives were made and developed in the field. The distance traveled in Africa was approximately 6,000 miles. Groups were studied at altitudes from sea level to 8,000 feet. The tribes studied were of Hamitic, Nilotic, Bantu and Negro origin. Dietary habits of different tribes varied considerably even in similar districts. The present position of the tribes in relation to each other is apparently largely the result of race movements that have been in progress for many centuries, and while there has been some blending of certain tribes, they have in general retained their distinctive racial characteristics and tribal customs. They can be classified on several different bases. The most convenient for our use will be their nutrition, since, as in previous studies, particular attention has been paid to foods selected.

#### MASAI TRIBE, KENYA

We will first consider the Masai, a people of Nilotic origin, primarily cattle herders, who live now, as in the past,

the tribes of the north and central Africa. They occupy a large tract in the central southern game preserve. They live now as in the past in a lion infested country,



Fig. 1.—Itinerary for 1935 field studies.

largely on milk, blood and meat. Physically, they are tall and lithe. They have been accredited with being the most skilled warriors and the bravest of all

protecting themselves and their herds with long heavy spears. The British government has denied them the privilege of carrying their shields and has com-

pletely checked their raids on the surrounding tribes. They live in manyatas built of acacia thorn bushes, which effectively shield them and their cattle from raids of lions and leopards and other predatory animals. Their houses, built within the manyatas, consist of a framework of twigs built onto a form and the whole plastered over with the spore of their cattle mixed with clay. The cows are milked morning and evening in the manyatas and from time to time the steers are bled, usually at intervals of from thirty to forty days, in regular sequence, the frequency depending on the efficiency of the pasturage. The method of drawing the blood is unique. A torque is placed around the animal's neck and a special arrow shot from a bow into the jugular vein. The arrow is tipped with a very sharp curved knife, the depth to which it can cut being controlled by a shoulder on the arrow. Obstreperous animals are thrown and hobbled. About 2,000 or 3,000 c.c., from 4 to 6 pints, is obtained in a single drawing. The blood is defibrinated by whipping in the gourd with a stick, which collects the fibrin into a mass. A few ounces of this blood is given to each child daily, the quantity depending on special needs. Pregnant women receive their ration regularly. This is used in conjunction with milk, though not taken with it. The fibrin is cut into slices and fried. Animals are slaughtered sufficiently frequently to provide meat. The blood of slaughtered animals is carefully collected and used for food. Every edible part of the animal is utilized. Great emphasis is placed on the organs. A typical manyata shelters a chief and his family consisting of several wives and children. Each is provided with a separate cabin. There is every evidence of happy contented home life. Their dress frequently consists of a goat skin draped across the shoulder. The men and boys are employed in caring for the cattle

and keeping up the corral. The women take care of the food and the homes. The women in general are well built and some are quite good looking. A typical belle with current ornamentation is shown in Figure 2.

A study of 2,516 teeth in eighty-eight persons distributed through several widely separated manyatas shows only four persons with caries, with a total of ten



Fig. 2.—Masai girl. Masai girls are married at from 14 to 16 years, being purchased with cattle, the number depending on the bride's beauty.

carious teeth, or only 0.4 per cent of the teeth, attacked by tooth decay.

#### JALOU TRIBE, KENYA

The Jalou tribe occupies the territory along Lake Victoria and Kisuma 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 10 to 22 years, 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 that had ever had toothache hold up their hands. Nineteen so indicated. These were examined and the

teeth in ten persons revealed no teeth with dental caries.

#### JEANNES SCHOOL, KENYA

The Jeannes school located at Kabete is an institution where young married couples are trained in domestic science, agriculture, etc.

In a study of 388 teeth of thirteen persons, thirty-one teeth, or 7.9 per cent, were found to have been attacked by dental caries. These were in six persons, a percentage of 46.1.

#### PUMWANI MISSION SCHOOL, KENYA

Pumwani Mission School is a native suburb of Nairobi and therefore the inhabitants have recently had European contacts.

