THE BANTU DENTITION

A MORPHOLOGICAL AND METRICAL STUDY OF
THE TEETH, THE JAWS AND THE BONY PALATE
OF SEVERAL LARGE GROUPS OF SOUTH AFRICAN
BANTU-SPEAKING NEGROIDS

Thesis submitted to the University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Doctor of Philosophy.

by
Alexander Jacobson

1967.

DECLARATION

I hereby declare that this thesis entitled:

The Bantu Dentition : A morphological and metrical study of the teeth, the jaws and the bony palate of several large groups of South African Bantu-speaking Negroids, is my own work, and that the work forming the basis of the thesis has not been incorporated in a thesis submitted for another degree by myself.

Signed: A. Jacobson

Date: 26. Jan. 1968

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CHAPTER 1

INTRODUCTION

The value of studying dentition in the light of racial and population differences originates from the generally accepted theoretical consideration, that the many morphological characteristics of the teeth such as cusp size and numbers, form and groove patterns, are genetically determined. The comparison of these characteristics allows reasonably accurate conclusions to be drawn regarding racial affinity or differences among population groups.

Dental characters also tend to predominate in the diagnosis of most fossil species and genera and even in some families (Butler 1963). This is understandable in that teeth are the most durable parts of the body and best able to withstand destructive processes after death. Most of the identifiable remains of fossil mammals consist of teeth and evidence obtained by a study of the teeth usually forms the basis of palaeontological relationships and is a valuable means of establishing human status in fossil finds and collections.

The present study comprises an investigation of the teeth, the jaws and the bony palate of several large groups of South African Bantu-speaking Negroids. The purpose of the investigation was firstly to determine morphology of the teeth and the bony palate of the adult South African Bantu Negroids. Secondly, it was to determine whether the various South African tribal groups selected could be considered homogeneous on the basis of metrical and non-metrical characters of the teeth and bony palate, or whether the tribal groups distinguished by their geographical location and language differed in tooth morphology and measurements. The third objective was to evaluate the various dental and palatal characteristics in an effort to determine the racial status and affinities of the South African Bantu Negroids by comparative measurements and morphology. The available data afforded an opportunity of investigating these aspects of the Bantu dentition.

The study is concerned primarily with the Southern Bantu Negroids which easily outnumber all other groups of inhabitants of South Africa and are about four times as numerous as the white population of the country. According to the South African population register (1960 census) the Bantu Negroids in the Republic number 10,927,922, and in South West Africa 428,575. The number of Coloured people in the Republic is 1,509,258, Asiatics 493,868 and Whites 3,088,492.

To the writer's knowledge the only attempt that has hitherto been made to record in any detail the characteristics of the Bantu Negroid dentition has been that of Shaw (1931). Besides describing the teeth and the adjacent parts, he included short accounts of "taurodontism" in South African races, and of tooth extraction and mutilation customs associated with certain ethnic ceremonial customs. A shortcoming of Shaw's investigations, however, was that the material consisted of a random collection of Bantu Negroid skulls which was not tribally classified. In addition, separate measurements were not recorded for males and females. Furthermore, only the average, maximum and minimum dimensions, were tabulated in all instances. For purposes of interracial comparisons, the latter study does not provide sufficient statistical information to make comparisons worthwhile. For these reasons Professor P. V. Tobias suggested that the present statistical survey and critical analysis of the Bantu Negroid dentition be undertaken.

In my study of the dentition, morphological observations were made on various teeth for purposes of comparison. The teeth commonly selected for such observations are the first and second maxillary incisors, as well as all the molars, the reason being that the morphological characteristics of these teeth are noticeably more variable than those of the remaining teeth in the dentition. Tooth crown measurements of all the teeth were noted and selected indices calculated. Root measurements of the teeth were not included in the study since this would have involved extracting or forcibly removing teeth from the skulls, thereby possibly damaging the skeletal material.

The data provided a basis of comparison with other population groups. The tabulated figures were also used to ascertain whether there were any significant tribal or sex differences. A table of comparative tooth dimensions of the Bantu Negroids and other population groups is included at the end of the chapter on odontometry.

Morphological and metrical observations were likewise made on the palate and discussed. The literature revealed a variety of methods of measuring the palate; an effort was therefore made to select the most suitable and the dimensions were compared with those of other population groups.

The population classification in the study has been based on metrical and morphological features. More recently a series of genetic factors, such as the genes for various blood groups and for taste ability, have been used as aids in classifying Man. This genetic method of classification, it has been claimed, will supersede the traditional methods since, by specifying the gene frequencies in a racial group, more objective assessments of racial affinity became possible. But, according to Tobias (1953), the new method has produced a classification virtually identical with that arrived at by the older method. This suggests that the distribution of purely morphological features, on which the older classifications are based, approximates to the relative frequencies of the more precisely identified genes, which provide the new classificatory basis. It would seem that a genetic analysis of traditional morphological characters is desirable to provide a synthesis between the two techniques, but since this is beyond the scope of the present study, only the traditional metrical and morphological analyses were undertaken.

PRESENTATION OF THESIS

Following the introductory chapter, a brief account is given of the hybrid Bantu Negroid referred to in the text (Chapter 2). A short description of the main inhabitants of Southern Africa is provided. The study is based on an analysis of 460 crania and mandibles in the Anatomy Department collection. Details such as sex, stated age and tribal identification, were known in each case. To establish evidence of group affinities or characteristics, skulls in the collection from the largest groups of the same tribal origin were selected. These comprised the Natal Nguni, Cape Nguni, Sotho and Miscellaneous. General methodological considerations are outlined in this chapter. The various methods of measurement and statistical procedures are detailed in the respective chapters.

Chapter 3 is a morphological description of the position of the teeth in upper and lower jaws and the relationship of the teeth and dental arches to each other. Included in this chapter is a section on occlusal and interproximal attrition of teeth.

The morphology of the bony palate is discussed in Chapter 4.

In the following chapter various metrical observations on the palate and dental arches are recorded and discussed (Chapter 5). The reduced metrical data are presented in terms of mean values, ranges, standard deviations, coefficients of variation, standard errors of the mean and intergroup t-values. Population and intergroup comparisons are recorded in this section.

The morphology of the incisor and molar teeth of both jaws are dealt with in Chapter 6 and population and tribal comparisons are made. Following this, (Chapter 7) are the metrical observations on the teeth of the Bantu Negroids. The mesiodistal and buccolingual crown dimensions, crown areas and crown shape indices of the maxillary and mandibular teeth are recorded and the data are statistically analysed for purposes of comparing the teeth of the Bantu Negroids with those of other populations and for determining intergroup differences.

Variation in palatal, dental arch and tooth measurements are handled in Chapter 8. The coefficients of variability of absolute measures and standard deviations of indices and angles are computed and the sex and individual measures variability are discussed. Chapters 9 and 10 are devoted to sex differences in the Bantu Negroids and to the various morphological and metrical differences ~~between~~ among the four tribal sub-groups respectively.

The final chapter (Chapter 11) is a general summary of the text.

CHAPTER 2

MATERIALS AND METHODS

The inhabitants of southern Africa are usually listed under five main headings, viz., the Europeans, the Bantu-speaking Negroes, the Bush-Hottentot group, the Indians and the Coloureds. The pattern of racial types in southern Africa has been greatly complicated by miscegenation between the tribes and settlers over the years and, according to Dart (1937), is no new feature in the racial history of Africa. To give some idea of the hybrid Bantu referred to in the text, a brief description of the Bantu, Bushman and Hottentot is provided.

A. THE BANTU

The Bantu people are purported to have originated in the north and moved (down the African migration routes) to the south. The east coast of Africa was almost unknown to the nations of the west until the sixteenth century when the early Portuguese navigators explored it on their way to India and the Far East and planted garrisons upon it (Ommanney, 1955).

"Bantu" is correctly not a racial name, but a linguistic term. Most Bantu languages have similar qualities, and the roots of many words are the same, or approximately the same, all the way from Kenya to the Cape. For example, the word for "man" is umu-ntu in Zulu, un-tu in Xosa, oman-tu in Luganda and m-tu in Swahili.

The plural form, <u>aba-ntu</u> ("men") is the same in a number of languages, and from this comes the word "Bantu" itself, meaning "human beings".

Physically, the southern Bantu present great variability: all are essentially Negroes, but since they have acquired a varying amount of Mediterranean genes and have further mixed to a varying extent with Bushmen, Asian, Coloured and other peoples, they naturally show a diversity of physical characters. Yet certain Negro characteristics predominate, especially the character of the hair. They are described by Seligman (1959) as being, as a rule, well built, with strong muscular figures, and graceful bearing and gait, especially noticeable in the women, who are accustomed to carrying loads on their heads. The skin colour ranges from the black of the Swazi to the yellowish-brown of some of the Tswana, the latter probably reflecting some degree of intermarriage with Hottentots and Bushmen. The prevalent colour, however, is a dark chocolate, with a reddish tint.

Certain Negroid characteristics, such as the everted lips and the wiry, tightly curled hair, are specialized traits of the Bantu. The head is generally dolichocephalic and the face is usually prognathous. The shape of the nose is variable; usually it is flat and broad with wide nostrils, but it sometimes has a well-formed bridge with narrow nostrils. Unlike the Caucasoids there is little hair on the face and the beard does not grow until the middle twenties. Baldness is rare but many Bantu shave their heads periodically.

The system of land tenure is on a communal basis. The tribes occupy settled dwellings and polygamy is recognized. The women perform most of the agricultural labour, and the men are the hunters and the herdsmen. They are skilful in wood and metal working, wear a coarse cloth of cotton and are capable workers in pottery. Maize is the staple food. Bantu were originally located in the bush; many still remain in the bush, "lacustrine" or "riverine" dwellers who live deep in the rain forests and cling close to water, but large numbers of them have in recent years begun a steady march into the industrial centres in the various large cities in Africa.

The mode of life, social organization and religious system of all the southern Bantu show certain broad resemblances, but in details of history, language and various aspects of [illegible]ture there are a number of important differences whi[illegible]rding to Seligman (1959), permit their being cla[illegible] into four main groups :

1: Northern - The Shona peoples of Southern Rhodesia and of Mozambique.

2: Eastern - This group consists of two main subdivisions, Nguni and Tsonga.

1) The Nguni consists of the Cape Nguni of the Ciskei and Transkei and the Fingo. The Natal Nguni is comprised of the 'Zulu' of Natal and Zululand, the Swazi and the Transvaal Ndebele. The Ndebele of Southern Rhodesia are believed to be an offshoot of the Zulu of Natal.

ii) The Tsonga are subdivided into Tsonga, Ronga and Tswa and are found chiefly in Mozambique.

3: Central - This group, too, consists of two main divisions, Sotho and Venda.

i) The Sotho include the Southern Sotho of Lesotho and adjoining districts, the Tswana (Tlhaping, Rolong, Hurutshe, Kwena, Tswana, Ngwato, etc.) of Botswana and western Transvaal, and the Northern Sotho of the central and northern Transvaal.

ii) The Venda are a homogeneous group occupying the Soutpansberg district of the north-eastern Transvaal.

4: Western - The fourth large group comprises the Herero and Ambo in the central and northern districts of South-West Africa.

B. <u>BUSHMEN</u>

The Bushmen do not seem to go further back than the later Stone Age of 12,000 or 15,000 years ago (Silberbauer 1964). But their family tree is very much older and, according to the above writer, there is no doubt that they are indigenous to Africa and that they, together with the Hottentots, make up a population completely separate from any other.

The Bushmen ranged over the whole of Africa south of what we know today as the Republics of the Congo

(Kinshasa) and Tanzania. Their culture, it appears, was very similar to that of their present-day descendants who, in the heart of the Kalahari, still follow the life of hunter[redacted]-gatherers.

The Bantu-speaking peoples in their trek southwards, brought with them vastly more advanced technology, mining, agriculture, and cattle, and encroached on the land of the Bushmen. The history of these contacts is obscure but evidently Bantu and Busnmen lived together in some places for periods as masters and slaves, but eventually the Bushmen largely disappeared. The history of contact between Bushmen and European was equally unfortunate. The Bushmen fought back as best they could, but the advantage was naturally with the Whites as well as the Bantu, with their large well-organized communities, with trained, well-equipped warriors and reliable sources of food. By the end of the 19th century the only surviving Bushmen were those who lived in the arid central depression of southern Africa, the Kalahari of Botswana (formerly Bechuanaland), South West Africa, Southern Angola and the western extremity of Zambia and Rhodesia. The country where Bushmen did survive was either so inhospitable that nobody else wanted it,or was settled so sparsely by peaceful pastoralists that there was no room for both them and the Bushmen and the process of acculturation and absorption took the place of wars and extinction. Today, according to Silberbauer (1964),there are about 40,000 Bushmen of whom 25,000 are in Botswana.According to the population register of 1960,the number of Bushmen in

South West Africa is given as 11,762. The latter figure is based on linguistic criteria. Probably, a more reliable figure is that of Tobias (1956) who estimated that the number of surviving Bushmen in 1955 was 55,531.

The Bushman is so distinctive in appearance as to be distinguished at a glance from all other Africans save only the Hottentot (Seligman 1959). He is short, averaging about 62 inches with slightly built, well-shaped limbs, and small hands and feet. New data have revealed an increase in the mean stature of the Bushman over the years. This has been attributed to their passing through another Neolithic revolution, which is transforming their way of life from a nomadic, hunting, and food-gathering subsistence economy, to participation in a more settled, pastoral, food-storing existence (Tobias 1962).

The skin of the Bushman is yellow or yellowish-brown, and wrinkles particularly easily; the hair of the head is so tightly spiralled that it forms tufts or 'peppercorns', which appear to leave bare patches on the surface of the scalp. According to Seligman the head is mesocephalic (Cephalic Index 75 - 76 per cent), low in the crown and pentagonal as seen from above; the face is orthognathous, small and broad, with prominent cheek bones, very flat nose, low but bulging forehead, and pointed chin. Their eyes are narrow and the lids display a variety of folds; the lobe may be absent from the small squarish ear. The usual forward curvature of the lower end of the spine is exaggerated, making the buttocks especially prominent, and in the women there is often that considerable accumulation of fat on the buttocks and thighs to which is given the name steatopygia. The degree of steatopygia decreases significantly from young adulthood to old age.

A number of field studies on the Bushmen have been undertaken by the Nuffield-Witwatersrand University research expeditions. These are currently being co-ordinated to broaden and deepen the human biological study of these peoples, as well as to incorporate other aspects and disciplines and to expand the cultural, social and linguistic investigations (Tobias 1961).

C. HOTTENTOT

The physical characteristics of the Hottentots are similar to those of the Bushmen, the chief points of difference being a taller stature (about 64 inches), a larger and narrower head (Cephalic Index 73), and a more prognathous face (Seligman 1959). Apart from Bantu admixture in certain groups, the Hottentots are possibly the result of the mixture of Bushmen with early invading Hamites, from whom they may have received those linguistic and cultural features that distinguish them from Bushmen. The origin of the Hottentots is uncertain. It is generally believed that they arose in the North, perhaps in the neighbourhood of the Great Lakes of Central Africa, and that the Hottentots did not reach South Africa until after the Bushmen. The Hottentots are thought to have crossed the upper waters of the Zambesi and reached the West Coast, then pressed forward to the south where they ~~were~~

were found by the first Europeans to visit the Cape of Good Hope. Seligman believed that the Hottentot population of the Cape had become largely absorbed by racial admixture with incoming Europeans and East Indian slaves, and thus constituted the basis of the present 'Cape Coloured', 'Griqua' and 'Rehoboth half-breed' communities.

The Hottentots are a diminishing people, and only a remnant of their former customs and beliefs survives. Culturally, the outstanding difference between Bushmen and Hottentots is that until recently the former were hunters and food collectors only, while the latter are a pastoral people with herds of cattle and flocks of sheep.

D. MATERIAL

The present study is based on an analysis of 460 crania and mandibles of South African Bantu-speaking Negroes in the Department of Anatomy at the University of the Witwatersrand, Johannesburg. The skulls form part of the skeletal collection begun by Professor Raymond A. Dart in 1923. The skeletons have been prepared from dissection-hall subjects, consequently details such as sex, tribe and a statement of age are known in each case. The ages cannot be accepted as being completely reliable, since Africans of a generation or two ago were frequently illiterate and unaware of their exact birth date. Obvious discrepancies in the stated ages were recorded as 'undetermined'.

All the skulls are of adults or young adults, the ranges of stated ages being from 16 to 108 years. The majority are in the 20 to 50 year age category, and only 10 are below the age of 20 years.

The total number of male skulls is 356, that of female skulls, 104. It appears that the bodies of female paupers who have died in hospitals are more frequently claimed by relatives and friends. Another factor might be that in the Johannesburg area Bantu males outnumber females because of the influx of male industrial and mine labourers from the rural areas.

The hospital administration was responsible for recording the tribal identification of the subjects in the present series. Vaguely identified crania were not included in the sample. In earlier years, wars, tribal fighting, slave-trading, famine and pestilence contributed to the continual movement of the Bantu (Battiss et al, 1958). Nowadays, industrialization, education, rapid and easy transport, contribute to this migration and consequently more rapid detribalization of the Bantu peoples. According to De Villiers (1957), adult skulls such as those used in the present study, represent as yet unhybridized individuals, belonging in most instances to the first generation of urbanized Africans, whose parents on both sides were of the same tribe.

From the skulls in the collection, the largest groups of the same tribal origin were selected, in an effort to establish evidence of group affinities or characteristics on the basis of morphology and measurement. Since most of the skull material was of South African origin, it was not surprising to find that the largest tribal groups were those of the Natal Nguni, Cape Nguni and Sotho. It was hoped that the Shangaan and Tonga might have constituted a fourth group, but the paucity of skulls made it more desirable to group them with skulls of other tribes under a single heading of Miscellaneous . The Ndebele, originally an offshoot of the Natal Nguni, were probably already detribalized, consequently it was deemed desirable to group them in the Miscellaneous category.

A tribal breakdown of the ~~data~~ skulls in the present study is as follows:-

NATAL NGUNI

Zulu	76 males	28 females
Swazi	19 males	8 females
Total	95 males	36 females

CAPE NGUNI

Xosa	59 males	14 females
Fingo	8 males	5 females
Hl[illegible]	6 males	Nil
Pondo	15 males	Nil
Baca	10 males	Nil
Total	98 males	19 females

SOTHO

S.Sotho	77 males	32 females
Tswana	10 males	7 females
Rolong	2 males	5 females
Total	89 males	44 females

MISCELLANEOUS

Shangaan	33 males	1 female
Tonga	2 males	Nil
Venda	16 males	2 females
Ndebele	12 males	2 females
Shona	11 males	Nil
TOTAL:	74 males	5 females

Total sample: 356 males 104 females

i.e. 460 skulls altogether.

E. METHODOLOGICAL CONSIDERATIONS

Each skull was examined independently and all the morphological and metrical observations relating to the bony palate and teeth of each skull were listed on a blank form running to five foolscap sheets. Many of the morphological observations, though not readily amenable to measurement, were apparent to the eye. In order to classify the morphological observations, a series of standards was compiled from good examples of the various features: photographs of these standardized degrees of expression of each trait were compared with each skull, which was then categorized.

The advantages of metrical observations are that they are less subjective and data thus obtained can be statistically analyzed. In the study, palatal and tooth dimensions were measured directly on the skulls with a Boley gauge to an accuracy of 0.1 mm. The points of the gauge were carefully sharpened to make accurate measurements pos. ible. Palatal depth, however, was measured with a three-dimensional calipers designed by Korkhaus. The bizygomatic width and nasion-basion dimensions were effected with a Flower's sliding compass to an accuracy of 0.5 mm.

The sample in most instances was sufficient to enable a satisfactory statistical comparison to be made among [redacted] the tribal groups. The various methods of measurement and statistical procedures are detailed in the respective chapters.

CHAPTER 3

TOOTH POSITION AND OCCLUSION

A. THE OCCLUSION OF THE TEETH

Occlusion may be described as the relationship of the occlusal surfaces of the teeth when the jaws are closed. Each tooth in normal occlusion helps to maintain the adjacent teeth in harmonious relations, for the cusps interlock and each inclined plane of contact serves to prevent the teeth from sliding out of position (Figs 1 and 2).

Many deviations from the normal or ideal anatomic relationships between upper and lower dentitions are encountered. Whereas many of these departures may be included in the realm of normal variation, severe deviations are designated malocclusions. Malocclusions of the teeth are found in all races of man, and occasionally among lower animals. It has been one of man's afflictions from time immemorial, but, according to Angle (1907), it is generally conceded that it is becoming more common as civilisation progresses.

For practical purposes dentists, in describing occlusions, have universally adopted the classification of Angle (1898) His classification of occlusion was based on the mesiodistal relations of the teeth, dental arches and jaws, which he contended depend primarily upon the relative mesiodistal positions assumed by the first permanent molars after their eruption into occlusal contact. Angle

Fig. 1 Normal occlusion, frontal view

Fig. 2 Normal occlusion, lateral view

used the Roman numerals I, II and III to designate the three main classes of mesiodistal arch relationship viz; Class I or normal, Class II or distal, and Class III or mesial relationships of the cusps of the first permanent molars. In detail, his classification of occlusion was as follows:

Class I: The mandibular dental arch and body of the mandible are in normal mesiodistal relation to the maxillary arch. The mesiobuccal cusp of the maxillary permanent first molar occludes in the buccal groove of the mandibular permanent first molar when the teeth are approximated in centric occlusion. In the event of teeth in either or both jaws being irregular, the condition is designated an Angle Class I malocclusion.

* The three categories were designated Neutro-occlusion (Class I), Disto-occlusion (Class II) and Mesio-occlusion (Class III). This method of classification does not take into consideration the morphogenetic skeletal patterns or dysplasias. It is a static one-dimensional system of classification. Advances in clinical dentistry have necessitated not only a three-dimensional analysis of malocclusions by means of cephalometric roentgenography, but a dynamic or functional approach to the whole problem of occlusion. However, since clinical diagnosis and the treatment of malocclusions are of no concern in this study, Angle's classification has been used to classify the malocclusions present in the Bantu.

[Omission: Insert at *]

Class II: In this group the lower dental arch and the body of the mandible is in a distal or posterior relation to the upper dental arch as reflected by the first permanent molar relationship. The mesiobuccal cusp of the maxillary first molar occludes in the space between the mesiobuccal

Class I: The mandibular dental arch and body of the mandible are in normal mesiodistal relation to the maxillary arch. The mesiobuccal cusp of the maxillary permanent first molar occludes in the buccal groove of the mandibular permanent first molar when the teeth are approximated in centric occlusion. In the event of teeth in either or both jaws being irregular, the condition is designated an Angle Class I malocclusion.

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Class II: In this group the lower dental arch and the body of the mandible is in a distal or posterior relation to the upper dental arch as reflected by the first permanent molar relationship. The mesiobuccal cusp of the maxillary first molar occludes in the space between the mesiobuccal cusp of the mandibular first molar and the distal aspect of the buccal cusp of the second premolar.

Class III: In this category the mandibular dental arch and body of the mandible are in bi-lateral mesial relationship to the maxillary arch. The mesiobuccal cusp of the maxillary permanent first molar occludes in the interdental space between the distal aspect of the distal cusps of the mandibular permanent first molars and the mesial aspect of the mesial cusps of the second mandibular permanent molars.

PRESENT STUDY

In only 178 of the 460 Bantu skulls examined could the occlusion of the teeth be satisfactorily determined. Skulls in which a number of teeth were either lost or missing, or in which there was doubt as to the correct articulation of the teeth, were rejected from the sample. Of the 178 skulls, 140 were males and 38 were females.

Of the males, 96.4 per cent exhibited a Class I type of occlusion or jaw relationship, i.e., neutro-occlusion (Table 1). Class II, or disto-occlusions, were noted in 2.9 per cent of the sample (one of Class II's showing unilateral disto-occlusion). A Class III, or mesio-occlusion was noted in only a single Bantu male skull, viz., 0.7 per cent of the sample.

Among the females, only a single Class II occlusion was noted. This provided a percentage figure of 2.6, which closely approximates the percentage of Class II occlusions found in the male sample. The remaining female dentitions, viz., 97.4 per cent, exhibited a Class I jaw relationship.

DISCUSSION

In an analysis of 1,000 cases of malocclusion, Angle (1898) gave the percentage proportions of occlusion patterns as follows:-

Class I ... 69.2 per cent

Class II .. 26.6 per cent

Class III .. 4.2 per cent

In a report on the incidence of dental disease in children, prepared by the Medical Research Council's committee for the investigation of dental disease in 1925, Ainsworth reported the following percentage of occlusion patterns in boys and girls:-

Incidence of normal occlusion in boys	- 75%
Incidence of normal occlusion in girls	- 79%
Incidence of prenormal or Class III occlusions (boys and girls)	- 1.35%
Incidence of postnormal or Class II occlusions (boys and girls)	- 21.85%

In a review of the literature, Seipel (1946) reported that the incidence of Class II occlusions varied between 4.1 and 26.6 per cent in various populations. Class III occlusions remain fairly constant around an average of 2.8 per cent. The figures for his own Swedish sample are 10 and 4 per cent respectively.

Begg (1954) examined 800 skulls of Australian aboriginals and noted an incidence of Class II occlusion of 13 per cent, and Class III occlusion of 3 per cent. These figures do not differ greatly from Seipel's figures for modern Swedes. In comparing the incidence of occlusion patterns in Swedish mediaeval skulls with those of Seipel's figures for modern Sweden, Lundström and Lysell (1953) found that the incidence of Class II and Class III occlusions was approximately the same.

In the Aleuts, Moorrees (1957) observed that the most common malocclusion is of the Class I type, characterized by crowding and rotation of individual teeth without displacement of the molars. In contrast to a relatively high prevalence of Class II occlusions and a lower frequency of Class III occlusions in populations of white stock, Moorrees reported that the findings in the Aleuts show reverse proportions. The combined male and female incidence of Class I occlusion patterns in the Aleuts was found to be 86.8 per cent, whereas the incidence of Class III occlusions was 13.2 per cent. No Class II occlusions were seen in either the males or females.

From the literature it can be seen that the incidence of malocclusions is somewhat higher in some racial groups than in others. Brash, McKeag and Scott (1956) reviewed the evidence for the occurrence of malocclusions in non-European races and reached a tentative conclusion that they do occur in widely separated races, though not to the degree or extent that they do in Europeans. The observations in the Bantu support this contention.

According to Mills (1956) the possible reasons for the increase in incidence of malocclusions in civilized man are threefold. Firstly, the admixture of populations may be responsible for those malocclusions which are caused by discrepancies in the parts of the skull, and for the greater incidence of crowding and spacing of the teeth caused by discrepancy in size of teeth and jaws. Secondly, an individual with a severe malocclusion is more likely to survive in a civilized community and to perpetuate his malocclusion. In addition, he claimed that there is a greater likelihood that the weaker members of the community, generally, would survive, and these would be more likely to have crowded arches. This assumes, that malocclusions are in part genetically determined.

This is in accord with the thinking of Salzmann(1950), Graber (1961) and Noyes (1962), who stated that students of facial growth and clinical orthodontists seem agreed that the morphological pattern of the human face is of hereditary determination. From the study of identical twins, Lundström (1962) estimated the relative importance of quantitative variation of morphological characteristics. He concluded that not less than half of the variation within the maxillo-facial area is owing to differences in genetic composition among individuals. Thirdly, according to Mills, it is possible that environmental factors in the condition of captivity or of civilization would cause malocclusion. Colyer (1931) studied the effect of captivity on the incidence of malocclusion in various animals. He noticed that the abnormalities seen in captive animals are similar in type to those seen in animals from the wild state, but are more marked, as a rule and the incidence is greater.

TABLE 1

PERCENTAGE INCIDENCE OF TYPES OF OCCLUSION IN THE SOUTH AFRICAN BANTU

SEX	ANGEL'S CLASS I		ANGEL'S CLASS II		ANGEL'S CLASS III		TOTAL
	No.	%	No.	%	No.	%	
Males	135	96.4	4	2.9	1	0.7	140
Females	37	97.4	1	2.6	0	0	38

B. CROWDING

There is little doubt that during recent centuries, a reduction in the size of the facial skeleton and, to a lesser extent, a reduction in the size of the teeth has occurred in man. According to Brash, McKeag and Scott (1956), a discrepancy between jaw size and tooth material is a major contributing factor responsible for the increased incidence of malocclusion or crowding in modern civilization. In this process it is possible that both environmental and genetic factors have been at work.

Orthodontic literature implies that, although malocclusion of the teeth with its associated dento-facial anomalies is present in rare instances in primitive man, it has become widespread only in civilized man. Robinson (1956) and Oppenheimer (1964) noted that crowding was present in the front teeth of Australopithecines. Tobias (1967, in press) noted a similar condition on Zinjanthropus.

Much of the modern prevalence of malocclusion may be the result of accumulated survival and multiplication of physically inferior individuals. This contention appears to be borne out by Collins (1932), whose study of the teeth in the Eskimo seemed to indicate that crowding of the teeth is for the most part a recently acquired condition. Keith (1925), too, commented on the increased incidence of malocclusions and crowding during more recent centuries. He was of the opinion that there is some degree of contraction of the palate and irregularity of the front teeth in at least 25 per cent of the present population of the British Isles. On the other hand, mal-occlusions and crowding of teeth ~~is~~ are definitely not confined to modern man. The incidence of tooth crowding and malocclusions in different living races is variable. Conditions of crowding and displacement of the teeth are found within the jaws, similar to those seen in other primates. Also, a considerable number of malocclusions are found which are due to abnormalities in the relationships of the jaws to each other; there are those which fall into Angle's Classes II and III malocclusion. The variation in incidence of all the types of malocclusions that exist in different population groups is illustrated in Table 2 which was prepared by Mills (1963) from figures given by Hellman in the discussion of a paper by Hrdlička (1935). Hellman's figures tend to indicate a high incidence of malocclusion in those of European origin, although they are equalled or exceeded by the incidence in several other groups.

TABLE 2

*INCIDENCE OF MALOCCLUSION IN VARIOUS RACES
(AFTER HELLMAN)

RACE	TOTAL No.	PERCENTAGE
ANCIENT AMERIND	16	6.25
MODERN AMERIND	35	8.6
ESKIMO	14	50
"HINDU"	39	35.9
JAPANESE	12	66.67
CHINESE (BORNEO)	14	91.4
BURIAT	32	15.6
TASMANIAN	11	27.3
AUSTRALIAN	14	28.6
NEGRO (EAST AFRICA)	33	21.2
NEGRO (SOUTH AFRICA)	10	Nil
NEGRO (WEST AFRICA)	76	32.9
NEGRO (W.R.U.) x	43	6.98
WHITE (W.R.U.) x	62	32.26
WHITE (DEMKO-HEGY)	41	34.2
WHITE (KESZO-HIDEGKUT)	108	44.5
WHITE (SZARAZD)	42	33.33

*Table taken from Mills (1963)
x Western Reserve University

Campbell (1925) reported that very rarely indeed does one find teeth erupting in markedly abnormal positions in the Australian aboriginal, as is so frequently the case with modern civilized folk. He stated that in this population the dental system is characterized by the large size of the jaws and ample space for all the teeth. The author does not mention the actual percentage incidence of crowding in the aboriginals. Nelson (1938) likewise did not report the incidence of crowding in the Pecos Indians, but merely stated general impressions gathered from his study. He said that disturbance of occlusion is relatively uncommon (save for mesio-palatal torsion of the upper central incisors). It seems that the chief malocclusion found among these Indians is the palatal displacement of the maxillary premolar.

In his study of Bushmen, Van Reenen (1964) observed that just over 10 per cent had crowded teeth. Crowding was generally highest in the non-adult age groups, particularly in adolescents, and it decreased with the years and was rare among the old-aged. Drennan (1929), on the other hand, reported that although the alignment in Bushmen was rarely perfect, it was good in 30 of the dentitions examined, slightly irregular in 21 skulls, and in one skull there was considerable displacement of the teeth.

The Tasmanian Aborigines, according to Steadman (1937), had well developed arches, but in 33 maxillae in which the molar region was sufficiently complete for a diagnosis to be made and in 21 mandibles in like condition, he found 14 upper and 8 lower impacted third molar teeth. Abrahams (1950) quoted Flower (1879) as having stated of the Tasmanians, "Their teeth are generally of large size, but there appears to be too little room for them in the jaw so that only in two out of eleven adult skulls in which their condition can be observed, are all of them normally placed". Abrahams contended that this megalodont condition is not uncommon in living orthognathous races such as Caucasians and Japanese, but it is unusual in a primitive population like the Tasmanians.

In the Aleuts crowding occurs in approximately one half of the total population (Moorrees 1957). The proportion does not apparently increase with age. In 1932, Collins compared the incidence of crowding between unhybridized and mixed Alaskan Eskimos. Seven of the 27 mixed types had crowded teeth, a percentage of 25.9, as opposed to 14.5 per cent of the unhybridized Eskimos. To obtain comparative data on the incidence of tooth crowding among Eskimo of an earlier period, he studied museum crania and reported an incidence of only 2.8 per cent of crowding in the adults.

Graber (1961) likewise recognized and mentioned the variations in the incidence of malocclusion in different population groups. He pointed out, too, that certain populations seem to show a predilection for certain types of malocclusion. The Japanese, for example, have a relatively high incidence of mandibular prognathism and crowding. In the United States a greater incidence of mandibular retrusion is seen in the whites, and there are fewer cases of mandibular prognathism. It is well known too that the incidence of retruded mandibles in the British Isles is high (Brash et al 1956).

