The DENTITION and PALATE

of the

AUSTRALIAN ABORIGINAL.

from observations on the skull.

A Study

in

Physical Anthropology and Dental Pathology.

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Submitted as a Thesis for the degree of Doctor of Dental Science of the University of Adelaide.

July, 1923.

PREFACE

Since the middle of last century it has generally been the custom to approach problems of anthropology by adopting the Theory of Evolution as a guiding principle; and it appeared to be the feeling among many of the earlier workers in this science that by this means of approach, the origin and history of mankind would soon be worked out, and all facts concerning him easily linked together into one long continuous chain of evidence. But the misapplication of evolutionary sequence in biological work has led to many errors in classification and phylogenetic relationships. With the passing of years and the ever increasing specialization in branches of knowledge concerning man, modern anthropologists have been forced to admit the problem of human ancestry a much more complex one than was optimistically believed by many of their predecessors. And so, rather than look for an early solution of those problems which deal with the relation of living races to one another and to fossil types, and that of man to his Primate relatives, at present, workers are content for the most part to collect, examine and record the material which is available and continually being brought to light. No details must be taken for granted, however small and seemingly insignificant they may appear, until they have been thoroughly investigated. This entails the long and patient work of examining and measuring material, or recording and analysing data, but a very necessary labor; for to obtain an orderly and systematic basis on which to work, the whole study, and particularly the physical aspect of Anthropology, is being treated more and more in a quantitative than the purely descriptive manner only.

In work on physical anthropology, a close and detailed study of the dentition and its associated structures does not seem to have attained the position of importance which it undoubtedly will as time goes on. Such data are frequently relegated to the optional or incidental observations; this, no doubt, being due to the importance attached to the study of those portions of the cranium directly associated with the brain.

Sir Arthur Keith in a recent article in "Nature" said, "It becomes more and more evident that we must trust to facial rather than to cranial features for the recognition and discrimination of human races". It is well known that the whole facial architecture is very intimately connected with and concerned in masticatory functions, and so a study of the facial region of the skull which does not include close and detailed attention to the teeth and the structures immediately adjacent to them, can hardly be looked on as quite complete.

The subject of Dentition can no longer be considered one of incidental interest, but must and will take its place as an important branch in the science of Physical Anthropology.

The following work is intended to serve as an introduction to the study of the Dentition and Palate of the Australian Aboriginal, some aspects being treated in detail others in a brief manner only.

Such a work, to be done in a really thorough and comprehensive manner, should preferably be undertaken by one engaged in full time work at a Department of Physical Anthropology; so that the many shortcomings of the present attempt can be partly accounted for by the fact that it is the product of only those spare hours which the writer has been able to devote to its preparation after his daily routine duties.

The attempt to produce this essay would have been futile had it not been that the writer has been privileged to work on the material in several institutions, and honored with the faithful assistance of a number of personal friends.

His thanks are due to the following:

To the Governing Board of the South Australian Museum for permission to work on the wonderful collection of Australian skulls in that Institution. To Mr Edgar Waite, the Director, for his ever courteous treatment, and also to members of the Museum staff.

To Professor Berry for permission to examine skulls in the Melbourne University Anatomical Museum and use of instruments.

To Mr J. Kershaw, Curator of the National Museum, Melbourne, for his kind treatment in facilitating an examination of specimens in that Institution.

To Professor Wood Jones, of the Anatomy Department, Adelaide University, and Hon. Curator of Anthropology in the South Australian Museum, whose guidance and loan of literature have been of inestimable value, it seems futile to attempt a record of my appreciation. To all who know him, he is one of the type of true gentlemen of Science to whom the assisting of young workers is a sacred duty, and the performance of which is to them a pleasure and reward in itself.

To Dr A.S. Randell for the loan of aboriginal skulls.

And not least of all to the following friends for their kind cooperation in the preparation of illustrations, mathematical results, text and typing same: Dr W. Ray, Messrs A. Williamson A.M.U.A., R. S. Burden B.Sc., Miss E. J. Young, Messrs P. S. Hossfeld, H. R. Underwood and C. Marshall.

Adelaide, June, 1923.

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INTRODUCTION

In the prefatory remarks it was stated that the study of that region of the cranium directly associated with the teeth has probably not attained the position of importance in physical anthropology that it should, and no doubt will attain.

It is now proposed to amplify this statement to some extent, and to point out that a detailed study of the teeth and adjacent structures over a large series of skulls is not only one of importance from the aspects of Physical Anthropology and Pure Dental Science, but also it provides data and lessons of no mean value to the problems of Applied Dental Science.

In the study of comparative anatomy, the dentition ranks as a subject of high importance, and among the Mammalia many classifications have rested solely on the morphology of a few teeth. Also, it might be mentioned, as Professor Wood Jones has pointed out in a recent publication (1), quite a number of fossil forms of Primates have been named and described by palaeontologists, solely on the evidence of single teeth and small fragments of jaws. However, when the subject is restricted to a group like the Primates, the differences between the dentitions are restricted, and thus the study becomes a more specialized one.

The evolution of the human dentition is a subject which has inspired copious writings and lengthy debate, and one which can only be clarified and made progressive by detailed studies on large amounts of material. A recent work of Gregory is a striking example of such a labor. [redacted]

The differences between the dentitions of various types of mankind have not as yet been sufficiently recognised to incite very special investigation. But this is probably due, not so much to the lack of obviousness in any differences as to the lack of specialized study.

When the problem of the teeth of fossil man is concerned, it has been shown that the study of comparative human dental anatomy can attain a position of marked importance. One has only to turn to the case of Mousterian Man, concerning whom the debates over the Krapina, Spy and Jersey specimens occupy writings voluminous. Then there are the innumerable pages devoted to opposing views on the dentition of the Piltdown find, or the much earlier discovery of Pithecanthropus erectus. Also it is obvious from the more recent notices which have been published on fossil types such as those of Wadjak and Rhodesia, that the condition of the teeth and their immediate structures is being studied in a more detailed manner than hitherto. The importance of a close study of the dental system of a modern primitive race in its relation to fossil man is obvious, and need not be dwelt on at present..

The study of the teeth of modern races for the purposes of morphological comparisons does not provide a very wide field for research, but there are features such as arch form, for instance, which are very important. Then the study of such a custom as dental mutilations is one which is perhaps more interesting than useful, but nevertheless it forms a part of those very important ethnological and psychological enquiries which deal with those primitive customs peculiar to the early stages of man's social makeup.

Approaching the subject more from the aspect of applied dental science, we find that a detailed study of the dentition even in the form of observations on museum specimens often reveals knowledge of very definite importance.

Observations on those portions of the skull concerned in mastication yield no small amount of information concerning the masticatory habits indulged in by the living possessor of the specimen. By such means we are able to discern the changes that man's jaw system has undergone during his march from primitiveness to the high standard of civilization. The changes and differences in progressive jaw development are noted; the alterations and results therefrom - in mandibular stresses and movements of the modern masticatory system from those of the so-called primitive one - become more apparent. Such increases in knowledge are undoubtedly useful when applied to such branches of Dental Science as Orthodontia and Dental Prosthesis. Still more striking perhaps is the lesson modern civilized people have to learn from a study of the teeth of primitive races, relative to those dental diseases, everywhere so persistent and ravaging, which civilization and its diet habits have produced. Dental Caries and Pyorrhoea Alveolaris are probably two of the most prevalent diseases to which modern man is subject, yet the lower races of mankind are, generally speaking, to a large extent free from these affections. The reasons for this are in some measure made quite clear by a study of native skulls, but, either through an exalted racial pride or sheer negligence, both the laity and more so the professions concerned - whose duty it is to acquaint themselves with and teach these things - are slow to learn the lessons to be learnt from our so-called savage, fellow human beings.

Although the foregoing remarks are a brief endeavor to point out some of the possibilities and value of a study of that portion of the skull concerned with masticatory function, it must be borne in mind that when taken in its complete sense, the region thus concerned would involve a large portion of the bony framework of the skull. For it is to be remembered that not merely the upper and lower jaws are involved in masticatory ~~masticatory~~ function; but it includes the whole architecture of the face, that is, up to the lower boundary of the forehead, a large proportion of the anterior part of the basal aspect of the skull, extending to the posterior margins of the glenoid fossa, also those portions of the lateral aspect of the skull which are involved by the temporal muscles.

The work here concerned is limited to the upper and lower arches, and the individual teeth constituting them, the palate, the alveolar ridges of the lower jaw and a few notes on the glenoid fossa. Time has not permitted the inclusion of a study on the whole mandible, which of course would give the term "masticatory system" , which I use so frequently, a closer approximation to its correct meaning than is implied throughout this work. It was felt that it would be highly preferable to leave the mandible for separate study in itself.

The above statements endeavor to point out to some extent the importance which may be attached to a close study of the dentition of a primitive race; yet such statements are in no way intended as a confident prophecy that the following pages must necessarily prove important additions to anthropological and dental science. However, for what their contents are worth, the writer offers these pages to any whose greater learning and keener insight may find in them a few small gleanings of information which will help in some work the importance of which is far greater than that granted to the humble study of recording a primitive aboriginal's dentition.

THE AUSTRALIAN ABORIGINAL

It will not be necessary ~~/~~in this work to deal with the Australian Aboriginal as a race otherwise than in a very brief manner.

Long before the study on man became recognised and established as the Science of Anthropology, travellers and all who studied different races of mankind looked on the indigenous human inhabitants of this continent as constituting one of the lowest and most interesting types existing on the earth. Ever since the study of man was placed on a systematic and methodical basis, facts concerning the Australian Aboriginals have been eagerly looked for, and remains both of himself and his handiwork are held at high value in the collection of the anthropologist.

This is easily understood when it is considered that in the study of the evolutionary progress of mankind, the lowest types attract a very ~~xxx~~ large share of attention; and among these the Australian has always been taken as a type to which one may turn and find in his physical, mental, moral and social make-up, stages of development much more primitive than those of people we are accustomed to designate as more or less modern racially. But although the status of our aboriginal is such an interesting one, and provides most striking material for comparative studies of mankind, yet of this race it can be said with safety that very few branches of study concerning him have been dealt with in anything like a comprehensive manner. In short, the sum total of our knowledge regarding these interesting people, who have been driven from their lands and in return treated most wretchedly, is very small. It is obvious that many practically untouched fields of research are waiting to be availed of by interested workers. Also it is highly desirable that all observations should be suitably and permanently recorded, no matter how small the amount of information may be. Particularly is this the case as the race is probably undergoing rapid disappearance, the process of which will be hastened only too quickly by the expected opening up of the centre of the continent.

One might earnestly urge the remarks of Dr Ramsay Smith made in an address in 1907 (2) in which he pointed out that too many opportunities for study of this race have been and are being lost, and that a great deal of anthropological research is yet to be done; and if it is to be done at all "the people forming the great majority to whom science is a recreation might surely unite in an effort to supply materials to those workers who apply themselves closely to what is an arduous and sometimes, unfortunately, an expensive task". It would also be very interesting to hear another similar address by such an authority as Dr Ramsay Smith, and especially to find out what results have, in his opinion, accrued from the concluding sentence in his abovementioned address:-- "If, however, by anything I have said, I have succeeded in making some people repentant over lost opportunities, and resolved to do something to help Australia - and especially South Australia - to take her proper place in anthropological research, then I am content."

Authoritative works and scientific writings are too numerous and too well-known to necessitate any further mention than that compulsorily occurring throughout these pages. Nevertheless, in passing, it may be stated that some of the chief problems of study concerning the Australian Aboriginal are:- his racial status relative to the living races of mankind; his relation to the fossil races; his manner of entry into Australia; the antiquity of man in Australia; whether or not he is pure stock, and if not, his particular relation to neighboring peoples; and especially his relation to the now extinct Tasmanian race. Such problems as these have led to much work and study both from the ethnological and the anthropological points of view, and there have been many illuminating theses published which contain the results of much patient and laborious observation and recording, all set down in an endeavor to obtain a solution of some or other of the above questions.

However, the work which deals with this race as a detailed study in physical anthropology is not nearly so voluminous as those records which are more of an ethnological nature; and of the former branch of study, only the mere mention can be made here of the names of some of the workers in this field. Probably chief among those whose work has been anything of a lengthy and detailed nature may be mentioned Flower, Turner, Professor Duckworth, Professor H. Klaatsch, W. Krause, Professor Berry, Dr Robertson, Dr Cross, Sir E. C.Stirling, Dr Ramsay Smith, H. Burkitt and Professor J. Wilson.

Turning now to sources where may be found special attention and records relating to the dentition of the Australian aboriginal, it will be found that these are by no means numerous, and in very few instances have the observers dealt with any large collection of material. Amongst the writings which are most useful on this subject, the following authors may be mentioned:- Flower and Turner - both of whose observations were always detailed and illuminating - H. Klaatsch, Professor Duckworth, Dr Ramsay Smith, Dr Brooke Nicholls, Dr Mattingley.

No reference need be made at this stage as to what extent these writers have dealt with the subject of Dentition, as their observations and records will be referred to under the various headings to which their work is related. However, with the exception of the work of Dr Nicholls, this subject has never been dealt with in such a manner as to be considered a comprehensive statement of the characteristics of the Australian's dentition, derived from the study of a really extensive collection.

SOURCES OF MATERIAL

The specimens on which the work of the following pages is based are located in the collections of various institutions and private persons.

The institutions on whose collections the writer has had the privilege of making observations and notes are:---

The South Australian Museum
Adelaide University Anatomical School Museum
National Museum of Victoria, Melbourne
Melbourne University Anatomy School Museum.

Besides these, the material in the private collections of Dr A. S. Randell and myself has been utilized.

THE MATERIAL

The specimens from which data have been recorded and observations made for this work include, in addition to a large number of complete skulls,crania with mandibles missing, odd mandibles, portions of upper and lower jaws which were sufficiently intact to provide recordable examinations, and a number of well preserved odd teeth collected from aboriginal burying grounds.

The total number of specimens dealt with, not including small pieces of jaws and odd teeth, is approximately 630.

The total number of teeth which have been examined for the various results dealing with measurements, occurrence of caries, cusp number, is approximately 10,500.

Although it is not suggested that all the specimens included in these totals have been subjected to every meadurement and observation considered in this study, yet such sections,as for example, the percentage of caries, frequency of mutilations and supernumerary teeth, do entail all these specimens, and this being so, such results are useful in having been ascertained from so large a series.

GEOGRAPHICAL CLASSIFICATION OF MATERIAL

It will be seen from the following notes that the material covers a fairly wide range of distribution in so far as South Australia and Northern Territory are concerned, but unfortunately the amount of material from the other States of which the author has been able to make records is rather small.

The following list shows approximately to what extent the various States have been represented by the specimens concerned herein:

South Australia	340
Northern Territory	150
New South Wales	14
Victoria	4
Queensland	1
Western Australia	15

In addition to these there is that usual number of specimens in large collections of which there is, unfortunately, no recorded data, and such have to be headed under "unknown" localities.

Approximately the number of specimens under this heading is 100.

It has been found desirable to separate many of the specimens from South Australia and the Northern Territory into a number of groups, these groups being named according to the locality from which the specimens forming them have been derived. Some of these groups have been found to provide in themselves interesting series of specimens for special study, as will be seen later in the work.

This further classification of the localities (see Figure 1) and the numbers representing them is as follows:

Northern Territory

Melville Island	22
Anson Bay	30

South Australia

Yorke's Peninsula	17
Adelaide District	54
Swanport, River Murray	105
Murray Mouth Lakes	25
The Cocrong	27

It will be seen that the tribes of the Northern Territory and South Australia are well represented, and in both cases the specimens are largely those of tribes inhabiting regions near to or on coastal localities. In the South Australian Museum there is sufficient material to represent by a large series these two distinct geographical regions.. A cursory glance over these skulls would certainly convince one of distinct and consistent differences in certain skull features of these two groups. Spencer(3) however, of the Northern Territory natives, writes: "It may be said that the coastal tribes have been in no way physically influenced by contact with Malays". From the point of view of the jaw region and particularly in the case of the ascending ramus of the mandible, there is an obvious and consistent difference. However, this point of interest is only referred to in passing; but such a double series would make an interesting field for research to ascertain what differences there are between the skulls of the two regions.

Of the group of specimens from Swanport it may be stated that in itself it constitutes a most interesting collection. With probably only a few odd exceptions the whole group consists of specimens which were obtained in one "find"; and the history of their recovery has been described in a lengthy and detailed manner by the late Sir Edward Stirling (4). The interest and value of any records of this group rest in the fact that they in all probability represent a stock entirely uncontaminated by influences of white population and so situated geographically as to be removed from suspicion of any intermixture of an outside race, as some of the north coastal tribes were undoubtedly so affected. As stated in the abovementioned article, "Thus there can be no question that these remains represent the pure strain of aboriginals ....."

SCOPE OF WORK

Although the observations concerned in this work cover many features of the aboriginal's dentition, they constitute what can be little more than an introduction to what is really a very large subject. Many of the features included herein have only been touched on and would permit of a much more detailed study than the present writer has had opportunity of pursuing.

As was previously stated, a complete study of the dental system would include a good deal more than a survey of the teeth and immediately adjacent structures, but it is hoped that sufficient has been done to provide at least a general idea of the teeth, arches and palate of this race.

The mandible in itself is a subject for very extensive and detailed work, and therefore the mention of conditions of the alveolar process and the so-called "mandibular torus" is all that has been included concerning the lower jaw beyond the actual teeth themselves.

The following schedule shows more or less completely the range of the work covered.

General description of the teeth and normal variations:
- Crown formation;
- Cusp patterns;
- Root formation.

Tooth Measurements.

The Pulp Cavity.

The Dental Index.

Variations .... in
1. Number
2. Position
3. Form.

The Palate Form and Development

The Dental Arches

The Occlusion of the Teeth

Eruption of the Teeth.

The Glenoid Fossa

The Mandibular Torus

The Gnathic Index

Abnormal developmental Conditions:

Odontomes

Enamel Nodules, etc.

Accessory dental masses.

Fourth Molar Pits.

Certain Functional Conditions:

Attrition, Occlusal and Interproximal.

Marked Root Divergence.

Absorption of and structural change, alveolar process.

Some Pathological Conditions:

Dental Caries

Alveolar Abscess Calculus.

Erosion. Periodontal Affections.

Notes on the Food of the Aboriginal.

Removal of the teeth.

Toothache.

Some aboriginal ideas on teeth.

Teeth of fossil man in Australia.

Some conditions bearing on problems on the dentition of fossil man.

Summary.

Some Preliminary Notes, Methods of Measurement, etc.

In referring to the Australian aboriginal as belonging to a primitive race, it must be pointed out that the word "primitive" is only used in its relative sense to distinguish him from the more advanced races of mankind. For, as Sir J. G. Fraser has pointed out, it is a very difficult task to attach a precise meaning to the word in its absolute sense, but that "in ordinary speech the relative sense of 'primitive' is freely admissable".

Although previously mentioned, it must be again pointed out that in the following pages the somewhat frequently appearing term "masticatory system" is not used in its full and correct sense, but only as involving the teeth and osseous structures adjacent to them, namely the dental arcades, alveolar ridges and palate.

It will be seen that in the present work there are many instances in which the data on certain features have not been compared with those of other races. This is to be accounted for partly by the lack of comparative data on many features of the human dentition, and also by the difficulty of gaining access to or securing literature published in other parts of the world.

Sex classification of material. On the advice of Professor Wood-Jones, no attempt has been made to give results for separate sexes. So many of the specimens herein concerned are unaccompanied by those other bones of the skeleton confirmatory of sex, that the general results would probably be much depreciated in value were the sex of the specimens judged and published merely on the evidence of skull appearance.

Age classification. A method of classification of material has been adopted here which might conveniently be termed "age classification"; and it is felt that such would be a very natural and desirable method to apply when development of structures and the occurrence of diseases are to be studied. The skulls, therefore, have been divided into five groups which are termed: infant, young, young adult, adult and aged. The definition of this grouping is as follows:

Infant: Skulls showing deciduous dentition only; this would probably mean children up to about five years of age.

Young: Skulls showing the transition stage from deciduous to permanent dentition; and those in which the second permanent molar is unerupted or only partially erupted, but not up into its normal position in the arch. This group includes children from the stage when the first permanent molar is in position up to an age which would probably be just prior to their teens. That is, approximately six to twelve years.

Young Adult: Skulls showing the permanent dentition completed so far as the second molars being well up into position in the arch, but third molars unerupted or only partly so. Adults with no third molars, or with these teeth, for various reasons, very backward in eruption, are easily excluded by general cranial and suture conditions. This group would include ages approximately from twelve to seventeen or more.

Adult: Permanent dentition quite complete as far as the eruption of teeth is concerned.

Aged: Those adult skulls which the general features, dental condition, and fusion of sutures would indicate as having belonged to individuals of advanced age.

It is felt that the above classification will prove useful for noting the period of life when dental diseases are most prevelent, and also give stages of development of the palate, for example, which would show progressive age changes in an interesting manner.

In the text the numbers in brackets ( ) indicate the source of the references, which will be found in corresponding numerical sequence at the end of the work.

Numbers in double brackets (( )) denote that a certain condition existed in that number of specimens.

In the present work no attempt has been made to provide the statistics in any other mathematical treatment than by merely giving totals, averages, maximum and minimum measurements and a few graphs. It is fully recognised that by the modern requirements of biometrics, results treated in the simplest mathematical manner are not of very great value. However, various conditions have made it impossible to adopt a more desirable means of treatment for the present, but it is intended that much of the work entailed here will be carried on and at a later date issued in a manner which will be more in keeping with the requirements of the modern methods of mathematical treatment of studies in physical anthropology.

The measurements of various structures and methods of securing them will be dealt with in detail in the pages concerned. The instruments most used were the usual calipers and slide compass by Hermann, Zürich, fine pointed dividers and two specially designed instruments for obtaining palate depths and arch length. These last two mentioned - which will be illustrated later - were designed and constructed by Mr Rogers of the Adelaide University, and their neatness and fineness in construction reflect great credit on his workmanship.

In securing measurements with calipers, etc. in millimetres, no attempt has been made to judge at greater precision than ·5. For instance, if a measurement were judged as being half way between 10 and 11 millimetres, it was called 10.5; but if nearer to the 10 mark it was called 10, or to 11, recorded as 11. Also in calculating indices, the result was only taken to one place of decimal; if the second decimal figure was above 5, the first was augmented by one. For example, 100.64 is recorded as 100.6, while 100.67 becomes 100.7.

It would perhaps be advisable to explain a method of natating the teeth at times used in this work, and one which is adopted almost universally in clinical work, and on account of its convenience is appearing more and more in dental literature. It is called Palmer's Notation, by which the teeth are numbered from 1 to 8, commencing at the central incisors in each case, upper and lower. The upper and lower arches and their right and left sides are indicated by lines at right angles. The following figure makes it clear:

$$\begin{array}{lcr|lc} \text{Upper} & \multirow{2}{*}{R} & 87654321 & 12345678 & \multirow{2}{*}{L} \\ \hline \text{Lower} & & 87654321 & 12345678 & \end{array}$$

So that the upper right central is indicated $\underline{1|}$; the lower left first molar $\overline{|6}$; lower right central and lateral $\overline{21|}$; upper left third molar $\underline{|8}$, and so on.

A

GENERAL DESCRIPTION

of the

TEETH.

DESCRIPTION OF THE TEETH

For the purpose of a general description of the teeth of the Australian native, an endeavor will be made to give a short and simple description of what one would suggest, after a study of a fairly large number of specimens to be the features of interest of more or less typical forms of the various teeth. This description will deal with each tooth in turn, and state the general shape of the crown, cusp patterns and root forms. Besides describing the more or less typical condition, there will be included what might be termed the "normal variations", leaving such special variations as, for example, extra roots or Carabelli's tubercle, to be dealt with under the section headed "Variations".

The dimensions of the tooth crowns and roots will be given. In some cases the number of specimens subjected to measurement will not be as great as is desirable, but this is accounted for, to a large extent, in two ways. Firstly, in very many of the skulls dealt with it was impossible to obtain root measurements because any teeth in the specimen with tendency to looseness had been firmly cemented into their sockets by the persons who prepared the specimens. Then again it was a matter of difficulty to measure the root length of first molars, because on account of the size and divergency of the roots it was impossible to remove the teeth without damaging both teeth and alveolar ridge. Then again on account of the marked occlusal wear on the molar teeth in a large number of the specimens, cusp patterns were entirely obliterated, so that the number of cusps could not be definitely determined.

UPPER CENTRAL INCISORS.

In the aboriginal these are very large, well-formed teeth. Considering the tooth as a whole, one cannot help but be struck by the shortness in root length compared with the general size, and in particular the inciso-gingival diameter of the crown.

The crown, viewed from its labial aspect, presents various shapes. Up to the present, time has not permitted a close application to these aboriginal teeth of the suggestion put forward by J. Leon Williams (5), that the shapes of anterior teeth may be grouped into three fundamental types, insofar as contour of the labial surface is concerned. However, it is obvious that there is a diversity of shape, and one could not lay down any particular outline of tooth as a racial characteristic.

The lingual aspect generally presents an evenly contoured surface, with no marked development of marginal ridges or tubercles. Occasionally a moderate amount of grooving is seen passing over the gingival eminence, but very rarely do these grooves become deepened into marked fissures.

From the material available, it would seem that the three developmental tubercles on the unworn incisal border, which are often seen in white children's teeth, are either absent or not well accentuated on the teeth of aboriginal children.

As before mentioned the root of this tooth is much shorter than one might expect from the size of the crown, and the apex is finished off in a very blunt fashion. The condition is never seen in which the upper third of a root tapers off with perhaps a bend distally or posteriorly, a feature so frequent in modern incisors.

The root is often somewhat recurved in keeping with the fairly marked prognathism of this race.

Some features of the incisor teeth will again be referred to under the heading of Variations in Form.

Figures 2 , 3, and 4 show a few specimens which have been selected with unworn anterior teeth, and give an idea of the variety of form.

The measurements of the teeth are given in tables at the end of this section, but the average measurements are here given compared with those of modern whites from the figures in Black's Dental Anatomy, and Japanese from measurements by Miyabara (see 6).

Crown M.D.	Crown L.L.	Root Length	Total Length.	
9.4	7.9	14.6	24.5	... Australian
9	7	12	22.5	... Modern White
8.4	7.4	11.3	22.9	... Japanese.

THE LATERAL INCISORS:

This tooth as in other races is a good deal smaller than the central, but with the Australian it is, practically always, a very well formed tooth. The same features dealt with for the central hold good for the lateral, as regards shape, size and surface markings. The chief point to emphasize about the lateral is the almost entire absence of diminutive and peg-shaped forms so often seen in present day teeth. This would seem to indicate that it is still of sufficient importance as a functioning member of the arch to escape the fate of disappearance which seems to be besetting the upper lateral incisors of modern civilized man.

Figures 2, 3 and 4 show examples of complete crowns.

Crown M.D.	Crown L.L.	Root Length	Total Length	
7.7	6.9	15.6	24.5	Australian
6.4	6.0	13	22	Modern White
7.0	6.5	11.7	21.7	Japanese

UPPER CANINES:

Although the canine of the Australian reaches a pitch of development in size and strength which at times appears almost amazing, it is still quite human in form, and presents no feature which could be termed simian. It is very large at the gingival and neck region. The root, as with the incisors, often finishes off in an abrupt and shorter manner than might be expected; and though the total length of the tooth is often great, the upper portion of the root is seldom tapering as is seen in many modern canines. Lingual tubercles and grooving in any marked degree are rare, but moderate grooving is occasionally seen.

The root of upper canine is generally recurved somewhat, see Figure 5, and sometimes to a marked degree.

Crown		Root	Total	
M.D.	L.L.	Length	Length.	
8.4	9	19.9	27.5	Australian
7.6	8	17.3	26.5	Modern White
7.9	8.6	15.4	26.4	Japanese

THE UPPER PREMOLARS:

These teeth are well formed, the first being somewhat larger than the second. They are larger and stronger looking in development than the same teeth in modern dentures. One difference which is probably the most obvious from present day teeth, besides that of size, is the greater development of the buccal cusp over the lingual and concomitant accentuation of the triangular grooves.

The first premolar generally had two roots, which if not completely separated all the root length were distinct in the upper half.

The second premolar was generally single rooted, though at times two rooted teeth were met with.

Various of the illustrations in later parts of the work show arches containing well formed and typical premolars.

	Crown M.D.	Crown L.L.	Root Length	Total Length.	
1st P.M.	7.8	10.3	16.3	22.6	Australian
	7.2	9.1	12.4	20.6	Modern White
	7.3	9.5	12.2	21.0	Japanese
2nd P.M.	7.2	10.1	16.9	22.3	Australian
	6.8	8.8	14.0	21.5	Modern White
	7.0	9.3	12.9	20.7	Japanese

FIRST UPPER MOLAR:

The first molars are generally the most conservative of all the teeth and do not often present marked variations.

In the aboriginal this tooth was always a large well-formed tooth, with four strong distinct cusps, separated by well-defined grooves. The disto-lingual cusp was always well-formed and showed no signs of reduction in size. It had well-formed mesial and distal marginal ridges, and the distal ridge seldom showed that splitting up into tubercles which is associated with reduction of the disto-lingual cusp.

The roots were large, well formed, and divergent to such an extent that with fully formed roots removal of this tooth from the jaw was an impossibility without completely wrecking the adjacent alveolar ridge or smashing up the crown or roots in the attempt.

The continuation of the lingual groove down over the lingual surface, and also its continuity with a shallow vertical groove on the lingual aspect of the lingual root, was fairly common. The anterior buccal root was generally wide labio-lingually and often showed a tendency to become two roots by the presence of a vertical constricting groove.

The well formed occlusal ~~surfac~~ surface is well depicted in various of the illustrations.

Crown M.D.	Crown L.L.	Root Length	Total Length	
11.4	12.8	13.5	19.5	Australian
10.7	11.8	13.2	20.8	Modern White
10.7	11.3	13.2	20.2	Japanese

The number of cusps will be dealt with later.

Fusion of the roots of this tooth is entirely absent, and rather, the opposite condition is very well marked.

SECOND UPPER MOLAR:

This tooth, as will be seen from the subsequent figures, is somewhat smaller in its mesio-distal diameter than the first molar, but it is frequently greater than the first in its labio-lingual diameter.

Its crown is large and well formed and has four strongly marked cusps and well defined grooves separating them. However, in this tooth it is obvious that a reduction in the size of the disto-lingual ~~mi~~ cusp was taking place. There has been no record in the present work of a tricuspid second molar, but it would appear that as the disto-lingual cusp diminishes in size, the lingual portion in particular of the distal marginal ridge becomes broken up into tubercles by supplemental grooves passing over it. From the present observations, this feature would appear to be well established, that is, the association of the breaking up of the distal marginal ridge into tubercles and the reduction in size of the distal portion of the crown.

The number of cusps will be dealt with on a later page.

The number of roots will be considered at the end of this section.

Crown M.D.	Crown L.L.	Root Length	Total Length	
10.9	13.1	13.6	19.6	Australian
9.2	11.5	13.0	20.0	Modern White
9.9	11.1	13.8	20.7	Japanese

THIRD UPPER MOLAR:

The third molar is the only tooth in the arch which shows any frequency in variations of form. But it must be borne in mind that this frequency of variation is only relative to the other members of the arch. For generally the third molar is quite is quite a good sized functioning tooth, and variations are much more the exception, compared with almost the regular occurrence of abnormal forms that is the case with this tooth in modern civilized people.

In the Austtalian the process of cusp reduction in size of the third molar has proceeded still further than in the second molar; and a variation not infrequently seen is a reduction in size of the disto-lingual cusp until it becomes a tubercle or cusplet, commensurate in size with those formed of the adjacent marginal ridge. The figures given below indicate the extent of normal quadricuspid form and the reduced variations. The disappearance of the fourth cusp is of course concomitant with the shifting of the lingual groove from its situation on the limgual surface, distally, till it is indistinguishable from the supplemental ridges in this region of the occlusal surface, or it becomes the distal triangular groove of the single lingual cusp.

Many of the photographs given here show cases of the typical well developed third molar. Its marked variations will be dealt with in a later section.

In root form the third molar generally possesses three separate roots, although occasionally fusion of the roots is met with to a more or less complete extent. However, it is only rarely that these teeth have their three roots fused together into the pyramidal form which is so often seen in modern third molars. Numerical results dealing with root number will come under the heading of "Roots".

Cusp numbers will also be treated later.

Compared with the third molars of modern whites, this tooth is a very active and hard working member of the dental arch.

Crown M.D.	Crown L.L.	Root Length	Total Length	
10.0	12.3	13.9	19.7	Australian
8.6	10.6	11.4	17.1	Modern White
8.9	10.6	10.5	16. 9	Japanese

LOWER INCISORS:

There is little or nothing to say with regard to these teeth beyond that they are always well formed and larger in size than the same teeth in present day dentitions. They bear practically the same relation in size to the upper incisors as do the modern teeth.

In the specimens observed there did not appear to be such a marked condition of the developmental tubercles on the unworn incisal borders as is often seen in modern teeth.

	Crown M.D.	Crown L.L.	Root Length	Total Length	
I1	6	6.3	13.4	21	Australian
	5.4	6.0	11.8	20.7	Modern White
	5.4	5.8	9.7	19.2	Japanese
I2	6.7	6.6	14.7	24.5	Australian
	5.9	6.4	12.7	21.1	Modern White
	6.0	6.3	11.6	21.3	Japanese

LOWER CANINE.

Little more can be said of this tooth than that compared with its modern representative, it is a larger and stronger tooth, its root being large and very firmly set in the jaw. The tooth is very conservative in shape and no marked indication of root bifurcation has been met with.

Crown M.D.	Crown L.L.	Root Length	Total Length	
7.6	8.3	18.1	28	Australian
6.9	7.9	15.3	25.6	Modern White
6.8	7.9	13.6	24.5	Japanese

LOWER PREMOLARS:

The first lower premolar is a much larger tooth than the same member of the modern arch. Its crown is large and strong looking and often bears that sectorial appearance which is reminiscent of the simian premolar.

The second premolar is also a large well formed tooth, its crown not infrequently presenting three cusps so well formed that the occlusal surface would almost rival some modern tricuspid molars in size.

	Crown M.D.	Crown L.L.	Root Length	Total Length	
Pm 1:	7.6	8.8	16.3	22.6	Australian
	6.9	7.9	14	21.6	Modern White
	7.6	8.3	12.2	21.5	Japanese
Pm 2:	7.7	8.9	16.5	22.5	Australian
	7.1	8.0	14.4	22.3	Modern White
	7.3	8.2	12.8	20.8	Japanese

FIRST LOWER MOLAR:

As in the case of the first upper molar, so with the lower, it is a large well formed tooth with cusps and grooves clearly defined and its whole structure varying but little in form. It always has five cusps and two roots. The crown is large in size and the roots consist of strong parallel plates somewhat rectangular in form. The mesial root is almost invariably bifurcated in its lower quarter, but the bifurcation may involve more of the root. The distal root is also very frequently bifurcated at its apex, but does not display this tendency quite so much as the anterior root.

The distal cusp is always well developed and shows no tendency to diminish in size and become a part of the distal marginal ridge; thus the disto-buccal groove is always well formed and extends onto the buccal surface of the crown.