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

#### C. M. S. SCHOOL, NUKURU, KENYA

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

#### CHEWYA AT KISUMU, KENYA

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

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

#### KIKUYU TRIBE, KIAMBU, KENYA

In contrast with the Masai, the members of the Kikuyu tribe, which inhabits



Fig. 3.—Typical Kikuyu woman dressed in skins. The large ear perforations are decorated. The lower incisors have been removed to provide opportunity for feeding in case of lockjaw.

findings constitute the report for this group. Of the nineteen, only one was found to have caries, two teeth being involved; which, for 546 teeth in those examined, gives a percentage of 0.4 showing caries.

In the Ogada Mission, a study of 258

a district to the west and north of the Masai, are primarily an agricultural people. Their chief articles of diet are sweet potatoes, corn, beans and bananas. The women use special diets during each gestation and lactation. They are prejudiced against using eggs, although not against chickens.

Dr. Anderson, the physician in charge of a large dispensary, advised me that



Fig. 4.—Member of Wakamba tribe. The teeth are pointed to enhance the beauty, the pulps often being exposed by the process.

there is very little pneumonia among the women, but much among the men, and that appendicitis, gallbladder trouble, cystitis and duodenal ulcer are practically unknown among the primitive natives who come to his hospital for care and treatment.

The Kikuyus are not so tall as the Masai and physically they are much less rugged. They, like many of the central African tribes, remove some of the lower incisors at the time these permanent teeth erupt. This custom is reported to have been established for the purpose of feeding in case of lock-jaw. One of the tribal customs which are striking is the making of large perforations in the ears, in which many metal ornaments are carried. A typical Kikuyu woman is shown in Figure 3.

A study of 1,041 teeth in thirty-three persons showed fifty-seven teeth with caries, or 5.5 per cent of the teeth in 36.4 per cent of the persons 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 was exhausted, which is usually in from 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 wastage of building material. There are few stands of native forest within easy reach of transportation.

#### WAKAMBA TRIBE, KENYA

The Wakamba tribe has a practice of pointing their teeth as shown in Figure 4. 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, 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 carving of art objects. They are

very 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 persons showed sixty-nine teeth with caries, or 6.2 per cent. Twenty-one and six-tenths per cent of the persons studied had dental caries.

#### MUHIMA TRIBE, UGANDA

The Muhima 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 raised chiefly the hump-backed cattle, the herds of this Ankola tribe are characterized by their large wide-spread horns. Like the Masai, the Muhima tribesmen are tall and very courageous. They defend their herds and their families from lions and leopards with their primitive spears. Like the other primitive cattle-raising people, they dominate adjoining tribes.

In a study of 1,040 teeth of thirty-seven persons, not a single tooth was found with dental caries.

#### BUGANDA TRIBE, MASAKA, UGANDA

Uganda has been called the Garden of Eden of Africa because of the abundance of plant foods, chiefly bananas and sweet potatoes, and abundant 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 persons revealed only three

teeth showing caries, or 0.4 per cent.

#### NYANKUNDE MISSION, IRUMU, BELGIAN CONGO

The group at the Nyankunde mission is made up of members of the following tribes: Bahema, Babira, Alur and Balendu. We will consider the representatives of these different tribes collectively because of their living 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. The district is located southwest of Lake Albert.

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

#### BOGORA MISSION, BELGIAN CONGO

The Bogora mission, located west of Lake Albert, 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 a considerable quantity of cereals, chiefly corn and beans, were used; also sweet potatoes and bananas. The latter were the chief foods of the other tribes, with a little goat's milk.

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

#### KASENYI PORT, LAKE ALBERT, BELGIAN CONGO

The natives at Kasenyi Port were members of several tribes surrounding this district who were largely temporarily resident as laborers. These 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 persons revealed 120 teeth with dental caries, or 6.1 per cent of the teeth. Fifty and eight-tenths per cent of the group had dental caries.

WEST NILE LABORERS FROM BELGIAN CONGO

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

A study of 320 teeth of ten persons revealed that no teeth had ever been attacked by decay.