PRESENT STUDY

In the Bantu, the teeth in the respective maxillary and mandibular arches were classified as either adequately accommodated, crowded or spaced. Where no evidence of generalized spacing existed and when the teeth were not overlapping or crowded (locally or generally), the arches were judged as being able to adequately accommodate the teeth.

The degree of crowding was arbitrarily determined by observation and rated as absent, mild, moderate or marked. A standard set of photographs was prepared (figs. 3, 4, and 5) of examples of the varying degrees of crowding and each dentition was compared with the photographs for purposes of classification. Since different degrees of crowding were sometimes evident in the maxilla and mandible of the same skull, observations on the upper and lower jaws were listed separately in the tables. Dentitions in which a number of teeth were either missing or absent were excluded from the sample.

In the Bantu male series, 75.5 per cent of the maxillary arches in a sample of 257 skulls were satisfactorily able to accommodate all their teeth with no evidence of spacing or overlapping. In the 265 male mandibles observed, 64.5 per cent had similar well aligned teeth.

The female dentitions evinced a very similar incidence of well aligned teeth in their maxillary arches. The percentage incidences were 76.2 and 67.1 respectively in a sample of 63 maxillae and 70 mandibles (Table 3).

CROWDING

Fig. 3   Mild crowding

Fig. 4   Moderate crowding

CROWDING

Fig. 5 Severe crowding

TABLE 3

PERCENTAGE INCIDENCE OF ADEQUATELY ACCOMMODATED TEETH IN THE BANTU

		TOTAL No. IN SAMPLE	ADEQUATELY ACCOMMODATED TEETH	PER-CENTAGE
MALE	MAX.	257	193	75.5
	MAND.	265	171	64.5
FEMALE	MAX	63	48	76.2
	MAND.	70	47	67.1
MALE and FEMALE	MAX.	320	241	75.3
	MAND.	335	218	65.1

The percentage incidence of crowded teeth in Bantu males and females was again remarkably similar. Of the 257 male maxillae examined, 11.7 per cent witnessed some degree of crowding. In the females, of the 63 maxillary arches in the sample, 11.1 per cent showed signs of crowded teeth.

In the male mandibles, 27.9 per cent of the sample of 265 possessed crowded teeth. These figures closely approximate those of the female, which, in a sample of 70 mandibles, showed a 27.1 per cent incidence of crowded teeth (Table 4).

TABLE 4

INCIDENCE OF CROWDED TEETH IN THE SOUTH AFRICAN BANTU

TOTAL No. EXAMINED	MAXILLA								TOTAL No. EXAMINED	MANDIBLE							
	DEGREE OF CROWDING						TOTAL CROWDING			DEGREE OF CROWDING						TOTAL CROWDING	
	MILD		MODERATE		SEVERE					MILD		MODERATE		SEVERE			
	No.	%	No.	%	No.	%	No.	%		No.	%	No.	%	No.	%	No.	%
MALES 257	21	8.2	7	2.7	2	.8	30	11.[illegible]	[illegible]	36	13.6	28	10.6	10	3.7	74	27.9
FEMALES 63	3	4.7	4	6.4	0	0	7	11.1	70	7	10	8	11.4	4	5.7	19	27.1

The table also demonstrates the incidence of the various degrees of crowding in the combined sample. The incidence of mild maxillary crowding in males was nearly twice as great as that found in females, viz; 8.2 per cent in males, 4.7 per cent in females. Moderate crowding was greater in females (males 2.7 per cent, females 6.4 per cent). Only .8 per cent of the male skulls, and nine of the females exhibited severe crowding of the maxillary teeth. Owing to the small sample of crowded female skulls (7 out of a total of 63), the latter figures cannot be regarded as significant.

In the mandibular arches, the percentage incidence of various degrees of crowding in males approximated those of females; crowding, males 13.6 per cent, females 10 per cent; moderate crowding, males 10.6 per cent, females 11.4 per cent; severe crowding, males 3.7 per cent, females 5.7 per cent.

Tables 5 and 6 were drawn up to compare the incidence of various degrees of crowding in the arches of the Bantu sub-groups. Although crowding was commoner in the Cape Nguni males, the sample was too small to be able to determine whether the incidence of various degrees of crowding differed significantly among the tribes.

TABLE 5

ACCOMMODATION OF TEETH IN THE MAXILLARY AND MANDIBULAR ARCHES OF VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

	NATAL NGUNI				CAPE NGUNI				SOTHO				MISCELLANEOUS				TOTAL			
Sex	Male		Female		Male		Female		Male		Female		Male		Female		Male		Female	
JAW	Max	Man	Max	Man	Max	Man	Max	Man	Max	Man	Max	Man	Max	Man	Max	Man	Max	Man	Max	Man
Adequate	60	51	20	20	53	44	10	8	43	40	15	15	37	36	3	4	193	171	48	47
Mild Crowding	4	11	1	3	6	14	0	2	7	8	2	2	4	3	0	0	21	36	3	7
Moderate Crowding	0	6	2	3	4	12	0	1	0	7	2	4	3	3	0	0	7	28	4	8
Marked Crowding	1	2	0	0	1	1	0	0	0	3	0	4	0	4	0	0	2	10	0	4
Spacing	5	1	4	1	10	5	0	0	15	10	4	3	4	4	0	0	34	20	8	4
Unable to Determine	25	24	9	9	24	22	9	8	24	21	21	16	26	24	2	1	99	91	41	34
TOTAL	95	95	36	36	98	98	19	19	89	89	44	44	74	74	5	5	356	356	104	104

TABLE 6

PERCENTAGE INCIDENCE OF CROWDING (ALL DEGREES) IN THE ARCHES OF VARIOUS BANTU TRIBAL GROUPS

	NATAL NGUNI				CAPE NGUNI				SOTHO				MISCELLANEOUS				TOTAL			
	Male		Female		Male		Female		Male		Female		Male		Female		Male		Female	
	Max	Man	Max	Man	Max	Man	Max	Man	Max	Man	Max	Man	Max	Man	Max	Man	Max	Man	Max	Man
Total Observed	70	71	27	27	74	76	10	11	65	68	23	28	48	50	3	4	257	263	63	70
Crowding	5	19	3	6	11	27	0	3	7	18	4	10	7	10	0	0	30	74	7	19
Percentage Crowding	7.1	26.8	11.1	22.2	14.9	35.5	0	27.3	10.7	26.5	17.5	35.7	14.6	20.0	0	0	11.7	20.2	11.1	27.1

DISCUSSION

The available information regarding the incidence of crowding per se is limited, a fact which makes comparisons difficult.

In his investigations, Shaw (1931) stated that in the Bantu, marked disturbances of the normal relationship of the teeth are rare and that occlusion is normal in an exceedingly high percentage of cases. Earlier on, in discussing variations in tooth position, Shaw recorded that in several instances individual teeth, especially upper canine teeth and lower incisor teeth, were slightly displaced either lingually or labially. With the exception of such slight variations in position, few cases of crowding were recorded in his material. Marked displacement of third upper molar teeth, due to lack of space and resulting crowding, was recorded in only four out of his 132 cases. Impacted third lower molars he encountered in three dentitions as well as three instances of marked spacing of teeth. No figures or percentage incidence of crowding were tabulated by Shaw, but it would seem that the percentage incidence of crowding (approximately 11 per cent in the maxilla and 27 per cent in the mandible) in the present investigation is somewhat higher. This is probably because, whereas Shaw in his study disregarded slight irregularities in his interpretation of alignment, the writer tabulated all degrees of crowding. Severe crowding was recorded in both investigations in only a few instances. Furthermore, differences in sample size might be responsible for part of the discrepancy in observations.

Severe crowding, or the incorrect occlusion of teeth (or bite) is widely regarded by dentists as a major contributing factor in periodontal disease with consequent bone destruction. A general impression gleaned from an examination of the present series of Bantu skulls is the relatively mild degree of alveoclasia in spite of the crowding in various regions of the dental arch. Alveoclasia, as defined by Shaw (1931, p.71), is "a resorption of the alveolar process of the jaws either of its crest or of the inner wall of the alveolae".

In his calculations, Shaw included all degrees of alveoclasia. He noted that over 50 per cent of his series of Bantu crania exhibited some degree of alveoclasia. Of the 132 skulls examined by Shaw, only 9 (6.8 per cent) had marked alveoclasia. The incidence of marked alveoclasia could not be determined in my series since many skulls had numerous missing teeth, which could have been caused by pathology and were consequently not included in the sample. Shaw did not distinguish between generalized or localized alveoclasia. In many instances the roots of individual teeth, particularly the palatal roots of the maxillary molars, were exposed. This condition may have been the result of a localized paradontal pocket.

According to Shaw, the percentage of alveoclasia is so high as to raise doubt whether in some cases the alveolar process may have been regarded as pathological when such was not actually the case. In the present study, there were instances of severe alveoclasia in various parts of the arch, but not necessarily in the crowded section of the arch. The area most frequently involved was around the molar teeth. In Shaw's series, too, the lower anterior teeth were least frequently involved. Yet the survey reveals that it is in the latter region that most of the crowding is evidenced. Hence, this study does not support the accepted view that periodontal involvement is associated with crowded teeth.

Since no comparative data are available, it is difficult to ascertain whether, with the advance of civilization, crowding is more prevalent in modern Bantu than in their ancestors. The change of diet from earlier, coarse, fibrous and gritty foods to one in which the food is soft, refined and well prepared, might suggest that an increase in the incidence of crowding in modern Bantu is a possibility. The former diet could conceivably have had the effect of abrading the teeth interproximally and occlusally. Interproximal attrition would tend to reduce the mesiodistal diameters of the teeth, thereby enabling them to be readily accommodated in the dental arch. Occlusal attrition eliminates the milder forms of malocclusion by wearing away so much of the interfering tooth cusps that the flat tooth surfaces then left do not restrict mandibular masticatory excursions. The relatively mild incidence of malocclusion in modern Bantu suggests, therefore, that it could be partly owing to their softer present-day diet. Unfortunately no series of earlier Bantu ~~and~~ on the rougher diet is available to verify this suggestion.

C. SPACING AND MID-DIASTEMATA

Jones (1916) earlier commented that Man is the only living primate whose teeth are arranged in a continuous series, and it is one of his distinctions that there are no gaps between them. Nevertheless, numerous instances of spaced teeth occur in human dentitions. The appearance of spacing can be either generalized or localized.

Generalized Spacing

When the sum of the mesiodistal diameters of the teeth is too small in relation to the alveolar arch, gaps or diastemata will occur. According to Brash (1926), spacing in the anterior region of the jaw takes place because of the deposition of bone in the outer alveolar plate. The erupting permanent incisor teeth then move out labially through the newly formed bone and increase the length and width of the anterior part of the palate.

Brash, McKeag and Scott (1956) stated that spacing of the teeth is not generally considered a normal feature of the adult human dentition. They contended that the teeth of modern man are nearer to the fossil model than their jaws; and therefore in the transition between fossil and modern man, the bony structures were more reduced in size than were the teeth. Rather than spacing, this would in effect tend to produce crowding.

Diminished use, according to Oppenheimer (1964), reduces the growth of the jaws. Animal experimentation by Thoma (1938), Washburn (1946) and Horowitz and

Shapiro (1951) demonstrated that the jaws, like other bones, grow in response to muscle demand and according to Wolff's law.

*

The period between fossil and modern man, as stated by Brash, McKeag and Scott, is a vague statement [redacted] since [redacted] this period extends from about two million to 5,000 years. Also, their statement that dentition assumed its human characteristic of loss of all spaces before the jaws were hominised implies that the presence of spaces is a non-human characteristic. This is perhaps true only in respect of the pre- and post-canine diastemata (which are not examples of generalized spacing but specific adjustments to one feature, a large canine protruding beyond the occlusal plane of the other teeth).

Van Reenen (1964) did not observe generalized spacing in adult Bushmen. Lysell (1958) in his investigation of mediaeval skulls found spacing in the maxillary arch. He did not state, however, whether the spacing was generalized or localized.

<u>LOCALIZED SPACING</u>

(i) <u>Midline Diastema</u>

Localized spacing commonly occurs in the maxillary midline between the central incisors and is usually referred to as a median diastema. A lateral diastema is usually absent in the Hominidae, except in a few specimens of the fossil hominine, <u>Homo erectus</u> (formerly called <u>Pithecanthropus</u>).

[Omission: Insert at *]

According to Moss (1962), there exists abundant anatomical, anthropological and orthopedic literature to support the statement that the further growth and maintenance of skeletal form is primarily dependent on the functional state of related soft tissues (i.e on the state of the functional matrix). Included among the related soft tissues ...

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According to Moss (1962), there exists abundant anatomical, anthropological and orthopedic literature to support the statement that the further growth and maintenance of skeletal form is primarily dependent on the functional state of related soft tissues (i.e. on the state of the functional matrix). Included among the related soft tissues were the "muscles of mastication" which he claimed are responsible for the maintenance of mandibular contouring in the areas of muscle attachment.

In the newborn, the labial frenum is attached to the crest of the alveolar ridge. With the eruption of teeth and the consequent increase in vertical dimensions of the jaws, the frenum usually migrates gumwards. In some instances, the frenum does not migrate superiorly in the upper jaws; instead it remains **firmly** attached to the intermaxillary suture. This band of non-elastic, unyielding fibres is heavy and may serve as a barrier to mesial migration of the central incisors during eruption, leaving a diastema of variable proportions. According to Tobias (1955) and Graber (1961) these midline diastemata are frequently hereditary. Some observers, according to Graber, consider the spacing itself the hereditary characteristic and the presence of the frenum incidental. They feel that the fibres that attach to the lingual papilla between the incisors remain intact because there has not been any pressure from the central incisors moving towards the midline. The riddle remains: is the diastema present because of the presence of the frenum, or is the frenum there because of the diastema? Tait (1929-30) did not consider that the frenum labii superioris was an etiological factor of midline diastemata. Salzman (1950) quoted Herbst as suggesting that the diastema may be due to hyperplasia of the premaxillary element of the maxilla, or to an increase of space in the alveolar ridge of the anterior portion of the maxilla due to lack of development of the maxillary lateral incisors. The former suggestion is not wholly accepted by Jacobson (1955) who doubts whether man possesses a premaxilla.

(ii) Lateral Diastema (pre- or post-canine diastema)

In the Pongidae the upper canines are almost always separated from the incisors by a well marked diastema (Le Gros Clark 1955). In the Bantu, pre- or post-canine diastemata were occasionally seen, but since these localized spaces did not appear to be particularly significant or characteristic of the race, these observations were not recorded in the study.

PRESENT STUDY

This investigation reveals that spacing between the teeth of the Bantu is either generalized or localized; in either instance the finding was tabulated as 'spaced'. Gaps caused by loss of teeth and consequent drifting of adjoining teeth, by attrition or by severe periodontal conditions, were not included among examples of spacing.

In the male maxillae, 21.5 per cent of crania examined revealed a midline diastema (Tables 7 & 8). The female maxillae evinced a slightly lower frequency of maxillary midline diastemata, viz., 16.7 per cent. In the mandibular arches, the male and female figures for midline diastemata are 7.7 and 4.1 per cent respectively (Table 9).

The frequency of generalized spacing of the teeth is, however, considerably less. The percentage incidence in the maxillary arches is much the same in the male as in the female, viz., 13.3 and 12.7 per cent respectively (Tables 10 & 11). The percentage incidence of generalized spacing is lower in mandibular dentitions, being 7.5 per cent in males and 5.7 per cent in females. The difference may be attributed in part to the relatively small sample, since in only four of the total of 70 female mandibles was spacing noted. The incidence of spacing of maxillary teeth is practically double that of mandibular teeth.

The incidence of maxillary midline diastemata varies in the tribal groups (Tables 7 and 8), e.g., the incidence of diastemata in the Sotho (30%) is practically double that in the Miscellaneous group (14.9%) and in the Natal Nguni (17.1%). In spite of the latter figures, it is felt that further investigations on larger samples are necessary before accepting these tribal differences as significant.

DISCUSSION

In the male maxillae, 21.5 per cent of the total sample revealed a maxillary midline diastema. That is, approximately one fifth (21.5%) of all the Bantu males exhibit a median diastema. It will be recalled that 13.3 per cent of the males examined showed generalized spacing. In a few instances of generalized spacing, for some unknown reason, the maxillary central incisors were juxtaposed. On the other hand, a few dentitions revealed a maxillary midline diastema with crowding in other parts of the arch. Tobias (1957-1958) too, found a number of such cases in his investigations on the living Tonga of Zambia.

The female maxillae evinced a slightly lower frequency of maxillary midline diastemata, viz., 16.7 per cent. It was noted that 12.7 per cent of the sample possessed generalized spacing of teeth. In the mandibular arches the percentage incidence for midline diastemata are 7.7 per cent in males and 4.1 per cent in females. These figures compare closely with the figures of 7.5 and 5.7 per cent which represent the percentage incidence of generalized spacing in male and female mandibles, respectively.

In the female sample of 60 skulls, only 10 (16.7%) evinced maxillary midline diastemata, in which case the different sex incidence of median upper diastemata (males 21.5%, females 16.7%) cannot be regarded as significant. The data were consequently pooled to get a total Bantu figure (54 cases out of 265 = 20.4%) (Table 8).

A survey of the specimens reveals that mandibular midline diastemata are not located as isolated phenomena; they usually tend to be associated with generalized spacing of all the teeth, in contrast with the position in the maxillary dentition. This suggests that the factor or factors making for a mid-upper diastema are different from the factors controlling generalized spacing of the upper teeth.

TABLE 7

THE INCIDENCE OF MID-DIASTEMATA IN THE UPPER AND LOWER DENTAL ARCHES OF VARIOUS SOUTH AFRICAN BANTU GROUPS

	NATAL NGUNI				CAPE NGUNI				SOTHO				MISCELLANEOUS				TOTAL			
	Male		Female		Male		Female		Male		Female		Male		Female		Male		Female	
	Max	Mand	Max	Mand	Max	Mand	Max	Mand	Max	Mand	Max	Mand	Max	Mand	Max	Mand	Max	Mand	Max	Mand
Diastemata Present	10	2	5	1	12	4	0	0	15	8	5	2	7	2	0	0	44	16	10	3
Diastemata Absent	48	68	15	24	39	64	11	14	34	48	20	28	40	48	4	4	161	228	50	70
TOTAL	58	70	20	25	51	68	11	14	49	56	25	30	47	50	4	4	205	244	60	73
Indeterminate	37	25	16	11	47	30	8	5	40	33	19	14	27	24	1	1	151	112	44	31
GRAND TOTAL	95	95	36	36	98	98	19	19	89	89	44	44	74	74	5	5	356	356	104	104

TABLE 8

PERCENTAGE INCIDENCE OF MAXILLARY MIDLINE DIASTEMATA IN BANTU TRIBAL GROUPS

RACIAL GROUP	DIASTEMA PRESENT		TOTAL SAMPLE IN WHICH FEATURE COULD BE DETERMINED		PERCENTAGE INCIDENCE	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
NATAL NGUNI	10	5	58	20	17.1	25
CAPE NGUNI	12	0	51	11	23.5	0
SOTHO	15	5	49	25	30.6	20
MISCELLANEOUS	7	0	47	4	14.9	0
TOTAL	44	10	205	60	21.5	16.7
	54		265		20.4	

TOTAL 9

PERCENTAGE INCIDENCE OF MID-DIASTEMATA IN TOTAL BANTU INTER-TRIBAL SAMPLE

		DIASTEMA PRESENT	TOTAL SAMPLE IN WHICH FEATURE COULD BE DETERMINED	PERCENTAGE INCIDENCE
MALE	MAXILLA	44	205	21.5
	MANDIBLE	18	244	7.7
FEMALE	MAXILLA	10	60	16.7
	MANDIBLE	3	73	4.1

TABLE 10

THE INCIDENCE OF GENERALIZED SPACING IN THE UPPER AND LOWER ARCHES OF VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

	NATAL NGUNI				CAPE NGUNI				SOTHO				MISCELLANEOUS				TOTAL			
	Male		Female		Male		Female		Male		Female		Male		Female		Male		Female	
	Max	Mand	Max	Mand	Max	Mand	Max	Mand	Max	Mand	Max	Mand	Max	Mand	Max	Mand	Max	Mand	Max	Mand
Total Arches	70	71	27	27	74	76	10	11	65	68	23	28	48	50	3	4	257	263	63	70
No. Spaced	5	1	4	1	10	5	0	0	15	10	4	[illegible]	4	4	0	0	34	20	8	4

TABLE 11

PERCENTAGE INCIDENCE OF SPACING IN THE UPPER AND LOWER ARCHES OF TOTAL SOUTH AFRICAN BANTU (INTERTRIBAL) SAMPLE

		TOTAL ARCHES EXAMINED	NO. SPACED	PERCENTAGE SPACED
MALE	MAXILLA	257	34	13.3
	MANDIBLE	265	20	7.5
FEMALE	MAXILLA	63	8	12.7
	MANDIBLE	70	4	5.7

D. ATTRITION

Attrition is the wearing away of tooth substance which takes place during the process of mastication. Marked wear is rarely seen in the teeth of civilized man, but is frequently observed in the teeth of more primitive people (Moses 1946). Attrition may occur on the occlusal surface of teeth or interproximally, but it usually occurs on both. Occlusal attrition may be caused by the rubbing of one tooth surface against another, as well as by the abrasive action of coarse fibrous foods or the presence of grit particles in the diet. Interproximal attrition is caused by the rubbing of adjacent teeth against one another in the slight vertical and lateral movements which occur in the normal course of mastication.

(a) OCCLUSAL ATTRITION

Following eruption, the occlusal and approximal surfaces of most teeth are subject to some degree of attrition. The rates of attrition are variable, not only in different populations, but among individuals of the same group. Several factors have been adduced to account for variations in attrition. These relate mainly to diet, hardness of teeth, chewing pattern and masticatory habits.

1. The influence of diet on attrition

Most workers tend to believe that rapid and excessive wear of teeth in more primitive peoples is a manifestation of food contamination with abrasives such as grit and sand

(Campbell 1925, Drennan 1929, Goldstein 1932, Abrahams 1949, Van Reenen 1964). Pickerill (1912), on the other hand, contended that coarse gritty food is not a sufficient factor to account for all occlusal attrition which occurs in "native" races. He believed that all "native" races are most careful in the preparation of their food, and that the acid juices of fruit and berries are a causative factor producing this condition. Pickerill's suggestion that acid juices cause occlusal attrition is not supported by evidence. Also, his claim "that nearly all 'native' races are most careful in the preparation of their food", is inconclusive. Various living conditions such as sandy terrains, the grinding of corn in hollowed stones, and working over open fires may be responsible for the inevitable inclusion of sand or grit and carbon in much of the food consumed.

2. The influence of the hardness of teeth on attrition:

The rate of attrition is dependant also on the hardness of teeth. Any dentist will verify that teeth vary in hardness among individuals, but this factor is difficult to assess from clinical examination alone. It was formerly thought that the variation in hardness in different specimens of enamel was due to a difference in the proportion of bone salts. McGhee (1944), however, attributed hardness to the amount of interlacing of the enamel rods; the greater the degree of interlacing, the harder the enamel. In very hard varieties, the minute structure presents a gnarled appearance which somewhat simulates a pine knot.

3. The influence of chewing on attrition

Prolonged chewing is another factor that can affect the rate of occlusal attrition. Van Reenen (1964) noticed that hunting-gathering Bushmen use their dentition for longer periods than farm Bushmen. In his several expeditions to the Kalahari, he observed that Bushmen at Takatschwane, for instance, collected various foods, such as gums from trees, which they chewed throughout the duration of a hunt. Vigorous and prolonged mastication rather than the nature of the food is the factor that Davies and Pederson (1955) believed accounts for the heavy attrition in urbanised Greenland natives.

4. The influence of masticatory habits on attrition

Masticatory habits may also affect the rate of attrition. In a study of the attritional values for the Australian Aboriginals at Haast's Bluff, Heithersay (1959, 1960) found that females show a greater degree of attrition than do males. This observation he attributed to the Aboriginal social system in which the male is considered the most important member of the social scale and tends to receive the choice and tender portions of the diet. He added that because of their psychological make-up, the women possibly chewed their food more thoroughly. Among other habits, the Eskimo clenches and probably grinds his teeth while Kayak paddling (Davies and Pederson 1955). The womenfolk on the other hand tend to prepare hides by chewing them and thus wear their teeth. Bushmen, according to Van Reenen (1964), in their nomadic existence, use their teeth to separate and chew fibres needed for making rope and consequently severely abrade their incisor teeth.

Abrahams (1947) noted differences between the attrition caused by the fibrous quality of the diet and that of chewing habits. The degree of wear caused by diet, he contended, is materially less than that caused by chewing habits. Where diet is the cause, there is usually a uniform type of horizontal wear. Where chewing habits are the cause, more complex oblique patterns of wear are fairly frequently seen. The attrition caused by the nervous habit of grinding the teeth, according to the author, usually leads to a uniform type of horizontal wear. The reasons for the greater degree of wear in the habitual chewer are two-fold. The habit involves more prolonged periods of chewing than does a diet of fibrous quality. Both betel-nut and tobacco are responsible for the introduction of slight abrasives into the mouth. In the case of betel-nut, lime is used in conjunction with the nut to bring out its flavour. The lime has a fine consistency, but the author contended that it is nevertheless sufficiently abrasive to cause wear of the teeth. In the case of tobacco, it is impurities of a gritty nature. These contentions were based on a number (unstated) of cases of attrition observed in the various races that inhabit the Cape - Caucasoids, Cape Coloured, Malays, Indians and Bantu. Abrahams observed too that in the case of betel-nut chewers and tobacco chewers it was quite common to find that the cusps had disappeared and dentine had been partly exposed by the age of

30 years. Dentine was completely exposed by the age of 40 years, and [redacted] not infrequently crowns of teeth had completely disappeared in persons of 50 years of age.

In sum, most instances of rapid or excessive attrition it appears can be attributed to the action of [redacted] various abrasives, such as sand, lime or tobacco grit on the teeth. The incorporation of sand or grit in soft foods can render them as abrasive as uncontaminated foods of a coarse fibrous nature. It is not the consistency of the food; rather it is the percentage of sand or grit in the diet that is mainly responsible for the degree of attrition. A number of individual habits, customs or chewing patterns accounts for the great variability in the amount and pattern of wear in dentitions, not only between different population groups but between males and females of the same population group, and among individuals of the same group and sex. Included among these habits or customs are dietary differences from the point of view that certain groups or individuals include more "veldkos" (edible roots) in their diet, which means more sand and grit and consequently a greater amount of attrition.

AGE INTERPRETATION

In assessing the age of an individual from the degree of attrition, Miles (1963) commented on the functional age of a tooth. The first molar erupts and starts its life of function at 6 years, the second molar at 12 years and the third molar at 18 years. In a subject of say 25 years, the first molar will have had a functional age of 19 years, the second a functional age of 13, and the third the functional age of only 7 years. He devised a formula to calculate the approximate age of an individual from the degree of attrition of the teeth. He was careful to add that it was doubtful whether the data and experience gained from the study of contemporary dentitions is applicable to archaeological material, because in general, in earlier times, dentitions were used with much greater vigour and in consequence wear of the teeth was much greater.

DEGREES OF ATTRITION

Various methods have been used to determine the degree of attrition in teeth. Broca (1879) recognized four degrees of attrition. In the first degree the enamel is abraded without obliteration of the cusps or exposure of dentine. The second stage is characterized by the disappearance of enamel and partial exposure of dentine. The third stage is typified by complete dentine exposure, while in the fourth stage, the wear extends to the neck of the tooth. At this stage the crown of the tooth has entirely disappeared.

In comparing the attrition of various age groups of Bushmen, Van Reenen (1964) adapted the classification used by Davies and Pederson (1955), but added a slight modification to include a further stage. He used a value known as the "weighted product of attrition". This value is determined by allocating one unit to every 1+ degree, two units to every 2+ degree and so on. The unit value is multiplied by the percentage value and the "weighted product of attrition" is the sum of all the values for each age group. This method is useful for showing quantitative differences in the severity of attrition of each age group for purposes of comparison in various geographic groups.

The classification of Broca has general acceptance, but one limitation is that it applies to a single tooth at a time. Also, it is difficult to categorize a tooth that exhibits different degrees of wear in different parts of the occlusal surface of the tooth; for example, a molar may evince more wear on the lingual or on the buccal section of the occlusal surfaces.

The difficulty of classifying the whole dentition is that different portions of one dental arch present different stages of wear. In order to overcome this problem a new technique, simpler than that used by Van Reenen, was devised whereby an overall estimate of the degree of attrition for the whole dentition could be readily calculated.

PRESENT STUDY

In the present study a method was devised for scoring the degree of attrition on individual teeth and getting a total or resultant score for the whole dentition. In order to express the overall degree of attrition, an "attritional index" was calculated for every dentition. This was determined by providing a unit value for each premolar and molar examined as follows.

The unit values for individual teeth were based on Broca's classification.

DEGREE OF ATTRITION	UNIT VALUE
No wear	0
Enamel worn without cusp obliteration or exposure of ... dentine	1
Cusps worn down and dentine exposed	2
Appreciable proportion of the crown surface is worn away with complete dentine exposure	3
Most of the crown has disappeared and wear has extended to the neck of the tooth.	4

The degrees of wear are illustrated in figs. 6, 7, 8, 9 and 10.

To calculate the attritional index from the above values, the sum of the unit values in each arch was divided by the number of teeth examined. Dentitions in which more than half the premolars and molars were missing were excluded from the sample. It was felt that a calculated index which involves taking all the premolars and molars into consideration would provide the most accurate expression of the overall degree of attrition in any dentition.

RESULTS

The sample of Bantu dentitions was divided into three age groups: up to 30 years of age, between 31 and 45 years inclusive, and those aged 46 years and older. All

Fig. 6 Ooclusal attrition - no wear
(unit value 0)

Fig. 7 Occlusal attrition. Enamel worn without cusp obliteration or exposure of dentine
(unit value 1)

Fig. 8 Occlusal attrition. Cusps worn down and dentine exposed. (Note dentine exposed on palatal cusp of second premolar and mesio- and disto-palatal and mesio-buccal cusps of first molar). (Unit value 2)

Fig. 9 Occlusal attrition. Appreciable portion of the crown surface is worn away with complete dentine exposure of all premolars and molars on the left side of the upper jaw. (Unit value 3)

Fig. 10 Occlusal attrition. Most of the crown has disappeared and wear has extended to the neck of the tooth.
(Unit value 4)

were adult or sub-adult skulls. Only seven male and three female skulls were below 20 years, the youngest being 16 years of age. From Tables 11 and 12 it is clear that the degree of attrition in the Bantu increases with age in both males and females. This observation agrees with the findings of most observers in their examination of different racial groups (Campbell 1925, Shaw 1931, Lasker 1945, Barret 1953, Begg 1954, Davies and Pederson 1955, Moorrees 1957, Heithersay 1960, Miles 1963, Goose 1963 and Van Reenen 1964).

In males and females under 30 years of age overall attrition was slight, that is, the enamel is worn without cusp obliteration or exposure of dentine. In males dentine was exposed in a few instances as indicated by a mean attritional index of 1.29 (range 0.78 - 2.9). In the middle age range (31 to 45 years), dentine was exposed in approximately 40% of the male and female dentitions examined. The mean attritional index for males in this age group was 1.44, with the range extending from 0.71 to 2.44. For the females it was 1.37 (range 0.78 to 2.20). In the oldest age group, attrition was marked, cusps were worn down and dentine exposed in most instances. The mean attritional indices for the males and females of this group were 1.83 (range 0.87 to 3.00) and 1.65 (range 1.00 to 3.00) respectively.

