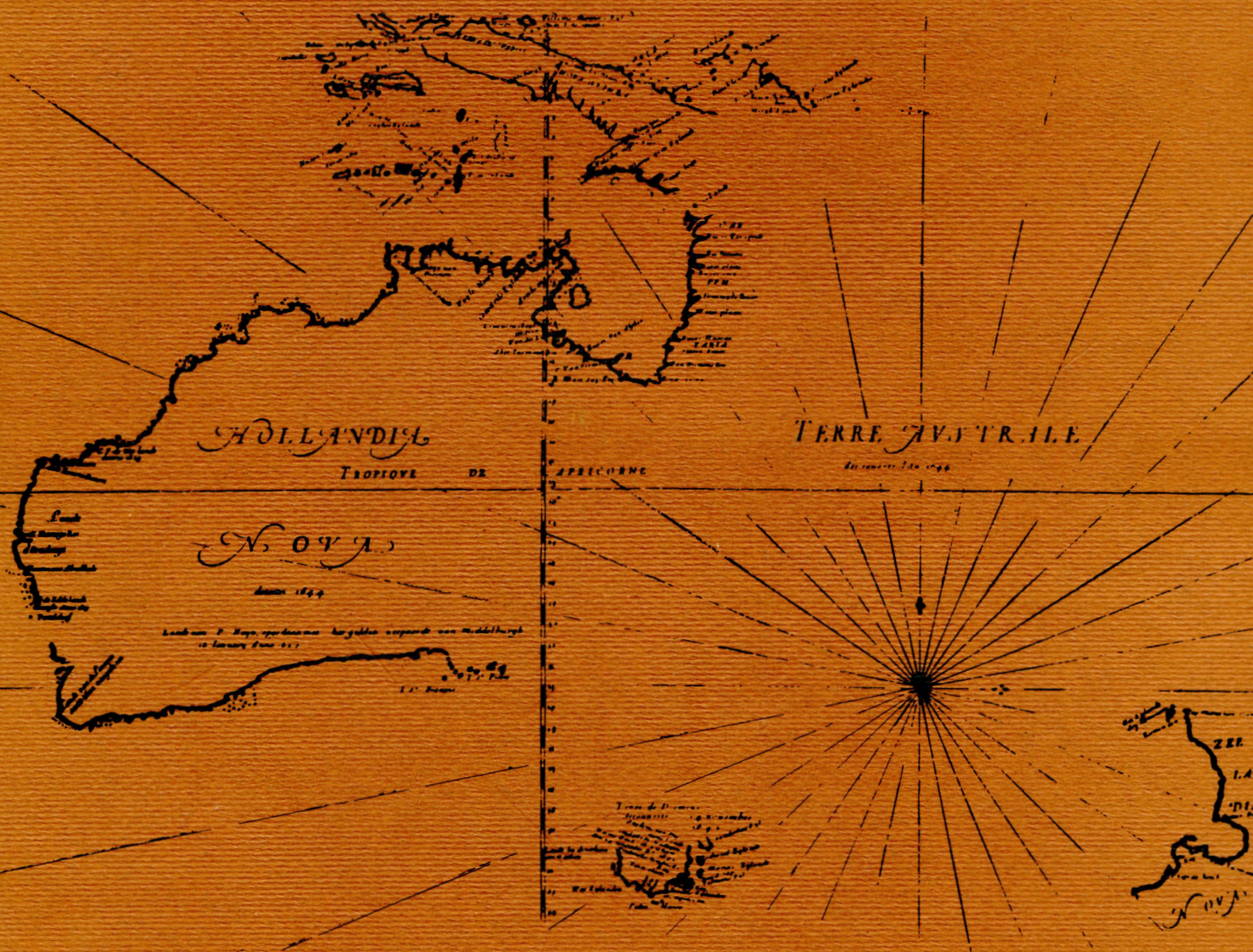


Coobool Creek

Peter Brown



TERRA AUSTRALIS
13

Department of Prehistory
Research School of Pacific Studies
The Australian National University

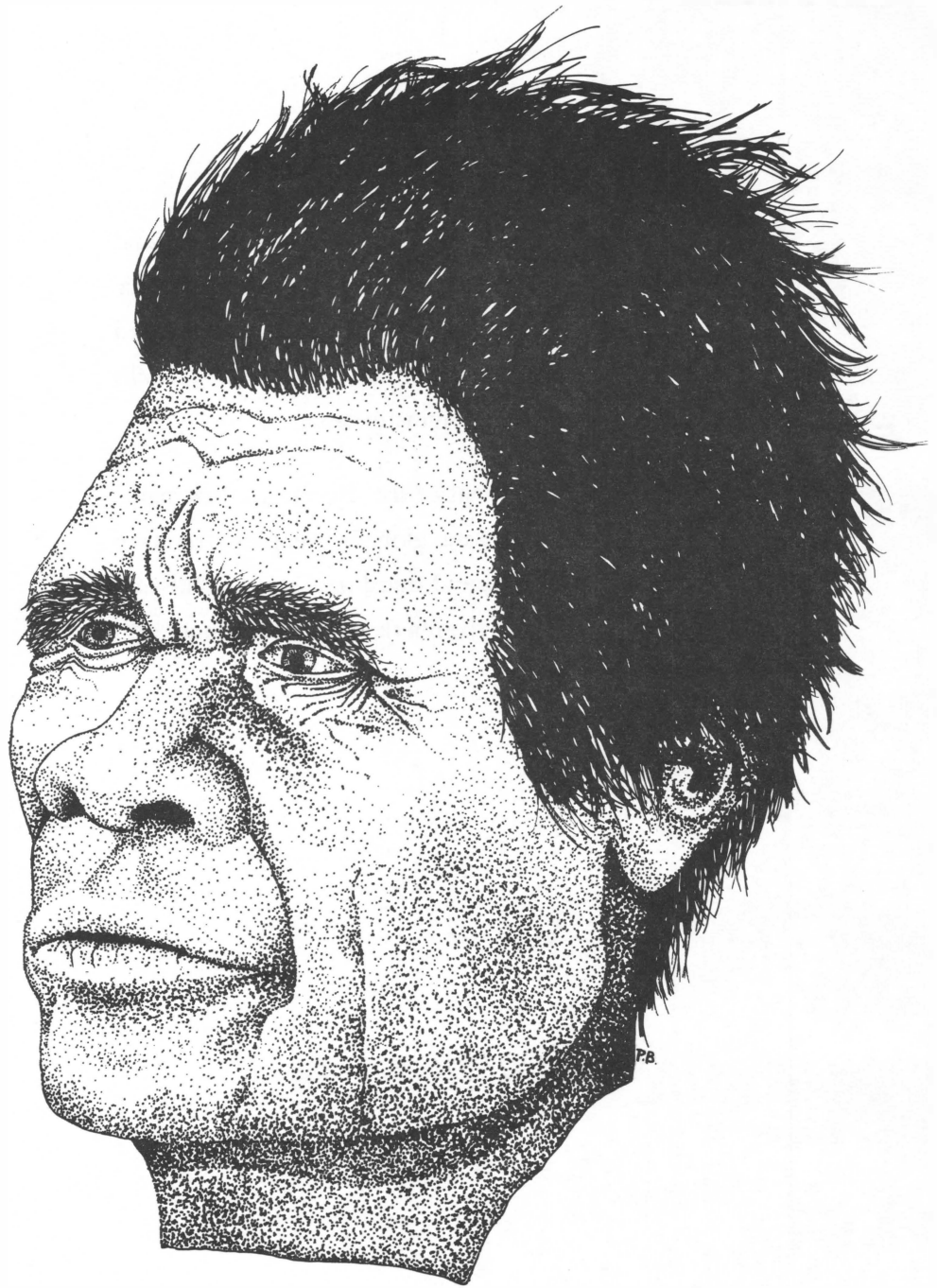
PREHISTORY RSPACS

Terra Australis reports the results of archaeological and related research within the region south and east of Asia, though mainly Australia, New Guinea and Island Melanesia - lands that have remained *terra australis incognita* to generations of prehistorians.

Its subject is the settlement of the diverse environments in this isolated quarter of the globe by peoples who have maintained their discrete and traditional ways of life into the recent recorded or remembered past and at times into the observable present.

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PREHISTORY RSPACS



TERRA AUSTRALIS

13

COOBOOL CREEK

**A morphological and metrical analysis of the crania,
mandibles and dentitions of a prehistoric
Australian human population**

Peter Brown

**Department of Prehistory, Research School of Pacific Studies
The Australian National University, Canberra
1989**

This is volume 13 in the series *Terra Australis*

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FOREWORD

A decade ago Dr Peter Brown, now of the Department of Archaeology and Palaeoanthropology, University of New England, was the first of a number of postgraduate scholars to begin work on aspects of human skeletal analysis in the Department of Prehistory. Before his doctoral research topic was finalised he 'discovered' the Coobool Creek remains in the collections of the Anatomy Department of the University of Melbourne. Given the existing prehistoric skeletal database and the important Australian and western Pacific evolutionary questions that were current at that time, the number of individuals and their anatomical features made documentation, reconstruction, description and analysis of the Coobool Creek cranial remains an important and urgent task. With an undergraduate background from the Department of Prehistory and Anthropology, The Faculties, Australian National University, as well as considerable artistic and manual skills, Brown combined the variety of talents required to deal effectively with this extensive collection. Despite problems determining the precise age of the collection, or individuals within it, Coobool Creek represents a major expansion of data from the Australian past. Discussion of the skeletal anatomy of these people will be a permanent aspect of palaeoanthropological research in Australia and the western Pacific in the future.

Over much of this same decade Aboriginal attitudes to several aspects of their heritage, skeletal remains in particular, have taken a new and highly public turn. The question of who owns the past and the material evidence for that past, has become a major anthropological and political issue. For those responsible for the excavation, reconstruction and description of skeletal remains this has been a difficult period. The legal action that saw the removal of the Coobool Creek and other skeletal remains from the University of Melbourne to the Museum of Victoria made it impossible for Dr Brown to fully revise and extend his doctoral research in the preparation of this volume. In early 1989 the Coobool Creek Collection was handed to Aboriginal custodianship in New South Wales for reburial, ending any extension of that research permanently. Those who have not been involved in this process may find it difficult to appreciate the ethical and professional dilemmas that this has meant for researchers.

This volume is the first on a human skeletal subject in the *Terra Australis* series and it therefore marks the important changes that have been going on in biological anthropology in Australia in recent years. Other skeletal studies in the series will extend the documentation of Australia's human biological past and further demonstrate the important evidence that prehistoric remains contribute to our understanding of the development of modern human form and variation.

Alan Thorne

PREFACE

This monograph represents a continuation of the research in my PhD thesis, 'Coobool Creek: a prehistoric Australian hominid population', which was submitted to the Department of Prehistory, Research School of Pacific Studies, Australian National University in 1982. My primary source of motivation for rewriting and expanding the original work was the absence of detailed descriptions for many of the 'classic' Australian hominid fossils. A profusion of words had been spoken, the occasional film produced, but comparatively little published. With the dearth of publications, several of these fossils have taken on mystical qualities which, at least from my own perspective, have little to do with reality.

In its general form this monograph follows the original thesis. However, the reconstruction of additional materials from Coobool Creek, combined with my own altered outlook on aspects of methodology and interpretation, made rewriting sections of the primary work a priority. There is a greater reliance on graphical means of data description and much of the analyses and data are new. The sections in the thesis dealing with 'the mark of ancient Java' have been omitted. I am becoming increasingly sceptical about the osteological evidence for such a link and intend to pursue this issue in the future. In other respects the essential details of the conclusions I reached in 1982 remain unaltered.

Peter Brown

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With the exception of Figure 2 which was drawn by Winifred Mumford, all of the illustrations in this monograph were produced by the author. The photographs were taken by Dragi Markovic, David McClenaghan and myself. Douglas Hobbs provided useful information on sometimes esoteric varieties of Macintosh software. I typed most of the original manuscript, with last minute assistance from Fiona Brown and Diane Watson. This volume was edited and produced by Jeanine Mummery, Winifred Mumford and Alan Thorne. I am particularly indebted to Jeanine for her fine editorial eye.

Peter Brown

CONVENTIONS

Reference is made throughout the text to Aborigine and Aboriginal and unless specified otherwise all references are to Australian Aborigines.

SITE CODES

BA	Barham
BB	Broadbeach
C	Cohuna
CC	Coobool Creek
K	Keilor
KS	Kow Swamp
LN	Lake Nitchie
LM	Lake Mungo
M	Mossgiel
MV	Murray Valley
N	Nacurrie
R	Roonka
SW	Swanport
T	Talgai

ABBREVIATION

WLH	Willandra Lakes hominid series
-----	--------------------------------

Peter Brown

I

INTRODUCTION

This project was inspired by the discovery and subsequent analysis of the terminal Pleistocene human skeletal series from Kow Swamp in the central Murray Valley (Thorne and Macumber 1972; Thorne 1975, 1976; Thorne and Wilson 1977). Analysis of the skeletal materials from Kow Swamp raised important questions concerning the origins and evolution of the Australian Aboriginal population. However, the fragmentary condition of the Kow Swamp sample, combined with limited amount of comparative skeletal material available at the time, restricted aspects of Thorne's description and analysis (Thorne 1975). Little skeletal material had been recovered from controlled archaeological excavation, with work at Roonka (Pretty 1977; Prokopec 1979; Smith *et al.* 1988) and Broadbeach (Haglund 1976; Freedman and Wood 1977) still in progress.

In the summer of 1979-80 while collecting data for a PhD thesis on the Australian Aboriginal oro-facial skeleton in the Department of Anatomy, University of Melbourne, I came across several metal cabinets containing a number of highly mineralised human crania and mandibles. My immediate impression, confirmed by subsequent cleaning, reconstruction and analysis, was that the crania were of unusually large size and morphologically similar to those from Kow Swamp and Cohuna. However, in marked contrast to the Kow Swamp sample there were a large number of individuals represented, the general level of preservation appeared to be excellent and the skeletal materials were free of post-depositional distortion. Realising the potential importance of this collection I asked the late Professor L.J. Ray for information concerning the origins of this portion of the 'Murray Black Collection' and for permission to transport some of the crania to Canberra for cleaning and reconstruction. Professor Ray's reply changed the course of my PhD thesis, of which this monograph is an extension.

Professor Ray informed me that the 'fossilised' part of the collection had been 'dug up' by the late George Murray Black from a sandridge near Coobool Creek in the central Murray Valley during 1950. The exact provenance of the site was unknown and no attempt had been made to record the stratigraphic association of the burials or any archaeological materials recovered from the cemetery. In my initial dis-

cussions with Professor Ray I expressed the belief that the questions of provenance and age would not provide a major obstacle. There was certainly a technological solution in the form of radiocarbon dating which I assumed would provide a rapid solution for one of these problems and I expected a survey of the district to locate the site. However, after seven years of research the questions of provenance and age remain largely unanswered. The precise geographic location of the Coobool Creek cemetery is unknown and contamination has prevented the radiocarbon dating of bone from the site.

The importance of the skeletal materials from Coobool Creek lies in their morphological and metrical similarity to those from Kow Swamp and in the contrast these materials provide with middle and late Holocene human skeletal materials from other parts of Australia. The major objective of this monograph is a morphological and metrical description of the crania, mandibles and dentitions from Coobool Creek followed by a comparison of the Coobool Creek series with the terminal Pleistocene, middle Holocene and recent skeletal collections from southeastern Australia. This process of comparative description provides a basis from which to explore several issues arising from Thorne's pioneering research at Kow Swamp (Thorne and Macumber 1972; Thorne 1975, 1977; Thorne and Wilson 1977). Principle amongst these is a consideration of post-Pleistocene change in Australian Aboriginal skeletal size and morphology. Related issues include sexual dimorphism, variation in cranial-vault thickness, artificial cranial deformation and structural reduction in the masticatory complex. I have previously published sections of this work (Brown 1981b, 1987a) but for reasons of completeness I reintroduce them here.

II

MATERIALS AND METHODS

INTRODUCTION

There are two major practical and theoretical problems associated with analyses of evolutionary change in Australian Aboriginal skeletal material. Firstly there is a sampling difficulty brought about by the scarcity of material recovered from dated archaeological contexts, and the generally poor preservation of the little material that is available. The second problem concerns the spectrum of hypotheses which have been generated from this material. Hypotheses which on the whole can not be unequivocally supported, or disproved, with the available data. Historically, the major area of debate concerns the variation in physical characteristics which have been described for fossil, and recent, Australian populations (Brown 1987a, 1988). As I have previously argued, explanations of this variation are represented by two conflicting groups of hypothesis. Either Australia was colonised by a single group of immigrants with subsequent variation resulting from genetic and environmental factors or there were multiple waves of temporally circumscribed, genetically distinct immigrants (Brown 1987a:41).

Therefore evidence of temporal change, in any given osteological feature, could be argued to provide support for several conflicting lines of argument. An apparently directional reduction in skeletal mass and associated morphological features may represent the accumulated genetic result of the amalgamation of two, or more, Pleistocene founder populations. Alternatively it could be the result of gene flow into Australia during the Holocene, or *in situ* evolutionary change in a single Australian population. A combination of these events, sampling problems, or even observer error, may also have contributed to the reported results. Until such time as these issues are resolved, analyses of temporal change in aspects of Aboriginal osteology must have a relatively broad area of focus.

MATERIALS

The reconstruction and analysis of the Coobool Creek sample (Brown 1981b, 1982, 1987a; Wu and Brown 1986) placed the geographical emphasis of this study within the Murray Valley. Although a considerable amount of skeletal material has been collected from this general area, the bulk of it comes from poorly

defined geographical localities and without associated archaeological context. An examination of temporal change in skeletal features requires a grasp of both interpopulation and intrapopulation variation, combined with some control of sequence. In this region, temporal control is provided by the Kow Swamp population dated to the period between 13,000 and 9000 years BP (Thorne and Macumber 1972; Thorne 1976), the Roonka series, with skeletal material from approximately 7000 years BP up until the European contact period, the small collection excavated from Barham dated to 5400-4500 years BP (Daley 1986), and skeletons of similar age excavated from the area between Mildura and Renmark by Blackwood and Simpson (1973). Unfortunately, the preservation of the Roonka and Mildura-Renmark material, in particular, is poor and these collections are now only suitable for a limited range of morphological observations. The best available comparative 'recent' samples come from Swanport (Stirling 1911; Pietrusewsky 1984; Brown 1987a) and a broader regional series collected from between Chowilla and Coobool by the late George Murray Black (Sunderland and Ray 1959; Pietrusewsky 1979; Brown 1981a, 1987a). A further control on both geographic and temporal factors was gained by the addition of the Broadbeach series from southeastern Queensland (Haglund-Calley 1968a, 1968b; Haglund 1976; Freedman and Wood 1977). The final sample consisted of skeletal material from Coobool Creek, Kow Swamp, Roonka, Barham, Broadbeach, Swanport and the 'recent' Murray Valley series. All of the available terminal Pleistocene skeletons, with the exception of Lake Tandou, were also included to examine specific questions of geographic and temporal variation raised by Thorne (1976; Thorne and Wilson 1977) and Freedman and Lofgren (1979b, 1983; Freedman 1986). The Lake Tandou skeleton, located in the Western Australian Museum, has been described in detail by Freedman and Lofgren (1983) and I will refer to their data where appropriate.

Two criteria were used for the selection of skeletal material from within each of these samples. Firstly, only demonstrably adult skeletal material was used. An individual skeleton was classed as adult if there was fusion of the sphenoid-occipital synchondrosis and epiphyses in the postcranial skeleton, where pre-

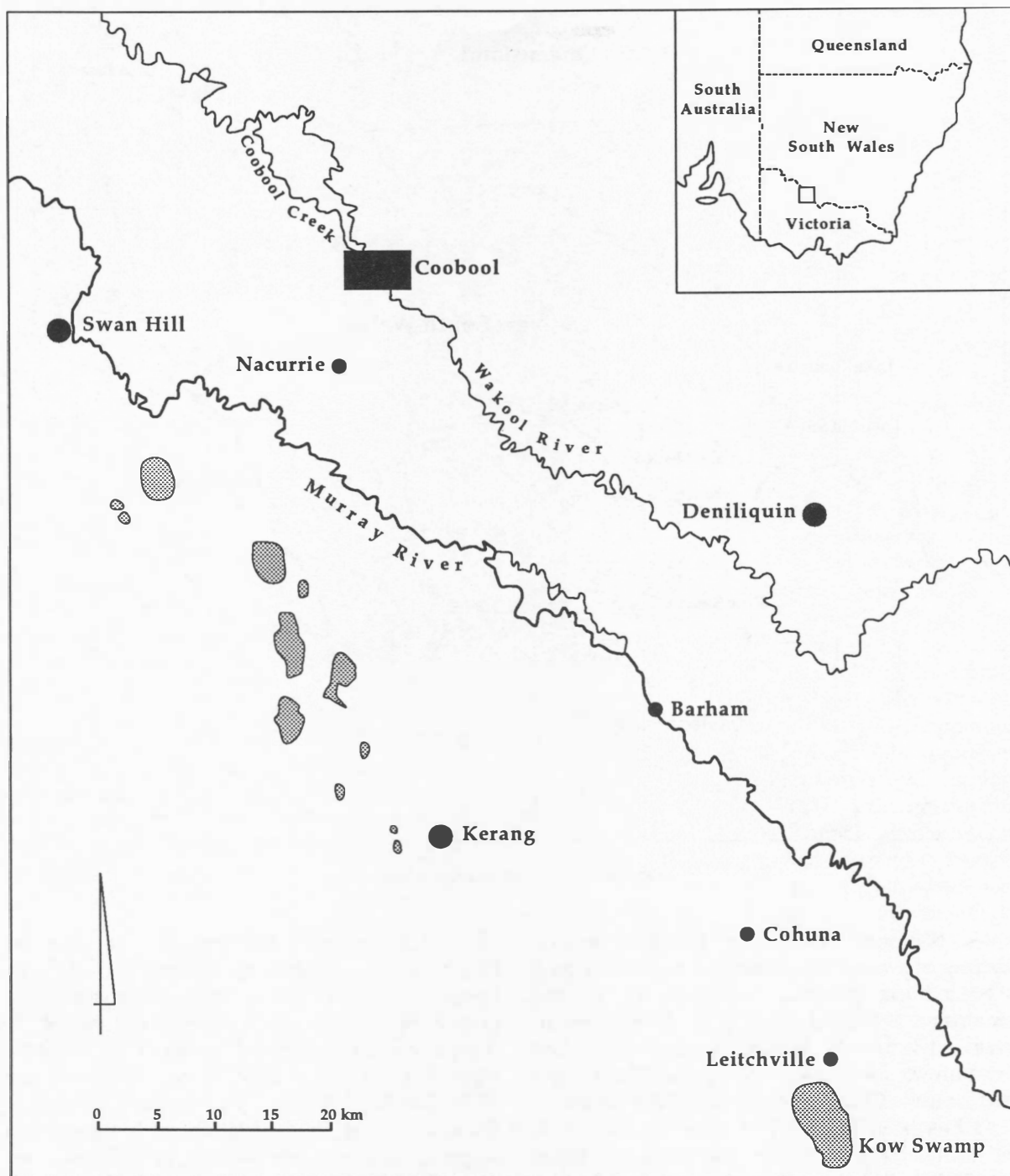


Figure 1 Location of the central Murray Valley sites of Kow Swamp, Cohuna, Barham and Nacurrie, and the area from which the Coobool Creek skeletons probably originated

served, and the third molars were in occlusion. Crania in which there was congenital absence of the third molars, but were clearly adult according to factors of tooth wear and closure of the spheno-occipital synchondrosis, were also included. The second selection factor was preservation. Skeletal elements with evidence of postmortem warping, or for which only a limited number of variables could be recorded, were

excluded. Due to some inconsistencies in the previously published information, and the need for a uniform methodology, I collected all of those data used in this analysis.

Barham (BA)

The Barham skeletons were recovered in a salvage excavation in 1972 by a team from the Australian Museum, Sydney, and the New South

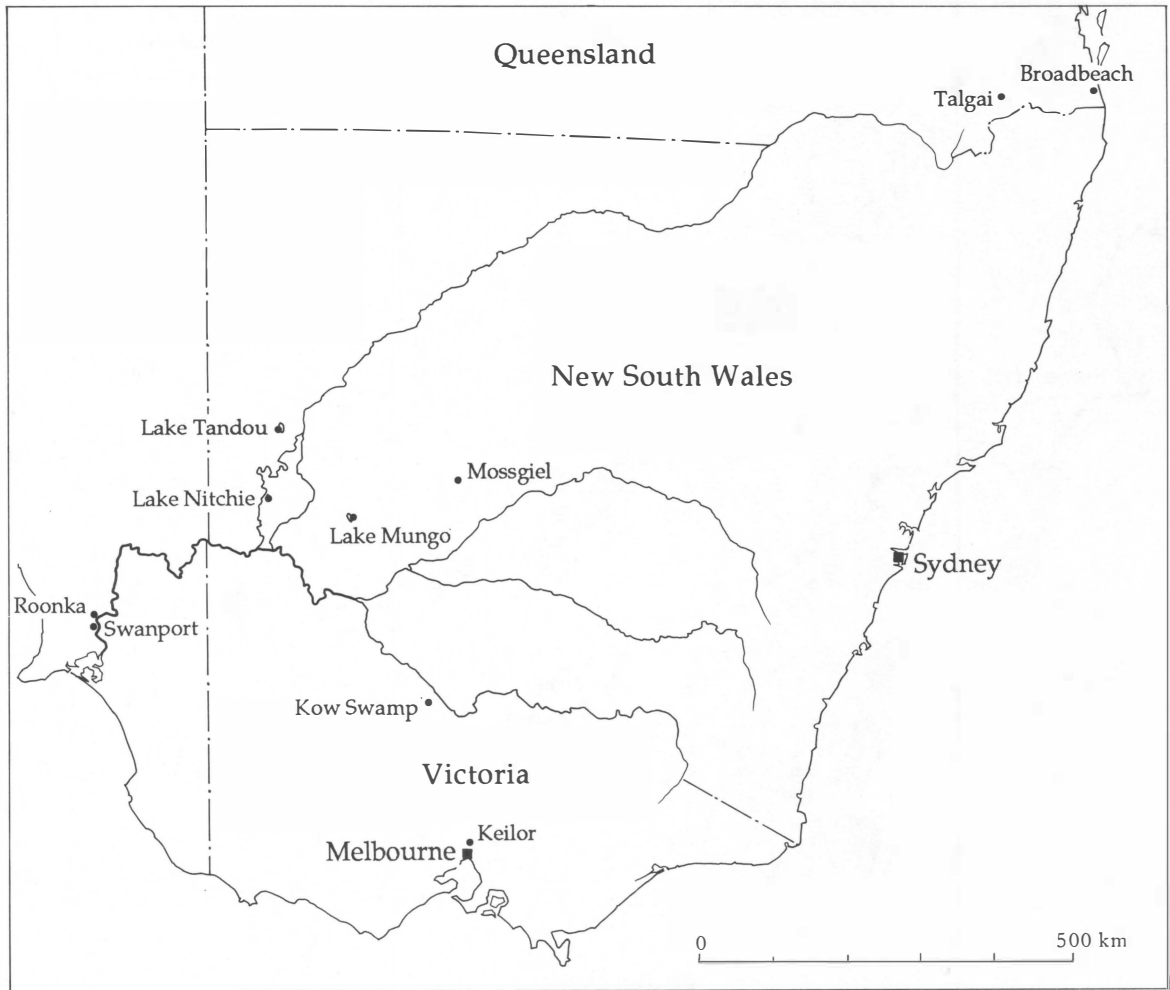


Figure 2 Site location map

Wales National Parks and Wildlife Service. Grading of a road, through what was discovered to be a burial ground, uncovered the skeletal remains of 14 individuals (Fig.1). These remains were subsequently housed in the Australian Museum, in association with Peter Thompson's field notes. Charcoal overlying Barham burial K2/1 has been radiocarbon dated to 5400 ± 90 and burial E4/1 to 4670 ± 110 years BP (Daley 1986:35-36). There are no published descriptions of the Barham skeletons. Daley (1986) combined a partial reconstruction and preliminary description of this material as part of her Masters thesis at the University of Sydney. Her analysis concluded that there was no evidence of the Coobool Creek and Kow Swamp morphological pattern in the Barham cranial vaults. I completed the reconstruction of the Barham skeletons in June-July 1987.

Broadbeach (BB)

The Broadbeach burial ground is located

about 1.5 km from the coastline at Mermaid Beach in southeastern Queensland (Fig.2). Between 1965 and 1968 a series of archaeological excavations at the site recovered the partial, or complete, skeletal remains of more than 100 individuals (Haglund-Calley 1968a, 1968b; Wood 1968; Haglund 1976). Radiocarbon dating of charcoal found in association with the burials suggests that the site was in periodic use for more than 1000 years, from about 1290 years BP until the European contact period (Haglund 1976; Freedman and Wood 1977). Although the remains of a large number of individuals were recovered from the site, they are for the most part poorly preserved, with only 18 of the adult crania being reasonably complete.

Published analyses of the skeletal material are restricted to those of Freedman and Wood (1977), Pietrusewsky (1979, 1984), Brace (1980) and Smith *et al.* (1981). Freedman and Wood conclude that the Broadbeach material 'almost certainly represents a localised sample, probably

a single tribe' (1977:17) and the results of their univariate and multivariate analyses distinguish between the Broadbeach crania and samples from coastal New South Wales and a broad Queensland series. Their univariate analysis indicated that the relatively large size of the Broadbeach crania and mandibles was a major distinguishing feature, while the multivariate comparison suggested that shape was also an important factor. Arrangements are presently being made for the reburial of the Broadbeach skeletons.

Cohuna (C)

The Cohuna cranium was discovered by George Gray in 1925 during the excavation of an irrigation channel close to the northern margin of Kow Swamp (Fig.1) (Macintosh 1952b, 1953). The cranium has not been radiometrically dated. Following chemical and physiographic analysis, Macintosh (1953) concluded that the cranium had become mineralised on Mt Hope and transported to the discovery site by water action. More recent research (Macumber and Thorne 1975) indicates that mineralisation of the cranium occurred in the soil in which it was found. This is supported by the good preservation of the facial skeleton, which is not what you would expect with water tumbling over it, and the claim that a number of skeletons were originally unearthed, not just a cranial vault.

Macintosh (1952c) described the teeth and palate of Cohuna, however, a detailed description of the cranium has yet to be published. Morphological and statistical comparisons have consistently placed Cohuna within the Kow Swamp population (Thorne 1976, 1977; Thorne and Wilson 1977; Brown 1987a). Common morphological features include a flattened frontal squama in association with a high cranial vault, great supraorbital breadth, a deep and prognathic facial skeleton, low and rectangular orbits, a large palate, thickened bones in the cranial vault and large overall size. The Cohuna cranium is missing a large section of its cranial base, both mastoid processes, the temporal process of the left zygomatic arch, all of the incisor teeth and right canine, and there is some damage to the left supraorbital region.

Coobool Creek (CC)

While collecting information for my PhD thesis in the winter of 1980 I came across a number of mineralised, and heavily carbonate encrusted, crania in the Department of Anatomy, University of Melbourne. Morphologically, several of the crania appeared similar to the dis-

tinctive terminal Pleistocene series recovered from Kow Swamp by Alan Thorne (1969, 1976; Thorne and Macumber 1972). The late Professor L.J. Ray informed me that this material was collected from a site near 'Doherty's Hut' at Coobool Crossing on the Wakool River between Swan Hill and Deniliquin in southern New South Wales (Fig.1) by the late G.M. Black during 1950 (Brown 1981a, 1987a). I requested permission to clean and reconstruct the Coobool Creek crania and mandibles for inclusion in my thesis; this request was subsequently granted by Professor L.J. Ray.

The Coobool Creek skeletons form part of the Murray Black Collection, previously housed in the Department of Anatomy, University of Melbourne, and at present located in the Museum of Victoria. As with the remainder of the Murray Black Collection this material was collected without recording either archaeological, or precise geographical, context. There are 126 individuals in the Coobool Creek series, some represented only by isolated teeth. For the most part the crania and mandibles were collected without their associated postcranial skeletons. Mineralisation and deposits of secondary carbonates made the postcranial skeletons too heavy to move and so they were left in the ground. Twenty-four of the more complete crania, the criteria being an apparently well preserved cranial base, facial skeleton and dentition, were selected for cleaning, reconstruction and inclusion in my thesis (Brown 1982). After the completion of my thesis I reconstructed nine more crania, their associated mandibles, and a small amount of postcranial material at the University of New England. Alterations in the *Victorian State Relics Legislation* in 1984, and the subsequent transference of the Murray Black Collection to the Museum of Victoria, have prevented further work on this material. Twenty-four male and nine female crania, the majority with associated mandibles, form the Coobool Creek sample which will be included in this analysis.

At the present time there are no radiocarbon dates directly associated with the Coobool Creek skeletal material. Initial attempts at radiocarbon dating of human bone from this site were frustrated by the immersion of all bone in a gelatin bath, as a preservative coating, shortly after recovery. Contamination by this modern collagen will make it difficult, if not impossible, to accurately determine the age of this collection. Uranium thorium dating of bone from CC65, conducted by the Australian Nuclear Science and Technology Organisation, obtained a date of $14,300 \pm 1000$ years BP (LLO-416). This supports

the anatomical and cultural comparisons linking Coobool Creek with Kow Swamp and distinguishing them from the mid-Holocene skeletons from this region (Brown 1981a, 1982, 1987a).

Keilor (K)

The Keilor cranium was discovered by James White in October 1940 while excavating a sand deposit near the junction of the Maribyrnong River and Dry Creek, about 2 km north of Keilor, Victoria (Mahony 1943:31). This carbonate encrusted cranium, and the few fragments of femur found near it, were deposited in the Museum of Victoria. Preliminary descriptions of the cranium were published by Wunderly (1943) and the teeth and palate by Adam (1943). Both the initial claims for extreme antiquity and Wunderly's description received considerable criticism (Jones 1944; Zeuner 1944; Weidenreich 1945b). More recent research has compared Keilor to a range of terminal Pleistocene and late Holocene Australian crania, with conflicting results (Thorne and Wilson 1977; Freedman 1986; Habgood 1986; Brown 1987a).

In 1971 the late Professor N.W.G. Macintosh obtained radiocarbon dates on secondary carbonates removed from the external surface of the cranial vault and femur fragment, and a bone collagen date for the femur, through the New Zealand Institute of Nuclear Sciences (Brown 1987a). The only measure of absolute age was provided by the bone collagen date of $12,000 \pm 100$ (NZ-1327). If the femur and cranium belonged to the same individual, and some support for this is provided by the similar carbonate dates of 6790 ± 50 (NZ-1326) and 6800 ± 100 (NZ-1321) respectively, then the cranium appears to be of terminal Pleistocene age. Keilor is reasonably well preserved, lacking only the temporal segments of both zygomatic arches, a large section of the right side of the basicranium and anterior dentition.

Kow Swamp (KS)

Archaeological excavations at Kow Swamp, 10 km southeast of Cohuna in the central Murray Valley (Fig.1), between 1968 and 1972 recovered the partial skeletal remains of more than 22 individuals (Thorne 1969, 1975, 1976; Thorne and Macumber 1972). Radiocarbon dates on shell from the grave of KS5 of $13,000 \pm 280$ (ANU-1236) and on bone apatite from KS9 of 9590 ± 130 (ANU-532) place this population in the terminal Pleistocene.

Morphological and metrical comparisons of the Kow Swamp crania have distinguished them from modern Aboriginal crania (Thorne 1976;

Pietruszewsky 1979; Brown 1987a) and a more gracile group of Pleistocene crania represented by LMI, LMIII and Keilor (Thorne 1977; Thorne and Wilson 1977). Thorne and Wilson (1977:399) argue that the Kow Swamp morphological patterns provides 'strong evidence that major morphological changes have occurred in the facial and frontal regions of Aboriginal crania from northern Victoria over the last 9000-10,000 years'. Interpretations of the significance of this Kow Swamp 'morphological pattern' are complicated by the presence of artificially deformed crania in this sample, as there are also at Coobool Creek (Brown 1981a, 1982, 1987a).

Despite extensive reconstruction, the Kow Swamp material is still extremely fragmentary, with only two of the crania, KS1 and 5, being relatively complete. Preservation is particularly poor for the basicranial areas and post-depositional warping is a problem with KS1 and 14. In my PhD thesis (Brown 1982), rather than remeasuring the skeletal material from this site, I relied on data used by Thorne (1975, 1976) for his original description. In the intervening period I have examined most of the skeletal material from Kow Swamp and recorded my own observations. When comparing the Kow Swamp data used in this analysis (Table 9) with those published by Thorne (1976:Table 4) a number of inconsistencies are apparent. Some of the differences between the two data sets are of a considerable magnitude and would certainly influence the results of statistical procedures. Therefore, in order to ensure consistency with the other materials in this analysis, I have used my own data. The Kow Swamp sample comprises KS1, 2, 3, 4, 5, 7, 8, 9, 14, 15 and 16.

Lake Nitchie (LN)

This unique burial was discovered by Jim Bowler on the northeastern shore of Lake Nitchie in 1969 (Fig.2) and excavated by N.W.G. Macintosh and K.N. Smith in 1970 (Macintosh *et al.* 1970). The Lake Nitchie skeleton, and associated pierced *Sarcophilus harrisi* canine tooth necklace, were described in some detail by Macintosh (1971), who reports a bone collagen date of 6820 ± 200 for the right femur. On the basis of overall size and dimensions of the fronto-facial skeleton Thorne (1977) and Thorne and Wilson (1977) place Lake Nitchie with the 'robust' group of prehistoric Australian crania (Kow Swamp, Mossgiel and Cohuna). This assessment is not supported by the more recent research of Habgood (1986) and Brown (1987a).

Lake Mungo (LM)

Fragmentary skeletal remains of over 40 individuals have been recovered from the Willandra Lakes region. However, only three of these (LMI, II and III) are presently available for study, with LMII consisting only of fragments. The calcrete block containing the LMI cremation was discovered in 1968, by Jim Bowler, deflating out of the Mungo unit at the southern end of 'the Walls of China' lunette, Lake Mungo (Bowler *et al.* 1970). Radiocarbon dating of bone fragments from the burial obtained an age of $19,030 \pm 1410$ years (ANU-618A) on bone apatite and $24,700 \pm 1270$ (ANU-618B) on the collagen fraction. A further date of $26,250 \pm 1120$ (ANU-375B) was achieved with charcoal from a hearth, stratigraphically equivalent to 15 cm above the burial (Bowler *et al.* 1972). It was considered that the most reliable estimate for the age of LMI was 24,500-26,500 years BP. This remains the oldest, positively dated, human burial in Australia.

Reconstruction and description of LMI was undertaken by Alan Thorne. However, only limited detailed information has been published (Bowler *et al.* 1970; Thorne 1971, 1976, 1977; Brown 1987a). Preservation of the cranium is poor, with the basicranial area intact but disarticulated from the vault, and a partial and fragmentary facial skeleton, dentition and mandible.

The LMIII skeleton was also discovered by Jim Bowler. In February 1974, after prolonged rain in 1973, Bowler noticed the exposed left side of a carbonate encrusted human cranium 500 m east of the LMI cremation site. Later that month, the extended burial that was LMIII was excavated by a team from the Australian National University (Bowler and Thorne 1976). Stratigraphic association with LMI suggested to Bowler and Thorne (1976:136-38) that an age of 28,000-32,000 years BP was probable for LMIII. Although the cranial morphology of LMIII has been used to provide evidence for the dihybrid origin of the Australian Aboriginal population (Thorne 1977; Freedman and Lofgren 1983), a description of this individual has yet to be published. As little of the basicranium, right side of the cranial vault and facial skeleton are preserved, detailed comparisons involving this individual are difficult (Brown 1987a).

Mossgiel (M)

A detailed description of the Mossgiel skeleton has recently been published by Freedman (1986), which also reviews the history and dating of the specimen. The Mossgiel skeleton was discovered in 1960, by Mr K.

Stewart, on Tumbridge Station, 24 km west of Mossgiel in western New South Wales (Fig.2). Preliminary descriptions of the Mossgiel skeleton were made by Macintosh (1963, 1967). Attempts made by Macintosh to obtain a radiocarbon date on bone collagen from the Mossgiel skeleton were unsuccessful. Dating of bone carbonate gave what Macintosh (1967) believed was a minimum age of 6010 ± 125 years BP.

The Mossgiel skeleton is approximately 60% complete, with most of the long bones having damaged articular surfaces; the basal area of the cranium is absent and the facial skeleton fragmentary. The maxillary and mandibular dentitions have suffered from the combined effects of acute wear and postmortem damage.

Murray Valley (MV)

Between 1937 and 1950 G.M. Black dug up a large series of Aboriginal skeletons from the area between Chowilla and Barham in the Murray Valley (Sunderland and Ray 1959). This material forms two separate collections in the National Museum of Australia, Canberra, and the Anatomy Department of the University of Melbourne (presently located in the Museum of Victoria). Only in the Anatomy Department Murray Black Collection can the postcranial and cranial elements of particular individuals be compared. The Canberra Murray Black Collection is subdivided into boxes of individual skeletal elements (left femora, right humeri, and so forth) which cannot be rearticulated. The Murray Valley series used in this analysis was drawn from the Anatomy Department collection so that the postcranial skeletons could be used to explore aspects of skeletal allometry and help validate cranial sexing methods.

The sample used here consists of 100 adult skeletons collected in the period 1943-50 from the area between Chowilla and Coobool in the Murray Valley (Sunderland and Ray 1959; Brown 1981a). Although there are more than 500 skeletons in the Anatomy Department collection, many are fragmentary and the crania often have poor preservation of the facial skeleton, dentition and mandible. The major criteria for selection were preservation, particularly of the cranial vault, dentition and pelvis. In addition, 60 crania and mandibles from Euston, in the Canberra Murray Black Collection, were used for direct comparison of continuous morphological features with the Coobool Creek series. No stratigraphical, chronological, archaeological or even precise geographical information is recorded for either of the Murray Black Collections. Morphological and metrical com-

parisons with the dated cranial series from Kow Swamp, Barham and Roonka suggests that the Murray Valley material can be considered to be broadly recent, 4000-100 years BP. Pietruszewsky's (1979) multivariate analysis of Aboriginal crania clustered the Murray Valley crania with recent material from Broadbeach, Roonka and Swanport. However, the lack of temporal control in the Murray Valley series remains a possible source of error.

Nacurrie (N)

A number of highly mineralised and carbonate encrusted skeletons were excavated by George Murray Black from a site near Nacurrie railway siding, approximately 35 km northeast of Swan Hill (Fig.1), in the winter of 1949 (pers. comm. from the late Professor L.J. Ray). These were taken to Melbourne and stored with the remainder of the Murray Black Collection in the Department of Anatomy, University of Melbourne. In February 1971 Professor Ray, former Head of the Department of Anatomy, sent the most complete of the skeletons from this site to Professor N.W.G. Macintosh for cleaning, reconstruction and analysis (information supplied by Mrs A. Macintosh). Macintosh and Larnach (1976:117) briefly refer to this individual as the 'Murrabbit skull' and remark that it 'is almost an identical twin to Cohuna. Its frontal curvature index is very nearly identical. It has a massive mandible'. After Macintosh's death in 1977 the Nacurrie 49.85 skeleton (N1) was returned to Melbourne.

In 1980 Professor Ray and I discussed the Nacurrie material with the aim of bringing Macintosh's work to fruition. This project, in turn, was not completed. Professor Ray's unexpected illness and death in 1981, and my wish to complete the analysis of the Coobool Creek skeletons before beginning a new project, intervened. It was not until 1983 that I was able to continue work on the Nacurrie material. Unfortunately, removal of the carbonate crust from the cranial vault, facial skeleton and mandible of the original specimen, N1, had not been conducted with adequate care. Abrasive tools had reduced the teeth to amorphous blocks of dentine and there was considerable loss of surface detail in the cranial and postcranial material.

The other skeletons from this site, consisting of a cranial vault without a facial skeleton, a complete postcranial skeleton and a cranium with associated mandible, cervical vertebrae and clavicle fragment, remained as they were found. With the exception of the postcranial skeleton, these were cleaned and reconstructed at the

University of New England.

Macintosh attempted to obtain radiocarbon dates for N1 through the New Zealand Institute of Nuclear Sciences in 1971. Dating of secondary carbonates, removed from the external surface of the cranial vault, suggested that N1 was somewhat younger than Keilor. In 1976, a cast was made of one femur so that the original could be used to obtain a radiocarbon date from the bone collagen fraction. This project was not completed.

Roonka (R)

The Roonka site is located on the Murray River, approximately 5 km south of Blanchetown in South Australia (Fig.2). Pretty (1977) has published a preliminary description of the stratigraphy of the site and artifactual assemblage with a brief description of the burials. Skeletal remains of more than 120 individuals have been recovered from Trench A, with radiocarbon dates indicating a sequence from at least 7000 years until the European contact period. The initial reconstruction and description of the material was undertaken by Prokopec (1979), and Pietruszewsky (1984) includes some of the Roonka crania in his multivariate comparison of Australasian and Pacific populations. Most recently, Smith *et al.* (1988) have described the morphological and metrical characteristics of the Roonka dentitions.

Unfortunately, much of the skeletal material from Roonka is poorly preserved with considerable post-depositional warping and erosion. Extensive reconstruction was often required and few of the crania are now suited for metrical analysis. Only eight male crania (R6, 37, 48, 66, 89, 91, 104 and 106), which on the basis of Pretty (1977) can be assigned to Phase II of the site (4000-7000 years BP), will be included in this analysis. They will be used to provide tooth-size data and some morphological information.

Swanport (S)

The large skeletal series from Swanport were collected primarily by F.R. Zeitz from a site 10 km southeast of Murray Bridge, South Australia, in 1911 (Fig.2). Stirling (1911) briefly described the stratigraphy of the site and argued, primarily on the basis of local oral history, that the burials overlapped the European contact period. The Swanport skeletons, although undated, are generally accepted as representing a recent population (Howells 1976a; Giles 1976; Pietruszewsky 1979; Brown 1987a). Pretty (1977) draws attention to the parallels between the recent material from Roonka and that from

Swanport, both in terms of artifact assemblage and form of the burials.

The cranial remains of approximately 90 individuals were recovered from the initial excavation, 11 with associated postcranial skeletons, and lodged in the South Australian Museum, with another 40 being collected from the general area after 1911. Forty-eight crania with well preserved, facial skeletons, cranial vaults, dentitions and mandibles were selected for this analysis.

Talgai (T)

The classic Australian fossil, Talgai, was discovered in 1884 on the Darling Downs, near Warwick in southern Queensland (Fig.2). After its purchase by the University of Sydney it was described by Stewart Smith (1918). Although crushed, distorted and covered with a layer of carbonate crust, Smith was able to conclude that Talgai was a juvenile male of 14-16 years. Features indicative of sex were large overall size, especially for the teeth and palate, and the morphology of the vault. Smith argued that although Talgai was undoubtedly of Australian type, palate shape and the size and morphology of the canine teeth were archaic and 'ape-like'. The subsequent reconstruction of the palate by Helman (1934) and description of the dentition by Macintosh (1952a) challenged Smith's observations. Talgai was now placed within the Australian range of variation, although the size of the palate and canine teeth were considered extraordinary.

There are no radiometric dates directly associated with the Talgai cranium although efforts have been made to date the soil horizon from which it supposedly originated. Oakley *et al.* (1975) report a date of $11,650 \pm 100$ years BP for this horizon. An attempt to clean and reconstruct the cranium by Macintosh was unsuccessful and this individual is now represented by disarticulated and eroded fragments.

METHODS

The metrical variables

Several factors influenced the selection of the metric variables for this study. Principal among these was the need for a detailed description of the Coobool Creek crania, mandibles and dentitions and comparison with terminal Pleistocene and Holocene collections. In particular, the Kow Swamp material is fragmentary, with poor preservation of the basioccipital area. In order to adequately compare skeletal material in varying states of preservation, an extensive list of

craniometric variables was chosen. As arguments bearing on the absolute age of the Coobool Creek skeletal material rest largely on comparisons with the dated Kow Swamp material, a number of variables was selected specifically for this purpose.

The list of variables was also expanded during the course of the project to allow the examination of morphological questions arising out of the ongoing analysis. Most significant among these was the issue of artificial cranial deformation which required a more detailed examination of cranial curvature and breadth. The gradual expansion of the variable list, and changes in emphasis during the course of the project, largely brought about by the reconstruction of the Coobool Creek series, has resulted in the complete variable list being recorded for only four of the major samples (Coobool Creek, Kow Swamp, Murray Valley and Swanport). The Broadbeach skeletons were examined prior to the reconstruction of the Coobool Creek sample; due to preparations being made for the reburial of the Broadbeach collection it has not been possible to reexamine them. Therefore, the Broadbeach series is represented by a shortened variable list.

The craniometric variables used in this analysis were recorded directly from the crania and mandibles using standardised equipment (GPM-brand sliding, spreading and coordinate calipers, mandibulometer and anthropometric tape). All linear dimensions on crania and mandibles were recorded to the nearest millimetre. Cranial-vault thickness was recorded to the nearest 0.1 mm using a pair of specially modified vernier calipers (Brown 1987a, 1987b). Dental buccolingual breadths were also measured to the nearest 0.1 mm using a modified Mitutoyou dial caliper with fine, sharpened beaks.

For all the claims of anthropometrics as an objective science a survey of the descriptive literature on anthropometric methodology (Martin and Saller 1957; Stewart 1947; Montagu 1960; Comas 1960; Krogman 1962) reveals alarming conflicts in descriptions of 'standard' anthropometric points. As data which is incapable of reproduction by others has little, if any, value this presents an ongoing obstacle to comparative research. A detailed description (in German) of the full range of anatomical points and features used in osteological research can be found in Martin and Saller (1957). In the selection of the mandibular variables I was influenced by the observations of Freedman and Wood (1977) and they provide detailed descriptions of the majority of the mandibular variables used in

this analysis. The location of the points from which cranial-vault thickness dimensions were recorded follows those in Brown (1987a, 1987b). The variable descriptions which I have used do not represent a consensus of those in the published literature, but simply correspond to points defining measurements used in this analysis. Where I have used a point which does not correspond exactly to one in the literature, it is not referenced. The definition in this instance is my own. The following variable descriptions, and Figures 3-6, define the location of the anatomical points used in the analysis, as well as presenting the formulae for the modules and indices used in the text.