Crown M.D.	Crown L.L.	Root Length	Total Length	
12.3	11.9	14.2	21.9	Australian
11.2	10.3	13.2	21.0	Modern White
11.5	10.7	12.1	19.3	Japanese

SECOND LOWER MOLARS:

The unworn second mandibular molar is somewhat elliptical in the outline of its occlusal surface, but becomes more rectangular with interproximal wear. It will be seen by later figures that this tooth in the Australian's dentition has departed somewhat from the supposed typically primitive occlusal pattern showing five cusps. In the major percentage there is a quadricuspid crown, although even when showing this formula there is frequently a very marked development of the distal marginal ridge; no doubt it is this latter feature which has led some observers to term such a cusp number as 4½. But in these cases it is debatable whether this distal marginal development can be termed a cusp, because in a true five cusped lower molar the fifth cusp - the distal - is marked off from the disto-buccal cusp by a distinct disto-buccal groove; but in most cases of this well developed distal marginal ridge there is no sign of this particular groove extending from the occlusal down over the buccal surface.

However, even in its quadricuspid form this tooth is exceedingly well developed. Figure 6 shows two well formed and practically unworn second molars placed beside two second lower molars from modern white mouths, the latter teeth, if compared with a collection of modern molars, would be considered fairly well developed teeth. The comparison is striking.

The roots of second lower molars are rarely fused and seldom show any tendency in that direction. Also it is not unusual to see the apical quarter or fifth of the roots bifurcated.

Crown M.D.	Crown L.L.	Root Length	Total Length	
12.5	11.7	15	22.2	Australian
10.7	10.1	12.9	19.8	Modern White
11.1	10.2	11.3	18.4	Japanese

THIRD LOWER MOLAR:

As was the case with the corresponding upper molar, this tooth was the one of its arch most likely to show variations in form. However, from the subsequent figures it will be seen that on an average it was in dimensions not very much smaller than its neighbor. If those variations of crown form which show marked irregularities, be excluded, it will be seen from the records on cusp numbers that the majority of third molars possess five cusps. Although in root form it shows more liability to fusion than the other molars, yet it mostly shows two well formed and separated roots.

Again, as with the upper third molar, the striking difference between it and its modern representative is that it is almost invariably ~~ant~~ a thoroughly functioning and useful dental member. It is this feature which no doubt helps it considerably to retain most of the features of the typical primitive tooth.

Cusp and root records will be given later, and marked variations in form dealt with in a subsequent section.

Crown M.D.	Crown L.L.	Root Length	Total Length	
11.9	11.1	14	19	Australian
10.7	9.8	11.8	18.3	Modern White
10.5	9.8	10.5	17.2	Japanese.

NUMBER OF CUSPS ON MOLARS

The percentages are here given of the number of cusps on the occlusal surface of the molar teeth. A cusp has only been counted as such when it is a well formed eminence on the tooth and separated from its neighbors by distinct, well defined grooves. In such cases where an eminence has diminished in size to the extent that it can hardly be considered a cusp, and more a cusplet or tubercle - such as is the case in reduced conditions of the disto-lingual cusp on upper molars and distal cusp on lower molars- and exists as a tubercle of appreciable size, then the cusp quantity has been expressed with a + sign added to the number of the cusps.

	Upper Molars					Lower Molars				
	No. of teeth	4+	4	3+	3	No. of teeth	5+	5	4+	4
First	88	5.7	94.3	-	-	88	6.8	87.5	2.5	3.7
Second	208	3.8	96.2	-	-	125	-	32	4.8	63.2
Third	156	5.8	71.2	20.5	2.5	110	2.7	70	--	27.3

These results show that of the upper molars the first and second almost invariably show four well defined cusps; while the third, although displaying cusp reduction, shows over 70 per cent with four cusps.

With the lower molars, the first with few exceptions presents the quinquicuspid form; the second causes a departure from the primitive formula by showing a majority percentage of the quadricuspid form. The third mandibular molar instead of continuing the cuspal retrogression returns to the five cusp form in 70% of the specimens recorded.

Available records by other observers on the cusp number of Australian molars are compared with the above results, as follows:

3rd Upper Molar:	4 cusps	3 cusps	
	74.1%	25.8%	Nicholls (7)
	36%	47 %	Topinard
	77%	23%	Campbell

2nd Lower Molar:	5 cusps	4 cusps	
	13.6%	86%	Nicholls
	73.3%	-	De Terra
	32%	63%	Campbell

3rd Lower Molar:	5 cusps	4 cusps	
	73.3%	23.3%	Nicholls
	70%	27.3%	Campbell.

From these figures it will be seen that the results of the present writer are in close accordance with those of Nicholls, excepting in one case where the present findings gave a higher percentage for the five cusped second lower molar.

ROOTS

Records were kept of those cases in which the number and condition of the roots of the posterior teeth were observable beyond doubt.

The molar roots have been classified according as to their being distinctly separate, partly fused or completely fused. "Partly fused" being the term used to designate that condition in which, for example, one of the buccal and lingual roots of an upper molar might be joined by a thin plate of tissue or the two buccal roots more or less completely joined. "Fused" is that condition in which all the roots - either in upper or lower teeth - are joined into a somewhat pyramidal form, and the roots outlined by the presence of grooves down the sides of the mass.

Of course, as Kramberger has pointed out, the term "fused" is often inadvisedly used, because very often the so-called fused roots of a molar were never distinctly separate to become fused; the joined condition being one of initial development. However, the term will serve its useful purpose here in designating the divergence or otherwise of the roots.

	No. of Teeth	Upper Molars		
		Three roots	Three partly fused	Fused
M1	259	100%	-	-
M2	261	95.8%	4.2%	-
M3	203	70.9%	11.8%	17.3%

These results add confirmation to those of the cusp number in showing that the upper first and second molars are well formed teeth.. The third upper molar shows, by its percentage of rooted condition, a very marked comparison to those seen from the mouths of modern white people.

The following are the percentages for lower molar roots:

Lower Molars				
	No. of teeth	2 roots	Partly Fused	Fused
M_1	176	100%		
M2	174	98.3%	.6%	1.1%
M3	114	92.1%	4.4%	3.5%

Here again it is seen that as far as root formation goes, the lower molars are well formed teeth; over 90% in each case having two distinct roots. Also, as was pointed out before, in many specimens the first and second molars presented bifurcation of each root near its apex.

The following figures show the nature of root formation of upper premolars in so far as being single or double rooted.

The conditions have been classified as to whether two separate roots were present, only one root, or the midway condition in which the root portion would be bifurcated in approximately its apical quarter.

	No. of Observations	One Root	Partly Bifurcated	Two Roots
1st Pm	100	31%	13%	56%
2nd Pm	93	82.8%	7.5%	9.7%

Figures 7 and 8 show interesting examples depicting stages of root development.

In the upper row of Figure 7 are some upper molars; it will be seen that after the "neck" region of the crown has been formed, the next stage of development, and one just prior to the commencement of root forming, is the extending inwards from the periphery of little tongues of tissue which constitute the inter-radicular or basal portions of the crown. These little tongues may or may not meet at the centre and coalesce, according to whether the tooth is to have three entire separate roots, or two of the three more or less conjoint.

In the second row of Figure 7 it will be seen that the ingoing tongues have fused and their edges have turned up, as it were, and commenced growing in a direction at right angles to the initial direction of growth of the tongues. This represents the first stage in the process of root formation.

In the specimens shown in Figure 8 it can be seen that the stage of root formation has progressed still further, and the roots in this stage are like short spouts or tubes projecting out from the basal portion of the crown.

The more advanced stages of root development are not here illustrated because in appearance they are identical with the incomplete forms occasionally met with among any collection of extracted teeth. But it is not very often that one has the opportunity of meeting with such specimens as are here depicted which show the initial stages of root development; and also are shown in teeth which belong to a remarkably well formed dentition.

MEASUREMENTS OF TEETH

UPPER ARCH

	Mesio-Dist. Diam.				Lab.-Ling. Diam.				Total Length				Root Length			
	Obser-vations	Aver-age	Max.	Min.	Obser-vations	Aver-age	Max.	Min.	Obser-vations	Average	Max.	Min	Obser-vations	Aver-age	Max.	Min.
1st Incisor	56	9.37	10	8.5	93	7.9	9	7	4	24.5	27.5	23	18	14.6	18.5	12
2nd Incisor	78	7.65	9	6.5	126	6.91	8.5	6	5	24.5	26	22.5	15	15.6	18	14
Canine	116	8.43	9.5	6.5	159	9	11	7.5	7	27.5	32.5	22.5	41	19.95	23	14
1st Premolar	124	7.81	9	7	163	10.3	12	8.5	6	22.6	26	21	35	16.27	18	14
2nd Premolar	89	7.23	8.25	6.5	168	10.14	12	8.5	13	22.3	26	19.5	36	16.88	20	13
1st Molar	198	11.43	13	10	255	12.84	14.75	11.5	1	19.5	-	-	5	13.5	14.5	11
2nd Molar	168	10.93	12.5	10	241	13.1	16	11	8	19.6	20	19	15	13.6	16	12
3rd Molar	142	10.03	13	8	193	12.33	15	10	10	19.7	20.5	19	22	13.93	16	12.5

MEASUREMENTS OF TEETH

L O W E R A R C H

	Mesio-Dist. Diam.				Lab.-Ling. Diam.				Total Length				Root Length			
	Observa-tions	Avge	Max.	Min.	Observ-ations	Avge	Max.	Min.	Observ-ations	Avge	Max.	Min.	Observa-tions	Avge	Max.	Min.
1st Incisor	43	6	7	5	77	6.3	7.5	5.5	1	21	-	-	4	13.4	14	12.5
2nd Incisor	51	6.7	7.5	6	92	6.6	7.5	6	3	24.5	26	22	8	14.7	16	13
Canine	88	7.6	9	7	120	8.3	10	7	4	28	29	25.5	17	18.1	21	17
1st Premolar	93	7.6	9	7	120	8.8	10	7	5	22.6	25	21	23	16.3	19.5	14
2nd Premolar	79	7.7	9	6.5	109	8.9	10	7	2	22.5	23	22	16	16.5	18.5	15
1st Molar	139	12.3	14	11	186	11.9	13.5	10	3	21.9	23.5	20.2	7	14.2	16	13
2nd Molar	152	12.5	14.25	10	184	11.7	13.5	10	2	22.2	24	20.5	8	15	19	12.5
3rd Molar	136	11.9	14	9	152	11.1	13	8	1	19	-	-	6	14	14.5	13

The following figures give the results of measurements on the crowns of deciduous teeth

		M.-D.		L.L.	
		Observations	Average	Observations	Average
Upper	a	7	7.8	7	5.6
	b	7	6	7	5.3
	c	12	7.5	10	6.6
	d	25	8	30	9.7
	e	39	9.7	41	11
Lower	a	4	4.7	4	4.4
	b	8	5.4	8	4.7
	c	10	6.4	8	6.2
	d	21	9.1	21	8
	e	20	11.7	19	10.1

If this table be compared with that given by Black for the dimensions of deciduous teeth of modern whites, it will be found that most of these dimensions of Australian deciduous teeth are greater by a millimetre or more than those given for the civilized races.

THE PULP CAVITY

A detailed study of the pulp cavity is one which involves at the least a large amount of work in section cutting and radiography, and such is quite beyond the time available for, and the scope of the present essay.

However, by means of the radiographs and photographs of specimens given in this work, some general idea of pulp cavity features in the aboriginal teeth may be gained.

The reader should here refer to the series of radiographs showing development of the teeth in the lower jaw, Figures 9,10,11,12,13,14,15,16,17. and to the two plates showing progressive changes in the pulp cavities of permanent and deciduous lower molars in Figures 18,19.

It will be seen that in the completely formed tooth the pulp cavity is a fairly capacious chamber and the root canals of fairly large diameter. There is a rather marked thickness of tissue between the occlusal surface of the tooth crown and the occlusal wall of the pulp chamber. The floor of the chamber will be seen to lie very close to the external surface of the tooth where the roots join. It will be seen that the anterior horn of the cavity rises higher than the distal one.

The reduction in size which the cavity undergoes as a result of attrition are well illustrated in the various figures given. If the illustrations here submitted can be taken as representing the usual conditions prevailing in these pulp cavities, and the changes they undergo, a rather remarkable and unexpected state of affairs goes on in the reduction of the cavity.

Reduction in size of the pulp chamber is explained by a series of processes in which first the occlusal surface of the tooth is worn until the enamel being worn through, the dentine is exposed. On the encroachment of wear on to the dentine, or probably even before its actual exposure, the dentinal fibrils are subjected to irritation either thermally or by actual pressure. The terminal portions of the dentinal tubules apparently become closed by a calcific deposit, and thus the exposed dentine presents the characteristic "hardened and polished surface". The irritation of the fibrils is, of course, transmitted to the pulpal tissue and the latent power of the odontoblasts is stimulated, and active formation of secondary dentine is set up to withstand encroachment on the pulp cavity and its contents.

It would be expected that that portion of the pulp cavity nearest the tooth surface undergoing attrition would be the first site for the laying down of extra tissue; that, of course, would be the occlusal surface or "roof" of the pulp chamber. But close attention to the given illustrations will show that, in the case of the teeth therein concerned at any rate, it is on the <u>floor</u> of pulp chamber that the secondary deposit is most obvious, that is, <u>not</u> on the portion of pulp chamber nearest to the encroaching process. This does not imply that no secondary dentine is laid down on the roof of the pulp cavity, but certainly the thickness of tissue between the pulp cavity and root portion of the tooth is considerably thickened under attrition, whereas the initial outline of cavity roof is preserved to a large extent and remains at a level, relative to cervical enamel margin, which is strikingly constant compared with the change in height of the level of the cavity floor.

It will be seen also on reference to Figures 20 and 21, that the pulp chamber and root canals in the teeth of a chimpanzee are very similar in size and appearance to those of human teeth, and that under attrition the pulp cavity is reduced in a like manner.

Before leaving this subject it must be stated that it is not unusual for radiographic evidence to be introduced into subjects bearing on the comparative sizes in pulp cavities, but the effect of occlusal wear on the size of the cavities is a very important feature, as has been shown here; and it is quite possible that incorrect deductions may be made in some cases through lack of attention to the relation between occlusal wear and pulp cavity form.

THE DENTAL INDEX

Flower (8) investigated the size of teeth in order to ascertain whether their dimensions could be used as a racial indication. His studies considered the relation of the size of the teeth to that of the skull and the measurements used for this comparison were the length from the front of the first premolar to the back of the third molar (in situ) and the cranio-facial length. From these measurements he obtained his "dental index".

The index may be expressed thus:

$$\frac{\text{Length of premolar and molar crowns} \times 100}{\text{Basi-nasion length}}$$

This treatment gave figures ranging from 42 upwards, and Flower suggested the following classification:

42 microdont

43 mesodont

44 and upwards, megadont.

Tomes (29) gives the following racial classification by Flower's index:

Microdont -

European	Egyptian
British	Polynesian

Mesodont -

Chinese	Malays
American Indian	Negroes

Megadont -

Melanesians	Australian
Andamanese	Tasmanian

The same author goes on to say :-- "As to this classification, it is to be remarked that the teeth of Polynesians are actually larger than those of Europeans, but the cranio-facial axis is of extreme length, so that the index is reduced; this is also the case with the American Indians, whilst the Andamanese are brought into the megadont series by the relative size of the teeth to the basis cranii, though in this small people the teeth are actually small, considerations which diminish the value of the method".

The index given here for Australians is that derived from adult skulls with all the premolar and molar teeth in situ. If these teeth were all present on both sides of the upper arch, both sides were measured, and the average of the two taken. The method of securing this measurement is shown in Figure 22, and it is the distance between the most anterior point of the first premolar and the most posterior point on the normal third molar.

It will be pointed out later in the section dealing with interproximal attrition of the teeth that the length of the premolars and molars in situ will be less than the sum of the measurements of the individual teeth of the Pm + M series, owing to the wearing of approximating teeth one on the other.

The results of the work of the present writer are as follows :

Number of specimens measured for securing Pm + M length			....	100
Average length, Pm plus M series:				
	((159)) Upper arches		....	45.8
	((105)) Lower arches		....	49.6
Range.	Upper -	Maximum	....	50.5
		Minimum	....	40
	Lower -	Maximum	....	55
		Minimum	....	41
Average of Indices((86))			....	46.13
		Maximum	....	50
		Minimum	....	41.3

Thus according to the results obtained from these observations, the Australian comes under the classification ~~as~~ of

Megadont.

The following are the results of various observers who have worked out the Dental Index for this race.

	All skulls	No.	Male skulls	No.	Female skulls	No.
Duckworth (9) (which includes Davis, Flower, Turner, Quatrefuges et Hamy, Cauvin.)	45.3	49	45.1	30	46.5	16
Campbell	46.13	86				

A few comparative data dealing with the Dental Index are here given:

Orang-Utan	(Avge both sexes)	55.2	Duckworth (10)
Gorilla	(do.)	54.1	do.
Chimpanzee	(do.)	47.9	do.

		No. of specimens	Index, Avge	
Japanese:	Males	27	42.78	Mayabara (11)
	Females	9	42.36	
Aines:	Males	4	38.12	
	Females	5	39.89	

Flower, in the previously referred to essay, has given the following comparative data:

	Number of Observations	Average of both sexes
Gorilla	6	54.1
Chimpanzee	6	47.9
Orang	6	55.2
<u>Microdont</u>:		
British	33	41.3
Mixed Europeans	66	41.1
Ancient Egyptians	15	41.0
Polynesians (mostly Sandwich Islanders)X.	22	40.1
Natives of Central and Southern Asia	42	41.4
<u>Mesodont</u>:		
Chinese	12	42.6
American Indians	31	42.8
Malay of Java and Sumatra	70	43.3
African negroes X.	70	43.9
<u>Megadont</u>:		
Melanesians	21	44.2
Amdamanese	17	45.5
Australians	36	45.5
Tasmanians	13	48.1

X. Indicates that great length of basis cranii reduces index.

V A R I A T I O N S

1. Number

2. Position

3. Form.

1. VARIATION IN NUMBER

(a) Decrease;

(b) Increase.

(a) Decrease.

When dealing with a race of people like the Australians in whom the dental system is such a well-developed one, it is not to be expected that one would very frequently meet with cases of total absence of members of the permanent dentition. In modern civilized man, it is generally universally agreed that the upper lateral incisors and the third molars are undergoing a process of more or less rapid disappearance, this being put down to the fact that modern man is subjecting his dental outfit to a marked habit of disuse. Might we, therefore, expect to find a far lesser tendency to disappearance of these teeth in the case of the Australian who performed his masticatory functions in a very vigorous and thorough manner?

Considering first the lateral incisor, the writer can call to mind no instance from the large number of skulls examined which showed a condition of total developmental absence of the lateral incisor, or even a single example of this tooth's presenting itself in that poorly-developed, peg-shaped form which is not unusual in the mouths of modern white people. However, in the case of the third molars, several instances have been met with in which there seemed to be a complete lack of development of this tooth, especially in the mandible. In the examples which presented this total absence of third molars, all the other teeth of the arches were present, or had been at death, the first and second molars situated in normal and regular positions, yet there was no sign of one or more of third molars, and no evidence to suggest the probability of their having been lost through periodontal affection and alveolar absorption. In these cases the absence of teeth or a tooth was confirmed by radiographic examination.

The number of instances of apparently a complete developmental absence of third molars was nine. The following data give a more detailed record of the observations on this feature.

Mandible, 5 cases.

both teeth in 3.

one tooth in 2.

Maxilla, 4 cases.

both teeth in 3.

One tooth in 1.

For illustrations of a number of specimens showing apparent developmental absence of teeth, see Figures 23, 24, 25,26, 27, 28 and 29.

(b) INCREASE

SUPERNUMERARY TEETH.

The subject of supernumerary teeth is one of considerable interest and importance, especially in its relation to the question of human dental phylogeny. It is also a subject which is certainly deserving of an important place in any study which deals with the examination of the dental system of a series of skulls. The significance of these variations has been dealt with by various brilliant writers, whose opinions have often been reviewed by many others, and anything in the nature of a further survey of their works would be unnecessary on the present occasion. Osburn (12) and Nicholls have given simple and brief resumés of the various views of such writers as Röse, Zuckerkandl, Black, de Terra, Bateson, Bolk, for example, and fairly extensive bibliographies on the subject can be found accompanying the articles of these two essayists.

It is generally supposed that the occurrence of fourth molars is more frequent in dark races than in white civilized peoples. The presence of supernumeraries in the incisal region and the position they occupy, has always been fuel for the fire of debate which has raged for a long time as to which is our missing incisor. Then the appearance of extra teeth in the premolar region is hailed by some as evidence of our affinities to those lower primates who possess three premolars. However, these problems must be left to more learned writers; it is for the more humble worker to faithfully record such variations as they are observed; for it is only by careful and continuous recording that the comparative frequencies of these variations will be made clear.

In the present instance it is not proposed to deal with this subject in any speculative manner, but rather to make an attempt to review the occurrence of supernumerary teeth in the dental system of the Australian aboriginal in a style as complete as available materials and literature make possible. This means of treatment may help, in some measure, to establish a definite idea as to the frequency of supernumerary teeth in this race.

In many instances, reports on the occurrences of supernumerary teeth have not given any intimation as to the amount of material they covered. While such a method is adopted it is difficult to arrive at any definite idea as to the frequency of these anomalies, either as a racial feature or in its comparative aspect.

Below is given a table which shows the number of specimens in various collections dealt with in descriptions appearing in available literature, and the occurrence of supernumerary teeth mentioned in such descriptions, and where possible notes on the nature of the specimen are given.

Collection	No.of specimens included in report	Specimens reported with supernum.teeth	Author	Ref.No.
Roy.Coll.Surg. England	59	1	Flower	13
"Challanger" Report	49	2	Turner	14
"Thesaurus Craniorum" & "Supplement"	30	-	Davis	15
Cambridge Univ. Museum	38	1	Duckworth	16
Australian Museum,Sydney x	90	3	Klaatsch	17
Nat.Museum, Melbourne Univ.Aust.Sch. Museum,Melb.	76	1	Nicholls	18

x Also includes two skulls in German collections.

It will be seen from the above table that out of a total of some 340 odd specimens of which various dental details were included in their description, only 8 were recorded as containing examples of supernumerary teeth: about [redacted]. 2·3%.

The following list gives a fairly detailed account of the specimens recorded in the above list and also some odd examples which have been recorded separate from any description of a collection of material.

Number of supernumerary teeth	Position of supernumerary teeth	Nature of supernumerary teeth	Sex	Locality of Specimen	Author	Reference Number
2 (1 lost P.M.)	Behind 3rd upper Ms on rt. and left sides	Practically unworn. Small but well-formed molar; 4 cusps plus small 5th cusp between 2 dist. cusps. M.D. diam. 8.0 L.L. " 8.0 9 missing but socket indicated a smaller tooth than 9		Marano River District, Queensland	J.T.Wilson	19
1	Behind 3rd M. upper left	Rudimentary bicuspidate		Gippsland	Turner	20
1	Lying horizontally in palate ~~maxx~~ behind incisive canal				Turner	"
2 teeth 1 socket	Behind left upper M3 " right " "	9 partly destroyed by caries: Crown diam. 6 mm. 10 Unerupted. Crown diam. 5 mm. Irregularly cuspidated			Turner	21
2	Both sides of upper jaw. Teeth enclosed in maxilla.	"Fully developed 4th molars".		W.A.	Klaatsch	22
1	Enclosed in maxilla left side 4th M. region	Molar		Bowen, Nth Queensland	Klaatsch	"
1	Behind right upper M3.	Molar		Near Sydney	Klaatsch	"
1	Right side mandible mesial to molars.	Premolar			Klaatsch	"

Number of supernumerary teeth	Position of supernumerary teeth	Nature of supernumerary teeth.	Sex	Locality of specimen	Author	Reference number
2	In premolar region Mandible	Premolars			Klaatsch	22
1	Between two upper central incisors	Peg shaped			Nicholls	23
1(socket only)	Outer side of left upper 3rd M.	?			W.H.Flower	24
1	Right side mandible	"An accessory incisor tooth..... Its small size suggests that it might be a retained deciduous tooth".		S. Aust.	Duckworth	25
2 (sockets only)	Mandible. both sides behind 3rd molars	Sockets fairly large			Longman	26
1	Mandible. Lingual to 1st and 2nd left premolars.	Premolar in form.		Kimberley District.	In Perth Museum. Reported to me by Dr Chapman, Adelaide.	

It will be noticed that of the above examples the following points are worthy of attention.

Total number of occurrences		20
Occurring in Maxilla		14
" "	Mandible	6
" "	incisor region	3
" "	premolar "	4
"	behind third molars	12
"	laterally to molars	1

The fourth molar is apparently the most frequent supernumerary tooth according to these figures.

Turning now to the material examined by the present writer, the following figures show the frequency of this abnormality in individuals generally.

Number of specimens examined ...	600
" " " containing supernumerary teeth ...	8
Percentage	1.3

The following statements provide details as to the situation and nature of these occurrences:

Total number of examples 9

Occurring in maxilla ... 9

" " mandible ... Nil

Situated in incisor region 3.

" " molar " 6.

Two of the three cases in the incisor region are only represented by sockets; the possibility of these sockets belonging to retained deciduous incisors is very remote, as it might safely be said that deciduous teeth are almost never retained in the aboriginal up to adult age, and the instances met with are decidedly rare - only twice in the present material. Excepting one Victorian specimen, all the occurrences met with of supernumerary teeth or their sockets have been photographed, and they will now be described separately.

Figure 30. Specimen belonging to a young adult, with all teeth excepting the third molars completely erupted. The two centrals have been lost after death. The extra tooth is of simple conical shape and unerupted. It is situated close to the midline, lingually and mesially to the right central. The crown of the tooth can be seen through the empty socket of the right central.

Figure 31. Adult specimen, all teeth but one molar lost post mortem. Simple peg-shaped socket only, situated between the centrals and on the left side of the midline. Socket of left central displaced a little labially.

Figure 32 Adult specimen. Several teeth lost after death. Left lateral incisor had been removed before death, but although the socket was obliterated, the alveolar process had not yet absorbed into the characteristic ridge which eventually forms. Supernumerary represented by socket only, which is situated immediately behind the right central socket and close to the midline. Right central had been displaced labially. Simple peg-shaped socket, about 5 millimetres in diameter and 10 millimetres deep.

Figure 33. Old Adult specimen. Extra tooth is a fourth molar, situated immediately distal to the left third molar; erupted with its crown hard up against the third molar, but its occlusal surface does not reach the level of its functioning neighbor.

In form its crown is wellformed, and has three cusps, 2 buccal and one lingual, with the cusp areas adjacent to the central fossa finely crenated.

Diameters: M.D., 9.5 mm. L.L., 10.5 mm.

No indication of a supernumerary on the right side of arch.

Figure 34. Adult specimen. Dentition was complete at death; only molars in situ.

Supernumerary teeth occurred on both sides behind third molars. One on the left side is represented only by a fair sized conical socket about 8 millimetres in diameter. The right side is an unerupted tooth, the occlusal surface of which presents three somewhat irregular lobes. The tooth is seen through the broken surface of the alveolar ridge. In size the crown of this tooth is approximately 7 mm. M.D., and 9 mm. L.L.

Figure 35. Adult specimen. All teeth in position excepting three incisors, lost after death. Supernumerary occurs distally to the right third molar, and in form is a small, peg-shaped tooth, its crown being roughly circular in outline. The occlusal surface presents one large and three small tubercles. Diameter of

crown, 5 mm.. Total length, 14 mm. Crown height, 5 mm. No indication of an extra tooth on the left side.

A further example, which is not illustrated, occurred among the skulls in the Melbourne Museum, on a small number of which data were made. This example was situated behind the third molar on the left side, and its crown presented an occlusal surface consisting of four small tubercles. Crown measurements were: M.D., 8.5 mm; L.L., 6 mm.

Figure 36. Adult specimen. Supernumerary molar occurring in maxilla just behind a normal third molar on the right side. In form the extra tooth is like a small stunted molar. The crown shows no definite cusp forms; the labial and lingual surfaces curve well over on to the occlusal aspect of the crown. The fossa portion of the occlusal surface is finely crenated. The root portion is short and stunted with a partial formation of two roots.

Measurements. Total length, 13.5; crown height, 6; Crown, M.D. 6; L.L. 9.

No sign of an extra tooth on the opposite side or in the mandible. Anterior part of palate shows lingual displacement of left lateral incisor.

2. VARIATIONS IN POSITION

Under this heading will be considered those variations in which the teeth are in situations such as form an appreciable departure from their normal positions in the arches.

These variations in positions have been brought about by:

1. Undue retention of deciduous teeth;
2. Retention of fragments of deciduous teeth;
3. Diminution of available space, causing displacement;
4. Permanent teeth erupting in a marked abnormal position;
5. Avulsion of permanent teeth;
6. Loss of occluding members in opposite arch.

Variations in the position of permanent teeth caused by retained deciduous teeth are very rare, as the latter are normally and readily shed, and the regular masticatory movements of the aboriginal tend to induce and preserve normal tooth positions. See Figure 40.

A slight variation which is only rarely met with and one which does not greatly affect the general contour of the arch, is that of the first or second bicuspid, more often the second. This condition is generally associated with the retention in the alveolar process labially of small fragments of the deciduous molar roots - the "accessory dental masses" of some writers. In these cases there is sometimes seen a slight displacement of the permanent tooth lingually; but, as stated above, rarely sufficient to cause a marked interruption in the regularity of the arch contour.
See Fig 37

Displacement of teeth due to an apparent lack of space and resultant crowding of some members of the arch, was not a very frequent occurrence. In most of these instances the explanation of the condition is not apparent because in this race the dental system is characterised by the large development of the jaws and ample space for all the teeth. Such irregularities as these may have been caused by a previous irregularity existing in the deciduous dentition.

It is very rare indeed to find among the skulls of this race instances of teeth erupting in markedly abnormal positions such as is so frequently the case with modern civilized folk. By these maleruptions is meant, for example, impacted third molars, teeth erupting on the lingual aspects of the palate or facial portions of the maxillae. A few instances of impacted third molars are given in Figures 38,39.

The removal of one or more teeth is liable to cause a neighboring tooth to shift from its own normal position and diminish the gap, but this is seldom the case, for as was said before, the forces of mastication in this dental system tend to preserve correct position of teeth and outline of arch. A very interesting case is illustrated in Figures 41 and 42; here the deciduous upper right cuspid has been retained, and the right central and laterla incisors removed; yet the forces of mastication in this individual have preserved the regular arch contour in a most remarkable manner by the permanent canine erupting forward somewhat, and filling most excellently the gap left by the extracted teeth. A most striking example of the relation between form and function.

Loss of one or more members of an arch sometimes permits a tooth or teeth of the opposing arch to extend beyond the general occlusal plane of the remaining teeth of the same arch. Among these aboriginals this condition can sometimes be seen where a tooth has been knocked out or lost through marked alveolar absorption. However, these cases were not very frequent, and were presented chiefly in aged skulls.

VARIATIONS IN FORM

Under this heading it is proposed to deal with certain variations in tooth form which might be considered as being quite beyond the range of "normal" variations and worthy of special note in a separate section.

On the whole it can safely be said that in the Australian's dentition we do not meet with anything like the number of variations and anomalies in form that can be met with in any collection of teeth from modern white subjects. This state of affairs is, of course, only to be expected, for in the Australian we find those well formed jaws and teeth which indicate that the dental system had been made to function in a thorough and physiological manner, a condition which would tend to preserve and maintain normal structures .

There are some form variations in teeth which must be touched on in so far as they concern this race.

Most of the teeth in the arch are so regular in form, and in particular where the crown is concerned, that variations worthy of special note are almost non-existent; as, for example, the premolars and first molars.

Dealing first with the anterior teeth, it may be said that the lower six front teeth present no marked variations at all.

A feature which is to be looked for in the upper front six teeth is the presence of marked grooves and tubercles on their lingual surfaces. The present examination has shown that, although these features may be met with occasionally in slight or moderate degrees of development, these teeth only occasionally present those well marked groovings, pits, and development of the gingival ridge into tubercles, which are so often met with on the lingual surface of modern teeth.

Another variation which must not be omitted from reference is that of the incisors in which they are referred to as "spatulate"teeth . This particular shape of incisor is that in which the lateral margins of the teeth become markedly divergent towards the mesial border. Duckworth has previously called attention to them (27). See Figure 43. This appearance is not infrequently seen in the upper incisors of the Australian, but it would seem that this particular shape of tooth is not so frequent as some would have it, because the reduction of the crown by attrition of a quarter or more of its height will produce this appearance on the labial aspect of a tooth much more markedly than it might have shown in its unworn condition. That is, the spatulate form is more an acquired, than an actual normal outline of the tooth surface. See Fig. 44.

Another feature of anterior incisors is the so-called "shovel-shaped" teeth. This form of tooth has been dealt with at some length by Hrdlicka (28), and is the term given to that type of incisor which, in addition to being somewhat spatulate in form, has the mesial and distal marginal ridges on the lingual surface very well developed, so that with these ridges and the gingival portion well marked, the lingual fossa is much accentuated, giving the tooth crown a somewhat shovel-like appearance. This form of tooth is said to be typical of the dark races, and in particular the African Negro and American Indian.

It can safely be said that the "shovel-shape" formation of upper incisors is by no means a characteristic of the Australian's teeth. This feature is occasionally met with, but very rarely in an accentuated form, so it may be stated that in general this formation, which is said to be a frequent feature in the teeth of other primitive races, is not common with the Australian.

No instance has been met with in the present work of a marked lingual tubercle on the upper canine, a feature seen more or less frequently on modern canines. Figure 46 shows the only occurrence met with of a marked variation in the form of an upper canine (excepting an odotomatous aberration) in which what was probably the permanent tooth crown consisted of a short peg-like mass.

Marked variations in root formation of the premolars are not at all common. I have never observed a three-rooted upper premolar, for example, although such a feature would not be readily found on account of the difficulty of removing multi-rooted teeth from their sockets without severely damaging the specimen. A root formation of the lower first premolar, which has been met with, but by no means often, is the folding of the root in such a way that there is a tendency for the partial or complete formation of two roots. This abnormal form of root has been figured by Tomes (29). Figure 45 shows two specimens met with in the present work.

On passing to the molar series we find that in the case of the first molar, this tooth is morphologically probably the most conservative of all the teeth; and it is very rare to find any marked variation in its form, either in the upper or lower. In a very few instances I have found a small extra root occurring on the buccal side between the two normal roots of a lower first molar.

In the second molar, although more liable to present variations in occlusal pattern and root formation than the first molar, with it too marked variations in form are practically infrequent.

With the Australian, as in the case of modern whites, it is the third molars which vary most. However, in the case of the former, these variations are more the exception than the rule, because in most cases in the aboriginal's jaw the third molars, as has been previously mentioned, exist as comparatively large, well-formed, functioning organs. Relative to the other members of the arches, though, the frequency of abnormal forms in third molars is fairly marked. Besides entire absence of these teeth - which has already been dealt with - we occasionally find decided reduction in size, and at times an abnormality presenting an unusually large labio-lingual diameter. In order to save unnecessary description a series of photographs has been taken which cover fairly completely the marked abnormalities of these teeth. These are shown in Figures 47, 48, 49, 50, 51, 52, 53, 54.

The peculiar large third molars which sometimes occur, somewhat after the type shown in Figure 53, have been referred to by Klaatsch, who says he "can hardly avoid the suggestion that this extraordinary feature may be connected with the former existence of a fourth molar." He has taken this view because he thinks these abnormal teeth suggest themselves as a double tooth, "the inner portion of this double tooth corresponds with a fourth molar".