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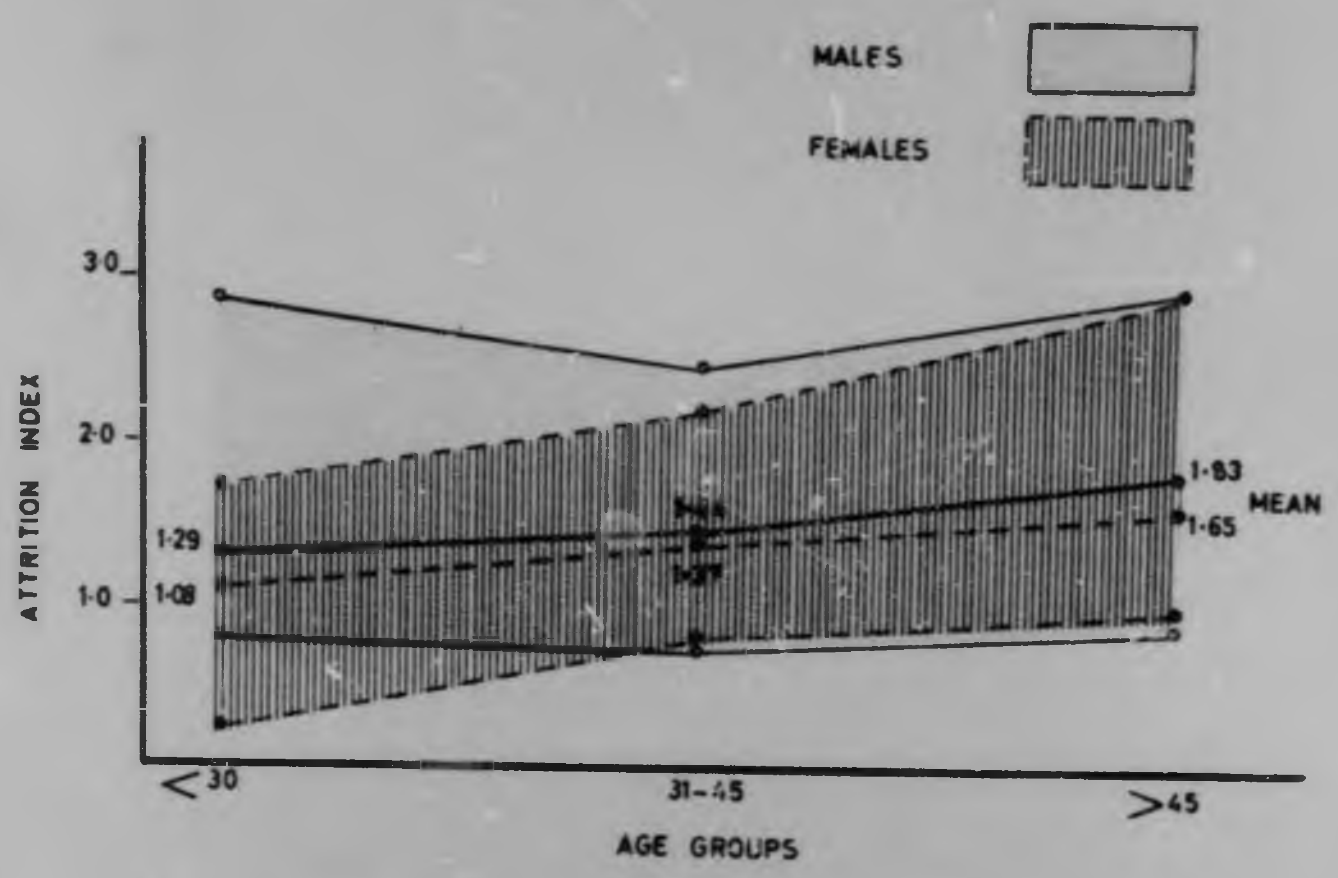

Fig. 11 The mean and range of occlusal attrition indices in males and females of South African Bantu sample

illustrated in Figure 11. The sex difference of the means in the middle age range (31 - 45 years) was smaller. There were no marked differences in means attritional indices among the tribal groups. Most mean indices in the three age groups of the various tribal groups conformed closely to the average for the whole population.

DISCUSSION

With few exceptions, the teeth of the Bantu, in contrast to the teeth of the Australian Aboriginals, exhibit only a moderate degree of wear. There are a number of factors which could account for differences in attrition. However, it is reasonable to infer that the South African Bantu individuals represented had reached a semi-civilized condition of life. Shaw (1931) believed, and the writer concurs, that with the gradual progress of civilization and the consequent alteration of diet, attrition has become less and less in the Bantu, until, in many cases, it has practically disappeared.

In the human denture, the occlusal plane in the buccal segment does not assume an exactly horizontal plane. In addition to the curve of Spee, the occlusal plane slants in an inwards and downwards direction in the lower molars and upwards and outwards in the upper molars. The angle of slant becomes progressively greater from the first to the third molar. This curve, known as Monson's curve, or the curve of George Villain (Fish 1952), has been characterized as the curve of occlusion in which each cusp and incisal edge touches or conforms to a segment of the surface of a sphere whose radius is approximately 4 inches with its centre in the region of the glabella (Boucher et al 1960).

Generally, when the cusps become worn by attrition, the occlusal surface flattens and usually adopts a helicoidal (Ackerman 1943) or horizontal pattern. Campbell adequately described the helicoidal curve which occurs in Australian Aboriginals, -

> "The mesial portion of the flat surface of the first molar is bevelled downwards and outwards, but further distally the surface becomes more into a horizontal plane. In the second molar the worn surface is more or less horizontal, its mesiobuccal corner perhaps being bevelled a little downwards and inwards. In the case of the third molar the bevel of the worn surface takes a direction downwards and inwards, the slant apparently becoming greater towards the disto-lingual corner of the tooth."

He ascribes this type of wear of teeth to the fact that in the region [illegible] first molars, the arch measurement is greater in [illegible]pper jaw than in the lower, and lateral masticatory movements are such that the buccal cusps of lower molars and lingual cusps of upper teeth become worn more readily than the other portions of the teeth.

Robinson (1956), Moses (1946, 1959) and Moorrees (1957) concur. They do not explain, however, why this inverse curve develops in the premolar and not in the last molar region. Van Reenen (1964) suggests a twofold reason:-

1. The mandibular premolars tend to travel more during lateral jaw excursions than the molars;
2. Monson's curve is minimal in the premolar region and most marked in the third molar region.

Thus, he reasons, the prominence of Monson's curve and the slight lateral jaw movement which occurs in the third molar region account for the absence of inverse Monson's curve in this region.

In most instances in the Bantu a horizontal type of attrition was evident. There were dentitions, however, which started horizontally and appeared to be gradually developing into what Shaw (1931) termed a "twisted occlusal plane".

Where there was evidence of crowding or malocclusion in the Bantu, the wearing of teeth assumed a different pattern, in that various individual teeth became particularly worn. This enabled a compensatorily balanced occlusion to be established. In a few instances the wear was mainly confined to one side of the mouth with a consequent oblique pattern of wear of the teeth on that side. In extreme cases of attrition the molar teeth could be occluded only when the mandible adopted bizarre positions. The curves of wear of individual teeth in these instances were sometimes concave and at other times sharply oblique.

The excessive degree of wear seen in isolated Bantu skulls could perhaps be attributed to any one or more of the aforementioned causative factors. Tobacco-chewing is a habit frequently practised among the Bantu and is possibly one of the main causative factors for the isolated instances of marked attrition. In the Bantu, as in most other groups studied, it is the males rather than the females who tend to wear their teeth to a greater degree. The heavier skeletal framework and musculature and consequently more powerful masticatory ability of the males and their proneness to tobacco-chewing are likely factors that could account for this sex discrepancy in attrition.

TABLE 11

MEAN AND RANGE OF INDICES OF OCCLUSAL ATTRITION IN VARIOUS SOUTH AFRICAN TRIBAL GROUPS

SEX	GROUP	AGE GROUPS								
		x - 30 YEARS			31 - 45 YEARS			46+ YEARS		
		MEAN	No.	RANGE	MEAN	NO.	RANGE	MEAN	No.	RANGE
MALES	Natal Nguni	1.29	23	0.74 - 2.90	1.51	34	0.71 - 2.44	1.90	33	1.00 - 3.00
	Cape Nguni	1.28	14	0.78 - 2.41	1.37	30	0.78 - 2.20	1.76	53	0.87 - 3.00
	Sotho	1.29	33	0.78 - 2.76	1.57	25	1.00 - 2.44	1.90	29	1.11 - 3.00
	Miscellaneous	1.30	16	0.90 - 2.40	1.21	13	0.86 - 2.15	1.79	24	1.00 - 3.00
FEMALES	Natal Nguni	1.08	12	0.84 - 1.75	1.35	13	0.95 - 2.20	1.31	7	1.00 - 1.71
	Cape Nguni	1.14	6	0.63 - 1.54	1.28	6	1.00 - 1.95	1.47	5	1.00 - 1.93
	Sotho	1.08	15	0.78 - 1.50	1.46	13	0.78 - 1.89	1.85	12	1.00 - 3.00
	Miscellaneous	0.93	3	0.25 - 1.55	1.11	1	1.11 - 1.11	2.50	1	2.50 - 2.50

TABLE 12

MEAN INDICES AND RANGE OF OCCLUSAL ATTRITION IN TOTAL SOUTH AFRICAN BANTU SAMPLE

SEX	AGE GROUPS								
	x - 30 YEARS			31 YEARS			46+ YEARS		
	MEAN	No.	RANGE	MEAN	NO.	RANGE	MEAN	NO.	RANGE
MALES	1.29	86*	0.78 - 2.90	1.44	102	0.71 - 2.44	1.83	139	0.87 - 3.00
FEMALES	1.08	36*	0.25 - 1.75	1.37	33	0.78 - 2.20	1.65	25	1.00 - 3.00

* 7 Males and 3 Females under age of 20 years.

(b) INTERPROXIMAL ATTRITION

Interproximal attrition or wear is a form of abrasion, consisting of the wearing away of the contact points between teeth as a result of a constant sliding against each other of approximating teeth during the act of mastication. Black (1902) pointed out that under natural conditions there is a wear of the approximal surfaces of all contacting teeth. He concluded that the amount of wear in the entire denture during a lifetime was almost equal to the width of a bicuspid in the vigorous masticator.

Severe interproximal attrition is not very often seen in civilized peoples but is general in the more primitive races. According to Shaw (1931), the teeth of Caucasoids show well-rounded approximal contacts, as opposed to the broad contacts of such races as the Bushmen and Australian Aboriginal. Shaw describes this morphological feature thus:

> "In cross-section an open S is described; the convex aspect of one tooth comes into close contact with the concave aspect of the approximating tooth and the concave area of the former with the convex area of the latter."

According to Shaw, this gave an interlocking effect when viewed from the occlusal surface and was characteristic of the dentition of many mammals. (The cross-section to which Shaw referred, was the view of the dentition from the occlusal surface). This contour is generally attributed to interproximal attrition. This explanation, according to Abrahams (1950), is open to doubt, since he contended that the contour obtains in Tasmanian specimens even where there is no sign of attrition. In addition, he stated that this functional condition would be expected to result in obliteration of contact between the affected units of the arch as it does in present day dentitions, rather than a close interlocking of the approximating teeth. This, according to the author, was actually seen to be the case in Tasmanian specimens in which interproximal attrition was evident. His conclusion was that, since the same approximal contour obtains in the Bushmen and the Australian Aboriginal, and also in many mammals, it seemed possible that the concave-convex surface with broad contacts was at one time usual, and that the well-rounded surface with small contact was a later refinement.

In examining teeth of the Tabor Hill Indians, Eskimo and Australian Aboriginals, Moses (1959) too observed characteristic interproximal wear. He stated that the wear on the interproximal surfaces seemed to produce an interlocking device of such a nature that the teeth almost appeared to be splintered.

Various methods have been applied to determine the amount of interproximal wear in a dentition. Campbell (1925) and Drennan (1929) endeavoured to determine the extent of this attrition by comparing the average length of the molar-premolar group of teeth in situ, where the attrition is easily observable, with the sum of the mean mesio-distal diameters of the individual teeth in the since he contended that the contour obtains in Tasmanian specimens even where there is no sign of attrition. In addition, he stated that this functional condition would be expected to result in obliteration of contact between the affected units of the arch as it does in present day dentitions, rather than a close interlocking of the approximating teeth. This, according to the author, was actually seen to be the case in Tasmanian specimens in which interproximal attrition was evident. His conclusion was that, since the same approximal contour obtains in the Bushmen and the Australian Aboriginal, and also in many mammals, it seemed possible that the concave-convex surface with broad contacts was at one time usual, and that the well-rounded surface with small contact was a later refinement.

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An estimate of the amount of approximal attrition was attempted also by Goose (1963) in a series of Saxon dentitions, in which the attrition did not often penetrate more than halfway into the enamel. It was, therefore, assumed that on average, a quarter of the enamel would be lost. This means that as much as 3.2 mm. of enamel substance might be lost from the premolars and molars combined. No entirely satisfactory method, however, has been evolved which will accurately determine the amount of interproximal wear in a dentition.

Begg (1954) firmly believed that the continuous loss of tooth substance by attrition is a normal functional process. He contended that teeth continually migrate throughout life in two directions, namely, horizontal (mesial migration) and vertical (continual eruption). This migration and eruption of teeth throughout life he regarded as compensating for interproximal and occlusal attrition. The process of tooth eruption he believed to be only a particularization of the much more primitive and general process of continual growth of many epithelial structures (for example, fish scales, skin, the gum surrounding the teeth, hair, finger- and toe-nails) to replace loss from friction and wear.

Weinmann (1947) endeavoured to explain the phenomenon of mesial tooth drift by attributing it to an apposition of bone on the distal wall of the alveolus which in turn produces slight relative mesial movement of the tooth. Moore (1952)[3],on the other hand, believed that the mesial drift tendency of cheek teeth is produced mechanically. The maxillary molar crowns, when viewed from the buccal aspect, present a longer mesial surface than distal surface. This factor, according to Moore, tends to make these teeth stand at a mesial axial inclination in respect to the occlusal plane. The mandibular molar crowns present the same characteristics in that they, too, have a longer mesial surface than distal surface, and hence have a mesial axial inclination to the ooclusal plane. Therefore, when the molars meet in ocolusion, they create a force upon each other, the resultant of which is mesial in direction. This mesial resultant or vector of force is usually referred to as the anterior component of force.

There appears to be general agreement that mesial migration of teeth may be considered as an adaptation to the continual loss of tooth substance at the contact points.

PRESENT STUDY

An examination of the cheek teeth of the maxillary and mandibular arches in the Bantu revealed varying degrees of interproximal attrition. In younger skulls in which occlusal attrition was minimal, the approximal contacts between the molars and premolars were more of a point contact rather than a surface contact. In instances where occlusal attrition was advanced, the approximal contacts between the cheek teeth were flat or in rare instances of the open S variety. In an endeavour to analyse the amount of interproximal wear in the Bantu dentition, varying degrees of attrition were arbitrarily determined and unit values designated, thus :- (See Fig. 12, 13 and 14.)

0 = No interproximal attrition

1 = Mild degree of interproximal attrition and flattoning of approximal surfaces.

2 = Moderate degree of interproximal attrition and flattening of approximal surfaces.

3 = Severe interproximal attrition with considerably flattened approximal surfaces.

4 = Open S interproximal attrition pattern.

This is a scale for any individual dental contact of which, with 5 cheek teeth in each half-jaw, there should be 4 x 4 = 16 contacts. To get an overall picture for a dentition each of the 16 contacts was scored and an average taken to give an index of interproximal attrition. In most instances where all the cheek teeth were present, the amount of interproximal attrition agreed and had the same rating. When cheek teeth were missing, the approximal contacts of the teeth on either side of the missing tooth were not scored because of the likelihood of drift. Dentitions in which a number of teeth were missing were not included in the sample.

Tables 13 and 14 show that the degree of interproximal attrition in both male and female Bantu increases with age. The amount of attrition appears to be slightly

INTERPROXIMAL ATTRITION

Fig. 12 Interproximal attrition - mild

Fig. 13 Interproximal attrition - moderate (P^2/M^1)

INTERPROXIMAL ATTRITION

Fig. 14 Interproximal attrition - severe

less in females of the various age groups. In adult males and females under the age of 30 years, the degree of attrition was generally mild to moderate, the mean values being 1.66 for the males and 1.56 for the females. In the next age group (31 to 45 years), the average figures are slightly higher, viz., 1.84 for males and 1.76 for females. This indicates that the majority of this group have a moderate degree of interproximal attrition. In the oldest age group (45 years and older), almost all the dentitions presented a moderate degree of attrition, giving inter-tribal means of 2.27 and 2.00 for males and females respectively. Noteworthy was the fact that in only one instance was a true open S type of interproximal attrition present in this, or, for that matter, any age group.

The pattern of age changes in the degree of interproximal attrition generally coincided with that in the amount of occlusal attrition, Table 15. This is graphically illustrated in Figure 15. In most instances, interproximal attrition was greatest in dentitions where occlusal wear was marked. However, this was by no means universal, and there were numerous instances in which a considerable degree of occlusal attrition was accompanied by only the mildest degree of interproximal attrition. Conversely, many dentitions showed minimal wearing of cusps, but severe interproximal attrition.

In the under 30 years age group, attrition is much commoner and more marked in the Natal Nguni (both males and females) than in the Cape Nguni, Miscellaneous or well

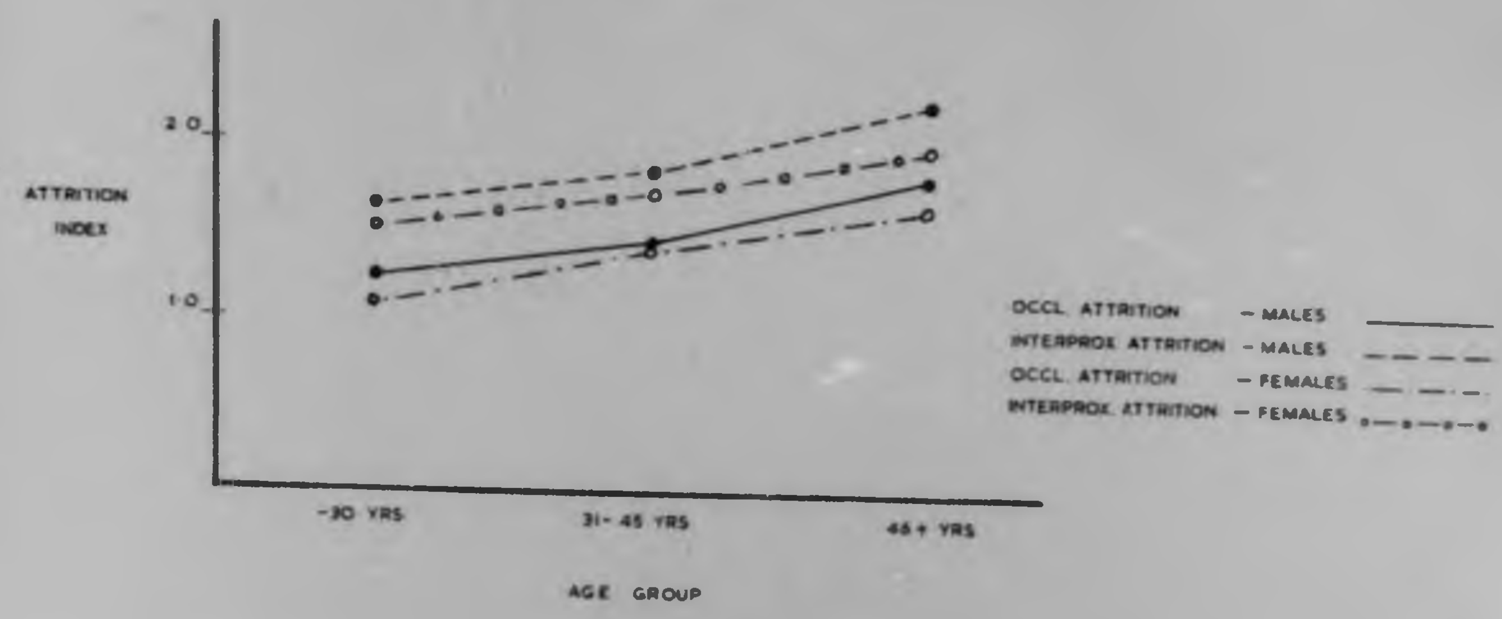

Fig. 15 Diagram to illustrate the correlation between the amount of occlusal attrition with the degree of interproximal attrition

sampled Sotho. The Miscellaneous under 30 year age group for some reason lags far behind other tribal groups in degree of attrition. All the attrition indices for male and female Cape Nguni and Sotho are much alike. In all adequate tribal group samples it would appear that in the older age groups, the degree of interproximal attrition is much the same.

DISCUSSION

No satisfactory method has been evolved which will accurately determine the amount of interproximal wear in a dentition. The method of determining the amount of interproximal attrition used in this study has definite limitations in that the degree of attrition was arbitrarily determined and classified by observation and comparison. However, since the classification was affected by a single observer, the results are sufficiently consistent to provide an overall impression of the degree of attrition in the group of Bantu skulls investigated.

The amount of wear in the Bantu proved to be individually variable. For example, six of the 21 dentitions of Zulu males below the age of thirty years had already progressed to the third stage of interproximal attrition (severe attrition with considerably flattened approximal surfaces), whereas three of the 21 dentitions of Zulu males of 46 years of age and older, possessed only a mild (or Stage 1) degree of approximal attrition. The probable reasons for these frequent variables are numerous, such as individual chewing habits, types of food, grit or sand content in diet, hardness of enamel, etc. - in fact all the factors which contribute to varying degrees of occlusal attrition. The mutual rubbing of adjacent teeth in their lateral and vertical movements, as well as the various fine abrasives frequently found in the diet, such as sand or grit, tobacco grit, lime particles, etc., which become lodged between the approximating surfaces of adjacent teeth and very likely add to the abrasive effects of the two enamel surfaces rubbing against each other, are likely the main factors responsible for interproximal attrition.

Another factor which also probably accounts for the different degrees of this attrition, even within a tribal group whose environmental and dietary habits may be similar, is the varying degree of mesial migration tendency in dentitions. In most dentitions it is this mesial migration tendency which is responsible for the maintenance of close approximal contacts between teeth. Whether this migration is effected by an apposition of bone on the distal alveolar wall or whether it is of a mechanical nature is open to speculation. The writer tends to favour the latter concept, since among the Bantu, as in most other racial groups, there are dentitions (though few) in which all the teeth are spaced. If bone apposition on the distal wall of the alveolus were omnipresent, there should in effect be no dentitions with spaces. In spaced dentitions, it would seem that the anterior component of force and consequently the mesial migration tendency of the teeth are absent. The varying anterior component of force could possibly be attributed to the mesial surfaces (when viewed from the buccal aspect) of the cheek teeth being approximately the same length as the distal surface. This factor would tend to make these teeth stand ve..ically in respect to the occlusal plane. When such teeth meet in function there is no mesial resultant or vector of force. Since adjacent teeth make no contact with each other, there is no evidence of interproximal attrition; that is, teeth retain their rounded approximal contours.

Conversely, there are those cases in the Bantu dentitions in which interproximal .rition is marked. Such instances could possibly be attributed to the marked mesial migration tendency of teeth in those dentitions. Such cases, frequently observed by dentists and orthodontists, are characterized by particularly rapid mesial drifting of teeth into the spaces created by an untimely extraction or loss of a primary molar or permanent tooth. Now it would seem that dentitions in which this mesial migration tendency is greatest would tend to exhibit the greatest amount of interproximal attrition, whereas in those dentitions in which the mesial migration tendency is minimal, the tendency for the teeth to wear interproximally would be less.

The fact that Bantu females generally exhibit less interproximal wear can possibly be attributed to their slighter muscular and bony structure which does not enable them to chew as vigorously as their male counterparts.

This is based on an assumption that muscular and chewing vigour, to a large extent, governs the anterior component of force, which in turn is mainly responsible for the mesial migration tendency and subsequent interproximal attrition. The proneness of Bantu men to chewing tobacco might partly be responsible for this attritional difference.

Unlike the Tasmanians (Abrahams 1950), the Bantu do not exhibit a concave-convex approximal contour of their teeth, even where there is no sign of attrition. The unworn contours between adjacent teeth in the Bantu are convex and with attrition tend to become flattened. The open S type of interproximal attrition commonly seen in the Australian aboriginal and Bushman was observed in only a single instance in the Bantu sample studied. Shaw (1931) noted this feature in four cases out of his sample of 13[illegible] Bantu.

The reason for the more marked attrition in the male and female under 30 years age group in the Natal Nguni is not clearly understood. However, one could speculate that it is in some way related to their robust musculature, which is characteristic particularly of the Zulu (Ritter 1957), and consequently their ability to chew vigorously. Because of the numerous factors which affect the degree and the rate of interproximal attrition, the value of any single observation in a dentition is strictly limited. With the advance of civilization, it is probable that the degree of interproximal and occlusal attrition will diminish since civilized man tends to eat more refined and softer cooked food.

TABLE 13

MEAN INDEX OF INTERPROXIMAL ATTRITION OF SOUTH AFRICAN BANTU TRIBAL AND AGE GROUPS*

SEX	TRIBAL GROUP	AGE GROUPS		
		x-30 YEARS	31-45 YEARS	46+ YEARS
MALES	Natal Nguni	1.91 (23)	1.97 (34)	2.23 (30)
	Cape Nguni	1.58 (12)	1.92 (12)	2.33 (33)
	Sotho	1.61 (33)	1.92 (25)	2.29 (28)
	Miscellaneous	1.47 (15)	1.61 (31)	2.23 (22)
FEMALES	Natal Nguni	1.73 (11)	1.92 (13,	1.36 (7)
	Cape Nguni	1.33 (6)	1.50) (6)	2.20 (5)
	Sotho	1.56 (16)	1.69 (13)	2.00 (10)
	Miscellaneous	1.33 (3)	1.00 (1)	3.00 (2)

*Figures in parentheses refer to number of dentitions studied.

TABLE 14

MEAN INDEX OF INTERPROXIMAL ATTRITION IN THE SOUTH AFRICAN BANTU*

SEX	AGE GROUP		
	x-30 YEARS	31 - 45 YEARS	46+ YEARS
MALES	1.66 (83)	1.84 (102)	2.27 (113)
FEMALES	1.56 (36)	1.76 (33)	2.00 (24)

*Figures in parentheses refer to the number of dentitions studied.

TABLE 15

COMPARATIVE TABLE OF MEAN INDICES OF OCCLUSAL AND INTERPROXIMAL ATTRITION IN THE SOUTH AFRICAN BANTU

AGE GROUPS	MALES		FEMALES	
	OCCLUSAL ATTRITION	INTERPROX. ATTRITION	OCCLUSAL ATTRITION	INTERPROX. ATTRITION
x-30 Years	1.29	1.66	1.08	1.56
30-45 Years	1.44	1.84	1.37	1.76
46+ Years	1.83	2.27	1.65	2.00

E. OVERBITE

It has frequently been recorded that primitive and prehistoric races have possessed what is called an "edge-to-edge" bite (labidodont), while in modern Caucasoids a slight overbite or scissor bite (psalidodont) is more commonly found. This labidodont feature has come to be looked upon as a characteristic of primitive races.

Campbell (1925) stated that the edge-to-edge bite is well known to be typical of the Australian Aboriginal dentition. He mentioned that in any series of Australian skulls which includes sufficient specimens of varying ages, it can be seen that the presence of the edge-to-edge bite is associated with the occlusal wear the teeth have undergone; that is, a diminution in the cusp height of molars and premolars is accompanied by an apparent shifting forward of the lower anterior teeth relative to the upper anterior.

In discussing Stone Age man's dentition, Begg (1954, 1965) noted that when permanent incisors first erupt there is an overbite, just as there is throughout life in civilized man. However, mastication of hard, coarse, gritty food soon causes Stone Age man's permanent incisors to wear incisally, at first at an oblique angle. The plane of wear of the incisal edges, he stated, at first slopes downward and forward. This obliquity is gradually reduced as the lower incisors move labially, relative to the upper incisors. Ultimately, this plane of wear becomes horizontal and in the same straight line as the flat plane of occlusion of the dentition generally.

In his study of Bushmen, Drennan (1929) showed that the bite in most of the "farm Bushmen" is on the whole of an edge-to-edge type. He mentioned that there is a slight tendency towards overlapping, when compared with the more accurate edge-to-edge bite,of the "nomadic Bushmen" but in no case is there anything like the degree of overlapping which is so prevalent in European dentitions. Van Reenen (1964) noticed that the incidence of an edge-to-edge incisor relationship in the Bushman was low in childhood and drops to a minimum in adolescence; it then rises gradually to a maximum in old age. The majority of aged Bushmen, he found, have an edge-to-edge bite. He observed that there is even a tendency for some of the middle and old aged Bushmen to develop a mandibular incisor protrusion, a stage further than an edge-to-edge relationship.

Sim Wallace (1927) stated that in prehistoric times our ancestors had generally an edge-to-edge bite. But they did not have it till adult life and until the wearing of the cusps of the teeth permitted it. He concluded that the overlap of the incisors was normal with Neolithic man, just as it is with primitive man until they wear the cusps of the teeth down. Bonwill (1899), too, noticed this phenomenon. He stated that the amount of overlap of the maxillary incisors decreases progressively with the wear of the teeth and eventually an edge-to-edge relationship between maxillary and mandibular incisors develops. If attrition progresses still further, the mandibular incisors may even protrude beyond the maxillary incisors when the teeth are in occlusion.

While the immediate prerequisite for the forward shift of the mandibular teeth is wear, tooth wear is in turn dependent on sound, well aligned teeth, satisfactory musculature and unhampered movement of the mandible. Moorrees (1957), in his study of the Aleuts, stated that it is therefore not surprising to encounter an edge-to-edge incisor relationship in older Aleuts who possess an excellent alignment of teeth and are relatively free from dental caries or periodontal disease, and who exhibit marked tooth wear. Occasionally a similar picture can be observed in Caucasoids and other racial groups.

A number of authors, such as Talbot (1904), Shaw (1931), Brash, McKeag and Scott (1956) and D'Amico (1960, 1961), have drawn attention to the fact that attrition with an edge-to-edge incisor relationship is found in primitive races and that with civilization and the consequent change of environment and diet, the amount of tooth wear diminishes and the labidodont changes to a psalidodont or overlapping bite. This change seems to have taken place in the Bantu and in many cases there is no evidence of an edge-to-edge incisor relationship.

PRESENT STUDY

To assess the amount of overbite in the dentitions, it was necessary to articulate the jaws. This could be achieved satisfactorily in 140 adult male skulls and in 38 adult female skulls. Any skulls in which the

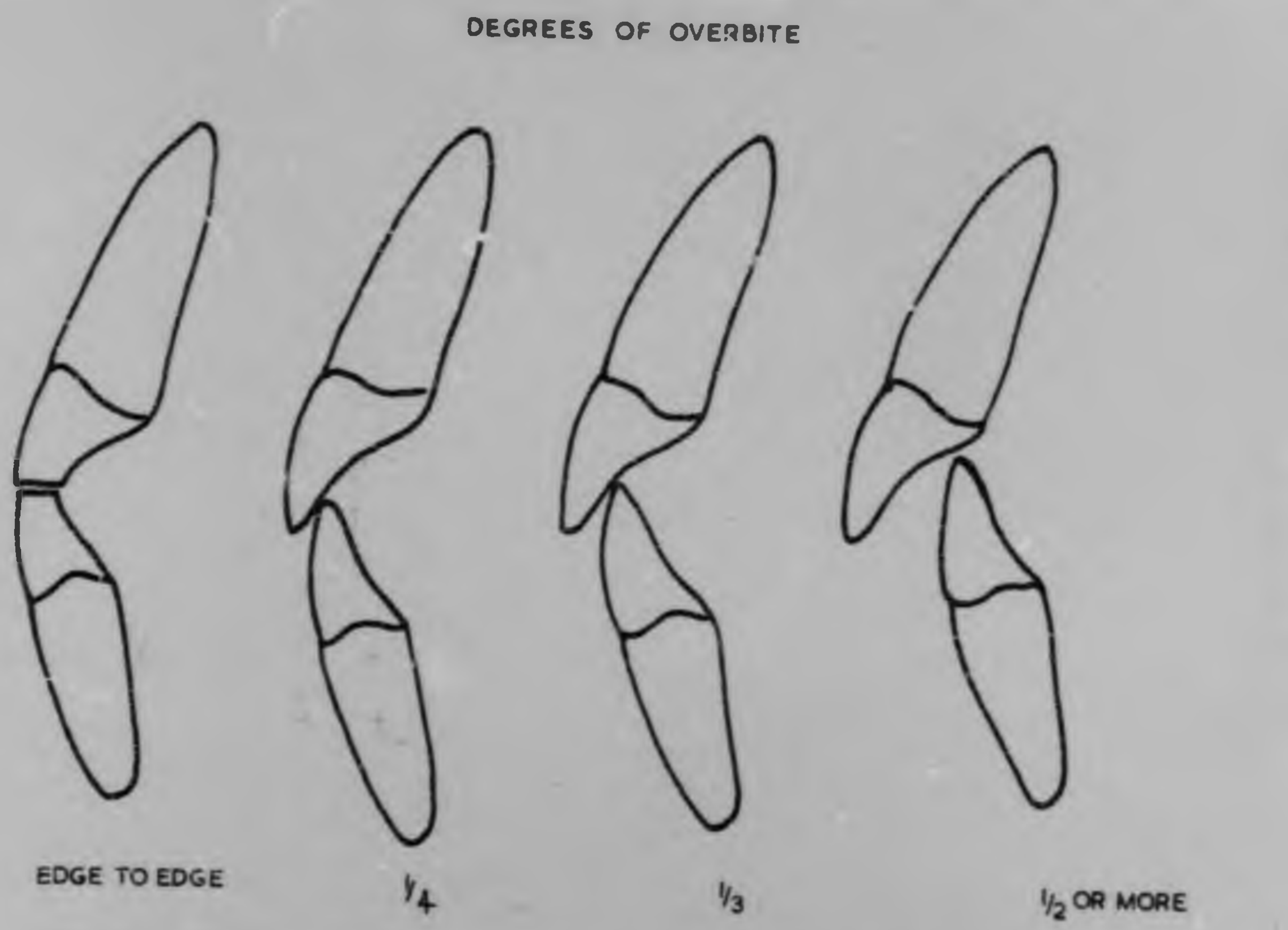

Fig. 16 Degrees of overbite

overbite might have been increased owing to extracted or missing anterior or posterior teeth were excluded from the sample.

The degrees of overbite were determined by observing the amount by which the maxillary incisors overlapped the corresponding mandibular incisors and recording the degree as, edge-to-edge, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, to $\frac{1}{2}$ or more (Figure 16). Definite protruding maxillary or mandibular incisors were classified as being Angle Class 2 or Class 3 respectively. Any open bites were recorded as such. In these instances, with the jaws in a closed position the molar teeth articulate but the incisors and sometimes the cuspids are parted.