- Alveolar breadth:** biectomolare (Larnach and Macintosh 1966:73).
- Alveolar length:** distance from alveolon to prosthion (Larnach and Macintosh 1966:73).
- Alveolon:** the middle of a transverse line connecting the posterior extremities of the maxillary alveolar border (Martin and Saller 1957:451).
- Asterion:** junction of the temporoparietal with the lambdoid suture (Fig.3) (Martin and Saller 1957:447).
- Auriculare:** the most lateral point on the root of the zygoma vertically above the centre of the auditory meatus (Fig.3) (Martin and Saller 1957:447).
- Basion:** the lowest median point on the anterior border of the *foramen magnum* (Fig.3) (Martin and Saller 1957:446).
- Bicondylar breadth (mandible):** the distance between the most lateral points on the two mandibular condyles (Fig.6) (Stewart 1947:196).
- Bigonial breadth:** the maximum diameter externally on the angles of the mandible (Fig.6) (Stewart 1947:153).
- Bregma:** the point of intersection of the coronal and sagittal sutures (Figs 3-4) (Martin and Saller 1957:444).
- Corpus thickness:** maximum thickness of the mandibular corpus at the level of M1-M2 (Fig 6).
- Corpus height:** height of the mandibular corpus interproximally between M1-M2 (Fig.5).
- Cranial module:** glabella-opisthocranion + basion-bregma + maximum cranial breadth/3.
- Dacryon:** point marking junction of sutures between lacrimal, maxillary and frontal bones (Figs 3-4) (Krogman 1962:317).
- Frontal curvature index:** frontal subtense (metopion) height \times 100/nasion-bregma chord (Larnach and Macintosh 1966:17).
- Ectoconchion:** the point on the lateral margin of the orbit marking the greatest breadth (Fig.4) (Krogman 1962:316).
- Ectomolare:** the most lateral point on the outer surface of the alveolar ridge, opposite the centre of the second maxillary molar (Martin and Saller 1957:451).
- Glabella:** in the Frankfurt horizontal plane, glabella is the most anterior midline point on the frontal bone (Figs 3-4) (Martin and Saller 1957:442).
- Gnathic index:** basion-prosthion \times 100/basion-nasion (Krogman 1962:320).
- Gnathion:** the lowest, midline point on the inferior border of the mandibular symphysis (Martin and Saller 1957:452).
- Infradentale:** the most anterosuperior point on the alveolar margin between the mandibular central incisors (Martin and Saller 1957:452).
- Inion:** the point where the superior nuchal lines meet at the midline.
- Lambda:** intersection of the sagittal and lambdoid suture (Fig.3) (Martin and Saller 1957:444).
- M2 arch breadth:** measured externally with the tips of the calipers placed on the cemento-enamel junction, above the anterior root, of the second mandibular molars.
- Mandibular length:** using a mandibulometer this is the maximum length of the mandible, when in a resting position, from the most anterior point on the symphysis to the most posterior point on both condyles (Fig.5) (Larnach and Macintosh 1971:28).
- Mastoideale:** the lowest point on the mastoid process (Fig.3) (Martin and Saller 1957:448).
- Mastoid depth:** this measurement called mastoid length by Larnach and Macintosh, was taken from the Frankfurt line vertically downwards to the tip of the mastoid process (Larnach and Macintosh 1966:43).
- Maximum supraorbital breadth:** the maximum supraorbital diameter of the frontal bone wherever found. In Aboriginal crania the most lateral points are generally located on the zygomatic trigones, although in some female crania the most lateral points may be on the fronto-malar suture (Larnach and Macintosh 1970:12).

- Maximum ramus breadth:** 'distance from the most prominent point on the anterior border of the coronoid process to the farthest point on the posterior border of the bone. The measurement is obtained by applying one of the branches of the sliding caliper tangentially to the posterior border of the mandible, and bringing the other branch in contact with the anterior border of the coronoid process' (Fig.5) (Stewart 1947:197).
- Metopion:** point in the median sagittal plane where frontal bone elevation above the nasion-bregma chord is at a maximum (Martin and Saller 1957:444).
- Minimum ramus breadth:** the smallest antero-posterior diameter of the ramus (Fig.5) (Stewart 1947:154).
- Nasal breadth:** the maximum breadth of the nasal aperture, between the anterior surfaces of its lateral margins (Comas 1960:404).
- Nasal index:** nasal breadth \times 100/nasal height (nasion-nasospinale) (Bass 1971:68-69).
- Nasion:** the midline point at which the internasal suture meets the fronto-nasal suture (Figs 3-4) (Martin and Saller 1957:448).
- Nasospinale:** the point at which a line tangent to the lower margins of the nasal aperture is intersected by the midsagittal plane (Figs 3-4) (Montagu 1960:48).
- Occipital curvature index:** occipital subtense height \times 100/lambda-inion chord (Brown 1981b).
- Occipital subtense height:** point in the median sagittal plane where occipital bone elevation above the lambda-opisthion chord is at a maximum (Fig.3).
- Opisthion:** the midpoint of the posterior border of the *foramen magnum* (Fig.3) (Stewart 1947:136).
- Opisthocranium:** the most distant (posterior) point on the cranium from glabella in the midsagittal plane, excluding the external occipital protuberance (Fig.3) (Comas 1960:398).
- Orbital breadth:** distance between ectoconchion and dacryon (Comas 1960:404).
- Orbital index:** orbital height \times 100/orbital breadth (maxillofrontale-ectoconchion) (Bass 1971:69).
- Orbitale:** the lowest point on the inferior border of the orbit (Figs 3-4).
- Orbital height:** the maximum internal height of the orbit perpendicular to its breadth (Comas 1960:404).
- Palate module:** maximum alveolar length \times maximum alveolar breadth/100 (Larnach and Macintosh 1966:73).
- Parietal curvature index:** parietal subtense height \times 100/lambda-bregma chord (Larnach 1974:215).
- Parietal subtense height:** point where parietal bone elevation above the bregma-lambda chord is at a maximum (Fig.3) (Larnach 1974:215).
- Postorbital breadth:** the minimum postorbital breadth of the frontal bone. This measurement corresponds with Martin and Saller's measurement number 9 (Martin and Saller 1957:449).
- Prosthion:** the most anteroinferior point on the maxilla between the maxillary central incisors, (Figs 3-4) (Martin and Saller 1957:449).
- Ramus height:** the vertical height of the condyle above the standard horizontal plane, measured with a mandibulometer (Fig.5) (Martin and Saller 1957:482).
- Sigmoid notch depth:** maximum depth of the sigmoid notch measured vertically from the tangent for the uppermost points on the condyle and the coronoid process (Fig.5) (Larnach and Macintosh 1971:21).
- Sphenion:** junction of the coronal suture with the sphenoid bone (Fig.3) (Martin and Saller 1957:447).
- Spheno-basion:** midsagittal point on the spheno-occipital synchondrosis (Martin and Saller 1957:446).
- Staphylion:** the point where a line tangent to the most anterior border of the posterior margins of the palatine bones crosses the midline (Martin and Saller 1957:450).
- Stenion:** medial point on the spheno-squamosal suture (Martin and Saller 1957:448).
- Stephanion:** point where the superior temporal line crosses the coronal suture (Fig.3) (Martin and Saller 1957:447).
- Symphyseal thickness:** the maximum antero-posterior dimension of the mandibular symphysis taken at a right angle to the symphyseal height dimension (Fig.6).
- Symphyseal height:** height of the mandibular symphysis measured from its lowest median point (gnathion) to the tip of the alveolar process between the medial incisors (infradentale) (Fig.5) (Stewart 1947:151).

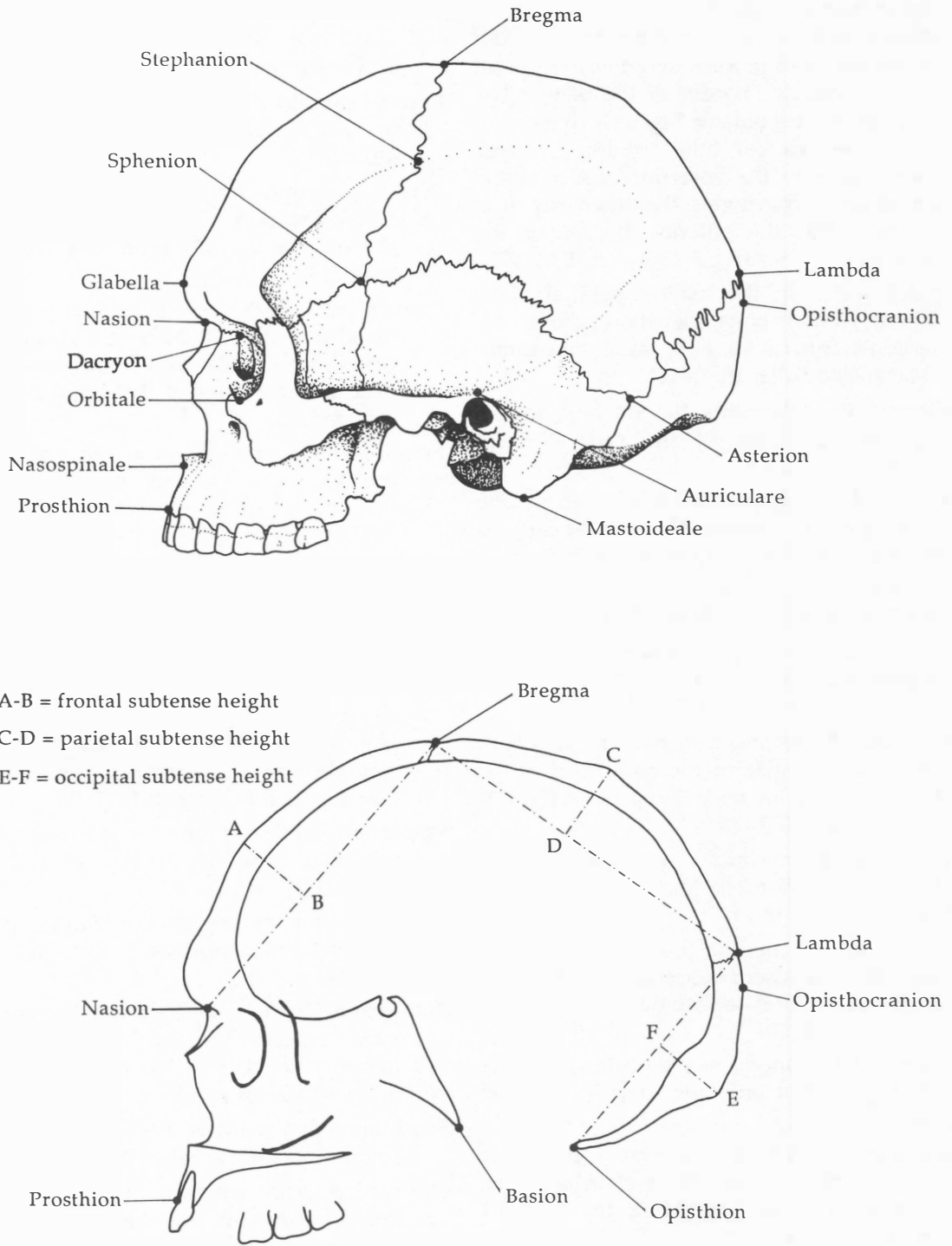


Figure 3 Lateral and cross-sectional views of a cranium showing the location of major craniometric points used in this analysis

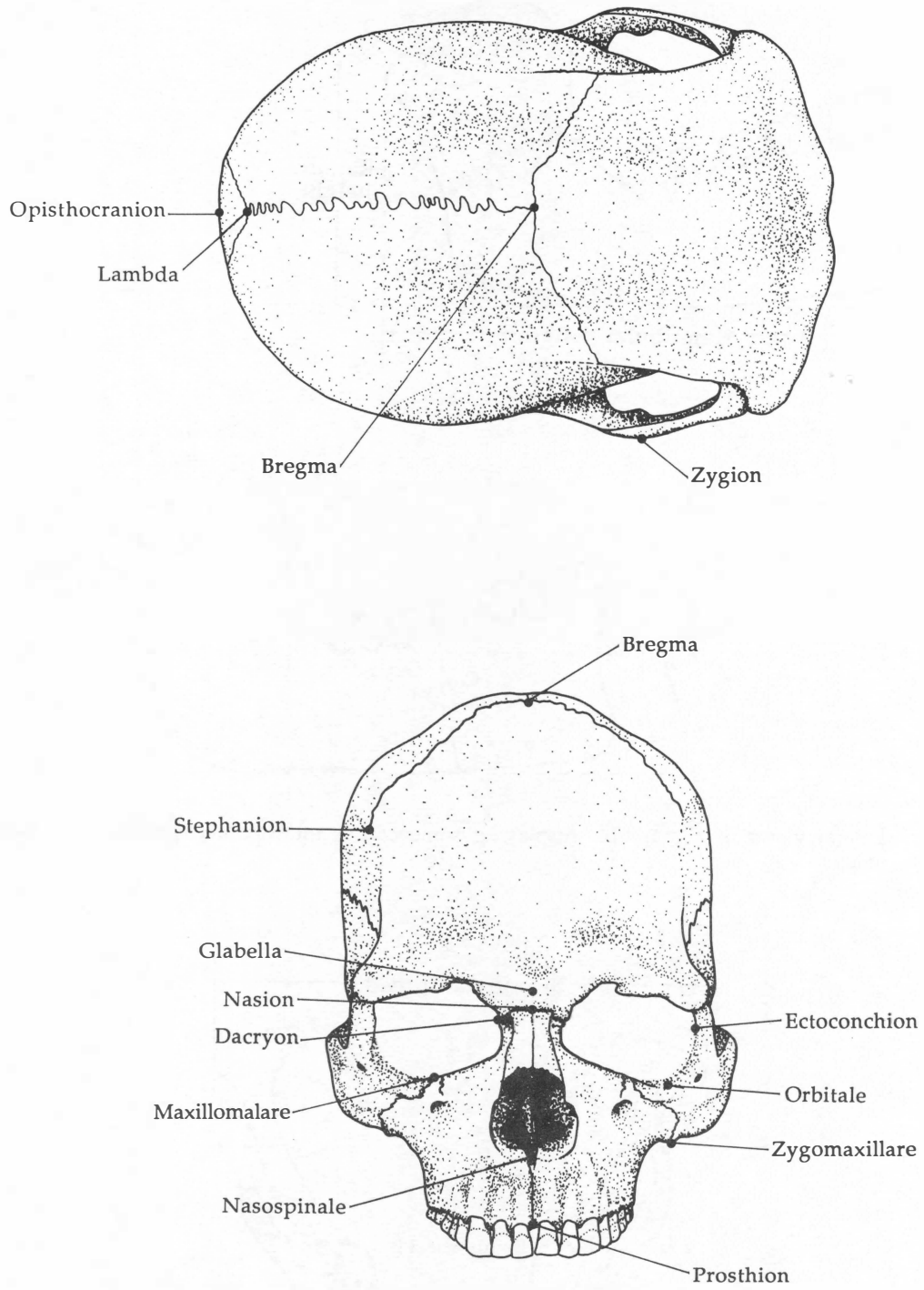


Figure 4 Superior and facial views of a cranium showing the location of major craniometric points used in this analysis

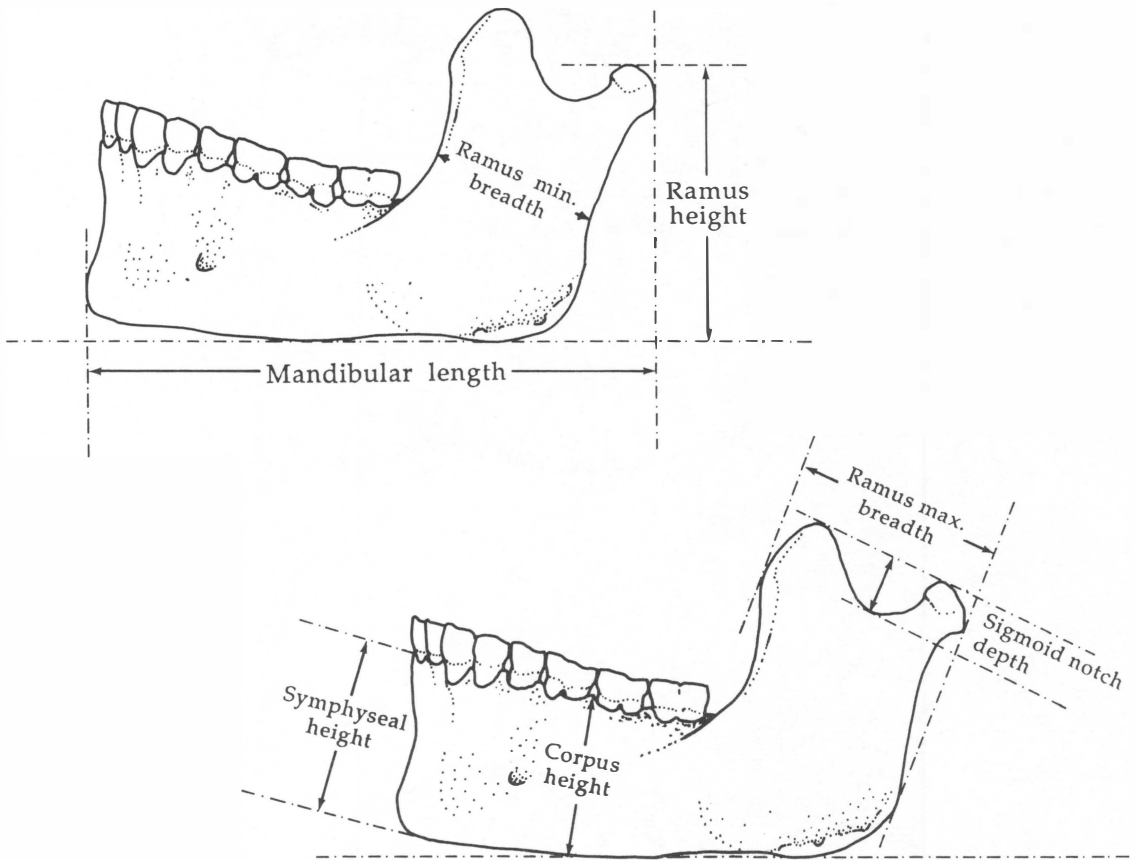


Figure 5 Lateral views of a mandible displaying some of the anthropometric dimensions used in this analysis

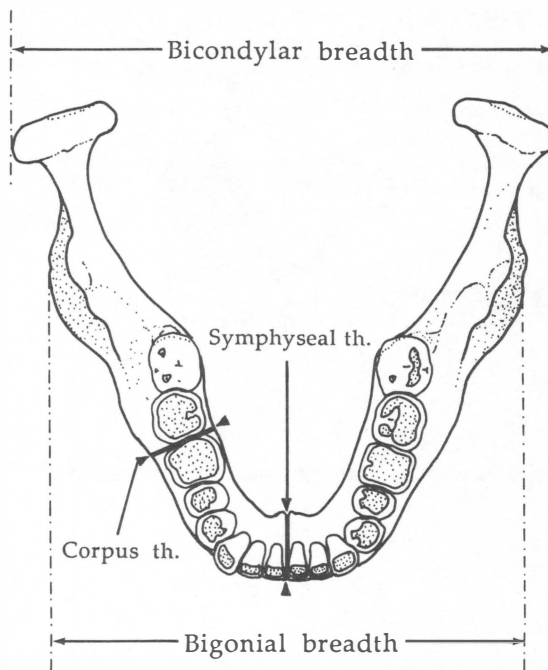


Figure 6 Superior view of a mandible displaying some of the anthropometric dimensions used in this analysis

Tooth breadth (buccolingual crown diameter): the greatest distance between the labial or buccal surface and the lingual surface of the tooth crown measured at right angles to the mesiodistal crown diameter of the tooth (Townsend and Brown 1979b:20).

Tooth length (mesiodistal crown diameter): the greatest distance between the approximate surfaces of the tooth crown measured with a sliding caliper held parallel to the occlusal and vestibular surfaces of the crown (Townsend and Brown 1979b:19).

Upper facial index: zygion-zygion x 100/nasion-prosthion (Krogman 1962:320).

Zygion: the most lateral point on the zygomatic arch (Fig.4) (Martin and Saller 1957:450).

Zygomaxillare: the lowest point externally on the zygomaxillary suture (Fig.4) (Martin and Saller 1957:450).

STATISTICAL PROCEDURES

All of those data used in Brown (1982) were examined for error prior to their use in this analysis and each of the statistics recalculated. Emphasis was placed on exploratory statistical techniques (Tukey 1977; Hoaglin *et al.* 1983) and procedures which produce the most informative and robust results from small samples (<50). Descriptive statistics (mean, standard deviation, standard error of estimate and coefficient of variation) were calculated using standard formulae. Graphical comparisons of the distributions of data from different samples (batches) were made using the Box plots developed by Tukey (1977) (Fig.7). Box plots provide a visual impression of the location, spread, skewness, tail length and outlying data points in a batch of data (Emerson and Strenio 1983). Within the box plot

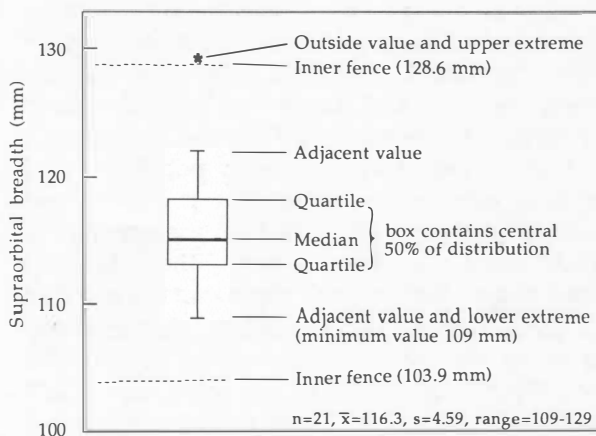


Figure 7 Box plot for supraorbital breadth in Coobool Creek males with associated nomenclature

there are boundaries (fences) beyond which the occurrence of scores could be considered unusual. For normally distributed data the 'hinge spread' will be $2 \times 0.674s = 1.348s$ and the box will locate the middle 50% of the data. The location of the median within the box provides some indication of symmetry. The 'inner fences' in normally distributed data are $4.674s$ from the mean and contain 99% of the distribution (Leinhardt and Wasserman 1979). The lines extending from the box locate the scores closest to, but inside the two inner fences and in most instances these indicate the position of the maximum and minimum values. Points outside the inner fence (less than 1% of the distribution) are termed 'outside values' and are highlighted in the display (*).

Student's *t* test is used to assess the significance of differences in the sample means. This test assumes that variables are normally distributed and there is equality of variance between the groups. Suitable tests for departure from the normal distribution in samples >50 are provided by the χ^2 goodness of fit, skew ($\sqrt{b^1}$), kurtosis (b^2) and a variety of non-parametric methods. For samples smaller than 50 there is a loss of sensitivity, particularly in $\sqrt{b^1}$ and b^2 due to the necessity of grouping together small tail frequencies when applying the test. A more powerful test for normality in small samples is the analysis of variance test developed by Shapiro and Wilk (1965) and this test will be employed here. Percentage points of the W distribution are given in Table 16 of Pearson and Hartley (1972). Distributions were also examined by plotting the values of a variable against corresponding percentage points of a standard normal variable (Gnanadesikan 1977). The Shapiro-Wilk statistic is calculated using the following formula:

Order observations $y_1 \leq y_2 \leq \dots \leq y_n$

$$S^2 = \sum_{i=1}^n (y_i - \bar{y})^2 = \sum_{i=1}^n (x_i - \bar{x})^2$$

$$b = \sum_{i=1}^k a_{n-i+1} (y_{n-i+1} - y_i)$$

$$W = b^2 / S^2$$

This procedure is illustrated in Figure 8. In this figure, data from two variables, one of which the W statistic indicated was approximately normally distributed and the other with a significant departure from normality, are plotted using histograms and normal probability plots. The histograms have normal curves calculated from

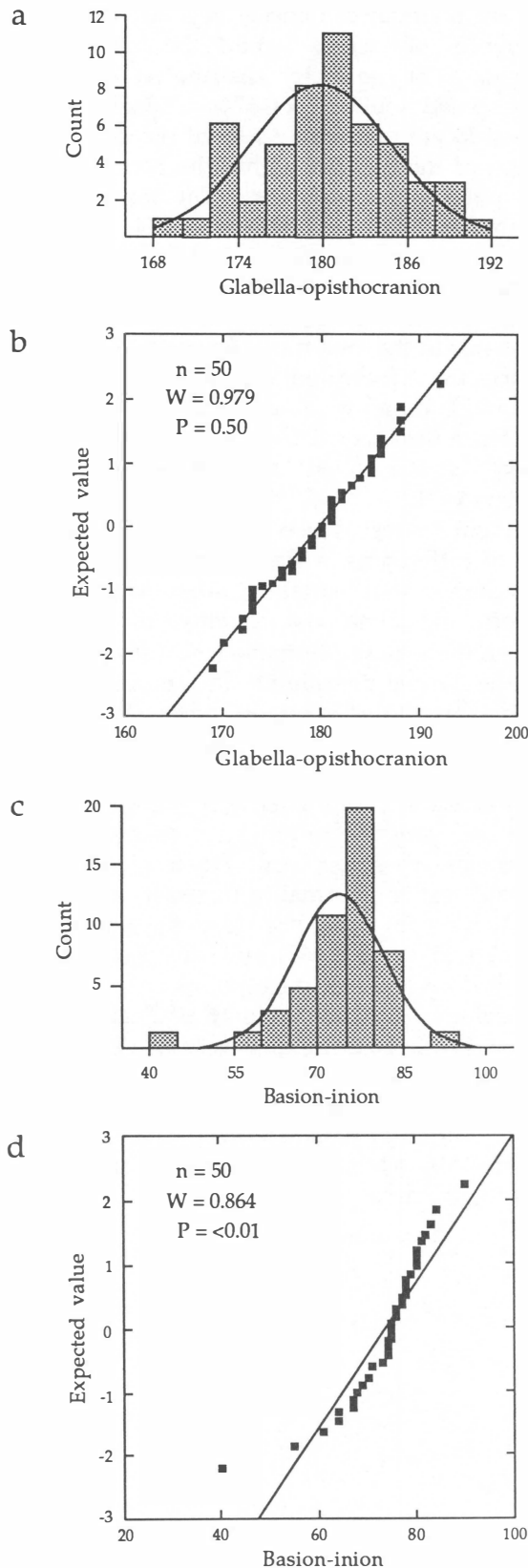


Figure 8

Histograms and normal probability plots of the distribution of glabella-opisthocranion and basion-inion in the Murray Valley female sample indicating the sensitivity of the Shapiro-Wilk statistic (W)

the sample means and standard deviations superimposed over them. Glabella-opisthocranion (Fig.8a) has a reasonably normal distribution while basion-inion (Fig.8c) has a right skew, kurtosis and long tails (outliers). Normal probability plots of these data show the points in glabella-opisthocranion (Fig.8b) corresponding with the straight line of a normal distribution. However, in Figure 8d the curvature at the ends of the plot indicates the length of the tails and the curvature in the middle an asymmetric distribution.

Homogeneity of variance was examined using the χ^2 test developed by Bartlett (1937). In instances where sample sizes are less than 10, Box's small sample F approximation was used for the probability value rather than Bartlett's usual χ^2 (Dixon and Massey 1969). Some caution is needed in applying Bartlett's test as it is sensitive to non-normality in data, particularly to kurtosis. With long-tailed distributions the test gives too many erroneous verdicts of heterogeneity (Snedecor and Cochran 1969). Where a statistically significant difference in variance is indicated by χ^2 , Student's t is calculated using the formula based on separate variance estimates. Bartlett's test is calculated using the following formula:

$$M = (2.3026) \left[(\sum f_i) \log s^2 - \sum f_i \log s_i^2 \right] \quad (s^2 = \sum f_i s_i^2 / \sum f_i)$$

$$C = 1 + \frac{1}{3(a-1)} \left[\sum \frac{1}{f_i} - \frac{1}{\sum f_i} \right]$$

$$\chi^2 = M/C \text{ with } (a - 1) \text{ degrees of freedom}$$

The association between pairs of variables was explored using Pearson's correlation coefficient, scatterplots and least-squares regression. To maximise the size of the samples, correlation coefficient matrices were calculated using the method of pairwise deletion. Where data sets are incomplete, this procedure has the disadvantage of possibly utilising a different subset of cases for each correlation. Sample sizes, significance levels, linearity and dispersion were examined for each of the correlations discussed in the text.

Multivariate comparisons, by population and by sex, were made using linear discriminant function analysis. The statistical assumptions of discriminant analysis, and the methods employed to comply with them, are discussed in the section on sex determination. Statistical calculations were performed using the SPSS* (SPSS Inc. 1986) and SYSTAT 3.1 (Wilkinson 1987) packages. Shapiro-Wilk statistics were calculated using a program (SHPWLK) written by Yvonne Pittelkow of the Coombs Computing Unit, Australian National University.

SEX DETERMINATION

The high degree of regional and sex-based variation in Aboriginal crania makes the accurate determination of sex crucial for interpopulation comparisons and analyses of temporal change. However, until comparatively recently, sex determination of isolated Aboriginal crania was a matter of individual experience and judgement (Klaatsch 1908; Hrdlička 1928; Fenner 1939). There were pitifully few crania in which the sex could be independently determined through an associated axial skeleton, therefore the accuracy of sex determinations based on isolated crania could not be objectively assessed. This situation was made more difficult by the commonly held belief that 'the considerable sexual differences in the Australian Aborigines makes the sexing of most of the skulls fairly easy' (Fenner 1939:249). As Hrdlička (1928) had previously noted, this initial impression of a clear sex-based bimodality in the distribution of the crania was an artifact of the extremes of variation, male and female. There was in fact a large area of overlap in the distribution of the male and female crania that made determining the sex of some crania extremely difficult.

The development of techniques for sexing isolated human crania, whether based on purely morphological criteria, combined morphological and metrical methods, or multivariate discriminant function analysis, has always involved a persistent 10-20% of crania that remain doubtful (Keen 1950; Giles and Elliot 1963). It is unlikely that any method of sex determination based on isolated bones of the human skeleton, including the pelvis (Washburn 1948), will ever achieve a resolution greater than 85-90%. Indeed Hooton (1943) suggested that even with the whole skeleton, sexing is possible in only 90% of cases. Both in terms of morphology and size, the male and female ranges for most osteological features overlap, producing an interphase zone. In the Aborigine this interphase of male and female osteological features is documented for the cranium (Larnach and Macintosh 1966, 1970; Brown 1973; Margetts and Freedman 1977; Freedman and Wood 1977; Brown 1981a, 1981b, 1987a), mandible (Larnach and Macintosh 1971; Freedman and Wood 1977; Wu and Brown 1986), pelvis (Davivongs 1963a), femur (Davivongs 1963b), clavicle (Ray 1959; van Dongen 1963), humerus and scapula (van Dongen 1963) and dentition (Barrett *et al.* 1964; Townsend and Brown 1979a, 1979b; Brown 1987a).

The first attempt to sex a large series of isolated Aboriginal crania was made by Klaatsch (1908). Working within the limitations of collec-

tions in which few of the crania had associated innominates, Klaatsch noted that 'female' crania could be distinguished by their smaller size, poorly developed muscular prominences, greater prognathism, smaller teeth and jaws, less developed superciliary ridges and more prominent forehead. In 1964 Larnach and Freedman formalised and extended Klaatsch's work with the development of a combined morphological and metrical technique for determining the sex in isolated Aboriginal crania. Since then, Aboriginal crania, with inadequate axial skeletons for independent sex identification, have frequently been sexed by this method (Freedman 1964; Larnach and Macintosh 1966, 1970; Thorne 1976; Wallace and Doran 1976; Margetts and Freedman 1977; Freedman and Lofgren 1979a; Pietrusewsky 1979, 1984; Brown 1987a).

There have always been two major problems associated with the use of the Larnach and Freedman technique. Firstly, although 107 coastal New South Wales crania were used to develop the method, only 18 of these could be independently sexed through an associated axial skeleton. Secondly, there is a large degree of regional variation in Aboriginal crania (Giles 1976; Pietrusewsky 1979, 1984; Brown 1987a), a variation which may influence expression of the morphological and metrical features used in the technique. The importance of regional variation was indicated in my reassessment of the Larnach and Freedman technique with an independently sexed series from the central Murray Valley region (Brown 1981b). With the larger Murray Valley crania the section points for the palate size and mastoid size modules had to be increased, as did the overall male/female section point. It was also clear that the continuous morphological traits (glabella prominence, superciliary ridge development, zygomatic trigone size, malar tuberosity prominence and occipital development) used in the technique were difficult to assess in terms of Larnach and Freedman's developmental categories. This is certainly not an easy technique for the novice to use. With large samples, reproducible results are almost impossible to obtain, even when using extreme care and repeated trials.

An alternative approach to sex determination is the use of linear discriminant functions developed on crania from a known sex population. This method has been used to determine the sex of isolated crania, either from the initial or an adjacent population (Thieme and Schull 1957; Hanihara 1958, 1959; Giles and Elliot 1963; Kajanoja 1966; Henke 1974; Richards 1984; Brown

1987a). Although discriminant functions developed on other populations have been used to sex Australian Aboriginal crania (Larnach and Freedman 1964; Brown 1981b), only recently have they been developed from independently sexed Australian crania (Townsend *et al.* 1982; Brown 1987a). It has been found that while discriminant functions produce accurate results for the population on which they were developed, a reduced level of correct classification can be expected when these functions are applied to different populations (Birkby 1966; Kajanoja 1966; Henke 1974). An additional difficulty concerns the preservation of crania in museum collections, as well as those recovered from archaeological sites. Damage to the facial skeleton, zygomatic arches and basicranium is often present and this limits the number of variables which can be consistently applied to large samples of isolated crania.

For instance Townsend *et al.* (1982) used lateral and frontal standardised roentgenograms, collected as part of a longitudinal growth study of Aborigines living at Yuendumu, to develop 21 discriminant functions for sexing isolated Aboriginal crania. Fourteen of the 21 functions required that bizygomatic breadth be recorded, 13 of the 21 required the use of basion-bregma, and several of the other variables were also associated with anatomical areas which are often not preserved in collections of archaeologi-

cal origin (bigonial breadth, basion-prosthion and ramus height). The application of their Function 8, which uses bizygomatic breadth, glabella-opisthocranion and basion-bregma, illustrates some of the difficulties which may arise from applying discriminant functions to populations other than those on which they were developed and where there is incomplete preservation (Fig.9). This function accurately predicted the sex of 87.5% of a sample of Aboriginal crania from the Murray Valley which could be independently sexed through associated innominates. This is less than the classification accuracy which Townsend *et al.* (1982:Table 4) obtain, 98% on their basic sample and 95% on a control, but still within acceptable limits. Function 8 was then applied to the series from Coobool Creek (Brown 1981b, 1987a). This sample was initially sexed using morphological criteria (Larnach and Freedman 1964; Brown 1981a) into nine females and 21 males. Many of the Coobool Creek crania have damaged zygomatic arches and basi-occipital regions, with only nine being complete enough to apply Function 8. The two morphological females, and five of the six morphological males, obtained discriminant function scores which exceeded the range of similarly sexed Murray Valley crania. Due to their large size, if the morphologically female crania had been sexed by Function 8 alone they would have been classified as male. In order to determine the sex

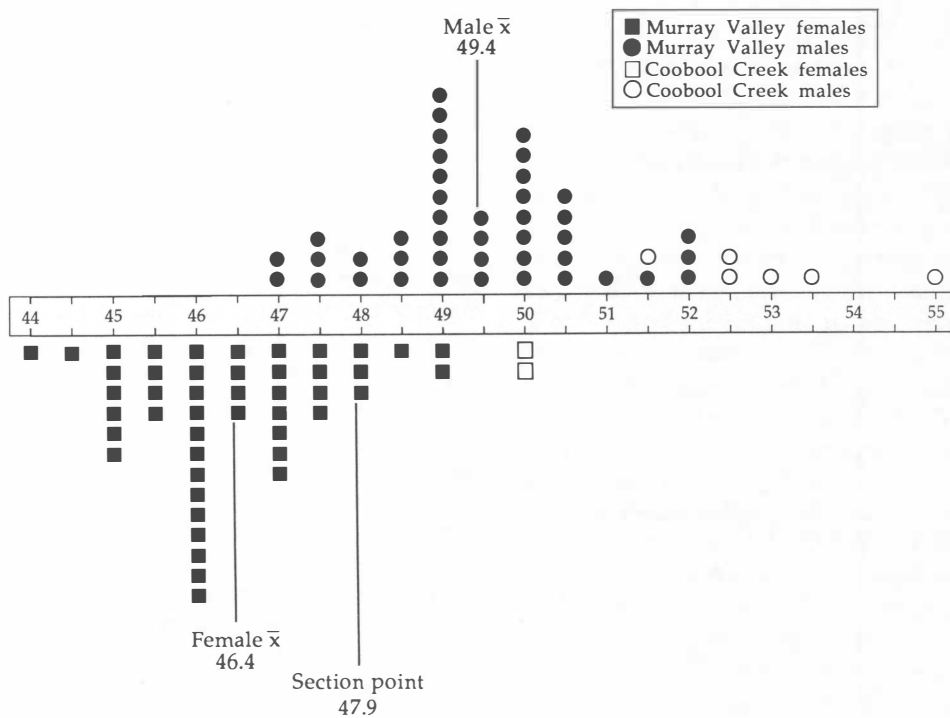


Figure 9 Sex determination of crania from the Murray Valley and Coobool Creek based on Townsend *et al.* (1982) discriminant function 8

of fragmentary cranial material, and assist in sexing the morphologically and metrically distinct terminal Pleistocene crania, a series of discriminant functions were developed from the Murray Valley sample. These discriminant functions were used in tandem with the combined morphological and metrical technique of Larnach and Freedman (1964; Brown 1981a).

Modified Larnach and Freedman technique

One hundred Aboriginal crania with associated postcranial skeletons formed the Murray Valley sample. Sex was determined through an examination of the pelvis and sacrum, as the highest levels of accuracy have been obtained using these (Washburn 1948; Phenice 1969). Emphasis was placed on the size and morphology of the acetabulum and greater sciatic notch, morphology of the pubis and sacroiliac articulation and breadth of the sacrum. Only individuals with clearly male or female innominates were included in the sample (47 males and 53 females).

The Larnach and Freedman technique entails the assessment of five morphological features and the calculation of two modules. For each of these characters three classes are delineated. Class 1 in each case represents the most characteristically female form of the feature, Class 3 the most male, and Class 2 the intermediate group. Each character is scored out of three and a total score, the sum of the seven characters is given out of a possible 21. Larnach and Freedman classed individuals scoring 7-11 as female and those scoring 12-21 as male.

Assessment of the five craniomorphic sexing characters (glabella prominence, superciliary ridge development, zygomatic trigone size, malar tuberosity prominence and the occipital muscle markings) in the Murray Valley sample was based on a set of standard casts of the original specimens that defined the Class 2 limits. These were supplied by the Department of Anatomy, University of Sydney. The dimensions used to determine palate and mastoid size were recorded to the nearest millimetre using the procedure defined by Larnach and Freedman (1964). The raw scores, class percentages, descriptive statistics and tests of significance for these data are presented in Brown (1981a) and will not be discussed in detail here.

The initial application of the Larnach and Freedman technique indicated that 39.6% of the Murray Valley female crania (as sexed on innominates) gained a total sex score higher than the Larnach and Freedman section point of 11

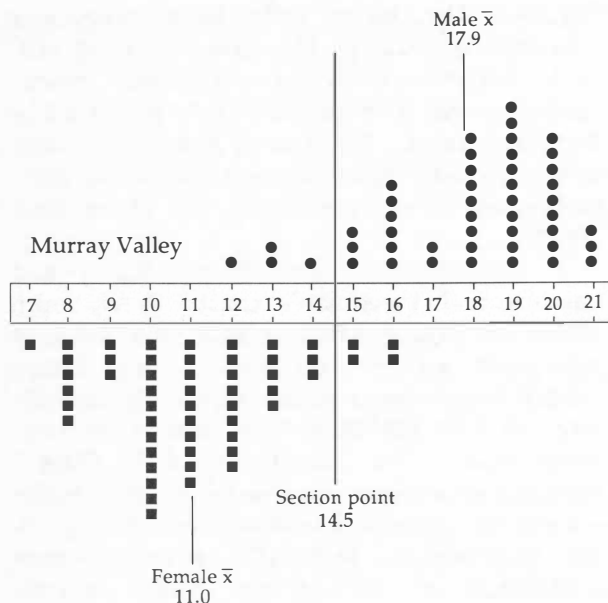


Figure 10a Larnach and Freedman sexing score distribution for Aboriginal crania from the Murray Valley

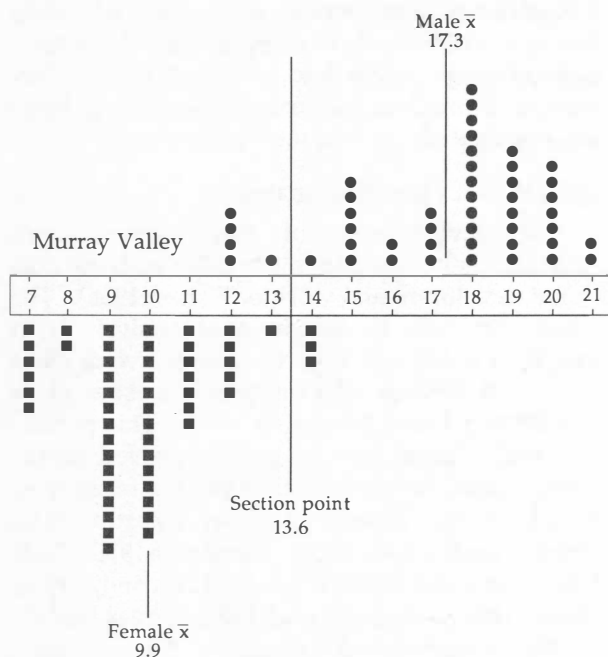


Figure 10b Distribution of the crania in Figure 10a using the recalculated Class 2 limits for palate and mastoid size

(Fig.10a). The Murray Valley female range was 7-16 and males 12-21. The section point of 14.5, calculated from the male and female means, correctly sexed 92.5% of the female and 91.4% of the male crania. There was, however, a large area of overlap (scores 12-16) between the male and female ranges containing 34% of the total crania.

A comparison of the Murray Valley and Larnach and Freedman's coastal New South Wales data indicated that the major discontinuity was palate and mastoid size. Murray Valley palates and mastoid processes are significantly larger ($P = .01-.001$) than those from coastal New South Wales. The recalculation of the Class 2 limits for palate size (increased from 35-39 to 39-42) and mastoid size (increased from 55-80 to 75-105) improved the bimodality of the sex-score distribution in the Murray Valley sample (Fig.10b). The area of overlap between the male and female sex scores (12-14) was reduced and contained only 15% of the total crania. The section point of 13.6 correctly sexed 94.3% of the female and 89.4% of the male crania. Although demonstrating that the Larnach and Freedman technique could accurately sex Aboriginal crania, it is apparent that there is some regional variation in the development of the sexing characters, most notably palate and mastoid size. This remains a problem for material stemming from areas other than the Murray Valley.

Discriminant function analysis

The development of linear discriminant function analysis began in the 1930s with its roots in the developmental work of Fisher (1936). The classic problem in discriminant analysis is to assign an unknown subject to one of two or more groups on the basis of a multivariate observation (Lachenbruch and Goldstein 1979). This predictive and inferential technique has proved particularly useful for determining the sex of isolated bones of the human skeleton (Martin 1936; Thieme and Schull 1957; Hanihara 1958, 1959; Giles and Elliot 1963; Giles 1964; Kajanoja 1966; Henke 1974; Townsend *et al.* 1982; Brown 1987a).

The discriminant function for deciding between alternative hypotheses (populations) on the basis of the observed data is the logarithm of the likelihood ratio for two simple hypotheses given the observation (Welch 1939). This discriminant function provides a sufficient reduction of data for drawing inferences on the two alternative hypotheses (Smith 1947; Rao 1966). The mathematical objective is to weigh and linearly combine the discriminating variables so that the groups are forced to be as statistically

distinct as possible. These discriminant functions are of the form:

$$D_i = d_{i1}z_1 + d_{i2}z_2 + \dots + d_{ip}z_p$$

where D is the score on discriminant function i , the d 's are the weighting coefficients, and the Z 's are the standardised values of the p discriminating variables used in the analysis (Nie *et al.* 1975). The maximum number of functions which can be derived is either one less than the number of groups or equal to the number of discriminating variables. These functions maximise the separation of the groups. A detailed description of the mathematical basis of discriminant analysis can be found in Eisenbeis and Avery (1972) and Goldstein and Dillon (1978), with an excellent summary of recent work in this field in Lachenbruch and Goldstein (1979). As the mathematical basis to discriminant analysis is well established it will not be examined further here.

Of greater importance is an examination of the underlying assumptions of discriminant analysis and multivariate statistics in general (Eisenbeis and Avery 1972; Corruccini 1975; Goldstein and Dillon 1978; Lachenbruch and Goldstein 1979). Linear discriminant analysis assumes that:

1. The initial groups used in developing the rule are correctly classified and that the groups are discrete and identifiable.
2. Large sample size.
3. The observations have a multivariate normal distribution in each population.
4. Equality of variance.
5. Linearity and homogeneity of covariance.

As Corruccini correctly points out, 'the uniformity of input data to these conditions is not commonly documented or defended by researchers in physical anthropology' (1973:744). This is certainly the case with the majority of published accounts of sex determination using discriminant functions (Giles and Elliot 1963; Giles 1964; Kajanoja 1966). As discriminant analysis will be used extensively in this analysis, these assumptions will be examined in detail.

Group classification

The basis for group membership was sex. Each cranium in the Murray Valley sample was originally sexed through its associated pelvis, with only what I considered to be positive males and females included in the analysis. My more recent experience with large-known sex samples of European and southern Chinese skeletons indicates that the overlap in male/female pelvic size and morphology probably resulted in a mis-

classification of 5-10%. As there are no large-known sex samples of Aboriginal skeletons available, this level of misclassification is unavoidable. Even with precise sex identification there remains an overlap in the male and female ranges in terms of cranial size and morphology. However, it is not a prerequisite of discriminant analysis that each group be statistically unique.

A possible source of error is the lack of geographic and temporal control with the Murray Valley material. This was unavoidable. This collection was used precisely because it is the only large, regional series of Aboriginal crania with associated postcranial skeletons available. The only two other populations with associated postcranial skeletons, Roonka and Broadbeach, are poorly preserved and not suitable for this type of analysis. Also, there are only five females in the Broadbeach sample.

Sample size

Formalised statements as to what constitutes a sufficiently large sample for purposes of discriminant analysis are few in the literature. Lachenbruch and Goldstein (1979) note this difficulty and observe as a general 'rule of thumb' that there should be three times as many observations as there are parameters to estimate in each group. This number will decrease for populations which are well separated and increase for those which are close together. Providing that there are no gross distributional irregularities in those data under examination, discriminant analysis does appear to be able to obtain reliable results from quite small samples, <30. In this instance, given the sex-based dimorphism in Aboriginal crania, and the restriction of the discriminant analyses to a maximum of seven variables, a sample size of 100 crania (53 female and 47 male) appears adequate.

Multivariate normalcy

The assumption of multivariate normalcy is central to all multivariate analysis dependent on probability theory (Cooley and Lohnes 1971; Corruccini 1975). In spite of this there appears to be no consensus as to the robustness of multivariate statistics for non-normal distributions. Mardia (1971) and Blackith and Reyment (1971) suggest that distributional irregularities do not adversely influence statistical distances, but Vogt and McPherson (1972) disagree. This situation is complicated by the absence of a recognised test for comparing data with the multivariate normal distribution. Some control on this can be obtained by limiting the number of observations

recorded and by analysing their distribution in univariate space (Sokal and Rohlf 1969). Normal probability plots and the Shapiro-Wilk statistic were used to compare data with a normal distribution.

Homogeneity of covariance

The performance of the linear discriminant function may be affected if the sample covariance matrices are unequal (Lachenbruch and Goldstein 1979). It has been generally assumed in the anthropological literature that the discriminant function is robust to inequalities in covariance (Giles and Elliot 1963; Giles 1964; Kajanoja 1966; Henke 1974). Tests of equality of the covariance matrices are not presented. The reason for this is that tests of dispersion homogeneity are powerful and almost always reject the hypothesis (Cooley and Lohnes 1971). Even with extreme data reduction I have found that with comparisons of human crania it is not always possible to obtain equality of covariance between groups. However, through careful variable selection the sample covariance matrices may be made reasonably similar. It has been demonstrated that the performance of the linear discriminant function is satisfactory if the covariance matrices are not too different (Gilbert 1969; Marks and Dunn 1974).

It should be remembered that irregularities in covariance matrices between populations may be of biological significance. The researcher must choose between satisfying the statistical assumptions of a particular technique and perhaps compromising the biological information that may be recovered from the analysis. In this instance, as I was interested only in classification, particular attention was placed on homogeneity of covariance. A test for homogeneity of covariance, Box's M (Box 1949), and its associated F test were employed.

Variable selection

The aim of the discriminant analysis with the Murray Valley crania was to develop discriminant function coefficients which could be used to sex the Coobool Creek series. Many of the Coobool Creek crania are incomplete, with damage to the zygomatic arches being particularly common. The first step was to select a subset of variables which displayed marked sexual dimorphism, as indicated by Student's *t* test, within the Murray Valley sample. The distribution of each variable was then compared to the normal curve using the Shapiro-Wilk statistic (*W*) and probability plots. Variables displaying a significant deviation from the standard normal

Table 1 Descriptive statistics for variables included in discriminant function analysis of male and female crania from the Murray Valley

Variable	Sex	n	\bar{x}	s	Shapiro Wilk	Probability	χ^2	Probability	Student's t	Probability
Maximum biparietal breadth	♂	54	130.5	4.52	0.978	0.10	0.085	0.770	3.45	0.001
	♀	53	127.2	4.70	0.973	0.10				
Glabella-opisthocranion	♂	47	189.1	5.75	0.962	0.10	0.897	0.344	8.55	0.000
	♀	52	179.8	5.02	0.979	0.50				
Basion-bregma	♂	45	133.4	4.04	0.972	0.10	0.287	0.592	8.23	0.000
	♀	50	126.3	4.38	0.951	0.05				
Supraorbital breadth	♂	47	108.5	3.48	0.957	0.10	1.389	0.239	4.29	0.000
	♀	53	105.2	4.12	0.951	0.05				
Nasion-nasospinale	♂	47	49.9	2.66	0.968	0.10	0.098	0.754	4.91	0.000
	♀	53	47.3	2.54	0.952	0.05				
Alveolar length	♂	47	64.1	3.98	0.970	0.10	2.009	0.156	6.65	0.000
	♀	53	59.3	3.24	0.970	0.10				
Mastoid depth	♂	47	31.2	2.35	0.954	0.10	0.717	0.397	9.14	0.000
	♀	53	27.1	2.08	0.944	0.05				

Table 2 Standardised discriminant function coefficients, means, section point and classification percentages for discriminant function 1 developed with the Murray Valley sample

Variable	Standardised coefficients
Maximum biparietal breadth	0.14833
Glabella-opisthocranion	0.46164
Basion-bregma	0.45796
Maximum supraorbital breadth	-0.25117
Nasion-nasospinale	0.20003
Alveolar breadth	0.32041
Mastoid depth	0.53185

Descriptive data	
Male mean	188.1
Male range	178-195
Male classification (%)	90.0
Female mean	176.8
Female range	169-184
Female classification (%)	95.7
Section point	182.5
Total classification (%)	93.4
Eigenvalue	2.309
Canonical classification	0.835
Wilk's Lambda	0.302
Chi-squared	102.33
Probability	0.000

distribution were excluded. Within this subset, variables which were preserved in the majority of the Coobool Creek sample were chosen. After a series of discriminant runs the optimum set of discriminating variables were selected from this set (Tables 1-2). Twenty of the 30 Coobool Creek crania were complete enough for an attempt to classify them using standardised discriminant function coefficients developed from the Murray Valley series.

Analysis and results

Linear discriminant functions were calculated using the SPSS package DISCRIMINANT (SPSS* 1986). The method chosen was MAHAL which maximised the Mahalanobis distance between groups. Probabilities of misclassification, plots of the discriminant scores, eigenvalues and Wilk's Lambda were examined for each function. Covariance matrices were calculated for the male and female samples and tested for homogeneity with Box's M (Box's M = 0.249, F = 0.816, P = 0.740). The F ratio associated with Box's M is not significant at the .05 level and it is reasonable to assume that the dispersion in the male and female groups is equal. The standardised coefficients (Table 2) indicate that the major contributor to the function is mastoid depth, followed by glabella-opisthocranion (maximum cranial length) and basion-bregma (cranial height). Previously, Larnach and Freedman (1964) found that the size of the mastoid process was an excellent single indicator of sex in Aboriginal crania. In a trial series of discriminant analyses the exclusion of mastoid depth from the variable list resulted in a 5-10% reduction in the discriminatory power of the final function.