Another molar variation which has been left to this section is the occurrence of tubercles, sometimes referred to as extra cusps, on the labial or lingual surfaces.

The presence of tubercles on the labial surface of upper and lower molars was found in the present work to be a rarity, and but very few examples were met with.

It is desired on account of the large amount of attention it has demanded, and the continuous essays it~~x~~ inspires, to make reference to the so-called "Carabellian tubercle". It is not intended to add to the already ~~xaxy~~ large amount of literature on this anomaly for the mere sake of increasing the pile, but because some writers would place a phylogenetic significance upon this tubercle, it is felt that is presence or absence in the dentition of a primitive type such as the Australian is a matter not without interest and importance.

This tubercle is found chiefly on the permanent first and deciduous second maxillary molars. It occurs on the lingual side of anterior lingual cusp and is generally considered as being derived from the cingulum. It seems almost doubtful whether the amount of writing which has been devoted to it is proportionate to its real significance.

Its name, "Carabelli's tubercle", was derived from that of Dr Georg Carabelli Edlen von Lunkaszprie, who about a century ago described it under the name of "tuberculus anomalus". It was referred to in association with the name of Carabelli chiefly in continental Europe, but of recent years it has come into such prominence that it is now known almost universally under the title of "the tubercle of Carabelli" as an anomaly commanding quite an amount of attention.

Owing to its presence on some of the Krapina specimens, its significance was discussed some years ago in the articles by Adloff and Gorganovic-Kramberger on these teeth which aroused such intense interest.

In 1917, Sabourand, a well-known French professor, advanced the hypothesis that the tubercle was diagnostic of syphilis. Since that time the significance of the tubercle in this aspect has been continually under review.

Two other Frenchmen, Gallipe and Jeanselm, attacked Sabourand's hypothesis as being quite without foundation, and many fellow-scientists of their country also entered the lists.

Sprawson (30) in England, within the last couple of did some investigation on the subject, but the result left him quite unconvinced to Sabourand's hypothesis. He writes: "In its incidence this cusp was found to be one of the commonest of the many variations from the normal dentition which occur in man. In size it varied considerably, from a slight prominence to a very well defined cusp; it was not always symmetrical on the two sides in the same individual, it was sometimes well marked on one side and entirely absent on the other, and occasionally associated with extra cusps elsewhere in the mouth, especially in the corresponding mandibular molar".

G. V. Black (31) wrote of this tubercle: "This cusp when it occurs is always bilateral, i.e. on both the right and left upper first molars. It is hereditary, appearing regularly in the teeth of children when present in the teeth of both parents. It occurs also, in a modified form, when present in but one parent. Therefore the cusp will be found in all possible varieties of development, from its largest size to the merest line marking its position on the lingual side of the mesio-lingual cusp."

Gregory (32) has also dealt with the importance of this cusp, and considers the strong development of the cingulum at the antero-internal corner of upper molars in primitive anthropoids, the occasional presence of Carabellian tubercles in certain recent anthropoids, and its presence in human types, as signifying a structural and phyletic relationship between these two genera.

Bolk, in the exposition of his hypothesis on the evolution of mammalian tooth forms, gives a definite genetic significance to the tubercle of Carabelli. According to his view, the mammalian tooth is a dimerous organ homologous with two generations of a reptilian tooth family, and should three generations be concerned in a mammalian tooth form, the third might appear as an eminence or cusp on the lingual side of his deuteromere, and so constitute the principal cusp of the third generation. The tubercle of Carabelli would be an instance of this condition occurring.

This brief resume on the Carabellian tubercle will be sufficient to indicate the position of importance it has attained in literature if not as an anatomical structure. The subject will be touched on again in a later section dealing with primitive man, but for the present we must now consider what conclusion we can arrive at as regards the prevalence of this tubercle on the Australian molars.

In considering the occurrence of this tubercle in the Australian molars, the present observations would seem to show that it does not frequently appear.

The following are the statistics which are so far available, and derived from molars which were not worn enough to obliterate the tubercle if present.

Total number of permanent first upper molars		...	60
Tubercle absent		...	40
"	present slight		18
"	"	medium	1
"	"	marked	1

The following record has been made from a few casual selections among Dental Hospital patients who presented permanent first molars:

Total no. of first molars examined		77
Tubercle absent ...		35
Tubercle present in varying stages of development ...		42
Slight (grooves only)	17	
Medium	15	
Marked	7	
Very Marked	3	

As far as these few figures go, it would seem that the tubercle occurs on over 50% of the first molars of modern white people, In the small series of anthropoid ape skulls which have so far been available for examination for the presence of tubercle, out of 21 first permanent upper molars, the presence of a tubercle on the mesio-lingual cusp was indicated on three teeth only by a small groove. It was also noted that in the Gorilla specimens, there was a tendency towards marked development of the internal basal cingulum; but this was not limited to the first molar, but was present on all three and the premolars as well.

From the foregoing results, although the statistics do not deal with a very large series, it would seem that the Tubercle of Carabelli was more of a modern dental development than a primitive one. This is contrary to the view held by Adloff and others. On the other hand if this tubercle be an accentuation of the basal cingulum, more frequent in modern than in primitive dentition, it would seem peculiar that such a tendency towards crown complexity should be associated with the process of cusp reduction which is typical of modern dentitions.

However, statistics on the presence of this tubercle on the molars of primitive and modern races have not yet been sufficient to make possible any definite postulation as to its being a primitive or modern development.

THE PALATE

Size, Form, Palatal Index.

Palate Contours.

Palate Height.

Post Dental Alveolar Processes.

Posterior Nasal Spine.

The Palatine Tori.

The Palatine Sutures.

THE PALATE.

A review of the works dealing with the cranium of the Australian Aboriginal shows that although such an object has always been placed by the physical anthropologist amongst the most valued and interesting objects of the material on which he works, yet the palate and dental arcades do not appear to have received very much special and detailed attention. This is no doubt due to the fact that man is essentially a product of intense cerebral evolution, and so those portions of the skull in immediate relation to the brain invite the major portion of study. One can feel sure that, with the growing attention given to the lower facial structures, and discussion aroused on this region of every new and noted discovery which is brought to light, a description of the palate will cease to remain among the "optional" requirements of anthropological studies.

Both Flower and Turner recorded data on the Australian palate, but neither included in their works anything in the nature of a detailed study.

Klaatsch (33) has given a description of the Australian palate, but his notes were apparently not based on a very large series of specimens, and are chiefly of a descriptive nature, as his quantitative observations embrace only a dozen or so skulls.

Krause (34) has made some remarks on the palatine sutures and tori, and also on the backward prolongation of the alveolar process.

Burkitt and Hunter (35) in a recent article have discussed varidus features of the hard palate.

In other data dealing with the Australian skull we find instances occurring of detailed accounts of the palatal region, in which an individual skull or a small series of skulls have been subjected to close observation and measurement; but such cases are not very numerous, and more often the bare statements made as to the size and shape of the palate are quite unsupported by any detail or measurement.

The present writer felt that with such a large quantity of material at his disposal, the result of such a series of measurements as time would permit being taken, might not be entirely without scientific interest and importance. One of the main objects in view while doing this work was to produce not merely columns of figures and the more or less interesting averages obtained therefrom, but to utilize the figures in constructing type contours of the palate, the upper and lower arches, using such measurements as were obtained from skulls belonging to groups whose purity could be relied on. By this means, which was introduced by Parsons, there can be provided a clearer and more interesting result to those unversed in mathematical treatments than that obtainable by the scrutiny of a table of numerical results.

It was intended to give here a short account of the methods used in obtaining the measurements of the palate, and then pass on to an account of work done and results accruing therefrom; but after consulting various works in which the palate has been dealt with to the extent that measurements were made, it was found impossible to allow the occasion to pass without indulging in a short survey of the methods adopted in various scientific writings to which access has been possible.

Reference to various works shows that there is obviously a decided lack of uniformity in opinion as to what are the boundaries of the "palate", and before entering upon any discussion upon a desirable interpretation of this term, the foregoing statement may be qualified by a brief resume of the methods adopted by writers to whom one would naturally turn for reference.

"M. Broca again takes account of the relation of the "maximum breadth of the vault of the palate to its maximum length, in making comparison of races. This is the palatine index." (36).

Flower (37) wrote:- "The index given by the measurement recommended in the French instructions is not very satisfactory, as the "points de repere" for these measurements, both length and width, are rather indefinite. The length terminates posteriorly at the palatal spine, a very variable point, sometimes greatly and sometimes but little developed, and giving no exact indication of the real length of the bony framework of the mouth, and, moreover, very often broken. The width of the palate is very difficult to determine precisely by measurement of the internal face of the alveolar arch.

I should therefore suggest using the external dimensions of this arch. The length should be taken from the alveolar point in front to the middle of a line drawn across the hinder border of the maxillary bones (the maxillary 'tuberosities'). This is easily measured by placing a cord or a thin piece of metal across the back of the mouth, resting on each side in the groove between the tuberosity and the pterygoids. The width is best taken between the outer borders of the alveolar arch immediately above the middle of the second molar tooth. These may be called the maxillary length and width, and the index obtained from them called the maxillary index."

Turner (38): "Professor Broca also estimated the dimensions of the hard palate without including the dentary arcade. Professor Flower modified and improved these measurements by including the dentary arcade along with the hard palate. He makes the length of the palate to extend from the alveolar point to a line drawn across the hinder borders of the maxillary bone, and its width between the outer of the alveolar arch immediately above the second molar tooth.

"Instead, however, of using the terms maxillary length, width, and index, which Professor Flower employs, I prefer to call these measurements palato-maxillary or palato-alveolar, as expressing more precisely their nature."

W. H. L. Duckworth in his "Studies in Anthropology" (39) in one place uses as the principal dimensions of the palate: external and internal diameters at the second molars, and the Sagittal diameter from prosthion to post palatine spine. Later he states the anterior palatine breadth as being that between the roots of the canine and first premolar; the posterior palatine breadth that between the first and second molar teeth. Again later in discussing the palatine length, he mentions the maxillary tuberosities, thereby no doubt referring to Flower's method.

A. Keith appears to have no settled landmarks for palate measurements. Although for the palate width he seems consistent in taking the distance between the outer borders of the second molar teeth, for his length measurement he varies. E.g., "measured from anterior alveolar point to mid point between distal borders of third molar teeth".(40). Then between the crowns of central incisors to a point midway between the posterior borders of last molars (41). From a line touching the labial surface of the central incisors to a line touching the curves of the two broad posterior palatine notches each side of the posterior palatine spine (42). In a recent article (43) a figure shows the anterior boundary as being a line which touches the labial border of the incisal surface of the central incisors.

International Congress, Monaco, 1906 (44) gives as points for palate measurements: Length from the mid point of a line tangent to the posterior margins of the central incisors to the mid point of a line touching the bottoms of the posterior palatine notches; width, between second molar teeth.

F. G. Parsons adopts points for measurement and construction of contours which are easily understood from a glance at diagram 55, copied from one published in an article by him (45).

E. V. Thompson (46). Breadth of palate between the inner alveolar walls at second molars. Length, from the point of the spina nasalis posterior to an imaginary surface tangential to the inner alveolar surfaces of the mesial incisors and also the length from the base of the spine.

A. Hrdlicka in his excellent volume "Anthropometry" (47) gives a translation of the Report of the Monaco Congress, and so apparently adopts the landmarks set down therein. However, in a subsequent part of the book in which he deals with methods of measuring the skull, he had a heading of landmarks written thus:- "Upper alveolar Process ('Palate')". The addition of the word "palate" here may or may not have intentional significance.

Wilder in a recently published manual of anthropometry (48) takes measurements for the palate which are internal to the alveolar ridge, and derives the palatal index from such observations.

It will thus be seen that there has been a diversity of ideas as to what the landmarks should be for palate measurements. The chief points to notice from the above given extracts are, that Flower and Turner improved on the French methods adopted in their day, and took length and breadth measurements of the palate which were maximum observations and included the dental and alveolar arches. Turner, however, applied to these measurements the terms "palato-maxillary" or "palato-alveolar" for the idea, in his estimation, of precision. Since then in recent years various observers have worked ~~in~~ up a veritable pot-pourri of terms and landmarks, and many of them have restricted the palate to that area internal to the lingual margins of the tooth sockets. It is not quite evident why the ridge, formed by the alveolar process and containing the teeth, should be looked on as a structure separate from the palate, of which it is only a part. Again, in studying the palate with an idea to recording its size and shape, we are dealing with the measurement of an area, and as it is generally regarded as desirable that in such an exercise the maximum readings be taken, there is no reason why the landmarks for palate measurement should be other than those set down by Flower. Also the present writer, after a review of the various methods and terms used throughout past years, fails to see why the external landmarks set down by Flower do not very simply and correctly provide the "palate length" and "palate breadth", and from them the "palatal index". And on this view are based the results set down in the following observations.

The suggestions of the terms "maxillary index" by Flower, and "palato-maxillary index" by Turner, have undoubtedly produced confusion among workers who came after them, and led to an incorrect application of the term "palate."

The International Congress Reports, previously mentioned, state the "bony palate" as an "optional" observation and give for its measurement landmarks which are internal to the alveolar ridge. "Length of palate. Anteriorly - the median point of a line tangent to the posterior alveolar border of the median incisors; posteriorly - the median point of a transverse line connecting the most anterior points of the notches in the posterior border of the palate. Breadth of palate. Distance between the internal alveolar borders between the second molars".

The view here taken is that the bony palate includes the "alveolar arch" of the Congress Reports; and so what is therein given as the "maxillo-alveolar index" will correspond with the "palatal index" stated in this work.

The description of the palate given in the following pages will consist of measurements of the palate and from them the production of palatal contours - these observations of course including the dental arch. Then such features as the various tori, the posterior spine, intermaxillary suture, post-dental alveolar process, etc., will be dealt with in a more or less detailed, and, when possible, quantitative manner.

The size of the palate is a feature which by the requirements of modern methods of study can only be recorded by mathematical observation. The measurements of the Australian palate have been taken by various workers, but inthe present work it seems desirable to review only those which provide the maximum dimensions.

The following are average length and breadth measurements given by various observers.

	Measurement	No. of skulls	Range	Author
Length	58	29	45-68	Duckworth
Breadth	64	29	55-71	do.
Length			48-68	Turner
Breadth			53-74	do.

The Palatal Index.

The palatal index indicates the breadth of the palate relative to the length, and is derived thus:

$$\frac{\text{Palate breadth} \times 100}{\text{Palate length}}$$

Below is given a list of the average palatal index of the Australian obtained from various sources, in some of which this index is expressed as the palato-alveolar index. The data given by Duckworth was compiled by him from all available data at the time (1904) when the work (49) from which the extract is taken was published.

No. of specimens	Average of indices	Author
63	110.1	Duckworth

The results of the present work are as follows:

Total number of young adult, adult and aged specimens from which index was obtained	134
Average of Indices	108.9
Range of Indices	124.5 - 95.2

The total number of skulls of all ages from which it was possible to obtain the palatal index will now be grouped to show the value of this index at the various ages.

	No. of specimens	Average of Indices	Range of Indices
Infant	9	130.4	146.9 - 100
Young	16	120.5	131.3 - 112.4
Young Adult	22	113.9	124.5 - 101.5
Adult	93	107.7	120 - 95.2
Aged	19	108.9	124.1 - 101.5

	No. of specimens	Average	
Australian	63	110.1	Duckworth
"	134	108.9	Campbell

Palate Form:

In order to classify the types of palate under some terms which indicate their form or contour, various methods have been adopted.

Turner (50), resorting to a precise method, grouped palates under terms which expressed the relation of width to length and classified them according to the value of their indices. These were:--

Dolichuranic	Index	below 110
Mesuranic	"	between 110-115
Brachyuranic	"	above 115.

Relying on this classification the findings of some observers of Australian palates have been :-

Turner.-- Dolichuranic
Duckworth.--Mesuranic (but almost Dolichuranic)

Topinard (51) described palate form under four aspects, "(1) Hyperbolic, when the branches of the arch go or diverge in a backward direction; (2) Parabolic, when they still diverge, but somewhat less so, and in such a manner as, that if prolonged they would eventually return upon themselves and meet; (3) In the form of the letter U, when they are exactly parallel; and (4) Elliptical, when they converge, whatever the degree of such convergence may be."

Duckworth adopts almost the same classification of palate form, and describes its general contour as being "elliptical, hypsiloid or parabolic, according as the two alveolar arcades are convergent, parallel, or divergent." (52).

The Australian palate has been described by :-

Duckworth.- elliptical or hypsiloid

Yet another, but very indefinite manner of describing the palate or alveolar arch is to use the terms square, circular, and horshoe-shaped.

Klaatsch considers the Australian arch belongs to the more or less square one of the lower races, and the one "which resembles that of the anthropoids must be accepted as the ancestral stage."

Gregory describes the Australian palatal arch as "variable, often -shaped."

According to the average of the palatal indides in the present observation taken for adult skulls generally, and adopting the classification of Turner, it will be seen that the form of the palate is

Then viewing the results obtained by taking the age groupings separately, we note the following:

	Average Index	Palate Form
Infant	130.4	Brachyuranic
Young	120.5	Brachyuranic
Young Adult	113.9	Mesuranic
Adult	107.7	Dolichuranic
Aged	108.9	Dolichuranic

PALATE CONTOURS

In order to obtain a clearer idea of the palate form of the Australian than could be obtained from a list of figures or such descriptive terms as have been just given, the method proposed by Parsons of drawing a type contour, will be adopted. This consists in constructing a contour from the averages of a certain series of measurements made on the palate. The diagrams, taken from Parsons (45), shown in Figure 55, illustrates the points he used. Most of his details have been followed in the present work. Also the following data, which tend to make the contours here given more complete than by Parsons' method, have been utilized:

Measurements of teeth

Length of dental arch

External Width of Dental Arch at all Teeth excepting the incisors

Internal width of arch at M2, P2 and C.

Maximum breadth of palate. (opp. M2)

Length of palate

Position of ant. pal. foramen, transverse sutures and post. nas. spine, in midline.

Length of post-dental alveolar process.

Figure 55d shows the landmarks of the various palate measurements secured in the observations.

The series of contours given in Figures 56, 57, 58 and 59, have been constructed from average measurements of the above observations, and show the average progressive development of the palate from infancy to adult age.

The type palate contours were prepared from the measurements of the number of specimens shown in the following list:

Infant	13
Young	21
Young Adult	25
Adult	106

The following gives a brief explanation of the landmarks indicated in figure .

Pr	Prosthion.	Most anterior point.
Or	Orale.	Median point on line tangent to median incisor sockets.
Al	Alveolon.	Median point on a line touching termini of post dental alveolar processes.
Sta.	Staphylion.	Median point on a line tangent to base of large notches on post border of palate.
D.		Extremity of posterior nasal spine.
Su.		Point where median and transverse palate sutures cross. If transverse sutures do not meet, then midway between them.
Fo.		Midpoint on post margin of the incisal foramen.
XX		Max. width of palate opp. M2.
YY		Inner palate width opp. M2.
PP		" " " " Pm2.
CC		" " " " C.

PALATE MEASUREMENTS

Averages and Min. and Max. range.

	Infant	Young	Young Adult	Adult
Pr-Sta	39.8	48.2	53.9	57.8
	34.5-44	46-52.5	46-60	51.5-67.5
Pr-D	42.8	52.3	57.9	62.7
	37.5-48	48.5-56	51-64.5	51-73
Pr-Al	38.2	48.9	55	60.5
	32-44	47-53.5	49-61.5	54-67
Or-Sta	35.7	42	47.4	51.5
	31.5-41	38.5-46.5	41-51	46.5-59.5
Su-Sta	8.6	10.9	11.8	12.7
	5.5-10	7.5-14	6-15.5	8-17.5
Fo-Su	19	25	27.2	29.4
	15.5-23.5	21-30	23-31	20-35
XX	ee 52.3	M1 58.8	62	62.1
	47-58	52-66	57-72	56-75.5
YY	ee 29	M1 32.5	35.8	39
	25-33	27.5-37	31-42	32-44.5
PP	dd 28.1	29.9	34	34.2
	24.5-31	28-32.5	31-41	30-41
CC	ee 25	26.4	25.8	26.4
	22-26	24-30	23-29	22.5-31

From these palatal contours can be seen the general development of the palate. There are several points in this process of development which demand special attention.

The first main point to notice is that there is a change from brachyuranic form in infancy to dolichuranic in the adult palate.

There is a marked increase in palate width in its anterior portion as adult form is approached. (Dealt with again in arch form).

It is shown that by the time the second molar is fully erupted and in position in the dental arch, the palate has practically reached its maximum breadth.

From the time of commencement of eruption of the first permanent molar onwards there is naturally a continual increase in palate length backwards, until the third molar is completedly erupted.

There is obviously continued and marked bone growth takes place at the transverse sutures during the time of eruption of the permanent molars. For it is shown in the contours that when the first molar crypt opens up this suture is opposite it, but rapidly passes back in its position as the second molar comes up into position.

It will be seen from the average figures given that the increase in bone growth near the transverse suture takes place by addition of bone to the posterior border of the horizontal process of the maxilla at about double the rate that it does to the anterior border of the horizontal process of the palate bone.

	I.	Y.	Y.A.	A.
Fo-Su	19	25	27.2	29.4
Su-Sta	8.6	10.9	11.8	12.7

But here, of course, we have not so far taken into account any addition to the maxillary portion which may take place at the intermaxillary suture. With this feature also is concerned the increase in length - i.e., along median line - of the premaxillary bone.

From the previous figures we get:

	I.	Y.	Y.A.	A.
Length of Premaxilla	12.2	12.3	14.9	15.9

From these results it would seem that the chief increase in length of this bone takes place in the period between what has here been grouped as the young stage and the young adult stage.

These observations, however, do not probe into the matter of palate development very deeply, but only touch on the general and most obvious features. However, even with the mathematical data so far obtained by the present work and opportunity for a little more detailed study of the palate, fresh features of interest would no doubt become obvious.

Figures 60 and 61 show two typically wellformed Australian palates and dental arches.

Figure 62 shows the remarkably large and well formed palate of a young adult specimen; one in which the third molars had only partly erupted. This palate measured 72 mm. in width.

PALATE HEIGHT.

Palate height, or depth, as it is often termed, is the vertical distance of the horizontal portion of the palate above the level of the alveolar ridges.

In many observations this feature is merely referred to in such terms as "high" or "shallow", which are probably sufficient for the purpose of a general description of a skull. However, in a specialized study of a part, as it has frequently been stated, it is advisable to adopt a method of observation which dispenses as much as possible with the personal judgment of the observer. Therefore, in dealing with palate height, fortunately it is possible to ~~xxxpx~~ resort to fairly definite means of measurement, which provides a reliable record of this feature. . For the present work, with the kind assistance of Mr Rogers, an instrument was designed; the same gentleman constructed in an excellent manner the simple and useful piece of apparatus shown in Figure 63.

The measurement was made in the region of the second molar. The observation was only made on specimens which showed a normal condition of the alveolar process around the molar teeth. The instrument was used in a manner shown fairly clearly in Figure 64.

The two arms <u>bb</u>, adjustable to any width, are placed on the lingual margins of the sockets of the second molars, the skull being held with palate upwards and in a horizontal position. The instrument being kept vertical, the sliding rod <u>r</u> is dropped on to the midline of the horizontal palate and fixed by the lock-screw <u>a</u>. The height is then read off from the graduated rod <u>r</u>, by placing a straight metal edge across <u>r</u>, touching the ends of <u>bb</u>. See B of Figure 64 .

The data obtained on this feature of the aboriginal palate are as follow.

For a general idea of the palate height all the skulls here classified as "young adult", "adult" and "aged" have been grouped together.

Total number of specimens measured	 128
Average height of palate	.........10.6
Mimimum record	 6
Maximum record	..........17.5

The average palate heights for the different ages are as follow:

	No. of specimens	Average height	Mimimum	Maximum
Infant (at Decid M2)	8	5.9	2.5	9
Young (at perm.M_1)	20	7.27	5	10
Young adult (at M2)	21	8.6	6	12
Adult (M2)	90	10.95	7	17.5
Aged (M2)	17	11.4	5	15

These results show that there is a fair range of variation in palate height even in all ages. The specimens of the "aged" group were carefully selected so as not to include those in which there was evidence of marked absorption of the alveolar process, and at the same time to ascertain from the measurements whether there was in the height of the ridge, any "normal" shrinkage; that is, any diminution in the height of the ridge not due to a periodontal affection, which, by the appearance of the bony tissue, had been active and extensive at time of death. The results show the difference as an average of 10.9 for adults, and 11.4 for aged specimens.

To anyone who has had opportunity of examining skulls of modern civilized peoples, or to the dental clinician who frequently has to secure models of the palate, it is obvious that the arch of the palate in its vertical aspect exists in a variety of shapes and heights, but with the Australian aboriginal, although as we have seen, there is a good deal of variation in the height of the palatal dome, yet in its shape it is very consistent.

The following brief description expresses what is in the average aboriginal skull the "height" features of that portion of the hard palate situated lingually to the teeth. The sides of the alveolar arch from about the second pre-molar region to the tuberosities, slant almost vertically on to the horizontal portion of the palate, which is almost always quite flat, excepting for the irregularities caused by muscle attachments and the shallow broad grooving for reception of the posterior palatine nerves and vessels. In the anterior portion, from the lingual margins of the sockets of the anterior teeth, the surface slopes upwards and backwards at about an angle of 45°, till it meets the horizontal portion.

Klaatsch measured the palate depth of a number of Australian skulls, but gives his measurement as having been taken at the first molar. In this work it was taken at the second molar as other palate measurements in the region of the molar series are taken opposite this tooth. Also for comparative purposes, the first molar would often be found wanting in a civilized race.

Klaatsch's results are as follows:

Number of adult skulls measured	12
Average palate depth	10.8 m.m.
Maximum	15 m.m.
Mimimum	7 m.m.

POST DENTAL ALVEOLAR PROCESSES

These portions of the palate form the posterior eminences or termini of the alveolar ridge.

They are frequently referred to as the maxillary tuberosities. However, the above term has been adopted for the present work, because here the purpose of their study is to ascertain the extent this process extends from the distal margin of the third molar socket.

Klaatsch (53) has termed this process the "processus molaris quaiti". He states that generally amongst the old males in Australian skulls this process can be observed. And "the condition met with amongst the Australian aborigines show that not only does the alveolar prolongation determine the appearance of this tooth, but that this formation of the jaw is a remnant of the stage when the fourth molar was characteristic of the common ancestor of mankind." On this view of explaining the presence of the large process in the aboriginal, might we not expect to find a similar formation in the palate of the anthropoids, even allowing for the differences of phylogenetic relationship and morphological specializations between them and Homo? The anthropoids do not show any marked development of post dental process, - according to Duckworth (54), "in the majority of instances so far available the maxillary tuberosity is frequently quite insignificant", - but yet they give a percentage of fourth molar occurrences probably much higher than man. Further, it is well-known from the study of the physiology of tooth eruption and movement that it is the presence of teeth which determines, ~~the~~ to a large extent, the formation of the alveolar process and ridge, not the alveolar process determining tooth appearance.

It seems very probable that in spite of the occasional appearance of a fourth molar to act as a reminder of the four-tooth-molar-series, "characteristic of the common ancestor of mankind", the lapse of time has been too great between that very primitive ancestor and homo sapiens to permit of such a variable osseous structure as is the alveolar ridge persisting as a primitive remnant.

Krause (55) also dealt with this process and the recurrence of pits in it.

In the present section this process will be dealt with first as regards its length as ascertained from a number of measurements; then reference will be made to presence of pits and groove on its superior portion; and lastly a few remarks on its significance as a structure.

With reference to the actual amount of backward prolongation of this process there have apparently not been very many quantitative data published.

Klaatsch gives the measurement of this process in a few skulls only, and these are probably of very well marked development.

Turner, in his description of Australian crania, wrote:-- "In many of the crania the maxillary had grown into a roughened mass which prolonged the dentary arcade from 1 to 1½ centimetres behind the last molar tooth".

Krause writes of this process in Australian skulls: "which occurred in 109 skulls averages 1 centimetres (10.07 millimetres)".

The following data show the extent of backward prolongation of post dental alveolar process in the material herein concerned.

The measurements were taken on skulls in which the third molars had completely erupted, the teeth being in situ or indicated by a well formed socket. Only those skulls in which the process was intact and complete were thus recorded, and the landmarks of measurement are shown in Figure 65.

Total number of observations	...	134
Average length of P.D.A.P.	.....	8.85 mm.
Maximum Record	...	15
Minimum "	...	4

These figures show that there is a fairly wide range of variation in the extent of backward prolongation of this process, but that on the whole the average amount of almost a centimetre of this ridge would indicate a fairly marked extension beyond the last tooth.

Thus the detailed observations on this structure so far recorded for Australian palates are:

	Observations	Average
Krause	109	10.07
Campbell	135	8.85

The recorded observations of previous writers and the above results show that in the Australian there is a fairly marked backward extension of these processes. In considering what may be the cause of such a condition, it has been remarked previously that the relation between the marked prolongation and the occurrence of fourth molars, as suggested by Klaatsch, does not appeal as being a satisfactory explanation. It is suggested as a result of the present observations that there might be a relation between the large size and backward extension of the maxillary sinus and the post-dental processes. It is well known that the accessory sinuses are well developed in the Australian cranium, and the maxillary sinus is certainly a well-developed space. It will be noticed, too, that the infratemporal surface of the maxilla, which forms the posterior wall of the antrum rises almost vertically from the posterior extremity of the process. In some specimens with this region broken, it can sometimes be noted that the posterior portion of the antral floor dips down somewhat into that portion of the bone which externally is presented as the post-dental process. The extremely cancellous nature of the bone forming this process would also imply its close proximity to an intraosseous cavity.

Although this question is one which requires further study and more extensive treatment, it is felt the suggested relation between the post-dental processes and the large maxillary sinuses in the Australian is a very probable explanation for the largeness in size of the former.

THE POSTERIOR NASAL SPINE

The posterior nasal spine is situated on the posterior border of the palate, and is formed by union of the thin pointed median ends of the horizontal portions of the palatine bones. It provides attachment for the musculus uvulae.

On the extent of the projection of this spine depends the depthe of the two large notches which form the posterior border of the horizontal part of the palate.

Krause in his account of Australian skulls (56) mentions this spine as occurring "124 times out of 165 skulls, 75%".

It has been found that with the present material, there were presented all conditions of prominence of this spine. In some cases one found a well marked, strongly projecting spine as shown in Figure 66, whilst the exactly opposite variation is depicted in Figure 67, in which, instead of a spine projecting, the palatal plate at its midline slopes backwards and upwards towards its junction with the vomer.

From the length measurements taken on the palate with and without the spine, the average length of the spine can be obtained; the spine length being the distance from its point to the line which touches the base of the two large notches forming the posterior border of the horizontal palatal plate. See Figure 65.

Total number of young adult, adult and aged specimens measured for length of post nasal spine	151
Average length of spine	4.9
Minimum ...	2
Maximum ...	10

Average length of spine at different ages :-

	No. of specimens	Average	Range	
			Mimimum	Maximum
Infant	10	2.8	1	4.5
Young	19	4	2	5
Young Adult	22	4.3	2.5	7
Adult and aged	129	5	2	10

From these results it will be seen that the range of variation in the length of the posterior nasal spine in this race is fairly great.

Unfortunately any observations on other races for comparison are rare.

The following are the only records at present available.

THE PALATINE TORI

As the bony palate has not been an object of very much detailed examination, references are not very extensive which deal with the presence and extent of bony elevations on the horizontal palatal plate. These elevations, generally situated along the midline of the palate, have been called by Carabelli the "Torus palatinus", but some writers have found it desirable to divide up the elevations into a number of tori, which will be enumerated later. The palatine torus has been very well dealt with by Godlee (57).

Godlee mentions that it has been dealt with by various Continental workers. Chassaignac seems to have drawn attention to it first as a syphilitic swelling. Stieda dealt with it exhaustively. Luschka, Virchow, Kupffer and Bessel-Hagen have referred to it.

Hooton (58) has dealt with it in detail, in its occurrence in Eskimo skulls.

Schwatt and Steinbach (59) made rather an extensive investigation on the suggestion that the palatine torus was associated with tuberculosis. Their statistics, however, show that this structure has no pathological significance relative to tuberculosis or any other disease.

For purposes of detailed study, as mentioned above, the elevations on the palate have been divided into various tori, but it is somewhat doubtful whether in some cases this elevation is worthy of the title "torus", in the usual acceptance of the term. Although it must be admitted that it is a term which has not been subjected to a precise definition. However, the elevations of the horizontal palate will be classified and treated separately as follows:

Torus maxillaris medianus. Along the midline where the two horizontal portions of the maxilla join.

Torus palatinus medianus. Along the mid-line where the two horizontal portions of the palate bones join.

Torus palatinus transversus. Extending transversely where the horizontal portions of the maxillae and palate bones join.

Crista palatina transversa. Along the posterior border of the horizontal plate of the palate bone.

These variations have had varying amounts of significance attached to them either as being racial characteristics or of pathological importance. They will therefore be treated separately in order that their frequency and development on the palate of the Australian will be made clear in so far as the present material has shown.

It is perhaps necessary to point out here that in the above classification, the first three of the group together probably go to make up what inless detailed descriptions is termed the torus palatinus.

In descriptions of the Australian skull, these tori have been mentioned by Krause (60), Klaatsch (61), Godlee, Burkitt and Hunter (62).

It is admittedly a difficult matter to present any statement of value which provides percentage occurrences of these tori or the degrees of their development; for the grades of development from entire absence of the structure to a marked condition are so gradual that a clear cut definition between the various degrees is impossible. Not only is this so for a single observer, but the difficulty is increased when the judgments of different observers are used for comparative work. However, as the method of recording the numerical incidence in detail is one which is frequently used by modern physical anthropologists, it will also be adopted here, but with the opinion of this writer that its chief value is that although it may assist in providing a general idea of the occurrence of the tori, ~~but~~ it has severe limitations in value for comparative work.

TORUS MAXILLARIS MEDIANUS:

This torus consists of a hyperostosis of the bone along each side of the suture between the two horizontal plates of the maxillae.

It varies in size and extent from a median ridge a few millimetres in width to a prominent boss a centimetre and a half or more in width. It may have a median sulcus dividing it into two ridges or may consist of a series of more or less connected swellings.

Some consider it due "to the disposition of the glands along the alveolar margins of the palatal roof".

Hooton, who marked its frequency in the Eskimo, considered it due to physiological factors. "In case of the upper jaw the strain medially directed is carried up to the summit of the palatine vault, and the thickening of the palatal roof along the median suture forms a buttress to resist the pressure."

Godlee pointed out that it is an anatomical variation which had often been mistaken for a pathological condition, especially in the case of the torus consisting of one or more irregular bosses.

Of its prevalence on the Australian palate, Godlee (63) writes: "I have found it well marked and very common amongst the Tasmanians; well marked but less frequent among the Australians; ....".

Klaatsch (64) says: "The torus maxillaris is generally very variable in the aboriginal", and it may be "a large and flat shield-like structure separated only by a shallow depression from the alveolar process"; or provided with a median groove, or quite absent.

Burkitt and Hunter have mentioned this torus and also the other elevations here considered, as occurring on a certain number of skulls, but do not give an opinion as to their occurrence on the Australian palate generally; no doubt owing to their observations on these structures not covering a large series.