PYGMIES, ITURU FOREST, BELGIAN CONGO

The Pygmies of Ituru Forest are said to have originally lived in trees and formerly were exceedingly shy and difficult to make a contact with. We were taken to several of their villages in the heart of the dense Ituru forest and found them very well disposed through the confidence that has been established by the mission workers. Their shyness, 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 persons revealed eight teeth that had been attacked by tooth decay, or 2.2 per cent.

WANANDE TRIBE, BELGIAN CONGO

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

In an examination of 368 teeth of thirteen persons, there were eight teeth with caries, or 2.2 per cent in 15.4 per cent of the group.

BAITU TRIBE, NYUNGE, RUANDA, BELGIAN CONGO PROTECTORATE

Nyunge, Ruanda, lies south of Uganda, east of Belgian Congo proper and northwest of Tanganyiki. It lies just east of Lake Kivu. When we realize that Lake Kivu was only discovered in 1894, even though it is one of the important sources of the Nile waters, we understand 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 persons, not a single tooth was found to have been attacked by dental caries.

NATIVE HOTEL STAFF AT GOMA, BELGIAN CONGO

The group studied at Goma consisted of the inside and outside servants of a tourist hotel on Lake Kivu.

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

TERRAKEKA, UPPER NILE, SUDAN

The people of Terrakeka are tall and live largely on fish and other animal life. This part of the Sudan consists of a large district, a marshland called the Sudd. It is covered with rank papyrus from 15 to 30 feet high. This jungle of rank marsh growth swarms with a wide variety of animal life, large and small.

An examination of 548 teeth of eighteen persons revealed not a single tooth had been attacked by dental caries.

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 6 feet tall and the men range from 6 to 7½ feet in height. Their food consists very largely of the animal life of the Nile, dairy products and milk and blood from the herds.

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

DINKAS, JEBELEIN, SUDAN

The Dinkas live on the Nile. They are not so tall as the Neurs, but 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. A typical belle is seen in Figure 5.

An examination of 592 teeth of twenty-two persons 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 these Europeans. This makes possible a comparative study of similar groups in these two cities: modernized Khartoum and primitive Omdurman.

A study of 1,284 teeth of fifty-two persons in an Arab school at Khartoum revealed that fifty-nine teeth, or 4.7 per

cent, had been attacked by dental caries, 44.2 per cent of the persons studied being affected.

In Omdurman, a study of 744 teeth in thirty-one persons 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 group had dental caries.

The groups examined, which were selected with the assistance of the government officials, consisted of the higher grade pupils in two advance native



Fig. 5.—Women from a tribe of the Upper Nile valley. Several of these tribes decorate their bodies with scar designs produced by rubbing ashes into deep cuts. The scars here shown are typical.

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 persons studied in the native hos-

pital at Khartoum 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 persons revealed thirteen that had been attacked by tooth decay, or 4.5 per cent.

#### IKHLAS SCHOOL, CAIRO, SUDAN

Ikhlas is a native school in which the students 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 persons revealed that 353 teeth, or 12.1 per cent, had been attacked by decay. Seventy-five per cent of the members 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 persons examined, of whom 300 had one or more carious teeth or teeth that had been lost by caries; i.e., 29.9 per cent of the group had dental caries. Of this total number of twenty-seven groups studied, there were several groups with practically complete immunity to dental caries, while other groups had a relatively high incidence of caries. The data will be analyzed further under comment.

#### 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 very marked variation of the incidence of irregularities was found in the different tribes, which 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 people were largely agriculturists, living primarily on vegetable foods. In the native Arab school at Omdurman, conducted almost entirely according to the native customs of selection and preparation of foods, 6.4 per cent of students had irregularities, while at 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. Among the families of the old established missions at Nukuru, 54.5 per cent had had irregularities. At the Jeannes school, 46.1 per cent, and at the Ogada mission, 30 per cent showed irregularities.