In male skulls, 47.1 per cent exhibited an edge-to-edge incisor relationship as opposed to 15.8 per cent of female skulls (Table 1[illegible]). The most frequently observed degree of overlap in the female was one quarter of a tooth overbite; this occurred in 42.1 per cent of the female sample. Paradoxically it was noted that the average age of the 11 female dentitions with a third of a tooth overlap was approximately 38 years, whereas the average of the six females presenting an edge-to-edge bite was 32 years. This anomaly is possibly due to sampling error or to inaccuracy in the determination of the ages. Individual habits or environment are also factors which affect such small numbers.

Four males presented a Class 2 incisor relationship. In spite of the rather excessive attrition in many cases, in only one instance did the mandibular incisors protrude ahead of the maxillary incisors. In almost all instances of severe attrition, the edge-to-edge incisor relationship pertained. One male and one female dentition exhibited anterior open bites of 3/8 and 1/8 of an inch respectively. The number of observations in the various tribal groups (Table 17) was too small to permit one to draw any conclusions.

DISCUSSION

In the Bantu male and female dentitions, only a moderate degree of occlusal attrition is evident, yet 47.1 per cent of the male sample exhibited an edge-to-edge bite. In the middle age range of the females, dentine was exposed on the occlusal surfaces of the molar and premolar teeth in approximately 40 per cent of the sample. (much the same as in the males), yet an edge-to-edge incisor relationship is evident in only 15.8 per cent of the whole female sample. It was previously noted that there is a positive sex difference in the degree of occlusal attrition in the Bantu, the males exhibiting a slightly greater degree of attrition. This difference, however, is not nearly as great as the sexual dimorphism in attrition of the incisor region, or in the relative proportions of labidodontism (males 47.1 per cent, females 15.8 per cent). In the past, it appears to have been assumed that there is a positive correlation between the amount of occlusal attrition in the molars and premolars and the degree of reduction of overbite. The figures on the Bantu do not support this assumption.

In discussing the conditions which produce this changed relationship of the incisors, Campbell (1925) suggested that with the wearing away of the cusps of the posterior teeth, the canine tips and incisal borders of the anterior teeth, the whole lower arch would be free to swing a little anteriorly, and produce an edge-to-edge bite. In an example, he pointed out that the position of the lower first molar relative to its upper homologue was practically unchanged from that of earlier stages. He contended that it had shifted no appreciable distance, if at all, and concluded that the main change had occurred in the anterior region of the arches. Campbell was cautious to add that he was not able to offer any sufficient explanation of the changes.

D'Amico (1961) believed that the edge-to-edge relation of upper and lower anterior teeth could not develop if the teeth of man possessed the compensating factors of crown structure and constant eruption seen in herbivores. The relation of the mandible would remain the same, with constant eruption of the teeth to compensate for wear. The radii from the incisal edges of both upper and lower central incisors in relation to the fulcrum or vertical hinge axis would also remain constant. He concluded, therefore, that the incisal edges of the lower central incisors would continue to describe the same arc as constant eruption compensated for progressive attrition.

It appears that D'Amico deduced this concept from observations on the skulls of prehistoric Californian

Indians who enjoyed an omnivorous diet. He contended that the rapid attrition of the teeth was due to their methods of preparing and cooking their foods. The use of stone and wooden mortars for grinding the food incorporated considerable amounts of abrasive substances. The cooking of meat over open fires allowed dust and carbon in it. These environmental factors he believed were responsible for the rapid attrition of teeth. He observed also that when western Europeans migrated to California, the Indians soon adopted their way of living. By doing so, the Indians eliminated the abrasive agents in their food and reduced the rough texture. This sudden change in culture soon obviated rapid attrition of their teeth and resulted in almost immediate charges in the functional relation of the teeth. D'Amico emphasized the importance of an overlap of the upper incisors and cuspids in individuals. He concluded that if upper cuspids are in "ideal" functional relationship, attrition of the occlusal surfaces of premolars and molars is almost completely eliminated.

Whether attrition should be regarded as normal or pathological in man is a contentious matter. Stallard (1964), Stuart (1964), and Stallard and Stuart (1961, 1963) believed that cusps are essential for a normal functioning dentition and that "worn teeth are in mal-occlusion". "Furthermore, we regard a tooth without cusps as a leg without a foot" (Stuart 1959) Stuart (1963) whose ideas coincide with those of Stallard, talks of a "mutual protection occlusion" which means that the molars and bicuspids when in centrically-related closure protect the incisors and cuspids; in the protrusive position the incisors protect the cuspids and the bicuspids and the molars; and in the lateral position the cuspids protect the incisors and the cusps of the molars and bicuspids. They contended that well defined cusps produce the most effective chewing or shearing mechanism.

These concepts are in direct conflict with those of Begg (1954) who contended that continual loss of tooth substance by attrition is a normal functional process and absence of [illegible] produces abnormalities. In fact, as some writers [illegible] stated, the presence of cusps in the adult huma[illegible]ition is a retention of the juvenile tooth form. U[illegible] D'Amico, Begg believed that teeth continue to erupt vertically in order to compensate for tooth attrition and, unlike Stuart and Stallard, Begg contended that unworn cusps are inefficient food masticators compared with flat-worn occlusal surfaces with dentine exposed and surrounded by a sharp-edged rim of enamel. This sharp enamel edge of the teeth is an efficient shearing instrument for mastication. Begg (1954, p.308) stated

> "As the cusps of the teeth are wearing away and the edge-to-edge incisor bite is becoming established, all of the lower teeth are gradually moving forward relative to the upper teeth so that the molars, premolars and canines eventually assume typical Angle Class 3 occlusal relationships. This attritional occlusion is the only anatomically correct occlusion."

According to Begg, therefore, in contrast with Campbell's view, the change from a psalidodont to a labidodont dentition is due to all the lower teeth moving forward, rather than to a change in the anterior segment only.

The degree and rate of attrition in the Bantu are variable and are in part related to the mode of life. The primitive methods of grinding corn in hollowed out stones and cooking over open fires, thereby permitting grit and carbon to be incorporated in the food, are factors which are partly responsible for an excessive amount of attrition. Excessive attrition with its edge-to-edge incisor relationship may be conditioned by other cultural practices such as the chewing of tobacco or betel-nut. In an endeavour to account for the vastly different sex incidence of edge-to-edge incisor relationships and the moderate occlusal attrition difference between the sexes, the possibility of different individual chewing patterns existing cannot be excluded. Scully (1960) has shown that variation in chewing patterns exist; although he did not specifically note any sex differences in the relative incidence of different patterns. This nevertheless could be a factor responsible for the Bantu females tending to wear their incisor teeth more rapidly than do the males. Another contributory cause could be that there is a subtle but definite dietary difference between males and females in Bantu society; men get the pick of the food, women get the left-overs. Women are the collectors of "veldkos" and probably do more nibbling on the job (Thomson 1954).

Strictly speaking, according to the concepts of Stuart and Stallard, attrition is not normal in modern man, whereas, according to Begg, only those dentitions which evince a considerable degree of attrition and possess an edge-to-edge incisor relationship are acceptable anatomical normals. Both concepts appear to be a little extreme. Modern man with his present day diet is as unlikely to exhibit extreme attrition as he is likely to exhibit absolutely no cuspal wear at all. A mild and variable degree of attrition is usual in man. Moses (1946) pointed out that tooth wear is characteristic not only of man; it may frequently be observed in animals such as the Macfarlane grizzly bear. Bears are classed as belonging to the order Carnivora, but many are omnivorous in habit. Polar bears are almost entirely carnivorous, while the grizzly, big brown and other bears which are land bears, eat about as much vegetable food (roots, fruit, berries) as animal foods. Moses showed that the Polar bear exhibited no tooth wear as compared to the considerable attrition observable in the Macfarlane bear. It would mean, therefore, that either wear or lack of wear could be usual for man or animals in a particular environment, the nature of the food and habits being important factors. The degree of wear is variable.

To the writer's knowledge, there is no conclusive evidence which clearly demonstrates the change in man from psalidodont to labidodont bite. D'Amico's theory would appear to be correct if the rate of attrition exceeded that of eruption. D'Amico, however, does not accept the theory of constant eruption. Murphy (1959), on the other hand, was able to demonstrate that teeth do erupt to compensate for tooth attrition, unless, of course, the rate of attrition exceeds the rate of eruption, in which case the vertical dimension of the jaw is reduced. No investigations evidently have been undertaken which relate chewing patterns to the rate of attrition on specific parts of the dental arch, for instance, do incisor teeth wear more rapidly in some individuals because of a specific chewing pattern? Clearly some other factor th the degree of attrition alone must be operating to influence the development of labidodontism. It is suggested that different chewing patterns may be one such factor.

TABLE 16

PERCENTAGE INCIDENCE OF THE OCCLUSAL RELATIONSHIPS OF INCISORS IN THE TOTAL BANTU GROUP

	MALE	FEMALE	MALE	FEMALE
	NUMBER		PERCENTAGE INCIDENCE	
Edge-to-Edge	66	6	47.1	15.8
1/4 Overbite	20	16	14.3	42.1
1/3 Overbite	35	11	25.0	28.9
1/2 - 1/2+	13	3	9.3	7.9

(The balance comprises Class 3, Class 2 and anterior open bites, viz., 5 males and 2 females).

TABLE 17

OCCLUSAL RELATIONSHIPS OF INCISORS IN VARIOUS BANTU TRIBAL GROUPS

	NATAL NGUNI		CAPE NGUNI		SOTHO		MISCELLANEOUS		TOTAL	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Edge-to-Edge	14	2	23	0	19	3	10	1	66	6
1/4	7	8	7	2	2	5	4	1	20	16
1/3	12	4	6	1	10	6	7	0	35	11
1/2 - 1/2+	3	0	5	0	3	2	2	1	13	3
Angle Class 3	0	0	0	0	0	0	1	0	1	0
Angle Class 2	1	0	1	0	1	1	1	0	4	1
Open-bite	1	1	0	0	0	0	0	0	1	1
TOTAL OBSERVED	38	15	42	3	35	17	25	3	140	38
Unable to determine.	57	21	56	16	54	27	49	2	216	66
TOTAL.	95	36	98	19	89	44	74	5	356	104

SUMMARY

1. THE OCCLUSION OF THE TEETH

Angle's classification of occlusion was used in recording the various tooth relationships to each other in the Bantu.

The incidence of neutro-occlusions in the Bantu is particularly high, viz., 96.4% and 97.4% in the males and females respectively.

Disto-occlusions were noted in a little over 2.5% of male and female skulls and only a single Class III occlusion was noted in an adult male skull.

The findings and reports on the coincidence of malocclusions in various population groups vary considerably among investigators. From the reports, however, it can be gleaned that the incidence of Class II and Class III occlusions in the Bantu are among the lowest of the populations studied.

2. CROWDING

Various degrees of crowding were determined individually for upper and lower arches.

Approximately three-quarters of all Bantu males and females are readily able to accommodate their teeth with no evidence of spacing. The incidence is slightly less in mandibular arches.

The incidence of crowding or overlapping teeth in male and female maxillae is a little over 10% whereas of mandibular teeth about a quarter of the sample in both sexes exhibits crowding.

The incidence of marked crowding of maxillary teeth is low, i.e. 6.66 per cent. The females evince no markedly crowded upper arches.

The incidence of moderate crowding of maxillary teeth in females on the other hand, is more than double the frequency found in males.

In lower dental arches, the incidence of marked and moderate crowding is higher in females than in males.

Male maxillae and mandibles have a greater incidence of milder crowding in both jaws than those of females. Generally, the teeth in Bantu females are more crowded than those of males.

No characteristic tribal differences in degree of crowding could be determined.

3. SPACING AND MID-DIASTEMA

Spacing of teeth in humans is either localized or generalized. The localized spacing in the present study is confined to midline diastemata.

One-fifth of all Bantu males evinced a maxillary midline diastema. In females, one-sixth possessed maxillary midline diastemata. In the pooled sample (male and female), the overall incidence of median upper diastemata was astonishingly high.

Approximately one-eighth of the dentitions in either males or females evinced generalized spacing.

In mandibular arches, the incidence of generalized spacing is about half that in the upper arches, viz. 7.5 per cent in males and 5.7 per cent in females.

The tribal differences in incidence of midline diastemata and generalized spacing could not be regarded as characteristic owing to insufficient samples.

4. ATTRITION

A. Occlusal attrition

The various factors responsible for the different degrees of occlusal attrition are discussed in detail.

In the present study a method is devised for assessing the degrees of attrition on individual teeth and obtaining a total or resultant score for the whole dentition. The overall degree of attrition is expressed as an index.

The sample is divided into three age categories, namely, up to 30 years of age, between 31 and 45 years inclusive, and those aged 46 years and older.

In the youngest age group, the overall attrition is slight. In the middle age range, dentine is exposed in about 40% of male and female dentitions examined, and in the oldest age group, the attrition is marked.

The degree of attrition increases with age in both sexes; this finding is ain accord with the observations of most observers.

There is a sex difference, the degree of attrition in males being greater than in females.

No tribal differences in attritional indices are adduced.

The Bantu as a population group, in contrast to the Australian Aboriginals, exhibit only a moderate degree of wear. This factor is probably the result of an altered diet with the progress of civilization.

Various types of occlusal plane wear are discussed.

B. <u>Interproximal attrition</u>

Interproximal attrition, like occlusal attrition, is more often observed in primitive races. Various explanations accounting for the different degrees and rates of wear in population groups are proffered by various writers.

In the present study, various degrees of attrition are arbitrarily determined, unit values assigned [redacted] to individual contacts and an average value calculated for each jaw

The sample is divided into age groups similar to those for occlusal attrition. The degree of attrition in the under 30 age group is mild to moderate, the degree of wear is slightly higher in the 31 to 45 year group, and highest in the 46 years and over age group.

As in the case of occlusal attrition, the degree of wear is generally greater in males than in females, and also tends to increase with age. The degree of interproximal attrition generally coincides with the amount of occlusal attrition; individual variations [redacted] however, frequently occur.

In the tribal subgroups, no characteristic differences in the degree of wear are evident in the various age groups. The only exception, however, is the Natal Nguni, under 30 years of age (males and females), which unaccountably exhibit a greater degree of wear than the remaining tribal groups.

5. OVERBITE

Attrition with an edge-to-edge incisor relationship is commonly found in primitive races. It appears that changed diet, from coarse to more refined and softer foods, has reduced the amount of tooth wear with the consequent change of incisor relationships from edge-to-edge to that of an overlapping bite.

Degrees of overbite are determined from the amount of incisor overlap. Nearly half the male skulls evinced an edge-to-edge incisor relationship, whereas only about 16% of females exhibited this characteristic.

In females, the most frequently observed overlap is that of a quarter of a tooth overbite (42.1%).

About a quarter of males and females possess an overbite of a third of a tooth. Relatively very few Bantu (under 10% in both sexes) have deep overbites of half or more of a tooth.

The assumption that there is a positive correlation between the amount of occlusal attrition in the molars and the degree of reduction of overbite is not supported in this study. Various possible factors responsible for the production of an edge-to-edge incisor relationship are discussed.

CHAPTER 4

MORPHOLOGY OF THE BONY PALATE

A. THE DENTAL ARCH SHAPE

Studies of the palate reveal a diversity of ideas as to what landmarks should be used for measurements of the palate and dental arcade. Measurements are simply means of examining some morphological features more precisely, but they are no substitute for morphological observations. Galloway (1937) and Tobias (1959, 1960) have emphasized that among the most valuable morphological indicators are some which, though apparent to the eye, are not readily amenable to measurement. Non-metrical classifications, according to de Villiers (1964), have the advantage of giving an impression of actual shape of the dental arcade and palate. Metrical classifications, on the other hand, afford a less graphic impression, but are less subjective.

Broca in 1879 described four main types of forms of dental arch shape, namely, elliptical, semi-elliptical, divergent and hyperbolic. Topinard (1894) introduced the terms hyperbolic, parabolic, U-shaped and convergent to describe these four shapes of the dental arch. Duckworth (1904) used a similar classification. According to Dieufale and Tournier (1908 cited by Shaw 1931) there are four main shapes of the palate in man, viz., elliptical, semi-elliptical, divergent and hyperbolic. This is the classification as used by Broca. In a paper relating to arch form, Hrdlička (1916) too mentioned four types of arch shapes. The elliptic arch he regarded as one, the curves of which would, if prolonged backward, form a more or less perfect ellipse. The ovoid is a modification of the elliptic. Sometimes the arch will show a beautiful curve in front but the posterior parts, from the first molars backwards, will be parallel; this he called the U-shaped. The next class of arches are those which approach a circular or backwards, will be parallel; this he called the U-shaped frequently very broad and short.

It was formerly held that the size of the teeth was the only factor occasioning the form of the arches. Hellman (1919) did not accept this theory, and advanced the view that form and position of the teeth determined the shape of the dental arch. He pointed out that the different form and position of the teeth in the maxilla and mandible have occasioned, even in the same individual, two differently shaped arches. He supported his argument by showing that the arches of anthropoids may take on any one of six shapes, even though measurements of the teeth reveal too small a variation to account for the diversity.

Form and position of teeth, according to Krogman (1927), are vitally important in differentiating racial types. He contended that the incisors and canines of Caucasoids, lying on a flattened curve, give an open divergent arch. In Negroids, the incisors and canines are spread over a greater area, giving an arch more nearly approaching the U-shape of the anthropoids, whereas those of the Mongoloids are intermediate. Occasionally, he noted, the arch of the Negroids may converge from the second molars backwards as in the letter C. Shaw (1931) in his study of the Bantu used the classification of Broca, Dieufale and Tourniers.

For his study of arch shape in the Aleuts, Moorrees (1957) recognised six different categories which were adapted largely from Hrdlička: hyperbolic, relatively broad; parabolic, resembling half an oval; ovoid, parabolic but converging in the molar segments; trapezoid, flat in the incisor region; omega-shaped, parabolic but constricted in the premolar region; and all forms which cannot be placed in one of the other five categories.

The variability of dental arch form, according to Scott (1957), can be most conveniently described by the use of a catenary chain of constant length, but variable in the distance between its points of suspension. His method was described and illustrated, but no comparative tables using this method were recorded in his article. Table 18 illustrates the terminology used by various authors in the classification of dental arch shapes.

Present Study

For the study of dental arch shape in the Bantu, six different categories were adopted from Topinard (1894), Hrdlička (1916) and Moorrees (1957)(Fig. 17).

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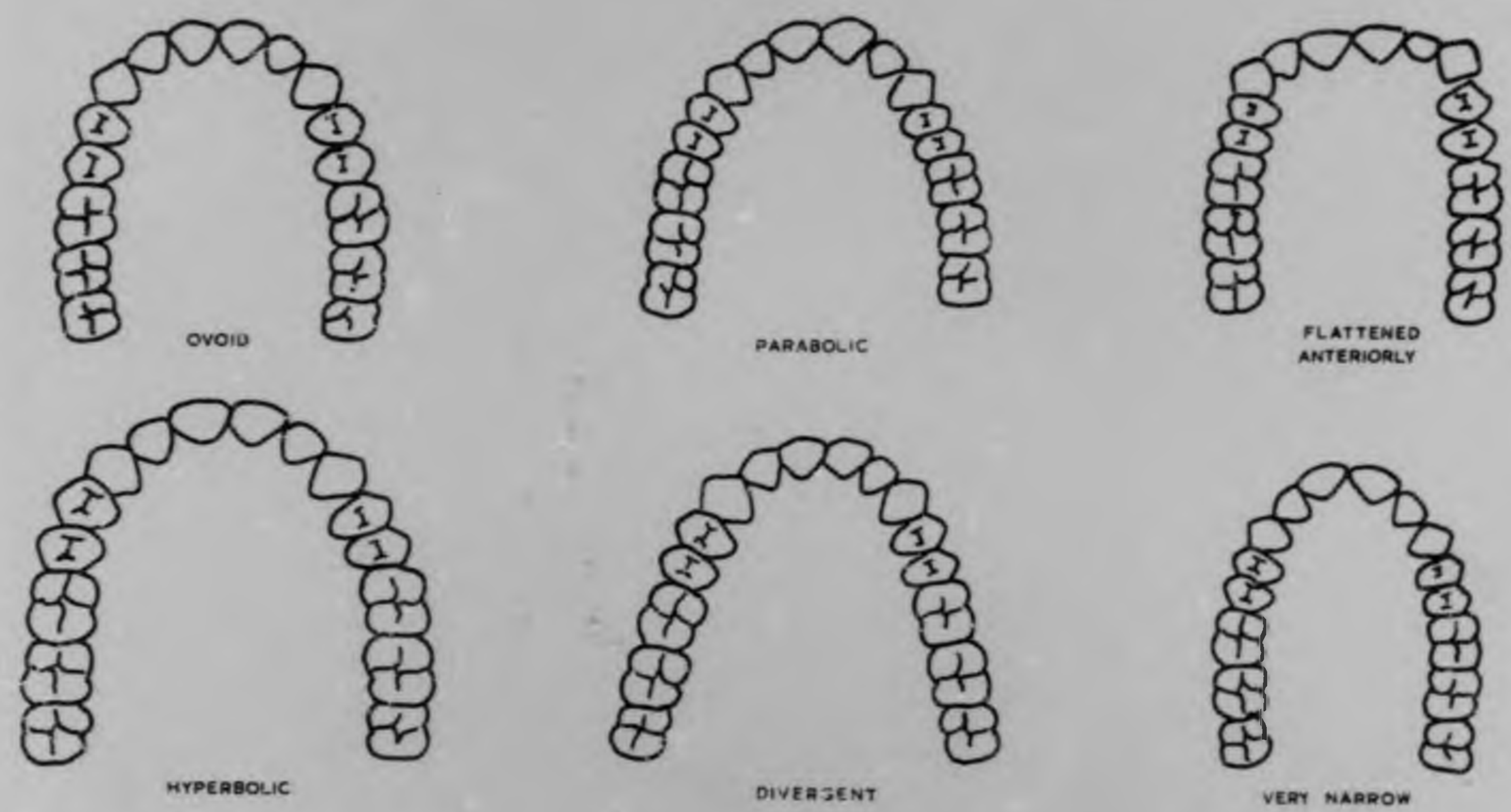

Fig. 17 Dental arch shapes

1. Ovoid - - - resembling half an oval
2. Hyperbolic - a relatively broad arch, the arms of which from M^1 backwards are parallel or very slightly divergent
3. Parabolic - the arms of the arch diverge, but somewhat less than in the hyperbolic type of arch
4. Divergent - when the arms are distinctly diverged
5. Flattened anteriorly - various shaped arches which have a distinct flattened anterior segment
6. Very narrow - particularly narrow arches of various shapes
7. Asymmetric and unclassifiable - All forms which cannot be placed in any of the above categories

A few crania in which many teeth were either missing or lost were not included in the sample. Both maxillary and mandibular arches were classified into the same seven categories.

Of the Bantu crania as a group (Tables 19 and 20) 13.80% of males and 17.31% of females possess an ovoid maxillary arch form. The hyperbolic maxillary arch is the modal form in males (36.05% in contrast with 25.96% in females), whereas in females the modal pattern is the parabolic type of arch form (33.65% in contrast with 28.17% in males). The incidence of divergent maxillary dental arches is much the same in both sexes viz., 14.96% in males and 14.42% in females. Arches which are flattened anteriorly and very narrow arches form a very small percentage of the sample.

In the mandible, the divergent type of arch is the modal pattern in both males (33.43%) and females (38.45%), (Table 20). The next most common arch form is the parabolic, which in males forms 27.25% of the sample and in females 17.31%. The hyperbolic arch is seen in 19.13% and 13.46% of males and females respectively. The least frequent type of dental arch is the ovoid, occurring in 7.28% and 11.53% of males and females respectively. There is a considerably higher incidence of anteriorly flattened dental arches in the mandibles than in the maxillae in both sexes, viz., 5.89% and 3.85% in the males and females respectively. This may possibly be related to the higher incidence of dental crowding in the lower jaw observable in both sexes. Crowding is usually manifested in the lower incisor region.

In the tribal sub-groups (Tables 19 and 20), Sotho males have a preponderance of hyperbolic arches in both maxillae and mandibles, viz., 56.18% in the maxilla and 43.82% in the mandible. This group shows no evidence of flattening of the arches anteriorly which suggests that the arches in the males are wide and well developed. On the whole, the dominant types of arch contours in the maxillae in the Sotho are of the hyperbolic and parabolic types.

In the mandible, the Natal Nguni, Cape Nguni and Miscellaneous groups of both sexes possess a relatively large percentage of divergent arches when compared to the Sotho. This observation confirms that the Sotho possess a different type of arch contour from that of the other groups.

Discussion

A considerable amount of confusion exists in the literature regarding the boundaries of the bony palate and the determination of arch form. This confusion was adequately reviewed by Campbell (1925) who referred to the various methods of measuring the palate as a 'veritable pot-pourri of terms and landmarks'. Much of the confusion may be attributed to semantics as well as to the system of classifying arch forms. The terms, hyperbolic, U-shaped elliptical, semi-elliptical, parabolic, etc., appear to have been confused and misinterpreted by various authors. The distinguishing features of the different arch forms were arbitrarily determined by various observers and were not clearly described or defined. Different terms appear to have been used to describe similar arch forms. The following is a table of possibly equivalent terms:

POSSIBLY EQUIVALENT TERMS USED BY VARIOUS AUTHORS TO DESCRIBE ARCH FORMS

1. Ovoid - - semi-elliptical, convergent horseshoe, circular or horseshoe
2. Hyperbolic - U-shaped, hyperbolic U-shaped, divergent U-shaped
3. Parabolic - elliptical, divergent U-shape
4. Divergent - omega-shaped, divergent U-shape
5. Flattened Anteriorly
6. Very narrow
7. Asymmetric and unclassifiable

Shaw (1931), in his classification of dental arcades in the South African Bantu Negro, placed only 18.0% of jaws in the divergent category. According to de Villiers (1964), however, the contour of the dental arcade of the Bantu has most commonly a "divergent-U" shape (73.1% in male crania and 75.3% in female crania). This contour Galloway described as characteristic of the Negro. The "convergent horseshoe-shaped" and "hyperbolic U-shaped" contours, which he found characteristic of the Bush and Boskop physical types respectively, are relatively uncommon in the South African Negro. In de Villiers's series, the former type is present in 14.6% of males and 12.7% of females, and the latter type in 12.3% and 12.0% respectively. In the present study 14.96% of Bantu males and 14.42% of females were placed in the "divergent" category. These figures approximate the findings of Shaw, and at first glance appear to be considerably at variance with those of de Villiers and Galloway (Table 21). However, the "divergent" category used by Shaw and the present author does not correspond to the "divergent-U" category of Galloway and de Villiers. The "divergent-U" would seem to include all jaws which in the present study, show the divergent pattern, most of the hyperbolic (the arms of which are parallel or very slightly divergent) and the parabolic (the arms of which diverge but somewhat less than in the hyperbolic) arches. If all these jaws in the author's series were incorporated into a single divergent U-shaped category, the incidence of divergent-U arches would be 79.18% in males and 74.03% in females: these figures are close to the figures of de Villiers.

The incidence of ovoid arches in the present study was 13.80% in males and 17.31% in females. These figures compare favourably with those for the equivalent arch form viz., convergent horseshoe shaped, for which de Villiers cited frequencies of 14.6% and 12.7% for males and females respectively.

The relatively high incidence of hyperbolic and parabolic dental arch forms in the present study tends to support the observations of Krogman in Negroids. It is difficult to compare the incidence of ovoid, hyperbolic and parabolic arch forms in the present study with the elliptic, semi-elliptic and hyperbolic figures of Shaw, as the latter author did not clearly define his arch shapes. Even with the table of equivalents, the findings in the two studies cannot be reconciled. The subjectiveness of the classificatory system and the possibility of individual variability in the two sample groups are possible factors responsible for the discrepancy in findings. De Villiers commented on the discrepancy between her findings and those of Shaw thus: "The reason for this discrepancy is not apparent, but the extreme subjectiveness of this form of classification is well illustrated". However, the dental arch measurements and indices when coupled with this information, might well prove of value in population studies.

TABLE 18

TERMINOLOGY USED BY VARIOUS AUTHORS IN CLASSIFYING ARCH SHAPES

BROCA (1879)	TOPINARD (1894)	HRDLIČKA (1916)	MOORREES (1957)	DE VILLIEPS (1964)	PRESENT STUDY
Hyperbolic	Hyperbolic	Elliptic	Hyperbolic	Hyperbolic U-shape	Hyperbolic
Elliptical	Parabolic	U-shaped	Parabolic	Convergent U-shape	Parabolic
Semi-Elliptical	U-shaped	Circular	Ovoid	Divergent U-shape	Ovoid
Divergent	Convergent	Ovoid	Trapezoid		Divergent
			Omega-shaped		Flattened anteriorly
			Unplaced		Very Narrow

TABLE 19

MAXILLARY AND MANDIBULAR ARCH FORMS IN VARIOUS SOUTH AFRICAN BANTU GROUPS

	NATAL NGUNI				CAPE NGUNI				SOTHO				MISCELLANEOUS				TOTAL			
	Male		Female		Male		Female		Male		Female		Male		Female		Males		Females	
	Maxilla	Mandible	Maxilla	Mandible	Maxilla	Mandible	Maxilla	Mandible	Maxilla	Mandible	Maxilla	Mandible	Maxilla	Mandible	Maxilla	Mandible	Maxilla	Mandible	Maxilla	Mandible
Ovoid	17	12	9	4	10	1	3	4	15	8	5	4	7	5	1	0	49	26	18	12
Hyperbolic	26	9	6	2	22	6	7	4	50	39	12	7	30	14	2	1	128	68	27	14
Parabolic	26	22	14	4	28	20	4	2	20	33	17	12	26	22	0	0	100	97	35	18
Divergent	18	40	6	23	29	53	2	6	0	5	6	9	6	21	1	2	53	119	15	40
Flat Anterior	1	5	0	1	1	10	0	1	0	0	0	2	0	6	0	0	2	21	0	4
Very Narrow	1	1	0	0	2	1	1	0	2	1	3*	2	1x	0	0	0	5	3	4	2
Asymmetric Unclassifiable	6	6	1	2	6	7	2	2	2	3	1	8	4	6	1	2	18	22	5	14
TOTAL:	95	95	36	36	98	98	19	19	89	89	44	44	74	74	5	5	355	356	104	104

*Gothic arch anteriorly

xOne side collapsed

TABLE [illegible]

PERCENTAGE INCIDENCE OF MAXILLARY ARCH FORMS IN SOUTH AFRICAN BANTU TRIBAL GROUPS

	NATAL NGUNI		CAPE NGUNI		SOTHO		MISCELLANEOUS		TOTAL	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Ovoid	17.89	25.00	10.20	15.79	16.85	11.36	9.46	20.00	13.80	17.31
Hyperbolic	27.37	16.67	22.45	36.84	56.18	27.27	40.54	40.00	36.05	25.96
Parabolic	27.37	38.89	28.57	21.05	22.47	38.64	35.14	0	28.17	33.65
Divergent	18.95	16.67	29.59	10.52	0	13.64	8.11	20.00	14.96	14.42
Flat.Anterior	1.05	0	1 02	0	0	0	0	0	0.56	0
Very Narrow	1.05	0	2.04	5.26	2.25	6.82	1.35	0	1.40	3.85
Asymmetric Unclassifiable	6.32	2.78	6.12	10.52	2.25	2.27	5.41	20.00	5.07	4.81

PERCENTAGE INCIDENCE OF MANDIBULAR ARCH FORMS IN SOUTH AFRICAN BANTU TRI[illegible]L GROUPS

	NATAL NGUNI		CAPE NGUNI		SOTHO		MISCELLANEOUS		TOTAL	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Ovoid	12.63	11.11	1.02	21.05	8.99	9.09	6.76	0	7.28	11.53
Hyperbolic	9.47	5.56	6.12	21.05	43.82	15.91	18.92	20.00	19.13	13.46
Parabolic	23.16	11.11	20.40	10.52	37.08	27.27	29.73	0	27.25	17.31
Divergent	42.11	63.89	54.08	31.58	5.62	20.45	28.38	40.00	33.43	38.45
Flat.Anterior	5.26	2.78	10.20	5.26	0	4.55	8.11	0	5.89	3.85
Very Narrow	1.05	0	1.02	0	1.12	4.55	0	0	0.84	1.93
Asymmetric Unclassifiable	6.32	5.56	7.14	10.52	3.37	18.18	8.11	40.00	6.18	13.46

TABLE 21

TABLE OF PERCENTAGE INCIDENCE OF MAXILLARY ARCH FORMS IN THE SOUTH AFRICAN BANTU AS DETERMINED BY VARIOUS INVESTIGATORS

SHAW 1931		DE VILLIERS 1964			PRESENT STUDY		
ARCH SHAPE	COMBINED MALES AND FEMALES	ARCH SHAPE	MALES	FEMALES	ARCH SHAPE	MALE	FEMALE
Elliptical	45	Divergent U-shape	73.1	75.3	Ovoid	13.80	17.31
Semi-Elliptical	25	Convergent Horseshoe	14.6	12.7	Hyperbolic	36.05	25.96
Hyperbolic	12	Hyperbolic U-shape	12.3	12.0	Parabolic	28.17	33.65
Divergent	18				Divergent	14.96	14.42

B. SUTURES OF THE HORIZONTAL PALATE

Campbell (1925) and Shaw (1931) recorded the sutures of the palate in the Australian aboriginals and Bantu Negroids respectively. The midline palatal and transverse palatal sutures which are situated between the horizontal portions of the maxillary and palatal bones, are well marked until late in life. In older skulls these sutures, like most cranial sutures, tend to become entirely obliterated.