With regard to the material examined by the present writer, as far as his interpretation of the degrees of development of the torus goes, he would say that the torus maxillaris medianus is comparatively rare, and only in remarkably few instances is it at all well developed, and, indeed, in not many cases is it even obvious enough to be recorded. When it does occur to such an extent as to be appreciable at all, it is generally continuous with the median ridge on the horizontal palatal process, that is, the torus palatinus medianus. Fig 68

The following table is an endeavor to classify numerically the occurrence of the various degrees of development of this torus on the palates examined.

	Total examined	Absent	Slight	Medium	Pro-nounced	Very pro-nounced
Infant	10	5	4	-	1	-
Young	21	17	3	1	-	-
Young Adult	25	21	3	-	-	1
Adult	110	88	15	6	1	-
Aged	47	36	6	3	2	-

Torus Palatinus Medianus:

The ridge or boss occupying the midline of the horizontal plates of the palate bones has been given by some the above-named torus, and described separately from the Torus Maxillaris medianus, which is situated further forward.

Godlee expresses doubt that this is a true torus, but thinks rather that it adopts the appearance of a torus owing to two deep hollows lodging masses of glandular tissue, occurring on the palatal plates and leaving the middle line portion raised like a ridge. Also large, broad trumpet-shaped orifices of the posterior palatine foranima may add to this effect.

Of its presence on the Australian palate :-

Krause (65), after giving a frequency of the Torus palatinus transversus of nearly 40%, says: "Vicl seltener, aber als regelrechter medianer Wulst, erscheint ein Torus palatinus medianus".

Klaatsch, of the Australian material he examined, says: "I find it very often more or less ~~xxxxx~~ developed. ..... In some cases it is seen to be merely the posterior portion of a longer ridge comtinued forwards as far as the foramen incisium. This longer ridge, the torus maxillaris medianus, is met with in the chimpanzee (but not in the gorilla nor orang, so far as the limited material at my disposal goes".

In the present observations it was found that in its simplest form this torus existed as a very thin ridge in the midline, widening and levelling off somewhat in its foremost portion towards the transverse sutures. But in the form in which it occurred mostly and in a marked condition at all, this torus was presented as a triangular, shield-like boss, with the apex towards the posterior nasal spine and its base situated at the level of the transverse suture. Again in this latter condition the torus was obviously part and parcel of what some writers have termed the Torus palatinus transversus. This condition is fairly well shown in Figure 69.

Whether this structure is a true torus or not, and even if it be often continuous with the Torus maxillaris medianus and torus palatinus transversus, the following table gives its frequency and development in stages from a small thin ridge to a well-marked triangular boss.

	Total examined	Absent	Slight	Medium	Pronounced	Very pronounced
Infant	10	4	3	3	-	-
Young	21	6	13	1	1	-
Young Adult	25	7	15	3	--	1
Adult	108	27	44	21	14	2
Aged	47	11	21	9	6	-

Torus palatinus Transversus:

This name has been applied to a ridge situated transversely across the horizontal palate in the region of the transverse sutures.

Krause (66) considered that its frequency in the Australian palate was enough to necessitate its noting: 57 cases out of 149 skulls - 38·3%.

Klaatsch (67) states that his observations did not confirm the findings of Krause, but that formations in the form of spines "closely connected with the larger palatine furrow", were more or less frequent.

The observations of the present writer over a fairly extensive collection of material would support the view of Klaatsch. If the shield-like boss referred to above and considered as a median torus, be held to also incorporate a transverse torus, then whenever this triangular eminence is recorded in medium or marked form we must consider the transverse torus as being more or less present also. But as a torus occurring separate and distinct on its own, it must be held here that a transverse torus rarely, if ever, exists on the Australian palate. The small spinous or tubercular eminences situated laterally near the furrow for the posterior palatine vessels and nerve, are almost always present, and often loop over to unite, incompletely or completely, with a similar process arising from the base of the alveolar ridge.

It is not proposed to tabulate any numerical results of the occurrence of this torus, because, as before stated, it practically never occurs separate from the shield-like formation, or apart from the structure consisting of both the median tori in the form of a long, broad, flat and continuous ridge.

Crista palatina transversa:

This elevation is of hardly a torus, but for purposes of description it is very convenient to include it along with the abovementioned structures.

It is the transverse ridge situated laterally on the margin of each of two large curves or notches which form the posterior boundary of the hard palate. It gives attachment to the tendon of the Tensor veli palatini muscle.

This structure may consist of a ridge, only in that portion of bone immediately behind the lesser palatine foramina, but the ridge may flatten out and become non-existent passing towards the midline. However, the ridge may continue in the form of a marked crest for some distance along the border of the notch. The variations are from entire absence of crest to an upstanding crest two or three millimetres high.

Krause in his observations on the Australian palate considered this crest worth noting as a frequently occurring, sharp and thin elevation, in some cases several millimetres in height.

Klaatsch also mentions its occurrence in varying degrees in the Australian specimens he examined.

It should also be stated that this ridge occasionally occurs not along the posterior margin of the palate bone, but three or four millimetres ~~anterior~~ to the border of the bone.

	Total examined	Absent	Slight	Medium	Pronounced	Very pronounced
Infant	7	3	2	1	1	-
Young	21	9	5	5	2	-
Young Adult	25	8	7	6	3	1
Adult	100	55	29	12	4	-
Aged	43	28	9	6	-	-

When the palatine torus is considered as a single development, that is, not divided into separate tori, as the foregoing treatment dealt with it, it has been stated that Hooten studied it in the skulls of Eskimos, Lapps and Icelanders, and put forward the view that the torus acted as a supporting buttress for the palatine vault against severe stresses exerted by these people in mastication. Its absence as a marked development in the Australian palate would naturally suggest that this explanation hardly seems sufficient, for there can be no doubt about the severity of masticatory stresses in the Australian. However, this, like many other interesting problems, can only be solved by continual specialized and comparative studies. Hooten on page 61 of his essay says, "It will be apparent from the above figures that the palatine torus occurs most frequently in peoples of extreme northern or southern habitat with the exception, possibly, of the big-jawed Australians and Tasmanians, and the Polynesians (among the last named of whom Cocchi gives the occurrence as 73.3 per cent of 30 cases). It seems to me quite probable that a large number of observations would reduce the percentages of occurrence in these groups, as neither of the two Australian skulls in the Peabody Museum exhibit the character, and an adequate number of Papuan skulls (242) examined by Cocchi shows only 35.2 per cent."

The findings of the present work would probably meet with the expectations of Hooton, and a survey of a large series of Australian skulls would probably modify his views explanatory of the presence of the torus.

THE SUTURES OF THE HORIZONTAL PALATE.

The suture occurring in the midline of the palate and those situated transversely between the horizontal portions of the maxillary and palate bones remain well marked till well on in life, and it is only occasionally in the aged skulls that one finds obliteration of these sutures.

In the group of skulls which have been classified as "aged", out of a total of 377 specimens, 155 of these showed partial or complete fusion of the palatal sutures.

With a number of specimens on which detailed observations have been made, it has been recorded how the plates of bone, which are marked off by the above mentioned sutures, are situated relative to one another. In some the right hand horizontal maxillary plate meets the left side horizontal palatal plate; in other cases these are separated because the other two plates touch; in the third type the two portions of the transverse suture are continuous and form a cross pattern with the median suture. Figure 70 diagrammatically illustrates the three phases.

Out of a total of 166 recorded observations:

In 62 R. max. portion met L. pal. portion
In 55 L. " " " R. " "
In 39 the two portions of transverse suture were continuous.

It is interesting to note that in the early stages of palate development the two portions of the transverse suture are generally continuous. This was the condition in

7 out of 10 infant specimens
11 " " 21 young " .

THE INTERMAXILLARY SUTURE.

The intermaxillary suture which divides the premaxilla bone from superior maxilla, is considered to have an important relation to the formation of the anterior part of the palate.

Colyer (68) states that well defined sutures are associated with well formed anterior regions of the palate. Also that "the outer portion fills in first, the inner portion being often well marked in the skulls of children of twelve to sixteen years of age".

Tomes (69) studied the growth of human jaws and also those of apes, and considers that the date of closure of the intermaxillary suture is closely associated with the elongation of the jaw and prognathism. "Thus a large part of the prognathism of these apes is due to a long-continued growth in the intermaxillae, and it would be interesting to ascertain if the prognathism of the lower races of mankind is also due to the obliteration of the suture being deferred longer than in European ~~jaws~~ races..."

Hrdlicka, in an account (70) of a number of Eskimo skulls from Southampton Island, North of Hudson Bay, - 14 adults, 1 adolescent, 2 infants, - makes the following interesting remarks concerning them. "Alveolar prognathism is usually well marked." "The alveolar prognathism is in most of the specimens well manifest, it is due, of course to the size and alignment of the teeth". "A rather curious fact is that nearly one half of the adult skulls show patent and in some instances large remnants of the premaxillary sutures."

In the present work record was made during the observations of the palate of cases which showed persistence of the intermaxillary suture; the following statements will give some idea as to the presence of this suture in Australian specimens.

In the group classified as "infants", a total of 13 palates, showed persistence of the suture in every instance; in one or two only a portion of the suture was obvious, but in the rest it was well marked. See Figure 71 .

In the group classified as "young" specimens, a total of 22 palates shosed this suture in every case. In extent the suture was well marked in varying amounts ranging from a quarter to half the distance or more from the foramen to the margin of the tooth sockets. In most it was obvious for about a third the distance. See Figure 72.

In the group of "young adult" specimens, the following were the recorded instances: (See Figure 73)

Total number of palates ...	25
Well marked persistent suture	2
Slightly " "	19(i.e.about 4-8 mm.)
Suture fused	4

In the "adult" specimens of which detailed study was made on the palatal area, and records kept of the persistence of any of this suture, it was found that out of 107 specimens portion of the suture was still evident in 19 of them, or 18%. See Figure. 74.

From the above figures it will be seen that persistence of the intermaxillary suture almost invariably occurs in young specimens, right from infancy up to the young adult age; and also portions of the suture are not infrequently met with in people of adult years.

THE DENTAL ARCHES

Measurements of the dental arches were of course taken as a necessary part for building up the palatal contours.

Arch widths were taken at all the teeth excepting the incisors. This measurement was the maximum width taken with the two arms of the sliding calipers against the labial surfaces of the two teeth concerned.

Arch length was also a maximum measurement taken from the labial surfaces - near the incisal region - of the two central incisors and the distal surfaces of the third molars. This measurement was secured with a small instrument ~~mixm~~ made by Mr Rogers of the Adelaide University, and it proved very useful for this purpose. Fig 74a

The arch measurement of the upper and lower arches of deciduous and permanent dentitions are given on a later page.

Also a series of type arch contours have been prepared which show the development of arch form. See Figures 74d, 74e, 74f and 74g.

An interesting result is shown in Figure 74h which consists of superimposed contours of that portion of the arches anterior to the first permanent molar.

It is shown that with an increase in arch width in its anterior portion there is a diminishing in the premolar dental projection.

The acquirement of an edge to edge bite is no doubt involved in this change.

Fig. 74b shows the parallel shape of the arch which is frequently seen in the Australian dentition.
Fig. 74c shows a series of mandibles with the squarish front portion of the arch; also frequent in the Australian jaw.

ARCH MEASUREMENTS

AVERAGES

		Width				Length
		M_1	e.	d.	c.	
Infant	Upper	-	50.5	44	33	33.5
	Lower	-	42.8	36	28.1	28
Young	Upper	57.7	53.8	47.8	41.1	42.8
	Lower	55.2	47.6	41	33.3	39.5

	Width						Length
	M_3	M2	M_1	P2	P_1	C	
Young U	62.7	61.8	60	53.7	49.6	42.7	48.7
Adult L	-	59.1	55.7	47.6	43.2	35.1	48.3
Adult U	64.8	65.2	61.4	54.6	50.8	42.7	57
Adult L	65.3	61.8	56.5	49.3	42	33.8	57.1

OCCLUSION OF THE TEETH

OCCLUSION OF THE TEETH

Occlusion has been described as the normal relations of the occlusal inclimed planes of the teeth when the jaws are closed. This condition in the normal denture for modern peoples, to express it simply, consists in an interdigitation of the cusps of the posterior teeth of the upper and lower jaws, the buccal cusps of the lower teeth fitting up into the sulci of the upper teeth and each lower molar tooth being situated half a cusp length in front of its corresponding upper molar. Also the lower incisors and cuspids occlude behind the upper anterior teeth.

The first point of interest to be considered in studying occlusion in the Australian's dentition is that connected with the manner in which the anterior teeth antagonise. It has been frequently recorded that all primitive and prehistoric races have possessed what is called an "edge to edge" bite. That is, instead of the lower anterior teeth biting up against the lingual surface of the upper teeth, the incisal borders of the anterior teeth, upper and lower, directly antagonise; so that this feature has come to be looked on as characteristic of primitive races.

It has been stated by Bonwill that an almost constant relation exists between the overbite in the incisal region and the length of the cusps of the premolar and molar teeth; Figure 79. A marked overbite would usually show the molars and premolars with high cusps and vice versa. If this may be taken as the correct version of the conditions, then an edge to edge incisal bite must be due to either very short cusp height or reduction of cuspal height by attrition.

The edge to edge bite has been noted by various observers as present in a number of the existing lower races of mankind, and is well known to be typical of the Australian dentition.

In any series of Australian skulls which contains sufficient specimens of varying ages, it can be seen that the presence of the edge to edge is dependent on the amount of occlusal wear the teeth have undergone. That is, a diminution in the cusp height of molars and premolars is accompanied by a shifting forward of the position of lower anterior teeth relative to the upper anteriors.

Reference to the illustrations will give a fair idea of the conditions pertaining to various ages of Australian specimens.

Figure 75 shows a young specimen in which the first permanent molars are just up into normal position, and the central and laterial incisors also almost completely erupted. It is seen that the upper incisors are relatively more procumbent.

Figure 76 shows another young specimen with the anterior teeth at a slightly more advanced stage of eruption, and the condition of overbite is still present.

Figure 77 shows a still older stage of an individual in its teens, the second molars being well up into position in the arches, but as yet in this specimen occlusal wear has not advanced very much. It is here obvious that the overbite condition still prevails.

~~Figure shows an adult with third molars up into functioning positions, but here occlusal wear has taken place, and the clear cuspal interdigitation on the labial aspect is not so clearly marked.~~

Figure 78 shows the final adult stage where sufficient wear of all the teeth in the arches has taken place so that the flattened incisal borders of the lower anterior teeth are opposed to the similarly ground down edges of the upper anteriors.

The specimens here illustrated are quite representative of the age groups from which they have been selected, and should be sufficient to show that the condition of "edge to edge"bite, said to be typical of the Australian dentition, was one which, though present in the adult almost without exception, was a modification only acquired by the attaining of adult age.

Turner (71) many years observed this condition as being very noticeable in Australian crania,and wrote at some length on it. He discussed the relations of the two arches to one another, and made numerous observations on the lengths of the arches, and refers to the relation between overbite and the reduction of prognathism, and the cranial changes involved in the latter process. However, Turner evidently did not consider the relation occlusal wear might have to edge to edge bite conditions.

In considering the changes occurring in the bringing about of this relation of the arches, it might be 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 the edge to edge bite. But it will be noted in referring again to Figure that the position of the first lower molar relative to its upper homologue is practically unchanged from that of earlier stages; it has shifted anteriorly no appreciable distance, if any at all. Therefore it seems as if we must consider the main change as having occurred in the anterior region of the arches.

It seems that the condition must be brought about by some change in the relative positions of the anterior teeth in the two arches. With this in view, a series of measurements have been commenced which might help to elucidate the question, but up to the present the writer cannot offer any explanation which will definitely explain the changes; although no doubt,as with many such problems, the solution when obtained will prove a very simple one.

One or two interesting points have presented themselves in the work so far done on this particular item. In an endeavor to ascertain the nature of changes which take place in the anterior portion of the arch, a number of measurements have been taken on jaws of varying ages, of what might be termed the pre-molar arch triangle. This consists of two measurements taken from the anterior point of mesial contact on the incisal border of the centrals to the mid-point of the mesio-occlusal line angle of the first molars; and a baseline measurement of the triangle between the same two points on the molars.

From results so far obtained, it would seem that the actual tooth prognathism beyond this ~~xxxxx~~ base line is actually greater in young skulls than in adults, and that the lessening in the adults is due, slightly perhaps, to the wearing down of the incisal border of the incisors, but more so to a widening of the arch in the canine-premolar region. A coordination of treatments of both arches along these lines will probably make clear the acquirement of the edge to edge bite.

ERUPTION OF THE TEETH

ERUPTION OF THE TEETH

On the subject of the eruption of the teeth of the Australian, little appears to have been written. Although it is generally believed, and probably correctly so, that the teeth of the native erupt somewhat earlier than do those of the civilized white, there appear to have been no observations recorded on the living subject.

It is proposed to record here a few observations on the eruption of the teeth, made on the material under present consideration.

On the whole it would appear that the replacement of the deciduous dentition by the permanent took place in a very orderly and normal manner. The radicular portions of the deciduous teeth almost invariably showed that they had been absorbed in a regular manner by the developing permanent teeth immediately below them. And, as has been shown in earlier pages, the cases of abnormally long retained deciduous teeth with irregularities in positions of permanent organs, were very rare. The condition, which one sometimes hears termed the "double row" of teeth, would, of course, be a very unexpected rarity were it met with. Needless to say, it was not.

The occasional retention of small pieces of the roots of deciduous teeth will be dealt with under the heading of "Accessory Dental Masses".

Dr Ramsay Smith (72) has dealt with various points of interest associated with the development and eruption of teeth in the Australian aboriginal. He directed attention to the following special points of interest:- peculiarities of the "gubernacular canals"; grooves for the enamel germs occurring between the first and second, and the second and third upper molars; mode of development and eruption of the second and third upper molars; osseous growth of the jaws and position of transverse palatine suture relative to the molars.

A few remarks on some of these points may be of interest.

In the above mentioned article Ramsay Smith gives a very excellent photograph of the palate of an aboriginal infant. After drawing attention to the positions of the anterior gubernaculer canals, he says on page 227: - "Internal to each canine tooth there is a swelling marking the position of the non-erupted permanent canine." This, of course, is quite erroneous, for at this stage of development the permanent canine teeth, or such of them as have been formed, are situated high up in the maxillary bones, somewhere between the region of the infra orbital foramina and the borders of the nasal aperture. See Figure 83. The swellings on the palate referred to do not cover the unerupted canines, but the unerupted permanent lateral incisors. Close attention to native skulls will show an interesting arrangement of the unerupted incisors in the infant palate. The crowns of the permanent central incisors are situated in an almost vertical position immediately beneath the four deciduous incisors - the size of the permanent central incisor is such that its incisal border is almost as long as the sockets of both deciduous incisors~~xxxxxxx~~. While the permanent lateral incisors are placed in a somewhat horizontal position and immediately behind distal angle of the edge of the central incisor. It is this position of the developing laterals which forms the swellings somewhat internal to the deciduous canines, and not the permanent unerupted cuspids, as was supposed by Ramsay Smith. A close examination would probably reveal that the condition shown in "Figure 2" on page 228 of his essay is a similar case.

In the same article the above writer calls attention to the mode of eruption of the second and third molars, in which these teeth during their initial stages of erupting look backwards. He suggests "the probability is that it is a racial character." This condition of the molar teeth - the first molar included to a lesser degree - erupting through the alveolar process with their occlusal surfaces facing backwards and outwards to some extent is only a "racial character" in that it must occur in all races which have a large and vigorous maxillary development and possess a normally developed and spacious maxillary antrum. Arthur Keith, many years ago, pointed out this method of eruption of molar teeth in both man and apes, and Figures 80 and 81 which are slightly modified copies of drawings given by him in an essay (73) on this subject, help to make the condition clear. The permanent molar teeth develop in the posterior bony wall of the antrum; and as that portion of the antral space adjacent to the developing molars enlarges in a direction downwards, backwards and outwards, the developing and erupting teeth are carried in a similar direction, until their final position is that which they occupied in a well formed dental arch. Figure 82 is a photograph of the actual skull of a young aboriginal, and shows in a manner similar to that in the diagrams taken from Keith's essay, the eruption of the molar teeth.

As stated above there is apparently no data recorded which gives the age at which teeth erupt in the Australian aboriginal child, so that what difference there may be in the period of tooth eruption between them and modern white children is not definitely known. It is generally believed that teeth erupt somewhat earlier in native races than in modern civilized peoples.

A series of twenty odd skulls of young individuals among the present material provided various stages in the transition from deciduous to the permanent dentition, and a few notes have been made to ascertain the sequence in which the permanent teeth erupt. The number of specimens is hardly sufficient to base any hard and fast statements on, but such conditions as were presented revealed the following:

It would appear that the upper first permanent molars and central incisors erupt at much about the same time. Then follow the lateral incisors; next the first premolars. The second premolars and canines erupt about the same time, but this period was not well represented in the series. Then come the second molars and finally the third molars.

In the lower jaw the sequence is apparently much the same as the upper, excepting that the canine would appear to come before the second premolar, and rather keep pace with the first premolar. This latter feature is recognised as taking place in white children also.

In carrying out the radiographic section of these observations, a series of mandibles have been recorded so that various ages would be represented. In these there can be seen in a very excellent manner the stages of tooth development and eruption from infancy up to adult age. Reference to these illustrations will show that they themselves provide a description which need not be unnecessarily burdened with further statements. See Figures 9 to 17.

THE GLENOID FOSSA

GLENOID FOSSA (Mandibular Fossa)

Studies of the glenoid fossa have been made by various observers in order to ascertain whether its shape has any racial or phylogenetic significance, and in what manner its variations are related to mandibular movements.

The shape of this fossa is closely wrapped up in the question of anatomical articulation and other aspects of Prosthetic Dentistry. In this light close study of its shape has been made by Dolomore & Tomes, Turner, Wilson, Gysi and other students of masticatory movements.

More from the point of view of physical anthropology, this structure has been noted by Duckworth, Guiffrida-Ruggeri, Knowles, Hawkes and Wallis, and Sullivan.

Knowles (74) for example points out the narrow glenoid fossa as being particularly characteristic of the Eskimos, while of the same conditions Sullivan (75) says, "The shallow glenoid fossa can have no racial or phylogenetic value. At best it might give a possible hint as to the masticatory habits of an individual".

Hawkes and Wallis (76) confirmed to some extent the observations of Knowles, but also showed there was considerable variation of the fossae among the Eskimos.

Sullivan studied a series of 122 Eskimo skulls, and gave the following approximate percentages of fossa variations:

Deep and short	21%
Medium and short	15%
Shallow and elongated	31%
Flat and elongated	33%.

Sullivan also gives a list covering a considerable number of skulls, chiefly of American Indians from the southern part of the Northern continent and various regions in South America. Here again he shows that instead of providing a racial characteristic, all types present considerable variation of the fossae.

Of this fossa in the skull of the Australian aboriginal, Duckworth says, "The glenoid fossa is shallow".(77).

Sullivan noted that, with the series examined by him, there was "a marked asymmetry of the fossae, not only in different skulls of the same race but also on the left and right sides of the same skull".

The present writer found that with the series here considered, the instances of asymmetry in the fossae of the same skull were decidedly rare (excepting perhaps in some of the aged skulls, which presented a different problem, namely, pathological alterations due to a productive osteitis); this striking symmetry being no doubt due to the fact that the Australian aboriginal obvidusly used both sides of his dental arches in a very regular manner, as is evidenced, in the majority of cases, by the symmetry in the occlusal wear of the teeth.

The following notes constitute only a very brief survey of the structure as presented by the material herein dealt with, but they are perhaps sufficient to give some idea as to its variations in a fairly large series of Australian crania.

The difficulty of recording observations on the glenoid fossa is that it does not lend itself to measurement very easily, and a series of contours secured by the method of Dolomore and Tomes cannot be readily presented nor recorded mathematically.

Sullivan classified the variations into: deep and short, medium and short, shallow and elongated, flat and elongated.

Any classification of this nature must of course rest greatly on the personal judgment of the observer. In the present instance, even though appreciating the difficulties in adopting such a method, the writer has resorted to a process of measurement, and has only taken into account the depth of the fossa.

The method adopted is made sufficiently clear by Fig. 84, the skull being held in a horizontal position with its basal aspect upwards, and the measurement secured by an adjustment of the instrument used in taking palate depths. The landmarks as shown in the diagram, being, a, the middle or lowest (the skull being upside down) part of the cavity; and b, a point on the eminentia articularis, which would be approximately on a line passing through a at right angles to the long axis of the fossa; the depth here indicated being that distance from the bottom of the fossa to where the rod, resting vertically on a, is intersected by a horizontal line from b.

Sullivan comes to the conclusion that shallowness of the fossae in the adult is due to vigorous masticatory habits, the articulation moving forwards on the roots of the zygomatic arches and wearing down the articular eminences. Also that the wear of teeth provides evidence in support of this conclusion.

Such would undoubtedly seem a justifiable explanation of changes in depth of the fossae, but some of the records obtained by the present writer would tend to show that marked wear of the teeth is not always associated with shallow glenoid fossae. Unfortunately the number of records obtainable from aged skulls was not great, but the following instances are interesting.

From the records of aged skulls, I can obtain four which give fossae depths of 6, 6, 8 and 8 m.m., which descriptively would be termed fairly deep fossae; but these three examples all show stage ~~IIII~~ of occlusal attrition, which indicates a very marked condition of wearing down. Against this one is also able to select from records of adults of varying ages, depths of fossae measuring 6, 6, 8 m.m., and all these showing stage II of occlusal wear, which is only sufficient to have worn through to the dentine and not reduced the height of crown very much.

This shows that there does not always exist a simple relation between the wear of the teeth and shallowness of the fossae, merely dependent on masticatory habits. There are undoubtedly other factors to be taken into consideration. Probably one of these is the nature and thickness of the interarticular disc.

By adopting the method of studying this structure as it is presented by the grouping system used in this work, it should be possible to trace to some extent the progressive changes in the depth of the fossa throughout life.

The following table shows the results of the measurements.

Age Group	Number of Observations	Minimum Depth	Maximum Depth	Average Depth
Young	14	3	5	4.2
Young Adult	21	3	6	4.5
Adult	91	1.5	8	4.7
Aged	24	3	8	5.6

It must also be noted that in the case of a number of infant skulls, the fossae were so shallow that they did not lend themselves to measurement very well with the instrument used, but in these instances it would be safe to say that their depth ranged from 1.5 to 2 m.m.

The number of measurements on fossae of aged skulls was not great owing to so many of the specimens presenting their fossae pathologically altered by marked depositions of bone.

However, there are probably sufficient records to show that in the Australian native the depth of the glenoid fossae presents considerable variation, even when specimens of approximately similar ages are compared.

The fossae are fairly regular in general form throughout this race, and in the older individuals they become widened antero-posteriorly owing to the articular eminence and the anterior wall of the cavity becoming flattened with wear.

The instances of asymmetry in the depths of the fossae in the same skull are so few that it can safely be said that the two fossae of a skull are, on the whole, decidedly symmetrical.

The results would also tend to show that, if we exclude those aged skulls showing fossae shallowed by a productive arthritis, the glenoid fossa increases in depth from infancy to old age. And that, in so far as the present observations show, masticatory function - as indicated by much worn teeth - does not produce a reduction in the depth of the fossae. This being contrary to the opinion recorded by Sullivan.

However, as mentioned above, the present observations on this structure have been limited, and a much more exhaustive study of the fossae would be necessary before a thorough understanding of their form and variations could be attained.

Figures 85, 86, 87 and 88 illustrate fossae in specimens of various ages, and show in the infant, young, and adult skulls its increasing depth. The aged specimen shows the condition of the fossa which is not infrequently presented in skulls of advanced age. The reduction of the articular eminence and the deposition of osseous material in the fossa leads to a large, flat and roughened articular area being formed.

THE MANDIBULAR TORUS

THE MANDIBULAR TORUS

The Mandibular Torus, so-called, is a hyperostosis of the mandible, and consists either of a continuous ridge, or more or less connected elevations situated on the lingual side of body of the mandible just above the mylohyoid line, particularly in the region of the pre-molar series. It has been observed chiefly on Eskimo jaws and of others occupying the cold, sub-Arctic regions of the Northern Hemisphere.

It is spoken of by various writers as being a physiological hyperostosis derived from the heavy functional strain on the cheek teeth during those vigorous chewing habits indulged in by such peoples; the torus acting as an extra support against the abnormal strain of mastication directed towards the median line.

Hrdlicka (78) has written of it that it "is undoubtedly of functional origin, the result of extraordinary pressure along the line of teeth most concerned in chewing, yet its occurrence in infant skulls indicates that at least to some extent the feature is already hereditary in these Eskimo (Southhampton Island)."

Hooton (79) of the Harvard University, has dealt with the torus, as observed in a series of mandibles belonging to Icelanders; and in his articles deals with the distribution of ~~character~~ this feature in his series of specimens, and compares his data with those given by previous writers on its occurrence in other peoples.

As the character is one which does not lend itself to classification by measurement, Hooton has separated the occurrence into classes: absent, slight, medium, pronounced, very pronounced.

The present work included a search among the numerous Australian mandibles available for indications of this torus, but taking into consideration Hooton's "slight" class only, which "includes mandibles which exhibit small and isolated but easily perceptible additions of compact tissue along the lingual borders of the alveolar processes", it is very doubtful ~~with~~ whether any of the mandibles examined show sufficient justification for their inclusion even in it. And on the present writer's interpretation of the presence or absence of this feature, it must be said that the mandibular torus is entirely wanting in the Australian.

The mandibles which have been closely examined for this feature, when classified and tabulated according to Hooton's grouping, would provide the following result:

	Absent	Slight	Medium	Pronounced	Very pronounced	Total
Cases	100	-	-	-	-	100
Per cent.	100	-	-	-	-	

If, as has been stated by some writers, the mandibular torus is essentially a functional adaptation, its marked absence in the Australian native requires some explanation. For an examination of the Australian dentition must convince one that it would be difficult to find another people whose masticatory habits subjected the dental system to greater stresses than did those of this native. The forthcoming explanation would probably be that the primitive, heavy and strong type of mandible possessed by the Australian did not require any extra osseous reinforcement against the heavy demands in mastication.

GNATHIC INDEX

GNATHIC INDEX

It is not proposed to give any further account of this condition other than to place on record some statistical data. To deal with the index is perhaps including a subject which is a little beyond the range expected from the title of this work, but as the Basi-nasal length has to be obtained for deriving the Dental Index, it was decided to include the Basi-prosthionic length among the observations made, and thus make the Gnathic Index procurable from a fairly large series of skulls.

The Index adopted here is, of course, that of Flower. Discussion of other methods of obtaining this index must be left to various standard works and more extensive writings on the subject. For example, Bückner (80) in an article on the prognathesm of the Tasmanians, gives a very interesting survey of different methods for securing this index.

The total number of adult skulls from which the required lengths were obtainable was 123.

The general results are as follows:

Average of Gnathic indices for both sexes, old adult and aged skulls	104.3
Maximum	115.3
Minimum	96.2

Following the procedure adopted for other sections of this work, the skulls have been taken in groups according to their ages, and the Gnathic Index studied as to its value from infancy to old age.

The number of skulls of all ages from which the required measurements could be taken was 153.

This total has been classified into the groups previously described with the following result:--

Infant skulls	...	1
Young "	...	14
Young adult "	...	15
Adult "	...	95
Aged "	...	28

The Indices of these groups are given in the following table:

Group	No. of skulls	Average	Range	
			Maximum	Mimimum
Infants	1	100	-	-
Young	14	99.4	105.7	93.3
Young adults	15	103.3	106.7	100
Adults	95	104.5	115.3	93.1
Aged	28	103.7	112	96.2

The condition of maxillary projection is expressed as being:

Orthognathous if index is below 98

Mesognathous " " " between 98-103

Prognathous " " " above 103.

Therefore from the above results we see that omitting the infant group, which is ~~xxxr~~poorly represented, the

Young are Orthognathous

Young Adults are Mesognathous

Adults are Prognathous.

A table of comparative data on this condition taken from Buchner's article shows an interesting series of results:

No.		Gnathic Index	
43	(Orang Utan female	176	
	(" " male	170	
40	(Chimpanzee male	131	
	(" female	125	
55	(Gorilla male	123	Prognathic
	(" female	120	
	Gibraltar (Sollas)	105.7	
36	African negroes	104.4	
58	Melanesians	103.4	
90	Australians	102.38 - .30	
32	Tasmanians	102.08 - .40	Mesognathic
19	Andamanese	101.32 - .55	
29	Hindus	98.7	
32	Chinese	97.94 - .48	
184	Europeans	96.2	Orthognathic
50	Modern Italians	95.92 - .32	

It will be seen that in the results of the present work the adults and aged specimens either separately or combined fall within the prognathous group in distinction from their place in the above list.

SOME DEVELOPMENTAL ABNORMALITIES

1. Odontomes
2. Enamel Ridges and Nodules
3. Accessary Dental Masses.
4. Fourth Molar Pits.

ODONTOMES

If the occurrence of abnormal tooth structures depends upon the amount of balance there exists between the development, form and function of the dentition, and marked variations and abnormalities are concomitant features of a degenerating dental system, then in such a well formed and thoroughly functioning dentition as the Australian possessed we would not expect to meet very frequently marked aberrations in the dental organs.

In the present work only one case was met with which showed anything in the nature of a marked aberration of tooth development. This was an example of radicularodontome, or what would probably be more correctly classified as a "dilated composite odontome" of the radicular type.

This occurrence was in the skull of an infant, which has three deciduous molars in situ, but the anterior deciduous teeth had been lost post mortem. The permanent incisors showed that they had been almost about to erupt. It may be assumed that the age of the child was about five years.

<u>Situation</u>. The odontome presented itself on the facial aspect of the left maxilla immediately above the first deciduous molar. See Figure 89. The coronal portion appears to have erupted through the surface of the bone, the enlarged root portion was covered superficially by a thin covering of bone which has broken away since death.

<u>Form</u>. The coronal portion of this specimen is more or less completely formed, although it presents a somewhat ill-shapen, hypoplastic appearance. At what would approximately ~~xxxx~~ coincide with the gingival region the tooth suddenly takes on a very dilated form. See Figure 90. The enlarged portion of the structure simulates on a very

exaggerated scale the root form of a canine, but after some distance this dilated and hollow root portion suddenly cases - at death? - further development, leaving a wide open orifice.

Dimensions:	Coronal portion:		
	Labio-lingually	4	mm
	Mesio-distally	7	mm
	Radicular portion:		
	Labio-lingual diam.	13	mm
	Mesio-distal do.	11	mm
	Height on buccal side	15	mm
	Total length	19	mm

On close examination the crown portion of the structure shows that practically only its tip and for a short distance up the labial surface is covered with well formed enamel. The remainder of the crown, such as it is, appears to be formed of very hypoplastic dentine.

From appearances and position it would seem that this anomaly is a marked aberration of the upper left permanent canine.

ENAMEL RIDGES AND NODULES

These are enamel ridges and excrescences situated on the neck of molar teeth or in the region of the junction of two roots. The ridges are continuous with the enamel of the crown, but the nodules may be in no way connected with the coronal enamel.

These formations ~~werex~~ termed "odontomes" by Salter in 1874, and in the beautifully compiled "Report on Odontomes" (81) by Gabell, James and Payne, they are also described under the group of Composite Odontomes. The cause of these formations is unknown, although various suggestions have been made, such as: gemination with a supernumerary tooth; budding from a tooth germ; mechanical interference during growth; development of an extra cusp.

