THE USE OF THE CONCEPT OF TOOTH MATERIAL AS AN INDICATION OF TOOTH SIZE IN A GROUP OF KALAHARI BUSHMEN*

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ABSTRACT

The limitations of Fowler's dental index are discussed. A new concept of tooth size is defined using the measurement "tooth material" as proposed by Ashley E. Howes. In the case of groups or races, the mean total tooth material of both arches is used to determine the size of the dentition. According to this concept, the Kalahari Bushmen of the present study are microdont. Material published by other investigators is also used to classify other groups according to this new concept of tooth size.

INTRODUCTION

Individual form and size are the two principal characters which distinguish one tooth from another. Variation in both these characters occur and this fact makes it possible to differentiate a tooth in one individual from a similar tooth in another individual. The present study is concerned with individual tooth size as well as the size of the dentition as a whole. If the deciduous and permanent dentitions are compared, the former is readily recognised as consisting of small teeth while the latter consists of large teeth. This difference in size, however, cannot be estimated without measurement. The dimensions selected for measurement and for the interpretation of tooth size depends entirely on what the investigator wishes to demonstrate. Thus, Fowler[1] proposes an index of tooth size, which expresses as a percentage, the ratio of the distance from the most mesial point of the maxillary first premolar to the most distal point of the maxillary third molar, to that of the basion-nasion length. Using this index three types of dentitions are defined (a) the small or microdont dentition (b) the medium-sized or mesodont dentition and (c) the large or megadont dentition. If the index is less than forty-two the dentition is regarded as microdont; if it is between forty-two and forty-four the dentition is mesodont and, finally, if the index is greater than forty-four the dentition is described as megadont. Fowler thus uses only a segment of one arch in order to define the size of the entire dentition.

While Fowler's dental index is widely used in anthropological studies there are definite limitations to its use. For example it cannot be used until the third molars have erupted, nor can the basion-nasion length be measured directly except on skulls. Furthermore, this index is a ratio of the mesio-distal length of teeth (in the maxillary arch) to a certain length of the skull and is thus not at all a true measurement of tooth size. Lastly, the premolar-molar length measured *in situ* is not always a true reflection of the sum of the mesio-distal diameters of the individual molar and premolar teeth. A number of variables associated with every dentition, for example, the curve of Spee, irregularities in the arch form and age-changes can alter this measurement. Since irregularities in arch form and age-changes are important in this investigation they must be considered more fully. In the European as well as in a number of other races, the dentition described by anatomists is one in which all the teeth in each arch touch one another on their mesial and distal surfaces. In these dentitions the maximum mesio-distal diameters of the teeth have more influence on arch size than any other dimension of the teeth. Irregularities in the arch form occur for many reasons, one of which is the effect of hybridisation on the dental arch. It is suggested by some

* Paper presented to the Johannesburg Congress of the Association, July, 1960.
(Accepted for publication, 18th August, 1961.)

investigators that the genes for the teeth and supporting skeletal bone are not linked. Thus, Abel[2] examined hybrids of Bushmen, Hottentots and Negroes and finds crowding of the teeth in some cases. This he attributes to the inheritance of large teeth from one parent and small jaws from the other. Crowding of the teeth therefore causes irregularity of arch form and thus decreases the measurement of that arch but Fowler nevertheless uses it to express tooth size. All dentitions also undergo changes with age. The mesiodistal diameters of the teeth decrease due to interstitial attrition or wear. In the case of the Bushmen, this decrease is substantial in both the deciduous and permanent dentitions because by the time all the permanent teeth have erupted, attrition is already perceptible, particularly as far as the first molars are concerned. The rate of reduction of this dimension varies of course from one dentition to another.

Fowler's dental index has been used by a number of investigators. Tomes[4] used it to classify the dentitions of a number of races, and in the light of the present investigation it is interesting to note that he classified Europeans and British as microdont; Negroes as mesodont and Australian aborigines as megadont. Other investigators have used this index to classify the tooth size of Bushmen. In view of the previously mentioned limitations of this index it is therefore not surprising to find that Broom[1] classified a group of Kalahari Bushmen as megadont while Drennan[3] found a certain Bushman tribe to be mesodont and at a subsequent investigation yet another group to be microdont.