In some crania the right maxillary plate meets the left palatal plate; in others the left maxilla meets the right palatine, and in the third type the transverse sutures of each side meet in the midline so that the four bony plates meet at a point (Figure 18).

Present Study

Crania with obliterated or doubtful suture lines were automatically excluded from the sample.

The relationship of the palatal sutures was labelled according to the way the horizontal plates of the maxillary and palatal bones met i.e.

R. Max/L.Pal = The right maxilla met the left palatine

L. Max/R.Pal = The left maxilla met the right palatine

Point Junction= The two transverse sutures met in the midline

In Table 22 it may be seen that a little over half (54.2%) the male Bantu crania examined show the transverse palatal sutures to be continuous. In the female the

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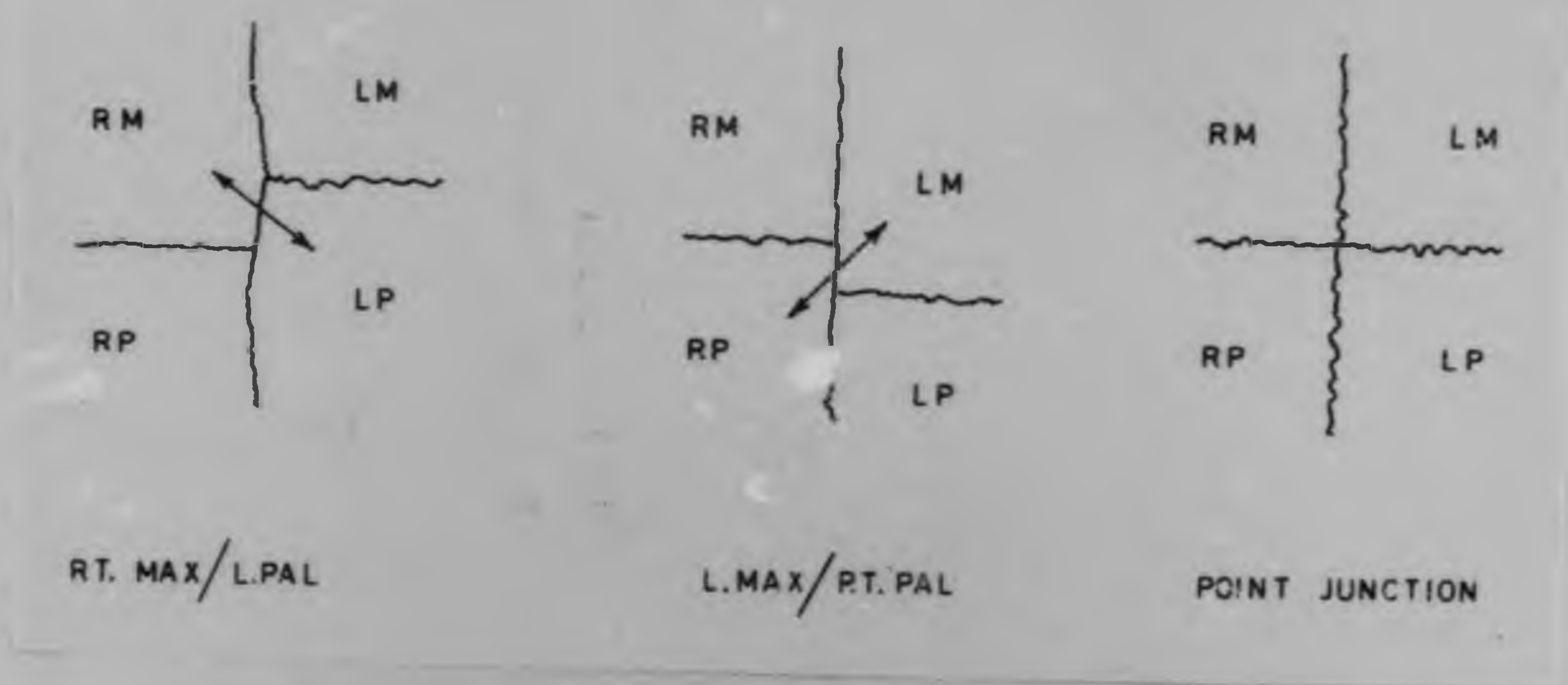

Fig. 18 Schemata of sutures of the horizontal palate

figure is smaller, viz., 37.7%. The percentage incidence of cases in which the right maxilla meets the left palatine portions is 25% and 29.8% in males and females, respectively, while the left maxilla meets the right palatine in 20.8% of males and 32.5% in the females.

In the various tribal groups the percentage of cases in which the transverse sutures were continuous varied from 47.7% to 61.4% in males and from 33.4% to 40.00% in females. The number of cases in which the transverse sutures were not continuous varied in different male and female Bantu tribal groups between 14.0% and 40.0%. (Tables 23 & 24)

Discussion

The tendency of the horizontal palatal sutures to be continuous is higher (54.2%) in males than in females (37.7%) for the various tribal groups and for the total Bantu sample. Asymmetrical patterns are more frequent in females.

The relationships of the palatal sutures in various tribal groups is so varied as to appear completely random. Shaw in his study of the Bantu noted that 63.2% possessed horizontal palatal sutures which were continuous. The present findings are not very different from those of Shaw. The Australian aboriginal, according to Campbell (1925), possess an even lower incidence (23.5%) of palatal sutures that meet in the midline. The suture relationship in the palate seems to be of limited value in anthropological studies.

TABLE 22

PERCENTAGE INCIDENCE OF PATTERNS OF PALATAL SUTURES IN THE SOUTH AFRICAN BANTU

SUTURE RELATIONSHIP	MALES No.	MALES %	FEMALES No.	FEMALES %
R. Max/L. Pal.	69	25	23	29.8
L. Max/R. Pal.	56	20.8	25	32.5
Point Junction	143	54.2	29	37.7
TOTAL	268	100	77	100

TABLE 23

INCIDENCE OF PATTERNS OF PALATAL SUTURES IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

SUTURE RELATIONSHIP	NATAL NGUNI		CAPE NGUNI		SOTHO		MISCELLANEOUS	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
R.Max/L.Pal.	22	5	17	6	16	11	14	1
L.Max/R.Pal.	13	8	16	6	19	9	8	2
Point Junction	41	8	35	6	32	13	35	2
TOTAL DE-TERMINABLE	76	21	68	18	67	33	57	5
Unable to determine	19	15	30	1	22	11	17	0
GRAND TOTAL	95	36	98	19	89	44	74	5

TABLE 24

PERCENTAGE INCIDENCE OF PATTERNS OF PALATAL SUTURES IN VARIOUS SOUTH AFRICAN TRIBAL GROUPS

SUTURE RE-LATIONSHIP	NATAL NGUNI		CAPE NGUNI		SOTHO		MISCELLANEOUS	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
R.Max/L.Pal	29.0	23.8	25.0	33.3	23.9	33.3	24.6	20.0
L.Max/R.Pal.	17.1	38.1	23.5	33.3	28.4	27.3	14.0	40.0
Point Junction	53.9	38.1	51.5	33.3	47.7	39.4	61.4	40.0
TOTAL	100	100	100	100	100	100	100	100

SUMMARY

DENTAL ARCH SHAPE

The confusion in the literature pertaining to the determination of arch form is discussed. A table of possibly equivalent terms used by various authors to describe arch form is provided in an effort to reconcile the findings.

The modal form in the maxillae of Bantu males is the hyperbolic type of arch. In females, the modal pattern in the upper jaw is the parabolic type of arch.

In the mandible, the divergent type of arch is the modal pattern in both males and females. The next most common type of arch in the mandible of both sexes is the parabolic. Also noted was a considerably higher incidence of anteriorly flattened dental arches in the mandible than in maxillae of both sexes. This appears to be related to the higher incidence of lower jaw crowding observable in both sexes.

In most of the tribal sub-groups, the dominant types of arch contours in the maxillae are the hyperbolic and parabolic types. The Sotho males, however, have a preponderance of hyperbolic arches in both maxilla and mandible, with no evidence of flattening of the arches anteriorly. The arches in Sotho males tend to be wide and well developed.

In the mandible, the Natal Nguni, Cape Nguni and Miscellaneous groups possess a relatively large percentage of divergent arches when compared to the Sotho. The mandibular arches in the Sotho, particularly males, are of the broader hyperbolic type.

Observations on Bantu arch form by various observers are reviewed and compared with the findings in the present study. An effort was made to reconcile these observations, many of which at first would appear to be diverse.

SUTURES OF THE HORIZONTAL PALATE

About half of the Bantu males in the study present left and right horizontal palatal sutures which are continuous. The percentage of continuous sutures is lower in females, i.e. asymmetrical patterns are more frequent in females.

Among the tribal groups the pattern of palatal sutures is too varied to yield characteristic inter-group differences.

CHAPTER 5

A. METRICAL OBSERVATIONS ON THE PALATE, DENTAL ARCHES AND JAWS

I.A. MEASURES OF SIZE AND SHAPE OF THE PALATE

(a) Palatal Length, Breadth and Index

(b) Palatal Height

B. MEASURES OF SIZE AND SHAPE OF THE DENTAL ARCHES

(a) Biometric Method

(b) Anthropometric Method

(c) Odontometric Method

C. BICUSPID WIDTH

D. RELATIONSHIP BETWEEN DENTAL ARCH MEASUREMENTS AND FACIAL MEASUREMENTS

E. PROGNATHISM

SUMMARY

A. METRICAL OBSERVATIONS ON THE PALATE, DENTAL ARCHES AND JAWS

One of the problems of measuring the palate is the determination of its boundaries. In this respect there has been a decided lack of uniformity of opinion. Flower (1879) suggested measuring the external dimensions of the arch. He advocated taking the length of the arch from the alveolar point in front to the middle of a line drawn across the hinder border of the maxillary bones (the maxillary 'tuberosities'). He suggested that the width is best taken between the outer borders of the alveolar arch immediately above the middle of the second molar teeth. These he called the maxillary length and width.

At the International Congress at Monaco in 1906, the palatal measurements were given as follows: length, from the midpoint of a line tangential to the posterior margins o[illegible] entral incisors to the midpoint of a line ta[illegible] to the curves of the posterior palatine notches, [illegible]h, between the midpoints of the second molar teeth.

Anthropologists for the most part have based their measurements on the methods used by Martin (1928). The breadth of the arch is measured by taking the greatest distance between the buccal surfaces of the second molars, and the length is the measured distance between the tangent to the labial surfaces of the central incisors and a plane tangent to the distal surfaces of the second molars, perpendicular to the occlusal plane.

Odontologists on the other hand, have tended to select points of reference in the two dental arches, in such a manner that these points of reference approximate when the teeth are in occlusal contact.

Campbell (1925) reviewed the literature pertaining to the various methods of measuring the palate and concluded that there was no reason why the landmarks should differ from those set out by Flower. Shaw (1931), too, used this method in his measurements of the palates of the Bantu. It is evident that Campbell was in error when he applied the term "palate" to what Flower had defined as "maxillary" measurements; thus Campbell confused the two concepts by confusing the two anatomical entities. Anatomically it is accepted that the palate does not include the alveolar arches; unfortunately, Shaw perpetuated Campbell's error, and Robinson (1956) was similarly misled.

Most biometricians differentiate between maxillo-alveolar and palatal dimensions. This procedure has been adopted by such writers as Martin (1928), Buxton and Morant (1933), Galloway (1941), de Villiers (1964) and Tobias (1967) and has been applied in the present study.

A. MEASURES OF SIZE AND SHAPE OF PALATE

I.A. (a) Palatal Length, Breadth and Index

The palatal diameters and indices are well known measurements; these were determined according to the technique of Martin (1928). The length of the palate is the measured distance between orale and staphylion. Orale is the median point in a line tangent to the posterior surface of the median incisor sockets. Staphylion is the median point on a line tangent to the notches in the posterior border of the hard or bony palate.

The palatal breadth is the measured distance between the two endomolaria, viz. the distance between the inner aspects of the alveolar margin opposite the middle of M^2 (fig. 19). These distances were measured to the nearest 0.5 mm with a Boley gauge, the points of which were sharpened. A palatal index was computed from these measurements. This index expresses the breadth of the palate as a percentage of its length.

PRESENT STUDY

The Bantu males have mean palatal dimensions which are significantly larger (at the level of 5 per cent) than those of the females; the mean palatal lengths in males and females are 46.99 mm and 45.30 mm respectively, a difference which is significant with a "t" value of 4.79 (Table 25). The mean palatal breadths of males and females are 40.08 mm and 38.33 mm respectively, the males possessing significantly broader palates (t = 5.34).

The mean palatal index for males is 85.48, which therefore places them at the low end of the brachystaphyline category (85.0 - x). The mean palatal index for females is slightly smaller than that of males, viz. 84.76; this locates them at the upper end of the

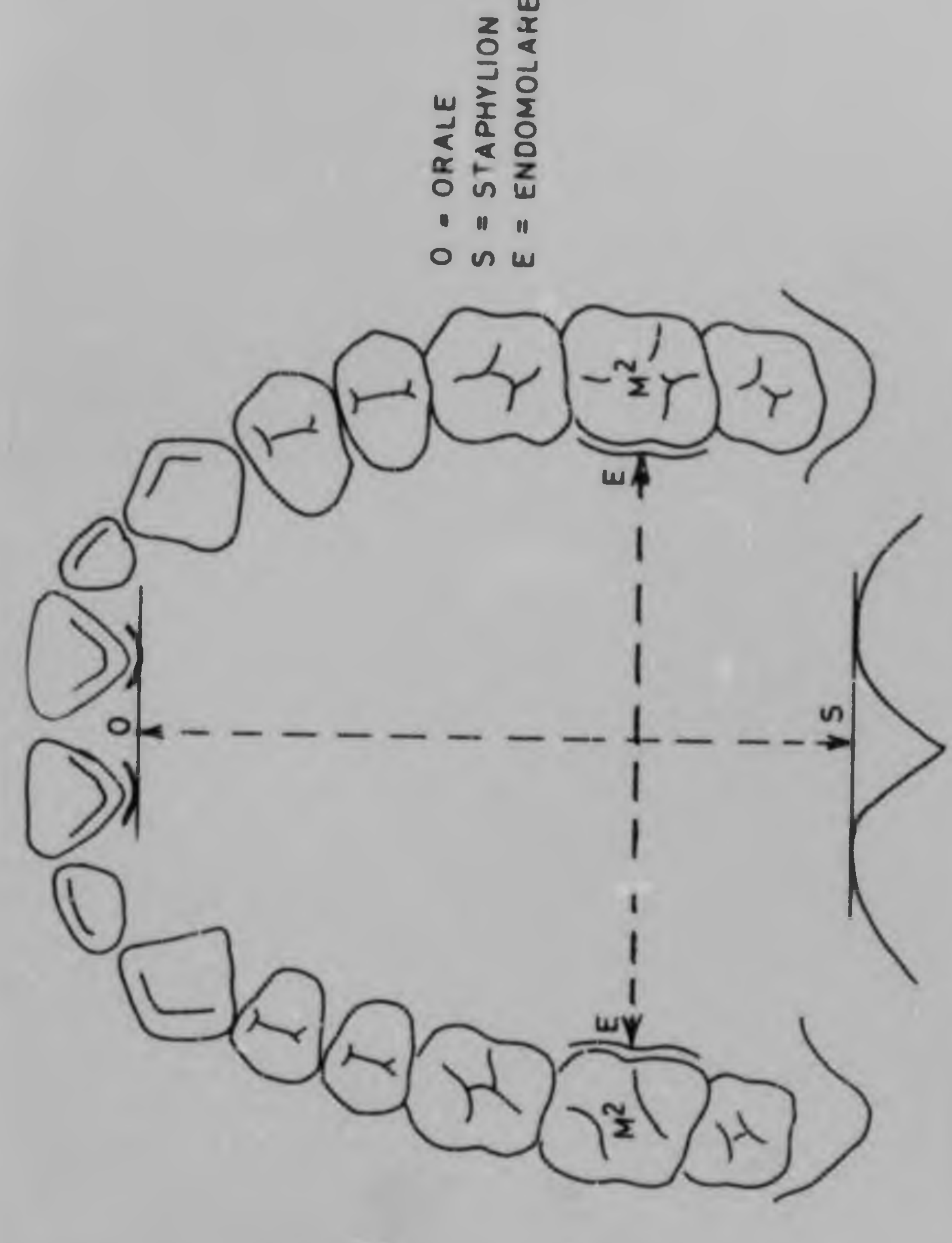

Fig. 19 Termini of palatal length and breadth

mesostaphyline category (80.0 - 84.9). The mean palatal indices do not differ significantly between male and females (t = 1.17). Individual values for this character show a wide range from leptostaphyline (x - 79.9) to brachystaphyline.

In the various Bantu tribal groups, the Cape Nguni and Sotho males have a mean index in the brachystaphyline class, whereas the rest of the male groups are on the average mesostaphyline (Table 28). The Miscellaneous females are located towards the lower end of the mesostaphyline range, whereas the rest of the female tribal groups border on the upper end of the mesostaphyline range.

In order to establish whether the observed differences among the means of the four tribal groups were significant. "t"-tests were calculated. The values of "t" are shown in Table 29 . Where "t" is underlined, it is significant at the 5 per cent level.

There is no significant difference in the mean palatal lengths and breadths among the four groups. There are, however, significant differences in the palatal indices of various Bantu male groups; the Cape Nguni males (87.13) have significantly higher mean indices (i.e. relatively broader palates) than the Natal Nguni males (84.86). The mean palatal index of Cape Nguni males (87.13) is likewise significantly greater than that of the Miscellaneous group (83.64). Finally the

Sotho males (mean index 85.99) have significantly broader palates than the Miscellaneous males (mean index 83.64). The females show no significant intergroup differences in palatal measurements or indices.

Since in the Miscellaneous group 34 of the 71 crania were either Shangaan or Tonga, it was decided to compare this sub-group with the other tribal groups. In view of the much smaller number of Shangaan - Tonga females, an analysis was not made for females separately.

The means, standard deviations, co-efficients of variation, and standard errors of the mean for the Shangaan-Tonga are listed in Table 30.

As before "t" -tests were made to establish whether significant differences existed between Shangaan - Tonga and each of the other tribal groups. The results are given in Table 31. The mean palatal breadth of the Cape Nguni males (40.52) is significantly greater at the 5 per cent level than that of the Shangaan - Tonga.

The results of comparing the mean palatal indices of the various tribal groups are as follows:-

Cape Nguni (87.13) significantly greater than Natal Nguni (84.86)

Natal Nguni (84.86) significantly greater than Shangaan - Tonga (81.60)

Cape Nguni (87.13) significantly greater than Shangaan - Tonga (81.60)

Sotho (85.49) significantly greater than Shangaan - Tonga (81.60).

None of the remaining "t" values is significant at the 5 per cent level. Thus, whereas there are no significant tribal differences among mean lengths and breadths of the Natal Nguni, Cape Nguni, Sotho and Miscellaneous groups, there are [redacted] differences in palatal arch breadth when each of the former three tribal groups is compared with the Shangaan - Tonga. The palatal breadth of the Shangaan-Tonga is smaller than the corresponding dimension of the other tribal groups.* [redacted] ~~A result,~~ The palatal indices are significantly different, though the mean Shangaan-Tonga index still falls into the mesostaphyline category.

DISCUSSION

The mean palatal length of Bantu males is relatively short (46.99 mm), only the unsexed Chinese (44.98 mm), Bush (43.43 mm) and Ovambo (44.63 mm)possessing shorter palates (Table 32). The mean palatal length of Uganda males (47.9 mm) approximates that f the antu. Among females, the Uganda (44.8 mm), Bugoye (45.58 mm) and Mulera (45.5 mm) females possess similar or shorter palates than the Bantu females (45.30 mm). The unsexed Chinese, Bush and Ovambo, too, possess shorter palates.

The Bantu male palate is relatively broad (40.08 mm); the Predynastic Naquada (40.3 mm), Nubian (39.40 mm), Haya (39.4 mm), Bugoye (39.0 mm), Ugandans (39.9 mm), and the unsexed Ovambo (39.63 mm) all possess similarly broad palates. As in the males, the female Bantu palate is relatively broad (38.33 mm) and is exceeded in breadth by only the unsexed Ovambo (39.63 mm) and South East African Negro (38.38 mm). The Haya females (38.0 mm)

* In the case of the Cape Nguni, the difference is significant (2.80).

possess similarly broad palates.

The mean index of Bantu male palates (85.48) falls into the lower end of the brachystaphyline category, whereas that of the females (84.46) is placed in the upper part of the mesostaphyline category (Table 33). In general, the Bantu possess palates which tend to be meso-brachystaphyline. The Ovambo and Bushmen tend to have relatively broader palates.

The palatal measurements on the Bantu by de Villiers (1964) and those of the present study are slightly at variance; the mean palatal lengths of males in the present study are approximately 2.0 mm less than those of de Villiers. The mean palatal breadths in the present study exceed de Villiers's means by 2.0 mm. On the other hand, the mean palatal length of the Bantu as determined by Shaw (1931), was 46.1 mm for both sexes which is similar to the dimensions for males (46.99 mm) and females (45.30 mm) in the present study.

The fact that "t" - tests show no tribal differences in palatal length measurements in the present study coincides with the findings of de Villiers. De Villiers's "t" - test on palatal breadth measurements in the males, however, yield results different from those of the present study. She found a significant difference in this measurement between Shangaan-Tonga on the one hand, and Natal Nguni and Sotho males on the other, and that the difference between Shangaan-Tonga and Cape Nguni was just below the significance level. The present findings are at variance in that the only significant difference in palatal breadth measurements is between Cape Nguni and Shangaan-Tonga males.

The differences in mean palatal index among the tribal groups determined in this study support the findings of de Villiers.

The palatal breadth as determined by Shaw is not explicitly defined. From his diagram, it is difficult to determine whether the width was measured from endomolare to endomolare, or between the lingual surfaces of the M^2's themselves. Accordingly, in the present investigation the shortest distances between the palatal surfaces of the upper second molars were measured as well and the following figures resulted:

SHORTEST DISTANCE BETWEEN THE INNER SURFACES OF THE UPPER SECOND MOLARS IN THE SOUTH AFRICAN BANTU NEGROIDS

	No.	Mean	Range	S.D.	C.V.	S.E.	"t"	Verdict of Significance (5 per cent level)
Male	260	41.60	33.5 - 49.5	2.70	6.5	.17	5.63	Significant
Female	70	39.30	29.0 - 45.0	3.11	7.9	.37		

The mean palatal breadth as determined by Shaw was 38.6 mm for the combined sexes. The mean measurements in the present study are slightly higher than those of Shaw, viz. 38.33 mm in females and 40.08 mm in males.

Since the molars tend to diverge slightly, the mean figures for the shortest distances between the inner surfaces of the upper second molars, are somewhat higher than the palatal width measurements determined from endomolare to endomolare.

The palatal dimensions tend to place the Bantu palates in the meso-brachystaphyline category.

TABLE 25

PALATAL MEASUREMENTS AND INDICES IN THE SOUTH AFRICAN BANTU NEGROIDS

CHARACTER	SEX	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	"t" for male-female differences of means
Palatal Length	Male	330	46.99	38.5 - 58.0	3.06	6.5	0.17	4.79 Significant
	Female	93	45.30	39.5 - 51.5	3.00	6.6	0.31	
Palatal Breadth	Male	319	40.08	31.5 - 47.0	3.22	8.0	0.18	5.34 Significant
	Female	91	38.33	32.0 - 42.5	2.60	6.8	0.27	
Palatal Index	Male	307	85.48	67.5 -109.0	7.01	8.2	0.40	1.17 Not significant
	Female	87	84.46	64.0 100.5	7.21	8.5	0.77	

TABLE 26

PALATAL LENGTH IN VARIOUS SOUTH AFRICAN BANTU TRIPAL GROUPS

POPULATION GROUP	MALES						FEMALES					
	No.	Mean	Range	S.D.	C.V.	S.E.	No.	Mean	Range	S.D.	C.V.	S.E.
Natal Nguni	85	47.29	41.0 - 58.0	2.91	6.2	0.32	33	45.17	40.5 - 48.0	2.85	6.3	0.50
Cape Nguni	92	46.68	38.5 - 55.5	3.05	6.5	0.32	18	45.19	39.5 - 51.5	3.27	7.2	0.77
Sotho	83	46.57	39.0 - 58.0	3.14	6.7	0.34	37	45.46	39.5 - 51.5	3.08	6.8	0.51
Miscellaneous	70	47.52	39.5 - 54.5	3.16	6.6	0.38	5	45.26	43.0 - 48.5	2.16	4.8	0.97
TOTAL	330	46.99	38.5 - 58.0	3.06	6.5	0.17	93	45.30	39.5 - 51.5	3.00	6.6	0.31

TABLE 27

PALATAL BREADTH IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

POPULATION GROUP	MALES						FEMALES					
	No.	Mean	Range	S.D.	C.V.	S.E.	No.	Mean	Range	S.D.	C.V.	S.E.
Natal Nguni	84	39.89	31.5 - 46.5	3.68	9.2	0.40	34	38.45	32.0 - 42.0	2.22	5.8	0.38
Cape Nguni	88	40.52	34.5 - 46.0	2.54	6.3	0.27	17	38.18	32.0 - 42.5	2.84	7.4	0.69
Sotho	76	40.08	32.0 - 47.0	3.26	8.1	0.37	36	38.44	32.0 - 43.5	2.71	7.0	0.45
Miscellaneous	71	39.74	34.5 - 45.5	3.32	8.3	0.39	4	36.88	33.0 - 40.5	3.68	10.0	1.84
TOTAL	319	40.08	31.5 - 47.0	3.22	8.0	0.18	91	38.33	32.0 - 42.5	2.60	6.8	0.27

TABLE 28

PALATAL INDICES IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

POPULATION GROUPS	MALES						FEMALES					
	No.	Mean	Range	S.D.	C.V.	S.E.	No.	Mean	Range	S.D.	C.V.	S.E.
Natal Nguni	80	84.86	69.0 - 109.0	6.81	8.0	0.76	32	84.76	75.5 - 92.0	5.37	6.3	0.95
Cape Nguni	85	87.13	69.0 - 104.5	7.17	8.2	0.78	17	84.91	65.5 - 95.5	6.80	8.0	1.65
Sotho	74	85.99	68.0 - 99.5	6.88	8.0	0.80	34	84.44	64.0 -100.5	9.23	10.9	1.58
Miscellaneous	70	83.64	67.5 - 104.5	7.38	8.8	0.88	4	80.30	74.0 - 85.0	4.93	6.1	2.46
TOTAL	307	85.48	67.5 - 109.0	7.01	8.2	0.40	87	84.46	64.0 -100.5	7.21	8.5	0.77

TABLE 29

RESULTS OF "t")TESTS OF PALATAL MEASUREMENTS AND INDICES IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

PALATAL LENGTHS (ORALE - STAPHYLION)

	MALES				FEMALES			
	Natal Nguni	Cape Nguni	Sotho	Miscellaneous	Natal Nguni	Cape Nguni	Sotho	Miscellaneous
Natal Nguni		1.36	1.55	0.46		0.03	0.41	0.07
Cape Nguni			0.25	1.70			0.29	0.04
Sotho				1.87				0.14
Miscellaneous								

PALATAL BREADTHS (ENDOMOLARE - ENDOMOLARE)

	MALES				FEMALES			
	Natal Nguni	Cape Nguni	Sotho	Miscellaneous	Natal Nguni	Cape Nguni	Sotho	Miscellaneous
Natal Nguni		1.30	0.35	0.27		0.35	0.01	1.26
Cape Nguni			.94	1.63			0.32	0.78
Sotho				.63				1.06
Miscellaneous								

PALATAL INDEX($\frac{\text{Breadth}}{\text{Length}}$ x 100)

	MALES				FEMALES			
	Natal Nguni	Cape Nguni	Sotho	Miscellaneous	Natal Nguni	Cape Nguni	Sotho	Miscellaneous
Natal Nguni		2.09	1.03	1.05		0.08	0.17	1.58
Cape Nguni			1.02	2.97			0.20	1.27
Sotho				1.98				.88
Miscellaneous								

TABLE 30

PALATAL MEASUREMENTS AND INDICES OF SHANGAAN AND TONGA MALES

CHARACTER	NO.	MEAN	S.D.	C.V.	S.E.
Palatal Length	34	47.78	3.08	6.4	0.53
Palatal Breadth	34	38.95	2.86	7.3	0.49
Palatal Index	34	81.60	6.83	8.4	1.17

TABLE 31

"t" - TESTS BETWEEN MEAN PALATAL MEASUREMENTS AND INDICES OF SHANGAAN-TONGA MALES AND THOSE OF OTHER SOUTH AFRICAN BANTU TRIBAL GROUPS

		Natal Nguni	Cape Nguni	Sotho
Shangaan-Tonga	Palatal Length	0.80	1.78	1.93
	Palatal Breadth	1.48	2.80	1.84
	Palatal Index	2.32	3.93	3.09

SERIES	INVESTIGATOR	SEX	PALATAL LENGTH				PALATAL BREADTH				PALATAL INDEX			
			No.	Mean	S.E.	S.D.	No.	Mean	S.E.	S.D.	No.	Mean	S.E.	S.D.
AUSTRALIAN	Galloway 1941	?	104	51.75	0.70	3.60	105	37.69	0.60	3.10	104	67.08	0.74	3.74
CHINESE	Galloway 1941	?	55	44.98	0.74	2.72	55	37.51	0.76	2.82	55	83.62	2.08	7.68
EGYPTIAN														
PREDYNASTIC NAQUADA	Fawcett 1902	Males	75	55.8	0.28	3.62	75	40.3	0.29	3.75	67	71.9	0.61	7.36
EGYPTIAN 'E' 26th - 30th DYNASTY	Pearson & Davin 1924	Males	817	49.7	0.08	3.33	703	38.1	0.07	2.63	668	78.4	0.18	6.79
NUBIAN KERNA	Collett 1933	Males	87	52.0	0.28	3.82	82	39.40	0.22	2.90	67	83.6	0.58	7.04
BUSH	Galloway 1941	?	89	43.43	0.72	3.40	108	37.44	0.60	3.14	89	86.75	1.76	8.28
S.E. AFRICAN NEGRO	Galloway 1941	?	99	49.03	0.88	4.34	101	38.38	0.68	3.43	98	78.61	1.96	9.00
OVAMBO	Galloway 1941	?	16	44.63	2.16	4.30	30	39.63	1.04	2.57	15	88.60	4.38	8.49
GABOON NEGRO	Galloway 1941	?	31	49.81	1.18	3.30	30	36.70	1.20	3.27	28	71.50	2.30	6.06
EASTERN BANTU SPEAKING NEGRO														
HAYA	Czekanowski 1951	Males	59	50.2	0.42	3.20	51	39.4	0.34	2.42	50	78.4	1.06	7.51
		Females	36	48.9	0.49	2.95	32	38.0	0.47	2.68	32	78.0	1.13	6.37
MULERA	Czekanowski 1951	Males	130	48.8	0.31	3.44	147	34.1	0.18	2.19	124	80.3	0.54	6.06
		Females	93	45.5	0.39	3.78	105	33.3	0.17	1.70	88	80.6	0.79	7.0[illegible]
BUGOYE	Czekanowski 1951	Males	168	48.77	0.25	3.18	77	39.0	0.24	3.20	163	80.22	0.58	[illegible].38
		Females	105	45.58	0.33	7.4	107	36.9	0.28	2.8	97	80.45	0.66	8.07
UGANDA	Górnay 1957	Males	69	47.9	0.45	3.75	75	39.9	0.29	2.48	77	84.2	0.76	6.69
		Females	50	44.8	0.40	2.81	54	37.0	0.38	2.80	55	83.4	0.92	6.8[illegible]
SOUTHERN BANTU SPEAKING NEGRO														
SOUTH AFRICAN BANTU	Shaw 1931	Male & Female	?	46.1			?	38.6			456	78.2	0.34	
	de Villiers 1964	Males	491	48.9	0.16		505	38.1	0.14		125	77.3	0.59	
		Females	130	47.0	0.28		135	36.4	0.23					
	Present Study 1967	Males	330	46.99	0.17	3.06	319	40.08	0.18	3.22	307	85.48	0.40	7.01
		Females	93	45.30	0.31	3.00	91	38.33	0.27	2.60	87	84.46	0.77	7.21

TABLE 33

COMPARATIVE TABLE OF MEAN PALATAL INDEX CATEGORIES

LEPTOSTAPHYLINE (x - 79.9)				MESOSTAPHYLINE (80.0 - 84.9)				BRACHYSTAPHYLINE (85.0 - x)			
SERIES	INDEX	SEX	INVESTIGATOR	SERIES	INDEX	SEX	INVESTIGATOR	SERIES	INDEX	SEX	INVESTIGATOR
AUSTRALIAN	67.08	?	Galloway 1941	CHINESE	83.62	?	Galloway 1941	BUSH	86.75	?	Galloway 1941
PREDYNASTIC NAQUADA	71.9	M	Fawcett 1902	NUBIAN	83.6	M	Collett 1933	OVAMBO	88.60	?	Galloway 1941
EGYPTIAN 'E' 26th - 30th DYNASTY	78.4	M	Pearson & Davin 1924	MULERA	80.3	M	Czekanowski 1951	S.A. BANTU	85.48	M	Present Study
S.E. AFRICAN NEGRO	78.61	?	Galloway 1941		80.6	F	" "				
GABOON NEGRO	71.50	?	Galloway 1941	BUGOYE	80.22	M	" "				
HAYA	78.4	M	Czekanowski 1951		80.45		" "				
	78.4	F	" "	UGANDA	84.2	M	Gormay 1957				
S.A. BANTU	78.2	M	de Villiers 1964		83.4	F	" "				
	77.3	F	" " "	S.A. BANTU	84.46	F	Present Study				

(b) Palatal Height

The literature reveals a number of methods of determining palatal height or depth which tend to make comparisons difficult. Keith (1924) defined the palate height as the height to which the midline of the bony palate rises vertically above the plane of the chewing surfaces of the second pair of molar teeth.