Wedl in accounting for them says: "It is obvious that the nodules or ridges which are met with upon the molars are the result of localized continuations of the development of the enamel between the already developed basal portion of the roots, and are produced by the strip of the enamel organs which has persisted longer than the rest." With part of this account of the formations the present writer is in decided accord, for the material on which this work is based has provided some very excellent specimens for the study of these enamel structures.

In so far as the enamel ridges are concerned, in the molars of the Australian they are so frequent as to be almost considered a normal condition.

The enamel nodules also are by no means rare, but finding them is not an easy matter, as the removal of molar teeth from a specimen is generally impossible without serious damage to both teeth and jaws.

Nicholls has drawn attention to the presence of these enamel prolongations or tags which give the enamel margin a sharp V-shaped dip towards the root bifurcation. He says:

"it appears that is possible to trace a full series of such 'epithelial outgrowths' from these isolated specks and enamel nodules, through the rudimentary conical 'peg-shaped' teeth, and the multiple cone teeth, to the supernumerary teeth of their respective series, including the much-discussed fourth molar". The present writer is not inclined to agree with the view that these ridges and small nodules bear a "serial" relation to rudimentary and supernumerary teeth. The appearance of these ridges in various degrees of development, and the ridge being sometimes represented by a series of isolated enamel specks, or at times a portion of the ridge, or an isolated speck developing to the size of a nodule, seems rather to point to their being formed from a remnant of the enamel organ which formed the tooth on which this enamel aberration exists, and not in the manner of an extra rudimentary tooth, or portion of a tooth, which is formed by a prolongation of a free end of the tooth band in an effort to form an extra tooth entity. In brief, one is formed from the remnant of an enamel organ, the other from a separate partly or completely formed tooth germ. However, this view is put forward tentatively, as time has not permitted a detailed and prolonged enquiry into the subject.

That part of the statement by Wedl which says the nodules and ridges are "the result of localized continuations of the development of the enamel between <u>the already developed basal portion of the roots</u>" cannot be accepted here as correct, for a study of tooth formation in those stages just prior to and at the commencement of actual root forming will show that these enamel ridges and specks are formed <u>before</u> the root actually commences to form. It is hoped that in a future publication these statements will be borne out by the evidence of a series of illustrations from actual specimens, showing various stages in the development of ridges and nodules.

Figure 91 shows a good example of a rather large enamel nodule occurring on an upper molar.

Figure 92 shows some upper and lower molars in that stage of formation when the initial portion of the roots has just been or is about to be formed. In these illustrations the teeth have been somewhat enlarged, and show fairly clearly that the small prolongations of enamel which form enamel ridges are present actually before the roots commence to form; and in some cases extend well onto the inter-radicular portion of the crown.

ACCESSORY DENTAL MASSES

This term is the one generally applied to small masses of tooth substance which are found in the alveolar ridges of both jaws, and most frequently situated in the maxilla in the region between the first molar and second premolar. These masses have been suggested by some as having a morphological and phylogenetic significance, and are considered to bear a relation to the third premolars of the lower Primates.

In the majority of cases there seems to be no striking evidence which would lead one to consider them as anything else than the unabsorbed or unexfoliated portions of deciduous molar roots.

These masses are small in size and bear no resemblance to actual supplemental teeth, which sometimes occur in similar regions and are commensurate in size and form with the teeth adjacent to them. The matter of subjecting these masses to microscopical examination does not appear to have been dealt with in any detailed and persistent manner.

Duckworth has referred to these masses in several of his writings.

In one essay on this subject (82), he deals with the occurrence as regards frequency, race, age and sex.

The following extracts from this source give his findings of its occurrence racially.

	Occurrences
a. Natives of New Britain	Greatest frequency.
b. Natives of Australia	Next to a in frequency.
c. African negroes	" " b in frequency.

Egyptians,	100 crania	...Nil
Europeans,	50 "	... 1
Peruvians,	100 "	... 2

Dealing with the anthropoids he gives :-

	Specimens	Cases of abnormality
Lower Primates	12	--
Hylobates	6	--
Chimpanzee	4	--
Gorilla	13	7
Orang-utan	9	1

He discusses the probabilities of these masses being remains of, or actual vestigial deciduous teeth, and their possible relation to third premolars. Concluding he writes: "It is thought, however, finally, that the assumption may be maintained that some of the fragments do represent third premolars".

Duckworth also discusses these accessory masses in a later work (83), although not to the same length as in the above essay.

Professor A. F. Dixon (84) paid special attention to this abnormality in examining a series of Ibo skulls from West Africa. The so-called accessory masses he considered were unabsorbed portions of deciduous molars, and that such an origin would account for their rather variable microscopic structure.

The following figures show with what frequency these masses occurred in the material under present discussion. Although the observations for this particular feature have not covered the whole of the available collections, those skulls which are recorded in the totals given below have been carefully examined for these masses, and the position of the latter noted.

	No. of specimens examined	No. showing accessory masses
Infant specimens	13	-
Young "	21	2
Young adult "	~~22~~ 25	2
Adult "	97	6
Aged "	33	1

That is, the occurrence was recorded in 11 specimens out of 189.

Of these 11 cases -

6 occurred in the maxilla
5 " " " mandible.

All were situated either between the two premolars or between the second premolar and first molar, mostly in the latter position. A few masses were situated lingually, but most of them labially and in positions which will be explained on the next page and also illustrated by photographs.

The probability of these masses being related to, or themselves actually being supernumerary teeth, does not appear to be very great on the evidence which has so far been brought forward on the subject. It would appear that when accessory teeth do occur in the premolar region - that is, teeth which by their appearance, shape and structure show more or less complete development into root and crown, the latter having normal enamel - they are to a large extent commensurate in form and size with the teeth to which they are adjacent. But the masses under present consideration show little or nothing of the form of an actual tooth, not even one of a very small and rudimentary type.

The present writer would agree entirely with Professor Dixon that they represent unabsorbed portions of deciduous molars.

Some writers have expressed a difficulty in explaining the presence of these masses, but a little attention to a series of skulls should readily clear up the problem.

It can be seen that in individuals with whom the process of eruption of the permanent teeth and absorption of the superposed deciduous teeth proceeds in a regular and normal manner, the roots of the latter teeth disappear in a very convenient ~~xxxxxx~~ way to make room for the erupting crown of the tooth beneath; a process, the normal physiology of which is well illustrated in Australian specimens. In the case of the deciduous molars, the inner aspects of the two or three roots are absorbed away to leave a cup-like space which conforms to the general shape of permanent premolar crown immediately beneath. In many cases when the absorption process has well advanced the roots of the molar become thinned down considerably; see Figure . With the roots thinned down, the tooth probably becoming somewhat loose as eruption of the permanent tooth advances, it would not require more than the heavy stresses to which the aboriginal's teeth are subjected to break off the deciduous crown, and leave portion of the root or roots in the alveolar process. The buccal roots of an upper second deciduous ~~teeth~~ molar would provide very favorable conditions for such an occurrence. Reference to photographs of specimens should be sufficient to make this clear and convincing. Figure 94 shows a young specimen with a second premolar just erupting, and the deciduous molar above it has been lost, leaving the small unabsorbed sockets of the two buccal roots - or portions thereof - of the molar. Figure 95 on the right hand side again shows the same feature, but here we have a root portion retained in its socket, to constitute an "accessory dental mass". The left hand side of the same illustration shows a further stage where both the two buccal and lingual root portions are retained in situ. It is very probable that these small root masses are exfoliated as the individual grows older, but in some cases they are retained right on to adult years. See Figure 96; also refer back to Figure 37..

Figure 101 shows the palate of a young baboon. Accessory dental masses can be seen in the region of the second premolar which in position and appearance are strikingly identical with those shown in Figure 95.

FOURTH MOLAR PITS

These pits occur in the post dental alveolar process just behind the third molars, and are thus called by some writers fourth molar pits. They seem to occur most frequently in the upper jaw.

They vary a good deal in size from a mere groove to a well defined pit or fossa, a couple of millimetres deep and three or four in diameter.

Figures 97, 98, and 99 give an idea as to the appearance of these pits in upper jaws.

There seems to be some justification in assuming them to bear a close relation to the occurrence of fourth molars; for it would seem that they are caused by a backward prolongation of the "tooth band", a structure essential in the formation of tooth germs, and either buds of the tooth band are formed, or there is an actual commencement of tooth formation. The alveolar process forms round this developing bud, forming a groove or pit.

That such, or something similar, takes place is rather borne out by comparison of the above mentioned illustrations with one of a much younger specimen shown in Figure 100. It will be seen that there is a striking resemblance between grooves and third molar crypts just behind the second molar, to the formations in the other specimens; particularly those shown in Figures 97 and 99.

SOME FUNCTIONAL CONDITIONS

1. Attrition: Occlusal
   Interproximal.
2. Extra Root Divergence.
3. Alveolar Absorption in Mandibles.
4. Structural Change of Alveolar Process.
5. Function and Root Exostosis.

A T T R I T I O N

Besides the destruction caused by chemico-parasitical means, loss of tooth substance may take place mechanically in a variety of ways. For examples may be mentioned:- excessive use of tooth brush and gritty cleansers, stem of pipe, the rubbing of a part denture or its clasp, grinding of opposing teeth against one another, hard and gritty foods. These are referred to under such classificatory terms as erosion, abrasion and attrition.

It is quite obvious, even in perusing modern text-books, that these three terms are used in a very loose and interchangeable manner, and it is to be regretted that uniformity of nomenclature is not encouraged more than it has been in the past.

The terms "abrasion" and "erosion" are both applied to that condition of wearing away of the teeth by excessive use of tooth powders; also the terms "abrasion" and attrition" are both applied to the wearing away of tooth substance by the process of mastication. However, some writers are careful not to mix these terms, but apply them for the naming of conditions which are quite distinct from one another. "Erosion" is the term applied to a peculiar class of shallow, polished looking cavities which occur near the gingival margins on the labial surface, generally of the upper anterior teeth. Just how much these peculiar cavities are due to tooth brush use or to some chemical process, is apparently not yet solved.

"Abrasion" is the wearing away of tooth substance by the action of some foreign body in the mouth, such as the stem of a pipe, the clasp of a denture, or gritty tooth powder.

"Attrition" is that wearing away of the teeth which takes place during the process of mastication. This may be due to the rubbing of one tooth surface against another, coarse food, or the presence of grit in the food. The latter, of course, might be called a foreign substance in the mouth, but the distinction between it as a foreign body and an abrasive tooth powder, for instance, seems justifiable.

Attrition might affect the teeth generally, as is seen in the case of native races; or it may affect only a few teeth in the arch, as is seen in the mouths of white people where an irregular bite or a displaced tooth may produce a localised attrition. Among civilized people, cases of general attrition are mostly restricted to persons well on in years

Attrition may occur occlusally or interproximally. Occlusally, due to the rubbing of teeth of opposing arches on one another, and coarse foodstuffs; interproximally, by the rubbing of adjacent teeth against one another in those slight lateral movements which take place during mastication.

In native races, the occlusal wear is, of course, accelerated by their use of hard and gritty foods, and whereas with them interproximal wear of the teeth is the usual condition, among civilized people it is rarely seen, and only occurring to a slight extent. Interproximal wear due to vigorous use of the teeth is viewed with such dismay by some writers on operative technics that with them cavities must be prepared interproximally, and fillings inserted to restore the so-called "ideal" contact point.

Pickerill holds that coarse and gritty food is not a sufficient factor to account for all the occlusal attrition which occurs in native races. He writes (85): "but, as we have seen, this cannot be held to have been anything like sufficient in amount, since nearly all native races are most careful, in the preparation of their food, to "eliminate all the obviously coarse particles and to cook it thoroughly". Although the present writer would not deny the possibility of the action of acid juices of fruit and berries being a factor in causing this condition, and appreciates the qualified remark "nearly all native races", yet he feels impelled to assert that from personal observation and research, the Australian native does not bother to eliminate coarse particles and grit from his food, nor would it be learnt from accounts of his cooking methods that such were very thorough.

The following notes will show that a more or less detailed study of the condition of attrition provides some quite interesting results. Occlusal attrition in its various aspects will be considered first.

a. OCCLUSAL ATTRITION

OCCLUSAL ATTRITION IN ABORIGINAL CHILDREN. The condition of attrition is one which is not very often seen in the mouths of civilized children and is most often observable on the anterior teeth, where the tips of the canines or the incisal edges of the incisors may be worn away somewhat; but anything in the way of a general wearing of the molars occlusally, beyond mere cusp tips, is a rarity. A study of the infant and young aboriginal skulls soon reveals the fact that solid food and a vigorous mastication were early acquirements of the native child.

Accounts of native life reveal the fact that even though children were breast fed till a late age (according to "civilized" ideas) and it was not unusual for children of four and five years to still avail themselves of such a food source, yet it is also true that at a very early age they were also given food which would provide masticatory exercise of a vigorous nature.

The series of skulls containing deciduous teeth which have come under the notice of the present writer practically all provide conditions of quite appreciable amounts of occlusal attrition, and most specimens, by the time the first permanent molars have arrived at functioning positions in the arches, contain deciduous molars whose crowns are worn to the extent of the dentine being exposed.

Figure 102 shows a young specimen with well worn teeth, while Figure 103 shows a number of deciduous molars presenting various degrees of attrition.

The latter illustration also shows interproximal facets on deciduous teeth.

a. OCCLUSAL ATTRITION

Occlusal Attrition in Adults.

In this work the method adopted of recording the stages of occlusal wear of the teeth is that which was suggested by Broca.

Four degrees of wear:

1. Enamel worn, without cusp obliteration or exposure of dentine;
2. Cusps worn down and dentine exposed;
3. A further stage in which there is quite an appreciable amount of the crown of the tooth worn away;
4. An extreme stage of wear in which most of the crown has disappeared and the wear has extended to the neck of the tooth.

Nicholls in his work has criticised this method as being slightly sumbersome; but as the present writer does not see that his method is very different from or any improvement on Broca's, the scheme of the latter is here adopted; moreover, Broca's suggestion has for years been used and referred to by many other writers.

The classification is one which, of course, rests solely on the personal judgment of the observer, and there can be no marked demarkation between each of the four stages suggested. Also, different portions of one arch may present different stages of wear, but in such instances when dealing with a large collection a certain amount of compromise must be resorted to.

On the following page the young adult, adult and aged skulls have been classified under the various stages of wear which their teeth have presented.

	I	II	III	IV	No. of specimens
Young Adult	18	1	-	-	19
Adult	19	61	21	5	106
Aged	1	4	23	15	43

In dealing with the subject of occlusal attrition, a remarkable condition of wear in the molar region is seen in the teeth of the Australian, and no doubt in any human dentition of a similar type.

It has been observed long ago of course that in the human denture the occlusal plane of the molar series is not in an exact horizontal plane, but slants in a direction inwards and downwards on the lower molars and upwards and outwards on the upper molars, the angle of slant becoming progressively greater from first to third molar.

Whatever relation this stated normal occlusal plane of molars may have to the flat occlusal plane worn down by use of the teeth, and what differences there may be between the two, does not seem to have been made a subject for special study.

However, in the adult Australian denture the worn occlusal plane in the molar region presents a remarkable condition. The curve of the worn plane is not a simple one becoming progressively greater in one direction from first to third molar, but a compound one. It may be briefly described as follows.

When the molar cusps become worn down so that the occlusal surface becomes a more or less flattened one - to describe the condition in the mandibular molars - the mesial portion of the flat surface of the first molar is bevelled downwards and outwards, but further distally the surface comes more into a horizontal plane. In the second molar the worn surface is more or less horizontal, its mesio-buccal corner perhaps being bevelled a little downwards and outwards, and its disto-lingual corner slightly 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. But in the case of the third molar the angle of dip of the attritional plane from the horizontal appears greater because the whole body of the tooth is generally tipped over a little lingually from a vertical position. For the upper jaw, of course, all these directions are the reverse.

Figure 104 will probably illustrate much better than words the above described condition, compared with the molar occlusal plane generally described for modern dentitions. Figures 105 and 106 also illustrate the condition in an actual Australian specimen.

R. Neumann of Breslau, in a recent article (86), has dealt with this peculiar type of occlusal wear in the Australian dentition, and compared it with that seen in modern European dentures. Neumann's essay is a very illuminating and painstaking one, and must have involved a considerable amount of work. He has subjected the condition to a rather intense mathematical treatment and took means to secure various angles of wear and indices. However, whether it is due to lack of material, or not including other simple measurements in his observations, it seems to the present writer that Neumann has missed the main feature of the Australian's denture, which explains this peculiar type of occlusal wear.

Neumann has endeavored to explain the differences in the planes of occlusal attrition between the Australians and Europeans by differences in angle of inclination which the teeth have towards the occlusal plane.

It is fairly obvious, though, that this peculiar type of wear in the molar region of the Australians and which is not seen in modern dentures, is explainable by differences in arch width between the molar teeth in the upper and lower arches.

In the case of the first molars, at this region of the arch, the measurement is greater in the upper jaw than in the lower, and the action of lateral masticatory movement is such that the buccal cusps of the lower molars and lingual cusps of upper teeth become worn more readily than the other portions of the teeth. In the region of the second molar the arch widths of upper and lower jaws more nearly approximate and the occlusal wear shows itself to be more in a horizontal plane. In the case of the third molars it has been shown on earlier pages that the arch width in this region is greater in the lower jaw than in the upper, a feature not seen in modern dentures. That this type of wear is related to this feature of arch widths can be shown by the fact that in the Australian specimens this compound attritional curve is always present when the arch width at the third molars is greater in the lower than in the upper. When the arch widths at this region are the same or the upper the greater, then the attritional curve alters accordingly.

Also involved in the production of this type of wear is what would appear to be another definite factor, namely that the Australian's masticatory action was a regularly alternated one, first to one side then to the other, each lateral excursion being made with one condyle alternately acting as a rotational centre. By this means the molar teeth on each side perform a movement outwards and slightly forwards, the length of swing being less of course on that side which acts as the rotating centre.

The above account is only a short endeavor to describe and explain this peculiar result of attritional wear, and in attempting brevity it is hoped that the result has not produced sufficient obscurity to hide the main points. However, the subject is one requiring more careful and elaborate treatment than could be attempted in the present thesis.

Before dispensing with this section the writer would like to record his disagreement with the opinion of some writers who would state that in the anthropoid ape the masticatory excursions are not lateral, and that the upstanding canines prevent horizontal movement. Observation on a collection of anthropoid jaws would surely show otherwise. For in some anthropoid jaws conditions can be seen which are remarkably similar to some of those here described as present in the Australian denture; whether they be termed anthropoid features in the former case or simian in the latter, is beside the question for the present.

Figure 113 shows portion of a chimpanzee jaw with quite marked occlusal and interproximal attrition and both types of wear are strikingly similar to those seen in the Australian jaws. Also reference to Figure shows that the same changes in size of the pulp cavity take place in the ape's teeth as a result of attrition as in those of man. The same figure shows that there is a horizontal stratification in the cancellous structure of the bone surrounding the ape's worn teeth very similar to that in the aboriginal jaw, Figure 123.

All these features in the ape, so similar to those seen in the aboriginal dentition, would indicate that the masticatory movements must, to some extent anyway, be similar. And it is difficult to explain many of these features in the native's dentition by other than vigorous lateral masticatory excursions of the jaw.

Figure 107 shows the mandible of a chimpanzee in which occurs the curved molar occlusal plane previously described. As in the case of the human denture, the compound curve is in the apes jaw associated with those arches in which the lower arch is wider than the upper at the region of the third molar. This would seem to be supporting evidence to the previous suggestion that the compound curve was due in some measure to the excess width of the lower arch over the upper at its posterior end.

A few photographs have been prepared of specimens which show interesting conditions of occlusal wear.

Figure 108 shows the upper arch of a specimen in which occlusal wear has proceeded to an extreme degree; the anterior and premolar teeth have had, in nearly every tooth, the whole of the crown worn away. The wear on the molars has also been extremely heavy. The interesting feature is that only on the lingual root canal of the first upper right premolar has an exposure of the pulpal cavity taken place. In all the other teeth the deposit of secondary dentine has kept pace with the wastage of crown tissue.

Figure 109 illustrates a similar example, and Figure 110 also shows this same specimen viewed from the labial aspect.

Figures 111 and 112 show two molars in which occlusal wear has been particularly marked on one side of the crown. In both instances it will be seen that the wearing away has extended well beyond the enamel margin, and has involved quite an amount of the roots. Yet in these, the process of secondary dentine formation had still held out against any exposure of pulp tissue..

INTERPROXIMAL ATRRITION

Interproximal wear of the teeth is a condition which is not very often seen in the mouths of people belonging to civilized races, whereas it is quite general among the so-called savage races.

This condition of wearing away of the teeth substance is undoubtedly caused by the rubbing of proximate surfaces against one another during those slight movements of the teeth which take place during those lateral excursions of the mandible involved in the vigorous masticatory habits of many native races. Hopewell Smith in some of his recent writings has propounded the idea that there can be no movements of teeth, the adjacent tissues of which are in a healthy condition; and that any movement signifies an abnormal and pathological condition. This assertion has apparently not received very great credence so far, and most seem to view the idea as one based on the very fine distinctions in a patho-histologist's point of view. An examination in a large series of skulls belonging to a native race would certainly lead one to think that quite an appreciable amount of tooth movement is a normal and physiological occurrence when the human denture is made to function in a thorough manner. For one sees consistene evidence of lateral tooth movement, with adjacent bony tissue which certainly appears normal and healthy.

The observations of the present writer have convinced him that interproximal wear is a condition not limited to the dentures of native races only, for an examination of anthropoid skulls also reveals the condition both of occlusal and interproximal wear. It has been stated by some writers that there can be no lateral movements during mastication with the anthropoid apes, but it is difficult to imagine how some conditions of wear could exist in the molars, premolars, and the lingual surfaces of upper canines without an appreciable amount of lateral swing of the lower jaw. See back to Figure 61

This type of tooth wear causes the presence of facets on the mesial or distal - or both surfaces of the tooth, the size of the facet varying according to the density of the enamel, the period of time the tooth has functioned, the amount of lateral stress on the teeth during mastication.

Figure 115 shows a series of Australian aboriginal teeth with various sizes of facets produced by interproximal wear.

Owing to the set of forces which tend to preserve the correct position of the teeth and the integrity of the arches, the space which would be caused through loss of tooth substance is taken up by these forces causing the teeth to drift together and persist in close proximal contact. See Figure 114. It is due to this fact that the length obtained by measuring the molar-premolar series of teeth in situ is generally less than that obtained by taking the sum of the mesio-distal diameters of the individual teeth of the same series. The difference would be that loss of intero-posterior length due to interproximal wear. The extent of this wear occurring in the combined M + Pm series can be derived to some approximation of accuracy by adding together the average mesio-distal diameters of the individual teeth of the series, and comparing it with the average M plus Pm length.

Taking the measurements which have been recorded in earlier sections, and applying them to this problem, the results are as follows:-

	Upper	Lower
Sum of the average M-D diameters of individual teeth of M+Pm series	47.4	52
Average M+Pm combined length	45.8	49.6
Difference (ie wear)	1.6	2.4

Another feature of interproximal wear which is worthy of note is the occurrence of wear of only one of the approximating teeth; that is to say, a concave facet may be worn in the distal surface of one tooth, and into it fits the unworn curved approximating portion of the mesial surface of the adjacent tooth. Figure 114 X illustrates a good example of this occurrence. This may be due to the density of enamel of one tooth being just sufficiently greater to preserve an advantage over its neighbor. I examined a number of these occurrences in order to ascertain if perchance the time of eruption and concomitant rigidity of one tooth compared with another had anything to do with this unequal wear, but that means of approach provided no criteria whatever.

From Black's Dental Anatomy, the following statements relative to interproximal wear are quoted:-- "In many individuals of middle or advanced age the points of proximate contact become much worn and flattened by rubbing on each other during mastication. From this cause they often become so broad as to hold food material firmly between them, which is gradually forced against the gum septum, causing its absorption and forming a pocket for the lodgment of debris, and thus gives rise to serious difficulties. Facets formed by interproximal wear may be found in my collection of teeth." Again he wrote:- "Therefore the proximate contact of the teeth is such as would be made by the contact of two marbles, or at a single small point." (87). To quote from much more recent writings of McGehee (88), "Interproximal wear is a form of abrasion, consisting in abnormal wearing away of the contact points as a result of a constant sliding against each other of approximating teeth, during the act of mastication. The contact points become worn and flattened, frequently presenting well marked facets, in consequence of which condition a drifting together of "adjoining teeth occurs, and a shortening of the total length of the arch results, thus diminishing the total masticating surface. Symptoms of interproximal wear: The contact points are worn and flattened. Packing food into the affected interproximal spaces occurs, causing discomfort to the patient. As a result, fermentation and putrefaction of the food occurs, ultimately producing cavity formation, gingivitis, resorption and destruction of gum, pericementum and bony tissue, with general pyorrheal disturbance." Etc. etc.

Such statements as the above, which have been taken from ahtheritative writings are surely entirely incompatible with a comparative study of human dentitions. It seems hardly correct to postulate ideal conditions on bases which are not sound or supported by good evidence. The fact is too often lost sight of that the modern human denture is by no means one to look at for expressions of normal physiological mastication. One might say that with the modern "civilized" human dentition the abnormal is normal. And so with the subject of interproximal wear and "contact points", how can an ideal "contact point" of two approximating teeth be such as two approximating marbles would make, when a functioning dentition seems undoubtedly to produce tooth movement and concomitant wear of approximating tooth surfaces? Also we notice that in native races we find this interproximal wear progresses to marked degrees of tooth faceting and yet their adjacent bony tissue shows no sign of marked peridental affections.

The defined contact point of the above writers may be desirable to them, but in the light of the evidence of functioning dentitions it would hardly seem normal.

EXTRA DIVERGENCE OF MOLAR ROOTS

An interesting feature which must be noted is that of the molar roots of aboriginal teeth which have been subjected for a long time to very heavy usage. Attention has been called to this previously by Ramsay Smith, and perhaps it will be fitting to quote a few of the sentences from the article (89) in which the subject was mentioned. "No one who has had an opportunity of examining many aboriginal teeth of the sort I have referred to can conclude that dentine, when once formed, is unalterable. The evidence is that it is alterable at all stages. This fact is further shown in what is called "dislocation" of the teeth. In this condition the lingual roots of the molar retains its position in the alveolar, while the buccal roots change, in a very considerable degree, the angle they make with the lingual root; and this occurs by moulding without any absorption of the dentine of any of the roots. Accretion or hypertrophy of the dentine if it occurred, would obviously decrease the angle. This mutability or 'malleability' is of great importance in connection with this question of evolution of heterodont forms ....."

In the early stages of the present writer's observations on the Australian dentition, this feature of the extra splaying out of molar roots under heavy stresses was noted, and the idea that their angle between buccal and lingual roots was widened became firmly believed in. It was not surprising, of course, to learn later that such a keen observer as Dr Ramsay Smith had not missed this feature, and had recorded his opinion some years ago in a published essay. Unfortunately it can only be noted here that the present worker is entirely in accordance with Ramsay Smith's view, as for the present there is not sufficient recorded evidence to support the view.

A means of obtaining the angle between the molar buccal and lingual roots was devised and a number of measurements have been made to endeavor to ascertain if there is any marked difference between the average root angle in slightly worn teeth and that of teeth which obviously had been subjected to prolonged stresses. It is a difficult matter to secure many molar teeth for root measurements without damaging the specimens; and so far the series of measurements secured is hardly large enough to work on for results. However, it is hoped that further work will permit an offering of some concrete evidence on the point.

ALVEOLAR ABSORPTION IN MANDIBLES

An interesting condition is seen in the two mandibles illustrated in Figures 116 and 117. These lower jaws had become edentulous, no doubt the teeth being lost through generalised pericdontal affection, but teeth still remained in the upper jaw and especially in the molar regions. The living possessors of these mandibles must have used their lower edentulous ridges very much for mastication, with the result that the alveolar ridges and a large amount of the body of the mandibles have been obsorbed by masticatory pressure.

The loss of bony tissue has progressed to such an extent that the inferior dental canal, which runs along the bone in the lower portion of the horizontal body of the jaw, has been exposed, and in places quite worn through. See Figure .

Also, as in both these cases upper molar teeth were present with flat occlusal surfaces, the "worn" surfaces of the mandibles have modified their form to cope with the function demanded of them, and have developed a flange of bone extending towards the median plane; thus giving a wide flat surface of bone to functionally oppose the flat surfaces of the upper molars. See Figure 116.

Figure 118 gives a side view of the mandible illustrated by Figure 116.

STRUCTURAL CHANGE OF ALVEOLAR PROCESS

A physiological change in the osseous structure of the jaw bone dependent on thorough functioning of teeth is well depicted in several of the radiographs.

It has been repeatedly asserted that the masticatory system of the Australian was subjected to vigorous work, and that various features pointed to marked lateral movements being involved in that function. It has been pointed out also that in the apes it is possible that to some extent similar chewing movements were indulged in. It is only to be expected that in jaws with teeth which were subjected to heavy strains, there would be some provision for the osseous structure surrounding the tooth roots to cope with these heavy demands. It can be shown that when the denture becomes a completed functioning unit and suffers the wear and tear of heavy masticatory tasks, the cancellous structure of the alveolar process which surrounds the neck and roots of the teeth becomes altered, no doubt to better withstand the lateral stresses of the teeth. It will be seen in the radiographic Figures 121-2 and also in the chimpanzee's jaw, Figure 20, ~~both~~ all of which contain teeth more or less unworn, that the appearance of the cancellous alveolar structure around the tooth roots is somewhat irregular and the interstitial spaces generally roundish. But in Figure 123 of an adult specimen, and Figure 21 of a chimpanzee jaw, both having well worn teeth, it is shown that the alveolar bone structure is much more compact and has arranged itself into lamellae which are strikingly parallel to one another and to the border of the bone.

This modification of the bony structure of the alveolar process has no doubt been brought about, so that mechanically it is a more efficient arrangement of the solid tissue, and one better fitted to withstand the stresses of mastication by providing firm implantation for the teeth.

* The marked similarity of this feature between man and ape is certainly interesting.

FUNCTION AND ROOT EXTOSOSIS

The condition known as "extososis" of the roots is one which would probably be more correctly referred to under pathological conditions, but the object of here including it under functional conditions will be understood from the following note.

Extososis can be simply described as an abnormal deposition of cementum on a tooth root brought about by an inflammatory condition of the periodontal membrane.

The inflammatory condition might be brought about by bacterial infection or trauma.

For the present we may neglect further consideration of bacterial infection, and consider that the generally accepted traumatic causes of a pericementitis would be either direct trauma, malocclusion, or crowding of or pressure on teeth owing to lack of space. But a feature of this exostosed condition of roots which seems to have been overlooked is the relation between this condition and tooth function, or rather, lack of function.

The ~~fxxxix~~ function of the periodontal membrane in a completely formed and erupted tooth is to act as a connecting cushion between the tooth and the bony walls of its socket, and to serve as a slightly resilient buffer against the forces the tooth is subjected to during mastication.

During the present observations it has been noted that although the teeth of the Australian were undoubtedly subjected to heavy and severe work, yet the roots of the teeth, and particularly the molars, are remarkably free from extososed appearances. It has also been noted that in practically all those examples where molar teeth were developmentally absent, the corresponding molar or molars in the opposite jaw which thus/had no antagonising member and so never properly functioned, possessed roots which presented marked extosesis, similar to that present on so many teeth removed from the mouths of present day white people. In these aboriginal teeth so affected the periodontal membrane could hardly have been traumatically affected, as they had ample room in which to erupt.

Extosesed roots are by no means rare among a collection of extracted teeth from modern white jaws which seldom function adequately. Also most unerupted and impacted teeth present more or less extosesed condition of the roots.

It would seem that there is possibly a relation between a failure of the periodontal tissue to perform its correct function and the condition of that membrane in which abnormal deposits of hard tissue are laid down on the tooth root.

SOME PATHOLOGICAL CONDITIONS

1. Dental Caries;
2. Alveolar Abscess;
3. Erosion;
4. Calculus.
5. Periodontal Affections

THE OCCURENCE of DENTAL CARIES.

THE OCCURENCE of DENTAL CARIES.

Professor H.Pickerill wrote in his well-known work on dental caries (90) :- "It is now universally admitted that dental caries is to a great extent a disease accompanying civilization,and that its numerical incidence is largely proportionate to the state of civilization to which a particular race has attained."

The remarkable prevalence of this disease among civilized peoples and the dental conditions revealed by the study of skulls of primitive races show the truth of this statement only too strikingly. The following tables which which have been taken from Pickerall's work will be sufficient to illustrate this point; (91).

Class of Persons examined.	Number of persons examined.	Percentage of persons having carious teeth.	Investigators
English and Scotch schoolboys & girls.	10500	86.00	Brit. Dent. Ass.
Residents of Baden and Hamburg.	–	98.75 96.40	Röse
Halfax children	–	95.00	M.O.H for Halifax.
Leith school children.	270	98.60	Robertson.
Kettering children	5724	93.00	Layton.
Birmingham school children.	1424	94.70	Richards.
Cambridge Dental Clinic.	1403	96.50	Cunningham.
School children of Northern Germany.	19725	95.00	Schleswig-Holstein Dental Association.

Race	Percentage of skulls showing carious teeth.
Esquimaux	I.4
Maoris	3.0
Indians of N.W. American Coast	3.9
Fiji Islanders	5.2
Northern Hindoos	5.9
North American Indians	9.5
Eastern Polynesians	II.4
Southern Hindoos	I4.0
Zulus	I4.2
Sandwich Islanders	I9.0
Australians	20.5
Bushmen	20.6
Negroes (slaves)	20.8

Race.	Number of teeth examined.	Percentage of carious teeth.
Asiatics (including Malays, Chinese, Japanese, Armenians, Hindoos and Burmese)	2180	2.064
Egyptians and Africans	3306	3.418
Polynesians and Australians	2738	4.309
Central Americans	930	4.872
North Americans (including Esquimaux)	27362	5.093
South Americans (including Tierra del Fuegians and Guanches)	67I9	5.804
Europeans (including "a few modern soldiers")	3422	7.079

Regarding the occurence of caries in the teeth of the Australian Aboriginal, there are very few records which have covered any very extensive collection of material. Below are given available references in which the incidence of caries is expressed in figures.

Mummery (92) stated the percentage of Australian skull showing caries as being 20.5 .

Patrick (93) in a list showing the result of an examination of prehistoric crania in American Museums, gives Polynesians and Australians combined as having a percentage of 4.309 carious teeth out of a total of 2738 teeth examined.

Brooke Nicholls (94) "The total number of teeth examined by me was I033, and these showed 75 carious cavities, i.e. a percentage of 7.2 %, which is a great contrast to the 35 per cent already enumerated."

Mattingly (95) in an examination of a number of living aboriginals in Coolgardie District W.A. and the Northern Territory, gives a detailed record of fifty individuals. Of these 18% of the mouths presented caries. Out of the total number of teeth present in this series, only 1.07% were carious.

Of course it has been rightly mentioned by several of the above writers that the true state of affairs cannot be appreciated unless the proportion of sound to carious teeth has been ~~mentioned~~ given, and it is only by the statement of details such as Dr. Brooke Nicholls has given in his work, that the nature and incidence of the condition are made thoroughly clear.

It is hoped that the details and records given below, which cover such a large amount of material, will prove useful additions to such findings as have already been published.