The canonical function associated with discriminant function 1 indicates a high correlation between the function and the variables which define group membership. The converted discriminant function scores (produced by multiplying the raw data for each individual with the standardised coefficients in Table 2) are plotted in Figure 11a. The distribution is not particularly bimodal but this may improve with a larger sample. Henke (1974) obtained a multimodal distribution in his discriminant analysis of a large series of known sex crania. More importantly the section point identifies 90.0% of the male and 95.7% of the female crania with an overall accuracy of 93.4%. Under ideal circumstances the classificatory power of this function should be tested by applying it to another, independently sexed, large sample of Aboriginal crania. Unfortunately, suitable samples do not exist. However, an illustration of the robustness

of the function could be obtained by applying it to a known sex series of southern Chinese crania. With the Chinese sample of 24 males and 14 females, the Murray Valley discriminant function correctly sexed 79.6% of the males and 78.6% of the females (male \bar{x} 185.8, female \bar{x} 176.1, section point 180.95). Given the morphological differences between Aboriginal and southern Chinese crania this is a reasonable result. The discriminant function developed from the Murray Valley crania was then applied to the Swanport and Coobool Creek series.

Swanport

Of the 48 crania from Swanport included in this analysis only six could be sexed through an associated pelvis. All of the Swanport crania were initially sexed using the Larnach and Freedman (1964) technique. The palates and mastoid processes of the Swanport population are not as large as those in the Murray Valley sample, so the modified Class 2 limits for palate and mastoid size were not employed. The total sex scores for these crania are plotted in Figure 12. Using the section point developed from Murray Valley crania (14.5), individuals scoring less than 15 were classed as female and those scoring greater than 14 as male. It is to be expected that between 10-15% of the total are misclassified by this section point.

As an alternative means of sexing, and to double-check the Larnach and Freedman sex scores, the standardised discriminant function coefficients developed on the Murray Valley crania were then applied (Fig.11b). In Figure 11b, individuals classified as female according to the Larnach and Freedman (1964) technique are plotted below the axis and males above. The discriminant results support those obtained in the Larnach and Freedman analysis. Two crania (S92 and 97) obtained intermediate scores with both techniques. Townsend and Brown (1979a) found that canine size was a good discriminator between male and female Aborigines. In this instance the large maxillary canines of S97 (buccolingual breadth 9.7 mm) suggest it is male and the small dentition of S92 appears to be female.

The smaller size of the Swanport crania relative to the Murray Valley sample is reflected in the distribution of the discriminant function scores. The Swanport section point (179.1) is lower than that in the Murray Valley sample (182.5) as are the male and female mean scores. Due to the regional variation in Aboriginal cranial size and morphology I think it is unlikely that any one sexing technique will ever achieve

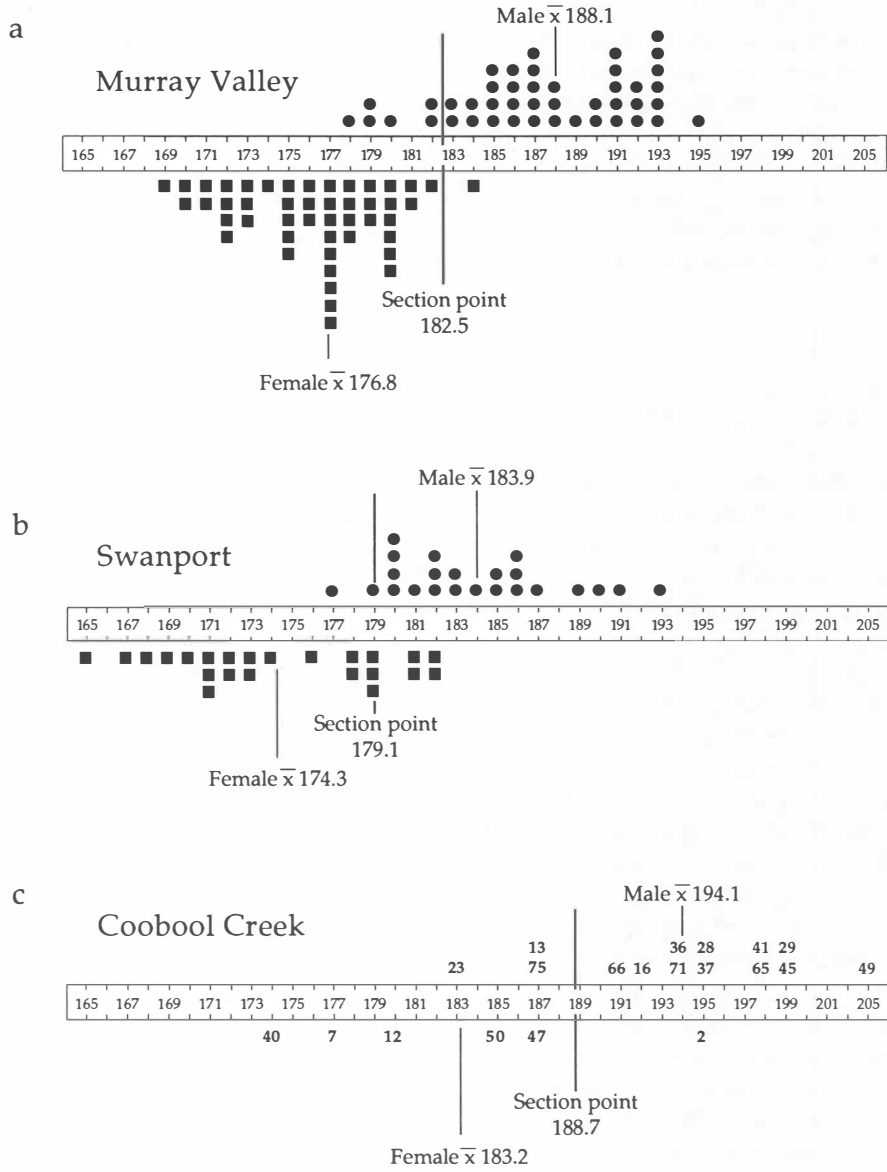


Figure 11 Distribution of male and female crania from the Murray Valley, Swanport and Coobool Creek using discriminant function 1

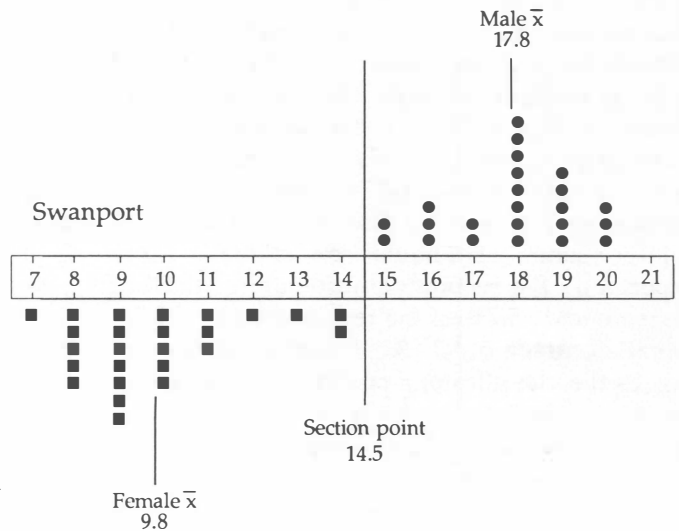


Figure 12 Larnach and Freedman sexing score distribution for Aboriginal crania from Swanport

an accuracy greater than 85-90% in continent-wide applications. The combined results of the Larnach and Freedman and discriminant function analyses indicate that there are 25 male and 23 female crania in the Swanport sample.

Coobool Creek

None of the Coobool Creek crania used in this analysis has associated postcranial skeletons complete enough for a positive identification of sex. Sex determination is possible only through an examination of the crania. This is complicated by temporal factors, most notably their relatively large size and the presence of artificial deformation (Brown 1981b, 1987b). As a result, it is probable that the direct application of discriminant functions developed from the recent Murray Valley sample would produce misleading results (Fig.11c). In Figure 11c the relatively large size of the Coobool Creek male and female crania is indicated by the use of discriminant function 1. Crania which on morphological grounds were male are plotted above the horizontal axis and females below. Several of the 'male' and 'female' crania obtain discriminant function scores which exceed their respective Murray Valley range and the section point is located at a much higher score. Taken in isolation this analysis would have mistakenly identified several of the female crania, particularly CC2, as male. Fortunately, there is presently no evidence of temporal variation in the five craniomorph sexing characters of Larnach and Freedman (Thorne 1975).

The Coobool Creek crania were sexed using the modified form of the Larnach and Freedman (1964) technique (Table 3) with the increased Class 2 limits for palate and mastoid size (Brown 1981a). The palates and mastoid processes in the Coobool Creek crania are extremely large, in some crania exceeding the recorded Australian range. Even using the increased Class 2 limits no crania were found to have Class 1 mastoid processes and only two (CC1 and 7) have Class 1 palates. However, the morphological sexing characters were all within the modern range of development. Two features (glabella prominence and the size of the occipital muscle markings) were generally not prominent and this may balance the high scores achieved for the two modules (palate size and mastoid size). The section point developed using the modified Larnach and Freedman technique on Murray Valley crania was applied to the Coobool Creek series. Individuals scoring greater than 13 were classed as male and those scoring less than 14 as female. These results are plotted in Figure 13.

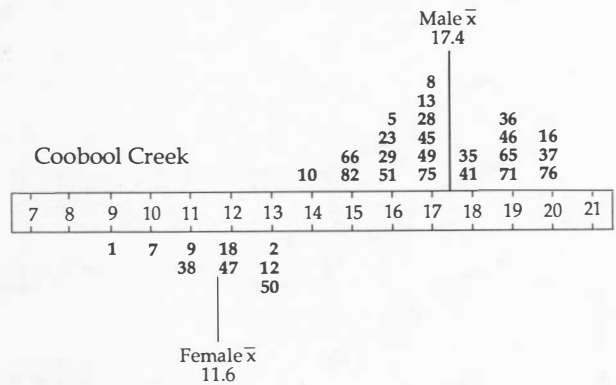


Figure 13 Modified Larnach and Freedman sexing score distribution for the Coobool Creek crania

Kow Swamp, Cohuna, Keilor and Mossgiel

Thorne (1975) sexed the Kow Swamp crania using the Larnach and Freedman (1964) technique supported by information from the postcranial skeleton. Given the fragmentary condition of these crania, Thorne's assessments are as accurate as the material allows. The adult male Kow Swamp crania comprise KS1, 5, 7, 8, 9, 14 and 15 and the females KS4 and 16 (possibly adolescent).

Application of both the Larnach and Freedman method (1964; Brown 1981a) and standardised discriminant function coefficients to the Cohuna and Keilor crania indicate that they are clearly male (Brown 1987a). Freedman's (1986) detailed description of the Mossgiel skeleton, combined with my own observations, indicates that this is a male individual. Although post-depositional damage to both innominates prevented their use in sex identification, the application of the Larnach and Freedman (1964) technique to the cranium obtained a score above the female section point.

Lake Mungo I and III and WLH 50

Each of these crania are fragmentary, and without postcranial skeletons complete enough for sex identification. For one of these, LMI, this does not present a problem. The small size and ultra-feminine morphology of LMI make it clear that it is female (Thorne 1975; Brown 1987a).

Far more problematic is the sex of LMIII. Recently several authors (Flood 1983:67-68; Thorne 1984; Wolpoff 1985a, in press; Stringer and Andrews 1988) have described one of the more recently discovered skeletons from the Willandra Lakes region; WLH 50 from Lake Garnpung close to Lake Mungo. Wolpoff (in press) argues that the cranial vault of WLH 50 exhibits dramatic metric similarity to the archaic

Table 3 Raw scores for the seven Larnach and Freedman (1964) sexing characters in the Coobool Creek crania

Specimen number	Glabella prominence	Superciliary ridge prominence	Zygomatic trigone development	Malar tuberosity size	Mastoid size	Occipital markings	Palate size	Larnach and Freedman sex score	Sex score plus missing value	Mastoid length	Mastoid width	Mastoid depth	Mastoid module ¹	Alveolar length	Alveolar breadth	Palate module ²
1	1	1	2	1	-	1	1	7	9	-	20	12	-	57	65	37
2	2	1	1	1	3	2	3	13	13	31	24	16	119	70	67	47
5	3	2	3	1	3	2	-	14	16	34	29	22	217	-	-	-
7	1	1	1	1	3	3	-	13	17	28	25	16	112	-	-	-
8	2	3	2	-	3	3	-	13	17	28	25	16	112	-	-	-
9	2	1	2	1	2	1	2	11	11	30	22	15	99	60	70	42
10	2	1	2	3	3	1	-	12	14	28	28	23	180	-	-	-
12	2	2	3	1	2	1	2	13	13	28	21	17	117	60	66	40
13	3	2	3	2	3	1	3	17	17	30	23	15	103	63	73	46
16	2	3	3	3	3	3	3	20	20	32	22	20	141	68	74	50
18	2	2	1	2	2	1	2	12	12	29	25	13	94	61	65	40
23	1	2	3	2	3	2	3	16	16	31	26	16	129	62	70	43
28	2	2	3	1	3	3	3	17	17	29	24	19	132	69	76	52
29	2	1	3	3	3	1	3	16	16	34	26	18	159	61	71	43
35	3	3	3	-	3	2	-	14	18	37	29	18	193	-	-	-
36	3	3	2	3	3	3	3	20	20	30	27	15	122	65	74	48
37	2	3	3	3	3	3	3	20	20	31	26	19	153	66	72	48
40	-	-	-	2	-	-	3	-	-	-	-	-	-	64	75	48
41	2	2	3	2	3	3	3	18	18	35	24	15	126	63	73	46
45	2	3	2	2	2	3	3	17	17	30	23	15	104	67	67	45
46	3	3	-	3	3	2	3	17	19	33	25	15	123	68	75	51
47	2	1	2	1	2	2	2	12	12	32	21	13	87	58	71	41
49	2	2	3	2	3	2	3	17	17	36	26	18	168	66	72	48
50	2	1	3	1	2	1	3	13	13	26	25	14	91	61	72	44
51	2	2	2	3	3	1	3	16	16	32	22	17	120	62	72	45
65	3	2	3	3	3	2	3	19	19	30	25	16	120	62	73	45
66	2	2	3	3	2	1	2	15	15	27	22	16	95	61	68	41
71	3	2	3	2	3	3	3	19	19	32	26	17	141	66	83	55
75	2	1	3	3	3	2	3	17	17	31	25	16	124	66	69	46
76	3	3	3	3	3	3	-	18	20	35	20	19	133	-	-	-
82	2	2	3	1	2	3	-	13	15	31	22	17	116	67	-	-

1 Mastoid length x mastoid width x mastoid depth/100

2 Alveolar length x alveolar breadth/100

Homo sapiens from Ngandong. This is supported by Stringer and Andrews (1988:1266) who find that WLH 50 is 'the only credible morphological intermediary between middle Pleistocene Indonesian hominids and late Pleistocene Australians'. Although these claims have yet to be tested, data in Flood (1983) and Wolpoff (in press), combined with my own observations, indicate that at the very least WLH 50 has a particularly large and robust cranial vault. However, while Wolpoff (1985a, in press) argues that WLH 50 is temporally earlier than other prehistoric skeletal materials from Australia this is not supported by the dates published for this specimen. Using electron spin resonance, Caddie *et al.* (1987) demonstrated that WLH 50 appeared to be of similar age, or younger, than LMIII. This has some relevance to the potential sex of LMIII.

If LMI and WLH 50 represent the extremes of female and male variation in the Willandra Lakes region during the late Pleistocene then LMIII is morphologically and metrically intermediate on the scale they represent. Bowler and Thorne (1976), using the mandible sexing technique of Larnach and Macintosh (1971), sexed this individual as male. Unfortunately only 33 of the 93 mandibles used by Larnach and Macintosh to

develop their sexing technique were of known sex and their results are in doubt, as is that for LMIII. The application of standardised discriminant functions developed from 138 known sex Aboriginal mandibles also indicated that LMIII was male (Brown 1987a). However, this issue is complicated by the evidence for greater size and robusticity in the Pleistocene combined with the apparent contemporaneity of LMIII and WLH 50. When the same discriminant functions were applied to three of the Coobool Creek female mandibles two of them obtained scores on the male side of the section point (Brown 1987a:Fig.2). Future detailed description and comparison of the LMIII skeleton may clarify this issue.

Broadbeach, Roonka, Nacurrie and Lake Nitchie

The skeletal material from each of these locations was sexed through an examination of their associated pelves and sacrum. Emphasis was placed on the size and morphology of the acetabulum and greater sciatic notch, morphology of the pubis and sacro-iliac articulation and breadth and curvature of the sacrum (Washburn 1948; Krogman 1962; Phenice 1969).

III

THE COOBOOL CREEK CRANIA

UNIVARIATE AND MORPHOLOGICAL
COMPARISON

Introduction

In the post-Darwinian rush to elucidate the evolutionary sequence linking *Homo sapiens* with the common ancestor of the Hominoidea, considerable attention was focused on the apparently 'primitive' features of Aboriginal crania (Huxley 1864; Topinard 1872; Turner 1884; Hartman 1885; Schoetensack 1901; Klaatsch 1908). From this initial descriptive work has arisen a large descriptive and comparative literature on Australian crania.

The non-metric, morphological characteristics of Australian crania have been extensively described, with the recent work of Larnach and Freedman (1964), Larnach and Macintosh (1966, 1970) and Thorne (1976) stemming from the pioneering studies of Klaatsch (1908) and Fenner (1939). Initially the emphasis of these studies was purely descriptive (Klaatsch 1908; Krogman 1932; Fenner 1939), with little attention to internal geographic differentiation and sexual dimorphism. In more recent work (Larnach and Macintosh 1966, 1970; Kellock and Parsons 1970; Thorne 1976; Pietrusewsky 1984; Freedman 1986; Brown 1987a) there has been an increasing emphasis on regional, temporal and sex-based variation in aspects of Aboriginal cranial morphology.

Historically the emphasis of the craniometric studies have followed a similar pattern to the morphological analyses. The initial emphasis was descriptive, with Klaatsch (1908) reporting the metrical characteristics of 87 crania from Queensland. Morant (1927) combined data from previous studies in his comparison of Tasmanian and continental Australian crania. During the same period Hrdlička (1928) published a large-scale metrical survey of nearly 1000 crania from the Departments of Anatomy and Museums in Sydney, Melbourne, Adelaide and London. Hrdlička's data demonstrated what anthropologists up until that time had believed but not quantified, that there was marked regional and sex-based variation in Aboriginal cranial morphology.

With recent univariate and multivariate analyses there has been an increasing concentration on aspects of regional and temporal varia-

tion (Freedman 1964; Brown 1973; Thorne and Wilson 1977; Freedman and Wood 1977; Margetts and Freedman 1977; Pietrusewsky 1979; Brown 1987a). However, functional statements are largely restricted to analyses of the oro-facial complex, with an extensive series of papers resulting from the long-term growth study of the Walbiri and Pintubi people of Yuendumu (Barrett *et al.* 1963a; Barrett *et al.* 1965; Brown and Barrett 1973; Brown 1973).

Metrical and morphological descriptions have also been published on the majority of the individual prehistoric, terminal Pleistocene and early Holocene, crania which have been discovered since Talgai was unearthed in 1884. The Talgai cranium was initially described by Smith (1918), with Helman (1934) and Macintosh (1952a) later challenging his observations on the presence of distinctive archaic features in the teeth and palate. Wunderly (1943) provides a description of the Keilor cranium; Macintosh (1971) Lake Nitchie; Wallace and Doran (1976) Mt Cameron West; Freedman (1986) Mossgiel; Freedman and Lofgren (1983) Lake Tandou; and in a series of publications Thorne (1969, 1976; Thorne and Macumber 1972) covers the morphological and metrical characteristics of the Kow Swamp crania. Less detailed information is available for a number of other prehistoric crania, including those from Lake Mungo (Bowler *et al.* 1970; Bowler *et al.* 1972; Bowler and Thorne 1976) and Roonka (Prokopec 1979).

For purposes of morphological comparison I have been strongly influenced by the work of Klaatsch (1908), Fenner (1939), Larnach and Macintosh (1966, 1970) and Thorne (1975). My general approach is similar to that taken in Chapter IV with the Coobool Creek mandibles. Rather than attempt to compare the development of the continuous morphological features in the Coobool Creek crania with the graded data published for other Australian series, I make continual reference to 60 Aboriginal crania (30 males and 30 females) from Euston in the central Murray Valley. The Coobool Creek crania were also directly compared with those from Kow Swamp and Cohuna.

Using the statistical procedures outlined in Chapter II, metrical comparisons are made between the Coobool Creek crania and those from the Murray Valley, Swanport, Broadbeach, Barham and Kow Swamp samples, using the

Table 4 Descriptive and comparative statistics for the Coobool Creek male and female cranial dimensions (mm)

Variable	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	Shapiro Wilk	Probability	χ^2	Probability	Student's t	Probability																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
Maximum biparietal breadth	♂	22	137.9	4.23	3.06	129	145	0.922	0.10	1.35	0.245	2.49	0.019																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	9	133.2	5.91	4.43	119	138	0.757	0.01					Glabella-opisthocranion	♂	22	195.6	7.34	3.75	182	211	0.987	0.99	0.09	0.755	3.34	0.002	♀	9	186.1	6.67	3.58	176	195	0.918	0.10	Glabella-lambda	♂	22	191.9	7.77	4.04	179	207	0.968	0.50	0.62	0.428	3.56	0.001	♀	9	181.6	6.06	3.34	171	188	0.891	0.10	Basion-bregma	♂	20	141.2	5.52	3.90	134	153	0.963	0.50	0.37	0.540	1.68	0.103	♀	9	137.2	6.62	4.83	127	147	0.986	0.98	Basion-nasion	♂	20	104.8	3.12	2.98	100	111	0.940	0.10	3.50	0.061	2.83	0.009	♀	8	100.1	5.48	5.47	90	108	0.940	0.50	Basion-nasospinale	♂	16	102.5	3.50	3.41	97	109	0.921	0.10	0.19	0.660	3.64	0.002	♀	7	96.4	4.07	4.22	91	102	0.860	0.10	Basion-prosthion	♂	15	110.1	3.98	3.61	105	120	0.904	0.02	0.10	0.749	3.63	0.002	♀	7	103.7	3.54	3.41	99	108	0.921	0.10	Basion-lambda	♂	20	122.4	7.32	5.98	111	142	0.900	0.05	0.54	0.462	0.73	0.475	♀	8	120.3	5.72	4.75	111	127	0.941	0.50	Basion-inion	♂	20	77.6	5.09	6.55	68	92	0.822	<0.01	2.11	0.146	0.69	0.492	♀	8	76.3	3.05	3.99	72	81	0.934	0.50	Biauriculare	♂	21	126.2	4.29	3.39	117	137	0.506	<0.01	0.09	0.756	1.51	0.142	♀	9	123.7	3.90	3.15	118	129	0.905	0.10	Biasterion	♂	22	112.2	5.51	4.91	103	129	0.804	<0.01	0.04	0.850	1.61	0.119	♀	9	108.7	5.83	5.36	96	113	0.804	0.05	Bisphenion	♂	20	108.0	4.64	4.29	100	115	0.812	<0.01	0.33	0.562	4.23	0.000	♀	8	100.1	3.83	3.82	95	108	0.759	0.02	Glabella-bregma	♂	22	117.7	5.15	4.37	110	128	0.838	<0.01	0.38	0.536	4.04	0.000	♀	9	109.9	4.25	3.86	102	115	0.915	0.10	Nasion-bregma	♂	22	120.9	5.14	4.25	114	131	0.856	0.01	0.71	0.398	3.37	0.002	♀	9	114.4	3.94	3.44	108	120	0.901	0.10	Metopion height	♂	22	23.8	3.62	15.21	16	30	0.960	0.50	0.01	0.905	0.61	0.547	♀	9	22.9	3.25	14.19	19	29	0.896	0.10	Nasion-metopion	♂	22	53.8	4.95	9.20	43	62	-	-	0.03	0.860	1.71	0.097	♀	9	50.6	4.69	9.26	41	57	-	-	Maximum supraorbital breadth	♂	21	116.3	4.59	3.94	109	129	0.954	0.50	5.28	0.022	3.33	0.003	♀	7	110.3	1.79	1.62	108	113	0.952	0.50	Minimum postorbital breadth	♂	22	99.4	6.05	6.08	87	110	0.953	0.10	0.43	0.510	1.03	0.310	♀	8	96.6	7.41	7.67	89	112	0.983	0.95	Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-	♀	2	135.5	2.12	1.56	134	137	-	-	Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20
Glabella-opisthocranion	♂	22	195.6	7.34	3.75	182	211	0.987	0.99	0.09	0.755	3.34	0.002																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	9	186.1	6.67	3.58	176	195	0.918	0.10					Glabella-lambda	♂	22	191.9	7.77	4.04	179	207	0.968	0.50	0.62	0.428	3.56	0.001	♀	9	181.6	6.06	3.34	171	188	0.891	0.10	Basion-bregma	♂	20	141.2	5.52	3.90	134	153	0.963	0.50	0.37	0.540	1.68	0.103	♀	9	137.2	6.62	4.83	127	147	0.986	0.98	Basion-nasion	♂	20	104.8	3.12	2.98	100	111	0.940	0.10	3.50	0.061	2.83	0.009	♀	8	100.1	5.48	5.47	90	108	0.940	0.50	Basion-nasospinale	♂	16	102.5	3.50	3.41	97	109	0.921	0.10	0.19	0.660	3.64	0.002	♀	7	96.4	4.07	4.22	91	102	0.860	0.10	Basion-prosthion	♂	15	110.1	3.98	3.61	105	120	0.904	0.02	0.10	0.749	3.63	0.002	♀	7	103.7	3.54	3.41	99	108	0.921	0.10	Basion-lambda	♂	20	122.4	7.32	5.98	111	142	0.900	0.05	0.54	0.462	0.73	0.475	♀	8	120.3	5.72	4.75	111	127	0.941	0.50	Basion-inion	♂	20	77.6	5.09	6.55	68	92	0.822	<0.01	2.11	0.146	0.69	0.492	♀	8	76.3	3.05	3.99	72	81	0.934	0.50	Biauriculare	♂	21	126.2	4.29	3.39	117	137	0.506	<0.01	0.09	0.756	1.51	0.142	♀	9	123.7	3.90	3.15	118	129	0.905	0.10	Biasterion	♂	22	112.2	5.51	4.91	103	129	0.804	<0.01	0.04	0.850	1.61	0.119	♀	9	108.7	5.83	5.36	96	113	0.804	0.05	Bisphenion	♂	20	108.0	4.64	4.29	100	115	0.812	<0.01	0.33	0.562	4.23	0.000	♀	8	100.1	3.83	3.82	95	108	0.759	0.02	Glabella-bregma	♂	22	117.7	5.15	4.37	110	128	0.838	<0.01	0.38	0.536	4.04	0.000	♀	9	109.9	4.25	3.86	102	115	0.915	0.10	Nasion-bregma	♂	22	120.9	5.14	4.25	114	131	0.856	0.01	0.71	0.398	3.37	0.002	♀	9	114.4	3.94	3.44	108	120	0.901	0.10	Metopion height	♂	22	23.8	3.62	15.21	16	30	0.960	0.50	0.01	0.905	0.61	0.547	♀	9	22.9	3.25	14.19	19	29	0.896	0.10	Nasion-metopion	♂	22	53.8	4.95	9.20	43	62	-	-	0.03	0.860	1.71	0.097	♀	9	50.6	4.69	9.26	41	57	-	-	Maximum supraorbital breadth	♂	21	116.3	4.59	3.94	109	129	0.954	0.50	5.28	0.022	3.33	0.003	♀	7	110.3	1.79	1.62	108	113	0.952	0.50	Minimum postorbital breadth	♂	22	99.4	6.05	6.08	87	110	0.953	0.10	0.43	0.510	1.03	0.310	♀	8	96.6	7.41	7.67	89	112	0.983	0.95	Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-	♀	2	135.5	2.12	1.56	134	137	-	-	Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																		
Glabella-lambda	♂	22	191.9	7.77	4.04	179	207	0.968	0.50	0.62	0.428	3.56	0.001																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	9	181.6	6.06	3.34	171	188	0.891	0.10					Basion-bregma	♂	20	141.2	5.52	3.90	134	153	0.963	0.50	0.37	0.540	1.68	0.103	♀	9	137.2	6.62	4.83	127	147	0.986	0.98	Basion-nasion	♂	20	104.8	3.12	2.98	100	111	0.940	0.10	3.50	0.061	2.83	0.009	♀	8	100.1	5.48	5.47	90	108	0.940	0.50	Basion-nasospinale	♂	16	102.5	3.50	3.41	97	109	0.921	0.10	0.19	0.660	3.64	0.002	♀	7	96.4	4.07	4.22	91	102	0.860	0.10	Basion-prosthion	♂	15	110.1	3.98	3.61	105	120	0.904	0.02	0.10	0.749	3.63	0.002	♀	7	103.7	3.54	3.41	99	108	0.921	0.10	Basion-lambda	♂	20	122.4	7.32	5.98	111	142	0.900	0.05	0.54	0.462	0.73	0.475	♀	8	120.3	5.72	4.75	111	127	0.941	0.50	Basion-inion	♂	20	77.6	5.09	6.55	68	92	0.822	<0.01	2.11	0.146	0.69	0.492	♀	8	76.3	3.05	3.99	72	81	0.934	0.50	Biauriculare	♂	21	126.2	4.29	3.39	117	137	0.506	<0.01	0.09	0.756	1.51	0.142	♀	9	123.7	3.90	3.15	118	129	0.905	0.10	Biasterion	♂	22	112.2	5.51	4.91	103	129	0.804	<0.01	0.04	0.850	1.61	0.119	♀	9	108.7	5.83	5.36	96	113	0.804	0.05	Bisphenion	♂	20	108.0	4.64	4.29	100	115	0.812	<0.01	0.33	0.562	4.23	0.000	♀	8	100.1	3.83	3.82	95	108	0.759	0.02	Glabella-bregma	♂	22	117.7	5.15	4.37	110	128	0.838	<0.01	0.38	0.536	4.04	0.000	♀	9	109.9	4.25	3.86	102	115	0.915	0.10	Nasion-bregma	♂	22	120.9	5.14	4.25	114	131	0.856	0.01	0.71	0.398	3.37	0.002	♀	9	114.4	3.94	3.44	108	120	0.901	0.10	Metopion height	♂	22	23.8	3.62	15.21	16	30	0.960	0.50	0.01	0.905	0.61	0.547	♀	9	22.9	3.25	14.19	19	29	0.896	0.10	Nasion-metopion	♂	22	53.8	4.95	9.20	43	62	-	-	0.03	0.860	1.71	0.097	♀	9	50.6	4.69	9.26	41	57	-	-	Maximum supraorbital breadth	♂	21	116.3	4.59	3.94	109	129	0.954	0.50	5.28	0.022	3.33	0.003	♀	7	110.3	1.79	1.62	108	113	0.952	0.50	Minimum postorbital breadth	♂	22	99.4	6.05	6.08	87	110	0.953	0.10	0.43	0.510	1.03	0.310	♀	8	96.6	7.41	7.67	89	112	0.983	0.95	Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-	♀	2	135.5	2.12	1.56	134	137	-	-	Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																									
Basion-bregma	♂	20	141.2	5.52	3.90	134	153	0.963	0.50	0.37	0.540	1.68	0.103																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	9	137.2	6.62	4.83	127	147	0.986	0.98					Basion-nasion	♂	20	104.8	3.12	2.98	100	111	0.940	0.10	3.50	0.061	2.83	0.009	♀	8	100.1	5.48	5.47	90	108	0.940	0.50	Basion-nasospinale	♂	16	102.5	3.50	3.41	97	109	0.921	0.10	0.19	0.660	3.64	0.002	♀	7	96.4	4.07	4.22	91	102	0.860	0.10	Basion-prosthion	♂	15	110.1	3.98	3.61	105	120	0.904	0.02	0.10	0.749	3.63	0.002	♀	7	103.7	3.54	3.41	99	108	0.921	0.10	Basion-lambda	♂	20	122.4	7.32	5.98	111	142	0.900	0.05	0.54	0.462	0.73	0.475	♀	8	120.3	5.72	4.75	111	127	0.941	0.50	Basion-inion	♂	20	77.6	5.09	6.55	68	92	0.822	<0.01	2.11	0.146	0.69	0.492	♀	8	76.3	3.05	3.99	72	81	0.934	0.50	Biauriculare	♂	21	126.2	4.29	3.39	117	137	0.506	<0.01	0.09	0.756	1.51	0.142	♀	9	123.7	3.90	3.15	118	129	0.905	0.10	Biasterion	♂	22	112.2	5.51	4.91	103	129	0.804	<0.01	0.04	0.850	1.61	0.119	♀	9	108.7	5.83	5.36	96	113	0.804	0.05	Bisphenion	♂	20	108.0	4.64	4.29	100	115	0.812	<0.01	0.33	0.562	4.23	0.000	♀	8	100.1	3.83	3.82	95	108	0.759	0.02	Glabella-bregma	♂	22	117.7	5.15	4.37	110	128	0.838	<0.01	0.38	0.536	4.04	0.000	♀	9	109.9	4.25	3.86	102	115	0.915	0.10	Nasion-bregma	♂	22	120.9	5.14	4.25	114	131	0.856	0.01	0.71	0.398	3.37	0.002	♀	9	114.4	3.94	3.44	108	120	0.901	0.10	Metopion height	♂	22	23.8	3.62	15.21	16	30	0.960	0.50	0.01	0.905	0.61	0.547	♀	9	22.9	3.25	14.19	19	29	0.896	0.10	Nasion-metopion	♂	22	53.8	4.95	9.20	43	62	-	-	0.03	0.860	1.71	0.097	♀	9	50.6	4.69	9.26	41	57	-	-	Maximum supraorbital breadth	♂	21	116.3	4.59	3.94	109	129	0.954	0.50	5.28	0.022	3.33	0.003	♀	7	110.3	1.79	1.62	108	113	0.952	0.50	Minimum postorbital breadth	♂	22	99.4	6.05	6.08	87	110	0.953	0.10	0.43	0.510	1.03	0.310	♀	8	96.6	7.41	7.67	89	112	0.983	0.95	Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-	♀	2	135.5	2.12	1.56	134	137	-	-	Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																
Basion-nasion	♂	20	104.8	3.12	2.98	100	111	0.940	0.10	3.50	0.061	2.83	0.009																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	8	100.1	5.48	5.47	90	108	0.940	0.50					Basion-nasospinale	♂	16	102.5	3.50	3.41	97	109	0.921	0.10	0.19	0.660	3.64	0.002	♀	7	96.4	4.07	4.22	91	102	0.860	0.10	Basion-prosthion	♂	15	110.1	3.98	3.61	105	120	0.904	0.02	0.10	0.749	3.63	0.002	♀	7	103.7	3.54	3.41	99	108	0.921	0.10	Basion-lambda	♂	20	122.4	7.32	5.98	111	142	0.900	0.05	0.54	0.462	0.73	0.475	♀	8	120.3	5.72	4.75	111	127	0.941	0.50	Basion-inion	♂	20	77.6	5.09	6.55	68	92	0.822	<0.01	2.11	0.146	0.69	0.492	♀	8	76.3	3.05	3.99	72	81	0.934	0.50	Biauriculare	♂	21	126.2	4.29	3.39	117	137	0.506	<0.01	0.09	0.756	1.51	0.142	♀	9	123.7	3.90	3.15	118	129	0.905	0.10	Biasterion	♂	22	112.2	5.51	4.91	103	129	0.804	<0.01	0.04	0.850	1.61	0.119	♀	9	108.7	5.83	5.36	96	113	0.804	0.05	Bisphenion	♂	20	108.0	4.64	4.29	100	115	0.812	<0.01	0.33	0.562	4.23	0.000	♀	8	100.1	3.83	3.82	95	108	0.759	0.02	Glabella-bregma	♂	22	117.7	5.15	4.37	110	128	0.838	<0.01	0.38	0.536	4.04	0.000	♀	9	109.9	4.25	3.86	102	115	0.915	0.10	Nasion-bregma	♂	22	120.9	5.14	4.25	114	131	0.856	0.01	0.71	0.398	3.37	0.002	♀	9	114.4	3.94	3.44	108	120	0.901	0.10	Metopion height	♂	22	23.8	3.62	15.21	16	30	0.960	0.50	0.01	0.905	0.61	0.547	♀	9	22.9	3.25	14.19	19	29	0.896	0.10	Nasion-metopion	♂	22	53.8	4.95	9.20	43	62	-	-	0.03	0.860	1.71	0.097	♀	9	50.6	4.69	9.26	41	57	-	-	Maximum supraorbital breadth	♂	21	116.3	4.59	3.94	109	129	0.954	0.50	5.28	0.022	3.33	0.003	♀	7	110.3	1.79	1.62	108	113	0.952	0.50	Minimum postorbital breadth	♂	22	99.4	6.05	6.08	87	110	0.953	0.10	0.43	0.510	1.03	0.310	♀	8	96.6	7.41	7.67	89	112	0.983	0.95	Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-	♀	2	135.5	2.12	1.56	134	137	-	-	Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																																							
Basion-nasospinale	♂	16	102.5	3.50	3.41	97	109	0.921	0.10	0.19	0.660	3.64	0.002																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	7	96.4	4.07	4.22	91	102	0.860	0.10					Basion-prosthion	♂	15	110.1	3.98	3.61	105	120	0.904	0.02	0.10	0.749	3.63	0.002	♀	7	103.7	3.54	3.41	99	108	0.921	0.10	Basion-lambda	♂	20	122.4	7.32	5.98	111	142	0.900	0.05	0.54	0.462	0.73	0.475	♀	8	120.3	5.72	4.75	111	127	0.941	0.50	Basion-inion	♂	20	77.6	5.09	6.55	68	92	0.822	<0.01	2.11	0.146	0.69	0.492	♀	8	76.3	3.05	3.99	72	81	0.934	0.50	Biauriculare	♂	21	126.2	4.29	3.39	117	137	0.506	<0.01	0.09	0.756	1.51	0.142	♀	9	123.7	3.90	3.15	118	129	0.905	0.10	Biasterion	♂	22	112.2	5.51	4.91	103	129	0.804	<0.01	0.04	0.850	1.61	0.119	♀	9	108.7	5.83	5.36	96	113	0.804	0.05	Bisphenion	♂	20	108.0	4.64	4.29	100	115	0.812	<0.01	0.33	0.562	4.23	0.000	♀	8	100.1	3.83	3.82	95	108	0.759	0.02	Glabella-bregma	♂	22	117.7	5.15	4.37	110	128	0.838	<0.01	0.38	0.536	4.04	0.000	♀	9	109.9	4.25	3.86	102	115	0.915	0.10	Nasion-bregma	♂	22	120.9	5.14	4.25	114	131	0.856	0.01	0.71	0.398	3.37	0.002	♀	9	114.4	3.94	3.44	108	120	0.901	0.10	Metopion height	♂	22	23.8	3.62	15.21	16	30	0.960	0.50	0.01	0.905	0.61	0.547	♀	9	22.9	3.25	14.19	19	29	0.896	0.10	Nasion-metopion	♂	22	53.8	4.95	9.20	43	62	-	-	0.03	0.860	1.71	0.097	♀	9	50.6	4.69	9.26	41	57	-	-	Maximum supraorbital breadth	♂	21	116.3	4.59	3.94	109	129	0.954	0.50	5.28	0.022	3.33	0.003	♀	7	110.3	1.79	1.62	108	113	0.952	0.50	Minimum postorbital breadth	♂	22	99.4	6.05	6.08	87	110	0.953	0.10	0.43	0.510	1.03	0.310	♀	8	96.6	7.41	7.67	89	112	0.983	0.95	Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-	♀	2	135.5	2.12	1.56	134	137	-	-	Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																																																														
Basion-prosthion	♂	15	110.1	3.98	3.61	105	120	0.904	0.02	0.10	0.749	3.63	0.002																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	7	103.7	3.54	3.41	99	108	0.921	0.10					Basion-lambda	♂	20	122.4	7.32	5.98	111	142	0.900	0.05	0.54	0.462	0.73	0.475	♀	8	120.3	5.72	4.75	111	127	0.941	0.50	Basion-inion	♂	20	77.6	5.09	6.55	68	92	0.822	<0.01	2.11	0.146	0.69	0.492	♀	8	76.3	3.05	3.99	72	81	0.934	0.50	Biauriculare	♂	21	126.2	4.29	3.39	117	137	0.506	<0.01	0.09	0.756	1.51	0.142	♀	9	123.7	3.90	3.15	118	129	0.905	0.10	Biasterion	♂	22	112.2	5.51	4.91	103	129	0.804	<0.01	0.04	0.850	1.61	0.119	♀	9	108.7	5.83	5.36	96	113	0.804	0.05	Bisphenion	♂	20	108.0	4.64	4.29	100	115	0.812	<0.01	0.33	0.562	4.23	0.000	♀	8	100.1	3.83	3.82	95	108	0.759	0.02	Glabella-bregma	♂	22	117.7	5.15	4.37	110	128	0.838	<0.01	0.38	0.536	4.04	0.000	♀	9	109.9	4.25	3.86	102	115	0.915	0.10	Nasion-bregma	♂	22	120.9	5.14	4.25	114	131	0.856	0.01	0.71	0.398	3.37	0.002	♀	9	114.4	3.94	3.44	108	120	0.901	0.10	Metopion height	♂	22	23.8	3.62	15.21	16	30	0.960	0.50	0.01	0.905	0.61	0.547	♀	9	22.9	3.25	14.19	19	29	0.896	0.10	Nasion-metopion	♂	22	53.8	4.95	9.20	43	62	-	-	0.03	0.860	1.71	0.097	♀	9	50.6	4.69	9.26	41	57	-	-	Maximum supraorbital breadth	♂	21	116.3	4.59	3.94	109	129	0.954	0.50	5.28	0.022	3.33	0.003	♀	7	110.3	1.79	1.62	108	113	0.952	0.50	Minimum postorbital breadth	♂	22	99.4	6.05	6.08	87	110	0.953	0.10	0.43	0.510	1.03	0.310	♀	8	96.6	7.41	7.67	89	112	0.983	0.95	Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-	♀	2	135.5	2.12	1.56	134	137	-	-	Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																																																																																					
Basion-lambda	♂	20	122.4	7.32	5.98	111	142	0.900	0.05	0.54	0.462	0.73	0.475																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	8	120.3	5.72	4.75	111	127	0.941	0.50					Basion-inion	♂	20	77.6	5.09	6.55	68	92	0.822	<0.01	2.11	0.146	0.69	0.492	♀	8	76.3	3.05	3.99	72	81	0.934	0.50	Biauriculare	♂	21	126.2	4.29	3.39	117	137	0.506	<0.01	0.09	0.756	1.51	0.142	♀	9	123.7	3.90	3.15	118	129	0.905	0.10	Biasterion	♂	22	112.2	5.51	4.91	103	129	0.804	<0.01	0.04	0.850	1.61	0.119	♀	9	108.7	5.83	5.36	96	113	0.804	0.05	Bisphenion	♂	20	108.0	4.64	4.29	100	115	0.812	<0.01	0.33	0.562	4.23	0.000	♀	8	100.1	3.83	3.82	95	108	0.759	0.02	Glabella-bregma	♂	22	117.7	5.15	4.37	110	128	0.838	<0.01	0.38	0.536	4.04	0.000	♀	9	109.9	4.25	3.86	102	115	0.915	0.10	Nasion-bregma	♂	22	120.9	5.14	4.25	114	131	0.856	0.01	0.71	0.398	3.37	0.002	♀	9	114.4	3.94	3.44	108	120	0.901	0.10	Metopion height	♂	22	23.8	3.62	15.21	16	30	0.960	0.50	0.01	0.905	0.61	0.547	♀	9	22.9	3.25	14.19	19	29	0.896	0.10	Nasion-metopion	♂	22	53.8	4.95	9.20	43	62	-	-	0.03	0.860	1.71	0.097	♀	9	50.6	4.69	9.26	41	57	-	-	Maximum supraorbital breadth	♂	21	116.3	4.59	3.94	109	129	0.954	0.50	5.28	0.022	3.33	0.003	♀	7	110.3	1.79	1.62	108	113	0.952	0.50	Minimum postorbital breadth	♂	22	99.4	6.05	6.08	87	110	0.953	0.10	0.43	0.510	1.03	0.310	♀	8	96.6	7.41	7.67	89	112	0.983	0.95	Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-	♀	2	135.5	2.12	1.56	134	137	-	-	Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																																																																																																												
Basion-inion	♂	20	77.6	5.09	6.55	68	92	0.822	<0.01	2.11	0.146	0.69	0.492																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
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	♀	9	123.7	3.90	3.15	118	129	0.905	0.10					Biasterion	♂	22	112.2	5.51	4.91	103	129	0.804	<0.01	0.04	0.850	1.61	0.119	♀	9	108.7	5.83	5.36	96	113	0.804	0.05	Bisphenion	♂	20	108.0	4.64	4.29	100	115	0.812	<0.01	0.33	0.562	4.23	0.000	♀	8	100.1	3.83	3.82	95	108	0.759	0.02	Glabella-bregma	♂	22	117.7	5.15	4.37	110	128	0.838	<0.01	0.38	0.536	4.04	0.000	♀	9	109.9	4.25	3.86	102	115	0.915	0.10	Nasion-bregma	♂	22	120.9	5.14	4.25	114	131	0.856	0.01	0.71	0.398	3.37	0.002	♀	9	114.4	3.94	3.44	108	120	0.901	0.10	Metopion height	♂	22	23.8	3.62	15.21	16	30	0.960	0.50	0.01	0.905	0.61	0.547	♀	9	22.9	3.25	14.19	19	29	0.896	0.10	Nasion-metopion	♂	22	53.8	4.95	9.20	43	62	-	-	0.03	0.860	1.71	0.097	♀	9	50.6	4.69	9.26	41	57	-	-	Maximum supraorbital breadth	♂	21	116.3	4.59	3.94	109	129	0.954	0.50	5.28	0.022	3.33	0.003	♀	7	110.3	1.79	1.62	108	113	0.952	0.50	Minimum postorbital breadth	♂	22	99.4	6.05	6.08	87	110	0.953	0.10	0.43	0.510	1.03	0.310	♀	8	96.6	7.41	7.67	89	112	0.983	0.95	Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-	♀	2	135.5	2.12	1.56	134	137	-	-	Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																																																																																																																																																										
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	♀	9	108.7	5.83	5.36	96	113	0.804	0.05					Bisphenion	♂	20	108.0	4.64	4.29	100	115	0.812	<0.01	0.33	0.562	4.23	0.000	♀	8	100.1	3.83	3.82	95	108	0.759	0.02	Glabella-bregma	♂	22	117.7	5.15	4.37	110	128	0.838	<0.01	0.38	0.536	4.04	0.000	♀	9	109.9	4.25	3.86	102	115	0.915	0.10	Nasion-bregma	♂	22	120.9	5.14	4.25	114	131	0.856	0.01	0.71	0.398	3.37	0.002	♀	9	114.4	3.94	3.44	108	120	0.901	0.10	Metopion height	♂	22	23.8	3.62	15.21	16	30	0.960	0.50	0.01	0.905	0.61	0.547	♀	9	22.9	3.25	14.19	19	29	0.896	0.10	Nasion-metopion	♂	22	53.8	4.95	9.20	43	62	-	-	0.03	0.860	1.71	0.097	♀	9	50.6	4.69	9.26	41	57	-	-	Maximum supraorbital breadth	♂	21	116.3	4.59	3.94	109	129	0.954	0.50	5.28	0.022	3.33	0.003	♀	7	110.3	1.79	1.62	108	113	0.952	0.50	Minimum postorbital breadth	♂	22	99.4	6.05	6.08	87	110	0.953	0.10	0.43	0.510	1.03	0.310	♀	8	96.6	7.41	7.67	89	112	0.983	0.95	Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-	♀	2	135.5	2.12	1.56	134	137	-	-	Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																																																																																																																																																																																	
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	♀	9	22.9	3.25	14.19	19	29	0.896	0.10					Nasion-metopion	♂	22	53.8	4.95	9.20	43	62	-	-	0.03	0.860	1.71	0.097	♀	9	50.6	4.69	9.26	41	57	-	-	Maximum supraorbital breadth	♂	21	116.3	4.59	3.94	109	129	0.954	0.50	5.28	0.022	3.33	0.003	♀	7	110.3	1.79	1.62	108	113	0.952	0.50	Minimum postorbital breadth	♂	22	99.4	6.05	6.08	87	110	0.953	0.10	0.43	0.510	1.03	0.310	♀	8	96.6	7.41	7.67	89	112	0.983	0.95	Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-	♀	2	135.5	2.12	1.56	134	137	-	-	Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																																																																																																																																																																																																																																																																													
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	♀	9	50.6	4.69	9.26	41	57	-	-					Maximum supraorbital breadth	♂	21	116.3	4.59	3.94	109	129	0.954	0.50	5.28	0.022	3.33	0.003	♀	7	110.3	1.79	1.62	108	113	0.952	0.50	Minimum postorbital breadth	♂	22	99.4	6.05	6.08	87	110	0.953	0.10	0.43	0.510	1.03	0.310	♀	8	96.6	7.41	7.67	89	112	0.983	0.95	Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-	♀	2	135.5	2.12	1.56	134	137	-	-	Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																																																																																																																																																																																																																																																																																																				
Maximum supraorbital breadth	♂	21	116.3	4.59	3.94	109	129	0.954	0.50	5.28	0.022	3.33	0.003																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	7	110.3	1.79	1.62	108	113	0.952	0.50					Minimum postorbital breadth	♂	22	99.4	6.05	6.08	87	110	0.953	0.10	0.43	0.510	1.03	0.310	♀	8	96.6	7.41	7.67	89	112	0.983	0.95	Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-	♀	2	135.5	2.12	1.56	134	137	-	-	Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																																																																																																																																																																																																																																																																																																																											
Minimum postorbital breadth	♂	22	99.4	6.05	6.08	87	110	0.953	0.10	0.43	0.510	1.03	0.310																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	8	96.6	7.41	7.67	89	112	0.983	0.95					Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-	♀	2	135.5	2.12	1.56	134	137	-	-	Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																																																																																																																																																																																																																																																																																																																																																		
Bizygion	♂	7	143.1	4.94	3.45	136	150	0.948	0.50	-	-	-	-																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	2	135.5	2.12	1.56	134	137	-	-					Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232	♀	7	99.0	4.61	4.65	92	105	0.875	0.10	Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																																																																																																																																																																																																																																																																																																																																																																									
Bizygomaxillare	♂	15	101.5	4.43	4.36	94	109	0.961	0.50	0.01	0.910	1.23	0.232																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	7	99.0	4.61	4.65	92	105	0.875	0.10					Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585	♀	8	103.3	8.56	8.28	92	117	0.902	0.10	Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																																																																																																																																																																																																																																																																																																																																																																																																
Bistephanion	♂	21	105.1	7.54	7.17	87	119	0.976	0.50	0.16	0.683	0.55	0.585																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	8	103.3	8.56	8.28	92	117	0.902	0.10					Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
Bistenion	♂	22	72.0	3.42	4.75	64	79	0.970	0.50	1.67	0.196	1.97	0.058																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	8	69.4	2.20	3.17	67	73	0.912	0.10																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		

Table 4 (continued)