Buxton and Morant (1933), Galloway (1941), Trevor (1950, 1959), Sperber (1958) and de Villiers (1964) measured palatal height with a palatometer from the level of a line between the endomolaria in the median plane of the palate. Campbell (1925) used a similar definition, namely, the vertical distance of the horizontal portion of the palate above the level of the alveolar ridges. Klaatsch (1908 cited by Campbell) measured the palate depth at the first molars (whereas endomolare is at the second molar).

Shaw (1931), Abrahams (1945) and van Reenen (1964) followed Keith's method of determinating the palate heights in their investigations. A modification of this method was adopted by Lundström (1948) and Lysell (1958). According to these authors the height of the palatal vault was measured at right angles to the plane of occlusion in the plane through the deepest points in the central fossa of the first molars and the highest point of the vault (usually the midline). Moorrees (1957) determined palatal height by measuring in a median plane, the greatest distance between a line connecting the mesio-lingual cusp tips of the maxillary first molars and the highest point of the palate. In the present investigation, the method used in determining palatal depth or height in the Bantu crania, was based on that of Moorrees. Skulls in which the molar teeth were severely abraded were not included in the sample.

PRESENT STUDY

A three dimensional calipers designed by Korkhaus was used to measure palatal depth. The points of the calipers were placed on the mesio-lingual cusps of the maxillary molars and a rod located midway between these points moved vertically through a hole in the central metal bar enabling the palatal depth to be measured. The height of the palatal vault was measured to the nearest 0.1 mm. The mean palatal heights of Bantu Negroids are listed in Table 34.

TABLE 34

PALATAL HEIGHT MEASUREMENTS OF THE SOUTH AFRICAN BANTU NEGROIDS

SEX	NO.	MEAN	S.E.	S.D.	C.V.	RANGE	Verdict of "t" Significance (5 per cent level)
Males	282	22.06	.17	2.80	12.7	16.0 - 31.0	2.47 Significant
Females	75	21.18	.32	2.74	12.9	15.0 - 27.5	

The "t" test reveals a significant difference in the respective mean palatal heights of the Bantu males and females. The males generally possess a slightly deeper palate.

Table 35 summarizes the means, standard deviations, co-efficients of error, etc. in the various South African Bantu groups. The means of the various groups are very similar.

TABLE 35

PALATAL HEIGHT MEASUREMENTS OF VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

GROUP	MALES					FEMALES				
	No.	Mean	S.D.	C.V.	S.E.	No.	Mean	S.D.	C.V.	S.E.
Natal Nguni	72	21.68	2.93	13.5	.34	20	20.83	2.85	13.7	.53
Cape Nguni	80	22.18	2.60	11.7	.29	14	21.82	2.82	13.0	.76
Sotho	[illegible]4	21.93	2.99	13.6	.35	28	21.36	2.50	11.7	.47
Misc.	[illegible]6	22.54	2.60	11.6	.35	4	20.12	3.35	16.6	1.68

In order to determine whether differences in palatal heights exist between the groups, a one-way analysis of variance was carried out. This was done for males and females separately (Table 36).

TABLE ....

TABLE 36

Summary of results of One-way Analysis of Variance:-

PALATAL HEIGHT MEASUREMENTS OF VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

SEX	Natal Nguni No.	Natal Nguni Mean	Cape Nguni No.	Cape Nguni Mean	Sotho No.	Sotho Mean	Miscellaneous No.	Miscellaneous Mean	F
Male	72	21.68	80	22.18	74	21.93	56	22.54	1.081) Not
Female	29	20.83	14	21.82	28	21.36	4	20.12	1.542) significant

On analysis, the F-ratio was smaller than the critical ratio which indicated that the differences among the means of the tribal groups were not significant. The calculations were determined at the 5 per cent level of significance, at which level the observed F-ratio would exceed the critical ratio in five cases out of a hundred, on average, even though no significant differences were present.

DISCUSSION

It might be argued that it is deemed more desirable to measure palatal height from the deepest point in the central fossa of the molars, rather than from the cusp tips, since the latter wear with attrition. This is not necessarily correct; Murphy (1959) showed that continual tooth eruption compensates for 'normal' attrition. Only in cases of excessive attrition with a consequent decrease in the vertical dimensions of the teeth, would the eruption rate not fully compensate for the degree of wear.

Shaw (1931) using a similar though not identical

TABLE 36

Summary of results of One-way Analysis of Variance:-

PALATAL HEIGHT MEASUREMENTS OF VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

SEX	Natal Nguni No.	Natal Nguni Mean	Cape Nguni No.	Cape Nguni Mean	Sotho No.	Sotho Mean	Miscellaneous No.	Miscellaneous Mean	F
Male	72	21.68	80	22.18	74	21.93	56	22.54	1.081 Not
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On analysis, the F-ratio was smaller than the critical ratio which indicated that the differences among the means of the tribal groups were not significant. The calculations were determined at the 5 per cent level of significance, at which level the observed F-ratio would exceed the critical ratio in five cases out of a hundred, on average, even though no significant differences were present.

DISCUSSION

It might be argued that it is deemed more desirable to measure palatal height from the deepest point in the central fossa of the molars, rather than from the cusp tips, since the latter wear with attrition. This is not necessarily correct; Murphy (1959) showed that continual tooth eruption compensates for 'normal' attrition. Only in cases of excessive attrition with a consequent decrease in the vertical dimensions of the teeth, would the eruption rate not fully compensate for the degree of wear.

Shaw (1931) using a similar though not identical technique records a mean palatal depth of 19.5 mm (combined males and females) in the Bantu. The mean measurements for the Bantu males and females in the present study is 22.06 mm and 21.08 mm respectively. This can be attributed partly to the slightly different method of determining palatal height. Shaw measured palatal height from the 'chewing surfaces of the second pair of molar teeth' whereas the present measurements were made at the level of the first molars.

The Bantu males possess significantly deeper palatal vaults than do females ($t = 2.47$). This is in accord with the findings of de Villiers (1964) who used a different method of measuring palatal depth. In his study of Bantu - speaking Negroes of the Zulu tribe, Sperber (1958) too noted marked sexual dimorphism with regard to palatal depth; the Zulu males possessed deeper palates than the females. The range of individual values in the present study show that both male and female series include deep and shallow palates (males 16.0 mm to 31.0 mm and females 15.0 mm to 27.5 mm).

The t-tests show no significant intergroup differences in either the male or female series. These observations are again in accord with those of de Villiers who noted no significant differences among Natal Nguni, Cape Nguni, Sotho and Shangaan-Tonga.

The palatal height of the average Bushman, according to van Reenen (1964), appeared to be about 2.0 mm less than that of the average Bantu. This did not take into account the thickness of the mucosa. Keith (1924) suggested that 2.0 mm should be allowed for the thickness of the soft tissue in this area. According to van Reenen, if this suggestion were accepted, there would be little difference in mean palatal height between Central Kalahari Bushmen (mean 17.3 mm) and Bantu (mean 19.5 mm). However, van Reenen's comparison was based on Shaw's figures which are at variance with the present study (combined male and female mean 21.88 mm). (Table 37).

By comparing the present findings with all available series where measurements have been based on roughtly comparable techniques (Table 37), it would appear that the Bantu have palates which are deeper than those of Bushmen and Medieval Swedes, and which approximate the palatal depths of Aleuts and Whites. Since measurements on Bushmen, Aleuts, Calvinia and Namaqualand Whites were taken on plaster casts, 2.0 mm was added to each mean measurement to allow for the thickness of soft tissue. According to Sperber (1958), however, such an addition is unjustified, since the figures from Pittard and Trolliet (1932/3) for Bushman skulls compared very favourably with these measurements on Bushman casts. Further, he noted that measurements on Lake Chrissie Bushman casts fell well within the range observed in macerated material.

There appears to be lack of agreement regarding methods of comparing measurements on casts with those on macerated skulls. This factor, in addition to the slightly different techniques of measuring palatal depth make population comparisons difficult: however, Table 37 may serve as a rough guide to variations in palatal depths of various populations.

TABLE 37

COMPARATIVE TABLE OF PALATAL DEPTH MEASUREMENTS BY INVESTIGATORS USING ROUGHLY COMPARABLE TECHNIQUES

Group	Nature of Material	Males	Females	Combined Sex	Investigator
Whites	Skulls			21.6	Keith 1924
(Calvinia and Namaqua-land Whites	Casts			21 + (16 per cent of sample) 19-21 (64 per cent of sample -19 (20 per cent of sample)	Abrahams 1946
(Medieval (Swedes	Casts	19.64	17.41	18.53	Lysell 1958
Aleuts	Casts			18.8	Moorrees 1957
Bushmen	Casts			17.3	Van Reenen 1964
Bantu	Casts			19.5	Shaw 1931
Bantu	Skulls	22.06	21.18	21.88	Present Study

B. MEASURES OF SIZE AND SHAPE OF THE DENTAL ARCHES

(a) Biometric Method

The maxillo-alveolar length, according to biometricians, is measured from prosthion to alveolon. Prosthion is the most anterior point on the process between the sockets of the upper central incisor teeth; alveolon is the point at which the interpalatine suture* meets a line drawn tangential to the posterior border of the maxillary tuberosities.

The maxillo-alveolar breadth is the measured distance between the outer borders of the alveolar socket immediately above the upper second molars (ectomolare to ectomolare) (fig. 20).

In an effort to glean some idea of shape, an index which expresses the width of the maxilla as a percentage of its length was computed. This index is known as the maxillo-alveolar index or Flower's maxillary index.

PRESENT STUDY

It can be seen from Table 38 that Bantu males possess significantly longer and broader maxillo-alveolar arches than do females. Also, the males have a significantly higher mean maxillo-alveolar index, i.e. they possess relatively broader arches than the females.

The means, standard deviations, etc. of the various Bantu tribal groups have likewise been listed (Tables 39, 40 & 41), and 't'-tests were carried out between pairs

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* or median sagittal plane

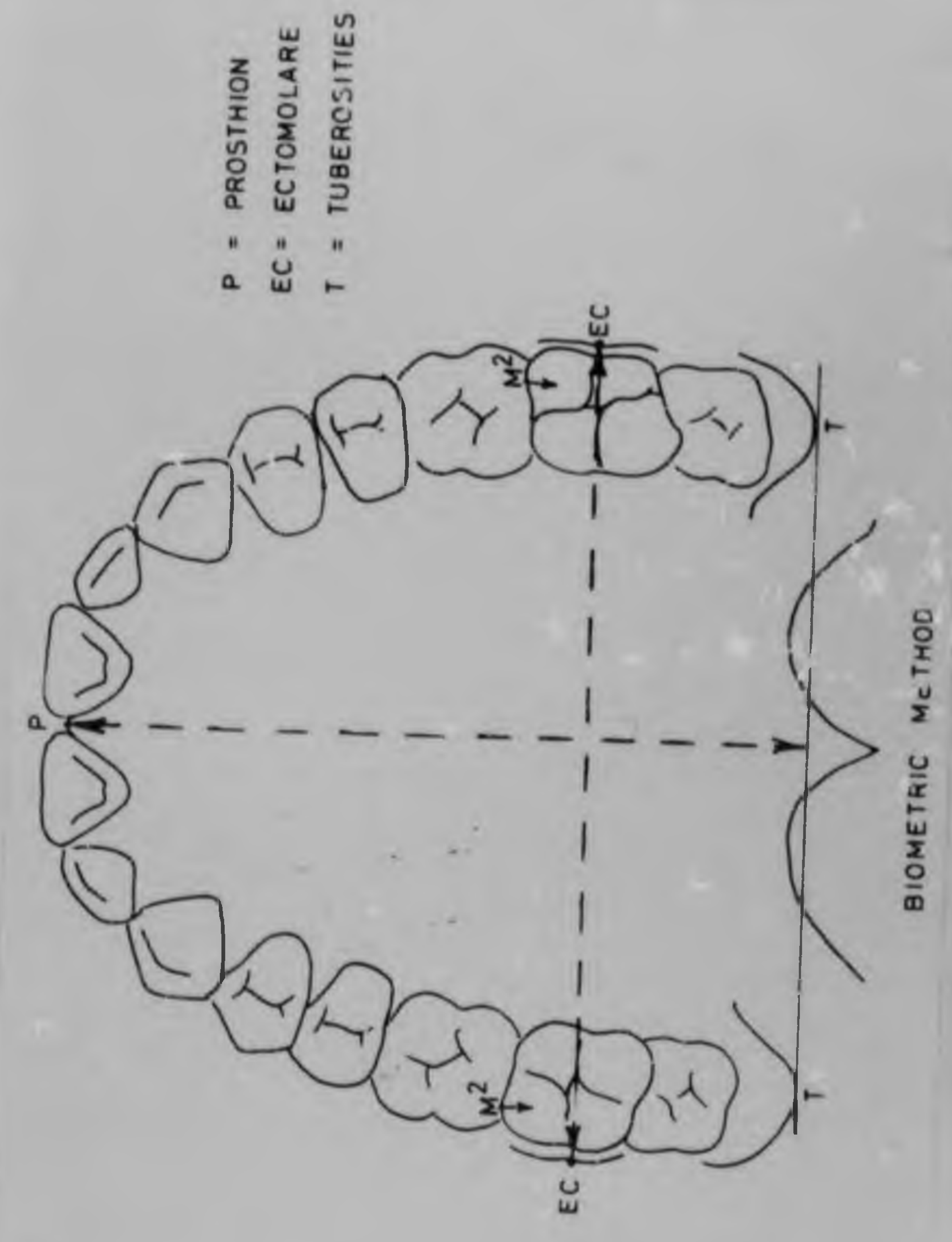

Fig. 20 Termini of dental arch length and breadth (Biometric method)

of group means.

The 't' values indicate that the differences are not significant at the 5 per cent level.

Since a considerable proportion (35 out of 74) of the Miscellaneous males were comprised of Shangaan and Tonga, the data for these two tribes were analysed as a separate Shangaan-Tonga sub-group, and the maxillo-alveolar dimensions compared with those of the Natal Nguni, Cape Nguni and Sotho. The means, and/ other statistical constants [redacted] are listed in Table 42; 't'-tests were run to establish significant tribal [redacted] differences at the 5 per cent level (Table 43). The small sample of Shangaan and Tonga females did not warrant analysing separately.

From the table it will be seen that the differences between the following mean values are significant at the 5 per cent level.

Maxillo-alveolar Length (Males only)

Shangaan and Tonga (56.70) significantly greater than
Natal Nguni - (54.94);

Shangaan and Tonga (56.70) significantly greater than
Cape Nguni - (55.47);

MAXILLO-ALVEOLAR INDEX (Males only)

Natal Nguni (113.08) significantly greater than
Shangaan and Tonga - (108.86);

Cape Nguni (112.73) significantly greater than
Shangaan and Tonga - (108.86);

Sotho (112.78) significantly greater than
Shangaan and Tonga - (108.86);

Turner (1901) classified maxillae according to their maxillo-alveolar indices : below 110 dolichuranic, between

110 and 115 meso-uranic, above 115 brachy-uranic. The mean indices of the various Bantu tribal groups for both sexes fall in the meso-uranic category (Table 44).

The mean maxillo-alveolar index for Bantu females is 110.34 which falls at the low end of the meso-uranic category, just above the limit of the dolichuranic group.

Sotho and Miscellaneous females have the lowest mean indices (108.2 and 109.01 respectively) which fall within the dolichuranic category. The Cape Nguni females (110.06) fall just within the meso-uranic category. The Natal Nguni females are meso-uranic, as are the Natal and Cape Nguni and Sotho males. The Miscellaneous males are dolichuranic (109.93). On analysis, it was found that the Shangaan-Tonga males contribute a large part of the dolichurany with their mean index of 108.86.

DISCUSSION

The maxillo-alveolar lengths in my series of Bantu may be compared with those recorded by de Villiers. The mean maxillary lengths in the present study (55.67 in males and 53.89 in females) closely approximated the figures of de Villiers (55.4 in males, 53.2 in females).

In maxillo-alveolar breadth measurements, however, there was a discrepancy of approximately 2 millimetres: the mean maxillo-alveolar breadths of males and females in the present study were 62.3 mm and 59.3 mm respectively, as compared with 64.0 mm and 61.2 mm for the corresponding mean values in de Villiers's series of males and females. In a discussion on this point with Dr de Villiers, it was agreed that the discrepancy could probably be attributed to a difference in measuring technique. Whereas de Villiers measured maxillo-alveolar breadth from the outer surface of the alveolus opposite the M^2's in the present study the measurements were taken from the buccal surfaces of the alveolar sockets of the M^2's. This difference in method could readily account for a difference of approximately 1 millimeter on either side of the arch.

The difference in arch breadth measurements accounts for differences in the mean maxillo-alveolar indices of males and females; according to de Villiers the mean index for male Bantu (116.1 per cent) lies in the brachyuranic class, whereas the present study places the mean in the meso-uranic class (112.21 per cent). The figure obtained in the present study is close to those obtained by Shaw and Galloway for combined sexes, namely, 110.5 per cent and 112.31 per cent respectively. The mean index for female Bantu, according to de Villiers, is somewhat higher (114.9 per cent) than the corresponding mean in the present study (110.34 per cent). Table 45 is a comparative table of maxillo-alveolar dimensions on the Bantu. However, the only truly valid comparison here is between the data of de Villiers and those of the present study. In view of the established sex differences, Shaw's and Galloway's data will have varied according to the relative proportions of the two sexes, and therefore cannot be compared accurately with the results of de Villiers and of the present investigation.

Having been engaged for some years in the metrical study of South African skulls, Galloway (1941) obtained striking differences in the maxillo-alveolar dimensions of various South African Negro groups. He also noted that these measurements displayed much variability, which threw doubt on the utility of metrical features of this part of the skull as a criterion for racial analysis (op.cit.p.285). In the comparative table (Table 45), Shaw's skeletal material comprised crania from no fewer than 21 different tribes. Galloway's South-East African negroes consisted of 54 Basuto and 48 Zulu skulls while de Villiers (1[illegible]) selected four main tribal groups, viz. Natal Nguni, Cape Nguni, Sotho and Shangaan-Tonga. The present study likewise consisted of four groups, the Miscellaneous group incorporating the Shangaan-Tonga.

Whereas de Villiers found no differences in either the maxillo-alveolar lengths or breadths in the various Bantu tribal groups, the present study reveals significant differences at the 5 per cent level. It appears that the male Shangaan-Tonga have longer arches than either the Natal or Cape Nguni. Also the mean index for this group (108.86) was smaller than for all the other male groups. This means that the mean falls into the dolichuranic category, whereas those of other groups fall in the mesouranic class.

Summing up, de Villiers stated that, brachyurany may be considered as characteristic of the South African Negro. On the other hand, Galloway stated "At all events there is a sharp demarcation between the broad arcades of the Ovambo and Batetela, and the elongate ones of the South-East African and Gaboon Negro". Both Galloway's data, the findings of the present study, and Shaw's mean maxillo-alveolar index of 110.5 per cent contrast sharply with the above statement. The latter three studies all demonstrate that the Bantu possess mean maxillo-alveolar indices which fall in the mesouranic category.

TABLE 30

MAXILLO-ALVEOLAR MEASUREMENTS AND INDICES IN THE SOUTH AFRICAN BANTU NEGROIDS

(AS DETERMINED BY FLOWER'S METHOD)

CHARACTER	SEX	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	"t" for male-female differences of means (5 per cent level)
Maxillo-alveolar length	Male	347	55.67	40.0 - 66.0	2.93	5.3	0.16	
	Female	102	53.89	46.0 - 62.5	3.14	5.8	0.31	5.11 Significant
Maxillo-alveolar breadth	Male	342	62.38	53.5 - 71.0	3.00	4.8	0.16	
	Female	99	59.30	50.0 - 66.0	3.19	5.4	0.32	8.59 Significant
Maxillo-alveolar index	Male	334	112.21	87.5 -142.5	7.02	6.2	0.38	
	Female	95	110.34	92.5 -128.0	6.98	6.3	0.72	2.30 Significant

TABLE 39

MAXILLO-ALVEOLAR ARCH LENGTH IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

POPULATION GROUP	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	92	54.94	40.0 - 62.5	3.48	6.3	0.36	36	53.51	46.0 - 60.0	3.16	5.9	0.53
Cape Nguni	95	55.47	47.5 - 65.0	2.41	4.3	0.25	19	55.22	50.5 - 62.5	3.36	6.2	0.77
Sotho	86	55.77	47.5 - 66.0	3.27	5.9	0.35	42	54.22	47.5 - 61.0	2.91	5.4	0.45
Miscellaneous	74	56.70	49.0 - 64.0	2.31	4.1	0.27	5	52.60	51.0 - 55.5	4.00	7.6	1.79
TOTAL	347	55.67	40.0 - 66.0	2.93	5.3	0.16	102	53.89	46.0 - 62.5	3.14	5.8	0.31

TABLE 40

MAXILLO-ALVEOLAR ARCH BREADTH IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

POPULATION GROUP	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	89	62.15	58.5 - 69.5	2.90	4.7	0.31	34	60.54	55.0 - 64.5	3.06	5.1	0.52
Cape Nguni	94	62.61	53.5 - 70.5	2.88	4.6	0.30	18	59.27	53.5 - 66.0	3.62	6.1	0.85
Sotho	85	62.52	54.5 - 68.0	3.45	5.5	0.37	42	56.53	50.0 - 64.0	2.97	5.1	0.46
Miscellaneous	74	62.23	55.5 - 71.0	2.71	4.4	0.32	5	57.40	53.5 - 62.5	4.28	7.4	1.91
TOTAL	342	62.38	53.5 - 71.0	3.00	4.8	0.16	99	59.30	50.0 - 66.0	3.19	5.4	0.32

TABLE 41

MAXILLO-ALVEOLAR INDICES IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

POPULATION GROUP	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	85	113.06	98.5-142.5	7.52	6.[illegible]	0.82	31	113.49	108.5-120.5	5.45	4.8	0.98
Cape Nguni	92	112.73	87.5-125.0	7.41	6.6	0.77	18	110.06	92.5-120.0	7.83	7.1	1.85
Sotho	83	112.78	101.0-134.5	6.40	5.7	0.70	41	108.24	94.0-128.0	7.76	7.2	1.21
Miscellaneous	74	109.93	97.0-129.5	6.78	6.2	0.79	5	109.00	102.0-118.5	8.40	7.7	3.76
TOTAL	334	112.21	87.5-142.5	7.02	6.2	0.38	95	110.34	92.5-128.0	6.98	6.3	0.72

TABLE 42

MAXILLO-ALVEOLAR MEASUREMENTS AND INDICES OF SHANGAAN-TONGA MALES

CHARACTER	NO.	MEAN	S.D.	C.V.	S.E.
Maxillo-alveolar Length	35	56.70	3.30	5.8	.56
Maxillo-alveolar breadth	35	61.64	3.29	5.3	.56
[illegible]	[illegible]	[illegible]	6.19	5.7	1.05

Natal Nguni	92	54.94	40.0 - 62.5	3.48	6.3	0.36	36	53.51	46.0 - 60.0	3.16	5.9	0.53
Cape Nguni	95	55.47	47.5 - 65.0	2.41	4.3	0.25	19	55.22	50.5 - 62.5	3.36	6.2	0.77
Sotho	86	55.77	47.5 - 66.0	3.27	5.9	0.35	42	54.22	47.5 - 61.0	2.91	5.4	0.45
Miscellaneous	74	56.70	49.0 - 64.0	2.31	4.1	0.27	5	52.60	51.0 - 55.5	4.00	7.6	1.79
TOTAL	347	55.67	40.0 - 66.0	2.93	5.3	0.16	102	53.89	46.0 - 62.5	3.14	5.8	0.31

TABLE 40

MAXILLO-ALVEOLAR ARCH BREADTH IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

POPULATION GROUP	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	89	62.15	58.5 - 69.5	2.90	4.7	0.31	34	60.54	55.0 - 64.5	3.06	5.1	0.52
Cape Nguni	94	62.61	53.5 - 70.5	2.88	4.6	0.30	18	59.27	53.5 - 66.0	3.62	6.1	0.85
Sotho	85	62.52	54.5 - 68.0	3.45	5.5	0.37	42	58.53	50.0 - 64.0	2.97	5.1	0.46
Miscellaneous	74	62.23	55.5 - 71.0	2.71	4.4	0.32	5	57.40	53.5 - 62.5	4.28	7.4	1.91
TOTAL	342	62.38	53.5 - 71.0	3.00	4.8	0.16	99	59.30	50.0 - 66.0	3.19	5.4	[illegible]

TABLE 41

MAXILLO-ALVEOLAR INDICES IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

POPULATION GROUP	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	85	113.08	98.5-142.5	7.52	6.6	0.82	31	113.49	108.5-120.5	5.45	4.8	0.98
Cape Nguni	92	112.73	87.5-125.0	7.41	6.6	0.77	18	110.06	92.5-120.0	7.83	7.1	1.85
Sotho	83	112.78	101.0-134.5	6.40	5.7	0.70	41	108.24	94.0-128.0	7.76	7.2	1.21
Miscellaneous	74	109.93	97.0-129.5	6.78	6.2	0.79	5	109.00	102.0-118.5	8.40	7.7	3.76
TOTAL	334	112.21	87.5-142.5	7.02	6.2	0.38	95	110.34	92.5-128.0	6.98	6.3	0.72

TABLE 42

MAXILLO-ALVEOLAR MEASUREMENTS AND INDICES OF SHANGAAN-TONGA MALES

CHARACTER	NO.	MEAN	S.D.	C.V.	S.E.
Maxillo-alveolar Length	35	56.70	3.30	5.8	.55
Maxillo-alveolar breadth	35	61.64	3.29	5.3	.56
Maxillo-alveolar index	35	108.86	6.19	5.7	1.05

TABLE 43

RESULTS OF 'T'-TESTS ON DIFFERENCES BETWEEN MEAN MAXILLO-ALVEOLAR DIMENSIONS OF SHANGAAN-TONGA MALES AND OTHER BANTU GROUPS

MAXILLO-ALVEOLAR LENGTH

	NATAL NGUNI	CAPE NGUNI	SOTHO	SHANGAAN-TONGA
Natal Nguni		1.23	1.65	2.65
Cape Nguni			.69	2.00
Sotho				1.40
Shangaan-Tonga				

MAXILLO-ALVEOLAR BREADTH

	NATAL NGUNI	CAPE NGUNI	SOTHO	SHANGAAN-TONGA
Natal Nguni		1.08	.76	.80
Cape Nguni			.19	1.53
Sotho				1.31
Shangaan-Tonga				

MAXILLO-ALVEOLAR INDEX

	NATAL NGUNI	CAPE NGUNI	SOTHO	SHANGAAN-TONGA
Natal Nguni		.31	.28	3.18
Cape Nguni			.05	2.98
Sotho				3.11
Shangaan-Tonga				

TABLE 41

TABLE OF MAXILLO-ALVEOLAR INDEX CATEGORIES IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

BANTU MALES

DOLICHURANIC (Below 110 per cent)		MESO-URANIC (110-115 per cent)		BRACHY-URANIC (above 115 per cent)
Miscellaneous	109.93	Natal Nguni	113.08	
Shangaan-Tonga	108.86	Cape Nguni	112.73	
		Sotho	112.78	
		TOTAL	112.21	

BANTU FEMALES

DOLICHURANIC (Below 110 per cent)		MESO-URANIC (110-115 per cent)		BRACHY-URANIC (above 115 per cent)
Sotho	108.24	Natal Nguni	113.49	
Miscellaneous	109.00	Cape Nguni	110.06	
		TOTAL	110.34	

TABLE 45

COMPARATIVE TABLE OF MAXILLO-ALVEOLAR MEASUREMENTS AND INDICES OF THE SOUTH AFRICAN BANTU NEGROIDS

MAXILLO-ALVEOLAR LENGTHS

AUTHOR	MALES				FEMALES			
	NO.	MEAN	RANGE	S.E.	NO.	MEAN	RANGE	S.E.
De Villiers	487	55.4	41.C - 65.0	.17	135	53.2	43.0 - 60.0	.27
Present Study	347	55.67	40.0 - 66.0	.17	102	53.89	46.0 - 62.5	.31
Shaw	91	54.6*	45.0 - 63.0*	-				
Galloway	96	57.87*	48.0 - 67.0*	.72				

MAXILLO-ALVEOLAR BREADTHS

AUTHOR	MALES				FEMALES			
	NO.	MEAN	RANGE	S.E.	NO.	MEAN	RANGE	S.E.
De Villiers	511	64.0	54.0 - 73.0	.15	134	61.2	54.0 - 72.0	.29
Present Study	342	62.38	53.5 - 71.0	.16	99	59.30	50.0 66.0	.32
Shaw	91	61.3*	50.0 - 72.5*	-				
Galloway	96	64.71*	54.0 - 73.0*	.72				

MAXILLO-ALVEOLAR INDEX

AUTHOR	MALES				FEMALES			
	NO.	MEAN	RANGE	S.E.	NO.	MEAN	RANGE	S.E.
De Villiers	464	116.1	96.7 - 138.6	.32	125	114.9	96.6 - 134.9	.70
Present Study	334	112.21	87.5 - 142.5	.38	95	110.34	92.5 - 128.0	.72
Shaw	91	110.5*	101.5 - 120.5*	-				
Galloway	96	112.51*	55.3 - 132.7*	1.52				

*Combined M les and Females

(b) Anthropometric Method

Anthropologists usually follow the method advocated by Martin (1928) for measuring, in which the greatest linear dimensions, along previously defined planes or lines, are obtained. The maxillary arch breadth is measured by taking the greatest distance between the buccal surfaces of the maxillary second molars. Similarly, the mandibular arch breadth is the greatest distance between the buccal surfaces of the mandibular second molars.

The lengths of both maxillary and mandibular dental arches are measured as the shortest distance between the tangent to the labial surfaces of the central incisors, and a plane tangent to the distal surfaces of the third molars perpendicular to the occlusal plane.

Moorrees (1957) used reference points on the second molars instead of corresponding points on the third molars in order to obtain data on the greatest possible number of dentitions. The present study likewise uses the second molars (fig. 21).

PRESENT STUDY

The dental arch lengths and breadths in the Bantu using the anthropometric method of measurement are tabulated in Table 46.

The mean dimensions in the male Bantu are larger than the corresponding dimensions in the female. To determine whether these differences are significant

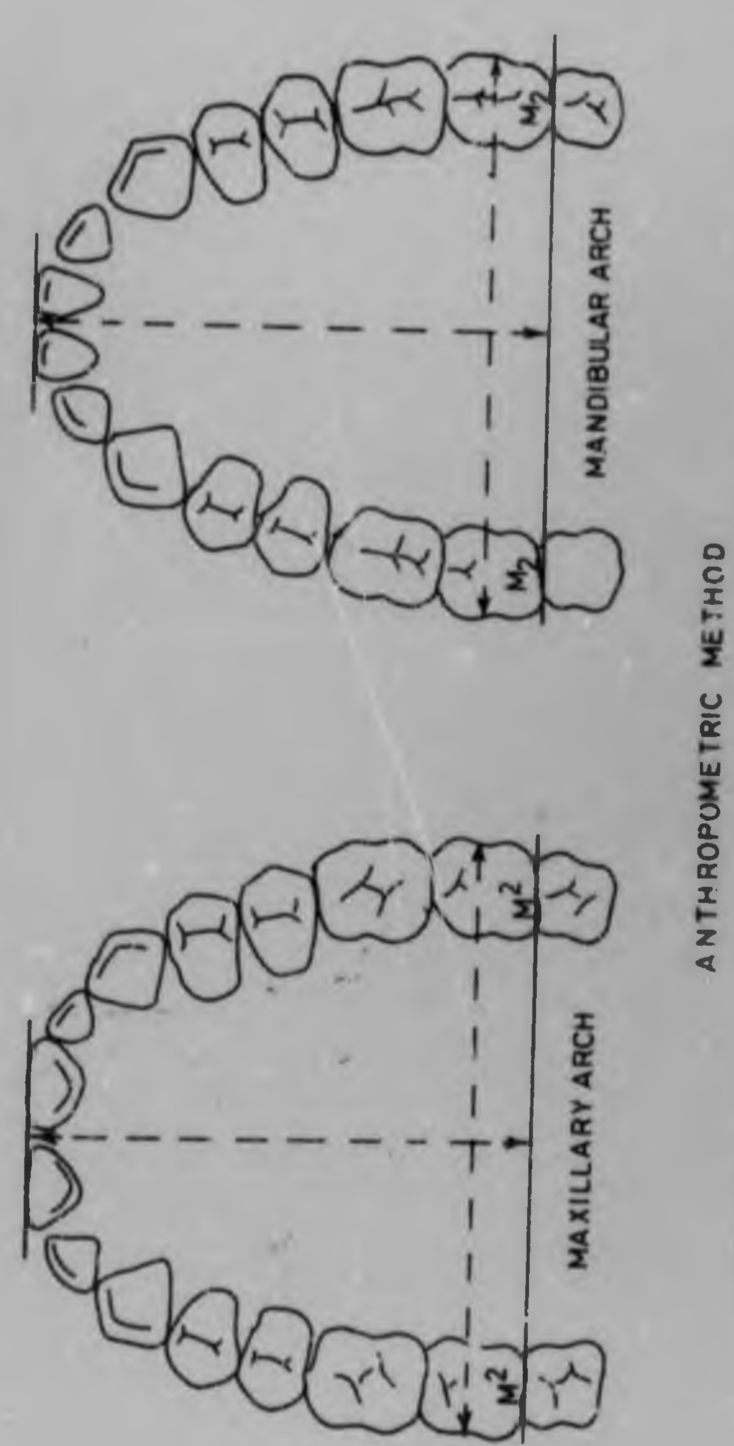

Fig. 21 Termini of dental arch length and breadth
(Anthropometric method)

't'-tests were carried out and the values of 't' were tabulated (Table 47). From the table it can be seen that the Bantu male maxillary and mandibular alveolar lengths and breadths are signifioantly larger (at the level of 5 per cent) than those of the Bantu female.