It has been previously stated how much material has been examined for results in this subject. But it must also be noted that there is, to some extent, a difficulty in drawing conclusions regarding the incidence of dental caries from a large collection such as that in the South Australian Museum. This difficulty is the practical impossibility of eliminating those cases which are not free from a suspicion of the taint of civilization. In many of the specimens whic show the presence of caries,there seems to be room for doubt as to the owners having existedd in anything like ~~the~~ their natural environment in so far as food habits were concerned. Some are known to have been town "identities"; other s to have come from long established pastoral and agricultural stations; while others again, from the Upper Northern Territory show features which one might suspect as being due to intermixture of external peoples. However, with the exception of the few skulls which were excluded as obviously being not Australian, all have been included in the general totals.

Further, in many of the specimens recorded,there was by no means a full complement of teeth present in the skull. This raises another point which must be borne in mind when studying statistical records such as these,namelt ,that when one has the opportunity of working on a large collection of skulls,and takes into consideration the nature and condition of the teeth remaining in certain specimens,to some extent a fairly safe inference may be drawn as to what was the condition of the teeth wich have been lost,post mortem, from those skulls. It is on the assumption just stated and on the knowledge of the acquired civilized food habits mentioned above; that the writer feels confident in stating that the true percentage of carious teeth occuring in the Australian Aboriginal in his natural habitat,is really less than the strikingly low percentage revealed by the present enquiry.

The results of the examinations on all available material,up to the time of writing are given on the following page.

Dealing first with the percentage of skulls ~~xx~~ containing carious teeth.

Total number of specimens containing teeth examined; 583

Total number of specimens containing carious teeth; 79

Percentage of specimens containing carious teeth: 13.55

It will be seen that the number of specimens ~~ix~~ dealt with here, is considerably greater than any given in previously recorded data, and also that the skulls concerned herein show a percentage much lower than that obtained by other observers.

	Number of specimens	Number with carious teeth	Percentage
Mattingly	50 (living)	9	18
Nicholls	76	27	35.4
Mummery	~~132~~ 132	27	20.5
Campbell	583	79	13.55

The more valuable and interesting figures are those which deal with the proportion of sound to carious teeth.

ADULTS.

Total number of teeth examined 10560

Total number of carious teeth present. . 167

Percentage of carious teeth. 1.58

Thus it will be seen that these figures form a further and striking support of those statements which declare dental caries to increase in their prevalence with the advancement of civilization.

But it is interesting to push the study a little further and see if any idea can beb obtained as to the prevalence of this disease among these people when they existed in a condition which we might presume was quite natural to them and entirely free from the taints of civilization.

A number of specimens have been grouped under the names of the localities in which they were found. In these instances it is definitely known that in some of the groups many of the specimens, while in others, practically all of the were found in batches on very old burial grounds. This knowledge makes them very much less liable to the doubtful refections which can be cast on a number of the skulls included in the above given general totals.

The following table shows the result of this scheme.

Locality	Number of specimens examined.	Specimens containing carious teeth.	Percentage	Number of teeth	Number of carious teeth.	Percentage
Melville Is. N.T.	22	4	18.2	459	5	1.08
Anson Bay N.T.	30	3	10	754	6	.79
Adelaide vicinity.	54	8	14.8	931	15	1.61
Swanport R.Murray.	105	11	10.5	1849	17	.91
Vicinity Murray Lakes.	25	2	8	419	3	.71
Coorong S.A.	27	1	3.7	557	4	.71
Yorke Peninsula.	17	0	-	353	0	-

It will thus be seen that by this means of treatment some very interesting figures are obtained, practically all the results showing a much lower proportion in the number of carious teeth to the total number of teeth present, than the result obtained in the general totals.

The two groups from the Northern Territory show a comparatively low occurrence of the disease.

The immunity from caries among the Yorke's Peninsula aboriginals is quite remarkable; and the few skulls from the lower parts of Eyre's Peninsula -not sufficient in number to tabulate as a group- also showed a similarly marked absence of any carious conditions of the teeth.

The Coorong series has a very low percentage, and the Swanport group which constitutes quite an appreciable number from one small locality, shows an occurrence of less than one decayed tooth per hundred. And even with the low percentage values which these two groups show, it must also be borne in mind that practically all the carious cavities presented were in skulls of old individuals, or a condition of caries occurring in a previously formed erosion cavity.

The group from the Adelaide vicinity show results somewhat higher than the others, and this is probably accounted for by the fact that the majority of the skulls forming this series were specimens belonging to individuals of middle or old age, and also erosion cavities were fairly numerous on the teeth of these aboriginals. Besides the natives of this part of the State were among the first to come in contact with civilised customs and food habits.

In order to show in detail how the teeth have been affected by caries, the following table indicates the numerical incidence of the condition, both as regards the different teeth and the tooth surfaces on which the carious cavities were present.

	Occurrence of Cavities	Mesial	Distal	Occlusal	Buccal	Unclass-ified.
1⌋	-	-	-	-	-	
2⌋	4	1	2	1		
3⌋	3	3	1			
4⌋	1	-	-	1		
5⌋	3	-	2	1		
6⌋	5	2	2	1		
7⌋	10	3	6	1		
8⌋	6	5	1	-		
⌊1						
⌊2	1	1				
⌊3	1	1				
⌊4	4	2	1	1		
⌊5	1	1				
⌊6	5	2	1	2		
⌊7	13	3	10			
⌊8	8	8				
1⌉	1	1				
2⌉	2		1	1		
3⌉	1			1		
4⌉	2			2		
5⌉	3	1		2		
6⌉	9	2	4	2	1	
7⌉	12	1	10	1		
8⌉	7	4	0	2	1	
⌈1	1	1				
⌈2	1		1			
⌈3	1			1		
⌈4	7	2		5		
⌈5	2		1	1		
⌈6	7	2	4	1		
⌈7	7	1	2	4		
⌈8	6	4		1	1	
Total	135	51	49	32	3	32

It has been stated above that some of the specimen showing caries undoubtly belonged to aboriginals who had live under civilized or partly civilized conditions, that is, particularlt in regard to their food habits; but apart from them their is a certain percentage of caries, low as it is, occurring among the aboriginal stock generally, and to this point it might be interesting to apply our attention for a while.

The above given figures show that out of specimens examined, 79 contained teeth affected 583 by caries.

The following list will give an idea at what age in the life of these natives the teeth were most liable to be affected by this disease.

Age Group	Infant	Young	Young Adult	Adult	Aged	Unclassified
Number of Specimens examined.	II	22	25	525		
Number affected by Dental Caries.	-	-	-	22	43	I4

This shows that the disease is, among these people, essentially one of old age. Brooke Nicholls has pointed this out previously, and the findings of the present writer coincide with his observations, namely that many of the occurrences of caries are closely associated with that marked occlusal wear of the teeth which is typical in the aged aboriginal.

Advancing years, no doubt, with some people brought about a lessening in the power of the pulp to withstand encroachment by the laying down of secondary dentine; with the result that the pulp chamber would become exposed, death and disappearance of the pulp providing a receptacle for caries producing material and bacteria and then as a further development the coronal portion of the tooth would be completely undermined and destroyed by progressive carious action.

Another interesting point to which attention must be drawn is that in almost every instance in which a carious condition was found in the teeth of specimens from the Swanport and Adelaide groups in particular, there was clear evidence to show that the carious cavity was not primarily due to the action of caries, and that the carious cavity was secondary and supervened on one due to Erosion. That is to say, a cavity had been formed on the mesial or distal surfaces of various teeth, and then either to its size or to some other local or general causes, the so-called erosion action had given way to the more destructive carious one; and an irregular, roughened carious cavity supervened on the clear cut, smooth erosion cavity.

The erosive cavities just mentioned will be dealt with more fully under the heading of "Erosion."

Thus it must again be definitely stated that there are afew important points to be remembered in connection with the occurrence of dental caries in the Australian Aboriginal. The disease is, in the native in his uncivilized state, practically limited to old age; it is closely associated with the extreme attrition of teeth and the presence of large cavities formed by the prolonged action of so-called erosion. These factors can, on the whole, be accepted as accounting for the majority of instances of caries occurring in the natives of uncivilized habits whose skulls have been here recorded.

Dental Caries in Children.

A state of affairs relative to the problem of Dental Caries, which is remarkably significant when one considers present day conditions, is presented by examination of the teeth of the children belonging to this race.

The skulls treated under this heading are those of the young and infant groups; that is, roughly speaking, those of chidren under twelve years of age. All the specimens concerned in the totals recorded below contained at least one or more deciduous teeth, excepting four, and these were obviously skulls of quite young persons with deciduous teeth lost post mortem.

The results of grouping the skulls of children together for statistics on the occurrence of caries is as follows; -

Number of young and infant skulls examined . .	37
Number of deciduous teeth present	212
Number of carious deciduous teeth	Nil.
Number of permanent teeth present	223
Number of carious permanent teeth	Nil.

For the purpose of comparison an endeavor has been made to secure a few statistics of more or less recent date, of the occurrence of dental caries among present day children of civilized races, and the extracts given on the following page are chiefly taken from the reports of dental work on school children in various countries.

S.S.Gress of New York,writing on the public health aspect of Preventive Dent~~is~~istry says(96),"The general condition of the school children of this country,relative to mouth hygiene,is appalling,if not disgraceful.The children in the first five grades in our public schools average six good size cavities."

Report of School Dentist (T.A.Edmondson) for Ipswich England.(97). "Of the 2112 children inspected,58% were re-inspections,and 42% first inspections. ...... Of the total number of mouths inspected only 12.26% had teeth perfectly free from decay,whilst 68.46% had mouths containing one or more septic or dead teeth,the average number of septic teeth per child being 2.29%."

Japanese School Children (98). Results of various examinations.

Percentage of children suffering from decayed teeth:	91.35.
Percentage of decayed teeth	19.46

Mr.A.Moore B.D.S.,Surgeon Dentist to the Education Department of South Australia, has very kindly supplied me with the following so far unpublished statistics on the occurrence of dental caries in the school children of this State.

Total number of children examined,ages ranging from 6 to 14 years. 1490

Of these 94% of the mouths contained carious teeth.

Total number of permanent teeth examined . .	23049
" " " " " carious . .	2769
Percentage	12.
Total number of deciduous teeth examined . .	11217
" " " " " carious . .	4584
Percentage	41.

These figures show an interesting comparison. As far as the results of the present examinations go, there appears to have been an absolute absence of this disease among the children of the Australian aboriginal race. This state of affairs is markedly different to that prevailing at the present day among children of white civilized races. The figures given are so striking as to require no further remarks on the comparative frequencies.

A remarkable feature of the teeth of these childre has been previously described, that is the condition of attrition present in their teeth. This condition is, of course associated with tough food and vigorous masticatory efforts, and there appears to be no doubt that the marked immunity from caries is dependent to no slight extent on these factors. A few remarks on the feeding of the aboriginal child will be included later in some general statements on native food.

To summarise the foregoing results in a few words we may say that dental caries in the Australian aboriginal is a disease which is entirely absent in children and young folk, occurs in a very low percentage of the teeth of adults, and most occurrences which are met with show that it is chiefly a disease of old age.

It is not proposed to enter into a resume of the theories which endeavor to account for the cause of dental caries; no doubt there are a number of factors which count very much in its production, and most of the theories put forward contain elements of truth in varying amounts. However, approaching the subject of the occurrence of the disease in the Australian race from a point of view which would not be one of intensive research on a particular line, but rather a view obtained from a general study of his dentition and habits, one would feel inclined to suggest various factors contributive to the absence of caries.

The dental condition of the race predisposed an inherent strength in the jaws and dental tissues of the individual.

The prenatal life of the individual was conducive to the laying down of constitutionally vigorous dental organs.

The immediate post-natal life of the aboriginal infant further aided and fostered a strong dental development.

The deciduous teeth when formed and erupted were made to perform their natural function in a vigorous manner, and thus led to the formation of a strong and disease resisting set of permanent teeth; and also to a stimulation of jaw growth which resulted in well-formed, uncrowded dental arches.

The diet throughout life was of such a nature as required a vigorous and thorough mastication; and this normal function being so well carried out ensured also a physiologically and mechanically useful ~~fut~~ flow of saliva, together with an active blood supply to dentel and adjacent tissues.

Evidence that these tissues were taxed with and responded to no mean strain is seen in the remarkable activity of the pulp in forming secondary dentine under attrition, and the intense buffer action the periodontal membrane must have served.

ALVEOLAR ABSCESS

A large series of Australian skulls generally presents excellent material for a study of the morbid anatomy of abscess conditions of the alveolar process.

As was pointed out in the section on Attrition, alveolar abscesses were present, in practically every instance, only in aged skulls with markedly worn teeth. It is obvious that as age advanced the pulpal tissues lost their tone, and their power of coping with the loss of hard tissue by laying down a deposit of secondary dentine in many individuals diminished.. The occlusal wear and tear of the teeth at times outdid the restorative powers of the pulp, and the latter broke down and the wear encroached onto and exposed the pulp chamber. Pulpal infection led to its death and eventual formation of an apical abscess.

Nicholls has referred to this condition and states that he found evidence of abscessed conditions of the alveolar process in 37 cases out of 1033 teeth examined.

The present work has led to the following results:

	No. of specimens examined	No. of specimens showing abscessed condition of alveolar process	
Infant	13	--	
Young	22	--	
Young adult	25	--	
Adult	124	24	19.4%
Aged	47	35	74.4%

It will be seen from these figures that this condition was to a large extent limited to those individuals who were fairly well advanced in years.

The following list shows which teeth the condition was most frequently associated with:

Out of a total of 185 teeth associated with the condition:--

Upper			Lower		
Right	I_1	..4	Right	I_1	...5
"	I_2	..5	"	I_2	.. 5
"	C	..7	"	C	.. 4
"	Pm_1	.11	"	Pm_1	. 7
"	Pm_2	4	"	Pm_2	1
"	M_1	14	"	M_1	12
"	M_2	..6	"	M_2	.. 4
"	M_3	. 1	"	M_3	.. 1
Left	I_1	..9	Left	I_1	.. 3
"	I_2	. 4	"	I_2	.. 2
"	C	.. 6	"	C	.. 4
"	Pm_1	11	"	Pm_1	3
"	Pm_2	1	"	Pm_2	4
"	M_1	14	"	M_1	14
"	M_2	. 4	"	M_2	.. 8
"	M_3	..3	"	M_3	.. 4

Figure 124 illustrates a typical extreme case in the aboriginal of jaws with much worn teeth and the alveolar process badly affected from alveolar abscesses.

CALCULUS DEPOSITS

Deposits of calculus are generally considered to be precipitated either fr om the salivary or serumal fluids. In the case of the former,the deposits occur mostly on the buccal surface of the upper molars and the lingual surface of lower incisors. Those deposits which are derived from serumal fluid occur subgingivally, and are found more frequently on approximal than on labial or lingual surfaces.

The survey of the material considered in this work has shown the following results.

Deposits which might be looked on as subgingiv -interproximal are exceedingly rare indeed.

Deposits occurring on the lingual surfac~~e~~ of lower incisors are very rare, and out of the skulls of al~~l~~ ages which have been examined, only very rare instances showing deposits in this region have been met with.

Deposits occurring on the labial surface of upper molars were much more frequent than those considered above. At times it was also present on the labial surfaces of lower molars. However, when present it was in practically all cases only very small in amount, taking the form of ~~xh~~ a thin ridge which followed out the contour of the gum margin. And in very few cases were there found any of those copious deposits which one sees so frequently in the mouths of present day white people.

Nicholls in his examination of 76 Australian cranii found calculus present in very small amounts in 19 cases.

In the present examination, the presence of calculus on the labial surfaces of cheek teeth was recorded in 35 cases out of a total of 140 of all ages.

In the instances of the occurrence of calculus deposits recorded above, nearly all the specimens were such as could be unquestionably labelled "aged", both from the general condition of the teeth and the extent of synostosis in the cranial sutures.

This study alone shows the marked contrast between the condition which prevailed among the aboriginals and white folk of the present day. Amongst the latter it is probably the food habits which largely contribute to a faulty metabolism through which extensive calculus deposits occur so frequently among people of all ages, and give rise to such universal periodontal affections.

EROSION

It was stated in an earlier section that "Erosion" was a term which has frequently been confused with other terms, and particularly with the word "abrasion". In lay terminology these two words may serve to express very similar conditions, and even with some writers on dental subjects the two words are often treated as synonymous; but the more explicit writers generally redtrict the dental term "erosion" to indicate that condition characterised by a peculiar class of tooth cavities situated near to the gingival margin and typified by their wedge or saucer shape, shallowness and dense polished surface.

Among modern civilized peoples these cavities generally occur in the labial surfaces of anterior teeth near to the gingival margin.

A destruction of tooth substance in certain carnivores, and in particular the seals, has been termed by some, erosion. But whether the typical appearance is presented, or merely a condition which bears a superficial resemblance to erosion, there does not seem to have been sufficient attention paid to the condition to definitely describe it.

Years ago Miller demonstrated, to the satisfaction of many, that erosion cavities could be produced by the action of a toothbrush and gritty toothpaste.

Others again believe this explanation not quite satisfactory, and maintain that acid fluids in the mouth are a very important factor in the production of these cavities.

Various other suggestions have been put forward as probable causes of this condition, but as yet there appears to be no universal acceptance of any one complete explanation of the occurrence.

In this section it is proposed to record a few observations of the occurrence of these erosion cavities in the teeth of the Australian aboriginal, and though they may offer nothing fresh towards a solution of the problem, they ~~a~~ are at least very interesting.

It may be definitely stated that, in so far as the present observations are concerned, no condition whatsoever that simulates the typical erosion cavity on the labial surface of anterior teeth has been met with in the Australian dentition. The condition when present almost always occurs on the molars, but is occasionally seen affecting the premolars.

The next feature is that the cavities never occur on the labial surface of the teeth, but always on the mesial or distal surfaces. The cavities are generally situated near the cervical margin of the tooth, and appear as cleanly cut cavities in a horizontal direction labio-lingually.

As just mentioned the cavities are cleanly cut, and are so remarkable in form that they often appear as if they had been artificially cut out with a small "rat-tail" file. They are half circular in section and vary from about one to four millimetres in diameter.

In many instances of the occurrence of dental caries in the aboriginal teeth, these erosion cavities have been the primary destructive process of the tooth, and then the ordinary condition of caries has supervened on the site of erosion. This is seen by the area of destruction still retaining some of the form of an erosion cavity. In such instances had reached fairly large dimensions before the onset of the carious process.

Another interesting feature concerning the occurrence of this condition, and one which could not but force itself into recognition, was the geographical distribution of the instances presented. It has been noted that of the skulls containing teeth which present these cavities, practically all without exception come from regions which are adjacent to rivers or lakes. Such regions where the aboriginals lived are of course also characterized by the presence of enormous "kitchen middens" in the form of heaps of mussel (Unio) shells.

The above referred to districts which are well represented by skulls in the collections concerned in the work, are adjacent to the River Murray, its lower terminal lakes and the Coorong. It was in these specimens particularly, and in some from the coastal regions of the Adelaide district, that the erosion cavities were found. Particular attention was paid to notice whether the condition did occur generally at all, or if there was a definable localization of ~~the~~ its occurrence, and on the whole the latter contention has been very well borne out.

It is interesting to reflect on whether there is any possible connection between this localized occurrence of the condition, and the probably abundant but unvaried diet of the dwellers in such habitats. The food would very likely consist chiefly of ~~fis~~ fish, shell fish and aquatic birds.

Those who put forward the hypothesis that acid fluids of the mouth largely act in the formation of erosion cavities, state that acid calcium phosphate is the most likely chemical factor concerned.

I have briefly stated this interesting problem to Professor Brailsford Robertson, but he has opinioned that, although certainly interesting, he can see nothing in the prima facie ~~explanation~~ presentation of the matter to indicate anything definite with regard to an explanation.

For illustrations of the occurrence in aboriginal teeth, see Figures 119, 120.

PERIODONTAL AFFECTIONS

The effects of marked periodontal affections in the absorption of alveolar process during life is often very well seen in the dried skull. An Australian collection will show that in that race, the tissues surrounding the teeth were sometimes the site of ravishing disease.

Brooke Nicholls has dealt with this condition in Australian specimens, and found indications of what he considered were the results of pyorrhea alveolaris in about a third of the specimens he examined.

In old Australian specimens the results of periodontal lesions are seen by the loss of teeth and exposure of roots by denudation of the surrounding bony process.

In the present work the observations have shown that marked periodontal lesions were almost wholly limited to old age, and that in all ages previous to a fairly advanced stage of life, the alveolar process was generally firm and compact in appearance and well up round the teeth in a normal manner.

FOOD OF THE ABORIGINAL

The food of the aboriginal no doubt has a very close relation to his general immunity from dental diseases. However, it is a subject which cannot be more than briefly touched upon at the present juncture.

It is obvious from a study of infant specimens that at a very early age the aboriginal children had to masticate food of such a nature as to cause very appreciable wear of the teeth. This is borne out by the statements of various writers. Mr G. Aiston, who was for many years a police officer stationed in the far north of this State, and saw a greeat deal of native customs and domestic habits, has assured me that it is quite the usual thing for infants to be given food similar to that indulged in by the grown up natives, almost as soon as they possess any teeth at all.

Another interesting feature in the feeding of aboriginal children, is the length of the period during which they feed from their mother's breast. Several writers have mentioned that it was not at all unusual to see a native child of three, four, or even five years of age, cease its play, and run to its mother and partake of a meal from her breast.

Among grown ups, as has been pointed out by various observers, the aboriginal diet consisted of almost anything which was edible. However, it would seem that flesh food was preferred, and formed the major portion of the Australian's diet. The seeds from various grasses, native fruits, tubers, roots and insects were also included in his dietary; but it would seem that the food which was most easily obtained and prepared, was preferred by the natives as fitting in with his ideas on economy of time and labor.

Shortage of game would no doubt drive him to less favored articles of food; but I have been informed by close observers that vegetable and cereal items were more or less incidental to his staple meat diet.

In the preparation of his food, the native undoubtedly adopted only the crudest of methods, and ones which are very far removed from the socalled refinements of modern cooking. Whatever preparation his food did get, it was undoubtedly in such a condition when eaten as to require very vigorous masticatory efforts. The whole structure and condition of the aboriginals' jaws and teeth point to this in a very emphatic manner. The method of preparing some of his cereal foods on stone grinding utensils no doubt involved the inclusion of grit. This would assist to some extent in the marked wearing away of his teeth.

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DENTAL MUTILATIONS.

That peculiar class of customs in which primitive races of mankind mutilated different parts of the body in various ways was indeed a very old and widespread one. Here and throughout this section the customs are often referred to as belonging to the past, but there is no doubt that they are still adhered to, in varying degrees, among some of the still existing low native races in the more uncivilised parts of the world.

Among such practices, that of mutilating the dental arches was perhaps one of the oldest, and one which still requires satisfactory explanation as to its significance. The distribution of this custom was undoubtedly world-wide: this has been shown to be the case by numerous records, a few of which signify its occurrence in Neolithic Britain, Africa, the Far East, Australia, Mexico and Peru. The occurrence of the custom is graphically represented to some extent in Figure No. 125. The chief source of information referred to in plotting this map has been the work of Sir J. G. Fraser (99). Von Ihering (100) has also dealt with the distribution of this custom, but unfortunately his work was not available.

This type of mutilation generally took the form of forcibly removing one or more teeth, either in the upper or the lower arch, or sometimes in both. The upper central incisors seemed to be most frequently selected for removal, though at times the laterals, and in some instances even the whole six anteriors, were involved.

The operation was performed in various ways; some of the methods carried out by the Australian Aboriginals are probably representative of those generally adopted, and these will be described later.

Naturally the interesting question concerning this practice is that of its meaning; and without of the numerous reasons given for its performance is likely to be the most primitive. In other words, what is the origin of such a peculiar custom. It is not proposed to make any attempt here to delve very deeply into this aspect of the subject, as it is one which becomes really more involved than it would appear at first sight. The question is dealt with at some length in the work of Fraser referred to above.

It is felt that it may not be out of place to review briefly some of the records made by various observers who have come in contact, in various parts of the world, with natives among whom this custom was prevalent. These reasons stated by them will be interesting to remember when we deal with those ideas which are said to underlie the Australian Aboriginal's persistence in the custom.

The reasons given are those concerned in initiation ceremonies, for tribal identification, ornamentation, mourning rite, and in some cases a custom having no very definite reason for its performance, yet a necessary operation because of some vague bearing it has on the future welfare of the individual or the safety of his fellows.

As a custom which forms an important part of the ceremony by which a youth is initiated into manhood, such indulgence appears to be restricted to Australia, and this aspect will be treated more fully later on.

As a means of tribal identification, - or if not strictly so, certainly for purposes closely allied to such,- Africa has provided many examples. Speke (101) recorded it as having been a method of tribal identification in certain districts of the Upper Nile. In referring to the Wanyam-Uesi, he wrote: "All extract more or less their lower incisors, and cut a Λ between their two upper incisors". Again, "The Gani were such barbarians ...... and any person ... who had a full set of teeth as the Waganda have would be surely killed by them".

Also among many African tribes the removal of front teeth was done because, in the mind of the native, his personal appearance was much enhanced by their absence. For instance, Darwin (102) wrote: "The natives of the Upper Nile knock out the four front teeth, saying that they do not wish to resemble brutes". Also, Fraser writes: "The Bakota in Africa who adopted this practice say that they do so in order to be like oxen, while those who retain their teeth are like zebras".

As a mourning rite, Fraser says that "In Hawaii it was a custom to knock out one or more teeth as a mark of grief at the death of a chief or king, and though this custom was not obligatory, it was yet so common that in the old heathen days few men were to be seen with an entire set of teeth, and many had lost all their front teeth both on the upper and lower jaw, which, apart from its other inconveniences, caused a great defect in their speech. The custom was practised both by men and women, but more often by men than by women."

Then it is said that in Formosa children had the eye tooth removed because it strengthened their speed and wind in hunting (103).

In certain districts in China, "before the daughters are given in marriage, two of their teeth must be beaten out to prevent damage to the husband's family." The women of Central Celebes are similarly treated because it was said a woman once bit her husband so severely that he died (104).

The custom was certainly more prevalent and general in Africa and Australia than elsewhere. F. von Luschan expressed the belief that as regards Africa, "most if not all of the deformations and mutilations of the teeth seem to have come from Indonesia"(105).

There is undoubtedly a close relation between the customs of filing the teeth and extracting them, the former being much practised in certain parts of India and South

America (106), while extraction was not practised. On this point Fraser writes:- "The wide prevalence of the custom of filing the teeth and the comparative absence of the custom of breaking them out in the Indian Archipelago favors the view that the former is a mitigation of the latter, the barbarous old practice of removing certain teeth altogether having been softened into the one of removing only a portion of each."

The abovementioned examples show that the reasons given for the practice are both varied and quaint. It is also obvious, when one reviews the literature that deals with the subject, that even with such a comparatively simple custom as extraction of teeth, much more research will be required to clear up such questions as to whether the practice was one merely acquired from a neighboring tribe or people; or whether the habit existed as a degenerate form of a previously much more important custom; and what was likely to be the origin of or the first primitive idea which prompted this world-wide form of mutilation.

THE CUSTOM AMONG THE AUSTRALIANS

In turning to this custom as it was practised by the Australian aborigines, we find that very little has been written on the subject, apart from those accounts included in the various descriptions of the native customs in general. Sir J. G. Fraser, in dealing with the practice as a primitive rite, has referred to the Australians fairly extensively, but practically nothing has been done in the way of a detailed review of the custom as it occurred over the continent as a whole.

The following account is an attempt to provide this neglected study in a more or less comprehensive manner; and though it is obviously incomplete, on account of the material involved only representing portion of the continent, yet it is felt that it will be sufficient to provide a fairly reliable and general survey of the custom.

The method of study has been to collect data from the various works of standard authors on Australian native customs and the descriptions of Australian crania in anthropological writings, and to record observations on the large number of skulls which have been available to the present writer.

In the observations on actual specimens for tooth removal, it has been taken as satisfactory evidence of a deliberate removal when there was an absence of one or more anterior teeth, upper or lower, in a specimen which otherwise showed the presence of all the other teeth at death, and in which the gap showed complete absorption of the alveolar process, leaving a more or less sharp osseous ridge between the adjacent teeth. See Figs. 126 127.

The following schedule shows the different aspects of the custom, and the order in which they will be treated in the subsequent text.

THE CUSTOM OF REMOVING TEETH

Geographical Distribution:	A. From written acccounts;
	B. From specimens.
Frequency:	A. From written accounts;
	B. From specimens.
The teeth Removed:	A. From written accounts;
	B. From specimens.
Sex:	
Age at which operation is performed:	A. From written accounts;
	B. From specimens.
The Implements Used:	
Preliminaries to Operation:	
The Operation:	Position of patient;
	Surgery of operation;
	Post operative procedures.
Disposal of Teeth:	
Reasons for the Custom.	

In the above, "A" indicates that the sources of information have been the various standard works together with notes personally collected from observers; "B" is an account based on notes and statistics derived from examination of the actual skulls concerned in this work.

GEOGRAPHICAL DISTRIBUTION OF CUSTOM

It has been shown by numerous records that the practice was carried on almost all over the continent; but it is also clear that, even at the time when observations were commenced by the European settlers in this country, the custom differed markedly in its significance in different parts of the continent. It has been definitely stated that in some parts ~~af~~ the operation was not performed at all; in others it was a fairly general, but more or less optional practice; while with some portions of the race the custom was a definite and necessary part of certain initiation ceremonies.

A. From all available written accounts of aboriginal customs an endeavor has been made to ascertain in detail the distribution of the custom. In order to save lengthy description and quotation, means have been taken to diagrammatically illustrate this distribution, and the map shown in Figure 129 gives a rather interesting result. The method of compiling the diagram was to represent every reference by a sign which denoted whether the custom was wanting, optional, or compulsory, and each sign was placed so as to correspond, as near as possible, with the district referred to. In a few instances the region mentioned in the reference was fairly large and in these cases several distinguishing signs were marked in and connected with stipled lines.

It will thus be seen that so far as can be ascertained from this method of attacking the subject the main features which present themselves are:- the more or less optional continuance of the custom in the central and northern parts of the continent; its absence in the coastal areas of South Australia, Victoria and lower Western Australia; the observance and importance of the practice as a necessary part of ceremonial customs in the south eastern part of the continent.

Figure 128 gives a general view of the areas concerned in the three aspects of the customs.

The distribution of the custom can also be ascertained to some extent by a study of the aboriginal crania, that is, in those cases in which the source of the specimen has been recorded.

Dealing first with the available writings of various workers who have described Australian crania in detail, the list given below shows the sources of various specimens which presented mutilations of the dental arch. In a number of cases the locality given is "Australia", or the name of one of the States; however, to make the list as complete as possible, all instances that have been recorded as showing evidence of tooth removals, have been included.

TURNER:	Queensland Mudgee River Murray, N.S.W. Perth, W.A. Rockhampton ((2)) "New Hollander".	
DUCKWORTH:	New South Wales Australian ((3)) McLeay River, N.S.W. Piccaninny Creek, Victoria	
W. H. FLOWER:	Port Essington, N.T. ((4)) Darling Downs, Queensland Australia	
BROOKE NICHOLLS	Northern Territory Victoria South Australia New South Wales	Localities not defined.

It will be seen that although this list indicates a fairly general distribution of the custom, it is hardly large or detailed enough to be very useful.

B. Turning now to those skulls which have been examined by the present writer, the following list shows the localities from which these specimens have been derived. Unfortunately it is only South Australia and the Northern Territory which are concerned to any extent in the material dealt with in this work, the other States not being very heavily represented by specimens.

N.W. Australia	Parallana
Melville Island	Mt Eba, S.A.
Southport, N.T.	Silverton
Cygnet Bay, W.A.	Cooper's Creek, S.A.
Gulf of Carpentaria	Swamport, S.A.
Newcastle Waters, N.T.	Tailem Bend, S.A.
Charlotte Waters, N.T.	Coorong, S.A.
Borroloola, N.T.	Talerno, Riv. Darling, N.S.W.
MacArthur River, N.T.	Murray Bridge, S.A.
Powell's Creek, N.T.	Milang, S.A.
Innaminka	

See Fig. 130.

These localities, which chiefly concern South Australia and the Northern Territory, show that the latter is well represented, while with South Australia the Murray River regions are represented, even though descriptive records of native customs state the operation was not performed there.

Reviewing the evidence provided in the foregoing notes we find that besides indications of fairly general distribution of the custom, the following points of interest are provided.

There are a few regions recorded where the custom is said to have been quite absent, and such regions were almost surrounded by tribes who indulged in the practice. For instance, with the Kamilaroi group, located in north east corner of New South Wales, the practice was wanting;

yet east, south and west of them the custom was a compulsory one.

Basedow (107) states that of Bathurst and Melville Islands the natives "do not practise the knocking out of one or two incisors as they do on the mainland. Major Campbell, however, reports having observed the custom on Melville Island". Also, Spencer (108) makes no mention of the custom having been carried out on these islands. However, as was shown in the list of localities concerned with the present work, specimens are recorded from Melville Island, which show undoubted evidence of tooth removals.

Taplin, who for a long time studied the natives of the Murray Mouth Lakes and Coorong regions, and wrote extensively on their customs, definitely stated that the practice was not indulged in by these tribes, yet we find skulls recorded from Tailem Bend, Swanport, Murray Bridge, Milang and the Coorong, all of which show evidences of the mutilation. With these cases, though, it is to be remembered that the practice, as a compulsory affair, existed right along the Murray and its associated rivers in New South Wales and Victoria, almost up to the South Australian border, and occasional natives so affected may have ended their existence lower down the river; or the custom itself, by contact of river tribes one with another, may have passed down to the lower regions of the Murray, to become an occasional, even if not a general practice among the natives of these parts.

It is also interesting to note that over a large area of Victoria the operation was a compulsory one, yet of the skulls in the Melbourne Museums examined by Dr Nicholls and myself, not a very large percentage presented evidences of tooth removals. This could be accounted for if the material concerned had been derived chiefly from the coastal regions, which was not the case in most of those I had the opportunity of examining; unfortunately I have no detailed record as to the sources of the skulls entailed in Dr Nicholls' data.

Records of the skulls from the Adelaide district, Yorke's and Eyre's Peninsulas, bear out the statements set down by observers of the native customs in these areas, for out of some seventy odd specimens not one showed clear evidence of a tooth removal.

Considering the continent as a whole, as was previously stated, there appears to have been three fairly well defined areas corresponding to the absence and the optional and compulsory occurrence of this custom. These have been diagrammatically represented in Figure 128.

A very significant feature of this distribution is that wherever the custom is optional, the prevalent form of ceremonial mutilation of the body was circumcision; and where tooth removal was compulsory, the circumcision operation was not performed. By some it is held that tooth removal was the older form of mutilation and that the custom of circumcising reached the continent at its northern shores, and gradually worked its way southward, and everywhere superseded the former practice as the important rite excepting in the south eastern portion of the continent. The fertile areas of the Northern Territory, the verdant regions of the east coast, together with the great rivers which flowed in southerly and westerly directions from Queensland and New South Wales, must all have made conditions favorable for migrations both of people and customs to the southern and south easterly parts of the continent.