Variable	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	Shapiro Wilk	Proba- bility	χ^2	Proba- bility	Student's t	Proba- bility
Inion-opisthion	♂	22	44.2	4.78	10.81	35	55	0.920	0.10				
	♀	8	42.9	4.70	10.95	35	49	0.968	0.50	0.01	0.956	0.66	0.512
Lambda-opisthion	♂	22	102.2	6.54	6.39	93	120	0.857	0.01				
	♀	8	102.0	3.62	3.54	97	109	0.972	0.50	2.79	0.094	0.09	0.927
Occipital subtense height	♂	21	29.1	3.54	12.16	20	38	-	-				
	♀	5	25.0	6.81	27.24	13	29	-	-	3.41	0.065	1.95	0.063
Lambda-occipital subtense	♂	21	54.4	5.32	9.77	46	61	-	-				
	♀	2	52.5	5.50	10.47	46	50	-	-	0.01	0.941	0.66	0.515
Asterion-opisthion	♂	22	66.5	2.72	4.09	62	71	0.968	0.50				
	♀	8	66.3	2.31	3.48	63	69	-	-	0.25	0.619	0.23	0.819
Basion-asterion	♂	20	80.6	5.07	6.29	65	87	0.868	0.01				
	♀	8	78.0	5.95	7.62	65	84	0.839	0.10	0.26	0.609	1.28	0.212
Basion-mastoidale	♂	20	54.2	1.91	3.52	51	57	0.916	0.10				
	♀	8	54.0	2.61	4.83	49	58	0.965	0.50	1.03	0.310	0.28	0.781
Basion-staphylion	♂	11	50.3	3.74	7.43	46	57	0.915	0.10				
	♀	6	47.7	3.26	6.83	44	53	0.982	0.50	0.11	0.739	1.43	0.173
Bregma-lambda	♂	22	119.2	6.12	5.13	107	129	0.895	0.05				
	♀	9	113.9	7.20	6.32	100	121	0.826	0.05	0.30	0.582	2.09	0.045
Parietal subtense height	♂	22	24.3	3.23	13.29	18	29	-	-				
	♀	9	22.9	3.44	15.02	16	28	-	-	0.04	0.825	1.06	0.296
Lambda-parietal subtense	♂	22	61.5	5.00	8.13	55	72	-	-				
	♀	9	57.8	4.84	8.37	50	66	-	-	0.01	0.914	1.89	0.068
Lambda-inion	♂	22	69.6	8.58	12.32	59	91	0.853	0.01				
	♀	9	67.1	8.19	12.20	55	81	0.955	0.50	0.02	0.878	0.52	0.606
Lambda-asterion	♂	22	87.9	6.70	7.62	77	106	0.949	0.10				
	♀	9	81.2	7.78	9.58	62	90	0.850	0.10	0.25	0.616	2.39	0.023
Nasion-nasospinale	♂	17	54.4	3.06	5.62	50	59	0.894	0.05				
	♀	8	50.0	3.50	7.00	45	54	0.857	0.10	0.17	0.675	3.17	0.004
Nasion-prosthion	♂	16	75.0	3.38	4.50	70	82	0.875	0.05				
	♀	8	68.6	3.92	5.71	63	76	0.892	0.10	0.20	0.651	4.13	0.000
Nasospinale-prosthion	♂	17	20.5	3.64	17.75	13	27	0.917	0.10				
	♀	9	18.6	1.74	9.35	16	21	0.889	0.10	4.46	0.035	1.48	0.152
Nasal breadth	♂	20	29.5	1.46	4.94	27	32	0.955	0.50				
	♀	9	28.0	2.18	7.78	25	32	0.907	0.10	1.82	0.177	2.18	0.038
Orbital height	♂	18	31.7	2.57	8.10	26	36	0.954	0.50				
	♀	8	32.8	1.67	5.09	30	35	0.779	0.05	1.52	0.218	1.08	0.287
Orbital breadth	♂	19	43.7	1.99	4.55	42	48	0.801	<0.01				
	♀	7	43.7	1.25	2.86	42	46	0.771	0.05	1.54	0.213	0.03	0.978
Biectoconchion	♂	17	108.4	3.35	3.09	103	114	0.924	0.10				
	♀	7	104.1	3.34	2.24	101	107	0.902	0.10	0.94	0.331	3.06	0.006
Alveolar length	♂	18	64.7	2.58	3.98	61	69	0.943	0.10				
	♀	9	60.4	3.84	6.35	57	70	0.761	0.02	1.76	0.185	3.44	0.002
Alveolar breadth	♂	17	72.7	3.69	5.07	67	83	0.900	0.10				
	♀	8	67.8	2.81	4.14	65	72	0.809	0.05	0.54	0.462	3.41	0.002

Table 4 (continued)

Variable	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	Shapiro Wilk	Proba- bility	χ^2	Proba- bility	Student's t	Proba- bility																																																																																																																																																																																																																																																																															
Bicanine breadth	♂	17	48.1	2.95	6.13	42	53	0.941	0.10	0.64	0.423	0.79	0.437																																																																																																																																																																																																																																																																															
	♀	9	47.2	2.27	4.80	44	51	0.960	0.50					Mastoid depth	♂	22	31.2	2.50	8.01	27	36	0.960	0.50	0.28	0.593	3.32	0.002	♀	8	27.9	2.10	7.52	25	31	0.954	0.50	Frontal arc	♂	21	133.9	6.70	5.00	112	143	0.956	0.50	0.75	0.385	2.42	0.022	♀	9	127.8	5.09	3.98	121	135	0.919	0.10	Parietal arc	♂	21	133.3	8.42	6.31	117	148	0.866	0.01	0.01	0.928	1.95	0.061	♀	9	126.7	8.66	6.83	108	135	0.924	0.10	Occipital arc	♂	21	121.7	1.98	1.62	109	143	0.889	0.02	3.63	0.057	0.08	0.932	♀	8	121.3	4.56	3.75	115	129	0.950	0.50	Frontal curvature index	♂	22	19.7	3.19	16.19	12	24	-	-	0.01	0.931	0.22	0.828	♀	9	20.0	3.28	16.79	16	25	-	-	Parietal curvature index	♂	22	20.3	1.95	9.60	17	23	-	-	0.64	0.424	0.28	0.782	♀	9	20.1	2.46	9.51	16	24	-	-	Occipital curvature index	♂	21	28.5	3.50	12.28	20	35	-	-	2.86	0.090	1.92	0.066	♀	5	24.5	6.42	26.20	13	29	-	-	Gnathic index	♂	15	105.0	3.36	3.20	98	111	-	-	0.01	0.946	0.08	0.935	♀	7	104.9	3.28	3.12	100	110	-	-	Nasal index	♂	17	54.6	4.08	7.47	47	61	-	-	0.05	0.819	0.31	0.759	♀	8	55.1	3.78	6.86	50	63	-	-	Orbital index	♂	17	71.8	5.96	8.30	60	86	-	-	3.86	0.049	1.40	0.173	♀	7	75.1	2.71	3.60	71	79	-	-	Palate module	♂	17	47.0	3.47	7.38	42	55	-	-	0.07	0.796	4.07	0.000	♀	8	41.1	3.18	7.73	37	50	-	-	Cranial module	♂	20	157.8	4.77	3.02	148	168	-	-	0.00	0.997	2.91	0.007	♀	9	152.2	4.78
Mastoid depth	♂	22	31.2	2.50	8.01	27	36	0.960	0.50	0.28	0.593	3.32	0.002																																																																																																																																																																																																																																																																															
	♀	8	27.9	2.10	7.52	25	31	0.954	0.50					Frontal arc	♂	21	133.9	6.70	5.00	112	143	0.956	0.50	0.75	0.385	2.42	0.022	♀	9	127.8	5.09	3.98	121	135	0.919	0.10	Parietal arc	♂	21	133.3	8.42	6.31	117	148	0.866	0.01	0.01	0.928	1.95	0.061	♀	9	126.7	8.66	6.83	108	135	0.924	0.10	Occipital arc	♂	21	121.7	1.98	1.62	109	143	0.889	0.02	3.63	0.057	0.08	0.932	♀	8	121.3	4.56	3.75	115	129	0.950	0.50	Frontal curvature index	♂	22	19.7	3.19	16.19	12	24	-	-	0.01	0.931	0.22	0.828	♀	9	20.0	3.28	16.79	16	25	-	-	Parietal curvature index	♂	22	20.3	1.95	9.60	17	23	-	-	0.64	0.424	0.28	0.782	♀	9	20.1	2.46	9.51	16	24	-	-	Occipital curvature index	♂	21	28.5	3.50	12.28	20	35	-	-	2.86	0.090	1.92	0.066	♀	5	24.5	6.42	26.20	13	29	-	-	Gnathic index	♂	15	105.0	3.36	3.20	98	111	-	-	0.01	0.946	0.08	0.935	♀	7	104.9	3.28	3.12	100	110	-	-	Nasal index	♂	17	54.6	4.08	7.47	47	61	-	-	0.05	0.819	0.31	0.759	♀	8	55.1	3.78	6.86	50	63	-	-	Orbital index	♂	17	71.8	5.96	8.30	60	86	-	-	3.86	0.049	1.40	0.173	♀	7	75.1	2.71	3.60	71	79	-	-	Palate module	♂	17	47.0	3.47	7.38	42	55	-	-	0.07	0.796	4.07	0.000	♀	8	41.1	3.18	7.73	37	50	-	-	Cranial module	♂	20	157.8	4.77	3.02	148	168	-	-	0.00	0.997	2.91	0.007	♀	9	152.2	4.78	3.14	145	158	-	-																		
Frontal arc	♂	21	133.9	6.70	5.00	112	143	0.956	0.50	0.75	0.385	2.42	0.022																																																																																																																																																																																																																																																																															
	♀	9	127.8	5.09	3.98	121	135	0.919	0.10					Parietal arc	♂	21	133.3	8.42	6.31	117	148	0.866	0.01	0.01	0.928	1.95	0.061	♀	9	126.7	8.66	6.83	108	135	0.924	0.10	Occipital arc	♂	21	121.7	1.98	1.62	109	143	0.889	0.02	3.63	0.057	0.08	0.932	♀	8	121.3	4.56	3.75	115	129	0.950	0.50	Frontal curvature index	♂	22	19.7	3.19	16.19	12	24	-	-	0.01	0.931	0.22	0.828	♀	9	20.0	3.28	16.79	16	25	-	-	Parietal curvature index	♂	22	20.3	1.95	9.60	17	23	-	-	0.64	0.424	0.28	0.782	♀	9	20.1	2.46	9.51	16	24	-	-	Occipital curvature index	♂	21	28.5	3.50	12.28	20	35	-	-	2.86	0.090	1.92	0.066	♀	5	24.5	6.42	26.20	13	29	-	-	Gnathic index	♂	15	105.0	3.36	3.20	98	111	-	-	0.01	0.946	0.08	0.935	♀	7	104.9	3.28	3.12	100	110	-	-	Nasal index	♂	17	54.6	4.08	7.47	47	61	-	-	0.05	0.819	0.31	0.759	♀	8	55.1	3.78	6.86	50	63	-	-	Orbital index	♂	17	71.8	5.96	8.30	60	86	-	-	3.86	0.049	1.40	0.173	♀	7	75.1	2.71	3.60	71	79	-	-	Palate module	♂	17	47.0	3.47	7.38	42	55	-	-	0.07	0.796	4.07	0.000	♀	8	41.1	3.18	7.73	37	50	-	-	Cranial module	♂	20	157.8	4.77	3.02	148	168	-	-	0.00	0.997	2.91	0.007	♀	9	152.2	4.78	3.14	145	158	-	-																																									
Parietal arc	♂	21	133.3	8.42	6.31	117	148	0.866	0.01	0.01	0.928	1.95	0.061																																																																																																																																																																																																																																																																															
	♀	9	126.7	8.66	6.83	108	135	0.924	0.10					Occipital arc	♂	21	121.7	1.98	1.62	109	143	0.889	0.02	3.63	0.057	0.08	0.932	♀	8	121.3	4.56	3.75	115	129	0.950	0.50	Frontal curvature index	♂	22	19.7	3.19	16.19	12	24	-	-	0.01	0.931	0.22	0.828	♀	9	20.0	3.28	16.79	16	25	-	-	Parietal curvature index	♂	22	20.3	1.95	9.60	17	23	-	-	0.64	0.424	0.28	0.782	♀	9	20.1	2.46	9.51	16	24	-	-	Occipital curvature index	♂	21	28.5	3.50	12.28	20	35	-	-	2.86	0.090	1.92	0.066	♀	5	24.5	6.42	26.20	13	29	-	-	Gnathic index	♂	15	105.0	3.36	3.20	98	111	-	-	0.01	0.946	0.08	0.935	♀	7	104.9	3.28	3.12	100	110	-	-	Nasal index	♂	17	54.6	4.08	7.47	47	61	-	-	0.05	0.819	0.31	0.759	♀	8	55.1	3.78	6.86	50	63	-	-	Orbital index	♂	17	71.8	5.96	8.30	60	86	-	-	3.86	0.049	1.40	0.173	♀	7	75.1	2.71	3.60	71	79	-	-	Palate module	♂	17	47.0	3.47	7.38	42	55	-	-	0.07	0.796	4.07	0.000	♀	8	41.1	3.18	7.73	37	50	-	-	Cranial module	♂	20	157.8	4.77	3.02	148	168	-	-	0.00	0.997	2.91	0.007	♀	9	152.2	4.78	3.14	145	158	-	-																																																																
Occipital arc	♂	21	121.7	1.98	1.62	109	143	0.889	0.02	3.63	0.057	0.08	0.932																																																																																																																																																																																																																																																																															
	♀	8	121.3	4.56	3.75	115	129	0.950	0.50					Frontal curvature index	♂	22	19.7	3.19	16.19	12	24	-	-	0.01	0.931	0.22	0.828	♀	9	20.0	3.28	16.79	16	25	-	-	Parietal curvature index	♂	22	20.3	1.95	9.60	17	23	-	-	0.64	0.424	0.28	0.782	♀	9	20.1	2.46	9.51	16	24	-	-	Occipital curvature index	♂	21	28.5	3.50	12.28	20	35	-	-	2.86	0.090	1.92	0.066	♀	5	24.5	6.42	26.20	13	29	-	-	Gnathic index	♂	15	105.0	3.36	3.20	98	111	-	-	0.01	0.946	0.08	0.935	♀	7	104.9	3.28	3.12	100	110	-	-	Nasal index	♂	17	54.6	4.08	7.47	47	61	-	-	0.05	0.819	0.31	0.759	♀	8	55.1	3.78	6.86	50	63	-	-	Orbital index	♂	17	71.8	5.96	8.30	60	86	-	-	3.86	0.049	1.40	0.173	♀	7	75.1	2.71	3.60	71	79	-	-	Palate module	♂	17	47.0	3.47	7.38	42	55	-	-	0.07	0.796	4.07	0.000	♀	8	41.1	3.18	7.73	37	50	-	-	Cranial module	♂	20	157.8	4.77	3.02	148	168	-	-	0.00	0.997	2.91	0.007	♀	9	152.2	4.78	3.14	145	158	-	-																																																																																							
Frontal curvature index	♂	22	19.7	3.19	16.19	12	24	-	-	0.01	0.931	0.22	0.828																																																																																																																																																																																																																																																																															
	♀	9	20.0	3.28	16.79	16	25	-	-					Parietal curvature index	♂	22	20.3	1.95	9.60	17	23	-	-	0.64	0.424	0.28	0.782	♀	9	20.1	2.46	9.51	16	24	-	-	Occipital curvature index	♂	21	28.5	3.50	12.28	20	35	-	-	2.86	0.090	1.92	0.066	♀	5	24.5	6.42	26.20	13	29	-	-	Gnathic index	♂	15	105.0	3.36	3.20	98	111	-	-	0.01	0.946	0.08	0.935	♀	7	104.9	3.28	3.12	100	110	-	-	Nasal index	♂	17	54.6	4.08	7.47	47	61	-	-	0.05	0.819	0.31	0.759	♀	8	55.1	3.78	6.86	50	63	-	-	Orbital index	♂	17	71.8	5.96	8.30	60	86	-	-	3.86	0.049	1.40	0.173	♀	7	75.1	2.71	3.60	71	79	-	-	Palate module	♂	17	47.0	3.47	7.38	42	55	-	-	0.07	0.796	4.07	0.000	♀	8	41.1	3.18	7.73	37	50	-	-	Cranial module	♂	20	157.8	4.77	3.02	148	168	-	-	0.00	0.997	2.91	0.007	♀	9	152.2	4.78	3.14	145	158	-	-																																																																																																														
Parietal curvature index	♂	22	20.3	1.95	9.60	17	23	-	-	0.64	0.424	0.28	0.782																																																																																																																																																																																																																																																																															
	♀	9	20.1	2.46	9.51	16	24	-	-					Occipital curvature index	♂	21	28.5	3.50	12.28	20	35	-	-	2.86	0.090	1.92	0.066	♀	5	24.5	6.42	26.20	13	29	-	-	Gnathic index	♂	15	105.0	3.36	3.20	98	111	-	-	0.01	0.946	0.08	0.935	♀	7	104.9	3.28	3.12	100	110	-	-	Nasal index	♂	17	54.6	4.08	7.47	47	61	-	-	0.05	0.819	0.31	0.759	♀	8	55.1	3.78	6.86	50	63	-	-	Orbital index	♂	17	71.8	5.96	8.30	60	86	-	-	3.86	0.049	1.40	0.173	♀	7	75.1	2.71	3.60	71	79	-	-	Palate module	♂	17	47.0	3.47	7.38	42	55	-	-	0.07	0.796	4.07	0.000	♀	8	41.1	3.18	7.73	37	50	-	-	Cranial module	♂	20	157.8	4.77	3.02	148	168	-	-	0.00	0.997	2.91	0.007	♀	9	152.2	4.78	3.14	145	158	-	-																																																																																																																																					
Occipital curvature index	♂	21	28.5	3.50	12.28	20	35	-	-	2.86	0.090	1.92	0.066																																																																																																																																																																																																																																																																															
	♀	5	24.5	6.42	26.20	13	29	-	-					Gnathic index	♂	15	105.0	3.36	3.20	98	111	-	-	0.01	0.946	0.08	0.935	♀	7	104.9	3.28	3.12	100	110	-	-	Nasal index	♂	17	54.6	4.08	7.47	47	61	-	-	0.05	0.819	0.31	0.759	♀	8	55.1	3.78	6.86	50	63	-	-	Orbital index	♂	17	71.8	5.96	8.30	60	86	-	-	3.86	0.049	1.40	0.173	♀	7	75.1	2.71	3.60	71	79	-	-	Palate module	♂	17	47.0	3.47	7.38	42	55	-	-	0.07	0.796	4.07	0.000	♀	8	41.1	3.18	7.73	37	50	-	-	Cranial module	♂	20	157.8	4.77	3.02	148	168	-	-	0.00	0.997	2.91	0.007	♀	9	152.2	4.78	3.14	145	158	-	-																																																																																																																																																												
Gnathic index	♂	15	105.0	3.36	3.20	98	111	-	-	0.01	0.946	0.08	0.935																																																																																																																																																																																																																																																																															
	♀	7	104.9	3.28	3.12	100	110	-	-					Nasal index	♂	17	54.6	4.08	7.47	47	61	-	-	0.05	0.819	0.31	0.759	♀	8	55.1	3.78	6.86	50	63	-	-	Orbital index	♂	17	71.8	5.96	8.30	60	86	-	-	3.86	0.049	1.40	0.173	♀	7	75.1	2.71	3.60	71	79	-	-	Palate module	♂	17	47.0	3.47	7.38	42	55	-	-	0.07	0.796	4.07	0.000	♀	8	41.1	3.18	7.73	37	50	-	-	Cranial module	♂	20	157.8	4.77	3.02	148	168	-	-	0.00	0.997	2.91	0.007	♀	9	152.2	4.78	3.14	145	158	-	-																																																																																																																																																																																			
Nasal index	♂	17	54.6	4.08	7.47	47	61	-	-	0.05	0.819	0.31	0.759																																																																																																																																																																																																																																																																															
	♀	8	55.1	3.78	6.86	50	63	-	-					Orbital index	♂	17	71.8	5.96	8.30	60	86	-	-	3.86	0.049	1.40	0.173	♀	7	75.1	2.71	3.60	71	79	-	-	Palate module	♂	17	47.0	3.47	7.38	42	55	-	-	0.07	0.796	4.07	0.000	♀	8	41.1	3.18	7.73	37	50	-	-	Cranial module	♂	20	157.8	4.77	3.02	148	168	-	-	0.00	0.997	2.91	0.007	♀	9	152.2	4.78	3.14	145	158	-	-																																																																																																																																																																																																										
Orbital index	♂	17	71.8	5.96	8.30	60	86	-	-	3.86	0.049	1.40	0.173																																																																																																																																																																																																																																																																															
	♀	7	75.1	2.71	3.60	71	79	-	-					Palate module	♂	17	47.0	3.47	7.38	42	55	-	-	0.07	0.796	4.07	0.000	♀	8	41.1	3.18	7.73	37	50	-	-	Cranial module	♂	20	157.8	4.77	3.02	148	168	-	-	0.00	0.997	2.91	0.007	♀	9	152.2	4.78	3.14	145	158	-	-																																																																																																																																																																																																																																	
Palate module	♂	17	47.0	3.47	7.38	42	55	-	-	0.07	0.796	4.07	0.000																																																																																																																																																																																																																																																																															
	♀	8	41.1	3.18	7.73	37	50	-	-					Cranial module	♂	20	157.8	4.77	3.02	148	168	-	-	0.00	0.997	2.91	0.007	♀	9	152.2	4.78	3.14	145	158	-	-																																																																																																																																																																																																																																																								
Cranial module	♂	20	157.8	4.77	3.02	148	168	-	-	0.00	0.997	2.91	0.007																																																																																																																																																																																																																																																																															
	♀	9	152.2	4.78	3.14	145	158	-	-																																																																																																																																																																																																																																																																																			

Table 5 Descriptive and comparative statistics for the Murray Valley male and female cranial dimensions (mm)

Variable	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	Shapiro Wilk	Probability	χ^2	Probability	Student's t	Probability																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
Maximum biparietal breadth	♂	46	130.5	4.52	3.46	122	143	0.978	0.50	0.09	0.770	3.45	0.001																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	51	127.3	4.72	3.70	115	139	0.973	0.50					Glabella-opisthocranion	♂	47	189.1	5.76	3.04	178	201	0.962	0.10	0.89	0.344	8.55	0.000	♀	52	179.9	5.02	2.80	169	192	0.979	0.50	Glabella-lambda	♂	47	184.3	5.76	3.12	170	198	0.992	0.99	1.48	0.223	9.26	0.000	♀	53	174.5	4.83	2.80	163	188	0.979	0.50	Basion-bregma	♂	45	133.5	4.05	3.03	126	143	0.972	0.10	0.28	0.592	8.23	0.000	♀	50	126.3	4.38	3.47	118	137	0.966	0.10	Basion-nasion	♂	45	102.5	3.29	3.21	95	108	0.956	0.10	1.43	0.231	8.33	0.000	♀	50	96.3	3.93	4.08	83	104	0.951	0.05	Basion-nasospinale	♂	45	99.0	3.89	3.92	90	107	0.963	0.10	3.60	0.058	5.71	0.000	♀	50	93.6	5.16	5.51	73	103	0.930	0.01	Basion-prosthion	♂	45	106.5	4.38	4.11	95	116	0.962	0.10	2.99	0.083	6.04	0.000	♀	50	100.2	5.67	5.66	83	110	0.946	0.02	Basion-lambda	♂	45	114.2	2.83	2.48	108	119	0.950	0.05	8.53	0.003	7.07	0.000	♀	50	108.8	4.41	4.05	91	118	0.926	0.01	Basion-inion	♂	43	81.5	4.93	6.05	69	91	0.969	0.10	8.94	0.003	5.49	0.000	♀	50	73.9	7.81	10.57	40	90	0.864	<0.01	Biauriculare	♂	47	121.3	4.23	3.49	112	131	0.967	0.10	0.99	0.319	6.23	0.000	♀	52	115.5	4.89	4.24	104	126	0.984	0.50	Biasterion	♂	44	111.5	3.84	3.45	105	120	0.961	0.10	0.04	0.847	7.71	0.000	♀	52	105.3	3.94	3.74	98	112	0.942	0.02	Bisphenion	♂	45	103.6	3.77	3.64	96	111	0.957	0.10	1.12	0.290	4.11	0.000	♀	52	100.2	4.44	4.43	92	110	0.972	0.10	Glabella-bregma	♂	47	109.9	4.38	3.99	99	117	0.963	0.10	0.41	0.521	8.32	0.000	♀	53	102.9	3.99	3.88	95	117	0.961	0.10	Nasion-bregma	♂	47	113.5	4.28	3.77	102	120	0.958	0.10	1.49	0.223	7.54	0.000	♀	53	107.5	3.59	3.34	100	120	0.954	0.05	Metopion height	♂	47	25.6	2.20	8.61	21	30	0.948	0.05	0.01	0.945	1.06	0.293	♀	52	25.2	2.18	8.69	21	30	0.951	0.05	Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000	♀	52	47.9	3.22	6.72	41	56	0.980	0.50	Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05
Glabella-opisthocranion	♂	47	189.1	5.76	3.04	178	201	0.962	0.10	0.89	0.344	8.55	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	52	179.9	5.02	2.80	169	192	0.979	0.50					Glabella-lambda	♂	47	184.3	5.76	3.12	170	198	0.992	0.99	1.48	0.223	9.26	0.000	♀	53	174.5	4.83	2.80	163	188	0.979	0.50	Basion-bregma	♂	45	133.5	4.05	3.03	126	143	0.972	0.10	0.28	0.592	8.23	0.000	♀	50	126.3	4.38	3.47	118	137	0.966	0.10	Basion-nasion	♂	45	102.5	3.29	3.21	95	108	0.956	0.10	1.43	0.231	8.33	0.000	♀	50	96.3	3.93	4.08	83	104	0.951	0.05	Basion-nasospinale	♂	45	99.0	3.89	3.92	90	107	0.963	0.10	3.60	0.058	5.71	0.000	♀	50	93.6	5.16	5.51	73	103	0.930	0.01	Basion-prosthion	♂	45	106.5	4.38	4.11	95	116	0.962	0.10	2.99	0.083	6.04	0.000	♀	50	100.2	5.67	5.66	83	110	0.946	0.02	Basion-lambda	♂	45	114.2	2.83	2.48	108	119	0.950	0.05	8.53	0.003	7.07	0.000	♀	50	108.8	4.41	4.05	91	118	0.926	0.01	Basion-inion	♂	43	81.5	4.93	6.05	69	91	0.969	0.10	8.94	0.003	5.49	0.000	♀	50	73.9	7.81	10.57	40	90	0.864	<0.01	Biauriculare	♂	47	121.3	4.23	3.49	112	131	0.967	0.10	0.99	0.319	6.23	0.000	♀	52	115.5	4.89	4.24	104	126	0.984	0.50	Biasterion	♂	44	111.5	3.84	3.45	105	120	0.961	0.10	0.04	0.847	7.71	0.000	♀	52	105.3	3.94	3.74	98	112	0.942	0.02	Bisphenion	♂	45	103.6	3.77	3.64	96	111	0.957	0.10	1.12	0.290	4.11	0.000	♀	52	100.2	4.44	4.43	92	110	0.972	0.10	Glabella-bregma	♂	47	109.9	4.38	3.99	99	117	0.963	0.10	0.41	0.521	8.32	0.000	♀	53	102.9	3.99	3.88	95	117	0.961	0.10	Nasion-bregma	♂	47	113.5	4.28	3.77	102	120	0.958	0.10	1.49	0.223	7.54	0.000	♀	53	107.5	3.59	3.34	100	120	0.954	0.05	Metopion height	♂	47	25.6	2.20	8.61	21	30	0.948	0.05	0.01	0.945	1.06	0.293	♀	52	25.2	2.18	8.69	21	30	0.951	0.05	Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000	♀	52	47.9	3.22	6.72	41	56	0.980	0.50	Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																		
Glabella-lambda	♂	47	184.3	5.76	3.12	170	198	0.992	0.99	1.48	0.223	9.26	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	53	174.5	4.83	2.80	163	188	0.979	0.50					Basion-bregma	♂	45	133.5	4.05	3.03	126	143	0.972	0.10	0.28	0.592	8.23	0.000	♀	50	126.3	4.38	3.47	118	137	0.966	0.10	Basion-nasion	♂	45	102.5	3.29	3.21	95	108	0.956	0.10	1.43	0.231	8.33	0.000	♀	50	96.3	3.93	4.08	83	104	0.951	0.05	Basion-nasospinale	♂	45	99.0	3.89	3.92	90	107	0.963	0.10	3.60	0.058	5.71	0.000	♀	50	93.6	5.16	5.51	73	103	0.930	0.01	Basion-prosthion	♂	45	106.5	4.38	4.11	95	116	0.962	0.10	2.99	0.083	6.04	0.000	♀	50	100.2	5.67	5.66	83	110	0.946	0.02	Basion-lambda	♂	45	114.2	2.83	2.48	108	119	0.950	0.05	8.53	0.003	7.07	0.000	♀	50	108.8	4.41	4.05	91	118	0.926	0.01	Basion-inion	♂	43	81.5	4.93	6.05	69	91	0.969	0.10	8.94	0.003	5.49	0.000	♀	50	73.9	7.81	10.57	40	90	0.864	<0.01	Biauriculare	♂	47	121.3	4.23	3.49	112	131	0.967	0.10	0.99	0.319	6.23	0.000	♀	52	115.5	4.89	4.24	104	126	0.984	0.50	Biasterion	♂	44	111.5	3.84	3.45	105	120	0.961	0.10	0.04	0.847	7.71	0.000	♀	52	105.3	3.94	3.74	98	112	0.942	0.02	Bisphenion	♂	45	103.6	3.77	3.64	96	111	0.957	0.10	1.12	0.290	4.11	0.000	♀	52	100.2	4.44	4.43	92	110	0.972	0.10	Glabella-bregma	♂	47	109.9	4.38	3.99	99	117	0.963	0.10	0.41	0.521	8.32	0.000	♀	53	102.9	3.99	3.88	95	117	0.961	0.10	Nasion-bregma	♂	47	113.5	4.28	3.77	102	120	0.958	0.10	1.49	0.223	7.54	0.000	♀	53	107.5	3.59	3.34	100	120	0.954	0.05	Metopion height	♂	47	25.6	2.20	8.61	21	30	0.948	0.05	0.01	0.945	1.06	0.293	♀	52	25.2	2.18	8.69	21	30	0.951	0.05	Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000	♀	52	47.9	3.22	6.72	41	56	0.980	0.50	Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																									
Basion-bregma	♂	45	133.5	4.05	3.03	126	143	0.972	0.10	0.28	0.592	8.23	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	50	126.3	4.38	3.47	118	137	0.966	0.10					Basion-nasion	♂	45	102.5	3.29	3.21	95	108	0.956	0.10	1.43	0.231	8.33	0.000	♀	50	96.3	3.93	4.08	83	104	0.951	0.05	Basion-nasospinale	♂	45	99.0	3.89	3.92	90	107	0.963	0.10	3.60	0.058	5.71	0.000	♀	50	93.6	5.16	5.51	73	103	0.930	0.01	Basion-prosthion	♂	45	106.5	4.38	4.11	95	116	0.962	0.10	2.99	0.083	6.04	0.000	♀	50	100.2	5.67	5.66	83	110	0.946	0.02	Basion-lambda	♂	45	114.2	2.83	2.48	108	119	0.950	0.05	8.53	0.003	7.07	0.000	♀	50	108.8	4.41	4.05	91	118	0.926	0.01	Basion-inion	♂	43	81.5	4.93	6.05	69	91	0.969	0.10	8.94	0.003	5.49	0.000	♀	50	73.9	7.81	10.57	40	90	0.864	<0.01	Biauriculare	♂	47	121.3	4.23	3.49	112	131	0.967	0.10	0.99	0.319	6.23	0.000	♀	52	115.5	4.89	4.24	104	126	0.984	0.50	Biasterion	♂	44	111.5	3.84	3.45	105	120	0.961	0.10	0.04	0.847	7.71	0.000	♀	52	105.3	3.94	3.74	98	112	0.942	0.02	Bisphenion	♂	45	103.6	3.77	3.64	96	111	0.957	0.10	1.12	0.290	4.11	0.000	♀	52	100.2	4.44	4.43	92	110	0.972	0.10	Glabella-bregma	♂	47	109.9	4.38	3.99	99	117	0.963	0.10	0.41	0.521	8.32	0.000	♀	53	102.9	3.99	3.88	95	117	0.961	0.10	Nasion-bregma	♂	47	113.5	4.28	3.77	102	120	0.958	0.10	1.49	0.223	7.54	0.000	♀	53	107.5	3.59	3.34	100	120	0.954	0.05	Metopion height	♂	47	25.6	2.20	8.61	21	30	0.948	0.05	0.01	0.945	1.06	0.293	♀	52	25.2	2.18	8.69	21	30	0.951	0.05	Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000	♀	52	47.9	3.22	6.72	41	56	0.980	0.50	Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																
Basion-nasion	♂	45	102.5	3.29	3.21	95	108	0.956	0.10	1.43	0.231	8.33	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	50	96.3	3.93	4.08	83	104	0.951	0.05					Basion-nasospinale	♂	45	99.0	3.89	3.92	90	107	0.963	0.10	3.60	0.058	5.71	0.000	♀	50	93.6	5.16	5.51	73	103	0.930	0.01	Basion-prosthion	♂	45	106.5	4.38	4.11	95	116	0.962	0.10	2.99	0.083	6.04	0.000	♀	50	100.2	5.67	5.66	83	110	0.946	0.02	Basion-lambda	♂	45	114.2	2.83	2.48	108	119	0.950	0.05	8.53	0.003	7.07	0.000	♀	50	108.8	4.41	4.05	91	118	0.926	0.01	Basion-inion	♂	43	81.5	4.93	6.05	69	91	0.969	0.10	8.94	0.003	5.49	0.000	♀	50	73.9	7.81	10.57	40	90	0.864	<0.01	Biauriculare	♂	47	121.3	4.23	3.49	112	131	0.967	0.10	0.99	0.319	6.23	0.000	♀	52	115.5	4.89	4.24	104	126	0.984	0.50	Biasterion	♂	44	111.5	3.84	3.45	105	120	0.961	0.10	0.04	0.847	7.71	0.000	♀	52	105.3	3.94	3.74	98	112	0.942	0.02	Bisphenion	♂	45	103.6	3.77	3.64	96	111	0.957	0.10	1.12	0.290	4.11	0.000	♀	52	100.2	4.44	4.43	92	110	0.972	0.10	Glabella-bregma	♂	47	109.9	4.38	3.99	99	117	0.963	0.10	0.41	0.521	8.32	0.000	♀	53	102.9	3.99	3.88	95	117	0.961	0.10	Nasion-bregma	♂	47	113.5	4.28	3.77	102	120	0.958	0.10	1.49	0.223	7.54	0.000	♀	53	107.5	3.59	3.34	100	120	0.954	0.05	Metopion height	♂	47	25.6	2.20	8.61	21	30	0.948	0.05	0.01	0.945	1.06	0.293	♀	52	25.2	2.18	8.69	21	30	0.951	0.05	Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000	♀	52	47.9	3.22	6.72	41	56	0.980	0.50	Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																							
Basion-nasospinale	♂	45	99.0	3.89	3.92	90	107	0.963	0.10	3.60	0.058	5.71	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	50	93.6	5.16	5.51	73	103	0.930	0.01					Basion-prosthion	♂	45	106.5	4.38	4.11	95	116	0.962	0.10	2.99	0.083	6.04	0.000	♀	50	100.2	5.67	5.66	83	110	0.946	0.02	Basion-lambda	♂	45	114.2	2.83	2.48	108	119	0.950	0.05	8.53	0.003	7.07	0.000	♀	50	108.8	4.41	4.05	91	118	0.926	0.01	Basion-inion	♂	43	81.5	4.93	6.05	69	91	0.969	0.10	8.94	0.003	5.49	0.000	♀	50	73.9	7.81	10.57	40	90	0.864	<0.01	Biauriculare	♂	47	121.3	4.23	3.49	112	131	0.967	0.10	0.99	0.319	6.23	0.000	♀	52	115.5	4.89	4.24	104	126	0.984	0.50	Biasterion	♂	44	111.5	3.84	3.45	105	120	0.961	0.10	0.04	0.847	7.71	0.000	♀	52	105.3	3.94	3.74	98	112	0.942	0.02	Bisphenion	♂	45	103.6	3.77	3.64	96	111	0.957	0.10	1.12	0.290	4.11	0.000	♀	52	100.2	4.44	4.43	92	110	0.972	0.10	Glabella-bregma	♂	47	109.9	4.38	3.99	99	117	0.963	0.10	0.41	0.521	8.32	0.000	♀	53	102.9	3.99	3.88	95	117	0.961	0.10	Nasion-bregma	♂	47	113.5	4.28	3.77	102	120	0.958	0.10	1.49	0.223	7.54	0.000	♀	53	107.5	3.59	3.34	100	120	0.954	0.05	Metopion height	♂	47	25.6	2.20	8.61	21	30	0.948	0.05	0.01	0.945	1.06	0.293	♀	52	25.2	2.18	8.69	21	30	0.951	0.05	Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000	♀	52	47.9	3.22	6.72	41	56	0.980	0.50	Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																														
Basion-prosthion	♂	45	106.5	4.38	4.11	95	116	0.962	0.10	2.99	0.083	6.04	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	50	100.2	5.67	5.66	83	110	0.946	0.02					Basion-lambda	♂	45	114.2	2.83	2.48	108	119	0.950	0.05	8.53	0.003	7.07	0.000	♀	50	108.8	4.41	4.05	91	118	0.926	0.01	Basion-inion	♂	43	81.5	4.93	6.05	69	91	0.969	0.10	8.94	0.003	5.49	0.000	♀	50	73.9	7.81	10.57	40	90	0.864	<0.01	Biauriculare	♂	47	121.3	4.23	3.49	112	131	0.967	0.10	0.99	0.319	6.23	0.000	♀	52	115.5	4.89	4.24	104	126	0.984	0.50	Biasterion	♂	44	111.5	3.84	3.45	105	120	0.961	0.10	0.04	0.847	7.71	0.000	♀	52	105.3	3.94	3.74	98	112	0.942	0.02	Bisphenion	♂	45	103.6	3.77	3.64	96	111	0.957	0.10	1.12	0.290	4.11	0.000	♀	52	100.2	4.44	4.43	92	110	0.972	0.10	Glabella-bregma	♂	47	109.9	4.38	3.99	99	117	0.963	0.10	0.41	0.521	8.32	0.000	♀	53	102.9	3.99	3.88	95	117	0.961	0.10	Nasion-bregma	♂	47	113.5	4.28	3.77	102	120	0.958	0.10	1.49	0.223	7.54	0.000	♀	53	107.5	3.59	3.34	100	120	0.954	0.05	Metopion height	♂	47	25.6	2.20	8.61	21	30	0.948	0.05	0.01	0.945	1.06	0.293	♀	52	25.2	2.18	8.69	21	30	0.951	0.05	Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000	♀	52	47.9	3.22	6.72	41	56	0.980	0.50	Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																					
Basion-lambda	♂	45	114.2	2.83	2.48	108	119	0.950	0.05	8.53	0.003	7.07	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	50	108.8	4.41	4.05	91	118	0.926	0.01					Basion-inion	♂	43	81.5	4.93	6.05	69	91	0.969	0.10	8.94	0.003	5.49	0.000	♀	50	73.9	7.81	10.57	40	90	0.864	<0.01	Biauriculare	♂	47	121.3	4.23	3.49	112	131	0.967	0.10	0.99	0.319	6.23	0.000	♀	52	115.5	4.89	4.24	104	126	0.984	0.50	Biasterion	♂	44	111.5	3.84	3.45	105	120	0.961	0.10	0.04	0.847	7.71	0.000	♀	52	105.3	3.94	3.74	98	112	0.942	0.02	Bisphenion	♂	45	103.6	3.77	3.64	96	111	0.957	0.10	1.12	0.290	4.11	0.000	♀	52	100.2	4.44	4.43	92	110	0.972	0.10	Glabella-bregma	♂	47	109.9	4.38	3.99	99	117	0.963	0.10	0.41	0.521	8.32	0.000	♀	53	102.9	3.99	3.88	95	117	0.961	0.10	Nasion-bregma	♂	47	113.5	4.28	3.77	102	120	0.958	0.10	1.49	0.223	7.54	0.000	♀	53	107.5	3.59	3.34	100	120	0.954	0.05	Metopion height	♂	47	25.6	2.20	8.61	21	30	0.948	0.05	0.01	0.945	1.06	0.293	♀	52	25.2	2.18	8.69	21	30	0.951	0.05	Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000	♀	52	47.9	3.22	6.72	41	56	0.980	0.50	Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																																												
Basion-inion	♂	43	81.5	4.93	6.05	69	91	0.969	0.10	8.94	0.003	5.49	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	50	73.9	7.81	10.57	40	90	0.864	<0.01					Biauriculare	♂	47	121.3	4.23	3.49	112	131	0.967	0.10	0.99	0.319	6.23	0.000	♀	52	115.5	4.89	4.24	104	126	0.984	0.50	Biasterion	♂	44	111.5	3.84	3.45	105	120	0.961	0.10	0.04	0.847	7.71	0.000	♀	52	105.3	3.94	3.74	98	112	0.942	0.02	Bisphenion	♂	45	103.6	3.77	3.64	96	111	0.957	0.10	1.12	0.290	4.11	0.000	♀	52	100.2	4.44	4.43	92	110	0.972	0.10	Glabella-bregma	♂	47	109.9	4.38	3.99	99	117	0.963	0.10	0.41	0.521	8.32	0.000	♀	53	102.9	3.99	3.88	95	117	0.961	0.10	Nasion-bregma	♂	47	113.5	4.28	3.77	102	120	0.958	0.10	1.49	0.223	7.54	0.000	♀	53	107.5	3.59	3.34	100	120	0.954	0.05	Metopion height	♂	47	25.6	2.20	8.61	21	30	0.948	0.05	0.01	0.945	1.06	0.293	♀	52	25.2	2.18	8.69	21	30	0.951	0.05	Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000	♀	52	47.9	3.22	6.72	41	56	0.980	0.50	Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																																																																			
Biauriculare	♂	47	121.3	4.23	3.49	112	131	0.967	0.10	0.99	0.319	6.23	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	52	115.5	4.89	4.24	104	126	0.984	0.50					Biasterion	♂	44	111.5	3.84	3.45	105	120	0.961	0.10	0.04	0.847	7.71	0.000	♀	52	105.3	3.94	3.74	98	112	0.942	0.02	Bisphenion	♂	45	103.6	3.77	3.64	96	111	0.957	0.10	1.12	0.290	4.11	0.000	♀	52	100.2	4.44	4.43	92	110	0.972	0.10	Glabella-bregma	♂	47	109.9	4.38	3.99	99	117	0.963	0.10	0.41	0.521	8.32	0.000	♀	53	102.9	3.99	3.88	95	117	0.961	0.10	Nasion-bregma	♂	47	113.5	4.28	3.77	102	120	0.958	0.10	1.49	0.223	7.54	0.000	♀	53	107.5	3.59	3.34	100	120	0.954	0.05	Metopion height	♂	47	25.6	2.20	8.61	21	30	0.948	0.05	0.01	0.945	1.06	0.293	♀	52	25.2	2.18	8.69	21	30	0.951	0.05	Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000	♀	52	47.9	3.22	6.72	41	56	0.980	0.50	Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																																																																																										
Biasterion	♂	44	111.5	3.84	3.45	105	120	0.961	0.10	0.04	0.847	7.71	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	52	105.3	3.94	3.74	98	112	0.942	0.02					Bisphenion	♂	45	103.6	3.77	3.64	96	111	0.957	0.10	1.12	0.290	4.11	0.000	♀	52	100.2	4.44	4.43	92	110	0.972	0.10	Glabella-bregma	♂	47	109.9	4.38	3.99	99	117	0.963	0.10	0.41	0.521	8.32	0.000	♀	53	102.9	3.99	3.88	95	117	0.961	0.10	Nasion-bregma	♂	47	113.5	4.28	3.77	102	120	0.958	0.10	1.49	0.223	7.54	0.000	♀	53	107.5	3.59	3.34	100	120	0.954	0.05	Metopion height	♂	47	25.6	2.20	8.61	21	30	0.948	0.05	0.01	0.945	1.06	0.293	♀	52	25.2	2.18	8.69	21	30	0.951	0.05	Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000	♀	52	47.9	3.22	6.72	41	56	0.980	0.50	Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																																																																																																																	
Bisphenion	♂	45	103.6	3.77	3.64	96	111	0.957	0.10	1.12	0.290	4.11	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	52	100.2	4.44	4.43	92	110	0.972	0.10					Glabella-bregma	♂	47	109.9	4.38	3.99	99	117	0.963	0.10	0.41	0.521	8.32	0.000	♀	53	102.9	3.99	3.88	95	117	0.961	0.10	Nasion-bregma	♂	47	113.5	4.28	3.77	102	120	0.958	0.10	1.49	0.223	7.54	0.000	♀	53	107.5	3.59	3.34	100	120	0.954	0.05	Metopion height	♂	47	25.6	2.20	8.61	21	30	0.948	0.05	0.01	0.945	1.06	0.293	♀	52	25.2	2.18	8.69	21	30	0.951	0.05	Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000	♀	52	47.9	3.22	6.72	41	56	0.980	0.50	Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																																																																																																																																								
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	♀	53	107.5	3.59	3.34	100	120	0.954	0.05					Metopion height	♂	47	25.6	2.20	8.61	21	30	0.948	0.05	0.01	0.945	1.06	0.293	♀	52	25.2	2.18	8.69	21	30	0.951	0.05	Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000	♀	52	47.9	3.22	6.72	41	56	0.980	0.50	Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																																																																																																																																																																																						
Metopion height	♂	47	25.6	2.20	8.61	21	30	0.948	0.05	0.01	0.945	1.06	0.293																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	52	25.2	2.18	8.69	21	30	0.951	0.05					Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000	♀	52	47.9	3.22	6.72	41	56	0.980	0.50	Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																																																																																																																																																																																																													
Nasion-metopion	♂	47	51.0	3.35	6.56	43	57	0.964	0.10	1.08	0.788	4.66	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	52	47.9	3.22	6.72	41	56	0.980	0.50					Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000	♀	53	105.2	4.12	3.92	94	115	0.983	0.50	Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																																																																																																																																																																																																																																				
Maximum supraorbital breadth	♂	47	108.5	3.48	3.20	101	116	0.957	0.10	1.38	0.239	4.29	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	53	105.2	4.12	3.92	94	115	0.983	0.50					Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000	♀	53	92.2	3.89	4.22	85	103	0.969	0.10	Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																																																																																																																																																																																																																																																											
Minimum postorbital breadth	♂	47	95.5	4.61	4.82	85	107	0.968	0.10	1.37	0.241	3.91	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	53	92.2	3.89	4.22	85	103	0.969	0.10					Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000	♀	50	126.5	4.53	3.58	118	138	0.964	0.10	Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																																																																																																																																																																																																																																																																																		
Bizygion	♂	44	135.6	5.01	3.69	124	146	0.981	0.50	0.45	0.500	9.19	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	50	126.5	4.53	3.58	118	138	0.964	0.10					Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000	♀	53	90.5	4.23	4.68	81	99	0.975	0.50	Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																																																																																																																																																																																																																																																																																																									
Bizygomaxillare	♂	47	94.5	4.18	4.42	86	108	0.969	0.10	0.01	0.926	4.69	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	53	90.5	4.23	4.68	81	99	0.975	0.50					Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162	♀	50	94.2	7.13	7.56	75	115	0.972	0.10	Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																																																																																																																																																																																																																																																																																																																																
Bistephanion	♂	47	92.1	7.63	8.28	73	105	0.968	0.10	0.22	0.643	1.41	0.162																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	50	94.2	7.13	7.56	75	115	0.972	0.10					Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
Bistenion	♂	47	71.9	3.79	5.29	62	79	0.930	0.01	2.13	0.144	6.25	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	49	67.4	3.05	4.53	61	74	0.964	0.10																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		

Table 5 (continued)

Variable	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	Shapiro Wilk	Probability	χ^2	Probability	Student's t	Probability
Inion-opisthion	♂	45	47.6	4.98	10.46	37	59	0.975	0.50				
	♀	49	43.7	5.40	12.35	31	55	0.979	0.50	0.29	0.588	3.61	0.000
Lambda-opisthion	♂	46	94.5	3.48	3.69	88	109	0.901	<0.01				
	♀	49	91.4	3.81	4.14	85	102	0.957	0.10	0.38	0.539	4.14	0.000
Occipital subtense height	♂	-	-	-	-	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-	-	-	-	-
Lambda-occipital subtense	♂	-	-	-	-	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-	-	-	-	-
Asterion-opisthion	♂	46	65.9	3.05	4.64	61	78	0.913	<0.01				
	♀	49	62.7	3.53	5.63	53	74	0.959	0.10	0.95	0.330	4.74	0.000
Basion-asterion	♂	45	77.8	3.78	4.86	61	84	0.859	<0.01				
	♀	50	73.7	3.10	4.21	65	82	0.976	0.50	1.78	0.182	5.79	0.000
Basion-mastoidale	♂	44	52.3	2.83	5.40	45	58	0.953	0.10				
	♀	50	49.4	2.87	5.80	43	56	0.959	0.10	0.01	0.920	4.96	0.000
Basion-staphylion	♂	44	47.7	2.49	5.22	42	54	0.979	0.50				
	♀	48	45.1	2.98	6.60	37	52	0.985	0.90	1.42	0.232	4.48	0.000
Bregma-lambda	♂	46	117.3	5.04	4.30	107	134	0.969	0.10				
	♀	53	112.3	4.79	4.27	96	123	0.951	0.05	0.09	0.756	5.31	0.000
Parietal subtense height	♂	44	23.2	2.05	8.83	19	28	0.936	0.02				
	♀	52	23.0	2.05	8.92	16	27	0.925	<0.01	0.01	0.981	0.54	0.591
Lambda-parietal subtense	♂	44	59.5	4.63	7.78	50	69	0.971	0.10				
	♀	52	55.6	4.44	7.99	46	66	0.962	0.10	0.07	0.794	4.18	0.000
Lambda-inion	♂	47	61.1	5.25	3.59	47	73	0.979	0.50				
	♀	52	59.6	5.77	9.68	47	77	0.963	0.10	0.43	0.512	1.37	0.172
Lambda-asterion	♂	47	82.3	3.57	4.34	74	92	0.975	0.50				
	♀	52	79.4	3.60	4.54	69	87	0.981	0.50	0.01	0.958	4.03	0.000
Nasion-nasospinale	♂	47	49.9	2.66	5.33	44	55	0.968	0.10				
	♀	53	47.3	2.54	5.37	42	53	0.952	0.05	0.09	0.754	4.92	0.000
Nasion-prosthion	♂	47	70.5	3.91	5.54	62	78	0.964	0.10				
	♀	53	65.6	3.72	5.68	57	74	0.980	0.50	0.12	0.732	6.51	0.000
Nasospinale-prosthion	♂	47	20.7	2.85	13.77	15	27	0.968	0.10				
	♀	53	18.2	2.86	15.74	11	25	0.949	0.05	0.01	0.973	4.36	0.000
Nasal breadth	♂	47	28.3	2.07	7.33	24	34	0.950	0.05				
	♀	53	26.4	1.92	6.55	23	33	0.937	0.01	0.28	0.591	4.86	0.000
Orbital height	♂	47	32.9	2.50	7.61	23	39	0.915	<0.01				
	♀	53	32.0	2.08	6.50	27	37	0.917	<0.01	1.72	0.190	1.96	0.053
Orbital breadth	♂	47	44.5	1.97	4.44	40	48	0.955	0.10				
	♀	53	42.3	1.67	3.95	38	47	0.962	0.10	1.34	0.247	6.12	0.000
Biectoconchion	♂	46	104.3	3.48	3.33	97	111	0.963	0.10				
	♀	53	99.4	3.73	3.76	90	108	0.974	0.50	0.23	0.628	6.74	0.000
Alveolar length	♂	47	64.1	3.98	6.20	56	73	0.970	0.10				
	♀	53	59.1	3.24	5.47	53	67	0.970	0.10	2.01	0.156	6.65	0.000
Alveolar breadth	♂	47	69.3	3.55	5.12	61	77	0.982	0.50				
	♀	53	64.0	2.79	4.36	57	70	0.970	0.10	2.78	0.095	8.25	0.000
Bicanine breadth	♂	47	46.5	2.33	5.01	41	51	0.964	0.10				
	♀	53	43.7	2.39	5.47	39	49	0.966	0.10	0.03	0.853	5.82	0.000
Mastoid depth	♂	47	31.2	2.35	7.55	26	36	0.954	0.10				
	♀	53	27.1	2.08	7.69	23	33	0.944	0.02	0.72	0.397	9.14	0.000