The means, standard deviations, standard errors of the mean, and the co-efficients of variation for the various Bantu groups were calculated and tabulated (Tables 48 & 49). In that there were no substantial differences in the anthropometric measurements between the various groups, it was felt that the calculation of 't'-tests for these measurements would be redundant.

DISCUSSION

DISCUSSION

The only other report that could be traced which used similar measurements was that of Moorrees (1957) in his study of the Aleut. Table 50 compares the anthropometric dental arch measurements of the Bantu with those of the Aleut.

The Bantu males tend to have slightly larger dental arches than the Aleuts. The maxillary and mandibular mean breadths of the Bantu females are slightly smaller than the combined male and female Aleut mean breadths.

The Bantu females, like the males, tend to have larger dental arch lengths than the Aleuts. This factor is not unexpected in that the Bantu are generally prognathous.

TABLE 46

DENTAL ARCH DIMENSIONS IN THE SOUTH AFRICAN BANTU NEGROIDS
(ANTHROPOMETRIC METHOD)

CHARACTER	SEX	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Maxillary Arch Breadth ($M^2 - M^2$)	Male Female	271 78	64.41 61.32	53.0 - 73.5 53.5 - 69.5	3.05 3.05	4.7 5.0	0.18 0.34
Mandibular Arch Breadth ($M_2 - M_2$)	Male Female	257 54	61.76 59.59	55.0 - 70.0 52.5 - 66.0	2.83 2.95	4.6 5.0	0.18 0.40
Maxillary Arch Length ($I^1 - M^2$)	Male Female	152 49	47.88 46.76	40.0 - 66.0 40.5 - 62.5	2.93 2.73	6.1 5.8	0.24 0.39
Mandibular Arch Length ($I_1 - M_2$)	Male Female	179 37	44.21 42.89	37.0 - 53.0 38.5 - 48.0	2.40 2.29	5.4 5.3	0.18 0.38

TABLE 47

'T' - TESTS FOR SEX DIFFERENCES IN MEAN DENTAL ARCH DIMENSIONS IN SOUTH AFRICAN BANTU NEGROIDS (ANTHROPOMETRIC METHOD)

CHARACTER	't'	SIGNIFICANCE AT THE 5 PER CENT LEVEL
Maxillary Arch Breadth ($M^2 - M^2$)	7.87	Significant
Mandibular Arch Breadth ($M_2 - M_2$)	4.94	Significant
Maxillary Arch Length ($I^1 - M^2$)	2.46	Significant
Mandibular Arch Length ($I_1 - M_2$)	3.19	Significant

TABLE 48

MAXILLARY ARCH LENGTH IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS
(ANTHROPOMETRIC METHOD)

POPULATION GROUPS	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	40	47.65	40.0 - 62.5	3.34	7.0	0.53	17	47.68	46.0 - 60.0	2.76	5.8	0.67
Cape Nguni	48	47.93	47.5 - 65.0	2.34	4.9	0.34	9	45.56	40.5 - 62.5	2.70	5.9	0.90
Sotho	37	47.76	47.5 - 66.0	2.97	6.2	0.49	20	46.52	42.5 - 61.5	2.77	6.0	0.62
Miscellaneous	27	48.28	42.0 - 64.0	3.18	6.6	0.61	3	46.67	41.0 - 55.5	2.02	4.3	1.17
TOTAL	152	47.88	40.0 - 66.0	2.93	6.1	0.24	49	46.76	40.5 - 62.5	2.73	5.8	0.39

MANDIBULAR ARCH LENGTH IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS
(ANTHROPOMETHIC METHOD)

POPULATION GROUPS NO. MEAN	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	54	44.10	38.5 - 50.0	2.19	5.0	0.30	16	43.02	40.0 - 48.0	2.49	5.8	0.62
Cape Nguni	54	44.42	39.5 - 49.5	2.45	5.5	0.33	6	41.42	40.0 - 43.5	1.59	3.8	0.65
Sotho	45	43.62	37.0 - 48.5	2.55	5.8	0.36	13	43.31	38.5 - 47.0	2.67	6.2	0.74
Miscellaneous	26	45.06	42.0 - 53.0	2.64	5.9	0.52	2	43.50	42.5 - 44.5	1.41	3.2	1.0
TOTAL	179	44.21	37.0 - 53.0	2.40	5.4	0.18	37	42.89	38.5 - 48.0	2.29	5.3	0.38

TABLE 49

MAXILLARY ARCH BREADTH IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS
(ANTHROPOMETRIC METHOD)

POPULATION GROUP	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	71	63.75	53.0 - 71.5	3.18	5.0	0.38	30	62.61	59.0 - 69.5	2.99	4.8	0.54
Cape Nguni	79	65.07	56.0 - 73.0	2.95	4.5	0.33	16	60.50	53.5 - 64.5	3.92	6.5	0.98
Sotho	72	64.16	55.5 - 71.5	3.08	4.8	0.36	28	60.61	54.0 - 65.5	2.64	4.4	0.50
Miscellaneous	49	64.68	59.0 - 73.5	3.10	4.8	0.44	4	59.92	55.0 - 64.5	4.08	6.8	2.04
TOTAL	271	64.41	53.0 - 73.5	3.05	4.7	0.18	78	61.32	53.5 - 69.5	3.05	5.0	0.34

MANDIBULAR ARCH BREADTH IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS
(ANTHROPOMETRIC METHOD)

POPULATION GROUP	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	68	61.66	57.0 - 70.0	3.06	5.0	0.37	21	59.87	54.5 - 66.0	3.38	5.6	0.74
Cape Nguni	70	62.16	56.0 - 69.0	2.50	4.0	0.30	11	60.35	54.5 - 65.5	3.36	5.6	1.01
Sotho	72	61.58	55.0 - 68.0	3.2[illegible]	5.2	0.38	19	59.11	52.5 - 63.0	2.50	4.2	0.57
Miscellaneous	47	61.54	56.5 - 65.5	2.40	3.9	0.35	3	57.87	55.0 - 61.0	2.90	5.0	1.67
TOTAL	257	61.76	55.0 - 70.0	2.83	4.6	0.18	54	59.59	52.5 - 66.0	2.95	5.0	0.40

TABLE 50

COMPARATIVE DENTAL ARCH DIMENSIONS IN ALEUTS AND THE BANTU NEGROIDS
(ANTHROPOMETRIC METHOD)

METRICAL CHARACTER	POPULATION	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Maxillary Arch Breadth	Aleut (males and females)	32	62.7	56.5 - 74.5	4.3	6.9	0.8
	Bantu males	271	64.1	53.0 - 73.5	3.05	4.7	0.18
	Pantu females	78	61.3	53.0 - 69.5	3.05	5.0	0.34
Mandibular Arch Breadth	Aleut (males and females)	41	61.3	55.0 - 68.5	3.0	4.9	0.5
	Bantu males	257	61.76	55.0 - 70.0	2.83	4.6	0.18
	Bantu females	54	59.59	52.5 - 66.0	2.95	5.0	0.40
Maxillary Arch Length	Aleut (males and females)	29	43.5	38.0 - 50.5	3.5	8.0	0.6
	Bantu males	152	47.88	40.0 - 66.0	2.93	6.1	0.24
	Bantu females	49	46.76	46.0 - 62.5	2.73	5.8	0.39
Mandibular Arch Length	Aleut (males and females)	26	42.2	36.0 - 47.5	3.4	8.1	0.7
	Bantu males	179	44.21	37.0 - 53.0	2.40	5.4	0.18
	Bantu females	37	42.89	36.5 - 48.0	2.29	5.3	0.38

(c) Odontometric Method

This method of measuring dental arches was introduced by Korkhaus in 1939. The maxillary arch breadth, on his method, is the distance between the intersection of the main occlusal grooves of the first molars. The mandibular arch breadth is the distance between the tips of the distobuccal cusps of the first molars.

The dental arch length of both maxilla and mandible is the shortest distance between a tangent to the labial surfaces of the median incisors and a plane through the arch breadth line (M1 - M1) perpendicular to the occlusal surface (fig. 22).

PRESENT STUDY

From Table 51 it can be seen that the mean maxillary length in the male is larger than in the female Bantu, but in the mandible the female has a slightly greater mandibular length.

The maxillary arch breadths in both maxilla and mandible are larger in the males than in the females.

In order to determine significant sex differences in the male and female measurements in the Bantu, 't'-tests were done and the results are tabulated in Table 52 ..

The mean maxillary arch lengths as well as the mean maxillary and mandibular arch breadths of males are significantly larger than those of females (at the 5 per cent level). The mandibular arch lengths of females are very slightly larger than those of the males but the

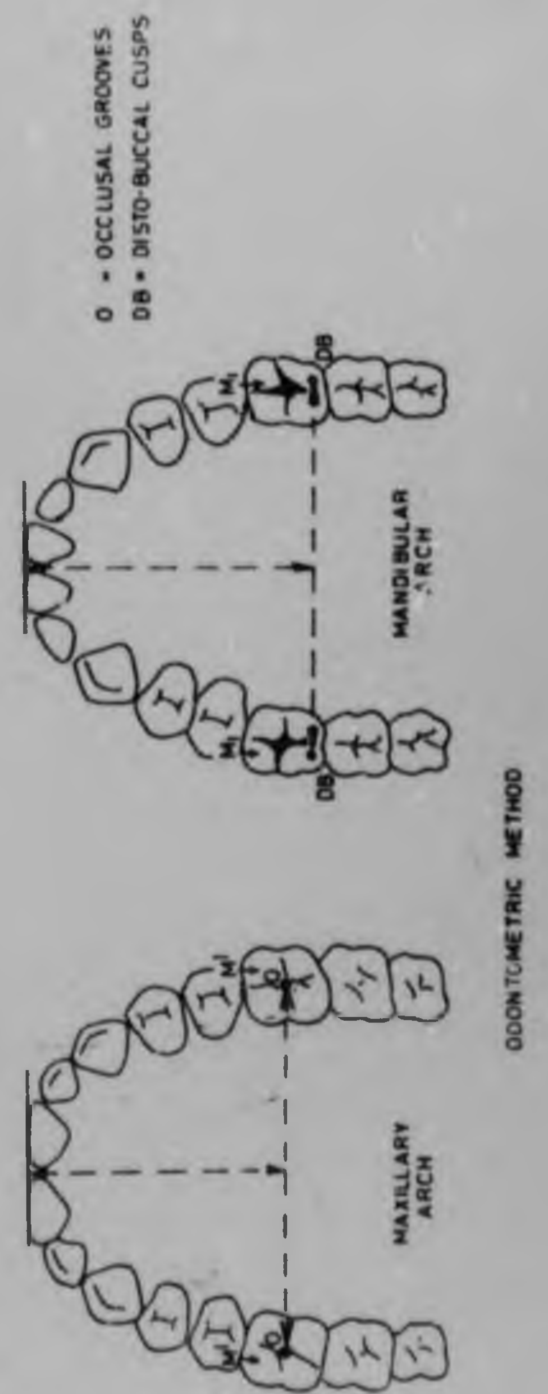

Fig. 22 Termini of dental arch length and breadth (Odontometric method)

differences are not significant.

The data for the mandibular arch lengths include three extreme values. Whereas the majority of observed values fell between 26 and 39, there were two values of 49 and one of 46. They came from a Zulu male, a Zulu female and a Sotho female respectively. The exclusion of these atypical values did not affect the conclusion that the means of the sexes are not significantly different for the variable.

The measurements for various Bantu tribal groups were tabulated in Tables 53 & 54. A one-way analysis of variance was made as shown in Table 55. In every instance there is no significant difference among the four groups.

DISCUSSION

Comparison with other population groups ~~are~~ is limited by the paucity of reports which make use of these points of reference. Moorrees (1957) in his investigation of the Aleuts included these measurements in his study. Seipel (1946) used a similar method in measuring the arches of medieval Swedish skulls.

From the comparative table (Table 56), it appears that the maxillary dental arch breadths of the Bantu are not larger than those of the Swedish skulls, but their lengths appear to be greater. The mean maxillary arch dimensions of male and female Bantu are slightly larger than the mean dimensions for Aleuts. The mean mandibular arch breadth of Aleuts, however, is larger than the mean breadths of either male or female Bantu. The Bantu tend to have greater maxillary and mandibular arch lengths than either the Aleuts or the Swedes.

The fact that the Bantu possess greater mean maxillary and mandibular dental arch lengths gives metrical expression to the greater degree of prognathism shown by the Bantu than either the Aleuts or Swedes. The greater mean breadth of the Aleut mandibular dental arch reflects the broad, robust and angular structure of the Aleut mandible.

TABLE 51

DENTAL ARCH DIMENSIONS IN SOUTH AFRICAN BANTU NEGROIDS (ODONTOMETRIC METHOD)

CHARACTER	SEX	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Maxillary Length ($I^1 - M^1$)	Male	156	32.34	27.0 - 40.0	1.89	5.8	0.15
	Female	43	31.49	27.0 - 35.5	1.97	6.2	0.30
Mandibular Length ($I_1 - M_1$)	Male	180	32.49	27.0 - 49.5	2.53	7.8	0.19
	Female	42	32.58	27.5 - 49.0	3.98	12.2	0.61
Maxillary Breadth ($M^1 - M^1$)	Male	272	50.40	44.5 - 59.5	2.85	5.6	0.17
	Female	74	47.63	40.0 - 55.5	2.97	6.2	0.34
Mandibular Breadth ($M_1 - M_1$)	Male	259	49.2	43.0 - 56.0	2.74	5.5	0.17
	Female	57	47.55	40.0 - 56.5	3.12	6.6	0.41

TABLE 52

'T' - TEST FOR SEX DIFFERENCES IN MEAN DENTAL ARCH DIMENSIONS (ODONTOMETRIC METHOD) IN TOTAL SOUTH AFRICAN BANTU NEGROIDS

CHARACTER	't'	Significant at 5 per cent Level
Maxillary Length	2.52	Significant
Mandibular Length	.13	Not significant
Maxillary Breadth	7.17	Significant
Mandibular Breadth	4.18	Significant

TABLE 53

MAXILLARY BREADTH IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS (ODONTOMETRIC METHOD)

POPULATION GROUP	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	66	50.22	45.0 - 59.5	2.94	5.9	0.36	28	48.29	45.0 - 53.0	2.65	5.5	0.50
Cape Nguni	77	50.75	46.0 - 58.0	2.54	5.0	0.29	14	47.36	43.5 - 55.5	3.28	6.9	0.88
Sotho	74	50.48	44.5 - 58.0	3.17	6.3	0.37	28	47.23	40.0 - 50.0	2.98	6.3	0.56
Miscellaneous	55	50.03	44.5 - 56.5	2.70	5.4	0.36	4	46.75	43.0 - 52.0	4.02	8.6	2.01
TOTAL	272	50.40	44.5 - 59.5	2.85	5.6	0.17	74	47.63	40.0 - 55.5	2.97	6.2	0.34

MANDIBULAR BREADTH IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS (ODONTOMETRIC METHOD)

POPULATION GROUP	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	66	49.29	45.0 - 56.0	2.86	5.8	0.35	23	47.68	43.5 - 53.5	2.69	5.6	0.56
Cape Nguni	71	49.56	43.0 - 55.0	2.61	5.3	0.31	11	48.14	43.5 - 56.5	4.28	8.9	1.29
Sotho	72	49.69	43.5 - 55.5	2.85	5.7	0.34	20	47.05	40.0 - 51.0	2.70	5.7	0.60
Miscellaneous	50	49.02	44.5 - 55.0	2.60	5.3	0.37	3	47.77	43.5 - 52.0	4.25	8.9	2.45
TOTAL	259	49.20	43.0 - 56.0	2.74	5.5	0.17	57	47.55	40.0 - 56.5	3.12	6.6	0.41

TABLE 34

MAXILLARY LENGTH IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS (ODONTOMETRIC METHOD)

POPULATION GROUP	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	36	31.88	28.0 - 39.0	2.32	7.3	0.39	16	31.96	28.5 - 35.5	2.75	7.0	0.56
Cape Nguni	47	32.63	27.0 - 40.0	1.36	4.2	0.20	6	29.82	28.0 - 31.5	1.34	4.5	0.55
Sotho	40	32.03	28.0 - 37.5	2.08	6.5	0.33	18	31.64	27.0 - 35.0	1.90	6.0	0.45
Miscellaneous	33	32.80	28.0 - 38.5	1.76	5.4	0.31	3	31.47	30.0 - 33.0	1.50	4.8	0.87
TOTAL	156	32.34	27.0 - 40.0	1.89	5.8	0.15	43	31.49	27.0 - 35.5	1.97	6.2	0.30

MANDIBULAR LENGTH IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS (ODONTOMETRIC METHOD)

POPULATION GROUP	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	53	32.20	28.5 - 49.5	3.24	10.0	0.44	18	32.76	28.0 - 49.0	4.50	13.7	1.06
Cape Nguni	51	32.45	27.5 - 36.5	2.05	6.3	0.29	4	30.70	29.0 - 32.5	1.69	5.5	0.84
Sotho	46	32.27	27.0 - 36.5	2.08	7.1	0.34	17	32.91	27.5 - 46.0	3.94	12.0	0.96
Miscellaneous	30	33.40	30.0 - 38.5	2.15	6.4	0.39	3	32.10	31.5 - 33.0	0.70	2.2	0.40
TOTAL	180	32.49	27.0 - 49.5	2.53	7.8	0.19	42	32.58	27.5 - 49.0	3.98	12.2	0.61

TABLE 55

SUMMARY OF RESULTS OF ONE WAY ANALYSES OF VARIANCE IN SOUTH AFRICAN BANTU TRIBAL GROUPS (ODONTOMETRIC METHOD)

CHARACTER	SEX	NATAL NGUNI		CAPE NGUNI		SOTHO		MISCELLANEOUS		F-RATIO	
		No.	Mean	No.	Mean	No.	Mean	No.	Mean		
Maxillary Breadth ($M^1 - M^1$)	Male Female	66 28	50.22 48.29	77 14	50.75 47.36	74 28	50.48 47.23	55 4	50.03 46.75	1.274 1.267	not significant not significant
Mandibular Breadth ($M_1 - M_1$)	Male Female	66 23	49.29 47.68	71 11	49.56 48.14	72 20	49.69 47.05	50 3	49.02 47.77	1.441 3.150	not significant not significant
Maxillary Length ($I^1 - M^1$)	Male Female	36 16	31.88 31.96	47 6	32.63 29.82	40 18	32.03 31.64	33 3	32.80 31.47	2.103 1.781	not significant not significant
Mandibular Length $I_1 - M_1$)	Male Female	53 18	32.22 32.76	51 4	32.45 30.70	46 17	32.27 32.91	30 3	33.40 32.10	1.618 2.754	not significant not significant

TABLE 56

COMPARATIVE TABLE OF MEAN DENTAL ARCH MEASUREMENTS
(ODONTOMETRIC METHOD)

CHARACTER	ALEUT (MOORREES 1957)	SWEDES (SEIPEL 1946)		BANTU (PRESENT STUDY)	
	Combined Sex	Male	Female	Male	Female
Maxillary Breadth	47.8	50.20	47.88	50.40	47.63
Maxillary Length	30.9	27.98	23.16	32.34	31.49
Mandibular Breadth	49.3	-	-	49.20	47.55
Mandibular Length	28.8	-	-	32.49	32.58

C. PREMOLAR WIDTH

To glean an impression of overall dental arch breadth, in addition to the breadth in the molar region, the distance between the buccal cusp tips of the left and right first premolars of the respective jaws was measured. In the narrow or tapered type of dental arch, this dimension would tend to be smaller than in the broad or square type of dental arch. Howes (1954) used this measurement as one of many in an evaluation of orthodontic problems and it serves as a basis of comparison between Whites and Bantu.

PRESENT STUDY

The premolar [redacted] width in the Bantu male and female crania was measured with a Boley gauge. The measurements were recorded to the nearest 0.1 mm. In several instances the mobility of teeth precluded this degree of accuracy, in which case the figures quoted should probably be regarded as accurate to 0.5 mm. The pertinent statistical data are given in Table 57. It may be noted that the premolar [redacted] widths in both maxillary and mandibular dental arches are significantly larger (at the 5 per cent) level in Bantu males than in females the values being 44.10 mm and 41.70 mm in the maxilla, and 35.97 mm and 34.24 mm in male and female Bantu mandibles respectively.

In the various tribal groups (Table 58) the mean maxillary and mandibular premolar [redacted] widths of male Bantu are little different. The mean dimensions of the maxillary arch of the Natal Nguni female tend to be slightly larger than those of the other three tribal groups. The mandibular premolar widths of the females in all the groups are close to the overall mean.

DISCUSSION

The premolar dimensions in the maxilla and mandible of the Bantu are larger than those of Caucasoids (Table 59), and this is true even though the White sample is a combined male and female sample. Even the Bantu female means exceed those of the Caucasoid combined series.

The larger mean premolar breadth dimensions of Bantu males is in accord with the significantly larger mean male palatal and maxillo-alveolar breadth dimensions.

The mean figures in the present study are slightly less than the figures of Jacobson and Dreyer (1956) (mean maxillary breadth 46.0 mm, mandibular breadth 38.3 mm) in their study of the Bantu. Among possible reasons for the discrepancy are firstly, the fact that the original sample consisted of only thirteen male and female Bantu patients. Secondly, the sample was a selected one, the basis of the selection being the clinical quality of the occlusion.

TABLE 57

MAXILLARY AND MANDIBULAR BICUSPID WIDTHS IN THE SOUTH AFRICAN BANTU NEGROIDS

CHARACTER	SEX	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	"t"	for male-female difference of means (5 per cent level)
Bicuspid width (maxilla)	Male	264	44.10	38.0 - 51.5	2.33	5.3	.14	7.74	Significant
	Female	75	41.70	37.5 - 48.5	2.34	5.6	.27		
Bicuspid width (mandible)	Male	270	35.97	29.0 - 47.0	2.77	7.7	.17	5.92	Significant
	Female	77	34.24	30.0 - 40.5	2.09	6.1	.24		

TABLE 58

MAXILLARY AND MANDIBULAR BICUSPID WIDTHS IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

MAXILLA

POPULATION GROUPS	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	68	44.07	38.5 - 49.0	2.09	4.7	.25	25	42.68	39.0 - 48.5	2.49	5.8	.50
Cape Nguni	74	44.17	39.0 - 48.0	1.97	4.4	.23	12	41.04	37.5 - 43.0	2.66	6.5	.77
Sotho	67	44.33	38.0 - 51.5	2.86	6.5	.35	34	41.25	38.0 - 45.5	2.25	5.5	.38
Miscellaneous	55	43.78	39.0 - 51.0	2.43	5.5	.33	4	42.00	40.0 - 45.5	2.48	5.9	1.24
TOTAL	264	44.10	38.0 - 51.5	2.33	5.3	.14	75	41.70	37.5 - 48.5	2.34	5.6	.27

MANDIBLE

POPULATION GROUPS	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	77	35.87	29.0 - 41.0	2.87	8.0	.33	31	34.74	30.5 - 40.5	2.28	6.6	.41
Cape Nguni	72	36.10	30.0 - 47.0	3.08	8.5	.36	8	33.56	31.0 - 36.0	1.82	5.4	.64
Sotho	68	36.27	30.5 - 41.0	2.45	6.8	.30	34	33.97	30.0 - 37.5	1.85	5.4	.32
Miscellaneous	53	35.53	31.0 - 45.0	2.54	7.2	.35	4	34.00	32.0 - 38.5	3.03	8.9	1.51
TOTAL	270	35.97	29.0 - 47.0	2.77	7.7	.17	77	34.24	30.5 - 40.5	2.09	6.1	.24

TABLE 59

COMPARATIVE [illegible] MAXILLARY AND MANDIBULAR BICUSPID W[illegible]THS

MAXILLA POPULATION GROUP	SEX	NO.	MEAN	RANGE
CAUCASOIDS (Howes 1954)	Combined	?	41.3	39.0 - 45.0
BANTU (Present study)	Male	264	44.10	38.0 - 51.5
BANTU " "	Female	75	41.70	37.5 - 48.5

MANDIBLE POPULATION GROUP	SEX	NO.	MEAN	RANGE
CAUCASOIDS (Howes 1954)	Combined	?	33.9	31.0 - 37.5
BANTU (Present study)	Male	270	35.97	29.0 - 47.0
BANTU " "	Female	77	34.24	30.0 - 40.5

D. RELATIONSHIP BETWEEN DENTAL ARCH MEASUREMENTS AND FACIAL MEASUREMENTS

Both Izard (1927) and Berger (1938) held that a relationship exists between the bizygomatic breadth of the face and the breadth of the maxillary dental arch of the individual.

Izard measured the width of the arch as the greatest distance between the buccal aspects of the maxillary second molars. The width of the face is indicated by the greatest bizygomatic distance. After measuring in the Museum of Natural History of Paris all skulls possessing normal arches, he showed that in almost all cases the breadth of the arch, though very variable, was about one-half of the bony bizygomatic diameter. This relationship was expressed by the following index:-

Transverse arch-face index (Izard's index)

$$= \frac{\text{Maxillary dental arch breadth } (M^2 - M^2)}{\text{Maximum bizygomatic distance.}} \times 100$$

Izard obtained a mean value of 50 for this index, although the index oscillates between extreme values of 47 and 54. In 75 per cent of cases it varies between only 48.5 and 51.5.

Berger measured the maxillary dental arch breadth between the central fossae of the first permanent molars. He measured maximum bizygomatic breadth on the living and not on crania. He found that the distance between the centres of the first maxillary molars is about one-third of the maximum bizygomatic breadth. According to

Berger in the 'normal' occlusion, this is 33.3 per cent. His formula for calculating the index is as follows:-

$$\text{Berger's Index} = \frac{\text{Maxillary dental arch breadth } (M^1 - M^1)}{\text{Bizygomatic diameter}} \times 100$$

PRESENT STUDY

The maxillary arch breadths, measured both by Izard's and Berger's methods, the bizygomatic diameters, and the I & B indices, for the Bantu cranial series, are listed in Table 60. The figures include the means, standard deviations, co-efficients of variation, standard errors of the means, and the 't'-test for significance of differences between male and female means.

From the table it can be seen that the mean bizygomatic and dental arch breadths of males are significantly larger than those of females. Although the mean Izard's index for females is significantly larger (at the 5 per cent level) than that for males, there is no significant sexual difference in the mean Berger's index. The higher index of Izard in females would indicate that the female bizygomatic breadth is relatively narrower than the male.

The mean Izard's index is remarkably constant in various Bantu tribal groups (Table 61).

With the exception of the Natal Nguni females, the other tribal groups possess mean indices very close to 48.0 per cent. The Nguni female mean index is higher, viz. 50.30 per cent, indicating a relatively broader arch or narrower bizygomatic breadth.

The mean Berger's indices in the various tribal groups are likewise relatively constant and lie close to the value of 39 per cent.

DISCUSSION

The mean bizygomatic diameter of the Bantu male is larger than that of the female. This is not unexpected in view of their heavier and larger bony framework, and confirms de Villiers's (1964) data on the Bantu. The maxillary arch breadths of males as measured by the methods of Izard and Berger are likewise significantly larger than those of females. This too is not unexpected in that the palatal and maxillo-alveolar arch breadths for the same sample revealed similar sexual dimorphism.

According to Izard's index the female Bantu * [redacted]

The difference in mean breadths of male and female arches (62.38 mm and 59.30 mm respectively) is approximately 3.1 mm in 62 mm, i.e. 5 per cent, which is proportionately less than the difference in male and female bizygomatic diameters (129.2 mm in males, 121.27 mm in females) which is approximately 8 mm in 129 mm, i.e. 6.2 per cent. In indices, therefore, the females evince a higher mean index than males.

Berger's index shows no significant sex difference. This is due to the fact that the difference in male and

[Omission: Insert at *]

have relatively broader palates than the males. This is contrary to the calculated palatal and maxillo-alveolar indices in which the Bantu male show either no significant sex differences (palatal indices) or in which the males possess relatively broader maxillo-alveolar arches than females. In accounting for this discrepancy it should be pointed out that Izard's calculations relate maxillary arch breadth to bizygomatic breadth which in females is considerably less than in males.

female arch breadths in the region of the M^1's is greater than the arch breadth difference in the region of M^2's. The sex difference in the arch breadths in the M^1 region (males 50.40 mm, females 47.63 mm) is approximately 2.8 mm on 50 mm, i.e. 5.6 per cent. Thus relating the proportionate difference of 5.6 per cent to the proportionate bizygomatic sex difference of 6.2 per cent the sex difference is not significant.

In the Bantu, the mean male and female Izard's indices are 48.27 and 49.02 respectively. This closely approximates Izard's 'normal' of 50. Berger's indices on the Bantu, on the other hand, are 39.00 (males) and 39.29 (females). These figures are far in excess of Berger's index of 33.3 for 'normals'.

Regrettably, neither Izard nor Berger provided any comparative tables of indices for various population groups. The only data that the writer was able to locate were those of Moorrees (1957) in his study of the Aleuts (Table 62). In this population group, he calculated a mean Izard's index of 44.8. This figure is far below the value of 50, which Izard held to be 'normal'. Berger's index on the Aleuts is 33.2 which accords with Berger's figures (33.3) for the 'normal'.

Moorrees reported a high degree of correlation between arch breadth and bizygomatic breadth in the Aleuts. The value of Berger's and Izard's indices will vary between a population with broad bizygomatic arches and one with narrow; one with large teeth and one with small; one with big arches and one with small; one with wide palate and one with a narrow palate. The figures in the present study suggest the usefulness of these indices as a sorting criterion in providing varying indices between different populations.