Spencer and Gillen (109) have stated thus:- "It can scarcely be doubted that there is a common origin for these customs in the central and coastal tribes - the details of agreement just referred to are, it seems to us, inexplicable except on this hypothesis. This would seem to imply, inasmuch as in one group of tribes we find tooth extraction the important ceremony with no trace of the form of ceremonies "(circumcision, etc.) practised in the other group, whilst in the latter side by side with the present initiation rite, we find tooth extraction in the form of a rudimentary custom, that the more ancient ceremony is that of tooth extraction".

However, there still remains the interesting point concerning some of the southern portions of South Australia, that although it has been definitely stated that tooth extraction was not practised, yet in many places circumcision and subincision were quite established rites.

FREQUENCY OF THE CUSTOM

A. From the usual descriptive account of a native custom, such as the removal of teeth, it is not easy to ascertain the frequency of the practice in any numerical fashion, particularly when the custom is an optional one, as the one under present discussion was, over a large part of the continent. Where the operation was an important part of the initiation of the youth it is safe to assume that all the males in such a district were subjected to it. Such was probably the case in the south eastern portion of Australia. In other parts where the custom existed as an optional procedure, we get little idea as to it's prevalence excepting in those cases where, concerning a certain area or tribe, a writer makes a definite statement as to the extent the practice was indulged in. For example, of the natives around Port Essington, N.T., C.Pasco states that "every male had a tooth of the upper jaw knocked out", even though tooth removal was not a part of the initiation ceremonies in that region. Then among many of the tribes of the coast on the southern side of the continent the practice was definitely known not to have existed.

However, on turning to records of this custom as shown in skulls of the aboriginals, we can obtain some rough numerical estimate of its occurrence.

Below is given a table which has been drawn up from the published results of various workers, who have stated the number of skulls in their records and have noted the occurrence of artificial removal of teeth. The list is certainly not very extensive, but sufficient to provide an interesting result and an approximate percentage of the prevalence of the custom generally. Although not provided in this table, the authors concerned have given in their lists the source of the specimen in all possible cases; and it is shown that all the States are fairly well represented among the various collections concerned.

No. of specimens examined	No. of cases of removals	Collection	Author
33	3	Cambridge Univ. Museum	Duckworth (110)
30	6	"Thesaurus Craniorum" and "Supplement"	J.B.Davis
59	6	Royal Coll.Surg.	W.Flower (111)
15	3	Army Med. Museum, Netley	W.Flower
49	7	"Challenger" Report	W. Turner (112)
76	9	Melb.National and Univ. Museums	B. Nicholls (113)
30 (living)	5	Central Aust.	Spencer and Gillen (114)
46 (living)	4	Northern Terr.	Mattingly (95)

As the above list has been compiled to include only the skulls of individuals of sufficient age to have been possible subjects to the operation of tooth removal, we see that of a general total of 338 specimens of both sexes derived from various parts of the continent, 43 gave evidence of having had teeth knocked out; that is, approximately 12.7%.

B. Turning now to the material which the present writer has had the opportunity of subjecting to careful examination for evidence of tooth removals, the following statistics may prove a further useful record of the numerical frequency of the custom:---

Total number of specimens of young adult, adult, and aged persons examined 530

Total number of specimens showing removals 56

Percentage of specimens showing mutilation 10.5

Combining the two sets of results, we get 99 instances occurring in a total of 868 specimens. This shows the occurrence of the custom as having affected about 11.4 % of adult individuals of the continent generally.

It may be conicidental, but it is certainly interesting that the percentage of frequency of occurrences in the present work should work out to a figure so close to that obtained from the combined totals of eight different observers of varied collections.

THE TEETH REMOVED

Among this race there seems to have been no definite preference for the removal of one particular tooth. However, the two upper central incisors, either one or both, were most frequently chosen, although almost any other incisors, upper and lower, were at times a possible selection for the mutilation, as the following data will show. The tables given below are not very extensive, and the specimens examined not abundantly representative of all the continent, yet both together they form sufficient data to give a reasonable idea as to the preference shown for any particular tooth.

A. When dealing with the available literature as a source of information on this point, it is found that few writers have known definitely, or ventured to state which particular tooth was removed by the natives with whom their descriptions dealt. A few have stated the particular tooth removed in a certain district or by a certain tribe, but the majority of observers have been able to specify no minuter detail than that the "upper front teeth" or the "upper incisors" were knocked out. On the following page is given a list of such details as have been stated by various ~~details~~ writers and observers who have been more or less explicit as to which teeth were removed.

DISTRICT	TOOTH REMOVED	OBSERVER
S.E. Corner of N.S.W.	"Upper left incisor" . |1 (?)	Howitt
S.W. Corner of N.S.W.	1| or |1, according to right- or left-handedness of boy	Howitt
Port Macquarie District	|1	Breton
Along the Murray, Murrumbidgee, Lachlan	|1 or |12	R. B. Smyth
Boulia District, Central Queensland	1|1	W. E. Roth
Dieri Tribe, Cooper's Creek, S.A.	1|1	S. Gason
do. do.	1|1	T. Vogelsang
Central Australia	|1 or 1|1	E. C. Stirling
Tennant's Creek, N.T.	|1	E. C. Stirling
Daly Waters, N.T.	1|1	E. C. Stirling
Kaitish Tribe, Central Australia	1|	Spencer & Gillen
McDonnell Ranges, " "	1|	F. J. Gillen
North Western Australia	2| sometimes |2 or 2|2	H. Basedow

The above list is not extensive, but such as it is, it shows that the upper central incisors right or left, sometimes both, are almost invariably the teeth affected in this operation; when only a single tooth is removed, the left upper central appears somewhat more frequently chosen than the right one.

Passing on to other already published sources of information on this point, we may take those anthropological writings in which various collections of Australian skulls are described, and which fortunately happen to contain details on their dentition which assist in the present discussion. In works by the stated authors are given various notes from which the table on the next page has been compiled. The source of the skull and the tooth concerned in the dental mutilation present in the skull, are ~~gixxen~~ shown.

It will be seen from this table that again, in almost every case, it is the upper central incisors which are the teeth selected, but we note here that in the number of cases where only a single tooth is removed, there is a slight excess in cases of right central removals over the left.

Of 31 cases of single removals :-

17 are upper right central;
14 are upper left central.

This list, although not large, provides details on this subject from examination of some 410 odd skulls, and as the localities show - some rather indefinitely - practically the whole of the continent is represented.

B. The following list has been compiled from records of the occurrences of tooth removals in the skulls examined by the present writer, showing the teeth involved and the source of the specimen.

In a few more or less aged specimens examined, showing absence of anterior teeth, there was a condition of the alveolar process similar to that present in cases of removals, yet room for reasonable doubt as to their being such. Rather, the evidence indicated them as losses resulting from a marked and local periodontal affection and absorption of alveolar process. These have not been included in this list.

The numbers in double brackets indicate that the locality was represented by more than a single specimen.

Both Upper Central Incisors

Cygnet Bay, N.T.	((2))
Newcastle Waters, N.T.	((2))
Borroloola, N.T.	((3))
Victoria River, N.T.	((2))
Gulf of Carpentaria	
McArthur River, N.T.	
Tennant's Creek, N.T.	
Derby, W.A.	((3))
Innaminka, S.A.	
Parallana, S.A.	
Milang, S.A.	
Coorong, S.A.	
Locality unknown.	

Right Upper Central Incisor

Port Darwin, N.T.		
Northern Territory		
Tolarno, N.S.W.		
Bunbury, W.A.		
North of Mt Eba, S.A.		
Tailem Bend, S.A.		
Morgan,	S.A.	
Swanport,	S.A.	((2))
Meningie,	S.A.	
Locality unknown		((2))

Left Upper Central Incisor

Borraloola,	N.T.	((2))
Powell's Creek,	N.T.	
Melville Island,	N.T.	
Chaʀlotte Waters,	N.T.	
Tailem Bend,	S.A.	
Murray Bridge,	S.A.	
Swanport,	S.A.	((7))

Upper Right lateral Incisor

Silverton, N.S.W.

Upper Left Lateral Incisor

Swanport, S.A.

Other Cases involving Upper Incisors

$\underline{21\|12}$	Northern Territory	
$\underline{21\|1}$	Cooper's Creek,	S.A.
$\underline{21\|12}$	Cooper's Creek,	S.A.
$\underline{21\|12}$	Borroloola,	N.T.
$\underline{21\|}$	Swanport,	S.A.

Involving Lower Incisors

$\overline{1\|1}$	Coorong,	S.A.
$\overline{\|1}$	Locality Unknown	

Involving Upper and Lower Incisors

$\frac{1\|1}{1\|1}$	North West W.A.

Again from this list it is seen that the upper central incisors are more frequently removed than any other teeth. Of the fifty six cases of tooth removal :--

In 46 cases the upper centrals are concerned. Of these :-

20 Both central incisors;
12 Upper right central;
14 Upper left central.

From this list the following points of interest should attract attention.

It is interesting to note that in those cases in which both upper centrals were removed, the majority was formed of specimens from the Northern Territory and the northern parts of Western and South Australia.

The distribution of cases of removal of a single upper central was fairly general.

Another important point to notice, and particularly is reference is again made to Figure 130, is that quite a number of cases of removal of a single upper incisor came from the extreme lower regions of the River Murray, and in particular was the left central incisor concerned. As has been previously stated, the information available from published accounts of the natives records that no extraction was resorted to among natives belonging to this region of the Murray. It is also interesting to note the occurrence of removed left upper centrals in these Lower Murray regions may have some relation to the fact that the left central was apparently the most frequently extracted tooth among those tribes who practised the operation, and lived higher up this river and its branches in Victoria and New South Wales.

The localities chiefly represented by specimens with dental mutilations are the Northern Territory and regions near to the lower end River Murray; this is due, of course, to the fact that the largest batches of skulls in the collections examined came from these places.

From the foregoing statements and lists it will be seen that one is safe in reiterating the statement that among the Australians in their custom of mutilating the dental arch, it was the upper central incisors, either singly or both, which were most often selected for removal.

SEX

The operation of tooth removal was practised on both sexes, although from accounts provided by numerous writers it would seem that on the whole, the males were probably more often concerned with it than females.

The following information derived from a few of the available sources shows that the performance on both sexes was fairly widespread.

Among the aboriginals of Central Australia whose customs have been dealt with at length by Spencer and Gillen, and Stirling, most, if not all of the tribes, carried out this custom, and the operation was performed on both boy and girl; the men and women dealing with their own sexes respectively.

Among the tribes immediately east of Lake Eyre, along Cooper's Creek, the operation was performed on both sexes. Gason has reported this, and also T. Vogelsang has supplied me with similar information.

W. E. Roth states that the operation in Central Queensland was a voluntary one and was performed on both sexes.

In practically all those regions of the south eastern portion of the continent, where the knocking out of a tooth or teeth was a very important part in the initiation ceremony of the male youth, the operation appears to have been done only on that sex. So far the present writer has not found any reference to its having been performed on girls in this part of the continent, the customs of which have been so ably described by Howitt and Fison, Brough Smyth, Mathews, Fraser and others. R. B. Smyth in his well-known work on the Victorian blacks says that among the tribes of this region who performed the operation of knocking out teeth, it was done to young men only.

In all other parts of the continent where the operation was performed, as previously stated, it was a more or less optional procedure, and men practised the custom almost everywhere even though it was not so general among the opposite sex. However, to this there are two references which are somewhat exceptional, and their quotation may be interesting.

The report of J. Mathew on certain Queensland tribes would seem to imply that in some cases the operation was restricted to females. "Among the Bidhala, or coast blacks, there were certain practices in vogue which were not observed by the Wapa, or inland blacks. The women of the Bidhala, in some places, had one of the front teeth purposely knocked out. In other parts of Australia this mutilation was performed on young men."

Of the Warramunga tribe in Central Australia, Spencer and Gillen write:- "Among the Warramunga it is comparatively seldom that teeth are knocked out in the case of the men, though women are frequently met with who have either one or two out".

In the case of the tribes where the practice is more or less optional, there is really no secrecy about its performance, only it is not etiquette for men to witness the operation when it is being done on a woman, and vice versa. The persons concerned retire some distance away from the main camp to perform the operation.

In regions where tooth avulsion forms an important part of the initiation rites, although the women frequently take part in portions of the ceremonies, they must on no account witness such significant features as consist in mutilation of the novices's body. The penalty for such a breach would be very severe, if not fatal.

AGE

The age at which the natives would undergo the operation of having a tooth or teeth knocked out would depend to some extent on what part of the continent they belonged to.

Youths who were of those tribes among which tooth knocking was a ceremonial rite would of course have to submit to the operation at a more or less standard age. Howitt, quoting R. Helms, says that among certain tribes in the south eastern corner of New Säuth Wales, the age at which a youth is subjected to the operation is from fourteen to sixteen. Among some of the Eastern Victorian tribes the same author writes that when a boy was about ten or eleven, when his whiskers were beginning to appear, he had to give up boyish ways, nakedness, and go and live among the young ~~mm~~ men in preparedness for his initiation. However, it is obvious that in these regions where the operation was compulsory it was at the beginning of, or in his early teens when his teeth were knocked out.

Where the custom was an optional one, according to the accounts of various writers, there seems to have been a much wider range of years over which it was carried out, and this is only to be expected where compulsion was lacking. S. Gason, writing of the Dieri tribe, puts the age down at from eight to twelve years. Mr T. Vogelsang, to whom I submitted Gason's account, assures me that he is certain the latter's description applies to a neighboring tribe and not the Dieri. He - Vogelsang - gives the age at which tooth removal is performed among the Dieri as between eighteen and twenty.

Curr, quoting Pasco on the Port Essington natives, and Foelsche on those of Raffles Bay, gives the age among the former 2at about sixteen/years of age", and for the latter, "when about eighteen years old".

For the tribes of Central Australia, Spencer and Gillen have stated that the operation may be performed at any time over quite a long period of years. Among the Warramunga, for instance, it is stated that "it is conducted at any period between early youth and middle age", and for the Kaitish tribe "at any age between that of ten and thirty".

Roth in his description of various Queensland tribes, mentions the ages at which tooth evulsion was performed; they differ in various localities. The ages range from "eleven or twelve years of age" and "before puberty" to being "a preliminary to betrothal", and also were "performed after the individual had arrived at full completion of puberty, after marriage". From the same writer are taken the following localities and the ages at which tooth removals were generally performed in those localities. Upper Sandford, W.A., sixteen; Hunter River, Queensland, sixteen; Granite Range, near Mitchell River, Queensland, twenty; Cloncurry River, Queensland, sixteen; between Flinders and Cloncurry Rivers, fifteen; junction of Thompson and Barcoo Rivers, fourteen; lower portion of Barcoo and Warrego Rivers, at about fifteen.

Thus it is seen that generally speaking the age for performance of the operation is at puberty when a compulsory rite, and at various ages, ranging from early youth to middle age, in these areas where it is quite an optional matter.

In so far as the age of the operation could be ascertained from observation of its occurrence in skulls, the material examined in the present work included nearly sixty skulls of specimens which have here been termed as infant, young and young adult; but not one presented any instance of a removal. As most of the present material came from the "absent" or "voluntary" regions, it would seem to show that in such parts, if performed at all, it must have occurred in the late teens, at the youngest estimate.

IMPLEMENTS USED FOR THE OPERATION

In reviewing the methods adopted by the natives in different parts of the continent for the removal of teeth, it is found that the ways amd means resorted to in performinging the operation were quite various; and it will be seen that many of the fundamental procedures involved in the modern means of extracting a tooth find their counterparts,in a primitive and crude manner, among those employed by the aboriginals. With the latter we certainly do not find a hypodermic syringe among their armamenteria, but there is no doubt that suggestion and determined fortitude produce an anaesthetising action, even if it be more psychic than physiologic.

The following descriptions of implements and materials used are selected from the methods adopted by various tribes throughout the continent generally.

Fur string was used by some for stuffing into the mouth of the patient. This was done at the beginning of the operation for several purposes, according to the natives: absorption of blood, partly of deadening the pain, and also to prevent the tooth being swallowed. The first and last of these reasons seem decidedly pertinent.

A piece of bone well sharpened at one end for lancing the gum prior to removing a tooth. For a similar purpose a piece of wood was used in some places, and the youth bit into it until the gum was forced back from the tooth.

Sharpened pieces of wood of various lengths to act as wedges for forcing between the teeth and loosening the one to be extracted. See Figure 131.

A piece of wood was sometimes used for a mouth gag.

A piece of wallaby skin folded two or three times was sometimes placed on the tooth to be removed. This was probably to prevent the implement pressed onto the tooth from slipping when struck, and injuring the gums.

The implements applied to the tooth in knocking it out were various. They chiefly consisted of pieces of wood of varying lengths, from two to three inches up to a foot or two; sometimes only prepared by shaping one end to blunted point, or in other cases shaped up into more or less of a chisel form. See Figures 132, 133, 134.

The article for applying the blow to the stick or chisel was probably any object which was convenient or handy at the required time. Stones of varying weights were most frequently used, but besides them, the necessary force was applied by using a spear-thrower, club, waddy, or any large, convenient piece of wood.

PRELIMINARIES TO OPERATION

There are a few remarks bearing on various doings prior to the actual operation, which it may not be out of place to include; for besides being interesting they will help to make the account of this custom, as carried on by the Australian native, more complete.

It has been mentioned already in a number of places that the knocking out of a tooth forms a very important part of the initiation ceremony in the south eastern portion of the continent. This ceremony is one which, in some places, may last almost continuously over a couple of days; or with all its preliminaries and preparation may extend over a couple of weeks. In these cases the tooth removal ceremony is generally preceded by various pantomimic displays and mysterious ritual, and for a full account of these doings reference must be made to such an authoritative source as Howitt, for example.

One interesting prelude to the tooth knocking ceremony in the south eastern region was the singing of the "tooth song". This was a song rendered for the purpose of making the boy's front teeth easily removable when he underwent the initiation ceremony. Besides being sung during the ceremony, it was often sung by the youth's male elder, in whose care he learnt manly ways and accomplishments, when out on hunting trips and other pastimes.

Although the operation was more or less optional throughout the central parts of the continent, and formed no part of the initiation ceremony, yet among the Warramunga tribe there was practised a certain amount of ceremony along with the operation. Spencer and Gillen give an account of these doings but do not state whether they consider much significance could be attached to such preliminaries. With these natives the operation was done far more frequently on women than on men, and as a rule was conducted at the end of a wet season, when the waterholes were full. Large numbers of the sex concerned gathered on the bank of a waterhole and several fires were lighted. The persons to be operated on went into the water up to their breasts and scooped up water into their mouths; after drinking some and then holding more in the mouth, the water was spat out in all directions. Then they splashed water over themselves to wet their head thoroughly; see Figures 135 136. Having done this they came out and lay down on the bank and the operation was performed. The object of filling the mouth with water before the operation was to numb the gums.

However, in the majority of those tribes with whom the custom was more or less optional, there were no preliminaries or preparation for the operation, and secrecy or privacy was no further observed than by retiring a little away from the main camp, it not being quite etiquette for members of one sex to see the operation performed on one of the opposite sex.

Roth has stated that at Butchers Hill near Princess Charlotte Bay in Queensland, it was the custom to cover the victim's eyes before the operation so that he would be unaware as to who the operator actually was.

THE OPERATION

Position of Patient.

The position of the patient during the operation was by no means the same for all the localities where the operation was performed, and some of the attitudes adopted certainly would appear more ludicreus than they would be comfortable for the operation.

In the south eastern portion of the continent a very prevalent method was that of making two holes a foot or more deep in the ground and the novice had to stand in these, one leg in each, while one elder held his ~~xxxx~~ arms down to his side, another holding his head in position for the operator. In some places these holes were filled in with earth while the youth was standing in them, thus keeping him steady, and preventing, or hindering any struggling should he prove a somewhat unwilling patient.

In other cases where the custom was a compulsory one, the youth was just held down by several men sitting or kneeling on him in such manner as was necessary to keep him still.

Collins gives an account of a quaint method in which the boy was seated on the shoulders of one of the chief performers in the ceremony while the latter sat on the ground. See Figure 137.

Another attitude adopted in the Centre was for a male relation of the youth to sit on the ground while the boy to be operated on lay down on his back and rested his head in the lap of the older man.

Naturally when the operation was an optional one, the persons submitting themselves to it would endeavor to make the position more convenient and comfortable than would a youth who was scared at the proceeding itself as well as having had to put up with all sorts of nerve wracking scene prior to the operation. Thus in most places where the practice was optional, the patient generally lay flat on his or her back and placed the head in a hole or depression in the ground which had been dug out for this purpose. The head would then lie back in a position more or less convenient for the removal of the tooth. See Figures 138 and 139.

An attitude adopted by some of the Central Queensland natives was a squatting one, the patient concerned also assisting in the operation upon himself. Also in other accounts of the Queensland natives are mentioned positions in one of which the old man operating placed the head of the patient in a convenient position on his thigh; and in another, "with the individual's head resting on the lap of one of his mates" who performed the operation.

PERFORMING THE OPERATION

It can be learnt from several writers that one method of attempting the operation was a decidedly novel one, and without implements. The chief operator in the initiation ceremony seized the boy's head between his hand and applied the incisors of his lower jaw just lingually to the youth's upper front tooth which he desired to remove, and gave a series of upward jerks to dislodge the tooth. This method was apparently rarely successful, and had to be followed by the usual application of hammer and punch. This method has only been recorded from the south eastern regions, and the writers have stated that it was supposed to be the correct method of extracting although it rarely proved effective.

Among some of the Arunta (Central Australia) natives, the first part of the operation consisted of stuffing fur string into the mouth of the patient. The reason for this was to absorb the blood, and partly for deadening the pain and preventing the tooth being swallowed.

It has been recorded that the use of a piece of wood for a mouth gag was resorted to by some, but this does not appear to have been routine practice by many.

The procedure of breaking the attachment of the sub-gingival tissue to the tooth is one which was carried out by the natives fairly generally. This was done in many cases by working the finger nail around the tooth, but by others a piece of sharpened bone served as a lancet for cutting round the tooth. Figure 131.

Roth says that among some of the Central Queensland natives this loosening of the gum "is then aided by biting hard into a stick held transversely in the mouth for a good ten minutes or so."

Another practice which was fairly general was that of loosening the tooth - or teeth - in its socket before actually knocking it out. This was done by forcing wedges between the teeth; the wedges consisted of sharpened pieces of wood. [redacted] [redacted]

Mr John Conrick has informed me that as far as he could remember the natives near Innaminka used to drive in wedges each side of the tooth or teeth to be removed, and leave them there overnight, and in the morning the teeth would be loose and easily removed by a sharp tap with a stone.

It is also certain that in a large number of places there was no preliminary loosening of the tooth, but its removal depended solely on the dexterity of the operator and the force of the blows he struck. If previously loosened of course it may not need much further application of force to dislodge it. But it is obvious that very often the removal was no easy matter and at times a considerable number of forceful blows had to be administered.

The actual removal of the tooth was performed in a variety of ways and with a variety of implements, which have been previously listed and figured.

The essential features of dislodging the tooth were, the application of force by some form of hammer or mallet, and directing this force on to the tooth by another implement. The former consisted of a piece of wood, a boomerang, waddy or club, but in a large number of instances a stone hammer seemed to be the article preferred. Then by another implement the force was directed on to the tooth, generally on its labial surface; the end of a spear or some other convenient weapon was sometimes used, but mostly the article consisted of a peg or chisel, made by sharpening the end of a short piece of wood to a blunt point. This implement was placed on the tooth and its other extremity struck with the hammer. Sometimes a piece of wallaby skin was folded and placed on the tooth first, presumably to prevent the chisel slipping and injuring the gum. By some the tooth was struck until completely dislodged, by others until it was loosened sufficiently to be removed from its socket by the fingers.

Roth records that among certain tribes in Queensland a stick is held vertically behind the tooth to be removed. In this case the patient"pushed the stick firmly upwards and forwards, a friend hammers away with a wooden chisel driven by a heavy stone for a mallet".

Curr mentions that on the Upper Sandford, W.A., a tooth was "broken off". It is not quite clear whether or not the endeavor was to snap off merely the coronal portion of the tooth,or whether such a result had been observed during an attempt to remove the tooth. However, the account states that "one of the front teeth is broken off. This is effected by fitting a forked stick on to the tooth and using it as a lever with a sudden jerk".

The same writer states that near Bulloo River in South West Queensland, the females have two teeth punched out. This was done by holding a stone inside the mouth in contact with the teeth to be removed, the teeth being struck labially in the usual manner with a chisel and hammer.

It was stated above that at times the removal of a tooth required quite a number of blows. This no doubt was often due to the very firm implantation of the tooth, making its removal a difficult matter. On such occasions the youth was admonished by his elders for having spent so much of his time in female company and playing with girls; for such behaviour, they affirmed, was the cause of the tooth holding so fast. And on such occasions a medicine man would, by some sleight of hand method, produce some pieces of female wearing apparel from parts of the youth's body, this being conclusive evidence that he had spent too much time with the opposite sex. Howitt records a case he witnessed, in which it required thirteen blows to dislodge the tooth.

It is recorded that in Central Victoria, among the Jajaurung tribe, the difficulty in the removal of a tooth was at times a prearranged affair. If a youth had been marked, as it were, by his elders as one who had indulged in feminine company far too much, the tooth knocking part of his initiation ceremony was intentionally much prolonged. The tooth was allowed to hold firmly and the operation purposely made difficult and troublesome, so that the performance might be a lesson to the boy and act as a warning to other youths.

There are one or two customs associated with the removal of teeth, which have been recorded by Roth in his writings on Queensland tribes. He mentions of the Cape York natives that when a boy is being operated on, the operator at each stroke pronounced the name of one of the countries owned by the lad's mother,or by her father, or another of her relatives. "These names are recited in regular order, and the country which is mentioned when the tooth breaks away is the land to which the lad will belong".

This writer also gives an account (115) of a similar custom adopted by the natives in the hinterland of Princess Charlotte Bay. Instead of the names of countries being called,as in the above, the names of various girls eligible for marriage, were repeated. It is written: "the one which happens to be called when the tooth is actually out, being recognised as the betrothed; needless to say,the name of the favorite is always kept to the very last".

These few notes and extracts will help to provide some idea as to the methods of the Australian in performing the operation, and also show a few of the quaint customs he associates with its performances.

POST OPERATIVE PROCEDURES

There were certain practices, often carried out immediately after the removal of the teeth, which in a number of cases were intended to be post operative treatment of the resultant injury. A brief description of these practices may be interesting.

Some natives applied mud to the sockets, and others wet clay, the purpose of which, according to them, was to reduce the haemorrhage and hasten the healing of the sockets.

Another method employed by some to remove the pain or stop the bleeding was the application of a firestick to the bleeding gums.

It is stated that in some places, after the tooth was out, the gum was closed by the friends of the youth. Presumably by this is meant a squeezing of the open socket to bring the surrounding gum into opposition.

Certain tribes in the Central areas are said to have applied hot gum leaves to the mouth as soon as the tooth was out, "to relieve the pain". And in other places, apparently for a similar purpose, a broiled fish was applied "to the gum of any one of the boys who had suffered from the stroke more than either of the others". See Fig 140.

Another supposed aid to the healing of the socket, although not an immediate post-operative measure, was the restriction placed on the eating of certain animal food.

However, the custom connection with this operation which was most universally carried out and everywhere held of great importance was that bearing on the disposal of the blood from the wound.

On no account was the blood to be merely expectorated, for if it were, the patient would bring all manner of undesirable events on himself.

Some believed that if the blood were spat out, or let fall on the patient's breast, "his legs would become crooked and he would be lame".

It was also held that failure to swallow the blood would prevent the gums from healing.

In most records of the operation it is mentioned that the blood was swallowed, but Collins in his early work on New South Wales described the operation, and said, "the blood that issued from the lacerated gum was not wiped away, but suffered to run down the breast and fall upon the head of the man on whose shoulders the patient sat."

A rather striking means of disposal of the blood was that employed by the natives of Cape York, and has been described by Roth. "The tooth having been dislodged, the lad is then given some water with which to rinse his mouth, and he gently lets the gory spittle fall into a water basket made of leaves. The old men carefully inspect the spittle, and trace in it some likeness to a natural object, an animal, plant, stone, or whatever it may be.. The nature object thus chosen will be the ori of the newly made man".

The same writer gives an account of the natives on the Pennefather River. With them after the teeth were removed, the latter were thrown into a pit dug for the purpose and the blood was spat into it also and both were covered up.

Among some of the Arunta groups in Central Australia, after the tooth was extracted and hurled away, the patient got up and gently threw a number of boomerangs at a shield which had been fixed upright in the ground some little distance away. Offerings of food then took place between various of the principals concerned in the event.

In the case of a girl, after the extraction she sprang to her feet and seized a pitchi which had been placed near by, filled it with sand, and dancing over the cleared space shook the pitchi "as if she were winnowing seed". When emptied she resumed her seat among the women. Spencer and

Gillen regard this performance "as indicative of the fact that she has reached the age when she can enter upon the duties of a woman, not the least important of which is symbolised by the pitchi filled with food, gathered in the bush, which she carries daily poised on the top of her head".

DISPOSAL OF THE TEETH

In practically no instance recorded do we find that the tooth was extracted and then straightway discarded, but nearly always it was disposed of with ceremony to varying extents, and in ways which signified varied and sometimes important meanings. Even in places where the extraction of the tooth was optional and entirely without ceremony, the disposal of the tooth was always a more or less ritualistic affair. In some instances there is no record as to why a certain method of disposal was adopted, and in these cases only the bare description of the custom can be given.

It is interesting to note that one very frequent use made of the extracted teeth was prevalent in many parts of the continent, and this was using the tooth as a symbol that the youth to whom the tooth belonged was no longer under the care and control of his mother,this being signified by the throwing of the tooth, after the ceremony, in the direction of the camp of the boy's mother. In other cases it was handed to the youth's mother, who "is custodian of the tooth and takes great care of it".

R. H. Mathews states that among certain New South Wales and Victorian tribes it was given to "the lad's mother's brother or to his mother's mother's brother if he is living".

J. Fraser reports of an account which said that the tooth was given to the lad's mother and she afterwards burnt it.

F. Bonney (116) writing on the customs of aborigines of the River Darling, gives the following account. "The youth places the tooth under the bark of a tree, near a creek, waterhole, or river: if the bark grows over it, or it falls into the water, all is well; but should it be exposed, and the ants run over it, it is believed that the youth will suffer from a disease in the mouth."

Brough Smyth (117) also gives a description of a disposal in some respects similar to the above. The youth on returning to camp after having had his teeth out "gave the teeth to his mother. The youth again retired to the forest, and remained absent two nights and one day; and his mother during his absence selected a young gum tree, and inserted in the bark of it in the fork of two of the uppermost branches, the teeth which had been knocked out. This tree ever afterwards was in some sense held sacred. It was made known only to certain persons of the tribe, and the youth himself was never permitted to learn where his teeth had been placed. If the youth died, the foot of the tree was stripped of its bark, and it was killed by making a fire about it, so that it might remain stricken and sere, as a monument of the deceased".

Another method of using the tooth, practised in the south eastern regions, has been described by Howitt. After the ceremonies were completed, the people gradually returned to their own districts. "The tooth would be carried by the Gommera of the place most distant from that of the youth to whom it belonged ~~to~~. He would then send or hand it on to the Headman of the locality next to him, thus it would pass from group to group of the inter-marrying community which had attended the Kuringal. It conveys its message, which is that so-and-so has been made a man. Finally it returns to its owner." And a similar method of a different district from that of the foregoing account: "It is fastened to a piece of Kaiung, the woman's apron, and is sent round to Tumut in a bag with some kangaroo teeth and red ochre." Or again among others, "With the teeth are sent a boomerang, a club (nulla nulla), and a shield for club fighting".

Gason reported of the Dieri that the drawn teeth were "placed in the centre of a bunch of emu feathers, smeared with fat and kept for about twelve months, or some length of time, under the belief that if thrown away the eaglehawk would cause longer ones to grow in their place, turn on the upper lip and thus cause death".

Vogelsang gives me an account of the Dieri manner of disposing of the teeth, and, though somewhat similar, his is probably more correct than Gason's. The teeth were wrapped up in emu feathers, greased with snake or fish fat, and then thrown away, generally into water, in the belief that by so doing illness would be prevented.

Relying again on the accounts of Spencer and Gillen on the tribes of Centre, we find the following are among the customs of tooth disposal practised by these natives.

Among the groups north east of the Arunta, after the tooth was removed, the old man who performed the operation held it up for an instant so that all could see it, and then "while uttering a peculiar, rolling, gutteral sound", threw it away as far as possible in the direction of the camp of the man's mother in the Alcheringa.

In an account of a Kaitish tribe girl having had a tooth removed, it was disposed of as follows: ".... having been told what to do by the older woman, she threw the tooth as far as she could in the direction of the Alcheringa camp of her mother. The tooth was left lying where it fell on the ground, no attempt being made to prevent it from falling into the possession of anyone who might by chance come across it. They have no idea of anyone attempting to do them any kind of injury by obtaining possession of the tooth and working evil magic upon it."

With the Warramunga, the woman - in the case of a girl - who performed the operation takes the tooth back to camp, "pounds it up, and places the remains in a small piece of flesh, which has to be eaten by the girl's mother. In the case of a male, his tooth is pounded up, put into meat and given to his mother-in-law to eat."

The Tjingilli, who knocked out a tooth near to the end of a rainy season when they considered they had had enough rain, threw the extracted tooth into a waterhole in the belief that it would drive the rain and clouds away.

With the Gnanji, after the operator had carried the tooth about for some time, it was given to the man or woman's mother, who in return made presents of food and red ochre. The mother then buried it by the side of a waterhole, that it might stop the rain, and increase the growth of water-lilies in the pool.

In the tribes north of the Centre, near the Gulf of Carpenteria, the extracted tooth was wrapped up in paper bark, and in the case of a male he sent it to his brother-in-law, while if a woman, her mother wrapped it up and handed it over to the woman's brother. In both cases the tooth was finally buried.

Roth mentions that among some of the Queensland tribes the removed tooth was either flung into water or buried. Those on the Pennefather River threw the teeth in a pit previously dug, and in it, along with the expectorated blood, they were buried.

It will be seen, even from this more or less brief account of the ways of disposing of the teeth, that there are two more or less general methods which stand out rather strikingly. One is the symbolical one in which the tooth was either thrown in the direction of the camp of the youth's mother or actually handed over to her; this as a sign that the boy had passed from her care and control to the ranks of manhood. Secondly, there is that group of customs in which teeth were buried or thrown into water with the idea that it would cause rain to cease, prevent illnesses, make water-lilies grow, and so on. The basic idea underlying their doing this was probably associated with sympathetic magic.

Another point which one can hardly fail to notice is that even though in many regions the practice was entirely an optional one, and in no way connected with initiation or other important ceremonies, and the operation performed quite without ceremony, yet in almost every case there was connected with the disposal of the tooth some more or less symbolical or magical ideas.

REASONS FOR THE CUSTOM

In reviewing the reasons which have been obtained by various workers for the practice of tooth removal among the Australians, it might be of interest to commence by again recalling some of the reasons recorded for the custom in other parts of the world, and note to what extent they apply to the race under present consideration.

As a mourning rite: So far, the present investigation has found no reference pointing out that the operation was performed for this reason. It is well known, of course, that bodily mutilation, in the form of gashing and scarring the flesh, was very prevalent among the Australians as a mourning custom, and in particular with the women folk. The greater the scarring the more keenly was the sorrow supposed to be felt for the lost one. But dental mutilations were apparently not resorted to for such expression.