Table 5 (continued)

Variable	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	Shapiro Wilk	Probability	χ^2	Probability	Student's t	Probability																																																																																																																																																																																																																																	
Frontal arc	♂	45	129.4	6.34	4.89	113	140	0.960	0.10	3.71	0.054	4.97	0.000																																																																																																																																																																																																																																	
	♀	51	123.7	4.77	3.86	114	140	0.969	0.10					Parietal arc	♂	43	130.3	6.16	4.72	119	149	0.962	0.10	0.18	0.666	4.64	0.000	♀	51	124.6	5.77	4.63	106	137	0.958	0.10	Occipital arc	♂	43	113.6	4.95	4.36	105	123	0.951	0.10	1.02	0.312	3.39	0.001	♀	49	109.8	5.76	5.25	100	129	0.928	<0.01	Frontal curvature index	♂	47	22.6	1.56	6.90	20	26	-	-	1.26	0.260	2.35	0.020	♀	52	23.4	1.84	7.86	20	28	-	-	Parietal curvature index	♂	44	19.8	1.14	5.75	17	23	-	-	3.65	0.056	2.52	0.013	♀	52	20.5	1.52	7.41	17	24	-	-	Occipital curvature index	♂	-	-	-	-	-	-	-	-	-	-	-	-	♀	-	-	-	-	-	-	-	-	Gnathic index	♂	45	103.9	3.53	3.39	97	111	-	-	0.78	0.377	0.72	0.469	♀	49	104.4	3.09	2.95	97	114	-	-	Nasal index	♂	47	56.5	5.69	10.07	38	70	-	-	2.78	0.095	0.68	0.498	♀	53	55.8	4.48	8.02	47	67	-	-	Orbital index	♂	47	74.0	5.76	7.78	54	86	-	-	0.91	0.340	1.63	0.105	♀	53	75.8	5.02	6.62	63	90	-	-	Palate module	♂	47	44.6	4.32	9.68	35	53	-	-	3.81	0.051	8.51	0.000	♀	53	38.1	3.26	8.56	31	45	-	-	Cranial module	♂	44	150.9	3.16	2.09	144	157	-	-	0.44	0.510	10.34	0.000	♀	47	144.4	2.86
Parietal arc	♂	43	130.3	6.16	4.72	119	149	0.962	0.10	0.18	0.666	4.64	0.000																																																																																																																																																																																																																																	
	♀	51	124.6	5.77	4.63	106	137	0.958	0.10					Occipital arc	♂	43	113.6	4.95	4.36	105	123	0.951	0.10	1.02	0.312	3.39	0.001	♀	49	109.8	5.76	5.25	100	129	0.928	<0.01	Frontal curvature index	♂	47	22.6	1.56	6.90	20	26	-	-	1.26	0.260	2.35	0.020	♀	52	23.4	1.84	7.86	20	28	-	-	Parietal curvature index	♂	44	19.8	1.14	5.75	17	23	-	-	3.65	0.056	2.52	0.013	♀	52	20.5	1.52	7.41	17	24	-	-	Occipital curvature index	♂	-	-	-	-	-	-	-	-	-	-	-	-	♀	-	-	-	-	-	-	-	-	Gnathic index	♂	45	103.9	3.53	3.39	97	111	-	-	0.78	0.377	0.72	0.469	♀	49	104.4	3.09	2.95	97	114	-	-	Nasal index	♂	47	56.5	5.69	10.07	38	70	-	-	2.78	0.095	0.68	0.498	♀	53	55.8	4.48	8.02	47	67	-	-	Orbital index	♂	47	74.0	5.76	7.78	54	86	-	-	0.91	0.340	1.63	0.105	♀	53	75.8	5.02	6.62	63	90	-	-	Palate module	♂	47	44.6	4.32	9.68	35	53	-	-	3.81	0.051	8.51	0.000	♀	53	38.1	3.26	8.56	31	45	-	-	Cranial module	♂	44	150.9	3.16	2.09	144	157	-	-	0.44	0.510	10.34	0.000	♀	47	144.4	2.86	1.98	139	151	-	-																		
Occipital arc	♂	43	113.6	4.95	4.36	105	123	0.951	0.10	1.02	0.312	3.39	0.001																																																																																																																																																																																																																																	
	♀	49	109.8	5.76	5.25	100	129	0.928	<0.01					Frontal curvature index	♂	47	22.6	1.56	6.90	20	26	-	-	1.26	0.260	2.35	0.020	♀	52	23.4	1.84	7.86	20	28	-	-	Parietal curvature index	♂	44	19.8	1.14	5.75	17	23	-	-	3.65	0.056	2.52	0.013	♀	52	20.5	1.52	7.41	17	24	-	-	Occipital curvature index	♂	-	-	-	-	-	-	-	-	-	-	-	-	♀	-	-	-	-	-	-	-	-	Gnathic index	♂	45	103.9	3.53	3.39	97	111	-	-	0.78	0.377	0.72	0.469	♀	49	104.4	3.09	2.95	97	114	-	-	Nasal index	♂	47	56.5	5.69	10.07	38	70	-	-	2.78	0.095	0.68	0.498	♀	53	55.8	4.48	8.02	47	67	-	-	Orbital index	♂	47	74.0	5.76	7.78	54	86	-	-	0.91	0.340	1.63	0.105	♀	53	75.8	5.02	6.62	63	90	-	-	Palate module	♂	47	44.6	4.32	9.68	35	53	-	-	3.81	0.051	8.51	0.000	♀	53	38.1	3.26	8.56	31	45	-	-	Cranial module	♂	44	150.9	3.16	2.09	144	157	-	-	0.44	0.510	10.34	0.000	♀	47	144.4	2.86	1.98	139	151	-	-																																									
Frontal curvature index	♂	47	22.6	1.56	6.90	20	26	-	-	1.26	0.260	2.35	0.020																																																																																																																																																																																																																																	
	♀	52	23.4	1.84	7.86	20	28	-	-					Parietal curvature index	♂	44	19.8	1.14	5.75	17	23	-	-	3.65	0.056	2.52	0.013	♀	52	20.5	1.52	7.41	17	24	-	-	Occipital curvature index	♂	-	-	-	-	-	-	-	-	-	-	-	-	♀	-	-	-	-	-	-	-	-	Gnathic index	♂	45	103.9	3.53	3.39	97	111	-	-	0.78	0.377	0.72	0.469	♀	49	104.4	3.09	2.95	97	114	-	-	Nasal index	♂	47	56.5	5.69	10.07	38	70	-	-	2.78	0.095	0.68	0.498	♀	53	55.8	4.48	8.02	47	67	-	-	Orbital index	♂	47	74.0	5.76	7.78	54	86	-	-	0.91	0.340	1.63	0.105	♀	53	75.8	5.02	6.62	63	90	-	-	Palate module	♂	47	44.6	4.32	9.68	35	53	-	-	3.81	0.051	8.51	0.000	♀	53	38.1	3.26	8.56	31	45	-	-	Cranial module	♂	44	150.9	3.16	2.09	144	157	-	-	0.44	0.510	10.34	0.000	♀	47	144.4	2.86	1.98	139	151	-	-																																																																
Parietal curvature index	♂	44	19.8	1.14	5.75	17	23	-	-	3.65	0.056	2.52	0.013																																																																																																																																																																																																																																	
	♀	52	20.5	1.52	7.41	17	24	-	-					Occipital curvature index	♂	-	-	-	-	-	-	-	-	-	-	-	-	♀	-	-	-	-	-	-	-	-	Gnathic index	♂	45	103.9	3.53	3.39	97	111	-	-	0.78	0.377	0.72	0.469	♀	49	104.4	3.09	2.95	97	114	-	-	Nasal index	♂	47	56.5	5.69	10.07	38	70	-	-	2.78	0.095	0.68	0.498	♀	53	55.8	4.48	8.02	47	67	-	-	Orbital index	♂	47	74.0	5.76	7.78	54	86	-	-	0.91	0.340	1.63	0.105	♀	53	75.8	5.02	6.62	63	90	-	-	Palate module	♂	47	44.6	4.32	9.68	35	53	-	-	3.81	0.051	8.51	0.000	♀	53	38.1	3.26	8.56	31	45	-	-	Cranial module	♂	44	150.9	3.16	2.09	144	157	-	-	0.44	0.510	10.34	0.000	♀	47	144.4	2.86	1.98	139	151	-	-																																																																																							
Occipital curvature index	♂	-	-	-	-	-	-	-	-	-	-	-	-																																																																																																																																																																																																																																	
	♀	-	-	-	-	-	-	-	-					Gnathic index	♂	45	103.9	3.53	3.39	97	111	-	-	0.78	0.377	0.72	0.469	♀	49	104.4	3.09	2.95	97	114	-	-	Nasal index	♂	47	56.5	5.69	10.07	38	70	-	-	2.78	0.095	0.68	0.498	♀	53	55.8	4.48	8.02	47	67	-	-	Orbital index	♂	47	74.0	5.76	7.78	54	86	-	-	0.91	0.340	1.63	0.105	♀	53	75.8	5.02	6.62	63	90	-	-	Palate module	♂	47	44.6	4.32	9.68	35	53	-	-	3.81	0.051	8.51	0.000	♀	53	38.1	3.26	8.56	31	45	-	-	Cranial module	♂	44	150.9	3.16	2.09	144	157	-	-	0.44	0.510	10.34	0.000	♀	47	144.4	2.86	1.98	139	151	-	-																																																																																																														
Gnathic index	♂	45	103.9	3.53	3.39	97	111	-	-	0.78	0.377	0.72	0.469																																																																																																																																																																																																																																	
	♀	49	104.4	3.09	2.95	97	114	-	-					Nasal index	♂	47	56.5	5.69	10.07	38	70	-	-	2.78	0.095	0.68	0.498	♀	53	55.8	4.48	8.02	47	67	-	-	Orbital index	♂	47	74.0	5.76	7.78	54	86	-	-	0.91	0.340	1.63	0.105	♀	53	75.8	5.02	6.62	63	90	-	-	Palate module	♂	47	44.6	4.32	9.68	35	53	-	-	3.81	0.051	8.51	0.000	♀	53	38.1	3.26	8.56	31	45	-	-	Cranial module	♂	44	150.9	3.16	2.09	144	157	-	-	0.44	0.510	10.34	0.000	♀	47	144.4	2.86	1.98	139	151	-	-																																																																																																																																					
Nasal index	♂	47	56.5	5.69	10.07	38	70	-	-	2.78	0.095	0.68	0.498																																																																																																																																																																																																																																	
	♀	53	55.8	4.48	8.02	47	67	-	-					Orbital index	♂	47	74.0	5.76	7.78	54	86	-	-	0.91	0.340	1.63	0.105	♀	53	75.8	5.02	6.62	63	90	-	-	Palate module	♂	47	44.6	4.32	9.68	35	53	-	-	3.81	0.051	8.51	0.000	♀	53	38.1	3.26	8.56	31	45	-	-	Cranial module	♂	44	150.9	3.16	2.09	144	157	-	-	0.44	0.510	10.34	0.000	♀	47	144.4	2.86	1.98	139	151	-	-																																																																																																																																																												
Orbital index	♂	47	74.0	5.76	7.78	54	86	-	-	0.91	0.340	1.63	0.105																																																																																																																																																																																																																																	
	♀	53	75.8	5.02	6.62	63	90	-	-					Palate module	♂	47	44.6	4.32	9.68	35	53	-	-	3.81	0.051	8.51	0.000	♀	53	38.1	3.26	8.56	31	45	-	-	Cranial module	♂	44	150.9	3.16	2.09	144	157	-	-	0.44	0.510	10.34	0.000	♀	47	144.4	2.86	1.98	139	151	-	-																																																																																																																																																																																			
Palate module	♂	47	44.6	4.32	9.68	35	53	-	-	3.81	0.051	8.51	0.000																																																																																																																																																																																																																																	
	♀	53	38.1	3.26	8.56	31	45	-	-					Cranial module	♂	44	150.9	3.16	2.09	144	157	-	-	0.44	0.510	10.34	0.000	♀	47	144.4	2.86	1.98	139	151	-	-																																																																																																																																																																																																										
Cranial module	♂	44	150.9	3.16	2.09	144	157	-	-	0.44	0.510	10.34	0.000																																																																																																																																																																																																																																	
	♀	47	144.4	2.86	1.98	139	151	-	-																																																																																																																																																																																																																																					

Table 6 Descriptive and comparative statistics for the Swanport male and female cranial dimensions (mm)

Variable	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	Shapiro Wilk	Proba- bility	χ^2	Proba- bility	Student's t	Proba- bility																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
Maximum biparietal breadth	♂	24	130.2	2.85	2.18	126	135	0.916	0.05	3.28	0.070	3.58	0.001																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	25	126.5	4.19	3.31	116	135	0.945	0.10					Glabella- opisthocranion	♂	24	189.6	5.82	3.06	180	202	0.973	0.50	0.035	0.851	4.69	0.000	♀	23	181.5	6.06	3.35	169	191	0.959	0.10	Glabella-lambda	♂	24	182.7	5.79	3.16	175	196	0.928	0.10	0.01	0.908	5.22	0.000	♀	23	174.0	5.64	3.25	162	182	0.944	0.10	Basion-bregma	♂	23	129.6	4.60	3.54	122	139	0.971	0.50	0.07	0.791	4.19	0.000	♀	25	124.2	4.34	3.50	118	133	0.892	0.01	Basion-nasion	♂	23	101.3	3.43	3.38	95	106	0.930	0.10	0.24	0.622	5.81	0.000	♀	25	95.8	3.09	3.22	90	102	0.972	0.50	Basion-nasospinale	♂	23	99.2	3.96	3.99	90	104	0.895	0.02	0.04	0.838	5.04	0.000	♀	24	93.2	4.13	4.44	82	101	0.929	0.05	Basion-prosthion	♂	22	104.6	4.71	4.50	96	114	0.970	0.50	1.21	0.271	3.58	0.001	♀	24	100.1	3.71	3.70	95	107	0.935	0.10	Basion-lambda	♂	19	111.3	6.46	5.80	94	123	0.889	0.02	0.18	0.670	1.49	0.144	♀	23	108.4	5.86	3.71	90	118	0.916	0.05	Basion-inion	♂	19	72.4	3.50	4.83	66	79	0.962	0.50	0.05	0.828	2.07	0.045	♀	22	70.1	3.68	5.25	64	80	0.949	0.10	Biauriculare	♂	19	121.0	3.87	3.19	113	128	0.946	0.10	0.53	0.467	4.22	0.000	♀	22	115.3	4.58	3.97	108	124	0.948	0.10	Biasterion	♂	20	100.0	3.41	3.10	104	117	0.979	0.90	0.41	0.522	4.37	0.000	♀	23	105.0	3.94	3.76	99	112	0.950	0.10	Bisphenion	♂	23	101.5	3.93	3.87	96	110	0.936	0.10	0.04	0.840	2.73	0.009	♀	24	98.4	3.76	3.82	92	106	0.953	0.10	Glabella-bregma	♂	24	109.6	3.36	3.06	102	116	0.982	0.90	1.34	0.247	6.25	0.000	♀	23	102.5	4.30	4.19	95	111	0.958	0.50	Nasion-bregma	♂	24	112.5	3.02	2.68	106	118	0.973	0.50	1.16	0.281	6.05	0.000	♀	25	106.5	3.78	3.55	100	113	0.971	0.50	Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395	♀	23	25.8	2.01	7.80	19	29	0.814	0.01	Nasion-metopion	♂	23	49.9	2.95	5.92	44	56	0.958	0.10	1.22	0.646	4.17	0.000	♀	23	46.0	3.26	7.07	41	53	0.961	0.10	Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59
Glabella- opisthocranion	♂	24	189.6	5.82	3.06	180	202	0.973	0.50	0.035	0.851	4.69	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	23	181.5	6.06	3.35	169	191	0.959	0.10					Glabella-lambda	♂	24	182.7	5.79	3.16	175	196	0.928	0.10	0.01	0.908	5.22	0.000	♀	23	174.0	5.64	3.25	162	182	0.944	0.10	Basion-bregma	♂	23	129.6	4.60	3.54	122	139	0.971	0.50	0.07	0.791	4.19	0.000	♀	25	124.2	4.34	3.50	118	133	0.892	0.01	Basion-nasion	♂	23	101.3	3.43	3.38	95	106	0.930	0.10	0.24	0.622	5.81	0.000	♀	25	95.8	3.09	3.22	90	102	0.972	0.50	Basion-nasospinale	♂	23	99.2	3.96	3.99	90	104	0.895	0.02	0.04	0.838	5.04	0.000	♀	24	93.2	4.13	4.44	82	101	0.929	0.05	Basion-prosthion	♂	22	104.6	4.71	4.50	96	114	0.970	0.50	1.21	0.271	3.58	0.001	♀	24	100.1	3.71	3.70	95	107	0.935	0.10	Basion-lambda	♂	19	111.3	6.46	5.80	94	123	0.889	0.02	0.18	0.670	1.49	0.144	♀	23	108.4	5.86	3.71	90	118	0.916	0.05	Basion-inion	♂	19	72.4	3.50	4.83	66	79	0.962	0.50	0.05	0.828	2.07	0.045	♀	22	70.1	3.68	5.25	64	80	0.949	0.10	Biauriculare	♂	19	121.0	3.87	3.19	113	128	0.946	0.10	0.53	0.467	4.22	0.000	♀	22	115.3	4.58	3.97	108	124	0.948	0.10	Biasterion	♂	20	100.0	3.41	3.10	104	117	0.979	0.90	0.41	0.522	4.37	0.000	♀	23	105.0	3.94	3.76	99	112	0.950	0.10	Bisphenion	♂	23	101.5	3.93	3.87	96	110	0.936	0.10	0.04	0.840	2.73	0.009	♀	24	98.4	3.76	3.82	92	106	0.953	0.10	Glabella-bregma	♂	24	109.6	3.36	3.06	102	116	0.982	0.90	1.34	0.247	6.25	0.000	♀	23	102.5	4.30	4.19	95	111	0.958	0.50	Nasion-bregma	♂	24	112.5	3.02	2.68	106	118	0.973	0.50	1.16	0.281	6.05	0.000	♀	25	106.5	3.78	3.55	100	113	0.971	0.50	Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395	♀	23	25.8	2.01	7.80	19	29	0.814	0.01	Nasion-metopion	♂	23	49.9	2.95	5.92	44	56	0.958	0.10	1.22	0.646	4.17	0.000	♀	23	46.0	3.26	7.07	41	53	0.961	0.10	Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																		
Glabella-lambda	♂	24	182.7	5.79	3.16	175	196	0.928	0.10	0.01	0.908	5.22	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	23	174.0	5.64	3.25	162	182	0.944	0.10					Basion-bregma	♂	23	129.6	4.60	3.54	122	139	0.971	0.50	0.07	0.791	4.19	0.000	♀	25	124.2	4.34	3.50	118	133	0.892	0.01	Basion-nasion	♂	23	101.3	3.43	3.38	95	106	0.930	0.10	0.24	0.622	5.81	0.000	♀	25	95.8	3.09	3.22	90	102	0.972	0.50	Basion-nasospinale	♂	23	99.2	3.96	3.99	90	104	0.895	0.02	0.04	0.838	5.04	0.000	♀	24	93.2	4.13	4.44	82	101	0.929	0.05	Basion-prosthion	♂	22	104.6	4.71	4.50	96	114	0.970	0.50	1.21	0.271	3.58	0.001	♀	24	100.1	3.71	3.70	95	107	0.935	0.10	Basion-lambda	♂	19	111.3	6.46	5.80	94	123	0.889	0.02	0.18	0.670	1.49	0.144	♀	23	108.4	5.86	3.71	90	118	0.916	0.05	Basion-inion	♂	19	72.4	3.50	4.83	66	79	0.962	0.50	0.05	0.828	2.07	0.045	♀	22	70.1	3.68	5.25	64	80	0.949	0.10	Biauriculare	♂	19	121.0	3.87	3.19	113	128	0.946	0.10	0.53	0.467	4.22	0.000	♀	22	115.3	4.58	3.97	108	124	0.948	0.10	Biasterion	♂	20	100.0	3.41	3.10	104	117	0.979	0.90	0.41	0.522	4.37	0.000	♀	23	105.0	3.94	3.76	99	112	0.950	0.10	Bisphenion	♂	23	101.5	3.93	3.87	96	110	0.936	0.10	0.04	0.840	2.73	0.009	♀	24	98.4	3.76	3.82	92	106	0.953	0.10	Glabella-bregma	♂	24	109.6	3.36	3.06	102	116	0.982	0.90	1.34	0.247	6.25	0.000	♀	23	102.5	4.30	4.19	95	111	0.958	0.50	Nasion-bregma	♂	24	112.5	3.02	2.68	106	118	0.973	0.50	1.16	0.281	6.05	0.000	♀	25	106.5	3.78	3.55	100	113	0.971	0.50	Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395	♀	23	25.8	2.01	7.80	19	29	0.814	0.01	Nasion-metopion	♂	23	49.9	2.95	5.92	44	56	0.958	0.10	1.22	0.646	4.17	0.000	♀	23	46.0	3.26	7.07	41	53	0.961	0.10	Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																									
Basion-bregma	♂	23	129.6	4.60	3.54	122	139	0.971	0.50	0.07	0.791	4.19	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	25	124.2	4.34	3.50	118	133	0.892	0.01					Basion-nasion	♂	23	101.3	3.43	3.38	95	106	0.930	0.10	0.24	0.622	5.81	0.000	♀	25	95.8	3.09	3.22	90	102	0.972	0.50	Basion-nasospinale	♂	23	99.2	3.96	3.99	90	104	0.895	0.02	0.04	0.838	5.04	0.000	♀	24	93.2	4.13	4.44	82	101	0.929	0.05	Basion-prosthion	♂	22	104.6	4.71	4.50	96	114	0.970	0.50	1.21	0.271	3.58	0.001	♀	24	100.1	3.71	3.70	95	107	0.935	0.10	Basion-lambda	♂	19	111.3	6.46	5.80	94	123	0.889	0.02	0.18	0.670	1.49	0.144	♀	23	108.4	5.86	3.71	90	118	0.916	0.05	Basion-inion	♂	19	72.4	3.50	4.83	66	79	0.962	0.50	0.05	0.828	2.07	0.045	♀	22	70.1	3.68	5.25	64	80	0.949	0.10	Biauriculare	♂	19	121.0	3.87	3.19	113	128	0.946	0.10	0.53	0.467	4.22	0.000	♀	22	115.3	4.58	3.97	108	124	0.948	0.10	Biasterion	♂	20	100.0	3.41	3.10	104	117	0.979	0.90	0.41	0.522	4.37	0.000	♀	23	105.0	3.94	3.76	99	112	0.950	0.10	Bisphenion	♂	23	101.5	3.93	3.87	96	110	0.936	0.10	0.04	0.840	2.73	0.009	♀	24	98.4	3.76	3.82	92	106	0.953	0.10	Glabella-bregma	♂	24	109.6	3.36	3.06	102	116	0.982	0.90	1.34	0.247	6.25	0.000	♀	23	102.5	4.30	4.19	95	111	0.958	0.50	Nasion-bregma	♂	24	112.5	3.02	2.68	106	118	0.973	0.50	1.16	0.281	6.05	0.000	♀	25	106.5	3.78	3.55	100	113	0.971	0.50	Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395	♀	23	25.8	2.01	7.80	19	29	0.814	0.01	Nasion-metopion	♂	23	49.9	2.95	5.92	44	56	0.958	0.10	1.22	0.646	4.17	0.000	♀	23	46.0	3.26	7.07	41	53	0.961	0.10	Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																
Basion-nasion	♂	23	101.3	3.43	3.38	95	106	0.930	0.10	0.24	0.622	5.81	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	25	95.8	3.09	3.22	90	102	0.972	0.50					Basion-nasospinale	♂	23	99.2	3.96	3.99	90	104	0.895	0.02	0.04	0.838	5.04	0.000	♀	24	93.2	4.13	4.44	82	101	0.929	0.05	Basion-prosthion	♂	22	104.6	4.71	4.50	96	114	0.970	0.50	1.21	0.271	3.58	0.001	♀	24	100.1	3.71	3.70	95	107	0.935	0.10	Basion-lambda	♂	19	111.3	6.46	5.80	94	123	0.889	0.02	0.18	0.670	1.49	0.144	♀	23	108.4	5.86	3.71	90	118	0.916	0.05	Basion-inion	♂	19	72.4	3.50	4.83	66	79	0.962	0.50	0.05	0.828	2.07	0.045	♀	22	70.1	3.68	5.25	64	80	0.949	0.10	Biauriculare	♂	19	121.0	3.87	3.19	113	128	0.946	0.10	0.53	0.467	4.22	0.000	♀	22	115.3	4.58	3.97	108	124	0.948	0.10	Biasterion	♂	20	100.0	3.41	3.10	104	117	0.979	0.90	0.41	0.522	4.37	0.000	♀	23	105.0	3.94	3.76	99	112	0.950	0.10	Bisphenion	♂	23	101.5	3.93	3.87	96	110	0.936	0.10	0.04	0.840	2.73	0.009	♀	24	98.4	3.76	3.82	92	106	0.953	0.10	Glabella-bregma	♂	24	109.6	3.36	3.06	102	116	0.982	0.90	1.34	0.247	6.25	0.000	♀	23	102.5	4.30	4.19	95	111	0.958	0.50	Nasion-bregma	♂	24	112.5	3.02	2.68	106	118	0.973	0.50	1.16	0.281	6.05	0.000	♀	25	106.5	3.78	3.55	100	113	0.971	0.50	Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395	♀	23	25.8	2.01	7.80	19	29	0.814	0.01	Nasion-metopion	♂	23	49.9	2.95	5.92	44	56	0.958	0.10	1.22	0.646	4.17	0.000	♀	23	46.0	3.26	7.07	41	53	0.961	0.10	Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																							
Basion-nasospinale	♂	23	99.2	3.96	3.99	90	104	0.895	0.02	0.04	0.838	5.04	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	24	93.2	4.13	4.44	82	101	0.929	0.05					Basion-prosthion	♂	22	104.6	4.71	4.50	96	114	0.970	0.50	1.21	0.271	3.58	0.001	♀	24	100.1	3.71	3.70	95	107	0.935	0.10	Basion-lambda	♂	19	111.3	6.46	5.80	94	123	0.889	0.02	0.18	0.670	1.49	0.144	♀	23	108.4	5.86	3.71	90	118	0.916	0.05	Basion-inion	♂	19	72.4	3.50	4.83	66	79	0.962	0.50	0.05	0.828	2.07	0.045	♀	22	70.1	3.68	5.25	64	80	0.949	0.10	Biauriculare	♂	19	121.0	3.87	3.19	113	128	0.946	0.10	0.53	0.467	4.22	0.000	♀	22	115.3	4.58	3.97	108	124	0.948	0.10	Biasterion	♂	20	100.0	3.41	3.10	104	117	0.979	0.90	0.41	0.522	4.37	0.000	♀	23	105.0	3.94	3.76	99	112	0.950	0.10	Bisphenion	♂	23	101.5	3.93	3.87	96	110	0.936	0.10	0.04	0.840	2.73	0.009	♀	24	98.4	3.76	3.82	92	106	0.953	0.10	Glabella-bregma	♂	24	109.6	3.36	3.06	102	116	0.982	0.90	1.34	0.247	6.25	0.000	♀	23	102.5	4.30	4.19	95	111	0.958	0.50	Nasion-bregma	♂	24	112.5	3.02	2.68	106	118	0.973	0.50	1.16	0.281	6.05	0.000	♀	25	106.5	3.78	3.55	100	113	0.971	0.50	Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395	♀	23	25.8	2.01	7.80	19	29	0.814	0.01	Nasion-metopion	♂	23	49.9	2.95	5.92	44	56	0.958	0.10	1.22	0.646	4.17	0.000	♀	23	46.0	3.26	7.07	41	53	0.961	0.10	Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																														
Basion-prosthion	♂	22	104.6	4.71	4.50	96	114	0.970	0.50	1.21	0.271	3.58	0.001																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	24	100.1	3.71	3.70	95	107	0.935	0.10					Basion-lambda	♂	19	111.3	6.46	5.80	94	123	0.889	0.02	0.18	0.670	1.49	0.144	♀	23	108.4	5.86	3.71	90	118	0.916	0.05	Basion-inion	♂	19	72.4	3.50	4.83	66	79	0.962	0.50	0.05	0.828	2.07	0.045	♀	22	70.1	3.68	5.25	64	80	0.949	0.10	Biauriculare	♂	19	121.0	3.87	3.19	113	128	0.946	0.10	0.53	0.467	4.22	0.000	♀	22	115.3	4.58	3.97	108	124	0.948	0.10	Biasterion	♂	20	100.0	3.41	3.10	104	117	0.979	0.90	0.41	0.522	4.37	0.000	♀	23	105.0	3.94	3.76	99	112	0.950	0.10	Bisphenion	♂	23	101.5	3.93	3.87	96	110	0.936	0.10	0.04	0.840	2.73	0.009	♀	24	98.4	3.76	3.82	92	106	0.953	0.10	Glabella-bregma	♂	24	109.6	3.36	3.06	102	116	0.982	0.90	1.34	0.247	6.25	0.000	♀	23	102.5	4.30	4.19	95	111	0.958	0.50	Nasion-bregma	♂	24	112.5	3.02	2.68	106	118	0.973	0.50	1.16	0.281	6.05	0.000	♀	25	106.5	3.78	3.55	100	113	0.971	0.50	Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395	♀	23	25.8	2.01	7.80	19	29	0.814	0.01	Nasion-metopion	♂	23	49.9	2.95	5.92	44	56	0.958	0.10	1.22	0.646	4.17	0.000	♀	23	46.0	3.26	7.07	41	53	0.961	0.10	Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																																																					
Basion-lambda	♂	19	111.3	6.46	5.80	94	123	0.889	0.02	0.18	0.670	1.49	0.144																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	23	108.4	5.86	3.71	90	118	0.916	0.05					Basion-inion	♂	19	72.4	3.50	4.83	66	79	0.962	0.50	0.05	0.828	2.07	0.045	♀	22	70.1	3.68	5.25	64	80	0.949	0.10	Biauriculare	♂	19	121.0	3.87	3.19	113	128	0.946	0.10	0.53	0.467	4.22	0.000	♀	22	115.3	4.58	3.97	108	124	0.948	0.10	Biasterion	♂	20	100.0	3.41	3.10	104	117	0.979	0.90	0.41	0.522	4.37	0.000	♀	23	105.0	3.94	3.76	99	112	0.950	0.10	Bisphenion	♂	23	101.5	3.93	3.87	96	110	0.936	0.10	0.04	0.840	2.73	0.009	♀	24	98.4	3.76	3.82	92	106	0.953	0.10	Glabella-bregma	♂	24	109.6	3.36	3.06	102	116	0.982	0.90	1.34	0.247	6.25	0.000	♀	23	102.5	4.30	4.19	95	111	0.958	0.50	Nasion-bregma	♂	24	112.5	3.02	2.68	106	118	0.973	0.50	1.16	0.281	6.05	0.000	♀	25	106.5	3.78	3.55	100	113	0.971	0.50	Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395	♀	23	25.8	2.01	7.80	19	29	0.814	0.01	Nasion-metopion	♂	23	49.9	2.95	5.92	44	56	0.958	0.10	1.22	0.646	4.17	0.000	♀	23	46.0	3.26	7.07	41	53	0.961	0.10	Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																																																																												
Basion-inion	♂	19	72.4	3.50	4.83	66	79	0.962	0.50	0.05	0.828	2.07	0.045																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	22	70.1	3.68	5.25	64	80	0.949	0.10					Biauriculare	♂	19	121.0	3.87	3.19	113	128	0.946	0.10	0.53	0.467	4.22	0.000	♀	22	115.3	4.58	3.97	108	124	0.948	0.10	Biasterion	♂	20	100.0	3.41	3.10	104	117	0.979	0.90	0.41	0.522	4.37	0.000	♀	23	105.0	3.94	3.76	99	112	0.950	0.10	Bisphenion	♂	23	101.5	3.93	3.87	96	110	0.936	0.10	0.04	0.840	2.73	0.009	♀	24	98.4	3.76	3.82	92	106	0.953	0.10	Glabella-bregma	♂	24	109.6	3.36	3.06	102	116	0.982	0.90	1.34	0.247	6.25	0.000	♀	23	102.5	4.30	4.19	95	111	0.958	0.50	Nasion-bregma	♂	24	112.5	3.02	2.68	106	118	0.973	0.50	1.16	0.281	6.05	0.000	♀	25	106.5	3.78	3.55	100	113	0.971	0.50	Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395	♀	23	25.8	2.01	7.80	19	29	0.814	0.01	Nasion-metopion	♂	23	49.9	2.95	5.92	44	56	0.958	0.10	1.22	0.646	4.17	0.000	♀	23	46.0	3.26	7.07	41	53	0.961	0.10	Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																																																																																																			
Biauriculare	♂	19	121.0	3.87	3.19	113	128	0.946	0.10	0.53	0.467	4.22	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	22	115.3	4.58	3.97	108	124	0.948	0.10					Biasterion	♂	20	100.0	3.41	3.10	104	117	0.979	0.90	0.41	0.522	4.37	0.000	♀	23	105.0	3.94	3.76	99	112	0.950	0.10	Bisphenion	♂	23	101.5	3.93	3.87	96	110	0.936	0.10	0.04	0.840	2.73	0.009	♀	24	98.4	3.76	3.82	92	106	0.953	0.10	Glabella-bregma	♂	24	109.6	3.36	3.06	102	116	0.982	0.90	1.34	0.247	6.25	0.000	♀	23	102.5	4.30	4.19	95	111	0.958	0.50	Nasion-bregma	♂	24	112.5	3.02	2.68	106	118	0.973	0.50	1.16	0.281	6.05	0.000	♀	25	106.5	3.78	3.55	100	113	0.971	0.50	Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395	♀	23	25.8	2.01	7.80	19	29	0.814	0.01	Nasion-metopion	♂	23	49.9	2.95	5.92	44	56	0.958	0.10	1.22	0.646	4.17	0.000	♀	23	46.0	3.26	7.07	41	53	0.961	0.10	Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																																																																																																																										
Biasterion	♂	20	100.0	3.41	3.10	104	117	0.979	0.90	0.41	0.522	4.37	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	23	105.0	3.94	3.76	99	112	0.950	0.10					Bisphenion	♂	23	101.5	3.93	3.87	96	110	0.936	0.10	0.04	0.840	2.73	0.009	♀	24	98.4	3.76	3.82	92	106	0.953	0.10	Glabella-bregma	♂	24	109.6	3.36	3.06	102	116	0.982	0.90	1.34	0.247	6.25	0.000	♀	23	102.5	4.30	4.19	95	111	0.958	0.50	Nasion-bregma	♂	24	112.5	3.02	2.68	106	118	0.973	0.50	1.16	0.281	6.05	0.000	♀	25	106.5	3.78	3.55	100	113	0.971	0.50	Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395	♀	23	25.8	2.01	7.80	19	29	0.814	0.01	Nasion-metopion	♂	23	49.9	2.95	5.92	44	56	0.958	0.10	1.22	0.646	4.17	0.000	♀	23	46.0	3.26	7.07	41	53	0.961	0.10	Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																																																																																																																																																	
Bisphenion	♂	23	101.5	3.93	3.87	96	110	0.936	0.10	0.04	0.840	2.73	0.009																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	24	98.4	3.76	3.82	92	106	0.953	0.10					Glabella-bregma	♂	24	109.6	3.36	3.06	102	116	0.982	0.90	1.34	0.247	6.25	0.000	♀	23	102.5	4.30	4.19	95	111	0.958	0.50	Nasion-bregma	♂	24	112.5	3.02	2.68	106	118	0.973	0.50	1.16	0.281	6.05	0.000	♀	25	106.5	3.78	3.55	100	113	0.971	0.50	Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395	♀	23	25.8	2.01	7.80	19	29	0.814	0.01	Nasion-metopion	♂	23	49.9	2.95	5.92	44	56	0.958	0.10	1.22	0.646	4.17	0.000	♀	23	46.0	3.26	7.07	41	53	0.961	0.10	Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																																																																																																																																																																								
Glabella-bregma	♂	24	109.6	3.36	3.06	102	116	0.982	0.90	1.34	0.247	6.25	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	23	102.5	4.30	4.19	95	111	0.958	0.50					Nasion-bregma	♂	24	112.5	3.02	2.68	106	118	0.973	0.50	1.16	0.281	6.05	0.000	♀	25	106.5	3.78	3.55	100	113	0.971	0.50	Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395	♀	23	25.8	2.01	7.80	19	29	0.814	0.01	Nasion-metopion	♂	23	49.9	2.95	5.92	44	56	0.958	0.10	1.22	0.646	4.17	0.000	♀	23	46.0	3.26	7.07	41	53	0.961	0.10	Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																																																																																																																																																																																															
Nasion-bregma	♂	24	112.5	3.02	2.68	106	118	0.973	0.50	1.16	0.281	6.05	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	25	106.5	3.78	3.55	100	113	0.971	0.50					Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395	♀	23	25.8	2.01	7.80	19	29	0.814	0.01	Nasion-metopion	♂	23	49.9	2.95	5.92	44	56	0.958	0.10	1.22	0.646	4.17	0.000	♀	23	46.0	3.26	7.07	41	53	0.961	0.10	Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																																																																																																																																																																																																																						
Metopion height	♂	24	25.3	2.23	8.81	20	30	0.968	0.50	0.24	0.626	0.86	0.395																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
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	♀	23	46.0	3.26	7.07	41	53	0.961	0.10					Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000	♀	25	104.7	2.89	2.76	100	110	0.949	0.10	Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																																																																																																																																																																																																																																																																				
Maximum supraorbital breadth	♂	24	110.3	3.14	2.84	103	116	0.955	0.10	0.15	0.698	6.42	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	25	104.7	2.89	2.76	100	110	0.949	0.10					Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011	♀	25	93.7	3.06	3.26	88	101	0.974	0.50	Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																																																																																																																																																																																																																																																																																											
Minimum postorbital breadth	♂	24	96.6	4.51	4.66	88	105	0.962	0.50	3.41	0.065	2.64	0.011																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	25	93.7	3.06	3.26	88	101	0.974	0.50					Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000	♀	23	127.3	5.40	4.25	118	135	0.932	0.10	Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																																																																																																																																																																																																																																																																																																																		
Bizygion	♂	19	136.8	2.94	2.14	133	143	0.934	0.10	6.46	0.011	6.84	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	23	127.3	5.40	4.25	118	135	0.932	0.10					Bizygomaxillare	♂	24	97.2	4.15	4.26	89	104	0.977	0.50	0.72	0.394	3.16	0.003	♀	25	93.7	3.47	3.70	88	101	0.963	0.10	Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																																																																																																																																																																																																																																																																																																																																									
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	♀	25	93.7	3.47	3.70	88	101	0.963	0.10					Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305	♀	19	95.6	6.72	7.03	84	106	0.945	0.10	Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																																																																																																																																																																																																																																																																																																																																																																
Bistephanion	♂	18	92.7	10.04	10.83	70	104	0.900	0.05	2.68	0.101	1.04	0.305																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	♀	19	95.6	6.72	7.03	84	106	0.945	0.10					Bistenion	♂	16	71.5	3.20	4.48	63	76	0.898	0.05	0.76	0.384	4.68	0.000	♀	22	67.1	2.59	3.87	63	72	0.939	0.10																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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Table 6 (continued)