#### COMMENT

In order to make direct application of the data obtained in these African studies, it is important to relate these new facts to those formerly obtained among other primitive groups and to note the difference in the physical environment of the various groups studied. In general, these African studies have been made in the tropics. The studies previously reported were made in the North Temperate and South Temperate and Arctic Zone. The climate is a factor, since, in the cold climates of the winters in the high Alps for the Swiss, and for

the Eskimos and Indians of the far North, there is required the consumption of considerably more food in order to provide the body with necessary heat and energy. In the Southern Pacific archipelagos, the salubrious climate would invite lethargy and naturally reduce the amount of foods required for maintaining body temperature. The natives of Equatorial Africa, except those at altitudes above 5,000 feet, have hot weather for two periods each year during the day, and even at 5,000 feet, the temperature is moderate at night, so that rest is easily obtained. For the residents of altitudes of less than 2,000 feet, heat is often extreme for several months of the year. We have accordingly a wide range of climatic conditions represented in the various racial groups studied.

It is important to review the efficiency with which the persons in these several groups were maintaining a high immunity to dental caries and to determine what the variable factors were in those members of the group who had lost their immunity to caries. It is important to note, at the same time, the wide variation of diets that are available and the foods consumed by the several groups, since the available foods constitute an important part of the local environment.

For the people of the isolated valleys of the high Alps studied in 1931 and 1932, the diet was found to be largely dairy products of especially good quality and entire rye, used chiefly as whole rye bread. The diet of the residents of Switzerland in the plains country and cities consisted of the items of foods used in modern civilization, including white flour products, sweetened foods of various kinds, particularly marmalades and jams, and other canned foods. The incidence of dental caries for the individual studies in the isolated Swiss valleys was found to be 4.6 per cent of the teeth

studied. For the highly modernized communities, the incidence of caries was from 24.7 per cent at Herisau in the plains country to 29.8 per cent at the summer resort of St. Moritz, also at a high altitude. The climate of Switzerland is delightful the year around. The winters, while stimulating, are not unduly severe.

My studies of the people of the Outer Hebrides, off the west coast of Scotland, in 1932 indicated that in those still living, as their ancestors had, very largely on oat products and sea foods, the incidence of caries was 1.2 per cent of the teeth examined. In those living in the highly modernized ports, 30 per cent of the teeth examined were found to be carious. The climate is bracing, but never extremely cold or hot.

In the Eskimos of western Alaska studied in 1933, living under very severe climatic conditions for most of the year, the percentage of teeth found to have been attacked by caries was 0.09 per cent. For the Eskimos living at the points of contact with modern civilization and using the imported foods, the incidence of caries was 13 per cent. This involved an increase 144 fold. The food of the Eskimos with high immunity consisted very largely of the animal life of the sea, of which they used chiefly the organs and fat. The isolated groups of Eskimos were reached by airplane. The severity of the winters would necessarily induce the Eskimos to eat a very liberal diet.

My study in 1933 of the Indians of the far north of Canada and along the Pacific coast revealed that, for those in the interior of the far north, where their isolation compelled them to depend on local food entirely, the food was almost completely limited to wild animals of the chase, chiefly moose and caribou. For all these northern Indians studied, the incidence of dental caries was only 0.16 per

cent. It is important that neither these isolated Eskimos nor the Indians had knowledge of modern procedures of oral prophylaxis. For the groups of Indians living near the Hudson Bay Posts and along the Pacific Coast, in contact with modern civilization and transportation facilities, the incidence of dental caries was 21.5 per cent, which is a 134 fold increase. A study of the Indians in six coast towns revealed an average of 40 per cent of the teeth attacked by dental caries. These groups were being taught oral prophylaxis. Two of the principal articles of barter at the Hudson Bay Posts were white flour and sugar.