If there are no irregularities in each of the dental arches and in their relationship to each other, the teeth are then in normal occlusion when the jaws are closed. Bearing this in mind and the fact that tooth size also depends on hereditary factors it is reasonable to assume that when individuals with a normal occlusion, and who show only the usual racial variation in tooth size, are selected from a group, most hybrids (such as in this case the Bantu-Bushmen type) will be excluded from that group. Also, by selecting young individuals dimensional changes in the teeth due to attrition are minimised. Measurements which exclude the last and even second-last molar teeth would make it possible to select individuals of just over twelve or thirteen years of age when the canines and premolars have just completed their eruption. On such individuals it would obviously not be possible to use Fowler's dental index.

Ashley E. Howes[6] compares the mesiodistal diameters of incisors, canines, premolars and first molars, or "tooth material," with other dental arch measurements. He finds that the tooth material of American Whites varies within narrow limits for all those with a normal occlusion. A similar analysis on Bantu teeth[7] reveals that their tooth material is larger than that of the American White and also falls within narrow limits for those with a normal occlusion. This racial difference compares favourably with similar differences observed by Tomes[4] using Fowler's dental index.

It is the purpose of this paper to determine the tooth material of a group of Kalahari Bushmen. In addition, the dentitions of a group of young adults with a normal occlusion will be analysed separately and the measurements obtained compared with those of the American White and Bantu. An attempt will be made to define a new concept of tooth size making use of the terms megadont, mesodont and microdont.

MATERIALS AND METHODS

In July 1959, the University of the Witwatersrand with the generous assistance of a grant from the Nuffield Foundation, sent a research expedition into the Central Kalahari where the casts of 103 adult Bushmen dentitions were obtained. All impressions were taken in Zelex and cast immediately in artificial stone which has an expansion of about 0.06%. Minimal dimensional changes were thus insured. The mesiodistal diameters of the maxillary and mandibular teeth of all the casts were measured with calipers in the manner proposed by Ashley E. Howes.[6] Casts of sixteen young adults classified as having a normal occlusion were selected and analysed separately. Tooth material values were calculated from data published by other investigators and included for comparison.

RESULTS

These are summarized in Tables I and II.

DISCUSSION

A comparison between the maximum, mean and minimum tooth material respectively of the selected group of Bushmen with a normal occlusion, and the values calculated for a group of American Whites,[6] with a normal occlusion reveals a remarkable similarity. The mean total tooth material of these two groups differs by only 0.6mm. A similar comparison, however, between the tooth material values for the total Bushman sample and the American Whites show some differences. The maximum values of the total Bushman sample are higher and the minimum much lower.

TABLE I

Comparison of tooth material (Ashley E. Howes) in millimeters of a group of Kalahari Bushmen, American Whites and Bantu.

	Maxilla			*Mandible*			*Total*		
Race	*Max.*	*Mean.*	*Min.*	*Max.*	*Mean.*	*Min.*	*Max.*	*Mean.*	*Min.*
Bushmen (present study) cases with normal occlusion	97.8	91.6	87.3	89	83.6	78.5	186.8	175.2	165.8
Bushmen (present study) all cases	101.9	89.2	66.5	95.9	80.9	63.5	197.8	170.1	130
American Whites (Ashley Howes)	98	91.7	85	89	84.1	78.5	187	175.8	163.5
Bantu (Jacobson and Dreyer[7])	109	102.7	96	100	93.7	87	209	196.4	183

TABLE II

Comparison of tooth material in millimeters as calculated from the mean mesio-distal diameters of the teeth of various groups.

Race or Group	*Mean maxillary tooth material*	*Mean mandibular tooth material*	*Mean total tooth material*
American White (Black) cited by (Shaw[9]) ..	95.4	86.8	182.2
Bantu (Shaw[9])	96.4	89	185.4
Bushmen (Drennan[5])	91.4	84.4	175.8
East Greenland Eskimo (Pederson[10])	96.4	—	?(±185)
Australian (Campbell[11])	103.8	95.8	199.6
Paranthropus (Robinson[12])	119.2	110.4	229.6
Australopithecus (Robinson[12])	109.4	111.4	220.8
Sinanthropus (Weidenreich cited by Robinson[12])	110.2	104.2	214.4
Baboons (Drennan[6])	74.7	66.3	141.0
Gorillas (Drennan[5])	60.7	68.0	128.7

As suggested earlier in this paper, hybridisation of the Kalahari Bushmen with Bantu may account for the higher maximum values of the total sample of the present study. The tooth material of the Bantu[7] is significantly larger than that of the selected group of Bushmen who have a normal occlusion. The minimum total value of the Bantu is only 3.8mm. lower than the maximum total value for the selected Bushmen of the present study. Hybridisation, however, may not be the only factor involved. Dreyer[8] states that a large tooth material is fairly common amongst South African Whites with no history of hybridisation. Only three of the 103 Bushmen studied have a relatively large tooth material, a number which may possibly be quite acceptable in a random sample of any population.