Variable	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	Shapiro Wilk	Probability	χ^2	Probability	Student's t	Probability																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
Inion-opisthion	♂	20	37.9	4.32	11.39	30	45	0.957	0.50	5.65	0.017	0.86	0.390																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	♀	23	39.6	7.51	18.96	31	69	0.939	0.10					Lambda-opisthion	♂	20	92.9	3.96	3.91	87	101	0.928	0.10	6.42	0.01	1.78	0.083	♀	23	89.7	7.16	7.98	66	100	0.868	0.01	Occipital subtense height	♂	23	28.4	3.29	11.58	24	34	-	-	4.80	0.028	0.99	0.326	♀	20	27.5	1.98	7.20	24	31	-	-	Lambda-occipital subtense	♂	23	46.6	5.50	11.80	37	59	-	-	0.29	0.593	2.95	0.005	♀	20	41.9	4.87	11.62	34	52	-	-	Asterion-opisthion	♂	20	62.9	3.08	4.89	57	68	0.961	0.50	5.22	0.022	0.34	0.733	♀	23	62.3	5.23	8.39	46	75	0.872	<0.01	Basion-asterion	♂	19	75.5	3.76	4.98	69	81	0.925	0.02	4.12	0.042	2.46	0.018	♀	23	73.1	2.36	2.23	69	78	0.956	0.10	Basion-mastoidale	♂	19	53.2	2.52	4.73	49	58	0.975	0.50	0.03	0.862	4.35	0.000	♀	23	49.8	2.42	4.86	45	54	0.965	0.50	Basion-staphylion	♂	18	47.8	3.15	6.58	41	53	0.967	0.50	3.13	0.077	3.13	0.003	♀	23	45.2	2.09	4.62	42	50	0.961	0.10	Bregma-lambda	♂	20	115.3	5.72	4.96	107	130	0.962	0.50	0.02	0.877	2.56	0.014	♀	23	110.7	5.92	5.35	98	119	0.947	0.10	Parietal subtense height	♂	20	22.8	2.82	12.36	17	27	-	-	0.36	0.549	0.03	0.978	♀	22	22.8	2.46	10.78	18	22	-	-	Lambda-parietal subtense	♂	20	59.6	4.23	7.09	53	66	-	-	0.63	0.426	1.11	0.275	♀	22	58.0	5.07	8.74	49	67	-	-	Lambda-inion	♂	19	67.1	5.48	8.16	58	76	0.963	0.50	0.04	0.844	1.96	0.057	♀	22	63.8	5.24	8.21	54	75	0.892	0.01	Lambda-asterion	♂	20	83.5	3.18	3.80	77	89	0.979	0.90	1.97	0.160	2.25	0.030	♀	23	80.7	4.39	5.43	73	88	0.961	0.10	Nasion-nasospinale	♂	24	51.5	2.17	4.21	46	56	0.946	0.10	4.64	0.031	4.72	0.000	♀	24	47.5	3.43	7.23	40	54	0.970	0.50	Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001	♀	24	63.6	4.29	6.74	56	72	0.945	0.10	Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998	♀	24	16.0	1.73	10.79	13	19	0.955	0.10	Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43
Lambda-opisthion	♂	20	92.9	3.96	3.91	87	101	0.928	0.10	6.42	0.01	1.78	0.083																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	♀	23	89.7	7.16	7.98	66	100	0.868	0.01					Occipital subtense height	♂	23	28.4	3.29	11.58	24	34	-	-	4.80	0.028	0.99	0.326	♀	20	27.5	1.98	7.20	24	31	-	-	Lambda-occipital subtense	♂	23	46.6	5.50	11.80	37	59	-	-	0.29	0.593	2.95	0.005	♀	20	41.9	4.87	11.62	34	52	-	-	Asterion-opisthion	♂	20	62.9	3.08	4.89	57	68	0.961	0.50	5.22	0.022	0.34	0.733	♀	23	62.3	5.23	8.39	46	75	0.872	<0.01	Basion-asterion	♂	19	75.5	3.76	4.98	69	81	0.925	0.02	4.12	0.042	2.46	0.018	♀	23	73.1	2.36	2.23	69	78	0.956	0.10	Basion-mastoidale	♂	19	53.2	2.52	4.73	49	58	0.975	0.50	0.03	0.862	4.35	0.000	♀	23	49.8	2.42	4.86	45	54	0.965	0.50	Basion-staphylion	♂	18	47.8	3.15	6.58	41	53	0.967	0.50	3.13	0.077	3.13	0.003	♀	23	45.2	2.09	4.62	42	50	0.961	0.10	Bregma-lambda	♂	20	115.3	5.72	4.96	107	130	0.962	0.50	0.02	0.877	2.56	0.014	♀	23	110.7	5.92	5.35	98	119	0.947	0.10	Parietal subtense height	♂	20	22.8	2.82	12.36	17	27	-	-	0.36	0.549	0.03	0.978	♀	22	22.8	2.46	10.78	18	22	-	-	Lambda-parietal subtense	♂	20	59.6	4.23	7.09	53	66	-	-	0.63	0.426	1.11	0.275	♀	22	58.0	5.07	8.74	49	67	-	-	Lambda-inion	♂	19	67.1	5.48	8.16	58	76	0.963	0.50	0.04	0.844	1.96	0.057	♀	22	63.8	5.24	8.21	54	75	0.892	0.01	Lambda-asterion	♂	20	83.5	3.18	3.80	77	89	0.979	0.90	1.97	0.160	2.25	0.030	♀	23	80.7	4.39	5.43	73	88	0.961	0.10	Nasion-nasospinale	♂	24	51.5	2.17	4.21	46	56	0.946	0.10	4.64	0.031	4.72	0.000	♀	24	47.5	3.43	7.23	40	54	0.970	0.50	Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001	♀	24	63.6	4.29	6.74	56	72	0.945	0.10	Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998	♀	24	16.0	1.73	10.79	13	19	0.955	0.10	Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																		
Occipital subtense height	♂	23	28.4	3.29	11.58	24	34	-	-	4.80	0.028	0.99	0.326																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	♀	20	27.5	1.98	7.20	24	31	-	-					Lambda-occipital subtense	♂	23	46.6	5.50	11.80	37	59	-	-	0.29	0.593	2.95	0.005	♀	20	41.9	4.87	11.62	34	52	-	-	Asterion-opisthion	♂	20	62.9	3.08	4.89	57	68	0.961	0.50	5.22	0.022	0.34	0.733	♀	23	62.3	5.23	8.39	46	75	0.872	<0.01	Basion-asterion	♂	19	75.5	3.76	4.98	69	81	0.925	0.02	4.12	0.042	2.46	0.018	♀	23	73.1	2.36	2.23	69	78	0.956	0.10	Basion-mastoidale	♂	19	53.2	2.52	4.73	49	58	0.975	0.50	0.03	0.862	4.35	0.000	♀	23	49.8	2.42	4.86	45	54	0.965	0.50	Basion-staphylion	♂	18	47.8	3.15	6.58	41	53	0.967	0.50	3.13	0.077	3.13	0.003	♀	23	45.2	2.09	4.62	42	50	0.961	0.10	Bregma-lambda	♂	20	115.3	5.72	4.96	107	130	0.962	0.50	0.02	0.877	2.56	0.014	♀	23	110.7	5.92	5.35	98	119	0.947	0.10	Parietal subtense height	♂	20	22.8	2.82	12.36	17	27	-	-	0.36	0.549	0.03	0.978	♀	22	22.8	2.46	10.78	18	22	-	-	Lambda-parietal subtense	♂	20	59.6	4.23	7.09	53	66	-	-	0.63	0.426	1.11	0.275	♀	22	58.0	5.07	8.74	49	67	-	-	Lambda-inion	♂	19	67.1	5.48	8.16	58	76	0.963	0.50	0.04	0.844	1.96	0.057	♀	22	63.8	5.24	8.21	54	75	0.892	0.01	Lambda-asterion	♂	20	83.5	3.18	3.80	77	89	0.979	0.90	1.97	0.160	2.25	0.030	♀	23	80.7	4.39	5.43	73	88	0.961	0.10	Nasion-nasospinale	♂	24	51.5	2.17	4.21	46	56	0.946	0.10	4.64	0.031	4.72	0.000	♀	24	47.5	3.43	7.23	40	54	0.970	0.50	Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001	♀	24	63.6	4.29	6.74	56	72	0.945	0.10	Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998	♀	24	16.0	1.73	10.79	13	19	0.955	0.10	Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																									
Lambda-occipital subtense	♂	23	46.6	5.50	11.80	37	59	-	-	0.29	0.593	2.95	0.005																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	♀	20	41.9	4.87	11.62	34	52	-	-					Asterion-opisthion	♂	20	62.9	3.08	4.89	57	68	0.961	0.50	5.22	0.022	0.34	0.733	♀	23	62.3	5.23	8.39	46	75	0.872	<0.01	Basion-asterion	♂	19	75.5	3.76	4.98	69	81	0.925	0.02	4.12	0.042	2.46	0.018	♀	23	73.1	2.36	2.23	69	78	0.956	0.10	Basion-mastoidale	♂	19	53.2	2.52	4.73	49	58	0.975	0.50	0.03	0.862	4.35	0.000	♀	23	49.8	2.42	4.86	45	54	0.965	0.50	Basion-staphylion	♂	18	47.8	3.15	6.58	41	53	0.967	0.50	3.13	0.077	3.13	0.003	♀	23	45.2	2.09	4.62	42	50	0.961	0.10	Bregma-lambda	♂	20	115.3	5.72	4.96	107	130	0.962	0.50	0.02	0.877	2.56	0.014	♀	23	110.7	5.92	5.35	98	119	0.947	0.10	Parietal subtense height	♂	20	22.8	2.82	12.36	17	27	-	-	0.36	0.549	0.03	0.978	♀	22	22.8	2.46	10.78	18	22	-	-	Lambda-parietal subtense	♂	20	59.6	4.23	7.09	53	66	-	-	0.63	0.426	1.11	0.275	♀	22	58.0	5.07	8.74	49	67	-	-	Lambda-inion	♂	19	67.1	5.48	8.16	58	76	0.963	0.50	0.04	0.844	1.96	0.057	♀	22	63.8	5.24	8.21	54	75	0.892	0.01	Lambda-asterion	♂	20	83.5	3.18	3.80	77	89	0.979	0.90	1.97	0.160	2.25	0.030	♀	23	80.7	4.39	5.43	73	88	0.961	0.10	Nasion-nasospinale	♂	24	51.5	2.17	4.21	46	56	0.946	0.10	4.64	0.031	4.72	0.000	♀	24	47.5	3.43	7.23	40	54	0.970	0.50	Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001	♀	24	63.6	4.29	6.74	56	72	0.945	0.10	Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998	♀	24	16.0	1.73	10.79	13	19	0.955	0.10	Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																
Asterion-opisthion	♂	20	62.9	3.08	4.89	57	68	0.961	0.50	5.22	0.022	0.34	0.733																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	♀	23	62.3	5.23	8.39	46	75	0.872	<0.01					Basion-asterion	♂	19	75.5	3.76	4.98	69	81	0.925	0.02	4.12	0.042	2.46	0.018	♀	23	73.1	2.36	2.23	69	78	0.956	0.10	Basion-mastoidale	♂	19	53.2	2.52	4.73	49	58	0.975	0.50	0.03	0.862	4.35	0.000	♀	23	49.8	2.42	4.86	45	54	0.965	0.50	Basion-staphylion	♂	18	47.8	3.15	6.58	41	53	0.967	0.50	3.13	0.077	3.13	0.003	♀	23	45.2	2.09	4.62	42	50	0.961	0.10	Bregma-lambda	♂	20	115.3	5.72	4.96	107	130	0.962	0.50	0.02	0.877	2.56	0.014	♀	23	110.7	5.92	5.35	98	119	0.947	0.10	Parietal subtense height	♂	20	22.8	2.82	12.36	17	27	-	-	0.36	0.549	0.03	0.978	♀	22	22.8	2.46	10.78	18	22	-	-	Lambda-parietal subtense	♂	20	59.6	4.23	7.09	53	66	-	-	0.63	0.426	1.11	0.275	♀	22	58.0	5.07	8.74	49	67	-	-	Lambda-inion	♂	19	67.1	5.48	8.16	58	76	0.963	0.50	0.04	0.844	1.96	0.057	♀	22	63.8	5.24	8.21	54	75	0.892	0.01	Lambda-asterion	♂	20	83.5	3.18	3.80	77	89	0.979	0.90	1.97	0.160	2.25	0.030	♀	23	80.7	4.39	5.43	73	88	0.961	0.10	Nasion-nasospinale	♂	24	51.5	2.17	4.21	46	56	0.946	0.10	4.64	0.031	4.72	0.000	♀	24	47.5	3.43	7.23	40	54	0.970	0.50	Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001	♀	24	63.6	4.29	6.74	56	72	0.945	0.10	Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998	♀	24	16.0	1.73	10.79	13	19	0.955	0.10	Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																																							
Basion-asterion	♂	19	75.5	3.76	4.98	69	81	0.925	0.02	4.12	0.042	2.46	0.018																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	♀	23	73.1	2.36	2.23	69	78	0.956	0.10					Basion-mastoidale	♂	19	53.2	2.52	4.73	49	58	0.975	0.50	0.03	0.862	4.35	0.000	♀	23	49.8	2.42	4.86	45	54	0.965	0.50	Basion-staphylion	♂	18	47.8	3.15	6.58	41	53	0.967	0.50	3.13	0.077	3.13	0.003	♀	23	45.2	2.09	4.62	42	50	0.961	0.10	Bregma-lambda	♂	20	115.3	5.72	4.96	107	130	0.962	0.50	0.02	0.877	2.56	0.014	♀	23	110.7	5.92	5.35	98	119	0.947	0.10	Parietal subtense height	♂	20	22.8	2.82	12.36	17	27	-	-	0.36	0.549	0.03	0.978	♀	22	22.8	2.46	10.78	18	22	-	-	Lambda-parietal subtense	♂	20	59.6	4.23	7.09	53	66	-	-	0.63	0.426	1.11	0.275	♀	22	58.0	5.07	8.74	49	67	-	-	Lambda-inion	♂	19	67.1	5.48	8.16	58	76	0.963	0.50	0.04	0.844	1.96	0.057	♀	22	63.8	5.24	8.21	54	75	0.892	0.01	Lambda-asterion	♂	20	83.5	3.18	3.80	77	89	0.979	0.90	1.97	0.160	2.25	0.030	♀	23	80.7	4.39	5.43	73	88	0.961	0.10	Nasion-nasospinale	♂	24	51.5	2.17	4.21	46	56	0.946	0.10	4.64	0.031	4.72	0.000	♀	24	47.5	3.43	7.23	40	54	0.970	0.50	Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001	♀	24	63.6	4.29	6.74	56	72	0.945	0.10	Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998	♀	24	16.0	1.73	10.79	13	19	0.955	0.10	Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																																																														
Basion-mastoidale	♂	19	53.2	2.52	4.73	49	58	0.975	0.50	0.03	0.862	4.35	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	♀	23	49.8	2.42	4.86	45	54	0.965	0.50					Basion-staphylion	♂	18	47.8	3.15	6.58	41	53	0.967	0.50	3.13	0.077	3.13	0.003	♀	23	45.2	2.09	4.62	42	50	0.961	0.10	Bregma-lambda	♂	20	115.3	5.72	4.96	107	130	0.962	0.50	0.02	0.877	2.56	0.014	♀	23	110.7	5.92	5.35	98	119	0.947	0.10	Parietal subtense height	♂	20	22.8	2.82	12.36	17	27	-	-	0.36	0.549	0.03	0.978	♀	22	22.8	2.46	10.78	18	22	-	-	Lambda-parietal subtense	♂	20	59.6	4.23	7.09	53	66	-	-	0.63	0.426	1.11	0.275	♀	22	58.0	5.07	8.74	49	67	-	-	Lambda-inion	♂	19	67.1	5.48	8.16	58	76	0.963	0.50	0.04	0.844	1.96	0.057	♀	22	63.8	5.24	8.21	54	75	0.892	0.01	Lambda-asterion	♂	20	83.5	3.18	3.80	77	89	0.979	0.90	1.97	0.160	2.25	0.030	♀	23	80.7	4.39	5.43	73	88	0.961	0.10	Nasion-nasospinale	♂	24	51.5	2.17	4.21	46	56	0.946	0.10	4.64	0.031	4.72	0.000	♀	24	47.5	3.43	7.23	40	54	0.970	0.50	Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001	♀	24	63.6	4.29	6.74	56	72	0.945	0.10	Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998	♀	24	16.0	1.73	10.79	13	19	0.955	0.10	Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																																																																																					
Basion-staphylion	♂	18	47.8	3.15	6.58	41	53	0.967	0.50	3.13	0.077	3.13	0.003																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	♀	23	45.2	2.09	4.62	42	50	0.961	0.10					Bregma-lambda	♂	20	115.3	5.72	4.96	107	130	0.962	0.50	0.02	0.877	2.56	0.014	♀	23	110.7	5.92	5.35	98	119	0.947	0.10	Parietal subtense height	♂	20	22.8	2.82	12.36	17	27	-	-	0.36	0.549	0.03	0.978	♀	22	22.8	2.46	10.78	18	22	-	-	Lambda-parietal subtense	♂	20	59.6	4.23	7.09	53	66	-	-	0.63	0.426	1.11	0.275	♀	22	58.0	5.07	8.74	49	67	-	-	Lambda-inion	♂	19	67.1	5.48	8.16	58	76	0.963	0.50	0.04	0.844	1.96	0.057	♀	22	63.8	5.24	8.21	54	75	0.892	0.01	Lambda-asterion	♂	20	83.5	3.18	3.80	77	89	0.979	0.90	1.97	0.160	2.25	0.030	♀	23	80.7	4.39	5.43	73	88	0.961	0.10	Nasion-nasospinale	♂	24	51.5	2.17	4.21	46	56	0.946	0.10	4.64	0.031	4.72	0.000	♀	24	47.5	3.43	7.23	40	54	0.970	0.50	Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001	♀	24	63.6	4.29	6.74	56	72	0.945	0.10	Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998	♀	24	16.0	1.73	10.79	13	19	0.955	0.10	Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																																																																																																												
Bregma-lambda	♂	20	115.3	5.72	4.96	107	130	0.962	0.50	0.02	0.877	2.56	0.014																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	♀	23	110.7	5.92	5.35	98	119	0.947	0.10					Parietal subtense height	♂	20	22.8	2.82	12.36	17	27	-	-	0.36	0.549	0.03	0.978	♀	22	22.8	2.46	10.78	18	22	-	-	Lambda-parietal subtense	♂	20	59.6	4.23	7.09	53	66	-	-	0.63	0.426	1.11	0.275	♀	22	58.0	5.07	8.74	49	67	-	-	Lambda-inion	♂	19	67.1	5.48	8.16	58	76	0.963	0.50	0.04	0.844	1.96	0.057	♀	22	63.8	5.24	8.21	54	75	0.892	0.01	Lambda-asterion	♂	20	83.5	3.18	3.80	77	89	0.979	0.90	1.97	0.160	2.25	0.030	♀	23	80.7	4.39	5.43	73	88	0.961	0.10	Nasion-nasospinale	♂	24	51.5	2.17	4.21	46	56	0.946	0.10	4.64	0.031	4.72	0.000	♀	24	47.5	3.43	7.23	40	54	0.970	0.50	Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001	♀	24	63.6	4.29	6.74	56	72	0.945	0.10	Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998	♀	24	16.0	1.73	10.79	13	19	0.955	0.10	Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																																																																																																																																			
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	♀	22	22.8	2.46	10.78	18	22	-	-					Lambda-parietal subtense	♂	20	59.6	4.23	7.09	53	66	-	-	0.63	0.426	1.11	0.275	♀	22	58.0	5.07	8.74	49	67	-	-	Lambda-inion	♂	19	67.1	5.48	8.16	58	76	0.963	0.50	0.04	0.844	1.96	0.057	♀	22	63.8	5.24	8.21	54	75	0.892	0.01	Lambda-asterion	♂	20	83.5	3.18	3.80	77	89	0.979	0.90	1.97	0.160	2.25	0.030	♀	23	80.7	4.39	5.43	73	88	0.961	0.10	Nasion-nasospinale	♂	24	51.5	2.17	4.21	46	56	0.946	0.10	4.64	0.031	4.72	0.000	♀	24	47.5	3.43	7.23	40	54	0.970	0.50	Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001	♀	24	63.6	4.29	6.74	56	72	0.945	0.10	Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998	♀	24	16.0	1.73	10.79	13	19	0.955	0.10	Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																																																																																																																																																										
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	♀	22	58.0	5.07	8.74	49	67	-	-					Lambda-inion	♂	19	67.1	5.48	8.16	58	76	0.963	0.50	0.04	0.844	1.96	0.057	♀	22	63.8	5.24	8.21	54	75	0.892	0.01	Lambda-asterion	♂	20	83.5	3.18	3.80	77	89	0.979	0.90	1.97	0.160	2.25	0.030	♀	23	80.7	4.39	5.43	73	88	0.961	0.10	Nasion-nasospinale	♂	24	51.5	2.17	4.21	46	56	0.946	0.10	4.64	0.031	4.72	0.000	♀	24	47.5	3.43	7.23	40	54	0.970	0.50	Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001	♀	24	63.6	4.29	6.74	56	72	0.945	0.10	Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998	♀	24	16.0	1.73	10.79	13	19	0.955	0.10	Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																																																																																																																																																																																	
Lambda-inion	♂	19	67.1	5.48	8.16	58	76	0.963	0.50	0.04	0.844	1.96	0.057																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	♀	22	63.8	5.24	8.21	54	75	0.892	0.01					Lambda-asterion	♂	20	83.5	3.18	3.80	77	89	0.979	0.90	1.97	0.160	2.25	0.030	♀	23	80.7	4.39	5.43	73	88	0.961	0.10	Nasion-nasospinale	♂	24	51.5	2.17	4.21	46	56	0.946	0.10	4.64	0.031	4.72	0.000	♀	24	47.5	3.43	7.23	40	54	0.970	0.50	Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001	♀	24	63.6	4.29	6.74	56	72	0.945	0.10	Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998	♀	24	16.0	1.73	10.79	13	19	0.955	0.10	Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																																																																																																																																																																																																								
Lambda-asterion	♂	20	83.5	3.18	3.80	77	89	0.979	0.90	1.97	0.160	2.25	0.030																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	♀	23	80.7	4.39	5.43	73	88	0.961	0.10					Nasion-nasospinale	♂	24	51.5	2.17	4.21	46	56	0.946	0.10	4.64	0.031	4.72	0.000	♀	24	47.5	3.43	7.23	40	54	0.970	0.50	Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001	♀	24	63.6	4.29	6.74	56	72	0.945	0.10	Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998	♀	24	16.0	1.73	10.79	13	19	0.955	0.10	Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																																																																																																																																																																																																																															
Nasion-nasospinale	♂	24	51.5	2.17	4.21	46	56	0.946	0.10	4.64	0.031	4.72	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	♀	24	47.5	3.43	7.23	40	54	0.970	0.50					Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001	♀	24	63.6	4.29	6.74	56	72	0.945	0.10	Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998	♀	24	16.0	1.73	10.79	13	19	0.955	0.10	Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																																																																																																																																																																																																																																																						
Nasion-prosthion	♂	23	67.6	2.84	4.20	62	73	0.950	0.10	3.62	0.057	3.69	0.001																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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Nasospinale-prosthion	♂	23	16.0	2.34	14.62	12	20	0.962	0.50	2.01	0.157	0.01	0.998																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	♀	24	16.0	1.73	10.79	13	19	0.955	0.10					Nasal breadth	♂	20	26.4	1.49	5.64	24	29	0.945	0.10	0.97	0.323	2.23	0.032	♀	23	25.4	1.19	4.71	23	27	0.892	0.01	Orbital height	♂	24	34.1	2.25	6.59	31	40	0.925	0.05	1.25	0.264	1.11	0.271	♀	25	33.4	1.78	5.32	31	38	0.928	0.05	Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000	♀	23	42.1	1.18	2.80	40	45	0.928	0.10	Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																																																																																																																																																																																																																																																																																																				
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Orbital breadth	♂	20	43.8	1.24	2.83	40	46	0.855	<0.01	0.05	0.824	4.52	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	♀	23	42.1	1.18	2.80	40	45	0.928	0.10					Biectoconchion	♂	22	103.5	3.24	3.13	95	110	0.958	0.10	0.03	0.874	3.66	0.001	♀	25	99.9	3.36	3.36	95	110	0.898	0.01	Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																																																																																																																																																																																																																																																																																																																																																																									
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	♀	25	99.9	3.36	3.36	95	110	0.898	0.01					Alveolar length	♂	24	61.2	3.25	5.31	54	67	0.965	0.50	5.08	0.024	4.68	0.000	♀	25	57.6	2.02	3.50	53	63	0.971	0.50	Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																																																																																																																																																																																																																																																																																																																																																																																																
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	♀	25	57.6	2.02	3.50	53	63	0.971	0.50					Alveolar breadth	♂	24	66.5	2.77	4.17	61	73	0.965	0.50	0.02	0.881	5.20	0.000	♀	25	62.3	2.85	4.58	58	67	0.932	0.10	Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000	♀	23	42.9	2.05	4.78	40	49	0.820	<0.01	Mastoid depth	♂	24	28.9	2.83	9.79	24	36	0.901	0.10	0.54	0.462	5.51	0.000	♀	25	24.8	2.43	9.80	20	28	0.925	0.10																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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Bicanine breadth	♂	16	45.9	1.81	3.94	43	49	0.920	0.10	0.28	0.594	4.68	0.000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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Table 6 (continued)

Variable	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	Shapiro Wilk	Proba- bility	χ^2	Proba- bility	Student's t	Proba- bility																																																																																																																																																																																																																																	
Frontal arc	♂	21	128.1	4.64	3.62	117	136	0.944	0.10	0.08	0.784	3.53	0.001																																																																																																																																																																																																																																	
	♀	20	122.8	4.94	4.03	112	130	0.945	0.10					Parietal arc	♂	21	127.0	5.70	4.48	118	137	0.961	0.50	0.59	0.440	2.01	0.051	♀	22	123.1	6.79	5.52	106	133	0.958	0.10	Occipital arc	♂	21	113.5	6.33	5.57	102	125	0.964	0.50	0.03	0.869	1.23	0.227	♀	23	111.1	6.11	5.49	95	119	0.932	0.10	Frontal curvature index	♂	24	22.5	1.77	7.86	19	26	-	-	0.03	0.853	3.52	0.001	♀	23	24.3	1.71	7.03	19	27	-	-	Parietal curvature index	♂	20	19.7	1.99	10.10	16	23	-	-	4.82	0.028	1.91	0.062	♀	22	21.4	3.32	15.51	18	32	-	-	Occipital curvature index	♂	19	30.1	3.19	10.59	25	35	-	-	0.85	0.356	0.75	0.454	♀	20	31.0	3.97	12.80	27	42	-	-	Gnathic index	♂	22	103.2	3.48	3.37	95	108	-	-	0.09	0.765	1.16	0.252	♀	24	104.5	3.71	3.55	96	112	-	-	Nasal index	♂	20	51.2	3.13	6.11	47	58	-	-	3.99	0.046	1.77	0.083	♀	23	53.5	4.96	9.27	46	65	-	-	Orbital index	♂	20	77.1	3.37	4.37	71	82	-	-	2.13	0.144	2.26	0.029	♀	23	79.9	4.70	5.88	72	90	-	-	Palate module	♂	24	40.7	2.90	7.12	35	46	-	-	0.94	0.333	6.32	0.000	♀	25	35.9	2.38	6.62	31	40	-	-	Cranial module	♂	23	149.8	3.10	2.06	146	157	-	-	0.85	0.356	5.67	0.000	♀	23	144.1	3.73
Parietal arc	♂	21	127.0	5.70	4.48	118	137	0.961	0.50	0.59	0.440	2.01	0.051																																																																																																																																																																																																																																	
	♀	22	123.1	6.79	5.52	106	133	0.958	0.10					Occipital arc	♂	21	113.5	6.33	5.57	102	125	0.964	0.50	0.03	0.869	1.23	0.227	♀	23	111.1	6.11	5.49	95	119	0.932	0.10	Frontal curvature index	♂	24	22.5	1.77	7.86	19	26	-	-	0.03	0.853	3.52	0.001	♀	23	24.3	1.71	7.03	19	27	-	-	Parietal curvature index	♂	20	19.7	1.99	10.10	16	23	-	-	4.82	0.028	1.91	0.062	♀	22	21.4	3.32	15.51	18	32	-	-	Occipital curvature index	♂	19	30.1	3.19	10.59	25	35	-	-	0.85	0.356	0.75	0.454	♀	20	31.0	3.97	12.80	27	42	-	-	Gnathic index	♂	22	103.2	3.48	3.37	95	108	-	-	0.09	0.765	1.16	0.252	♀	24	104.5	3.71	3.55	96	112	-	-	Nasal index	♂	20	51.2	3.13	6.11	47	58	-	-	3.99	0.046	1.77	0.083	♀	23	53.5	4.96	9.27	46	65	-	-	Orbital index	♂	20	77.1	3.37	4.37	71	82	-	-	2.13	0.144	2.26	0.029	♀	23	79.9	4.70	5.88	72	90	-	-	Palate module	♂	24	40.7	2.90	7.12	35	46	-	-	0.94	0.333	6.32	0.000	♀	25	35.9	2.38	6.62	31	40	-	-	Cranial module	♂	23	149.8	3.10	2.06	146	157	-	-	0.85	0.356	5.67	0.000	♀	23	144.1	3.73	2.58	138	150	-	-																		
Occipital arc	♂	21	113.5	6.33	5.57	102	125	0.964	0.50	0.03	0.869	1.23	0.227																																																																																																																																																																																																																																	
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	♀	23	24.3	1.71	7.03	19	27	-	-					Parietal curvature index	♂	20	19.7	1.99	10.10	16	23	-	-	4.82	0.028	1.91	0.062	♀	22	21.4	3.32	15.51	18	32	-	-	Occipital curvature index	♂	19	30.1	3.19	10.59	25	35	-	-	0.85	0.356	0.75	0.454	♀	20	31.0	3.97	12.80	27	42	-	-	Gnathic index	♂	22	103.2	3.48	3.37	95	108	-	-	0.09	0.765	1.16	0.252	♀	24	104.5	3.71	3.55	96	112	-	-	Nasal index	♂	20	51.2	3.13	6.11	47	58	-	-	3.99	0.046	1.77	0.083	♀	23	53.5	4.96	9.27	46	65	-	-	Orbital index	♂	20	77.1	3.37	4.37	71	82	-	-	2.13	0.144	2.26	0.029	♀	23	79.9	4.70	5.88	72	90	-	-	Palate module	♂	24	40.7	2.90	7.12	35	46	-	-	0.94	0.333	6.32	0.000	♀	25	35.9	2.38	6.62	31	40	-	-	Cranial module	♂	23	149.8	3.10	2.06	146	157	-	-	0.85	0.356	5.67	0.000	♀	23	144.1	3.73	2.58	138	150	-	-																																																																
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	♀	22	21.4	3.32	15.51	18	32	-	-					Occipital curvature index	♂	19	30.1	3.19	10.59	25	35	-	-	0.85	0.356	0.75	0.454	♀	20	31.0	3.97	12.80	27	42	-	-	Gnathic index	♂	22	103.2	3.48	3.37	95	108	-	-	0.09	0.765	1.16	0.252	♀	24	104.5	3.71	3.55	96	112	-	-	Nasal index	♂	20	51.2	3.13	6.11	47	58	-	-	3.99	0.046	1.77	0.083	♀	23	53.5	4.96	9.27	46	65	-	-	Orbital index	♂	20	77.1	3.37	4.37	71	82	-	-	2.13	0.144	2.26	0.029	♀	23	79.9	4.70	5.88	72	90	-	-	Palate module	♂	24	40.7	2.90	7.12	35	46	-	-	0.94	0.333	6.32	0.000	♀	25	35.9	2.38	6.62	31	40	-	-	Cranial module	♂	23	149.8	3.10	2.06	146	157	-	-	0.85	0.356	5.67	0.000	♀	23	144.1	3.73	2.58	138	150	-	-																																																																																							
Occipital curvature index	♂	19	30.1	3.19	10.59	25	35	-	-	0.85	0.356	0.75	0.454																																																																																																																																																																																																																																	
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	♀	24	104.5	3.71	3.55	96	112	-	-					Nasal index	♂	20	51.2	3.13	6.11	47	58	-	-	3.99	0.046	1.77	0.083	♀	23	53.5	4.96	9.27	46	65	-	-	Orbital index	♂	20	77.1	3.37	4.37	71	82	-	-	2.13	0.144	2.26	0.029	♀	23	79.9	4.70	5.88	72	90	-	-	Palate module	♂	24	40.7	2.90	7.12	35	46	-	-	0.94	0.333	6.32	0.000	♀	25	35.9	2.38	6.62	31	40	-	-	Cranial module	♂	23	149.8	3.10	2.06	146	157	-	-	0.85	0.356	5.67	0.000	♀	23	144.1	3.73	2.58	138	150	-	-																																																																																																																																					
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	♀	23	53.5	4.96	9.27	46	65	-	-					Orbital index	♂	20	77.1	3.37	4.37	71	82	-	-	2.13	0.144	2.26	0.029	♀	23	79.9	4.70	5.88	72	90	-	-	Palate module	♂	24	40.7	2.90	7.12	35	46	-	-	0.94	0.333	6.32	0.000	♀	25	35.9	2.38	6.62	31	40	-	-	Cranial module	♂	23	149.8	3.10	2.06	146	157	-	-	0.85	0.356	5.67	0.000	♀	23	144.1	3.73	2.58	138	150	-	-																																																																																																																																																												
Orbital index	♂	20	77.1	3.37	4.37	71	82	-	-	2.13	0.144	2.26	0.029																																																																																																																																																																																																																																	
	♀	23	79.9	4.70	5.88	72	90	-	-					Palate module	♂	24	40.7	2.90	7.12	35	46	-	-	0.94	0.333	6.32	0.000	♀	25	35.9	2.38	6.62	31	40	-	-	Cranial module	♂	23	149.8	3.10	2.06	146	157	-	-	0.85	0.356	5.67	0.000	♀	23	144.1	3.73	2.58	138	150	-	-																																																																																																																																																																																			
Palate module	♂	24	40.7	2.90	7.12	35	46	-	-	0.94	0.333	6.32	0.000																																																																																																																																																																																																																																	
	♀	25	35.9	2.38	6.62	31	40	-	-					Cranial module	♂	23	149.8	3.10	2.06	146	157	-	-	0.85	0.356	5.67	0.000	♀	23	144.1	3.73	2.58	138	150	-	-																																																																																																																																																																																																										
Cranial module	♂	23	149.8	3.10	2.06	146	157	-	-	0.85	0.356	5.67	0.000																																																																																																																																																																																																																																	
	♀	23	144.1	3.73	2.58	138	150	-	-																																																																																																																																																																																																																																					

Table 7 (continued)

Variable	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	Shapiro Wilk	Proba- bility
Inion-opisthion	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Lambda-opisthion	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Occipital subtense height	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Lambda-occipital subtense	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Asterion-opisthion	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Basion-asterion	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Basion-mastoidale	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Basion-staphylion	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Bregma-lambda	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Parietal subtense height	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Lambda-parietal subtense	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Lambda-inion	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Lambda-asterion	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Nasion-nasospinale	♂	12	50.2	3.98	7.92	45	56	0.915	0.10
	♀	3	48.3	3.51	7.26	45	52	-	-
Nasion-prosthion	♂	13	64.2	6.12	9.54	51	74	0.974	0.90
	♀	3	63.0	2.64	4.20	60	65	-	-
Nasospinale-prosthion	♂	12	16.1	3.32	20.57	12	23	0.939	0.10
	♀	3	16.3	2.08	12.75	14	18	-	-
Nasal breadth	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Orbital height	♂	9	35.0	1.80	5.15	32	37	0.896	0.10
	♀	2	34.0	-	-	32	36	-	-
Orbital breadth	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Biectoconchion	♂	5	108.4	3.64	3.36	104	114	0.955	0.50
	♀	3	101.6	1.52	1.50	100	103	-	-
Alveolar length	♂	15	61.1	3.18	5.21	56	67	0.972	0.50
	♀	3	60.3	2.08	3.45	58	62	-	-
Alveolar breadth	♂	14	67.7	3.83	5.66	56	73	0.728	<0.01
	♀	3	63.3	4.04	6.38	61	68	-	-
Bicanine breadth	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Mastoid depth	♂	14	30.2	2.29	7.59	26	33	0.922	0.10
	♀	2	27.0	-	-	24	30	-	-

Table 7 (continued)

Variable	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	Shapiro Wilk	Proba- bility
Frontal arc	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Parietal arc	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Occipital arc	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Frontal curvature index	♂	16	23.8	2.34	9.83	18	28	-	-
	♀	3	25.2	1.76	3.10	24	27	-	-
Parietal curvature index	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Occipital curvature index	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Gnathic index	♂	11	98.7	4.58	4.64	90	105	-	-
	♀	3	103.6	2.11	4.44	102	106	-	-
Nasal index	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Orbital index	♂	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-
Palate module	♂	13	41.3	3.50	8.47	35	48	-	-
	♀	3	38.2	3.07	8.04	35	41	-	-
Cranial module	♂	11	154.8	3.59	-	151	162	-	-
	♀	3	146.4	2.01	-	144	148	-	-

1 Broadbeach female sample is too small for meaningful statistical comparison with the Broadbeach males

Table 8 Comparison of male and female cranial dimensions from Coobool Creek with those from the Murray Valley, Swanport and Broadbeach¹ using Student's *t* test

Variable	Male				Female					
	Murray Valley <i>t</i>	Murray Valley <i>P</i>	Swanport <i>t</i>	Swanport <i>P</i>	Broadbeach <i>t</i>	Broadbeach <i>P</i>	Murray Valley <i>t</i>	Murray Valley <i>P</i>	Swanport <i>t</i>	Swanport <i>P</i>
Maximum biparietal breadth	6.41	.000	7.28	.000	4.38	.000	3.35	.001	3.68	.001
Glabella-opisthocranion	3.96	.000	3.04	.004	1.38	.176	3.26	.002	1.87	.071
Glabella-lambda	4.69	.000	4.57	.000	2.01	.052	3.89	.000	3.34	.002
Basion-bregma	6.31	.000	7.51	.000	1.37	.179	6.31	.000	6.68	.000
Basion-nasion	2.59	.012	3.42	.001	0.12	.906	2.44	.018	2.79 ²	.009
Basion-nasospinale	3.17	.002	2.70	.010	3.96	.001	1.38	.171	1.82	.080
Basion-prosthion	2.81	.007	3.73	.001	3.48	.002	2.25	.048	2.27	.031
Basion-lambda	4.48 ²	.000	4.97	.000	-	-	6.56	.000	4.91	.000
Basion-inion	3.02	.004	3.64	.001	-	-	1.50 ²	.144	4.18	.000
Biauriculare	4.38	.000	3.99	.000	-	-	4.71	.000	4.76	.000
Biasterion	0.57 ²	.572	1.55 ²	.128	-	-	2.18	.033	2.04	.051
Bisphenion	3.91	.000	4.95	.000	2.61	.015	0.06	.949	1.08	.289
Glabella-bregma	6.54	.000	6.43 ²	.000	2.18	.036	4.76	.000	4.34	.000
Nasion-bregma	6.30	.000	6.87 ²	.000	2.03	.050	5.26	.000	5.32	.000
Metopion height	2.25 ^{2,3}	.032	1.72 ^{2,3}	.091	3.81 ³	.001	2.39 ³	.020	2.87 ^{2,3}	.007
Maximum supraorbital breadth	6.92	.000	5.20	.000	1.80	.081	5.73 ²	.000	4.80	.000
Minimum postorbital breadth	2.93	.005	1.75	.087	0.49 ³	.624	2.06	.043	1.61	.117
Bizygion	3.72	.001	4.01	.001	0.49	.634	-	-	-	-
Bizygomaxillare	5.81	.000	3.10	.004	0.12 ^{2,3}	.909	4.93	.000	3.31	.002
Bistephanion	6.48	.000	4.37	.000	-	-	3.24	.002	2.48	.020
Bistenion	0.02	.914	0.41	.681	-	-	1.68	.097	2.21	.036
Inion-opisthion	2.65 ³	.010	4.41	.000	-	-	0.40 ³	.688	1.15	.261
Lambda-opisthion	5.16 ²	.000	5.48 ²	.000	-	-	7.30	.000	4.60 ²	.000
Occipital subtense height	-	-	0.20	.839	-	-	-	-	2.44 ^{2,3}	.024
Lambda-occipital subtense	-	-	3.39	.002	-	-	-	-	0.24	.807
Asterion-opisthion	0.68	.498	4.08	.000	-	-	0.27	.785	0.66	.418
Basion-asterion	2.69	.009	3.71	.001	-	-	3.14	.003	3.28 ²	.003
Basion-mastoidale	2.67	.010	1.52	.135	-	-	4.19	.000	4.11	.000
Basion-staphylion	2.73	.009	1.89	.070	-	-	1.93	.059	2.23	.034
Bregma-lambda	1.31	.195	2.14	.038	-	-	0.95	.348	1.27	.213
Parietal subtense height	1.36 ²	.183	1.62	.113	-	-	0.11 ^{2,3}	.915	0.11	.916
Lambda-parietal subtense	1.56	.124	1.28	.206	-	-	1.28	.205	0.14 ³	.894
Lambda-inion	4.27 ²	.000	1.10 ²	.011	-	-	3.72	.519	1.66	.840
Lambda-asterion	3.61 ²	.001	2.67 ²	.011	-	-	0.67 ²	.519	0.20 ²	.840
Nasion-nasospinale	3.44	.001	3.55	.001	3.22	.003	2.56	.013	1.74	.092

Table 8 (continued)

Variable	Murray Valley		Male Swanport		Broadbeach		Female Murray Valley		Female Swanport	
	t	P	t	P	t	P	t	P	t	P
Nasion-prosthion	4.04	.000	7.42	.000	6.21	.000	2.13	.013	2.91	.092
Nasospinale-prosthion	0.27	.791	4.67	.000	3.24	.003	0.35	.726	3.71	.001
Nasal breadth	2.22	.030	6.71	.000	-	-	2.24	.029	4.28 ²	.000
Orbital height	1.81 ³	.074	3.29 ³	.002	3.48 ³	.002	0.92	.359	1.02 ³	.314
Orbital breadth	1.51 ³	.135	0.12 ^{2,3}	.906	-	-	2.12	.038	3.07	.005
Biectoconchion	4.18	.000	4.61	.000	0.18	.863	3.27	.002	3.07	.004
Alveolar length	0.63 ²	.531	3.76	.001	3.58	.001	0.88	.378	2.81 ²	.008
Alveolar breadth	3.35	.001	6.23	.000	3.72	.001	3.46	.001	4.69	.000
Bicanine breadth	2.26	.027	2.53	.016	-	-	4.04	.000	5.12	.000
Mastoid depth	0.05	.960	2.81	.007	1.19	.240	0.91	.365	3.20	.003
Frontal arc	2.71	.009	3.23	.002	-	-	2.32	.024	2.48	.019
Parietal arc	1.59	.116	2.83	.007	-	-	0.91	.366	1.21	.235
Occipital arc	3.78 ²	.001	3.38	.002	-	-	5.38	.000	4.30	.000
Frontal curvature index	4.01 ^{2,3}	.000	3.67 ^{2,3}	.001	4.36 ^{2,3}	.000	3.04 ^{2,3}	.016	4.85 ^{2,3}	.000
Parietal curvature index	1.07 ²	.292	0.96	.339	-	-	0.53 ^{2,3}	.607	1.05 ^{2,3}	.304
Occipital curvature index	-	-	1.95 ³	.061	-	-	-	-	2.86 ³	.009
Gnathic index	0.97	.332	1.51	.139	4.04	.000	0.48	.633	0.25	.808
Nasal index	1.49	.143	2.84	.007	-	-	0.42	.673	0.84	.408
Orbital index	1.34 ³	.180	3.37 ³	.002	-	-	0.51 ³	.618	2.55 ³	.016
Palate module	2.08	.040	6.26	.000	4.43	.000	2.42	.019	4.94	.000
Cranial module	5.84	.000	6.57	.000	1.82	.079	4.73	.001	5.07	.000

t = Student's t

P = probability

1 Broadbeach female sample too small (n = 4) for significant comparison

2 Significant difference in variance indicated by Bartlett's χ^2 (P = .05-.001)

3 Coobool Creek mean less than comparative mean

Table 9 Descriptive and comparative statistics for the Kow Swamp and Barham male and female cranial dimensions (mm)

Variable	Sex	Kow Swamp					Barham				
		n	\bar{x}	s	Min.	Max.	n	\bar{x}	s	Min.	Max.
Maximum biparietal breadth	♂	2	138.5	-	138	139	4	131.0	5.35	124	137
	♀	-	-	-	-	-	1	118.0	-	118	118
Glabella-opisthocranion	♂	2	196.5	-	192	201	4	195.8	6.89	187	203
	♀	-	-	-	-	-	1	194.0	-	194	194
Glabella-lambda	♂	1	189.0	-	189	189	4	191.0	8.83	183	203
	♀	-	-	-	-	-	1	188.0	-	188	188
Basion-bregma	♂	-	-	-	-	-	2	137.0	-	135	139
	♀	-	-	-	-	-	-	-	-	-	-
Basion-nasion	♂	-	-	-	-	-	2	106.0	-	98	114
	♀	-	-	-	-	-	-	-	-	-	-
Basion-nasospinale	♂	-	-	-	-	-	2	99.5	-	91	108
	♀	-	-	-	-	-	-	-	-	-	-
Basion-prosthion	♂	-	-	-	-	-	2	104.0	-	96	112
	♀	-	-	-	-	-	-	-	-	-	-
Basion-lambda	♂	-	-	-	-	-	2	116.5	-	116	117
	♀	-	-	-	-	-	-	-	-	-	-
Basion-inion	♂	-	-	-	-	-	2	78.0	-	74	82
	♀	-	-	-	-	-	-	-	-	-	-
Biauriculare	♂	2	126.5	-	117	136	3	120.3	2.51	118	123
	♀	-	-	-	-	-	1	110.0	-	110	110
Biasterion	♂	2	112.0	-	112	112	4	110.8	6.34	103	118
	♀	-	-	-	-	-	1	103.0	-	103	103
Bisphenion	♂	-	-	-	-	-	2	99.0	-	93	105
	♀	-	-	-	-	-	-	-	-	-	-
Glabella-bregma	♂	3	118.0	3.60	114	121	4	116.8	4.19	111	121
	♀	2	103.0	-	97	109	1	110.0	-	110	110
Nasion-bregma	♂	4	120.3	3.30	116	124	4	118.0	4.24	112	121
	♀	2	108.0	-	104	112	1	113.0	-	113	113
Metopion height	♂	4	18.0	3.83	13	21	4	24.8	2.63	21	27
	♀	2	25.5	-	23	28	1	24.0	-	24	24
Nasion-metopion	♂	-	-	-	-	-	-	-	-	-	-
	♀	-	-	-	-	-	-	-	-	-	-
Maximum supraorbital breadth	♂	4	117.8	5.31	110	122	2	109.0	-	107	111
	♀	2	110.0	-	109	111	1	106.0	-	106	106
Minimum postorbital breadth	♂	4	100.0	5.35	95	106	3	92.3	2.51	90	95
	♀	1	101.0	-	101	101	1	92.0	-	92	92
Bizygion	♂	-	-	-	-	-	2	133.5	-	131	136
	♀	-	-	-	-	-	-	-	-	-	-
Bizygomaxillare	♂	2	104.0	-	103	105	2	95.0	-	93	97
	♀	1	-	-	-	-	1	93.0	-	93	93
Bistephanion	♂	4	99.3	6.96	80	110	1	76.0	-	76	76
	♀	1	-	-	-	-	1	91.0	-	91	91
Bistenion	♂	1	65.0	-	65	65	1	72.0	-	72	72
	♀	-	-	-	-	-	-	-	-	-	-
Inion-opisthion	♂	1	34.0	-	34	34	3	45.7	4.04	41	48
	♀	-	-	-	-	-	1	42.0	-	42	42

Table 9 (continued)

Variable	Sex	n	Kow Swamp				n	Barham			
			\bar{x}	s	Min.	Max.		\bar{x}	s	Min.	Max.
Lambda-opisthion	♂	-	-	-	-	-	3	98.3	2.51	96	101
	♀	-	-	-	-	-	1	90.0	-	90	90
Occipital subtense	♂	-	-	-	-	-	3	30.3	6.11	25	37
height	♀	-	-	-	-	-	1	24.0	-	24	24
Lambda-occipital	♂	-	-	-	-	-	3	59.7	4.04	56	64
subtense	♀	-	-	-	-	-	1	41.0	-	41	41
Asterion-opisthion	♂	-	-	-	-	-	3	65.7	15.01	51	81
	♀	-	-	-	-	-	-	-	-	-	-
Basion-asterion	♂	-	-	-	-	-	2	76.5	-	75	78
	♀	-	-	-	-	-	-	-	-	-	-
Basion-mastoidale	♂	-	-	-	-	-	2	51.5	-	51	52
	♀	-	-	-	-	-	-	-	-	-	-
Basion-staphylion	♂	-	-	-	-	-	1	44.0	-	44	44
	♀	-	-	-	-	-	-	-	-	-	-
Bregma-lambda	♂	5	119.8	4.71	116	127	4	120.3	9.91	114	135
	♀	1	115.0	-	115	115	2	117.0	-	113	121
Parietal subtense	♂	5	24.4	3.97	21	31	4	24.5	2.51	22	28
height	♀	-	-	-	-	-	2	24.0	-	24	24
Lambda-parietal	♂	4	60.0	4.54	56	66	4	68.3	4.78	64	75
subtense	♀	-	-	-	-	-	2	65.0	-	65	65
Lambda-inion	♂	4	66.5	11.67	54	82	4	85.8	9.06	79	99
	♀	-	-	-	-	-	2	89.5	-	80	99
Lambda-asterion	♂	5	86.8	4.14	84	94	4	85.8	9.06	79	99
	♀	-	-	-	-	-	2	89.5	-	-	-
Nasion-nasospinale	♂	3	55.7	2.31	53	57	4	51.0	2.30	49	53
	♀	1	47.0	-	47	47	1	51.0	-	51	51
Nasion-prosthion	♂	3	77.0	2.31	73	81	4	67.8	2.63	65	70
	♀	1	67.0	-	67	67	1	70.0	-	70	70
Nasospinale-prosthion	♂	3	21.3	2.31	20	24	4	16.5	0.57	16	17
	♀	1	20.0	-	20	20	1	19.0	-	19	19
Nasal breadth	♂	3	27.7	3.21	27	31	5	28.4	1.14	27	30
	♀	1	28.0	-	28	28	1	56.0	-	56	56
Orbital height	♂	4	28.8	1.89	27	31	4	33.8	4.19	28	38
	♀	2	29.5	-	29	30	1	31.0	-	31	31
Orbital breadth	♂	3	45.0	5.00	40	50	3	45.0	3.60	42	49
	♀	1	45.0	-	45	45	1	41.0	-	-	-
Biectoconchion	♂	3	111.3	9.29	101	119	2	102.5	-	101	104
	♀	2	107.0	-	104	110	1	101.0	-	101	101
Alveolar length	♂	1	65.0	-	65	65	3	58.3	4.04	54	62
	♀	1	61.0	-	61	61	1	58.0	-	58	58
Alveolar breadth	♂	2	71.5	-	70	73	2	66.5	-	64	69
	♀	1	69.0	-	69	69	1	66.0	-	66	66
Bicanine breadth	♂	3	49.7	2.30	47	51	4	45.3	2.75	42	48
	♀	1	46.0	-	46	46	1	43.0	-	43	43
Mastoid depth	♂	2	30.0	-	29	31	5	30.0	1.87	27	32
	♀	-	-	-	-	-	2	23.5	-	23	24

Table 9 (continued)

Variable	Sex	n	Kow Swamp				Barham				
			\bar{x}	s	Min.	Max.	n	\bar{x}	s	Min.	Max.
Frontal arc	♂	3	130.3	4.61	125	133	4	134.0	4.96	127	138
	♀	2	124.0	-	118	130	1	128.0	-	128	128
Parietal arc	♂	4	134.0	6.00	131	143	4	134.3	11.29	127	151
	♀	1	130.0	-	130	130	2	131.0	-	129	133
Occipital arc	♂	-	-	-	-	-	2	118.0	-	118	118
	♀	-	-	-	-	-	1	107.0	-	107	107
Frontal curvature index	♂	4	14.9	2.89	11	18	4	20.95	1.59	19	22
	♀	2	23.5	-	22	25	1	21.2	-	21	21
Parietal curvature index	♂	5	20.3	2.71	17	24	4	20.4	1.06	19	21
	♀	-	-	-	-	-	2	20.6	-	19	22
Occipital curvature index	♂	-	-	-	-	-	3	30.7	5.39	26	37
	♀	-	-	-	-	-	1	26.7	-	27	27
Gnathic index	♂	-	-	-	-	-	2	98.1	-	98	98
	♀	-	-	-	-	-	-	-	-	-	-
Nasal index	♂	3	48.9	7.30	42	57	4	55.0	3.79	51	59
	♀	1	59.6	-	60	60	1	51.0	-	51	51
Orbital index	♂	2	73.2	-	69	78	3	73.8	6.20	67	78
	♀	1	66.7	-	67	67	1	75.6	-	76	76
Palate module	♂	-	-	-	-	-	2	38.7	-	34	42
	♀	1	42.1	-	42	42	1	38.3	-	38	38
Cranial module	♂	-	-	-	-	-	2	153.8	-	151	156
	♀	-	-	-	-	-	-	-	-	-	-

Table 10 Dimensions of individual late Pleistocene and early Holocene Aboriginal crania (mm)

Variable	Cohuna	Keilor	Mossgiel	Nacurrie 1	Nacurrie 2	Kow Swamp 5	Lake Nitchie	Lake Mungo I	Lake Mungo III
Maximum biparietal breadth	131	142	138	-	139	139	141	130	132
Glabella- opisthocranion	199	197	203	209	206	192	197	-	191
Glabella-lambda	196	189	199	209	201	189	191	173	-
Basion-bregma	142	142	-	-	146	-	142	-	-
Basion-nasion	106	109	-	-	113	-	111	-	-
Basion-nasospinale	102	103	-	-	-	-	105	-	-
Basion-prosthion	112	109	-	-	-	-	-	-	-
Basion-lambda	127	129	-	-	125	-	120	-	-
Basion-inion	-	85	-	-	82	-	81	-	-
Biauriculare	127	133	-	-	126	117	138	-	-
Biasterion	109	111	114	-	110	112	120	103	113
Bisphenion	96	108	-	-	-	-	110	-	-
Glabella-bregma	126	113	120	134	126	-	122	-	-
Nasion-bregma	126	114	120	138	129	-	121	-	-
Metopion height	18	24	21	20	22	-	29	-	-
Nasion-metopion	-	-	-	-	-	-	-	-	-
Maximum supraorbital breadth	116	116	119	-	116	110	122	107	-
Minimum postorbital breadth	89	102	98	104	100	96	106	-	-
Bizygion	145	-	-	-	-	-	150	-	-
Bizygomaxillare	109	96	-	-	-	105	106	-	-
Bistephanion	94	120	-	96	105	109	-	103	-
Inion-opisthion	-	48	46	-	47	-	50	40	52
Lambda-opisthion	-	106	105	-	97	-	95	95	97
Occipital subtense height	-	32	-	-	27	-	31	-	30
Lambda-occipital subtense	-	60	-	-	52	-	44	-	40
Asterion-opisthion	-	67	67	-	61	-	69	-	71
Basion-asterion	-	87	-	-	77	-	81	-	-
Basion-mastoidale	-	53	-	-	54	-	60	-	-
Basion-staphylion	-	47	-	-	-	-	-	-	-
Bregma-lambda	116	119	121	123	124	127	123	108	114
Parietal subtense height	26	21	24	29	29	31	24	20	18
Lambda-parietal subtense	55	59	60	60	68	61	65	62	65
Lambda-inion	-	74	70	67	60	82	60	68	59
Lambda-asterion	88	85	91	90	86	94	88	76	79
Nasion-nasospinale	54	51	-	-	-	53	61	-	-
Nasion-prosthion	75	74	-	-	-	73	-	-	-

Table 10 (continued)

Variable	Cohuna	Keilor	Mossgiel	Nacurrie 1	Nacurrie 2	Kow Swamp 5	Lake Nitchie	Lake Mungo I	Lake Mungo III
Nasospinale-prosthion	21	24	-	25	-	20	-	-	-
Nasal breadth	30	27	-	-	-	30	32	-	-
Orbital height	30	32	-	-	-	31	34	27	28
Orbital breadth	44	42	-	45	-	40	47	-	-
Biectoconchion	110	107	-	-	108	101	114	97	-
Alveolar length	67	64	-	-	-	65	67	-	-
Alveolar breadth	74	71	-	-	-	-	74	-	-
Bicanine breadth	56	49	49	-	-	51	46	-	-
Mastoid depth	-	-	-	30	-	31	34	-	-
Frontal arc	-	127	-	149	143	-	-	-	-
Parietal arc	-	130	-	142	140	143	-	-	-
Occipital arc	-	129	-	-	117	-	-	-	-
Frontal curvature index	14.3	22.4	17.5	14.5	17.1	-	24.0	-	-
Parietal curvature index	22.4	17.6	19.8	23.6	23.6	24.4	19.5	18.5	15.8
Occipital curvature index	-	30.2	-	-	27.8	-	32.6	-	30.9
Gnathic index	105.7	100.0	-	-	-	-	-	-	-
Nasal index	55.6	52.9	-	-	-	56.6	52.5	-	-
Orbital index	68.2	76.2	-	-	-	77.5	72.3	-	-
Palate module	49.6	45.4	-	-	-	-	49.6	-	-
Cranial module	157.3	160.3	-	-	163.6	-	160.0	-	-

variables described in Chapter II. The descriptive and comparative data for these crania are presented in Tables 4-10. Raw data for the Coobool Creek craniometric variables are located in Appendix 1. Due to the small size of the Broadbeach female sample ($n = 4$), these crania will not be included in statistical comparisons. Lateral and facial views of some of the Coobool Creek crania and occlusal views of the palates are presented in Plates 1-8. The crania selected for the plates highlight some of the variation in size and shape which is present in the Coobool Creek series.

Morphologically and metrically the Coobool Creek crania are distinguished by their extreme variability. To some extent this variability is a function of artificial cranial deformation (Brown 1981b, 1987a) and the morphological and metrical features associated with this process will be examined in detail after the initial morphological comparison.

General appearance

The immediate impression that is gained with the Coobool Creek crania is of great overall size combined with extreme variability in the shape of the neurocranium. Facial skeletons are deep and broad with shallow rectangular orbits, broad nasal apertures, large palates and great supra-orbital breadth. Cranial vaults are extremely dolichocephalic with length, breadth and height dimensions which are either in the upper range, or exceed, those in the comparative samples (Tables 4-8). This is reflected in the cranial module results where the Coobool Creek male and female crania can clearly be distinguished from the two recent southeastern Australian samples from Swanport and the central Murray Valley (Table 8, Fig.14). Morphological variability in the Coobool Creek crania is most evident when they are viewed from a lateral aspect. In particular the manner in which the extremes of anteroposterior curvature of the frontal, parietal and occipital bones are combined with great cranial height and length, in some of the Coobool Creek crania, distinguishes them from the comparative samples (Murray Valley, Swanport and Broadbeach) used in this analysis.

The frontal bone

In keeping with the overall large size of the Coobool Creek cranial vaults their frontal bones combine great supraorbital breadth with marked anteroposterior length (nasion-bregma), several individuals exceeding the previously recorded Aboriginal range for these dimensions. However, this large size is not necessarily

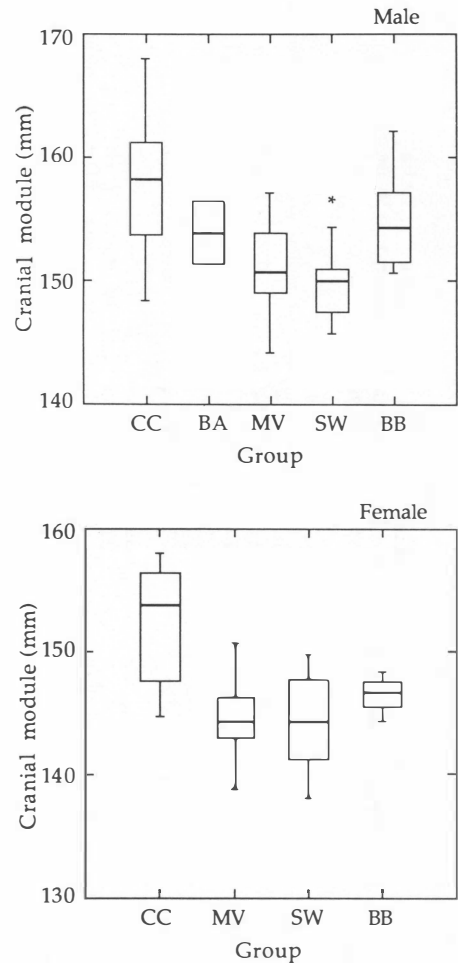


Figure 14 Box plots of cranial module dimensions in male and female Aboriginal crania from Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

paralleled by an associated increase in morphological development. In both the Coobool Creek and contemporary samples used in this analysis there is clearly a high degree of independence, at least within single-sex samples, between gross morphological development and overall size.

The glabella region (Fig.15) is preserved in all of the reconstructed Coobool Creek crania and its prominence was graded using the scale developed by Martin and Saller (1957:Fig.536) (Table 11). The frontal bones combine a typically low and broad glabella region with only moderate depression of the nasal root. The glabellae do not exhibit the inflated, prominent appearance of many modern Aboriginal crania.

The prominence of the superciliary ridges and zygomatic trigones (Fig.15) were scored according to the grades defined by Larnach and Freedman (1964), using casts defining their Class 2 limits provided by the Department of Anatomy, University of Sydney (Table 12). There

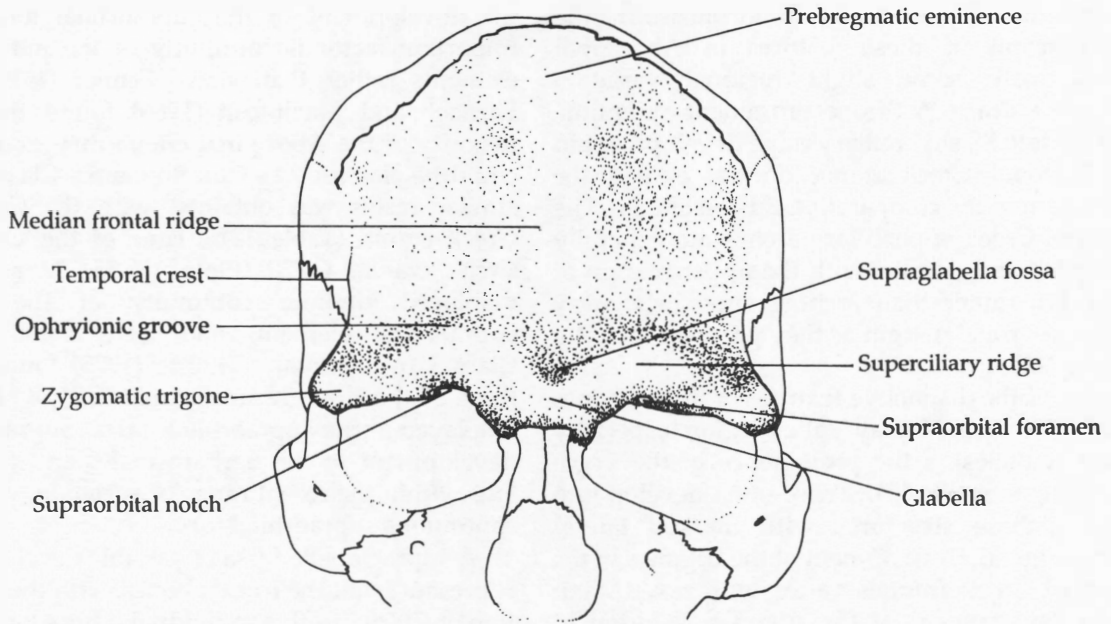


Figure 15 Supraorbital and frontal region in an adult male Aboriginal cranium

Table 11 Glabella prominence in the Coobool Creek crania

Class 1	-
Class 2	1*, 7*
Class 3	2*, 8, 9*, 10, 12*, 13, 16, 18*, 23, 40b*, 47*, 49, 50*, 58*
Class 4	5, 28, 29, 35, 36, 37, 41, 45, 51, 65, 66, 75, 82
Class 5	46, 71, 76
Class 6	-

* = Female

Table 12 Superciliary ridge prominence in the Coobool Creek crania

Class 1	1*, 2*, 7*, 9*, 10, 29, 40b*, 47*, 50*
Class 2	5, 12*, 13, 18*, 23, 28, 41, 49, 51, 65, 66, 71, 82
Class 3	8, 16, 35, 36, 37, 45, 46, 76

* = Female

Table 13 Zygomatic trigone development in the Coobool Creek crania

Class 1	1*, 7*, 18*
Class 2	2*, 8, 9*, 10, 36, 40b*, 45, 47*, 51
Class 3	5, 12*, 13, 16, 23, 28, 29, 35, 37, 41, 49, 50*, 65, 66, 71, 75, 76, 82

* = Female

is considerable sex-based dimorphism in the development of these features in Aboriginal crania, with some slight regional variation (Brown 1981a). With one prominent exception, CC76 (Plate 8), superciliary ridge development in the Coobool Creek crania do not exceed the maximum in the comparative Euston crania. The Coobool Creek superciliary arches are generally elongated and parallel with the upper margin of the orbit, rather than arching superiorly away from the orbital margin as they progress laterally (Plates 1-2).