My studies of 1934 made among the Melanesians and Polynesians of the Southern Pacific Islands provide important data from eight different archipelagos, the inhabitants of which were of different racial stocks and spoke different languages. Six of these archipelagos were populated with Polynesians and two with Melanesians. The incidence of dental caries among the Melanesians who were still sufficiently isolated to be dependent on native foods was 0.38 per cent of the teeth studied. For those living at the ports and using trade foods in considerable quantity, 29 per cent of the teeth studied had been attacked by tooth decay. For the isolated Polynesians still living on native foods, the incidence of dental caries was 0.32 per cent of the teeth studied. In the groups in contact with modern civilization, 21.9 per cent of the teeth were attacked by dental caries. Their salubrious climate and the ease with which food could be obtained was not inducive to an appetite comparable to that of the Eskimos and Indians of the far north. The contact with modern civilization in these various archipelagos was almost entirely limited to the calling of trader ships except in a few large ports where passenger ships call regularly or

frequently. The almost universal rule for exchange required white flour and sugar products, 90 per cent, and clothing, 10 per cent, as payment for the local products purchased. It is of interest that, in all these groups, the diets of those that had a high immunity to dental caries consisted of native foods, while the diets of those who were suffering from a loss of immunity to dental caries were limited to the foods less valuable for growth and repair. The foods used by those inhabitants of the South Sea Islands who had high immunity to dental caries consisted of a liberal supply of sea animal life eaten with the various native plant foods, vegetables and fruits.

Investigations were made in January and February, 1935, of the Indians living at present in Florida for comparison with studies of the skull material now in various museums and which had been taken from the mounds in Florida. These skulls, which were in an excellent state of preservation, showed practically 100 per cent immunity to dental caries and freedom from dental arch and tooth arrangement deformities. The Seminole Indians living today in Southern Florida can be divided into two groups: first, those living in the Cypress swamps and as nearly as possible restricting their diets to the native foods, such as those the pre-Columbian Indians used, consisting of fish, wild game, birds, alligators, turtles and shell fish, roots and fruits. The quantity of native game and fish now available has been greatly reduced, owing largely to the activities of white hunters, together with the draining of the Cypress swamps and the lessening of the primitive territory by the encroachment of civilization. This first group living in the Everglades has accordingly been compelled to use some store foods. The incidence of dental caries in this group was 4 per cent of the teeth studied. The second, and

by far the largest, group included those Indians along the Tamiami trail and in Miami and vicinity, who are living very largely on modern foods. Forty per cent of all the teeth examined in this group had been attacked by tooth decay. The modern foods consisted of those available in the stores, including white flour products, sweet goods, jams and canned goods together with such of the native foods as they could obtain, though with much difficulty. Because of the scarcity of the native foods in the vicinity of modern civilization, other affections, such as arthritis, were frequently found among the modernized group.

As for the tribes studied in eastern and central Africa in 1935, there was no possibility of their obtaining animal life from the salt water in any considerable quantity. Except for those groups living along the coast and in the vicinity of the lakes and rivers, there was little opportunity for the people of the interior to obtain fresh water animal life. While no doubt the ancestors of many of the local tribes had used wild game liberally, the rigid restriction imposed by the controlling governments has largely eliminated game as a source of food for the present generation. We have accordingly conditions which in some respects resemble those of several of the other large continents.

On the basis of the chemical analysis of the foods used by the various groups, particularly the mineral and activator content, there has been excellent correlation of the diets used by the various groups studied previously who had high immunity to dental caries.

Before undertaking the studies in Africa, I was impressed by my experience that no groups had yet been found building strong bodies and maintaining excellent health while depending entirely on plant foods. This accordingly constituted one of the important quests in both

the South Sea Islands and the recent African studies.

In addition to a liberal source of minerals for body building and repair, it has been apparent that all groups successful in maintaining a high immunity to dental caries have been using some special animal products of high quality. This seems to have been the essential source of fat-soluble activators or vitamins.

For the people of the high Alps, the dairy products were produced almost entirely on rapidly growing grass fresh or stored, which assured milk of exceptionally high vitamin content as ascertained by a chemical analysis of the vitamin content of the butter for the past four years. This is part of the study that I have been carrying forward for the past eight years on the variation of vitamin content of dairy products for the same place at different times of the year and for different places at the same time. An additional liberal source of phosphorus is provided for the people in these high Alpine valleys in the entire rye products.

For the people of the Outer Hebrides, the fat-soluble activators were provided liberally in the diet consisting largely of fish and other sea foods; including the use of cod livers mixed with oatmeal baked in cod's head.