For the purpose of tribal identification: There does not appear to be any definite evidence to indicate that this custom was used specifically for such a purpose, or even that one particular tooth was removed by one tribe as an intentional distinction from a neighboring tribe who extracted a different tooth. Mathew (118) says, "The knocking out of front teeth - one, two, or four, according to tribe - is an old world barbarity which has been perpetuated here". However, the idea is not supported by any other traceable reference; nor, as can be seen from the foregoing lists, was the extraction of a certain tooth definitely restricted to one region. Two upper centrals seemed to be a fairly regular treatment for Northern regions generally, and one tooth more the custom in the south eastern part of the continent.. However, we can see no definite leaning in the figures towards the idea of tribal identification.

For appearance' sake, ornamentation: Although it can be found in various reports on this custom that the operations were performed for the sake of improving the personal appearance, yet in almost all cases we find various forms of ceremony connected with them to some extent or other. In very few instances is the operation totally unattended either before, during, or after its performance, by any ritual. As far as can be gathered, the case of the practice in Africa is somewhat different, for there the custom of dental mutilation is generally recognised as being for decorative or tribal identification purposes. However, it must be added here that Sir J. G. Fraser (119), who has written on this custom, considers that with the Africans the reason of facial beautification is one which may be dismissed as quite unsatisfactory, and that with them also the custom is probably based on some deep seated superstition. With the Australian, even though in many places the custom was not part of any definite formal ceremony, there were nearly always connected with the operation some "memories", as it were, of it having been a much more important procedure in earlier times. The review, on earlier pages, of customs associated with the operation should support this view.

One very prevalent reason given by the natives for performance of this operation was that they did it because their forefathers had always done it before them. This, of course, appears to an enquirer a quite unsatisfactory reason; but to the aboriginal it was all sufficient; for practically his whole life was made up of doing things which his ancestors had done, and which he must do in the same way as they had done them. The continuance of all ancient customs was a sacred duty with them.

Spencer and Gillen (120) give a tradition existing among the Kaitish tribe, bearing on this practice. The Alcheringa people always said that teeth were knocked out because the water tasted better with one of them out; in fact, it was no good drinking water without having a tooth out, as otherwise the sand collected round the gums, whereas when the hole was made the sand was not tasted. In the Alcheringa two men of the Mantera (a snake, Vermicella annulata) totem arose at a place called Arinpera-lakilika, which means "mouth, teeth broken". They were brothers, and the elder said to the younger, "Suppose we pull our teeth out?" The latter, however, replied, "No, I will not pull my tooth out, I will knock it out." Then they made a small hole in the ground, and first of all the elder brother lay down with his head in the hole, and the younger one, taking a stick and a stone, knocked his tooth out. When he had done so he said, "Hullo, blood is coming from my brother's tooth". Then in turn he lay down and the elder brother operated on him. Then they sat down opposite to each other and remarked that they looked very well with their teeth out. They spat the blood out on to the ground, and buried their teeth, and a big waterhole arose to mark the spot. Later on, another man of the same totem, named Ilungunjia, arose at a place close by, and he it was who first of all heard from the old snakes about knocking out of teeth, and then taught the other black fellows how to do it, for they said, "The snakes knocked out their teeth in the Alcheringa; it is good for us to do the same".

Amongst the Warramunga (121) the removal of teeth was always performed after heavy rains, "when they have had enough and do not want any more to fall". The neighboring Tjingilli tribe also made the operation something of a magical ceremony, the final part of which consisted in "throwing the tooth into a waterhole" in the belief that it will drive the rainand clouds away".

Again with the Gnanji the operation was always performed in the rainy season. In this case the tooth was finally given to the mother of the person operated on, and she buried it near a waterhole, "the object of this being to stop the rain and to bring about an increase of the number of waterlilies growing in the pool".

Among the groups who inhabited what is called the Kartwia Quatcha or rain country - lying to the North East of the Arunta tribe - the operation was to some extent obligatory. With them the ceremony became especially associated with the rain or water totem. The explanation, devised by the natives to account for the association of the custom of tooth removal with the rain totem, was that the object of the rite was "to produce in the face a resemblance to what they call Alailinga, which is the name applied to certain clouds, dark with a light margin, which are of peculiar appearance and are said to portend the coming of rain". (122).

Concerning the Dieri Tribe and this custom, Gason has written (123) that "The Dierjerie, om being questioned, can assign no reason for thus disfiguring their children, than that when they were created the Moora-Moora knocked out two front teeth of the upper jaw of the first child, and, pleased at the sight, commanded that such should be done to every male or female child for ever after." Mr Theo Vogelsang, who has generously spent much time in making enquiries for me among Dieri people, informs me that they can give no other reason than that the appearance of having the teeth removed pleases them. He also assures me that the Dieri have no knowledge whatsoever of the Moora-Moora which Gason spoke of, and that this term probably belonged to some tribe adjacent to the Dieri.* However, the various customs which this tribe adhered to in the matter of disposal of the teeth points to the idea that there was br had been some deeper significance attached to the operation than merely that of improving the facial appearance.

Palmer (124) has stated that with some of the tribes near the Gulf of Car pentaria, the natives connect the removal of the teeth with the entry into their heaven, and "if they have the two front teeth out they will have bright clear water to drink, and if not they will only have dirty or muddy water". This introduces the idea of a native belief in a hereafter, of which there does not appear to be much general evidence in support

A rather original idea which was once given in all sincerity to the present writer was that a few front teeth of the males were extracted so that when he was partaking of a meal off a delicate bone, the absence of front teeth would ensure the leaving of some scraps of meat on the bone which was afterwards handed to his gin to provide her repast. Although the sharing of food was governed to some extent by tribal laws, yet one can have doubts that the males would go to such pain physically and socially out of respect for the appetities of their ladyfolk.

* Mr Gason's interpretation of the term Moora-Moora as "a good spirit, God, or Divine Being" does not appear a very desirable one; it seems more likely that this term would find its parallel in such examples as the "Alcheringa" of the Arunta tribes, or the "Daramulun" of South Eastern tribes.

Howitt has dealt extensively with the ceremonies of the South eastern part of the continent, and in these the removal of teeth plays a very important part. This writer has given practically no statements as to any reasons having been supplied by the natives for this operation, other than that "the intention of the ceremonies is evidently to make the youths of the tribe worthy members of the community according to their lights"; and the "belief inculcated as to the existence of a great supernatural anthropomorphic Being, by whom the ceremonies were first instituted, and who still communicates with mankind through the medicine-men, his servants".

As has been previously mentioned, Sir J. G. Fraser has written at some length on the subject of bodily mutilations, including the operation of tooth removal. For the latter he has drawn largely on data concerning the Australian aboriginal. It may not be out of place to draw on his work to the extent of quoting a few passages. He considers a curious parallelism exists between the ritual of circumcision and that of tooth removal, in that the disposal of the severed parts is remarkably similar in many instances. He writes: "With great diffidence I have conjectured that the two rites of circumcision and tooth extraction may have had this much in common that they were both intended to promote reincarnation of the individual at a future time by severing from his person a vital part or especially durable portion and subjecting it to a treatment which in the opinion of these savages was fitted to ensure the desired object of bringing him to life again after death. The evidence which has suggested this conjecture is indeed very slight and scanty, but a few points in it may be mentioned". The points which Fraser goes on to deal with have been cited in previous parts of this essay; they included, for example, the cases of putting the teeth up in a tree, which is burnt on the death of the person who owned the teeth; and again, those procedures of burying or planting removed teeth so that others should not find them or ants run over them, etc. He goes on: "These customs seem to show that a mystic relation of sympathy was supposed to exist between the man and his severed tooth of such that when it suffered he suffered, and that when he died the tooth and its temporary receptacle must both be destroyed"..... "If these aborigines believed in the reincarnation of the dead, as to which however we have no information, it might be that the burning of the tree and the tooth was intended to liberate the vital essence of the dead man as a preliminary to rebirth. In this connection it deserves to be noticed that it is the mother who deposits the tooth in the tree, just as in the Gnanji it is the mother of the patient who buries the tooth beside a waterhole." He also refers to the throwing of the tooth in the direction of the mother's Alcheringa camp. "This at least suggests that the tooth may possibly be regarded as an instrument of impregnation and therefore of new birth." Then he refers to the custom in its connection with the native's entry into his heaven: "Such a belief, if it is really held, proves that the practice of extracting teeth at puberty is associated in the native mind with the hereafter and is supposed to be a preparation for it." These extracts will be sufficient to show that Fraser has suggested various ideas underlying the performance of this custom, some of which, one might venture to agree, are made on rather slender premises; and ideas too, which would probably be unacceptable to those who have become acquainted with the native mind through years of contact.

Spencer and Gillen believe that for the practice of tooth removal and customs associated with it there was "a common origin in the central and coastal tribes," and they hold tooth extraction a more ancient custom than that of circumcision. They also consider it "unsafe to take for "granted that even as a rite of initiation the knocking out of teeth has always been confined to men". Of the underlying reaspm for its performance they say: "Into the question of what was the origin of the custom it seems hopeless to inquire".

The present writer does not propose to make any attempt here to probe into the psychological aspect of this custom, for as was stated at the beginning of the essay, the enquiry into the real meaning and origin of such a practice becomes much more involved than it would appear at first sight. The object, therefore, has been to set out various customs associated with and reasons given for the practice of tooth removal, so that the result, even though it may not provide many conclusive features, may at least form something in the nature of a systematic review of the custom.

SUMMARIZED NOTES ON THE CUSTOM

According to ethnological writings the custom was widely distributed over the continent, withthree areas fairly well defined, as: (1) a large central and northern areax of voluntary continuance of the custom; (2) a south eastern area of the custom as a compulsory initiatory rite; (3) a south coastal region of absence of the custom.

From a survey of the frequency of the practice as shown by examination of skulls, the present writer is inclined to agree with a statement made by Flower nearly fifty years ago, after his observations on museum specimens: "These skulls show that the practice of knocking out some of the front teeth on initiation into manhood is not so frequent as some writers on the customs of the Australians would lead us to believe." This applies not only to the custom as an initiation rite, but generally.

The teeth removed were generally one of the central incisors, but occasionally other teeth were involved; any of the other incisors, upper and lower, might be concerned, and occasionally two, three or even four teeth removed.

Written records have it that the age at which the operation was performed might be anything from nine or ten up to fifty; in a number of cases the age being definitely stated as in the early teens or just prior to them. A fairly appreciable number of skulls of persons in early life showed no instance of a removal occurring before the third molars had taken up their fully erupted position in the arch.

Implements, methods and materials used were various, but generally crudely and usefully suited to the purpose. Quite a number of stages in their operative technics were curiously yet roughly similar to modern dental methods.

In the large south eastern corner of the continent the custom was compulsory, and over a large portion of the remainder, optional. But in very many regions where it was optional, there were procedures carried out either before, during or after the operation, which showed that there was or had been a dpeper significance in the custom than was attributed by the natives concerned in it.

Although the problem ~~o~~f solving the origin of the custom and the task of appreciating its psychological significance are difficult, yet the present writer feels sure that by continued and more intensive study of the practice as it occurred not only in this continent but in its worldwide distribution, a clearer understanding of its meaning will be arrived at than that permitted by our present knowledge.

TOOTHACHE

AND ITS CURES

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TOOTHACHE

The following pages do not give any technical account of the condition called toothache as it occurred with the natives, but contain a number of quotations from various observers who have mentioned the condition in their writings, and also native methods of treating the ailment. It will be seen that some of the accounts are not without interest.

Taplin (125) who wrote extensively on the so-called Narrinyeri tribe says: "I have frequent cases of both neuralgia and toothache. A peculiar cause of toothache is the chewing of fibre for the purpose of making twine; this wears the teeth down to a level and makes them very tender to bite upon".

"In all cases the teeth are large, white and regular; toothache, notwithstanding, is prevalent."

Mary River, Queensland. Curr (126).

TOOTHACHE CURES:

Hunter River, N.S.W.--- "... the gums are bled for toothache." Curr (127).

"To cure toothache, a cape made of the basket rush is worn over the shoulders and round the neck, and is laid aside when the pain is gone - its name is weearmeetch. Another remedy is the application of a heated spear thrower to the cheek. The spear-thrower is then cast away, and the toothache goes with it in the form of a black stone, about the size of a walnut, called karriitch..... The natives believe that when these stones are thrown into the stream at a distance from their residence, they will return to the place where they were found; and so they are considered an infallible remedy for toothache, they are carefully preserved. They are also employed to make an enemy ill, and are thrown in the direction of the offending tribe, with a request to punish it with toothache. If, next day, the stones are found where originally picked up, it is believed that they have fulfilled their mission. Not far from the spot where these stones are plentiful there is a clump of trees called karriitch - meaning toothache - and the natives of the locality warn their friends never to go near it, for if they do they will be sure to get toothache."

J. Dawson (128).

SOME ABORIGINAL MYTHS AND IDEAS CONCERNING TEETH

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Some Aboriginal Ideas and Myths regarding Teeth.

A few pages will be devoted here to stating some rather quaint ideas which the aboriginal had in mind concerning teeth, and which variuos observers have fortunately taken the trouble to place on record.

W.E.Roth has recorded the following from various Queensland tribes. (129)

Tooth Decay and Childrens Teeth.

"Teeth get rotten and fall out in old age, because of a certain grub which the natives are very fond of eating. This caterpillar grows and burrows in decayed logs, and getting into the black's teeth does the same damage there as it does in the timber. When I asked why they did not give up eating this particular food, the aboriginals expressed themselves th the effect that they had too great a craving for it to deny themselves. The falling out of the teeth in old age is called by the same name as that for toothache. Milk-teeth, when they drop out, are buried in the growing bud, or at the butt, of the Cordyline terminatus; were this not done, no more teeth would come, (Tully River) "

"Children's teeth, when they fall out are put into the growing shoot of a Pandanus tree by their mothers; older boys will bury theirs in the ground. Were this custom neglected, they would get no others. (Pennifather River)"

"AS the child's milk-teeth fall out, each one as it comes away is given to the father or mother who buries it under a Barringtonia racemosa, where the grandparents are supposed to look for it. Sometimes the children themselves bury the teeth under the same species of tree. If attention were not to be paid to this matter, the grandparents would not provide them with new ones, as they are asked and supposed to do. (Bloomfield River)."

"In order that the child may ultimately get a second set, the milk teeth as they fall out are given to its father or mother who throws them away in the direction where it was born; here they are picked up by a species of large kangaroo, who preserves them by sticking them into a lump of bees' wax, to return them finally as required. (Proserpine River)."

It would seem too, that human teeth also play a useful part in the armamentarium of the aboriginal medicine man. For example: " When a man or woman dies and the body is buried, there remains the spirit part or Ulthana, that is, practically what may be called the equivalent of the ghost of the dead person, which is supposed to haunt the burial place and at night time to vome into the camp. . . . . . The Ulthana is supposed to be capable, like other spirits, of hurting its enemies, and the sure sign of an attack by one of them is the presence of human teeth in the body of the victim. Medicine men will sometimes extract these, which are regarded as an infallible indication of an attack by an Ulthana." (130)

TEETH OF FOSSIL MAN

IN AUSTRALIA

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TEETH OF FOSSIL MAN IN AUSTRALIA

The discovered remains of man in Australia which can be definitely described as fossil have, up to the present, been decidedly rare. In fact, there have been only two finds which have been brought forward as evidence of man's antiquity in Australia. It is of interest, however, to note that both cases have a particular bearing on dentition.

The first of which mention must be made is connected with the name of Gerard Krefft.

In 1874, in an article by Krefft (131), wherein he discussed an account of the finding of fossil remains of a large extinct wingless bird in Australia, the following statement occurs: "I have found the fractured crown of a human molar in the same matrix as Diprotodon and Thylocoleo at Wellington in this Colony. Man may therefore have been the contemporary of these animals and also of the Dromornis."

Some years later a description of the actual specimen was given by Etheridge (132) as follows: "The molar consists of about two thirds of the crown broken off from the remainder of the tooth, the under surface exposing the fractured dentine. The entire crown is so much worn down as almost to reach the alveolar border. Regarding the tooth as an upper right molar, the two inner cusps are almost worn away, leaving the sulcus dividing them now, as a ridge. The inner anterior cusp is the portion broken away, the inner posterior being ground quite flat. The outer cusps are worn almost into concavities exposing the dentine, the enamel forming a ring or wall around the inner margin. The tooth appears to be completely fossilised, for on comparing it with the teeth of the larger marsupials from the Wellington Caves, the mineral condition is without "question similar."

However, with regard to this find there seems to have been some disappointment over Krefft not having supplied sufficient confirmatory evidence, and also his entire omission to mention the finding of human remains in articles which he wrote subsequently, and in which reference to the human fossil was reasonably expected of him.

In summing up the evidence of man's antiquity in Australia, and in particular with regard to this tooth, Etheridge wrote: "That the molar crown found in the Wellington Breccia Caves appears to be that of a human being, and is to all intents and purposes a fossil. That its position in the cave and association with the other organic remains there entombed is open to doubt. That no other human remains have been found at Wellington under similar conditions."

The other discovery of fossil human remains, much more striking than that of Krefft, is the Talgai specimen, found near Warwick on the Darling Downs, South Queensland.

This fossil consists of the cranium of a youth, with the facial and cranial portions fairly complete.. It has been treated to a fairly lengthy description by Dr S.A. Smith, and the palate and teeth have received special consideration (133)

It will perhaps be not out of place to here briefly consider the teeth of the Talgai specimen and note what relation they bear to the Australian native of recent times.

The following teeth were associated in the skull:

Crown of left central incisor - separated from its root;

Two canines;

The two left premolars;

First and second molars on both sides.

The dimensions of the incisor teeth given by Smith are as follows:

	Crown			Neck		Root	
	M.D.	L.L.	Height	M.D.	L.L.	Length	Total Length
Central I. Rt.	10.9	8.6	10.6	8.0	7.0	18	28.6
" " L.	-	-	-	8.2	7.5	18	-
Lateral I. Rt.	-	-	7.5	8.0	7.0	18.5	-
" " L.	-	-	7.5	7.8	7.0	18.6	-

The average dimensions derived from the present observations are:

	M.D.	L.L.	Crown Height	Total Length
Central I	9.37	7.9	9.9	24.5
Lateral I	7.65	6.91	8.9	24.5

The Talgai canine teeth are described as enormous, and special attention has been given to the presence of the worn facets on their crowns. By the position of these facets, the describer ventures to assert that the upper and lower canines must have overlapped in length, although it is pointed out that there is no semblance of a chastema at all. In the hypothetical reconstruction on page 378 of the skull and absent teeth, it would appear that the anterior teeth were to be set at an edge to edge bite. Unless the dental system is to be taken as one of a very low type - and it does not appear to be such - it would seem from the observations given on earlier pages that at the age the living possessor of the skull had reached, an edge to edge bite would not yet have been acquired and overlapping of the canines would still exist.

The dimensions of the Talgai canines are as follows:

	Crown	
	M.D.	L.L.
Right	9.6	10.8
Left	9.6	10.9

Corresponding average dimensions recorded from the present material are:

M.D.	L.L.
8.43	9

The premolar teeth of the Talgai specimen apparently offered no particular features of interest excepting their size. Their crown dimensions are:

	M.D.	L.L.
1st	8.6	12.3
2nd	7.9 - 8.1	11.0

Modern Australian premolars (crown):

	M.D.	L.L.
1st	7.81	10.3
2nd	7.23	10.14

The Talgai molar crowns give the following dimensions:

	M.D.	L.L.
1st	12.6	13.1
	12.1	13.1
2nd	11.3	13.3
	11.1	13.5

Modern Australian molar crowns:

	M.D.	L.L.
1st	11.43	10.14
2nd	10.93	12.84

Although the Talgai molars are certainly larger than the average dimensions of modern Australian molars, yet they can be outdone in all dimensions by the maximum dimensions secured in the present work.

The maximum measurements of the above are:

	M.D.	L.L.
1st	13	14.75
2nd	12.5	16

From the foregoing figures it will be seen that the teeth of the Talgai youth are certainly larger than the average ~~xxxxxxxxxx~~ measurements of corresponding teeth in the modern aboriginal. However, with the exception of a few of the measurements, all those given of the fossil lie within the range of those of his modern representative.

CONDITIONS RELATING TO THE TEETH

OF FOSSIL MAN

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Australian Dentition relative to Extinct and Fossil Human Types

A somewhat bried study will now be made to ascertain in what way the observations made on the teeth of the Australians may have a bearing on the problems relating to the dentition of extinct and fossil forms of man. This will necessitate a certain amount of repetition of statements appearing in the ~~other~~ earlier parts of this work, but nevertheless their application in the present connection may not be without interest.

The first feature to be considered is the comparative sizes of the teeth. As comparative figures of all the teeth are not available for the present notes, attention will therefore have to be restricted chiefly to the molar teeth.

It will first be of interest to consider the size of the crown of the molar teeth of the Australian compared with those of the now extinct Tasmanian. For this purpose the figures of Nicholls and those of the present work are here given.

	M_1		M2		M3		
	M.D.	L.L.	M.D.	L.L.	M.D.	L.L.	
Tasm.	11.1	12.4	10.3	12.5	9.7	11.8	Nicholls
Aust.	10	12.5	10.5	12.9	9.5	11.9	Nicholls
"	11.4	12.8	10.9	13.1	10	12	Campbell

	M_1		M2		M3		
	M.D.	L.L.	M.D.	L.L.	M.D.	L.L.	
Tasm.	11.8	12	11.5	11.6	11.4	11.4	Nicholls
Aust.	11.6	11.19	11.8	12	11.5	11.4	Nicholls
"	12.3	11.9	12.5	11.7	11.9	11.1	Campbell

From these figures it will be seen that out of these twelve observations on molar teeth, according tothe results of Nicholls, the Australian has the larger measurement in seven cases, while in the findings of the present writer, the Australian teeth are larger in ten instances out of the twelve. The figures of the present work on the Australian teeth are probably more valuable than those of Nicholls (that is, excluding the more concise mathematical value by biometric treatment in the latter) because of the far larger number of observations taken. Therefore it may be taken that the Australian possessed larger teeth than the Tasmanian.

Turning now to comparative figures in cusp numbers, the following are the data from the same sources as for the crown size.

	M_1		M2		M3		
	4	3	4	3	4	3	
Tasm.	-	-	-	-	40%	40%	Nicholls
Aust.	--	-	100%	-	74%	25%	Nicholls
Aust.	100%	-	100%	-	71%	23%	Campbell

	M_1		M2		M3		
	5	4	5	4	5	4	
Tasm.	-	-	-	100%	50%	50%	Nicholls
Aust.	100%	-	13%	86%	73%	23%	Nicholls
Aust.	94%	3%	32%	68%	72%	27%	Campbell

From these figures on cusps it will be seen that the condition of molar cusp reduction has progressed to greater extent in the Tasmanian than in the Australian.

Therefore it seems safe tó infer that on the whole both from the points of view of size of crowns and cusp reduction, the teeth of the Australian, in so far as concerns the molar series, are more primitive than those of the Tasmanians.

It may now be of interest to consider briefly in what position the Australian molars stand relative to those of that fossil human type which existed in Western Europe during the Glacial Period, and which has been termed the Neandertal Race, or Homo primigenius.

First in dealing comparatively with the sizes of the molar crowns, the measurements derived from various sources by Nicholls have been taken and average dimensions secured. These have included the measurement of specimens from Krapina, Jersey, Predmost, Spy I and II and Heidelburg. In tabulating these the Neandertal averages have been stated, but the Australian measurements by Nicholls and the present writer have just been indicated by a + or − sign, according to whether they were greater or less than the Neandertal figures.

	M_1		M2		M3		
	M.D.	L.L.	M.D.	L.L.	M.D.	L.L.	
Neand.	11.6	10.9	11.6	11.2	11.1	11.1	
Aust.	−	+	−	+	−	+	Nicholls
"	−	+	−	+	−	+	Campbell

	M_1		M2		M3		
	M.D.	L.L.	M.D.	L.L.	M.D.	L.L.	
Neand.	11.4	11.3	10.8	10.9	11.4	11.5	
Aust.	+	−	+	+	+	−	Nicholls
"	+	+	+	+	+	−	Campbell

From the above figures it will be seen that in the upper molars the Neandertal average is greater for the M.D. diameters but less for the L.L. diameters. This would indicate that the Neandertal upper molar series is really more the primitive type in the diameter relations than the Australian. However, in the lower molar series the position is reversed, for not only are the Australian averages larger in most cases, but those in which the Australian is smaller would indicate a condition of crown shape nearer to the hypothetical primitive human form.

In considering the cusp formation in the teeth of Homo primigenius, we must rely chiefly on the writings of Gorganovic Kramberger. It has been pointed out by this writer that the molar series of Home Primigenius showed cusp reduction, particularly in the upper arch. The upper molars are like the modern Europeans in cusp formula, the lower like the Australians. He writes (134): "Die Reduktion der Hockerzahl der oberen Molaren wurde am meisten jener der Europaer, ~~xing~~ diejenige der unteren aber mehr jener der Naturvolker (Australier) entsprecken".

Of upper molars of Krapina man he gives;

15 first M as having 4 cusps

11-12 second M as having (4 cusps in 2
(3½ " " 1
(3 " " 9

From figures given on earlier pages it will be seen that there is a far greater cusp reduction in the second and third upper molars than was present in the Australian.

His figures on the cusps of the lower jaw would correspond somewhat with the cusp condition of the Australian lower molars. Thus as regards upper teeth Home primigenius shows ~~x~~ more primitive molar crown dimensions than the Australian, but more marked cusp reduction. While in the lower molar series, cusp reduction is probably about the same, in size and form the Australian has the more primitive molar crown.

It is the roots of Homo primigenius which have always aroused considerable interest. With their root formation as a fused like mass, and a marked increase in the neck portion of the tooth at the expense of the roots, these teeth form a marked contrast to the teeth of the Australian with their widely separated and well formed roots. It is the well marked root divergence as is present in the teeth of the latter race which is considered the primitive type of root form in human teeth.

It would seem therefore that, on the whole, the dentition of the Australian is probably more primitive in type than that of H. primigenius. And this is in accordance with the opinion of Kramberger (135) which he expresses in the words: "Der Krapina - Meusch konnte also hinsichtlich seiner bereits reduzierten Hocker an den M2 durchaus nicht in eine direkte genetische Reihe mit den Australiern gestellt werden, weil die letzteren in dieser Beziehung gewisz noch ~~primitiver~~ primitwer veranlagt sind als jener, was uns ubrigens auch die Beschaffenheit der Wurzeln belehrt hat".

The molars contained in the Piltdown jaw fragment are given by Tomes (136) as having the following dimensions

	M.D.	L.L.	
1st	12.5	11	Tomes
	11.5	9.5	Smith Woodward
2nd	12.5	11	Tomes
	12	10	Smith Woodward

These of course are not beyond the range of lower molars contained in Australian jaws so far as dimensions are concerned, but the Piltdown molars have a narrowing of the labio-lingual diameter in the distal part of the crown which is not at all characteristic of the Australian lower molars, and also the ratiox of the L.L. diameter to the M.D. diameter is less in the former than in the latter, and in this respect are more primitive.

The molars of Pithecanthropus erectus are certainly of large dimensions, but come within the range of the dimensions of corresponding Australian teeth.

		M.D.	L.L.	Total Length	Root Length
	2nd molar	12	14	20	12
	3rd "	12	16	21.5	14
Maximum Dimensions of Australianx.	(2nd Molar	12.5	16	20	16
	(3rd molar	13	15	20.5	16

A feature of the Australian dentition, recognition of which would possibly aid in problems concerning the dentition of fossil man and probably assist in reconstruction of his dental arches, is the compound occlusal plane in the molar series. This was described under the heading of Attrition.

It was also pointed out that this feature occurs in the ape's dentition, which is such that it presents well worn teeth and a lower arch wider than the upper in the third molar region. Now as regards fossil man, it is interesting to turn to the mandible fragment of the Piltdown discovery. If this piece of jaw is viewed from the lateral aspect it will be seen that the attritional bevel of the first molar is downwards and outwards, while in the second molar it is almost horizontal. The tooth socket for the third molar indicates that the crown of that tooth probably had a tilt lingually instead of being situated vertically in its socket - a condition very frequent in the Australian mandibular third molar. We may perhaps safely infer that the attritional plane of the Piltdown third molar was very similar to that seen in the Australian. Figures 141, 142 and 143 show the curved occlusal molar plane in a chimpanzee, that in the Piltdown specimen as represented by a cast, and thirdly in an Australian mandible fragment similar in region to the Piltdown specimen. If the above inferences on the Piltdown specimen were correct, then in a reconstruction its mandible would have the arch wider in the third molar region than that of the upper arch in the same region. It is to be noted that in the cast copy of the original reconstruction of the Piltdown specimen by Smith Wood which has been available to the present writer, such was not the case.

To one who has closely observed conditions of occlusal attrition, that of the Piltdown molars is very human. Also the possible similarity of its third molar lean to that of the Australian, for instance, seems to favor the view of its human designation; for all the members of the molar series are set decidedly vertical in the anthropoid ape's dentition.

Unfortunately the present writer has never had the opportunity of examining the Jersey fossil dental specimens, but from the illustrations in the account of them by Keith and Knowles (137) it would appear that in these, the various molar teeth were bevelled occlusally. It would be interesting to see if a compound molar occlusal curve could be reasonably formed in an arch reconstruction. In the account referred to a sketch is given of the probable positions of the teeth in reconstructions of the arches. In these, the lower arch has been made wider than the upper in the third molar region, but no reason is given for such a course.

It will not be without interest now to consider briefly the relation of the Australian palate to those of the various forms of fossil man. Unfortunately there are not many of the discoveries which have been attributed to the Pleisticene Period which possess intact palates. Therefore for consideration of some of the most noted finds, we have, for the present, to rely on various hypothetical palate reconstructions.

For comparative purposes a type contour of the Australian palate, Figure 144, is placed along with contours of: Figure 145, a hypothetical reconstruction of the Talgai palate, after S.A.Smith; Figures 146, 147, 148, and 149, are after Keith; Figure 146 from a drawing of the Gibraltar palate; Figure 147 a reconstruction of the Heidelburg palate; Figure 148, palate in the original reconstructed model of the Piltdown specimen; Figure 149 from Professor Boule's reconstruction of the palate of the La Chapelle specimen.

Then on another sheet are drawn palatal contours of more recent extinct types for comparison with the Australian type contour. Figure 151 is a type palate contour of some Bronze Age specimens, after Parsons. Figure 152 is an attempt by the present writer to construct a type contour of the Tasmanian palate. This was obtained by using measurements from accounts of Tasmanian specimens by Flower, Turner, Duckworth, Berry and Ramsay Smith. From these, however, only length and breadth measurements of palates could be obtained and for the other measurements desirable for constructing a contour a few measurements were obtained by the present writer from specimens in the Melbourne University Anatomy School Museum, through the kind permission of Professor Berry.

From these contours it will be seen that if the reconstructions of the palate of the various forms of fossil man of Europe be any approximation to truth, then the palates of these extinct beings exceeded what might be considered the average sized palate of the Australian aboriginal. There is no reason to believe, of course, that the palates of so far discovered fossil forms of man were "out-sizes", as it were, but it must also be remembered that the Australian contour is made of measurements including many smaller sized palates, and also a goodly mixture of female specimens. Among the larger specimens of Australian palates, it is not at all uncommon to find palate width ranging close to 70mm., and eight or nine met with reach 70, and one as high as 75.5 mm.; while in length well over 60 mm. is a common occurrence.

However, it can probably be laid down with safety that the palates of the oldest fossil forms of man were larger than those of the Australian.

When we consider the Australian palate along with the Bronze Age man and the Tasmanian - if the contour of the latter is a reasonably correct one - we find that the Australian had both a larger and probably more primitive type of palate. The divergence of the arches of the Bronze Age palate is particularly noticeable compared with the Australian.

In the consideration of palate forms of fossil man, a feature of interest is the great width and somewhat roundish form of the palate of Neandertal man. This type of palate is considered by some to be a specialization which has departed widely from the simian type, such as we see well represented in the Australian palate.. Among the reasons put forth to explain this specialization, we may quote one of such an authority as Keith (138): "The wide palate, the wide dental crowns and big bodies of the teeth seem to indicate powerful side-to-side grinding movements of the mandible during mastication. On the evidence of the teeth and palate one is inclined to regard Neandertal man as specially adapted to live on a rough vegetable diet."

It would be interesting to know why the Australian palate has retained its primitive form in spite of the vigorous lateral stresses which it was obviously subjected to, and what the diet of the Australian could be put down as on the evidence of his teeth and palate.

Professor Keith also attributed the root form of Neandertal ~~man~~ teeth to the diet which that type of man seemed to be burdened with; and that "with the improvement in food in modern times, the usual primate form of tooth roots appeared again." (139).

SUMMARY

SUMMARY

In briefly summarizing the results of the foregoing observations on the Australian dentition, the following points may be stated as being of leading interest.

The jaws and teeth of the Australian aboriginal are strikingly well formed, with a capacious palate, well formed arches and large teeth; all of which depict a thoroughly functioning and efficient masticatory system.

The teeth of the Australian in size, are probably larger than those of any other living race; and in relation to those of extinct races are sometimes larger, and in most dimensions equal in size.

The teeth in crown form, cusp number, and root form are exceedingly primitive, probably more than any living race, and also some extinct races, such as Tasmanian and Neandertal man.

The arches are well formed and the type contours show in the adult that parallel form which is considered the most primitibe outline.

The palate is well formed and capacious,and so far as available comparative results show, is probably larger than any living race; larger than the recently extinct Tasmanian and the Bronze Age dweller of Great Britain; but in its type form not so large as some of the Pleistocene forms of man like those of Heidelberg and Piltdown.

The Australian palate apparently does not possess the somewhat circular form that is attributed to Neandertal man, the former possessing the more primitive contour.

The symmetrical conditions of occlusal and interproximal wear of the teeth,and glenoid fossae depths, would indicate that the Australian probably indulged in masticatory movements which consisted of regularly alternated side to side excursions of the mandible.

The vitality of the pulp and periodontal membrane was apparently very vigorous, as has been shown in the case of the pulp by the remarkable manner in which it physiologically resisted encroachment on its cavity by secondary deposit; and in the case of the membrane by the marked functional stresses it withstood without showing evidence of frequent or general periodontal affections.

The condition of the deciduous teeth would show that the children were remarkably free from dental diseases, that their teeth were made to function from the beginning of their acquirement, and that such developments as ~~xkmix~~ eruption of the teeth, formation of the arches and development of the palate, took place in a very regular manner.

The Australian dentition was strikingly free from developmental aberrations and dental diseases. The latter, as represented by such universallyoccurring affections as caries, alveolar abscesses and periodontal lesions, were conditions almost entirely limited to old age.

The marked immunity from dental diseases would seem to be very closely related with the coarse tough food which formed their diet and the crude methods of preparation and cooking when such were utilized.

The observations show in every aspect a very marked difference between the well formed Australian dentition, and ill-formed, disease stricken masticatory outfit with which most modern civilized peoples are burdened. See Fig. 153.

Probably the chief benefit derived from such a study as has been here attempted, is the great lesson to be learned from the conditions presented, namely, that if modern civilized races are to preserve strength and contour in the lower architecture of the face, to make the masticatory organs a physiologically functioning unit, to prevent the awful present day ravages of dental diseases and their concomitant systemic disturbances, and through all these to assist in building up sounder and healthier conditions, then there will have to be some drastic changes in the present day dietary and method of food preparation. In short, a return to diet conditions much more primitive than those at present in vogue will be necessary.

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