One of the distinctive features of frontal bones from the central Murray Valley region (especially those of males) is the prominence of the zygomatic trigones (Fig.15). These often develop into large globose structures with marked lateral development. Development of the trigones in the Coobool Creek frontals varies with sex. Maximum development of the trigones is found in CC16, 29 and 76 (Plates 1-8) where it exceeds the Euston maximum (Table 13).

The combination of glabella, superciliary ridges and zygomatic trigones form the supraorbital torus (Cunningham 1908). Cunningham presents a detailed description of the morphology of the supraorbital region in primate crania. He subdivides the torus into three distinct types.

Type 1: the three elements of the supraorbital region are distinct and separate, with each superciliary ridge separated by a shallow median depression from glabella.

Type 2: the superciliary ridges and glabella are continuous as a single unit. On the outer side of the supraorbital notch the superciliary ridges extend outwards with a varying degree of prominence and for a varying distance towards the trigones. From the latter it is separated by a faint groove which ascends obliquely upwards and outwards from the supraorbital notch.

Type 3: all three elements are fused to form a continuous arch, the *torus supraorbitalis*, which extends from glabella to the fronto-malar suture.

Larnach and Macintosh (1966) found that in Aboriginal crania there was a need for an intermediate category (pseudo-torus) between Cunningham's Classes 2 and 3. In this transition type 'the floor of the sulcus supraorbitalis is pushed up by the fused projections of the superciliary and trigonal elements, but on closer examination it can be observed crossing the pseudo-torus from the supraorbital notch' (Larnach and Macintosh 1966:15). In assessing

the development of the supraorbital torus the important factor is continuity of the individual elements rather than size. Fenner (1939) and Larnach and Macintosh (1966) found that the majority of the Aboriginal crania they examined could be classified as Cunningham's Class 2. A similar result was obtained with the Coobool Creek crania (Table 14). Four of the Coobool Creek crania, CC28 (Plate 1), 35, 37 and 82, displayed definite continuity of the three supraorbital elements and were classified as Class 3 (true torus). Thorne (1975) found that three of the Kow Swamp crania (KS1, 8 and 15) displayed a true supraorbital torus. Supraorbital development in the Barham males and females falls within the recent range of variation, without continuous supraorbital tori.

A supraglabella fossa of variable development is present in all the frontal bones, with the exception of CC29. In this individual a broad and low median ridge extends from the middle third of the frontal downwards towards glabella, where it expands into a broad triangular field. This results in a continuous ridge running backwards from glabella towards bregma. When present the supraglabella fossa generally extends backwards and laterally into an ophryonic groove, which may extend to the temporal crests (Fig.15). Two features, the height of the superciliary ridges and the development of the frontal eminence, influence the depth of the ophryonic groove. Both male and female crania may have pronounced ophryonic grooves, however, in males an illusion of greater depth may be given by their contrasting supraorbital development. In comparison with the Euston male crania, the depth of this groove in the Coobool Creek series varies from extremely shallow (CC29 and 49) to deep (CC37).

Both supraorbital grooves and foramina occur in the reconstructed Coobool Creek crania (Fig.15). Bilateral notches are present in 21 of the 25 reconstructed crania (84%), with bilateral foramina in CC75 and 82 and a unilateral foramen in CC46. In both location and shape the Coobool Creek supraorbital grooves fall within the range of the comparative Euston sample.

Laterally, the development of the temporal crests is variable with extremely prominent crests in the male CC16 (Plate 4). In this individual the crests form pronounced broad ridges running from the fronto-malar to the coronal suture. They become less prominent on the parietals. On the medial side of the temporal ridges in this individual are extended, deep grooves running parallel with the temporal ridges along the middle third of the frontal bone. With the

Table 14 Supraorbital development in the the Coobool Creek crania

Cunningham Type 1	-
Cunningham Type 2	1*, 9*, 12*, 13, 18, 23, 29, 40b*, 45, 46, 47, 49, 50, 51, 65
Pseudo torus	16, 36, 41, 66, 71, 75, 76
Cunningham Type 3	28, 35, 37, 82

* = female

Table 15 Median frontal ridge development in the Coobool Creek crania

Absent	9*, 10, 18, 40b*, 47, 50, 65, 66, 71, 76
Slight	1*, 12*, 13, 23, 35, 41, 46, 49, 51, 75, 82
Medium	16, 28, 29, 45
Marked	36, 37

* = Female

exception of this individual, the degree of development of the temporal lines in the Coobool Creek crania is within the range of the Euston series. In both the Coobool Creek and Euston samples the temporal lines are more clearly demarcated on male, than in female, crania in association with broader zygomatic arches, larger temporal fossae, and a greater area of attachment for the temporal muscles.

Klaatsch (1908) and Fenner (1939) describe the form of the median frontal ridge in Australian Aboriginal crania. Fenner noted that in its 'extreme development it passes up from a strong glabella as a prominent rounded ridge on the frontal bone, obliterating the supraglabella fossa. It may end at bregma or may pass back as a prominent ridge on the anterior part of the parietal bones' (1939:251) (Fig.15). The development of the median ridge in the Coobool Creek frontals was graded relative to the average of the combined Euston sample (Table 15). A median frontal ridge is present in 17 of the Coobool Creek crania, with a maximum development in CC37.

Klaatsch (1908) noted that in the Indonesian *Pithecanthropus* crania the median ridge ended in a pronounced raised area of bone anterior to bregma, the prebregmatic eminence (Fig.15). A prominent prebregmatic eminence is present in CC65 (Plate 6) with a moderate development of this feature in CC12, 29, 35, 47 and 82 (Plates 1, 2, 5, 8). A prominent prebregmatic eminence is also evident in KS7, Cohuna and N1 and 2. This feature will be examined below in the discussion on artificial cranial deformation.

One of the major features distinguishing the Coobool Creek and Kow Swamp crania from mid-Holocene and recent Murray Valley crania is their great supraorbital breadth (Fig.16, Tables 4-

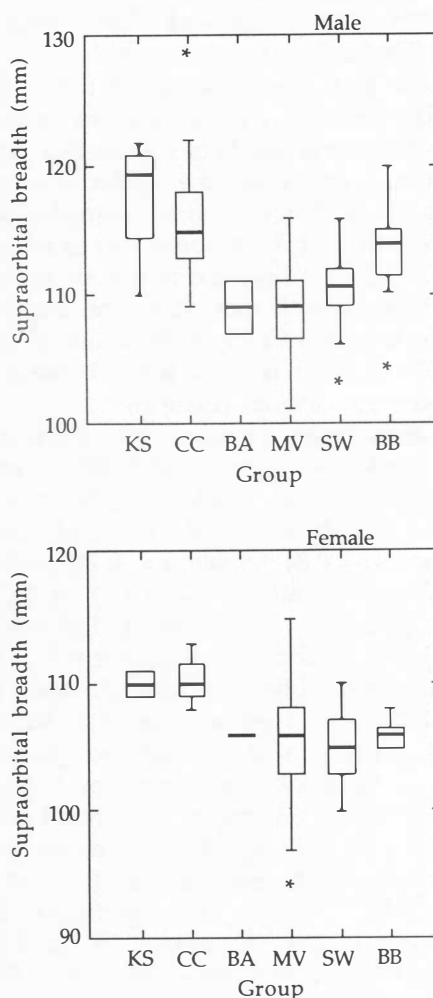


Figure 16 Box plots of supraorbital dimensions in male and female Aboriginal crania from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

10). Mean maximum supraorbital breadth in the Coobool Creek male and female samples is significantly greater than that in the Murray Valley and Swanport series ($P = .000$). The Coobool Creek male mean, while greater than the Broadbeach male mean, is not significantly so ($P = .081$). There is considerable sex-based dimorphism in this dimension in Aboriginal crania and the difference between the male and female means in each of the samples is significant ($P = .003-.000$). Maximum supraorbital breadth in the Coobool Creek sample (129 mm for CC76) exceeds the maximum in the comparative series (120 mm for Broadbeach), as well as Kow Swamp (122 mm for KS7) (Tables 9-10). Supraorbital breadths in the male and female mid-Holocene Barham sample have median dimensions which are the same as the recent Murray Valley series and distinct from Coobool Creek and Kow Swamp (Fig.16).

Larnach and Macintosh (1970) noted that in Queensland crania with prominent zygomatic trigones the lateral points of supraorbital breadth were often located on the projections of the trigones rather than on the fronto-malar suture. In the 170 northern Victorian crania examined by Thorne (1975), 72 had the points of maximum supraorbital breadth located on the trigone. In six of the Coobool Creek male crania (CC10, 16, 28, 29, 65 and 76) maximum supraorbital breadth is located on the trigone (Plate 1).

The association between maximum supraorbital and minimum postorbital breadth dimensions (Murray Valley males $r = 0.64$, females $r = 0.38$, pooled sex $r = 0.54$; Coobool Creek males $r = 0.84$, females $r = -0.22$, pooled sex $r = 0.64$), with a ratio of 1.14-1.12:1 in the comparative samples, would predict that this great supraorbital breadth is supported by broad minimum postorbital breadth dimensions at Coobool Creek. However, relative to supraorbital breadth there is reduced postorbital breadth at Coobool Creek (ratio of 1.17-1.14:1) and their mean minimum postorbital breadth dimensions are only significantly greater than the Murray Valley males and females ($P = .043-.005$), (Tables 4-8). There is significant sexual dimorphism in this dimension in the Murray Valley and Swanport samples ($P = .011-.000$) but not at Coobool Creek. The maximum value for minimum postorbital breadth in the Coobool Creek crania (110 mm for CC76) equals the Broadbeach maximum and both of these exceed the Kow Swamp maximum of 106 mm for KS7.

Thorne and Macumber (1972) indicate that in the Kow Swamp crania a poorly filled temporal region produces a high degree of postorbital con-

striction. Postorbital constriction can be indicated by the difference between maximum supraorbital breadth and the minimum postorbital diameter, when the latter is taken on the fronto-sphenoid suture (Larnach and Macintosh 1970). An examination of postorbital constriction in the Coobool Creek and Murray Valley crania indicates that there is no significant difference ($P = .250$) between these populations for this dimension (Murray Valley males $n = 44$, $\bar{x} = 21.7$, $s = 3.81$; females $n = 52$, $\bar{x} = 18.4$, $s = 3.14$; Coobool Creek males $n = 9$, $\bar{x} = 22.6$, $s = 2.34$). Both the Coobool Creek and Kow Swamp maxima for this dimension (26 mm for CC28 and 71 and 30 mm for KS1) fall within the Murray Valley male range (13-34 mm). Larnach and Macintosh (1970) found that there is considerable sexual dimorphism in this dimension and this is supported by the significant difference between the Murray Valley male and female means ($P = .000$).

The nasal bones

The Coobool Creek nasal bones are exceptionally broad and flattened, with the waisted appearance typical of Aborigines (Plates 1-2). Larnach and Macintosh (1966, 1970) examine the breadth of the naso-frontal articulation in Aboriginal crania from Queensland and coastal New South Wales and divide this dimension into three grades: narrow (<10 mm), medium (10-12 mm) and broad (>12 mm). Fifty-one of the 234 crania they examined (22%) were classified as broad. In contrast to this, 17 of the 20 Coobool Creek male crania for which this area is preserved (85%) have naso-frontal articulations broader than 12 mm. The mean breadth of this feature in the Coobool Creek male crania is significantly greater than that in the comparative Euston series but similar to the Swanport male mean (Table 16). Post-depositional damage to this region in several of the Coobool Creek female crania reduced the size of this sample to four with a mean of 11.8 ($s = 0.93$), which is less than that for the Swanport females ($\bar{x} = 13.2$, $s = 1.79$).

Broad fronto-nasal articulations are also a feature of the Kow Swamp crania, with Thorne (1975) recording a maximum breadth of 17 mm for KS4 and 7. There is complete fusion of the internasal suture in CC49, with partial fusion in CC12, 16, 37, 41, 46 and 66.

The zygomatic bones

Although relative to some populations (for instance Chinese and Europeans) Aboriginal crania have relatively small zygomatics, these

Table 16 Breadth of the naso-frontal articulation in male crania from Coobool Creek, Euston and Swanport (mm)

	n	\bar{x}	s	Min.	Max.
Coobool Creek	20	13.3	2.07	8.6	16.5
Euston	27	12.1	2.03	8.3	15.1
Swanport	22	13.4	2.26	7.0	17.0

Table 17 Zygomatic depth in male crania from Coobool Creek, Euston and Swanport (mm)

	n	\bar{x}	s	Min.	Max.
Coobool Creek	15	26.1	2.57	23.0	31.0
Euston	30	20.8	2.21	17.0	24.5
Swanport	22	21.7	2.01	18.0	25.0

Table 18 Malar tuberosity size in the Coobool Creek crania

Class 1	1*, 2*, 5, 7*, 9*, 28, 47*, 50*, 82
Class 2	13, 18*, 23, 35, 40, 40b, 41, 45, 49, 71
Class 3	10, 16, 29, 36, 37, 46, 51, 65, 66, 75, 76

* = Female

smaller bones are generally more robust. Within the recent Aboriginal range of variation the Coobool Creek zygomatic bones are distinct. They are typically extremely deep and robust structures, with prominent malar tuberosities and massive thickened frontal processes (Plates 1-8). Zygomatic depth (the minimum distance between zygomaxillare and the inferior margin of the orbit) in the Coobool Creek male crania is significantly greater ($P = .000$) than the means for the Euston and Swanport males (Table 17). Zygomatic depth in 11 of the 15 Coobool Creek male crania for which this dimension is preserved exceeds the Euston maximum, with a maximum of 31 mm (CC49:Plate 2) for this dimension in the Coobool Creek series.

The most prominent feature on the lateral surface of the zygomatic bone is the malar tuberosity (Fig.17). Fenner (1939:276) found that in Aboriginal crania 'the malar tuberosity takes the form of a prominent ridge on the malar surface of the bone running parallel with the inferior border'. All of the malar tuberosities in the reconstructed Coobool Creek crania are of this form. Thorne and Wolpoff (1981) add malar tuberosities to their list of morphological features, indicating evolutionary continuity between mid-Pleistocene populations in Indonesia and later populations in Australia. However, malar tuberosities are equally common in several populations from outside the

Australasian region (northern Chinese, Romano-British and western European).

There is considerable sex-based dimorphism in the prominence of the malar tuberosity in recent Aboriginal crania (Fenner 1939; Larnach and Freedman 1964; Brown 1981a) and a similar degree of dimorphism is present in the Coobool Creek series. The malar tuberosities were graded using the procedure developed by Larnach and Freedman (1964), with reference casts of their Class 2 limits. Fifty-eight per cent of the Coobool Creek male crania have large (Class 3) malar tuberosities (Table 18).

Variation in the size and depth of the masseteric attachment on the inferior border of the zygomatic bones is great. Although the fossae are often deep, broad and long, they are generally less rugose than the most rugged fossae in the Euston males. However, the actual area of attachment in the Coobool Creek crania is probably larger than that in the Euston series due to the great breadth of the inferior border of the bone. There is no apparent sex-based dimorphism in the development of the masseteric fossae in the Coobool Creek series as deep fossae are present in both male and female crania. In CC37 the inferior border of the zygomatic bones are particularly thickened, with deep and rugose fossae.

Medially the masseteric fossa is bordered by the maxillomalar suture (Fig.17). The inferior

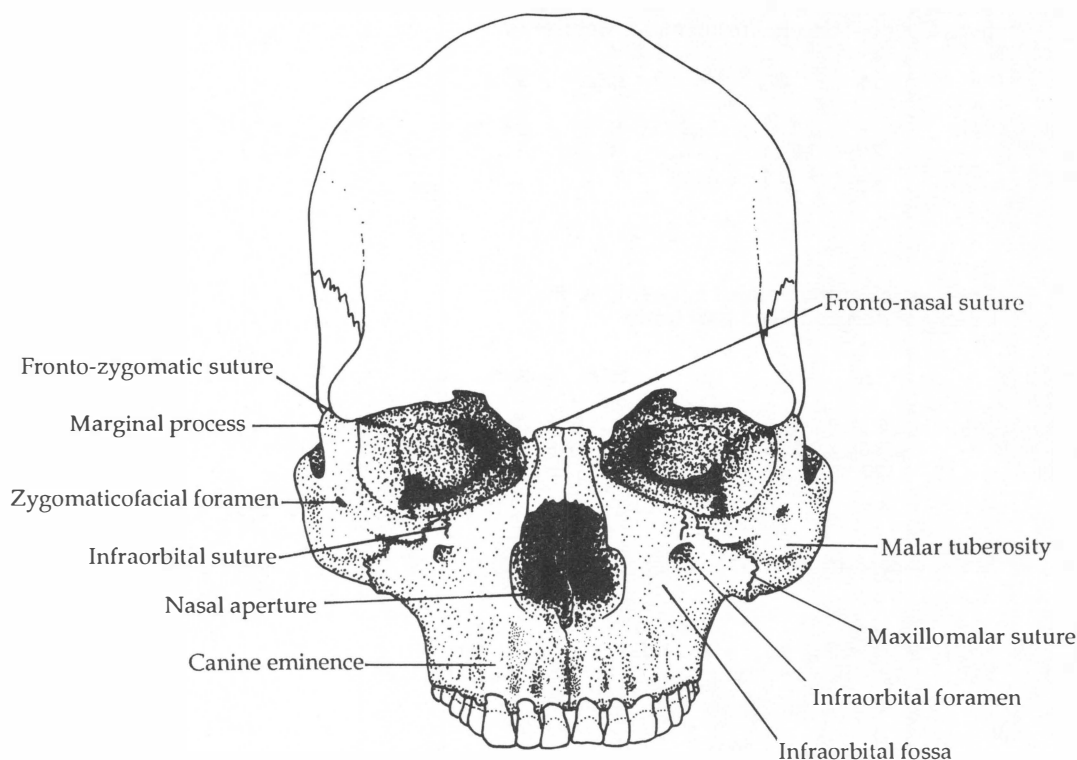


Figure 17 Facial skeleton in an adult male Aboriginal cranium

border of this suture protrudes in 20 of the Coobool Creek crania forming a tubercle of varied development. Superiorly the middle third of the maxillomalar suture lies in a pronounced depression. Thorne (1975:111) noted that this depression is produced by a thickening of the orbital border above and by an abrupt rise of the malar tuberosity posteriorly.

A distinctive feature of the zygomatic bones in the Coobool Creek, Kow Swamp and Nacurrie crania is the size and morphology of the frontal process. These form broad and thickened structures with extremely pronounced marginal processes (Fig.17). The marginal processes flare posteriorly and form a raised globular area (analogous to the zygomatic trigone) below the fronto-malar suture. The maximum size of this process in the Coobool Creek and Kow Swamp crania exceeds the Euston series. The maximum development of this feature in the Coobool Creek crania is in the males CC37, 49, 65 and 76, with minimal development in the female CC1 (Plates 1, 6, 8). The maximum breadth of the marginal process in the Coobool Creek series ranges from 12-23 mm, with a range of 12-19 mm at Kow Swamp.

The orbits

Fenner (1939:269) noted that 'the great cavernous orbits beneath over-hanging brows are one of the most striking features of the Australian facial skeleton'. He recorded variation in shape, from a low straight-sided rectangular form to an almost circular condition, and in the axis of orientation. There is some variation in the form of the orbit in the Coobool Creek crania, but the predominant shape is a narrow rectangle with a horizontal to slightly oblique orientation (CC12, 13, 16, 28, 36, 37, 49, 65, 75 and 76) (Plates 1-2). Larger, more rounded orbits with a taller lateral margin are found in CC1, 9, 23, 38, 45, 50, 51 and 66 (Plates 1-2).

Orbital height in the Coobool Creek males is at the lower end of the Australian range, with a significant difference between the Coobool Creek mean and the means for the Swanport and Broadbeach males (Table 8, Fig.18). It is the shallow rectangular orbits of these male crania, set above relatively massive malars, which is one of the more striking features of the Coobool Creek facial skeletons. Box plots of orbital height in the male samples display a reversal of the position normally occupied by Coobool Creek in comparisons of cranial dimensions. Orbital height is at a minimum at Coobool Creek, while

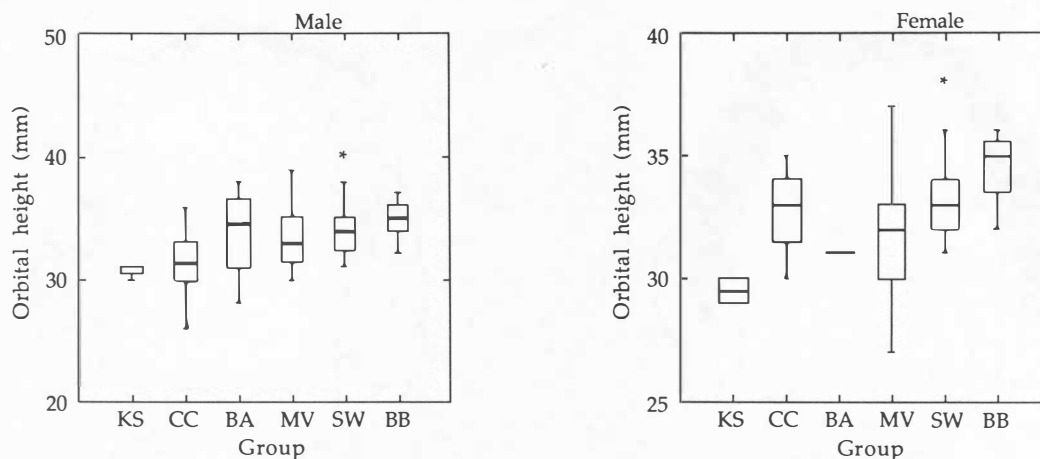


Figure 18 Box plots of orbital height dimensions in male and female Aboriginal crania from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

Barham and the recent samples all tend to have increased orbital height (Fig.18). These broad and shallow orbits are also a feature of the Kow Swamp male and female crania (Table 9), however, the Coobool Creek females have higher, more rounded, orbits.

The orbital indices indicate that all of the Australian samples, male and female, have orbits which are extremely broad in relation to their height (chamaeconchy). There is no significant difference in mean orbital breadth between the male samples, although, the Coobool Creek female mean is significantly greater ($P = .038-.005$) than the comparative female means (Table 8). A comparison of the male and female orbital dimensions (Tables 4-8) indicate dimorphism in both shape and size. Female orbits have greater height in relation to their breadth and are more circular in form. With the exception of Coobool Creek, male mean values for both height and breadth are greater than those for females drawn from the same population.

The maxillae

A combination of large size, deep and prognathic subnasal region, prominent canine eminence, extreme alveolar breadth and great nasal breadth, makes the maxillae from Coobool Creek and Kow Swamp distinct from recent, and mid-Holocene, Aboriginal crania.

The mean height of the subnasal region (nasospinale-prosthion) in the Coobool Creek male and female crania is significantly greater ($P = .003-.000$) than that for the corresponding sexes in the Swanport and Broadbeach samples, but not significantly greater than the Murray Valley ($P = .791-.726$). A large and prognathic subnasal area is a regional feature of recent crania from the

central Murray Valley, differentiating them from other Aboriginal populations. A deep and robust subnasal region is also found in most of the terminal Pleistocene and early Holocene crania from the central Murray Valley (Nacurrie, Cohuna and Kow Swamp), as well as distinguishing more recent crania from the same geographic area (Tables 8-10). The significant difference between the male and female means for subnasal height in the Murray Valley sample ($P = .000$) is not shared by either the Swanport ($P = .998$) or Coobool Creek samples ($P = .142$).

Subnasal prognathism was graded using casts of the limits of the medium grade defined by Larnach and Macintosh (1966:32) (Table 19). Great subnasal prognathism clearly distinguishes the Coobool Creek male and female crania from Larnach and Macintosh's coastal New South Wales and Queensland series, in which 27.0% and 25.7% respectively were classed as large. Thirty-seven per cent of the comparative Euston series, 35% of the males and 39% of the females, conform to Larnach and Macintosh's large-grade subnasal prognathism. The large size of the canine roots in the Coobool Creek crania produce long and prominent canine eminences, extending to within a few millimetres of the lateral margins of the nasal aperture. A combined eminence is formed by the bulging canine and first premolar roots in CC71, with a deep fossae anterior of the canine roots (Plate 7).

Following the method of Larnach and Macintosh (1966:31-32), the depth of the infra-orbital fossae was measured with coordinate calipers (Table 20). In only one individual (CC71) can the fossae be classified as deep according to Larnach and Macintosh's criteria.

There is some variability in the form of the

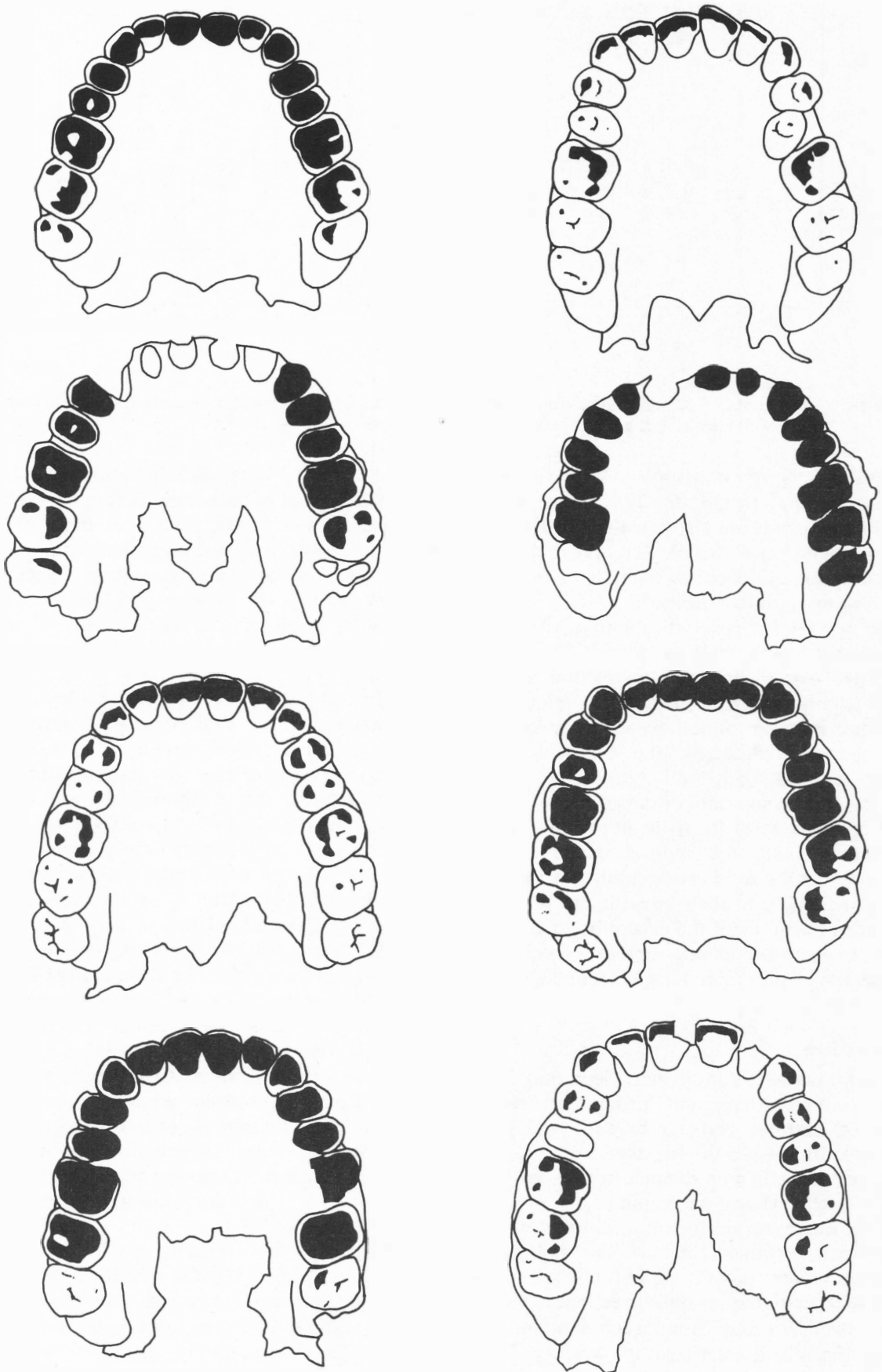


Figure 19 Palate shape variation at Coobool Creek

Table 19 Subnasal prognathism in the Coobool Creek crania

Absent	-
Small	-
Medium	13, 29, 65
Large	1*, 9*, 12*, 16, 28, 37, 40, 41, 45, 46, 49, 66, 71, 81

* = Female

Table 20 Depth of infraorbital fossae in the Coobool Creek crania (mm)

Absent	(0-2.9)	-
Slight	(3-5.9)	13, 28, 29, 37, 45, 46, 49, 65
Medium	(6-7.9)	16, 45, 66
Deep	(8-9.9)	71
Very deep	(>10)	-

Table 21 Location of points of maximum alveolar breadth in the Coobool Creek crania

Distobuccal root M1	12*, 37, 47, 65, 66
Mesiobuccal root M2	13, 23*, 41
Distobuccal root M2	1*, 16, 29, 38, 40, 45, 49, 50, 75
Mesiobuccal root M3	9*, 28, 36, 71

* = Female

palate in the Coobool Creek series (Fig.19). In general, as you move distally the tooth rows continue to diverge laterally until the second molar is reached, however, maximum alveolar breadth may also be located in a more posterior position. The post-canine teeth may be in relatively straight alignment or form part of a continuously curved arcade with the anterior teeth. Irrespective of palate shape, great alveolar breadth dominates throughout. This great breadth is evident both anteriorly (bicanine breadth) and posteriorly. Both in bicanine breadth and maximum alveolar breadth the Coobool Creek male and female mean dimensions are significantly greater ($P = .027-.000$) than those in the comparative samples (Table 8). Maximum alveolar breadth dimensions in the Coobool Creek males (83 mm for CC71) and females (72 mm for CC50) exceed the maxima at Kow Swamp (73 mm for male KS1 and 69 mm for female KS15) and in the recent samples (Murray Valley male 77 mm and female 70 mm). Although there has been a reduction in absolute dimensions, relatively great alveolar breadth appears to have been a distinctive feature of Aboriginal populations in the central Murray Valley region since the terminal Pleistocene (Brown 1981a, 1987a).

Within the Coobool Creek series the position of maximum alveolar breadth is, in each instance,

located posterior to the mesiobuccal root of the first molar and most frequently adjacent to the distobuccal root of the second molar (Table 21). In aged individuals the net result of occlusal and interproximal tooth wear and mesial migration (Murphy 1964) result in the third molars moving closer to, and eventually occupying, the position adjacent to the points of maximum alveolar breadth.

Although both the Coobool Creek and Kow Swamp crania are distinguished by their great alveolar breadth, this is not reflected in similarly great alveolar length. The increased area of alveolar bone necessary to support a large dentition is accomplished with a lateral, rather than an anteroposterior extension of the alveolar process. Alveolar length in the Coobool Creek sample, while towards the upper end of the Australian range and significantly greater than that in Swanport and Broadbeach ($P = .008-.001$) is not significantly greater than the recent Murray Valley sample (Table 8). There is marked sexual dimorphism in Aboriginal palate size (Larnach and Freedman 1964; Brown 1981a), with significant differences between the male and female mean palate modules in the Coobool Creek, Murray Valley and Swanport samples ($P = .001-.000$). Box plots of the palate module results reveal the large size of the Coobool Creek male and female palates, with the next closest group

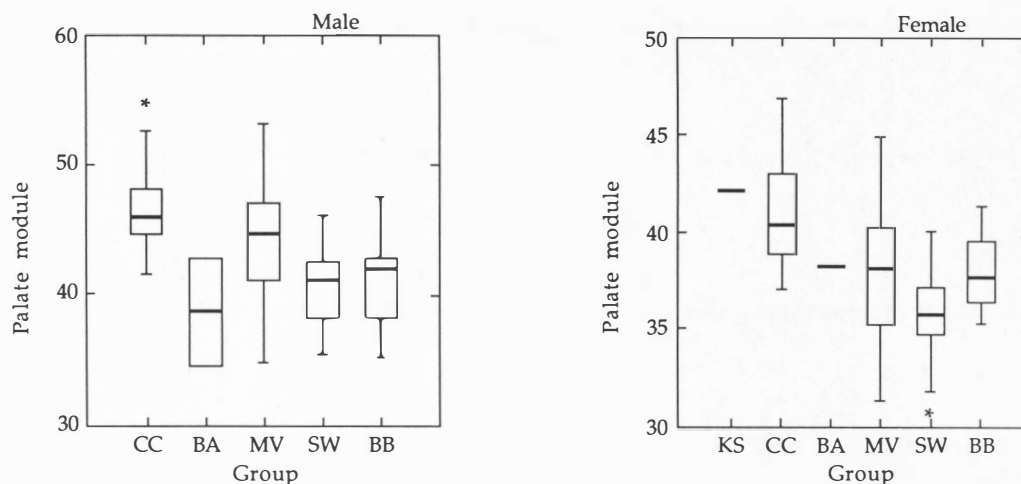


Figure 20 Box plots of palate module dimensions in male and female Aboriginal crania from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

being the recent Murray Valley series (Fig.20). Postmortem damage combined with the alveolar destruction associated with acute tooth wear excluded the Kow Swamp males from this comparison, while the female KS15 falls within the central 50% of the Coobool Creek female distribution. Both Cohuna (Palate module 49.6) and Keilor (Palate module 45.4) have relatively large palates which fall within the upper part of the recent Murray Valley range.

The form of the palatal walls in the Coobool Creek crania vary from nearly vertical in those crania with high, arched palates (CC16, 29, 41, 45, 46, 49 and 82) to a gradually sloping smooth curve where the palates are relatively shallow (CC65 and 66). Other palates are intermediate. Medially, slight elevations of the palatine processes are evident in 19 of the reconstructed crania. Campbell (1925:44) subdivided these elevations into four forms of palatine tori, and noted that 'it is somewhat doubtful whether in some cases this elevation is worthy of the title torus'. Most frequently the 'torus' in the Coobool Creek crania is represented by a small triangular boss occupying the midline of the horizontal plates of the palate bone (*torus palatinus medianus*). The seven median maxillary tori are of only moderate development, with maximum development in CC46 (Table 22).

Facial size and prognathism

The male crania from Coobool Creek have a mean upper facial height dimension (nasion-prosthion) which is significantly greater ($P = .000$) than each of the comparative male samples (Table 8). Great upper facial height is also found in the male crania from Kow Swamp ($n = 3$, $\bar{x} = 77.0$, $s = 2.31$, $r = 73-81$ mm) and Cohuna (75 mm), however, it is not a feature of the mid-Holocene Barham series ($n = 4$, $\bar{x} = 67.8$, $s = 2.63$, $r = 65-70$ mm) (Table 9). Mean upper facial height in the Coobool Creek females is significantly greater than the Murray Valley females ($P = .013$), but is not significantly greater than Swanport (Table 8).

A striking feature of the Coobool Creek crania is their great maximum midfacial breadth (bizygion) (Plates 1-2). It is unfortunate that this variable, which appears to be a major discriminator between Pleistocene and modern samples, is so poorly preserved in the Broadbeach and Kow Swamp crania. Mean bizygion breadth in the Coobool Creek male sample is significantly greater than the Murray Valley and Swanport means ($P = .001$), with the Coobool Creek male maximum (150 mm for CC49) exceeding the maximum in the comparative crania (146 mm for the Murray Valley). Bizygion breadth is not preserved in the Kow

Table 22 Form of palatine torus in the Coobool Creek crania

Median maxillary torus	13, 35, 41, 46, 51, 71, 82
Median palatine torus	9*, 10, 16, 29, 37, 40, 45, 66
Transverse palatine torus	-
Transverse palatine crista	-

* = Female

Swamp or Barham crania, although an estimate of 144 mm for KS1 should be close to the pre-depositional condition (Table 10). The mid-Holocene cranium from Lake Nitchie has a mid-facial breadth which equals the Coobool Creek maximum (Table 10).

Damage to the basioccipital area in the Kow Swamp crania prevents the calculation of the standard gnathic index for these crania. Thorne and Wolpoff (1981:344) examined facial prognathism in this material using a midline projection of auriculare as the base point. Data for the three Kow Swamp crania in which this index could be recorded were all above a recent Murray Valley mean, but within the range. Comparisons of the gnathic indices in this analysis (Table 8, Fig.21) indicate that the Murray Valley, Coobool Creek and Swanport crania are more prognathic than the Broadbeach crania ($P = .005$). There are, however, no significant differences between the gnathic indices of the

three southern Australian samples ($P = .808-.139$). Unlike the Murray Valley populations there is little subnasal prognathism at Broadbeach and the dimension basion-prosthion is reduced relative to basion-nasion, resulting in a low gnathic index. The two Barham crania in which this index can be recorded have oro-gnathic facial skeletons, while Cohuna with a gnathic index of 105.7 is relatively prognathic (Table 9).

In a roentographic study of prognathism in the Walbiri of Yuendumu, Barrett *et al.* (1963b) demonstrated a significant level of sexual dimorphism for this index ($P = .001$). Females were more prognathic than males. As there is no significant difference between the male and female mean gnathic indices in this analysis ($P = .469-.252$) (Table 4), there is a possibility of regional variation in dimorphism for this feature.

Parietal bones

These bones display considerable variation, both in size and morphology, in the Coobool Creek sample. A principal area of variation is the sagittal curvature of the parietals when viewed laterally (Plates 3-8). This and several other features which may have been the result of cultural practice will be discussed in the section dealing with artificial cranial deformation.

The Coobool Creek cranial vaults are extremely broad, with a mean maximum biparietal breadth in males and females which is significantly greater than the mean dimensions for the comparative samples ($P = .001-.000$) (Table 8, Fig.22). The maximum biparietal breadth of the Coobool Creek crania (145 mm for CC49) exceeds the maximum for the Murray Valley (143 mm) and Kow Swamp series (139 mm for KS5). There is a high degree of sexual dimorphism for this dimension, with a significant difference between the male and female means at Coobool Creek, Murray Valley and Swanport ($P = .019-.001$) (Tables 4-6).

In common with recent Aboriginal crania, the points of maximum cranial breadth in the Coobool Creek crania are not always located on the parietals (Table 23). In those crania with prominent parietal eminences (bosses) the most lateral point on the neurocranium is usually located on some part of the eminence. In six of the Coobool Creek crania, maximum cranial breadth (excluding the zygomatic arch) is located inferiorly, either on the supramastoid crests or on the most lateral points of the mastoid processes.

Following Larnach (1976), the height of the parietal eminences were measured with coordinate calipers and graded according to the categories he defined (Table 24). High conical

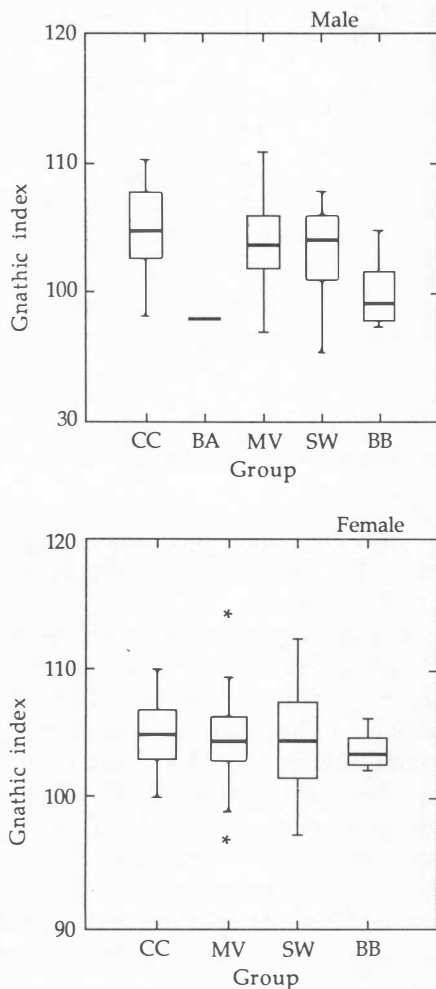


Figure 21 Box plots of gnathic index dimensions in male and female Aboriginal crania from Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

Table 23 Location of points of maximum cranial breadth in the Coobool Creek crania

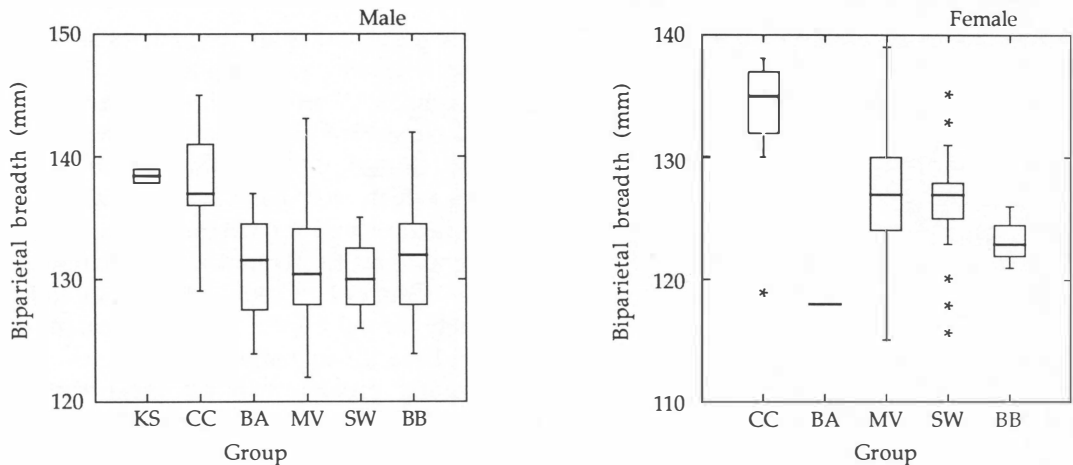
Parietal eminence	1*, 29, 41, 66
Squamous parietal	9*, 28, 45, 46, 71
Squamous temporal	13
Supramastoid crest	12*, 49, 65
Mastoid crest	16, 37, 76

* = Female

Table 24 Development of parietal eminences in the Coobool Creek crania (mm)

Very slight	(<22)	12*, 28
Slight	(22-24)	9*, 10, 23, 36, 37, 38*, 47*, 51, 76
Medium	(25-26)	13, 16, 46, 49, 50, 65, 71
Marked	(27-30)	1*, 29, 35, 45, 66, 75, 82
Great	(>30)	41

* = Female

**Figure 22** Box plots of maximum biparietal breadth dimensions in male and female Aboriginal crania from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

bosses are present in several of the Coobool Creek crania, with a maximum height of 31 mm in CC41. A comparison of these data with that for the Euston males indicates that the parietal eminence attains a significantly greater mean height in the Coobool Creek sample (Coobool Creek males $n = 20$, $\bar{x} = 25.6$, $s = 3.09$; Euston males $n = 30$, $\bar{x} = 22.9$, $s = 3.14$; $t = 3.03$, $P = .010$). Although some of the Coobool Creek crania which I suspect have been artificially deformed (CC1, 29, 35, 41, 66 and 82) have 'marked' to 'great' development of their parietal eminences, I am uncertain of the influence that the deformation process has had on this feature. Prominent parietal eminences are also a feature of CC45 which shows no evidence of being artificially deformed. It is possible that artificially deforming the shape of children's crania accentuates the development of the parietal eminences, but these

data also indicate that there is a genetic component to the prominent eminences in the Coobool Creek sample.

A low, triangular, mound-like elevation of bone, bordered anteriorly by the coronal suture, is present in the midline of several of the Coobool Creek parietals. This elevation of bone is a posterior continuation of the frontal median ridge and prebregmatic eminence. This feature is particularly prominent in CC29, 37 and N1. Viewed from above, the combined prebregmatic and postbregmatic eminence, which is centred on bregma, has the form of an extended diamond. Slight parasagittal depressions border these elevations in CC29, 41 and 66.

The inferior and superior temporal lines are visible, although in some instances faintly, in all of the reconstructed crania. On the frontal bones these lines curve sharply downwards in the area

of the coronal suture, and then curve upwards in the anterior third of the parietals before descending towards the lambdoid suture. Posteriorly the superior temporal lines form a pronounced ridge in several of the male crania, immediately anterior to the lambdoid suture (CC16, 28, 36, 41, 45, 46, 49, 65 and 75). In CC16 the great elevation of the superior temporal lines produces a strong torus which moves down to, and along, the lambdoid suture before continuing down the lateral surface of the mastoid process. Cohuna and the male Kow Swamp crania also have relatively prominent development of the posterior third of the temporal lines.

Temporal bones

The external auditory meatus in the Coobool Creek crania take the form of a deep and broad oval. Small bilateral auditory exotoses are present in three of the 26 crania (11.5%) where the auditory meatus is preserved (CC10, 16 and 29). Roche (1964) recorded auditory exotoses in 27.8% of a Murray Valley sample. Auditory exotoses are not present in the Kow Swamp, Cohuna or Nacurrie crania.

In the majority of the reconstructed crania there is some damage to the superior margin of the squamous portion of the temporal bones. Partial fusion of the temporoparietal suture is evident in two individuals. There is bilateral fusion of the posterior half of the suture in CC13. In CC10 there is almost complete fusion of the left suture while the right suture remains completely open. A marked lateral bulging of the vault in the area of the temporoparietal suture is found in CC9, 10, 35, 46 and 65.

The zygomatic processes of the temporal bones are robust, with the posterior margin of the zygoma extending into the suprastatal crest, which is itself continuous with the supramastoid crest. In common with recent Aboriginal crania there is pronounced sexual dimorphism in the development of the supramastoid and mastoid crests. These features are more pronounced in males, with the development of the supramastoid crest in CC76 exceeding that in the other Australian samples (Plate 8). The supramastoid crest is defined superiorly by a shallow to deep squamous temporal fossa (Larnach and Macintosh 1970). This fossa, which may extend upward and forward onto the parietals (CC16), generally proceeds anteriorly and inferiorly into the temporal fossa. It is pronounced in CC16, 49, 65 and 76.

Medially the glenoid fossae are broad and high, with prominent articular eminences. The eminence is slightly flattened in CC16, 28, 66 and

71 and there is evidence of slightly more pronounced arthritic damage, with vascular proliferation and remodelling of the bone surface, in CC36, 75 and 82. However, in comparison to the mid-Holocene (Barham and Roonka) and recent (Swanport and Murray Valley) crania from southeastern Australia, with similar levels of tooth wear, there is surprisingly little evidence of temporomandibular joint dysfunction. There is certainly nothing approaching the extreme arthritic damage, in some instances with ebonation, which is common at Swanport. The glenoid fossae in the Kow Swamp and Cohuna crania are broad and deep, with a prominent rounded eminence, while N1 has extensive arthritic remodelling of the left fossae and eminence (the only side preserved).

The depth of the Coobool Creek glenoid fossae were measured using the procedure developed by Larnach and Macintosh (1966:41). Larnach and Macintosh (1970) report a mean depth of 6.8 mm for male crania from coastal New South Wales and 5.7 mm for Queensland males. The Coobool Creek male mean is 7.1 mm, with a maximum depth of 8.5 mm for CC71 (Coobool Creek males $n = 19$, $\bar{x} = 7.1$, $s = 0.83$, $r = 5.1-8.5$ mm). A comparison of the Coobool Creek data with the graded data of Larnach and Macintosh (1966, 1970) indicates the great depth of the fossae in the Coobool Creek series (Table 25).

A regional characteristic of Aboriginal crania from the Murray Valley is the large size of the mastoid processes (Brown 1981a). There is considerable sexual dimorphism in the size of the mastoid process in Aboriginal crania, with significant differences between the male and female means for mastoid depth (height) in each of the samples used in this analysis ($P = .002-.000$) (Tables 4-6). The Coobool Creek male mastoid processes are long and robust, with prominent mastoid crests (Plates 3-8). Although the mean depth of the mastoids in this sample exceeds that in the comparative series, this is statistically significant only in comparison with the Swanport males and females ($P = .007-.003$) (Table 8). The maximum depth of the Coobool Creek mastoids (37 mm for CC49) exceeds the range of the comparative series (36 mm for the Murray Valley and Swanport males). A slight to prominent mastoid crest is present on all of the complete Coobool Creek mastoid processes.

Medial to the mastoid process, the digastric fossae are varied in length, depth and breadth. Extremely broad and deep fossae are found in CC10, 16, 65 and 71, with shallow and short fossae in CC46 and 66. The maximum develop-

Table 25 Depth of glenoid fossae in male and female Aboriginal crania (mm)

		New South Wales ¹ %	Queensland ² %	Coobool Creek %
Shallow	(0-5.0)	19.0	29.4	-
Medium	(5.1-7.0)	56.9	58.8	63.2
Deep	(>7.0)	24.1	11.8	36.8

¹ Larnach and Macintosh (1966)

² Larnach and Macintosh (1970)

ment of the fossae in the Coobool Creek crania exceeds that in the comparative Euston series. There is considerable asymmetry in the development of this area in both the Coobool Creek and Euston samples.

Occipital bone

There is a great deal of variation in the size and morphology of the Coobool Creek occipital bones. In particular, the angle formed by the nuchal and occipital planes, when viewed from a lateral aspect, exceeds the variation in the comparative samples (Plates 3-8). Specific aspects of this variation may be the result of artificial cranial deformation and these features will be discussed in the section dealing with this topic.

Both the male and female Coobool Creek occipital bones are of large size, but with a few notable exceptions, are not exceptionally robust structures. Mean length of the occipital (basion-lambda) is significantly greater in Coobool Creek males and females than in the respective sexes from the Murray Valley, Swanport and Broadbeach samples (Table 8, Fig.23). Although the Coobool Creek male occipitals are extremely long, this is not matched by marked biasterionic breadth. The Coobool Creek females, however, have a mean biasterionic breadth which is significantly greater than the Murray Valley and Swanport females ($P = .051-.033$) (Table 8).