For the Eskimos of western Alaska, the fat-soluble activators were provided liberally in the organs of the animals, chiefly from the sea, and by the oil of the seal, whale and other animals.

As for the Indians of the far north in Canada, depending on the animals of the chase almost entirely for nutrition, I found them eating very largely of the animal organs, heart, liver, kidney and brain and other special tissues, the muscle meat being secondary.

For the people of the South Sea Islands, the animal life of the sea provided a liberal source of the fat-sol-

uble activators as well as the minerals.

My studies in Africa were directed particularly toward the possible sources of fat-soluble activators or vitamins. Every group found to have a high immunity to dental caries was using one or more of the sources of fat-soluble activators of the groups previously studied. The cattle tribes depended largely, and some almost entirely, on milk, blood and meat of their herds. The cows were milked twice a day, morning and evening. The steers were bled at regular intervals. In a few cattle-raising tribes, these foods were supplemented with roots, chiefly sweet potatoes and, in some districts, with bananas or cereals.

For the people living in the vicinity of Lake Victoria and other lakes, and the large rivers, the fresh water fish were used liberally. The abundance of the fish in the upper Nile makes this an important source of food for nearby tribes. For example, a firm on Lake Albert has a contract for supplying 1 ton of dried fish a day to one of the Belgian Congo mines. The famous Nile perch grows to an enormous size, sometimes to over 150 pounds. For these people, the fish provide a very liberal source of the fat-soluble activators, since these native tribes eat practically all of the organs as well as the muscle meat.

It is of interest that, in all these studies, the stature of the members of the tribes seems to be related to the source of fat-soluble activators used. Of the three sources of fat-soluble activators so far found in use; namely, dairy products, animal life of the sea and the organs of land animals, the tribes using an excellent quality of dairy products liberally have proved to be the tallest. The tribes using the organs of animals were conspicuously resistant to climatic hardships and fatigue.

The evidence gathered in the South Sea Islands indicated that among the can-

nibalistic tribes, the liver was the most sought for portion, and indeed much evidence is available that, for the cannibals, the liver provided very important essential factors for life. This apparently constituted an important compelling force to the eating of prisoners.

Of the various tribes met in eastern and central Africa, the tallest were the Neurs. The men frequently exceeded 7 feet in height. I was particularly interested in a study of their diet and found that, in addition to maintaining herds of cattle and living on milk, blood and meat from that source, they were skilful hunters on the Nile and its tributaries. They hold in very high esteem the liver of animals. Their interpretation of life is that each man has a soul which controls and determines his personality; his soul resides in his liver and the means by which his soul can be nourished is entirely by eating liver. The liver is held to be too sacred to be touched with human hands and must be eaten without such contact.

In my studies of the Indians of the far north of Canada, I asked an old Indian how they obtained their wonderful wisdom regarding foods and the art of living. He told me that a great Power taught the Indians to watch the animals to see what they ate.

I found the native tribes in Africa using the same principle. When I inquired why they ate the organs of the animals, particularly the liver, they reported that when a lion, the strongest of the beasts for its size, kills a zebra or another animal, it starts by eating at the flank and goes directly to the liver as the first of the organs to be eaten.

On the basis of the fat-soluble activators or vitamin content of the foods used, I found that those groups using at least two of the three principal vitamin sources had the highest immunity to dental caries. Those using the lowest amount of the

fat-soluble activators had the greatest amount of dental caries. On this basis, namely, the fat-soluble activator content of the diet, those groups using the fat-soluble activators in liberal quantity had not more than 0.5 per cent of the teeth attacked by dental caries; while those using fat-soluble activators less liberally had up to 12 per cent of the teeth attacked by dental caries. All groups having a liberal supply of minerals, particularly phosphorus, and a liberal supply of fat-soluble activators, had 100 per cent immunity to dental caries.

This seems to provide means for a direct application of these data to the problems of the prevention of dental caries and the prevention of dental arch and facial deformities among the people of modern civilization.

Large numbers of samples of foods were obtained for chemical analysis and brought to my laboratories.