TABLE 60

IZARD'S AND BERGER'S INDICES IN THE SOUTH AFRICAN BANTU NEGROIDS

METRICAL CHARACTER	SEX	NO.	MEAN	S.D.	C.V.	S.E.	't'	Verdict of significance (5 per cent level)
Bizygomatic diameter	Male Female	346 102	129.20 121.27	5.30 4.77	4.1 3.9	.28 .47	14.36	Significant
Maxillary Dental arch breadth $M^2 - M^2$ (Izard)	Male Female	342 99	62.38 59.30	3.00 3.19	4.8 5.4	.16 .32	8.59	Significant
Maxillary Dental arch breadth $M^1 - M^1$ (Berger)	Male Female	272 74	50.40 47.63	2.85 2.97	5.6 6.2	.17 .34	7.17	Significant
Izard's Index	Male Female	332 97	48.27 49.02	2.22 2.44	4.6 5.0	.12 .25	2.71	Significant
Berger's Index	Male Female	261 72	39.00 39.29	2.36 1.97	6.0 5.0	.14 .23	1.06	Not significant

TABLE 61

IZARD'S AND BERGER'S INDICES IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

IZARD'S INDEX

TRIBAL GROUP	SEX	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	Male	85	48.27	41.5 - 52.5	2.40	5.0	.26
	Female	32	50.30	45.5 - 55.0	2.74	5.4	.48
Cape Nguni	Male	92	48.17	43.5 - 54.0	2.01	4.2	.21
	Female	18	48.06	45.0 - 51.5	(2.06)	(4.3)	(.49)
Sotho	Male	83	48.52	37.0 - 53.5	2.32	4.8	.25
	Female	42	48.60	43.5 - 52.5	2.46	5.1	.38
Miscellaneous	Male	72	48.12	44.0 - 53.0	2.21	4.6	.26
	Female	5	47.86	45.0 - 50.5	(2.53)	(5.3)	(1.13)

BERGER'S INDEX

TRIBAL GROUP	SEX	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	Male	62	39.04	32.5 - 42.5	2.67	6.8	.34
	Female	27	39.82	31.5 - 48.0	2.21	5.6	.42
Cape Nguni	Male	75	39.03	36.0 - 42.5	1.72	4.4	.20
	Female	14	38.68	35.0 - 44.0	(2.30)	(5.9)	(.61)
Sotho	Male	70	39.23	35.5 - 40.5	2.15	5.5	.26
	Female	27	39.13	34.0 - 43.0	1.63	4.2	.31
Miscellaneous	Male	54	38.61	32.5 - 42.0	3.00	7.8	.41
	Female	4	38.88	34.5 - 44.5	(2.17)	(5.6)	(1.09)

TABLE 62

IZARD'S AND BERGER'S INDICES IN VARIOUS POPULATIONS

IZARD'S INDEX

RACIAL GROUP	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Aleuts (Moorrees 1957)	31	44.8	39.0 - 55.0	3.9	8.7	0.7
Bantu male (present study)	332	48.27	37.0 - 54.0	2.22	4.6	0.12
Bantu female " "	97	49.02	43.5 - 55.0	2.44	5.0	0.25

BERGER'S INDEX

RACIAL GROUP	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Aleuts (Moorrees 1957)	33	33.2	29.0 - 38.0	2.0	6.0	0.4
Bantu male (present study)	261	39.0	31.5 - 48.0	2.36	6.0	0.14
Bantu female " "	72	39.29	32.5 - 42.5	1.97	5.0	0.23

E. PROGNATHISM

Prognathism may be defined as the degree of prominence of the facial skeletal profile in relation to the braincase (Barrett, Brown and Macdonald 1963a). It is a physical characteristic which has been discussed by many investigators who have used various definitions and methods of measurement, which have been adequately reviewed by Bjork (1947). Two indices or measures widely used in craniometry to express degree of prognathism are the alveolar index or gnathic index which is the length of the basion-prosthion line expressed as a percentage of the length of the basion-nasion line, and the facial angle or total profile angle which is the angle subtended by the nasion-prosthion line and the Frankfort horizontal (Martin 1957). According to the size of this angle, crania are classified as prognathous if the jaws protrude strongly, orthognathous if the jaws do not protrude or protrude slightly, while the intermediate type is called mesognathous. In the present study the facial angle was used to assess the degree of prognathism in Bantu skulls.

Prognathism can be a total facial prognathism, or, in terms of the orthodontic literature, a bimaxillary protrusion. The latter type of facial development was characteristic for all extinct races of mankind (Sicher 1952). Comparative anthropological data concerning the facial skeleton and its profile in various human racial groups, however, have clearly shown that there exists some difference between the profile of the nasal and that of the alveolar part of the maxilla (Snell 1952). He found it desirable, therefore, to determine separately the inclination of the nasal and the alveolar part of the upper facial skeleton. To do this, the nasal profile angle and the alveolar profile angle are measured. The nasal profile angle is the angle formed by the line from nasion to nasospinale with the Frankfort horizontal. If only the nasal part of the maxilla protrudes while the alveolar process approaches a more vertical position, the prognathism is diagnosed as nasal or middle face prognathism. In contrast to this type, alveolar or subnasal prognathism shows isolated obliquity or protrusion of the alveolar process of the upper jaw. In the present study, total, nasal and alveolar prognathism are measured.

Luthy (1912, cited by Bjork) suggested that the following classification be used for all three facial angles, viz. total, nasal and alveolar profile angles:-

Hyperprognathous	x - 69.9°
Prognathous	70.0° - 79.9°
Mesognathous	80.0° - 84.9°
Orthognathous	85.0° - 92.9°
Hyperorthognathous	93.0° - x

The lines and points of reference used in the present study are:-

Frankfort Horizontal - Is defined as the plane which passes through the poria and the

		lowest point of the left infra-orbital margin.
Nasion	-	The intersection of the internasal suture with the naso-frontal suture in the midsagittal plane (Graber 1962).
Prosthion	-	The most anterior point on the alveolar process between the sockets of the upper central incisor teeth.
Subspinale	-	The deepest midline point in the premaxilla between the anterior nasal spine and prosthion (Downs 1948).
Nasospinale	-	The lowest point on the inferior margin of the pyriform aperture in the midsagittal plane.

A stationary goniometer was used to determine the various angular measurements on the skulls. Skulls in which prosthion could not be readily located owing to alveolar resorption as the result of missing incisors, or because of fracture, were not included in the sample.

<u>Present Study</u>

The mean total profile angle in the male and female Bantu was 81.78° and 81.27° respectively, which places them in the lower (prognathous) end of the mesognathous category. The mean nasal profile angle in males was 86.96° and in females 86.95°, thus indicating nasal orthognathism. The mean alveolar profile angles for males and females are mesognathous (83.41° for males and

83.25° for females).

The degree of total, nasal and alveolar profile prognathism in both sexes in the Bantu was remarkably similar (Table 63). The 't'-tests reveal no significant differences between male and female means.

In every instance, except the alveolar profile angle, there were no significant differences between the four tribal groups (Tables 64, 65, 66 & 67). As before, for each of these one-way analyses of variance the significance test consists in obtaining the ratio of the between-groups variance to the within-groups variance, and comparing the F-ratio thus obtained with the critical ratio for the number of degrees of freedom concerned.

Since a number of analyses of variance were done in this study, it is possible that one of the F-ratios would exceed the critical ratio without indicating a population difference. The significant F-ratio appearing in the case of the alveolar profile angle (Males) could be attributed to the higher values in the two Nguni groups.

Footnote: It should be noted that the F-ratios, quoted in Table 67 , are always larger than unity, as the larger of the two variances (variance within-groups and variance between-groups) always forms the numerator of the F-ratio. Where the number of degrees of freedom of the denominator is very small, the critical ratio is high even when the number of degrees of freedom of the numerator is large. The F-ratios of 6.882 and 6.664 for the alveolar profile angle are not significant, because the number of degrees of freedom in the denominator was 3 in each case. In these cases the estimated 'within group variance' was more than six times the estimated 'between-group variance', but ratios of this magnitude may have occurred by chance because of the small number of degrees of freedom associated with the 'between-group variance'.

DISCUSSION

It was pointed out by Scott (1954a) that reduction in the functional importance and size of the nasal cavities may be a primary factor in the reduction of the human facial skeleton. Alveolar prognathism may then be considered as a compensatory growth mechanism with the function of maintaining a well-developed alveolar arch, upon a reduced facial skeleton. Scott (195[illegible]) noted that in the anthropoid apes, reduction of the nasal region has progressed less than in man, but alveolar prognathism, which in these animals is developed to a considerable extent, enables the dental arches to be supported on a relatively reduced facial skeleton.

The mean total profile angles for male Bantu (81.78°) and female Bantu (81.27°) places them in the mesognathous category. These observations closely approximate the corresponding figures determined by de Villiers which were 81.5° and 80.7°, and also confirm Galloway's (1937a, 1959) findings that the South African Negro is characteristically mesognathous.

Although the mean total profile angle shows the projection of the face to be more pronounced in the male than in the female, this sex difference is not significant, which is in accord with De Villiers' observations.

The intertribal differences in total facial and nasal prognathism are not significant (Table 67). The females of the various tribal groups, in spite of their slightly higher coefficient of variation (Table 66) reveal no significant alveolar profile difference. The Nguni males on the other hand evince a slightly higher degree of alveolar prognathism than the rest of the group.

Comparing the total facial prognathism with that of other populations (Table 68), it may be noted that except for the Eastern Bantu Negro (78.2^{o}) the South African Bantu possess the most mesognathous profiles.

The angle of nasal prognathism in the Bantu is 86.96^{o} in males and 86.95^{o} in females, viz. orthognathic. Snell (1952) measured the angle of nasal prognathism in 17 Negroid skulls and found the mean to be 82.9^{o}, viz. mesognathous (Table 69). The discrepancy in findings suggests that the observations were made on two entirely different Negro groups. Also; the angle of alveolar prognathism in Snell's sample (59.5^{o}) is at variance with similar observations in the present study (83.41^{o} in males, 83.25^{o} in females). This is difficult to explain even in the light of the probability of two different tribal groups.

In comparing the Bantu with the Caucasoids, Jacobson and Dreyer (1956) were able to demonstrate that the facial skeletal structures of the two ethnic groups were remarkably similar. The similarity in nasal structures is corroborated in the present study when the angle of nasal prognathism for the Europids (86.4^{o}) as determined by Snell, is compare with those of the Bantu (86.96^{o} in males and 86.95^{o} in females) (Table 69).

The cardinal difference between the dento-facial patterns of the Bantu and Caucasoids is that the former evince a greater degree of alveolar prognathism. According to Jacobson and Dreyer this is usually associated with the heavier and more flaccid oro-facial muscular pattern of the Bantu. Moorrees (1957), too, noted that in general the degree of inclination of incisors is greater in both Negroes and Mongoloids than in Caucasoids.

In sum, the total profile angle in the Bantu is characteristically mesognathous, whereas the mean nasal profile and alveolar profile angles are respectively orthognathous and mesognathous.

TABLE 63

TOTAL FACIAL, NAS[illegible] AND ALVEOLAR PROFILE ANGLES IN THE SOUTH AFRICAN BANTU NEGROIDS

CHARACTER	SEX	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	Verdict of Significance Test (5 per cent level)
Total facial Angle (Frankfort to Nasion-Prosthion)	Male	343	81.78	74.0 - 96.5	3.21	3.90	.17	1.51 not significant
	Female	101	81.27	59.5 - 91.5	2.89	3.31	.29	
Nasal Profile Angle (Frankfort to Nasion-Nasospinale)	Male	344	86.96	79.5 - 95.0	3.01	99.0	.16	.04 not significant
	Female	101	86.95	81.0 - 95.0	3.00	98.4	.30	
Alveolar Profile Angle (Frankfort to nasospinale-prosthion)	Male	343	83.41	74.0 - 93.0	3.69	22.22	.20	.39 not significant
	Female	101	83.25	75.0 - 90.0	3.63	21.7	.36	

TABLE 64

TOTAL FACIAL PROFILE ANGLES IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

POPULATION GROUPS	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	89	81.76	76.0 - 96.5	3.26	39.7	.35	36	81.21	75.0 - 88.0	3.38	38.4	.56
Cape Nguni	94	81.95	74.5 - 89.0	3.08	38.3	.32	19	81.40	75.5 - 85.5	2.85	33.1	.65
Sotho	87	81.66	75.0 - 90.5	3.35	40.1	.36	41	81.37	59.5 - 91.5	2.46	28.6	.38
Miscellaneous	73	81.70	74.0 - 88.0	3.15	38.0	.37	5	80.50	77.5 - 84.0	2.45	25.8	1.10
TOTAL	343	81.78	74.0 - 96.5	3.21	39.0	.17	101	81.27	59.5 - 91.5	2.89	28.9	.39

TABLE 65

NASAL PROFILE ANGLES IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

POPULATION GROUPS	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	90	86.72	79.5 - 95.0	2.97	90.7	.31	36	87.08	81.0 - 95.0	3.36	115.3	.56
Cape Nguni	94	86.86	80.0 - 90.0	2.98	94.4	.31	19	86.82	83.0 - 89.0	2.90	91.1	.66
Sotho	87	87.34	81.0 - 95.0	3.05	114.7	.33	41	87.05	81.5 - 94.0	2.72	92.3	.42
Miscellaneous	73	86.98	80.0 - 93.5	3.04	100.8	.36	5	85.70	83.0 - 89.5	2.59	60.2	1.16
TOTAL	344	86.96	79.5 - 95.0	3.01	99.0	.16	101	86.95	81.0 - 95.0	3.00	98.4	.30

TABLE 66

ALVEOLAR PROFILE ANGLES IN VARIOUS SOUTH AFRICAN BANTU TRIBAL GROUPS

POPULATION GROUPS	MALES						FEMALES					
	NO.	MEAN	RANGE	S.D.	C.V.	S.E.	NO.	MEAN	RANGE	S.D.	C.V.	S.E.
Natal Nguni	89	83.83	78.5 - 83.0	4.31	26.6	.46	36	82.76	75.0 - 89.0	4.12	23.9	.69
Cape Nguni	94	84.30	75.0 - 90.0	3.53	22.5	.36	19	84.34	77.5 - 90.0	3.77	24.1	.86
Sotho	87	82.75	74.0 - 93.0	3.47	20.1	.37	41	83.23	75.5 - 87.5	3.18	19.0	.50
Miscellaneous	73	82.54	74.5 - 92.5	3.30	18.9	.38	5	82.70	80.0 - 86.0	2.64	15.2	1.18
TOTAL	343	83.41	74.0 - 93.0	3.69	22.2	.20	101	83.25	75.0 - 90.0	3.63	21.7	.36

TABLE 67

RESULTS OF ONE-WAY ANALYSIS OF FACIAL PROFILE ANGLES IN SOUTH AFRICAN BANTU TRIBAL GROUPS

CHARACTER	SEX	NATAL NGUNI		CAPE NGUNI		SOTHO		MISCELLANEOUS		F	VERDICT OF SIGNIFICANCE (5 per cent level) TEST
		No.	Mean	No.	Mean	No.	Mean	No.	Mean		
Total Facial Angle	Male	89	81.78	94	81.95	87	81.66	73	81.70	6.882	Not significant
	Female	36	81.21	19	81.40	41	81.37	5	80.50	6.664	Not significant
Nasal Profile Angle	Male	90	86.72	94	86.86	87	87.34	73	86.98	1.435	Not significant
	Female	36	87.78	19	86.82	41	87.05	5	85.70	2.930	Not significant
Alveolar Profile Angle	Male	89	83.83	94	84.30	87	82.75	73	82.54	4.567	Significant
	Female	36	82.76	19	84.34	41	83.23	5	82.70	1.212	Not significant

TABLE 68

TOTAL FACIAL PR[illegible] ANGLES (measured in degrees) IN VARIOUS POPULATIONS

SERIES	MALES					FEMALES					INVESTIGATOR
	No.	Mean	S.D.	C.V.	S.E.	No.	Mean	S.D.	C.V.	S.E.	
Swedes	281	90.75	3.61		0.22	(unsexed)					Björk (1947)
Nubian											Collett (1933)
Kerma, 12th and 13th Dynasties	69	83.8	3.38		0.27						
A-Group, Before 5th Dynasty	34	83.0	2.76		0.32						
C-Group 7th to 10th Dynasties	44	83.3	3.47		0.35						
New Empire 18th to end Dynasties	36	84.3	3.56		0.40						
Meroitic 1st and 2nd Centuries A.D.	101	82.6	3.68		0.25						
X-group	55	83.5	3.60		0.33						
Egyptian											
Predynastic Naqada	62	84.4	2.87		0.25						Fawcett (19[illegible])
Egyptian Negroes	795	85.8	3.24	3.78	0.08						Pearson and Davin (1924)
Eastern Bantu-speaking Negro											
Uganda	69	78.2	3.79	4.85	0.46	45	78.2	3.20	4.09	0.48	Górnay (1957)
South African Bantu-speaking Negro	480	81.3			0.16	135	80.7			0.25	de Villiers (1964)
South African Bantu	343	81.78	3.21	3.90	0.17	101	81.27	2.89	3.31	0.29	Present study

TABLE 69

NASAL AND ALVEOLAR PROFILE ANGLES (measured in degrees) IN VARIOUS POPULATIONS

SERIES	SEX	ANGLE OF NASAL PROFILE				ANGLE OF ALVEOLAR PROFILE				INVESTIGATOR
		No.	Mean	S.D.	S.E.	No.	Mean	S.D.	S.E.	
Javanese (Surabaia)	Female	37	89.9	0.55	3.37	27	55.5	1.45	7.55	Snell 1938
Javanese (Surabaia)	Male	46	91.8	0.51	3.45	34	61.0	0.93	5.43	" "
Papuans from Biak	Male and Female	87	80.8	0.35	3.23	73	74.3	1.09	9.31	" "
Europids	Male and Female	30	86.4	0.64	3.52	30	70.5	1.29	7.15	Snell 1952
Javanese	Male and Female	30	88.3	0.76	4.17	30	56.1	0.98	5.37	" "
Negroids	Male and Female	17	82.9	0.97	4.00	17	59.5	1.56	6.32	" "
Bantu	Male	344	86.96	0.16	3.01	343	83.41	0.20	3.69	Present Study
Bantu	Female	101	86.95	0.30	3.00	101	83.25	0.36	3.63	" "

SUMMARY

Palatal length, breadth and index

Bantu males have mean palatal lengths and breadths which are significantly larger than those of females.

The mean palatal indices do not differ significantly between males and females.

The mean palatal index for males lies at the low end of the brachystaphyline category, whereas that of females is located at the upper end of the mesostaphyline category.

Individual values for this character show a wide range from leptostaphyline to brachystaphyline.

The various Bantu tribal groups revealed no significant difference in palatal length and breadth among the four groups.

Cape Nguni males have significantly higher mean indices (broader palates) than Natal Nguni and Miscellaneous males.

Sotho males also have significantly broader palates than Miscellaneous males.

Since in the Miscellaneous group, 34 of the 71 male crania were either Shangaan or Tonga, the latter sub-group was compared with other tribal groups.

Whereas there are no significant tribal differences among mean lengths and breadths of the Natal Nguni, Cape Nguni, Sotho and Miscellaneous groups, there <u>is</u> a difference in palatal arch breadth when the former three tribal groups are compared with the Shangaan-Tonga group.

The palatal breadth of the Shangaan-Tonga is smaller than the corresponding dimensions of the other tribal groups. As a result, the palatal indices are significantly different although the mean Shangaan-Tonga index still falls into the mesostaphyline category.

Palatal Height

Bantu males possess significantly deeper palates than females. Individual values for this character range from deep to shallow.

Various Bantu groups revealed no significant differences in palatal depth.

Dental Arch Dimensions

a) Biometric Method

Bantu males possess significantly longer and broader arches than do the females. It will be recalled that the male palates tend to be larger and broader than those of the female.

The significantly larger mean maxillo-alveolar index of males indicates that they tend to have broader palates than females. The dental arch of the Bantu is characteristically meso-uranic.

There were no significant differences in the maxillo-alveolar lengths, breadths or indices in the four tribal groups.

The Shangaan-Tonga (a sub-group of the Miscellaneous males) were analysed separately and their dimensions compared with those of the Natal Nguni, Cape Nguni and

Sotho. The mean maxillo-alveolar length of the Shangaan-Tonga was significantly greater than those of the two Nguni groups.

The mean maxillo-alveolar breadthe of the Shangaan-Tonga were not significantly different from the other tribal groups.

The indices of the Natal Nguni, Cape Nguni and Sotho are significantly greater than the Shangaan-Tonga. Because of the longer palates, the latter group tend towards dolichurany.

b) Anthropometric method

The mean dental arch lengths and breadths in the male Bantu, using this method, are significantly larger than those of females.

There were no substantial differences in the arch measurements among the various tribal groups.

c) Odontometric method

The mean maxillary arch length as well as the mean maxillary and mandibular arch breadths of males are significantly larger than those of females.

The mean mandibular arch length of females, using this method, is larger than that of ~~the fe~~males, but the difference is not significant.

No significant differences in arch dimensions between the four tribal groups were noted.

C. PREMOLAR ~~BICUSPID~~ WIDTH

The mean premolar ~~bicuspid~~ breadths in both maxillae and mandibles of Bantu males are significantly larger than those of females. This is in accord with the larger male palatal and maxillo-alveolar breadth dimensions.

The premolar ~~bicuspid~~ breadth dimensions in the Bantu maxilla and mandible tend to be larger than in Caucasoids.

D. RELATIONSHIPS BETWEEN DENTAL ARCH MEASUREMENTS AND FACIAL MEASUREMENTS

The mean bizygomatic diameter of Bantu males is significantly larger than that of females.

The dental arch breadths of males, as measured by the methods of Izard and of Berger, are significantly larger than those of the females.

The significantly higher index of Izard in females is attributed to the lesser bizygomatic diameter of females.

The mean male and female indices of Berger show no significant sex differences. This fact is attributed to the proportionately greater sex difference in mean dental arch breadths in the region of M^1.

With the exception of the Natal Nguni females, the tribal groups possess very similar Izard's indices. The Natal Nguni females exhibit higher indices.

The mean Berger's indices in the various tribal groups are likewise relatively constant.

E. PROGNATHISM

The mean total profile angle in Bantu males and females places them at the lower (prognathous) end of the mesognathous category.

The mean nasal profile angle for both sexes is orthognathous.

The mean alveolar profile angle for both sexes is mesognathous.

The degrees of total, nasal and alveolar profile prognathism in both sexes are similar. The 't'-tests revealed no significant sex differences.

The only significant difference between the four tribal groups is that the alveolar profile angles of the Natal and Cape Nguni males are slightly larger than those of the Sotho and Miscellaneous.

The Bantu exhibit a greater degree of alveolar prognathism than Caucasoids, but the facial skeletal structure of both races is remarkably similar.

CHAPTER 6

THE MORPHOLOGY OF THE MAXILLARY INCISOR AND MOLAR TEETH IN BOTH JAWS

I. THE MORPHOLOGY OF THE MAXILLARY INCISOR TEETH

- A. SHOVEL-SHAPED INCISORS
- B. MEDIAN RIDGES AND LINGUAL TUBERCLES
- C. OUTLINE SHAPE

II. THE MORPHOLOGY OF THE MOLAR TEETH

- A. THE NUMBER OF CUSPS ON THE MAXILLARY MOLARS
- B. THE TUBERCLE OF CARABELLI
- C. THE CUSP AND GROOVE PATTERNS OF THE MANDIBULAR MOLARS
- D. BUCCAL GROOVES AND PITS
- E. PARAMOLAR CUSPS

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I. THE MORPHOLOGY OF THE MAXILLARY INCISOR TEETH

In this section, attention will be directed to certain morphological and non-metrical features of the maxillary incisor teeth. The lingual surfaces of the maxillary incisors in the Bantu present much variation. The surfaces are either smooth, ridged, concavo-convex, shovel-shaped and/or possess lingual tubercles of varying sizes. The outline shapes of these teeth are likewise variable. In an endeavour to investigate the varied characteristics, the features are dealt with under separate headings, namely, shovel-shaped incisors, median ridges and lingual tubercles and the outline shapes of the maxillary incisor teeth. The differences in the morphology of the lower incisor teeth and canines in various racial groups are not readily discernible and consequently were not included in the present study.

I.A. SHOVEL-SHAPED INCISORS

Shovel-shaped incisors are readily recognized by their hollow lingual surface bounded on its lateral borders by well developed enamel elevations or marginal ridges. The depression thus formed gives the tooth the shape of a shovel. Hrdlička (1920, 1921) believed that the marginal overgrowth of enamel and the subsequent folding towards the lingual surface which produces this shovelling is to be regarded as a functional strengthening of the tooth rather than a sign of degeneration. On the other hand, according to Dahlberg and Mikkelson (1947), cross-sections through shovel-shaped incisors reveal that the heavy marginal ridges are not overgrowths of enamel, but consist of enamel and dentine of normal thickness. The shovel-shape of the incisors is mostly confined to the upper jaws and when present in the lower jaw is always less pronounced.

In an extensive study of the frequency of shovel-shaped incisors in different populations, Carbonell (1963) concluded that the investigations suggested the continued modification of the structural pattern on the lingual surface of upper incisor teeth from early to modern man. According to Carbonell, the shovel character associated with a lingual tubercle was almost consistently found in palaeo-anthropic man. In modern man, considerable diversity was observed, the shovel character being with or without the presence of a lingual tubercle and vice versa; thus, she confirmed the previous observations by Dahlberg (1951) and Moorrees (1957).

In the present study, the writer has used Hrdlička's classification of shovelling (see figs. 23, 24 and 25).

Shovel - The enamel rim with the enclosed fossa is well developed.

Semi-shovel - The enamel rim is distinct but the enclosed fossa is shallow.

Trace-shovel - Distinct traces of the enamel rim exist but they are not as developed as in semi-shovel.

Fig. 23 Trace shovel of maxillary central incisors

Fig. 24 Semi-shovel

Fig. 25 Shovel-shaped maxillary incisors

No-shovel - No perceptible traces of rim or fossa, or such faint or imperfect traces as not to deserve special categorization.

PRESENT STUDY

The lingual surface of many maxillary incisor teeth were partially or completely obscured or destroyed by attrition, caries or fracture. Only those teeth on which the lingual surface could be clearly determined were included in the sample.

The incidence of shovelling (of all grades) of the central incisors in the South African Bantu is 11.3 per cent in males, and 19.4 per cent in females (Table 70). The incidence of overall shovelling of the lateral incisors in the Bantu is 33.5 per cent and 61.1 per cent for males and females respectively (Table 71).

The incidence of no shovelling in the Bantu male and female central incisors is high, viz. 88.7 per cent in males and 80.6 per cent in females. The percentage incidence of no shovelling in the lateral incisors is slightly lower for males (66.5 per cent) and considerably lower in females (38.9 per cent).

The figures show that in the South African Bantu, the incidence of full shovelling of the central incisors is minimal, viz. 2.2 per cent in males and 7.1 per cent in females. The trace-shovel and semi-shovel figures of the central incisors of female Bantu tend to exceed slightly those of males.

The incidence of maximal shovelling of the lateral incisors in the male is negligible, viz. 0.4 per cent, whereas the incidence of maximal shovelling in the female is in contrast high, viz. 16.9 per cent. Thus, the females tend to exhibit a greater incidence of shovelling of both central and lateral incisors. The overall figures in Table 71 reveal that females exhibit a greater degree of overall shovelling of the lateral incisors than males, albeit the incidence of semi-shovel teeth in males slightly exceeds that in females. The figures show that the lateral incisors exhibit a greater general tendency towards shovelling than do the central incisors. The figures appear to reveal a positive sex difference, the females evincing in the main, a greater degree of shovelling of both central and lateral incisors.

Among the tribal groups (Tables 72 & 73), the female Natal Nguni revealed a particularly high incidence of shovelling of the lateral incisors. In the 39 teeth examined, the lingual surfaces of 25 were clearly defined (Table 73); of these, 9 or 36 per cent of the sample showed shovelling. The sample is insufficient to draw any conclusions from this singular deviation from the average. On the total incidence of shovelling, only the Miscellaneous groups (male and female) single themselves out for their low frequencies. The relatively lower frequency is more evident in the male lateral incisors. The female sample of lateral incisors in the

Miscellaneous group is too small to yield significant results.

Although shovelling occurs to varying degrees and in varying frequency in virtually all races, its high frequency and marked degree make it a valuable criterion in the identification of Mongoloid populations. Hrdlička (1920) used the incidence of shovelling as a differentiating factor between Pueblo and Plains Indians. The Pueblo Indians exhibited a greater incidence of shovelling. In his extensive studies on shovelling, Hrdlička (1920, 1921), noted that this feature occurred in almost every individual, and to a pronounced degree, in the American Indian, Eskimo, Chinese and Japanese. The Hawaiian male, who represents a high percentage of the Caucasoid race mixed with Mongoloid, Melanesian and Polynesian, showed an incidence of 42.9 per cent of shovel-shaped incisor teeth. The American Negro presented a low incidence (4.2 per cent), whereas in White Americans the incidence of shovelling was negligible, viz. 1.4 per cent. The overall incidence of shovelling in Bushmen, according to Van Reenen (1966), is relatively high, viz. 44.2 per cent and 66.1 per cent in the central and lateral incisors respectively.

Dahlberg (1945) used the incidence of shovelling of incisors as a criterion to demonstrate genetic relationships among population groups. The focal point for this character, according to the author, is definitely in China; and the farther away from China, the lower the frequency becomes. Dahlberg believed that this demonstrates the extent to which the genes bearing the shovel-shaped character have diffused, since he assumed a single focal origin for the mutation. He was, however, cautious to add that the incidence figures quoted refer to phenotypic characters and do not indicate the frequency of genes. Dahlberg contended that only after the manner of inheritance and other possible modifying conditions are determined can the gene frequency be established.

In a survey of 156 Cape Malays, Abrahams (1949) revealed the incidence of shovel-shaped incisors in this group to be fairly low, viz. 50 per cent of central and lateral incisors for varying degrees of shovelling. A comparison of the figures for these people with those compiled by Hrdlička revealed that, of the many races studied by him, only the American Negro and the White races had a lower percentage frequency. Abrahams submitted evidence which showed shovelling to be a recessive character, and the Cape Malays to be in the process of evolving a dominant "normal" type of incisor tooth form from the "abnormal" recessive ancestral type. Moorrees (1957) in his study of the Aleuts doubted the usefulness of shovelling as a means of differentiating among Mongoloid groups.

DISCUSSION

Shovel-shaped incisor teeth are not a feature characteristic of the South African Bantu; unlike Mongoloid populations. Shovelling of the central incisors is evident in only 2.2 per cent and 7.1 per cent of Bantu males and females respectively. These figures approximate those of the American Negro (Hrdlička 1920). The incidence of shovelling in the lateral incisors in the Bantu is the lowest of all racial groups, viz. 0.4 per cent, whereas in the Bantu females the incidence, whilst considerably more than in either American White or Negro, falls far short of the incidence of other racial groups shown in Table 74.

The incidence of no shovelling in the Bantu central and lateral incisors, is the highest of all racial groups, viz. 88.7 per cent in the central incisors and 66.5 per cent in the lateral incisors. The Bantu female central incisors likewise evince a particularly high incidence of no shovelling (80.6 per cent). The female lateral incisors on the other hand exhibit a lesser incidence (38.9 per cent) than the American White or Negro. Shaw (1931) too claimed that shovel types are exceedingly rare in the Bantu. A direct comparison, however, cannot be drawn between the figures of Shaw and those of the writer in that the former included both males and females in his sample, as well as combining his findings on both central and lateral incisors. Most of Shaw's sample were male skulls (112 out of 132). Shaw's combined (male and female, central and lateral incisors) incidence of 16.8 per cent is less than the male incidence (22.9 per cent) and considerably less than the female (43.3 per cent) incidence in central and lateral incisors of the present study. Carbonell (1963) in a study of various population groups observed an overall incidence of shovelling of 34.3 per cent and 53.2 per cent respectively in the central and lateral incisors of 122 Bantu casts. The casts were not sexually distinguished. Differences in frequency and variation in degrees of shovel-shaped incisors have been shown to exist within racial groups, such as American Indians (Hrdlička 1920) and Chinese (Lasker 1945). The Bantu in the three studies belong to the same broad ethnic group, but it is possible that the material may have come from different areas in Africa and may, therefore, represent different isolates.

The lateral incisors generally reveal a higher percentage of shovelling than the central incisors. In accounting for it, Moorrees (1957) believed that, since the lateral incisor is narrower than the central incisor, it is likely to give the impression of a more pronounced shovel, while, in reality, the ridge may be of the same height as in the central incisors.

The frequency of shovelling and of lingual tubercles appears to be unrelated in the Bantu. The incidence of shovelling in the central incisors of males and females is 11.3 per cent and 19.4 per cent respectively, whereas the overall incidence of tubercles in the same sample is 4.7 per cent and 14 per cent respectively. In the lateral incisors, the incidence of shovelling is 33.5 per cent for males and 61.1 per cent for females, whilst the overall incidence of lingual tubercles is 11.4 per cent and 16.9 per cent respectively for males and females. These unrelated figures support the contention of Hrdlička (1920) that the frequency of shovel-shaped form and of lingual tubercles bear no relationship to each other. Moorrees, too, noted the absence of the tuberculum in the majority of Aleut maxillary incisors, while the incidence of shovel shape was relatively high in this population.

Of the tribal groups, the Miscellaneous reveals a low frequency of shovelling. It is doubtful whether much significance can be attributed to this fact.

The phylogenetic significance of shovelling, according to Carbonell (1963), remains to be investigated further, in order to understand the morphological differentiation of this feature. Family studies would greatly enhance the knowledge of shovel morphology and the different degrees of variation; so far, according to Carbonell, few have studied the genetics of the trait. Abrahams (1949) observed the apparently recessive character of the shovel trait in the Cape Malays, where it is more infrequent than in the ancestral Malays. Lasker (1950) has noted concordance of both degree and expression of shovel-shape in monozygous twin pairs. Moorrees (1957) claims that the degree of shovelling is likely to have been overrated in description of populations with only a slight expression of this characteristic. Since the Bantu fall into this category, one would tend to exercise caution before attempting to use such data for interpreting the results of comparisons of populations.

TABLES ......

TABLE 70

PERCENTAGE INCIDENCE OF SHOVEL-SHAPED MAXILLARY CENTRAL INCISORS IN THE SOUTH AFRICAN BANTU

GROUP	SHOVEL-SHAPE					
	No. of teeth examined*	No Shovel	Trace Shovel	Semi-Shovel	Shovel	TOTAL Shovel
MALES	230	88.7	9.1	0	2.2	11.3
FEMALES	57	80.6	10.5	1.8	7.1	19.4

*The numbers quoted are for only those incisors on which the presence or absence, and the degree of shovelling could be determined.

TABLE 71

PERCENTAGE INCIDENCE OF SHOVEL-SHAPED MAXILLARY LATERAL INCISORS IN THE SOUTH AFRICAN BANTU

GROUP	SHOVEL-SHAPE					
	No. of teeth examined*	No Shovel	Trace Shovel	Semi-Shovel	Shovel	TOTAL Shovel
MALES	245	66.5	25.7	7.4	0.4	33.5
FEMALES	77	38.9	40.3	3.9	16.9	61.1

*The numbers quoted are for only those incisors on which the presence or absence, and the degree of shovelling could be determined.