The mean total tooth material of all the casts measured is not much lower than that of the American Whites or the selected group studied. The difference is only 5.7mm. and 5.1mm. respectively.

The minimum total tooth material of the whole sample is extremely low. This value is 33.5mm. less than the value for American Whites with a normal occlusion. Dreyer[8] finds that a value below the minimum is rarely found in the South African White. In the Bushman the marked wear of the teeth is probably responsible for most of this reduction of tooth material; a fact which stresses the importance of selecting young individuals who show minimal signs of attrition and have a normal occlusion in a study of this kind.

Table II compares the tooth material of a number of other groups calculated on the mean measurements of individual teeth.

It will be recalled that the mean total tooth material of the selected group of Bushmen of the present study and the same value for the American White are nearly identical. Of interest is the finding that the Bushmen studied by Drennan[5] have a mean total tooth material identical with that of the American Whites and nearly the same as that of the selected group of the present study. Drennan, however, classified the Bushmen he studied as mesodont. This is due to the shortness of the anterior cranial base and therefore the basion-nasion length of the Colesberg Bushmen studied by him.

Subjecting the tooth material of the American Whites, the Bantu and the Bushmen to statistical analysis, the standard deviation from the mean for the groups selected with a normal occlusion is 6.7, 6.6 and 6% respectively. Tooth material therefore appears to be a reliable racial characteristic provided that young individuals who have a normal occlusion and show minimal age changes in their dentition are selected. Table I shows that the American Whites have the lowest minimum total tooth material and the highest standard deviation from the mean, and it is suggested that they be designated as microdont and selected as the standard for this division of tooth size. Accordingly, all races that have a mean total tooth material between 187 and 163.5mm. are considered microdont. The Bushmen of this study are members of this division. The difference between the outer limits of this division of tooth size is 23.5mm. and it is suggested that the same difference should exist between the outer limits of the next division or the mesodont race. Thus the latter has a maximum total tooth material of 210.6mm. and a minimum total value of 187.1mm. The Bantu[7] have a mesodont dentition. A small percentage of this race is microdont. Finally, it is suggested that all races or groups with a mean total tooth material of between 234.2 and 210.7mm. should be designated as megadont. The upper limit of this division of tooth size is probably never found in living races today. It seems quite probable that the lower limit may be attained by some Bantu and possibly other races.

Table III summarizes and compares the present and the previous classifications of the tooth size of various groups.

It is suggested that the terms megadont, mesodont and microdont as proposed by Fowler to describe tooth size should be used to compare the mean total tooth material of one race or group with another provided individuals who have a normal occlusion and show minimal attrition are selected. Secondly, it is suggested that the tooth

TABLE III

Comparison of present and previous classifications of tooth size of various groups.

Race or Group	*Investigator*	*Present Classification*	*Previous Classification*
Kalahari Bushmen	van Reenen	Microdont	—
Kalahari Bushmen	Broom, cited by Drennan[5]	—	Megadont
Bushman tribe	Drennan[5]	Microdont	Mesodont
S.A. Bushmen	Drennan[5]	—	Microdont
Cape Colony and Griqualand West Bushmen	Broom, cited by Drennan[5]	—	Mesodont
Bushmen	Shrubsall, cited by Drennan[5]	—	Microdont
Europeans	Fowler[1]	—	Microdont
American Whites	Ashley E. Howes[6]	Microdont	—
Bantu	Jacobson and Dreyer[8]	Mesodont	—
Hottentots	Broom, cited by Drennan[5]	—	Microdont
Koranas	Broom, cited by Drennan[5]	—	Microdont
Australians	Campbell[11]	Mesodont	Megadont
Baboons	Drennan[5]	Micro-microdont	Megadont
Gorillas	Drennan[5]	Micro-microdont	Megadont
Australopithecus	Robinson[12]	Megadont	—
Paranthropus	Robinson[12]	Megadont	—
Sinanthropus	Weidenreich cited by Robinson[12]	Megadont	—

material of an individual should be compared with the race to which he belongs. The use of the terms to describe tooth size should be clearly separated as for example; the Kalahari Bushmen have a microdont dentition but certain individuals of the race may be mesodont and others possibly micro-microdont.