#### SUMMARY

1. These studies of native races in eastern and central Africa reveal in general a high immunity to dental caries, approximating 100 per cent for those tribes who are living on their best native foods in accordance with the accumulated wisdom of their tribes.

2. The isolation of the tribes studied in eastern and central Africa was more complete than for most of the primitive racial stocks previously reported.

3. Very few groups were found in central Africa who had low immunity to dental caries.

4. As studies were made progressively down the Nile from near its source to Cairo, there was a marked lowering of the immunity level for dental caries at the point of contact with modern civilization and its foods at Khartoum. There was a progressive increase to and including Cairo.

5. The only factor that was found to have changed at the point where immunity to caries was lessened was a change in foods used.

6. The characteristics of the foods of those groups who had high immunity to caries were a relatively high level of the fat-soluble activators or vitamins and a high level of minerals, including phosphorus.

7. The characteristics of the foods used by the groups with a low immunity to dental caries, when compared with the foods of the high immunity group, was a marked reduction in the sources of fat-soluble activators and in the amount of available minerals, particularly phosphorus.

8. Practically no divergence from the tribal pattern of dental arch and facial form as characterized by irregularity of the teeth was found in the groups using foods supplying liberally fat-soluble activators and minerals.

9. All dental arches were broad and normally curved and had quite normal intermaxillary relationships.

10. In the groups using foods low in fat-soluble activators or vitamins, if the mothers were using this diet during gestation and lactation and if the children had used it during the growth period, many cases were found of irregularities of the dental arches and divergencies from normal facial form.

11. The physical excellence of the groups using a dietary that was rich in fat-soluble activators and high in minerals greatly exceeded that of the groups living on less efficient foods.

12. The data obtained from the study of these African groups correspond in essential characteristics with those obtained on the people of Switzerland and of the Outer Hebrides, the Eskimos of Alaska, the Indians of the far north of Canada, the Melanesians of the Western Pacific archipelagos, the Polynesians of

the Eastern and Central Pacific archipelagos and the past and present Indians of Florida.

This is a preliminary report. More

detailed information will be made available when the chemical analyses are completed on the sample of foods collected.

8926 Euclid Avenue.

## RESECTION OF MANDIBLE: REPORT OF CASE

By GEORGE F. SEEMAN, D.D.S., Nashville, Tenn.

**HISTORY.**—A negro, aged 24, poorly developed and poorly nourished, came to the Nashville General Hospital with a swelling of the left side of the face, with from six to eight sinuses. Wide incisions were made and curettement and removal of diseased bone were carried out after the patient had been in hospital several weeks. This relieved him for a month, when he again came in for treatment. Swelling and drainage, with edema, had continued for a period of ten years. There was no history of diabetes, insanity or tuberculosis in the family. The Wassermann reaction was negative.

**Diagnosis.**—A roentgen-ray examination revealed a tumor, probably a benign odontoma, involving practically all of the left side of the mandible, with evidence of osteomyelitis. After numerous external incisions, internal drainage and removal of sequestra, a diagnosis was made of chronic osteomyelitis of the jaw, which was hopelessly diseased. Resection of a portion of the mandible was advised after consultation with the staff general surgeon. A series of roentgenograms taken over a period of several years revealed no extension of the original area.

**Treatment.**—Resection of the jaw was carried out, with the following technic: Instead of an incision carried down the median line and backward to a point under the lobe of the ear, the technic originally employed by G. V. Black, and later improved and modified by Robert H. Ivy, for circumferential wiring, was employed. Two small incisions were made through the skin at the lower border of the mandible,

one anteriorly and one posteriorly to the diseased area, as shown in Figure 1. With a small antrum trocar and cannula, as



Fig. 1.—Appearance of tumor in roentgenogram.

described in "Fractures of the Jaws," by Ivy and Curtis for circumferential wiring of edentulous jaws, a Gigli saw was passed around the jaw anteriorly and posteriorly to the segment to be removed. After internal resection of the mucoperiosteum, a piece of bone was removed 6 cm. long and from 2 to 4 cm. in diameter.

Figure 2 is a roentgenogram taken after resection.

The patient was given cod liver oil. He