It is tempting to conclude that the present classification suggests an evolutionary tendency to reduction of tooth material. There is, however, insufficient evidence to support such a hypothesis in this paper.

ACKNOWLEDGEMENTS

I am indebted to the Nuffield Foundation and the University of the Witwatersrand Kalahari Research Committee as well as to Professors Staz and Tobias, all of whom made the collection of the material for this study possible; to Professor Dreyer for his invaluable help and encouragement in the preparation of this paper; to Professor A. E. Dodds for correcting the manuscript; and to Messrs. J. van Heerden, C. Pentz and C. B. Preston for technical assistance.

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— NOTES AND NEWS

OOR IETS EN ALLES —

The recently-announced Nobel Prize for medicine has been awarded to PROFESSOR GEORG VAN BEKESY, Hungarian-born physicist who has been a senior research fellow at Harvard University since 1949, for his research on the physiology of hearing. He began his career as an engineer in telephone and telegraph technology, but later turned his attention to the study of human acoustic mechanisms. He is regarded as the greatest living expert on the inner ear. His discoveries have helped millions of deaf people.

DR E. J. MARAIS, van 1955 Direkteur van die Nasionale Fisiese Navorsingslaboratorium, is aangestel as Vise-President van die W.N.N.R. in die plek van DR W. S. RAPSON, wat aanstelling aanvaar het as navorsingsadviseur van die Transvaalse en Oranje-Vrystaatse Kamer van Nywerhede. Dr Marais sal in Februarie 1962 sy nuwe amp aanvaar.

LORD HAILSHAM, British Minister of Science, in delivering the Eighth Fawley Foundation lecture, spoke on the relationship between science and Government at Southampton University recently. "What we need is an administrative machine with a Minister at the head capable collectively of isolating the right questions, conducting the proper discussions of them with the right people inside and outside the Government machine, rendering intelligible the real arguments, providing at various levels of authority the means of arriving at rational conclusions with the human material in fact available, and finally supplying suitable means for carrying these conslusions into execution".

It is important, said Lord Hailsham, not so much that there was a Minister of Science, but that all Ministries should regard the application of science in their own spheres as one of its main responsibilities. Research should not be left to the Minister to organize, but should be carried out by the separate Ministries, nationalized industries and private firms.

The Metal Box Company of South Africa have made an amount of R8,000 available for bursaries to assist students in metallurgy and engineering. There will be three bursaries, two available for two years, for the last two years of study for a degree; two postgraduate bursaries also tenable for two years, and one for two years of advanced study overseas of aspects of ectallurgy and engineering for which there is as yet no adequate provision in South Africa.

Die gieterybedryf het in die afgelope drie jaar R15,000 tot die W.N.N.R. bygedra vir navorsing in verband met gieterysand. Gevolglik is 'n navorsingspos vir hierdie doel ingestel, wat beklee word deur DR P. H. RILEY. Daar is in Suid-Afrika meer as 2,p00 gieterye met altesaam 27,000 werknemers, en die nywerheid vervaardig 'n geweldige verskeidenheid gietstukke, groot en klein. Op 20 en 21 November 1961 het die W.N.N.R. 'n tweedaagss kursus in verband met gieterysand gereël en 'n aantal mense uit die gieterybedryf uitgenooi om dit by te woon.

DR E. M. VAN ZINDEREN BAKKER of the Department of Botany at the University of the O.F.S., Bloemfontein, has received a grant of R4,000 from the Nuffield Foundation for his palynological research and S700 from the Wenner-Gren Foundation for Anthropological Research for his field work.

The C.S.I.R. has set up a new research institute, the National Research Institute for Mathematical Sciences. It will be directed by DR A. P. BURGER, former head of the Mathematics Division of the National Physical Research Laboratory. One of its first acquisitions will be the C.S.I.R.'s second electronic computer, the I.B.M. 704, to be installed next year.

Although the C.S.I.R.'s first digital computer, Zebra, has been working night and day, it will soon be unable to cope with assignments on hand. The new computer works at high speed—it needs only a five-thousandth of a second to multiply two numbers of ten decimals each. It has an "immediate access" memory of 8,000 stored numbers, and interchangeable magnetic tape memories give it an unlimited storage capacity.