The dominating feature of the posterior surface of the occipital bone is the occipital torus. This torus is of varied development and, with the exception of the three male crania (CC37, 45 and 76), does not attain the prominence evident in some of the Euston male crania. The size of the torus varies from completely absent in the gracile female CC1, to small to medium in 23 individuals and large in CC37, 45 and 76. In all but three of the male crania (CC29, 35 and 66) the torus is ridge-shaped. Mound-shaped tori are found in the female crania, plus the males CC29, 35 and 66. The torus extends to, and is bilaterally continuous with, the mastoid crest in CC16, 28, 37 and 46. In two individuals (CC41 and 45) the

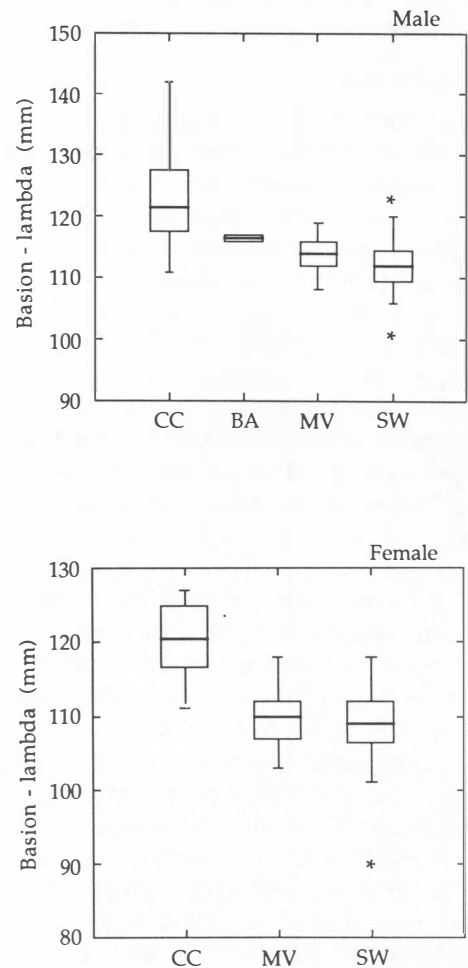


Figure 23 Box plots of basion-lambda dimensions in male and female Aboriginal crania from Coobool Creek, Barham, the Murray Valley and Swanport

torus terminates in the occipito-mastoid ridge and in the remaining crania reaches the occipito-mastoid suture. Thorne (1975:120-21) found that in five of the Kow Swamp crania (KS5, 7, 8, 9 and 14) the torus is continuous with the mastoid crest.

Superior to the torus is a slight furrow, the supratotal sulcus, which separates the occipital torus from the occipital plane (Larnach and Macintosh 1966). This feature is absent in four of the Coobool Creek crania (CC1, 9, 12 and 49), of which CC49 is male. Two individuals (CC37 and 45:Plate 5) have deep, distinctive furrows while in the remaining crania the sulcus is slight to moderate in development. When viewed laterally there may be a slight to prominent elevation of the triangular apex of the occipital bone relative to the posterior surface of the parietals. A slight elevation is present in CC9, 13, 28, 29 and 45, with greater elevation in CC41 and 66 (Plate 7). In the last two crania this elevation forms a pronounced eminence between the lambdoid suture and the occipital torus.

Inferior to the occipital torus the fossae associated with the origins of the major nuchal muscles display some sex-based variation, with shallow to indistinct fossae in the female crania. However, shallow fossae also feature in several of the male crania (CC10, 13, 29 and 66). Comparisons with the Euston male sample indicate that the average size and depth of the nuchal fossae is reduced in the Coobool Creek males. Deep, sharply delineated fossae are present in only four of the Coobool Creek crania (CC16, 28, 37 and 45).

The *foramen magnum* is of varied morphology, although it commonly has the form of a broad elongated oval, often tapering at the posterior end. Comparative dimensions of this foramen were recorded for the Coobool Creek and Murray Valley samples (Table 26). The Coobool Creek foramina have a greater mean length than those in the Murray Valley samples, with a significant difference between the female mean

values. There is a significant level of sexual dimorphism in the length ($t = 4.37, P = 0.000$) and breadth ($t = 2.25, P = 0.027$) of the foramen in the Murray Valley sample which is not repeated at Coobool Creek. The Coobool Creek occipital condyles are long, broad and high, with some asymmetrical variation. Bilateral double-faceted condyles are found in CC10, while all the remaining condyles are single.

A broad and symmetrical inca bone is present in CC49. This bone has a maximum breadth of 102 mm and length of 65 mm, with the lateral projections of the bone extending to within 7 mm of asterion. Larnach and Macintosh (1966, 1970) found only one inca bone in the 230 crania from coastal New South Wales and Queensland which they examined. Supernumerary bones in the remaining crania are restricted to small to large lambdoid bones (CC9 and 29 left and right sides, CC35 and 37 left side, CC66 right side and CC38 medial and left side). In CC9 there is a large lambdoid bone on the right side. Probably as a function of the abnormal ossification in this area, there is asymmetrical development of the occipital, with a bulging right side.

Cranial vault thickness

Comparisons of terminal Pleistocene and Holocene Aboriginal skeletal series have highlighted the reduction in size of the cranial vault, oro-facial skeleton, and dentition which has occurred over the last 13,000 years (Thorne 1976; Thorne and Wilson 1977; Brown 1987a). In terms of the osteological and dental features affected, this structural reduction is similar to that reported from other parts of the world during the same time period (Brace and Mahler 1971; Frayer, 1984; Carlson and Van Gervan 1977; Smith *et al.* 1986; Calcagno 1986; Formicola 1987; Kennedy *et al.* 1987). In both the Near East (Smith *et al.* 1985) and Australia (Thorne 1976; Brown *et al.* 1979) one aspect of this reduction in hard tissue mass involves the thickness of the bones within the cranial vault. Recently I examined cranial-vault

Table 26 Length and breadth of *foramen magnum* in male and female crania from Coobool Creek and the Murray Valley (mm)

	n	\bar{x}	s	Student's t	Proba- bility
<i>Length</i>					
Coobool Creek males	17	37.1	2.08		
Murray Valley males	43	36.1	1.70	1.92	0.060
Coobool Creek females	6	37.3	2.33		
Murray Valley females	48	34.2	2.21	3.16	0.003
<i>Breadth</i>					
Coobool Creek males	16	31.0	2.47		
Murray Valley males	44	30.4	2.37	0.81	0.421
Coobool Creek females	6	30.1	1.47		
Murray Valley females	48	29.3	2.13	0.88	0.383

thickness in all of the available terminal Pleistocene skeletal material from Australia (Brown 1987a). However, the absence of a well-dated mid-Holocene sample and comparative data from other Australian populations restricted the scope of the analysis.

Although the thickness of the bones within the cranial vault has been argued to distinguish between anatomically modern *Homo sapiens* and other species of the genus *Homo* (Stringer and Andrews 1988), and thickened cranial vault bones are an often repeated characteristic for *Homo erectus* (Weidenreich 1943; Sartono 1968; Chiu *et al.* 1973; Jacob 1976; Howells 1980), a surprisingly small amount of comparable data has been published. Todd (1924) recorded cranial vault thickness in a large series of sectioned male white crania, and using radiographic cephalometry, Roche (1953), Young (1957), Hansman (1966) and Brown *et al.* (1979) provide data on postnatal changes in European and Aboriginal crania. Sexual dimorphism in vault-thickness dimensions is examined by Adeloeye *et al.* (1975) for American Blacks and Whites, Brown *et al.* (1979) and Brown (1987a, 1987b) for Aborigines and Smith *et al.* (1986) for a Near Eastern series. In addition both Smith *et al.* (1986) and Brown (1987a) document a post-Pleistocene reduction in cranial vault thickness. As Brown *et al.* (1979) point out, direct comparison of these data is complicated by differences in measurement technique, measurement sites and failure to compensate for radiographic enlargement in some studies. To a large degree the conflicting results over sexual dimorphism and age-related changes contained within the published literature probably arise from these differences in investigative approach.

Following Brown *et al.* (1979), cranial-vault thickness in the Coobool Creek series was initially determined using tracings from standardised lateral radiographs (Brown 1982). Subsequently, I examined the accuracy of this form of measurement by comparing data transcribed from radiographs with those obtained through direct measurement (Brown 1987a, 1987b). Using the Coobool Creek sample a surprisingly low level of correlation ($r = 0.49-0.67$) was obtained, with significant differences between the two sets of means indicated by Student's *t*. The mean dimensions recorded from radiographs were consistently lower than those obtained through direct measurement. Therefore those data used in my PhD thesis were inaccurate and they have been replaced in this analysis with those obtained through direct measurement.

Following the procedure in Brown (1987a),

vault-thickness dimensions were recorded using two specially modified vernier calipers. The thickness of the cranial vault was measured to the nearest 0.1 mm at the following points: on the frontal squama midway between nasion and bregma, the prebregmatic eminence, the frontal bone adjacent to bregma, the right parietal bone adjacent to vertex, the right parietal eminence, the parietal bone adjacent to asterion and the external occipital protuberance. With the exception of the parietal eminence and asterion all dimensions were recorded at the midline. Where the sagittal suture was located in a marked depression, thickness at vertex was recorded from a more lateral position.

Male and female samples were processed separately so that the extent of sex-based variation could be examined, with the percentage of sexual dimorphism for each dimension calculated according to Garn *et al.* (1964). The vault thickness dimensions, by population and by sex, were plotted against the percentage points of a standard normal variable (Gnanadesikan 1977). With the exception of thickness at the external occipital protuberance their distributions did not deviate greatly from that expected of a normal distribution. A large proportion of the Murray Valley crania have associated postcranial skeletons. These were used to explore possible allometric relationships between the thickness of the bones within the cranial vault, size of the cranial vault and stature. In this instance stature was represented by the maximum length of the right femur.

Sources of measurement error

All of the samples (Tables 27-28) display considerable variation and to a large degree this is a reflection of the architecture of the endocranial surface of the cranial vault. Vault thickness dimensions recorded at the midline can be influenced by a number of anatomical features. The length and height of the frontal crest, depth of the groove for the superior sagittal sinus, grooves for the meningeal vessels, relative positions of the internal and external occipital protuberances and bone growth associated with suture development can all affect vault thickness at a given point. Similar factors can influence vault-thickness dimensions recorded from more lateral positions on the vault. Where measurements are recorded from fixed points, on the external surface, little control can be gained over this normal source of variation.

Measurement replicability was examined using the double determination method of Dahlberg (1940). The 26 Coobool Creek crania

Table 27 Cranial vault thickness in male crania from Coobool Creek, Kow Swamp, Barham, the Murray Valley and Swanport (mm)

	n	\bar{x}	s	Min.	Max.
<i>Midfrontal squama</i>					
Coobool Creek	20	10.4	2.41	6.5	16.3
Kow Swamp	4	8.7 ¹	1.64	6.7	10.5
Barham	5	8.2	2.28	4.9	10.7
Murray Valley	47	7.8 ^{1,2}	1.58	3.8	11.8
Swanport	19	7.8 ^{1,2}	1.50	5.2	10.0
<i>Prebregmatic eminence</i>					
Coobool Creek	20	11.2	2.29	7.8	15.4
Kow Swamp	4	11.8	2.40	8.7	14.1
Barham	4	10.5	1.70	9.2	12.9
Murray Valley	47	8.4 ^{1,2}	1.50	5.4	12.0
Swanport	19	7.6 ^{1,2}	1.04	6.1	10.2
<i>Frontal at bregma</i>					
Coobool Creek	20	10.8	1.93	8.1	14.1
Kow Swamp	4	10.1	1.44	7.3	12.0
Barham	4	10.7	1.70	9.4	13.2
Murray Valley	47	8.9 ¹	1.50	5.8	12.3
Swanport	19	7.8 ^{1,2}	1.05	6.5	10.5
<i>Vertex</i>					
Coobool Creek	20	9.2	1.68	6.1	13.7
Kow Swamp	4	9.7	3.04	6.0	12.5
Barham	5	8.0	2.39	5.4	11.8
Murray Valley	47	8.7	1.44	5.8	12.1
Swanport	19	7.0 ¹	0.97	5.3	9.2
<i>Occipital at lambda</i>					
Coobool Creek	20	12.8	1.76	9.8	17.1
Kow Swamp	5	10.0 ¹	2.00	6.9	11.7
Barham	5	9.8	2.90	6.5	13.9
Murray Valley	47	9.9 ¹	1.94	6.2	16.5
Swanport	19	8.5 ¹	1.24	6.7	10.3
<i>Parietal eminence</i>					
Coobool Creek	20	7.7	1.90	5.0	12.4
Kow Swamp	-	-	-	-	-
Barham	5	7.8	1.93	5.3	10.5
Murray Valley	47	6.4 ^{1,2}	1.12	4.0	9.0
Swanport	19	6.4 ¹	1.58	4.5	10.5
<i>Parietal at asterion</i>					
Coobool Creek	20	10.9	2.85	6.3	16.5
Kow Swamp	-	-	-	-	-
Barham	5	9.3	2.82	6.4	13.5
Murray Valley	47	9.1 ^{1,2}	1.66	5.6	11.8
Swanport	19	7.2 ^{1,2}	1.61	4.0	10.0
<i>External occipital protuberance</i>					
Coobool Creek	20	18.1	2.78	13.0	23.0
Kow Swamp	2	14.3	-	12.8	19.6
Barham	5	17.4	4.32	11.2	23.0
Murray Valley	47	15.1 ¹	3.17	9.5	23.2
Swanport	19	13.7 ¹	1.82	11.0	16.5

1 Murray Valley or Swanport mean which is significantly less than Coobool Creek (P = .05-.001)

2 Significant difference in variance indicated by Bartlett's χ^2 , Student's t calculated using separate variance estimate

Table 28 Cranial vault thickness in female crania from Coobool Creek, Kow Swamp, Barham, the Murray Valley and Swanport (mm)

	n	\bar{x}	s	Min.	Max.
<i>Midfrontal squama</i>					
Coobool Creek	8	8.4	1.73	5.8	10.5
Kow Swamp	1	7.8	—	—	—
Barham	2	6.8	2.75	4.9	8.8
Murray Valley	52	7.5 ¹	1.35	4.1	10.4
Swanport	18	7.5	1.40	5.6	11.5
<i>Prebregmatic eminence</i>					
Coobool Creek	8	8.4	1.07	7.2	9.7
Kow Swamp	—	—	—	—	—
Barham	1	8.7	—	—	—
Murray Valley	52	7.9	1.48	3.7	10.4
Swanport	19	6.8	1.07	5.2	9.5
<i>Frontal at bregma</i>					
Coobool Creek	8	8.4	1.97	5.8	10.9
Kow Swamp	1	7.3	—	—	—
Barham	1	8.0	—	—	—
Murray Valley	52	7.8	1.39	4.7	10.4
Swanport	19	6.3 ^{1,2}	0.93	5.0	8.0
<i>Vertex</i>					
Coobool Creek	8	7.4	0.50	6.9	8.5
Kow Swamp	1	6.9	—	—	—
Barham	2	6.3	1.27	5.4	7.2
Murray Valley	52	7.7 ²	1.35	3.4	9.8
Swanport	18	6.2	1.05	4.7	8.4
<i>Occipital at lambda</i>					
Coobool Creek	8	11.6	2.07	7.5	13.8
Kow Swamp	—	—	—	—	—
Barham	2	7.4	1.62	5.7	8.0
Murray Valley	52	9.7 ¹	1.75	6.1	15.1
Swanport	19	8.1 ¹	1.43	5.7	10.7
<i>Parietal eminence</i>					
Coobool Creek	5	6.8	0.93	6.0	8.0
Kow Swamp	—	—	—	—	—
Barham	2	6.9	1.62	5.7	8.0
Murray Valley	53	7.1	1.80	3.2	10.8
Swanport	19	6.2	1.31	4.0	8.5
<i>Parietal at asterion</i>					
Coobool Creek	5	8.4	1.84	6.4	11.0
Kow Swamp	—	—	—	—	—
Barham	2	6.9	0.78	6.4	7.5
Murray Valley	53	7.4	1.60	5.4	10.8
Swanport	19	5.6 ^{1,2}	0.90	4.0	7.5
<i>External occipital protuberance</i>					
Coobool Creek	8	15.5	5.33	10.0	23.5
Kow Swamp	—	—	—	—	—
Barham	1	11.2	—	—	—
Murray Valley	52	13.1 ¹	2.27	8.0	17.7
Swanport	19	10.1 ¹	2.44	5.5	14.0

1 Murray Valley or Swanport mean which is significantly less than Coobool Creek ($P = .05-.001$)

2 Significant difference in variance indicated by Bartlett's χ^2 , Student's t calculated using separate variance estimate

were measured on two separate occasions. Differences between the first and second observation were analysed by computing the standard deviation of a single determination. The magnitude of measurement error using Dahlberg's statistic ranged from 0.18-0.39 mm, with a mean of 0.23 mm. This is greater than the mean error obtained in dental replicability studies using similar measurement scales (Moorrees *et al.* 1957; Barrett *et al.* 1963a; Townsend and Brown 1979b; Brown 1987a), but comparable to the measurement error reported by Brown *et al.* (1979) in their study of cranial vault thickness. Comparison of the two sets of means, using Student's *t* test, did not produce significant results.

Vault thickness may also be influenced by localised trauma or a number of specific pathologies. Fortunately the majority of these have well-defined characteristics and are easily recognised (Sissons 1966; Ortner and Putschar 1985; Brown 1987a). Both radiographic and direct examination of the crania used in this analysis indicated that bone growth was normal and without pathological association. Several studies have also reported that there is a gradual, though irregular, increase in vault thickness throughout adult life (Todd 1924; Roche 1953; Adeloje *et al.* 1975). Others have been unable to confirm this trend (Tallgren 1974; Smith *et al.* 1985). It is possible that age-related changes may contribute to the problems associated with comparing small samples. This remains a possible source of error, however, the conflicting results obtained in analyses of age-related change suggest that the effects of skewed adult age distributions would only be minimal.

Sexual dimorphism and diachronic change

In each of the groups, where both sexes are represented, overall cranial-vault thickness is greater in males than in females (Tables 27-29). The Aboriginal crania from Coobool Creek, the Murray Valley and Swanport share significant differences between the male and female means at bregma, asterion and the external occipital protuberance. At Coobool Creek there are also significant differences for thickness at the mid-frontal squama and vertex. Comparison of the sexual dimorphism percentage figures for these two groups (Table 29) suggests that sexual dimorphism in cranial-vault thickness was much greater in southeastern Australia 13,000 years ago than in the recent period. However, the Coobool Creek female sample is relatively small, especially given the high degree of variation, and I would not like to emphasise these results too strongly.

There is a similar pattern to the levels of vault-thickness dimorphism in the two recent populations, Murray Valley and Swanport (Table 29). The lowest levels of dimorphism in each of these populations are for thickness at the parietal eminence. In the Murray Valley series, females have a slightly thicker mean value than males (dimorphism score -9.9%), while at Swanport the difference between the male and female dimorphism scores is only 3.2%. It is possible that the relatively greater thickness at this point may be associated with the generally more protruding parietal eminence in female Aboriginal crania. The sexual dimorphism percentages show considerable variation, however, the ranking of the percentage scores in the three modern groups indicates a general trend towards

Table 29 Sexual dimorphism in vault thickness dimensions for Aboriginal crania from Coobool Creek, the Murray Valley and Swanport

	Student's <i>t</i> test scores			% sexual dimorphism		
	Coobool Creek	Murray Valley	Swanport	Coobool Creek	Murray Valley	Swanport
Midfrontal squama	3.03 ²	0.12	0.62	23.8	5.5	4.0
Prebregmatic eminence	3.12 ²	1.64 ⁴	2.38 ¹	33.3	6.3	11.8
Frontal at bregma	3.17 ²	3.62 ²	4.65 ²	28.6	11.5	23.8
Vertex	2.62 ^{1,4}	3.42 ²	2.60 ¹	24.3	12.9	12.9
Occipital at lambda	1.74	0.51	0.98	10.3	2.0	4.9
Parietal eminence	1.67	1.34 ^{3,4}	0.43	13.2	9.9 ³	3.2
Parietal at asterion	2.51 ¹	3.21 ²	3.90 ^{2,4}	29.8	22.9	28.6
External occipital protuberance	3.67 ^{2,4}	3.11 ^{2,4}	5.11 ²	16.8	15.3	35.6
Mean	-	-	-	22.5	7.5	15.6

1 Male mean significantly greater than female mean ($P = .05-.01$)

2 Male mean significantly greater than female mean ($P = .008-.000$)

3 Female mean thickness at parietal eminence greater than male

4 Significant difference in variance indicated by Bartlett's χ^2 , Student's *t* calculated using separate variance estimate

maximum vault thickness dimorphism at asterion and in the posterior third of the frontal bone.

Male crania, particularly those from the Murray Valley area, often have a pronounced median sagittal ridge. This ridge may occupy the posterior two-thirds of the frontal, extending posteriorly to the middle of the parietals. In some instances, in males, this median ridge expands into a prominent prebregmatic, or bregmatic, eminence which may extend laterally down the coronal suture. In sagittally-sectioned crania the thickened median ridge results from a proportional increase in tabular bone and diploë. However, where a prominent prebregmatic eminence is present this is primarily composed of preferentially thickened diploë. Male Aboriginal crania also typically have a transverse occipital torus (Larnach and Macintosh 1966). Unfortunately, thickness dimensions recorded at the external occipital protuberance often produce a misleading picture of bone development in this region. Maximum vault thickness at the external occipital protuberance is largely dependent upon the relative position of the internal and external occipital protuberances. When both of these features are in alignment a maximum dimension is obtained. It is therefore possible for comparatively thin-walled female crania, without a prominent occipital torus, to gain thickness dimensions equal to more robust male crania at this point. In particular the Coobool Creek males, who as a group have well developed occipital tori, have relatively inferiorly located internal occipital protuberances. This has contributed to the anomalous results for vault thickness at the external occipital protuberance in this sample (Tables 27-29). Given the large degree of anatomical variation in this region I doubt that recording vault thickness at the external occipital protuberance has much value for comparative research.

Within the Aboriginal male groups, cranial-vault thickness is significantly greater at Coobool Creek than in the recent Murray Valley population. The other terminal Pleistocene series, Kow Swamp, has a similar pattern of increased thickness at the prebregmatic eminence, bregma and vertex, however, this is not extended to other parts of the cranial vault (Table 27, Figs 24-25). To a lesser degree the female results support those obtained with the males. With the exception of thickness at the midfrontal squama and parietal eminence, the Coobool Creek female means are either greater than, or equal to, those in the comparative recent populations (Table 28). Comparison of the Coobool Creek and recent

Murray Valley means reveals the substantial degree of reduction in cranial-vault thickness which has occurred in southeastern Australia over the last 13,000 years. This reduction in vault thickness is most obvious in the male frontals and female occipitals. The mean dimensions of the small Barham male sample combine aspects of both the terminal Pleistocene and recent Australian groups. In the absence of more substantial data from Aboriginal populations in the same time period, these results suggest that there was an ongoing reduction in cranial-vault thickness in southeastern Australia after 5000 years BP (Figs 24-25).

The most unusual aspect of vault thickness in the crania from Coobool Creek, Kow Swamp, Cohuna and Nacurrie is found in the frontal bones of those individuals which show evidence of artificial deformation (Brown 1981b, 1987a). There is a pronounced prebregmatic expansion of the diploë in some of these crania (CC29, 65, 66, 82, KS5, 7, Cohuna, N1 and 2), to form a prominent eminence on the midline of the external surface. Corresponding with this prebregmatic thickening there is often a constriction of the diploë in the middle third of the frontal squama. For instance in CC65 the minimum midline thickness of the midfrontal squama is 5.0 mm, with a thickness of 12.1 mm at the prebregmatic eminence.

Several studies have documented the directional reduction in the size of the cranial vault, oro-facial skeleton and dentition, which has occurred in southeastern Australia since the terminal Pleistocene (Thorne 1976; Thorne and Wilson 1977; Brown 1987a). A reduction in cranial vault-thickness could be linked with this through an allometric association with the overall size of the cranial vault or stature. Correlations between cranial-vault thickness, femur length and various cranio-facial dimensions were examined by population and by sex using the Murray Valley series. The levels of correlation displayed considerable variation, however, the association between some variables was consistent throughout. In the single-sex and pooled-sex samples there were either low positive or low negative correlations between the vault-thickness dimensions and femur length, maximum biparietal breadth, and nasion-prosthion. With the exception of the female segment, correlations involving bizygion breadth were also uniformly low, but with few negative values. In general the levels of correlation were decreased, rather than increased, in the pooled-sex results for these variables. There were moderate levels of correlation between maximum cranial length,

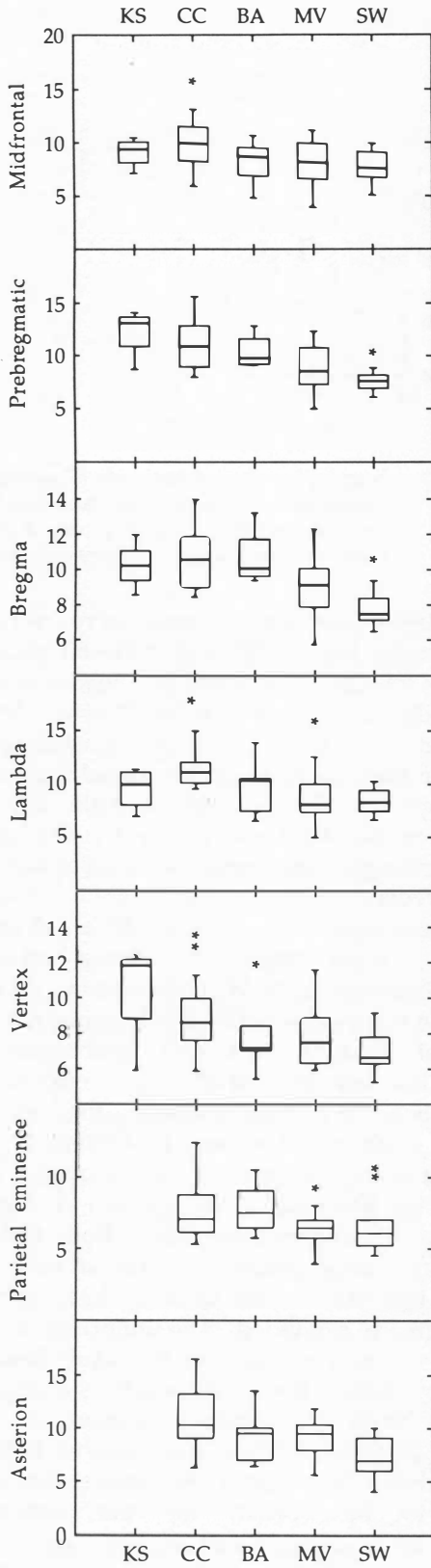


Figure 24 Box plots of vault thickness dimensions in male crania from Kow Swamp, Coobool Creek, Barham, the Murray Valley and Swanport (mm)

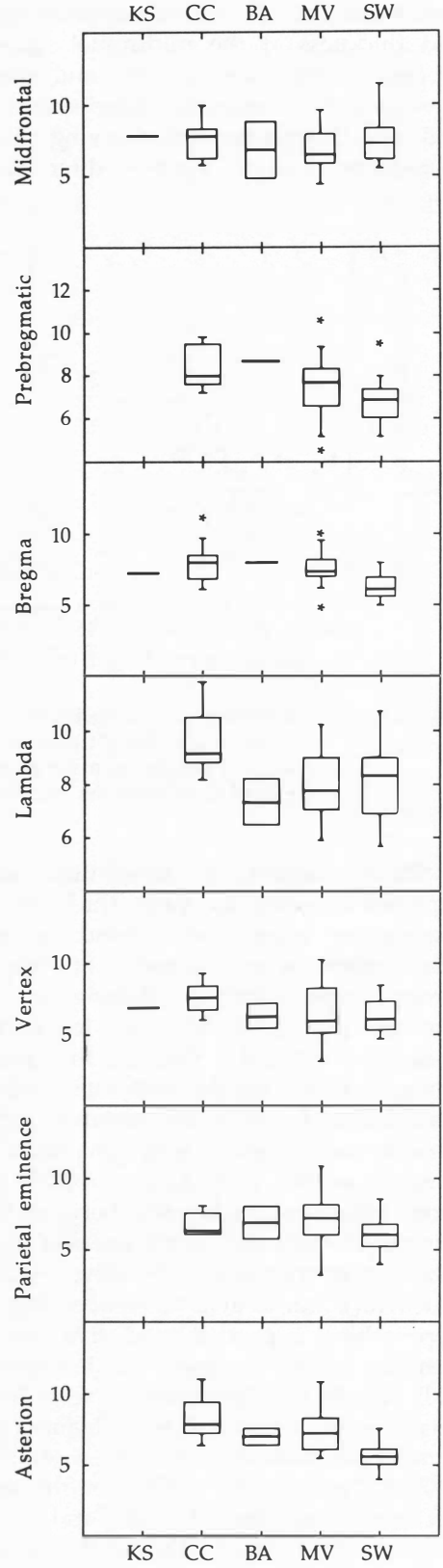


Figure 25 Box plots of vault thickness dimensions in female crania from Kow Swamp, Coobool Creek, Barham, the Murray Valley and Swanport (mm)

basion-bregma, maximum supraorbital breadth and thickness at the midfrontal squama, pre-bregmatic eminence, bregma and the parietal eminence. Scatterplots of these cranial thickness and size dimensions, while having considerable dispersion, had a clearly directional trend (Fig.26).

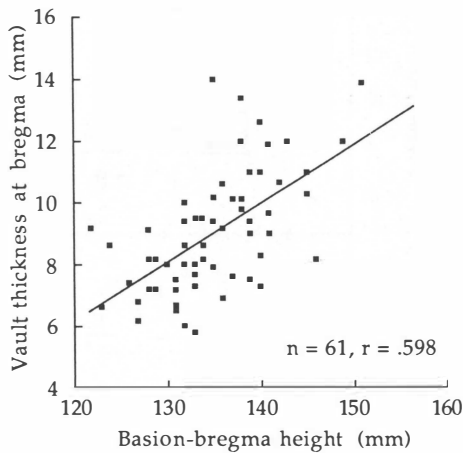


Figure 26 Scatterplot of association between basion-bregma height and vault thickness at bregma in male crania from Coobool Creek and the Murray Valley

Some evidence of correlation would be expected between the vault thickness and size dimensions given their broad topographical relationship, with thickness at bregma and basion-bregma height sharing a common reference point (male $r = .762$, female $r = -.005$, pooled sex $r = .592$). Even so, the levels of correlation from regions without a close topographical association, for instance supraorbital breadth and thickness at bregma (male $r = .350$, female $r = .541$, pooled sex $r = .457$) suggest a broad allometric relationship between the size of the cranial vault and the thickness of the bones of which it is composed. However, there is too much variation to give this association anything approaching a precise predictive nature. For example, using the entire pooled sample ($n = 110$) and then subdividing it according to sex (males = 66, females = 44), obtained Pearson's correlation coefficients of male = .411, female = .487 and pooled sex = .631, for the association between supraorbital breadth and thickness at bregma. Scatterplots displayed a linear trend, although with considerable dispersion (standard error of estimates male = 1.81, female = 1.23, pooled sex = 1.71), with a regression equation for the males of $x = -8.597 + 0.159y$, females $x = -10.671 + 0.168y$ and pooled sex $x = -17.566 + 0.237y$ (Fig.27).

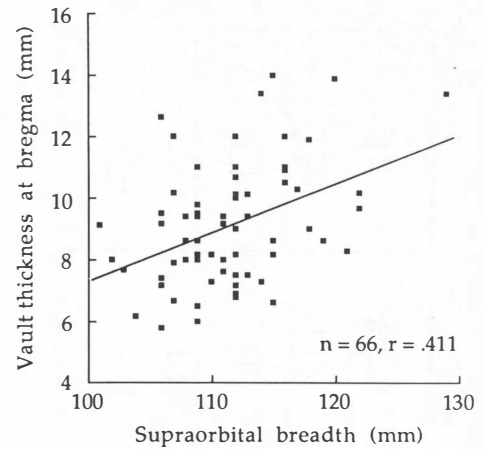


Figure 27 Scatterplot of association between supraorbital breadth and vault thickness at bregma in male crania from Coobool Creek and the Murray Valley

The oldest human skeletal material recovered from Australia, LMI, LMIII and WLH 50, dated to between 24,000-29,000 years BP (Bowler et al. 1972; Bowler and Thorne 1976; Thorne 1984; Caddie et al. 1987), display considerable variation in their vault thickness, cranial size and morphology. LMIII, probably a male, has a thickened cranial vault which is in the Coobool Creek and Kow Swamp range of variation while the LMI female cremation has a cranial vault which is extremely thin (Brown 1987a). Vault thickness in the largest and most robust specimen from this area, WLH 50 (Thorne 1984), exceeds the reported Australian Aboriginal range (midfrontal squama 16.5 mm, prebregmatic eminence 18.0 mm, bregma 17.2 mm, vertex 13.9 mm, lambda 16.2 mm, asterion 16.0 mm). However, bone structure in this individual is unlike that in any of the other *Homo sapiens*, or Australasian hominid crania which I have examined. Throughout the vault, both endocranially and ectocranially, the tabular bone is extremely thin (0.5-1.5 mm) while the intervening diploë is greatly expanded. The uniformity with which this occurs throughout the vault is not consistent with the osteological changes associated with the common haemolytic, or metabolic disorders (Ortner and Putschar 1985), but nevertheless it is in marked contrast to what appears to be normal for our species. Comparisons of cranial-vault thickness between Australian Aboriginal, American White, American Black and northern Chinese groups highlight the greatly thickened vaults in the Australian sample (Todd 1924; Roche 1953; Adeloje et al. 1975; Brown 1987b). Using the evidence provided by the Willandra Lakes crania

it is not clear if Australia's first human occupants had thickened cranial-vault bones or whether these developed within Australia at some time between 39,000-13,000 years BP.

I have previously argued (Brown 1987a) that one factor which may have selected for increased vault thickness is the traditional method of settling disputes in Aboriginal communities. Traditionally, Aborigines from southern and central Australia, males and females, involved in aggressive disputes will use a substantial wooden implement and strike towards the head of their opponent (Taplin 1874; Basedow 1925; Meggitt 1962; Tonkinson 1966). These disputes may arise from competition between women in a polygamous family unit, competition between real or classificatory brothers over women, competition for political or religious authority, accusations of infidelity, failure to fulfil perceived domestic responsibilities or over any major source of grievance within a clan (Tonkinson 1966; Reid 1978). Although there is some regional variation these fights commonly involve a fixed behavioural code. The combatants 'take it turn about to strike and parry. The head is the principal mark, but it is not against the rules to aim at the fingers The fight continues until one receives a blow on the head severe enough to disable them' (Basedow 1925:166-67). Injuries to the scalp and cranial vault are often severe, especially in situations where the initial formalised dispute escalates to a general mêlée involving the entire community (Taplin 1874; Meggitt 1962; Tonkinson 1966).

Evidence of the frequency, and severity, of this form of social interaction is common in skeletal material recovered from archaeological sites in Australia. In a sample of 430 Aboriginal crania (176 females and 254 males) from New South Wales, Victoria and South Australia there were well demarcated, single or multiple depressed fractures on the frontals, or parietals, of 59% of the females and 37% of the males (Brown 1987a). The majority of the fractures were located on the left side of the frontal, and left parietal, which is consistent with a blow from a right-handed person, where the combatants are facing each other (Fig.28). In each instance there was bone regrowth associated with the fracture indicating that the people had survived what was often severe trauma. Ethnographic accounts (Meggitt 1962; Tonkinson 1966; Reid 1978) suggest that the individuals most commonly involved in fighting within the band are young adults. Either younger wives victimised by older women in a polygamous family unit, young wives attacked after accusations of infidelity by

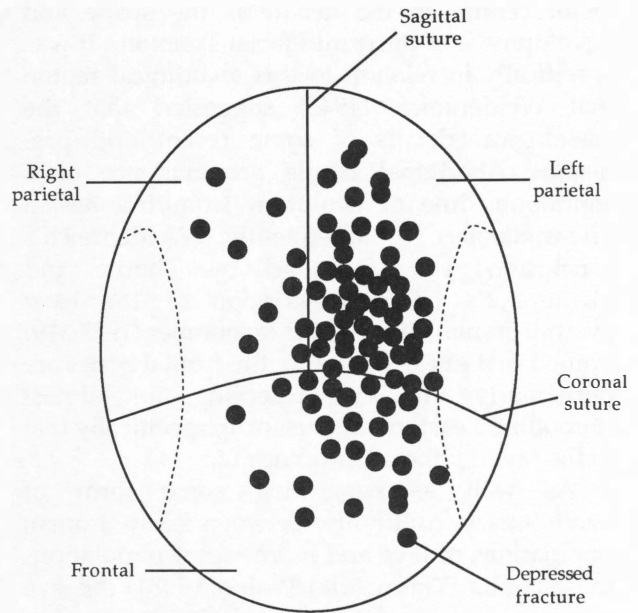


Figure 28 Diagrammatic superior view of cranial vault showing the location of depressed fractures in a sample of 430 Aboriginal crania from southeastern Australia (in some, two or more fractures are located in the same position with several individuals having multiple injuries)

their ageing husbands, or young men in multifarious disputes with either their peers or older individuals. Under these conditions the principal function of the neurocranium, that of insulating and protecting the brain, is under considerable stress. If the people most at risk are those who are at their reproductive peak then surely over an extended period of time selection will favour the genes of individuals with thicker bones in their cranial vaults. The cultural alternative of simply developing less harmful methods of settling disputes was not chosen. Perhaps it is as Tonkinson (1966:307) suggests, social cohesion in Aboriginal communities is ultimately reinforced by the conflicts that occur. The immediate, direct and forceful expression of anger in these socially controlled conflicts may reinforce common ties of kinship, and the need for group solidarity, after the breach.

ARTIFICIAL CRANIAL DEFORMATION

The extremes of morphological variation in Aboriginal crania have long fuelled debate as to the biological origins of the Australian Aboriginal population (Topinard 1872; Turner 1884; Birdsell 1949, 1967; Abbie 1951; Macintosh 1963; Thorne 1977; Freedman and Lofgren 1979b; Thorne and Wolpoff 1981; Brown 1987a). A

factor central to the debate is the shape and development of the fronto-facial skeleton. It was specifically in relation to this anatomical region that Weidenreich (1946) suggested that the osteological details of some recent and pre-historic Aboriginal crania are evidence of a continuous line of evolution from Indonesian *Pithecanthropus*. Subsequently, Weidenreich's conclusion was supported by Thorne and Macumber's (1972) description of the Kow Swamp crania. Thorne and Macumber (1972:319) argued that at Kow Swamp 'the frontal bones are particularly archaic, preserving an almost unmodified eastern erectus form, specifically that of the Javan *pithecanthropines*'.

As well as suggesting some form of evolutionary continuity between early human populations in Java and more recent populations in Australia (Thorne and Wolpoff 1981) the size and morphology of the fronto-facial skeleton has also been used to distinguish two distinct Australian Pleistocene populations (Thorne 1977; Thorne and Wilson 1977; Freedman and Lofgren 1979a).

A contrasting interpretation of the Kow Swamp and Cohuna crania by Brothwell (1975) suggested that the frontal recession evident in the Kow Swamp material was in fact too extreme to be natural and represented artificial cranial deformation rather than the persistence to 10,000 years BP of an archaic morphotype. Thorne's reply (1976), supported by Larnach (1978), observed that there were no structural osteological characters in the Kow Swamp crania that would support deformation. Thorne argued that given the extreme anterior recession, some corresponding posterior reaction should be observable. He found none: 'indeed the occipital region of the Kow Swamp cranium was fully developed and expanded' (Thorne 1976:110). The possibly accidental use of the singular 'cranium' highlights the difficulty in examining this issue at Kow Swamp. The posterior and basal areas of the majority of the crania from this site are incomplete, with two of the more complete occipitals (KS1 and KS14) suffering from post-depositional distortion.

The reconstruction of the Coobool Creek crania provided an opportunity to test this issue, as statistical and morphological comparisons indicate that these crania fall within the Kow Swamp range (Brown 1981b, 1987a). An immediate difficulty was in finding suitable material with which to test Brothwell's hypothesis. Under ideal circumstances it would have been preferable to compare artificially deformed and undeformed crania, with known

histories, from the same biological population. However, a sample conforming to these conditions is unavailable in Australia. The only definitely deformed crania available were Melanesian, the majority, members of the Arawe from southern New Britain (Blackwood and Danby 1955). Due to the morphological difference between Aboriginal and Melanesian crania, a direct comparison of deformed Melanesian crania with undeformed Aboriginal crania may have produced misleading results. The only undeformed Melanesian sample of adequate size, and from an area in reasonable geographic proximity to the Arawe, available in Australia came from the Sepik River region of northern Papua New Guinea.

The Arawe

A total of 57 artificially deformed crania in the collections of the Anatomy Department of the University of Melbourne, the South Australian Museum and the Australian Institute of Anatomy, Canberra, was examined. The Arawe of southern New Britain, forming the largest ($n = 25$) well-defined unit within this collection, were chosen as the representative artificially deformed group.

Sex was determined through a detailed examination of cranial morphology (Krogman 1962; Larnach and Freedman 1964). I would have preferred to have supported the morphological diagnosis with the use of discriminant functions (Giles and Elliot 1963; Townsend *et al.* 1982) but the alterations in shape and size resulting from the deformation process would have produced results which were less reliable than the original morphological sexing. This suggested that 16 male and nine female crania were present.

Blackwood and Danby (1955) present a detailed description of both the process of head-binding among the Arawe and its effect on the cranial vault. According to them the motive for head-binding appears to be a purely aesthetic one - the long head was admired and considered attractive to the opposite sex. They describe how, almost immediately after birth, a bandage consisting of strips of bark cloth and vine was bound around the infant's forehead and back of the cranium. The first bandage served for about three weeks, larger pieces being substituted as the child grew. The amount of deformation produced was left entirely to the discretion of the mother, who kept the bandage fastened tightly if she wished the child's head to be particularly long. Even at one-day-old deformation was quite marked. The bandage was kept on for about one year. Reasons given for discontinuing the

practice were the child's head was considered long enough or that the child kept pulling the bandage off.

Sepik River

The 26 crania in the Sepik River series, the majority with incised frontal bones, were obtained from museum collections in Canberra, Melbourne and Adelaide. There are no known ethnographic records of artificial cranial deformation being practised in the Sepik (Dingwall 1931) and the crania show no evidence of deformation. Sex was determined through an examination of cranial morphology (Krogman 1962; Larnach and Freedman 1964) combined with a discriminant function analysis of the crania and mandibles (Giles and Elliot 1963; Giles 1964). Close agreement was obtained between the morphological and metrical techniques. In the five instances where crania obtained intermediate discriminant function scores, greatest emphasis was placed on morphological characteristics. Fourteen male crania and 12 female crania were sexed by these analyses.

Methods

All dimensions were taken to standard osteological points using the methods discussed in Chapter II. Snedecor's variance ratio test (F value) was used to test differences between sample variances and Student's t test to assess differences in sample means. Data were compared with a standard normal distribution using normal probability plots and the Shapiro-Wilk statistic (W). The relationship between selected variables was examined using scatterplots and standard regression procedures (Snedecor and Cochran 1969). A series of linear discriminant analyses were performed using the procedures outlined in Chapter II. Following Jolicoeur (1959) and Lubischew (1962) correlation between individual measurements and the case's orthogonally-projected axis position were used to help interpret the canonical functions. The scatterplots produced for this purpose revealed more meaningful associations than would have been indicated by the canonical functions alone. Covariance matrices were produced for each group and a test for equality of the matrices, Box's M and its associated F test, employed (Box 1949).

Lateral radiographs were taken of eight of the Arawe and all of the Coobool Creek crania. Heavy mineralisation of the Coobool Creek crania, with the deposition of silica and manganese in the diploë and sinuses, resulted in a comparatively low level of resolution with this

material. These radiographs were compared with a series taken as part of the long-term growth study of Walbiri and Pintubi people at Yuendumu in central Australia (Brown and Barrett 1964, 1973; Brown *et al.* 1979).

UNIVARIATE AND MORPHOLOGICAL COMPARISON

Arawe and Sepik River

A number of the female crania from both of these groups had incomplete facial skeletons and damage to the basal sections of their vaults. For dimensions recorded from these regions, missing data restricted the size of the Sepik River female sample to four and the Arawe females to six. Due to the small size of the female sample, statistical comparisons were restricted to the males. The descriptive and comparative statistical data for the Arawe and Sepik River male crania are presented in Table 30. These data, as well as much of the discussion to follow, were originally published in Brown (1981b).

The more obvious visual differences between the Arawe and Sepik River crania are associated with the curvature of the frontal, parietal and occipital bones when viewed laterally (Fig.29). Compared to the Sepik River frontal bones, the Arawe frontals are greatly elongated and flattened. Both the mean frontal chord (nasion-bregma) and frontal arc length of the deformed crania are significantly longer ($P = .000$, $P = .048$) than in the undeformed series (Table 30). Viewed laterally, the flattening of the Arawe frontals is largely restricted to the anterior two-thirds, with the surface in some crania being slightly concave. There is little evidence of the frontal boss preserved and the point of maximum convexity (maximum frontal subtense height or metopion) is situated posterior to that in the Sepik series.

The mean frontal curvature index of the Arawe is significantly lower ($P = .000$) than that in the undeformed series, however, there is an overlap in range and the two groups can not be separated by this single index (Fig.30). In undeformed Melanesian and Australian Aboriginal crania as the length of the frontal bone increases (nasion-bregma) there is a corresponding increase in frontal subtense height (curvature) (Fig.30). Although this relationship is not tightly linear the points fall within reasonable proximity of the regression line. Some form of uniformity in this relationship might also be predicted for the Arawe. With increasing frontal flattening the chord and arc lengths of the frontal

Table 30 Comparative dimensions of the Arawe (AR) and Sepik River (SR) male crania (mm)

Variable	Arawe/ Sepik River	n	\bar{x}	s	Coefficient of variation	Min.	Max.	Snedecor's variance F	Proba- bility	Student's t	Proba- bility																																																																																																																																																																																																																																																																																																																																																																																																										
Maximum biparietal breadth	AR	14	126.4	4.57	3.61	119	133	1.45	0.511	2.91 ¹	0.007																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	132.0	5.51	4.17	120	140					Glabella- opisthocranion	AR	16	183.9	6.04	3.28	169	193	1.39	0.537	1.24	0.225	SR	14	180.9	7.12	3.93	170	192	Basion-bregma	AR	16	140.6	5.55	3.94	133	151	1.24	0.708	3.37	0.002	SR	14	134.1	4.99	3.72	123	141	Basion-nasion	AR	16	102.9	3.79	3.68	96	110	1.07	0.885	1.53	0.138	SR	14	100.7	3.93	3.90	95	107	Basion-nasospinale	AR	16	100.1	4.03	4.02	92	108	1.18	0.770	1.79	0.085	SR	14	97.6	3.71	3.80	90	106	Basion-prosthion	AR	11	105.8	4.29	4.05	100	113	1.16	0.783	1.90	0.071	SR	14	102.6	3.97	3.86	96	111	Basion-lambda	AR	16	122.7	8.67	7.06	102	131	1.28	0.666	4.33	0.000	SR	14	109.8	7.67	6.98	93	118	Basion-inion	AR	16	67.0	10.46	15.61	41	79	1.20	0.730	0.04 ¹	0.972	SR	14	67.1	11.46	17.07	29	77	Biauricular breadth	AR	16	122.3	5.99	4.89	113	133	1.44	0.519	2.08	0.047	SR	14	118.1	5.01	4.24	108	124	Bisphenion	AR	16	105.8	5.88	5.55	91	111	1.11	0.857	1.20	0.241	SR	14	103.3	3.04	2.94	96	118	Nasion-bregma	AR	16	118.9	3.98	3.34	111	126	1.89	0.257	5.96	0.000	SR	14	111.4	2.90	2.60	105	117	Frontal subtense height	AR	16	17.2	2.78	16.16	13	22	1.17	0.760	5.66 ¹	0.000	SR	14	23.2	3.02	13.01	19	29	Nasion-frontal subtense	AR	16	58.2	11.66	20.03	41	83	1.17	0.781	2.78	0.010	SR	14	46.8	10.76	22.99	10	53	Opisthion-lambda	AR	16	102.7	4.29	4.17	96	113	1.43	0.519	6.60	0.000	SR	14	93.2	3.58	3.84	90	102	Bregma-lambda	AR	16	111.1	6.18	5.56	99	120	1.46	0.482	1.84 ¹	0.077	SR	14	115.7	7.46	6.44	105	132	Parietal subtense height	AR	16	31.1	3.54	11.38	22	37	1.46	0.499	3.98	0.001	SR	14	26.4	2.93	11.09	21	31	Bregma-parietal subtense	AR	16	60.3	4.25	7.04	55	68	1.71	0.321	1.03	0.313	SR	14	58.4	5.56	9.52	51	70	Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010	SR	14	65.4	5.40	8.25	56	76	Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14
Glabella- opisthocranion	AR	16	183.9	6.04	3.28	169	193	1.39	0.537	1.24	0.225																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	180.9	7.12	3.93	170	192					Basion-bregma	AR	16	140.6	5.55	3.94	133	151	1.24	0.708	3.37	0.002	SR	14	134.1	4.99	3.72	123	141	Basion-nasion	AR	16	102.9	3.79	3.68	96	110	1.07	0.885	1.53	0.138	SR	14	100.7	3.93	3.90	95	107	Basion-nasospinale	AR	16	100.1	4.03	4.02	92	108	1.18	0.770	1.79	0.085	SR	14	97.6	3.71	3.80	90	106	Basion-prosthion	AR	11	105.8	4.29	4.05	100	113	1.16	0.783	1.90	0.071	SR	14	102.6	3.97	3.86	96	111	Basion-lambda	AR	16	122.7	8.67	7.06	102	131	1.28	0.666	4.33	0.000	SR	14	109.8	7.67	6.98	93	118	Basion-inion	AR	16	67.0	10.46	15.61	41	79	1.20	0.730	0.04 ¹	0.972	SR	14	67.1	11.46	17.07	29	77	Biauricular breadth	AR	16	122.3	5.99	4.89	113	133	1.44	0.519	2.08	0.047	SR	14	118.1	5.01	4.24	108	124	Bisphenion	AR	16	105.8	5.88	5.55	91	111	1.11	0.857	1.20	0.241	SR	14	103.3	3.04	2.94	96	118	Nasion-bregma	AR	16	118.9	3.98	3.34	111	126	1.89	0.257	5.96	0.000	SR	14	111.4	2.90	2.60	105	117	Frontal subtense height	AR	16	17.2	2.78	16.16	13	22	1.17	0.760	5.66 ¹	0.000	SR	14	23.2	3.02	13.01	19	29	Nasion-frontal subtense	AR	16	58.2	11.66	20.03	41	83	1.17	0.781	2.78	0.010	SR	14	46.8	10.76	22.99	10	53	Opisthion-lambda	AR	16	102.7	4.29	4.17	96	113	1.43	0.519	6.60	0.000	SR	14	93.2	3.58	3.84	90	102	Bregma-lambda	AR	16	111.1	6.18	5.56	99	120	1.46	0.482	1.84 ¹	0.077	SR	14	115.7	7.46	6.44	105	132	Parietal subtense height	AR	16	31.1	3.54	11.38	22	37	1.46	0.499	3.98	0.001	SR	14	26.4	2.93	11.09	21	31	Bregma-parietal subtense	AR	16	60.3	4.25	7.04	55	68	1.71	0.321	1.03	0.313	SR	14	58.4	5.56	9.52	51	70	Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010	SR	14	65.4	5.40	8.25	56	76	Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59														
Basion-bregma	AR	16	140.6	5.55	3.94	133	151	1.24	0.708	3.37	0.002																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	134.1	4.99	3.72	123	141					Basion-nasion	AR	16	102.9	3.79	3.68	96	110	1.07	0.885	1.53	0.138	SR	14	100.7	3.93	3.90	95	107	Basion-nasospinale	AR	16	100.1	4.03	4.02	92	108	1.18	0.770	1.79	0.085	SR	14	97.6	3.71	3.80	90	106	Basion-prosthion	AR	11	105.8	4.29	4.05	100	113	1.16	0.783	1.90	0.071	SR	14	102.6	3.97	3.86	96	111	Basion-lambda	AR	16	122.7	8.67	7.06	102	131	1.28	0.666	4.33	0.000	SR	14	109.8	7.67	6.98	93	118	Basion-inion	AR	16	67.0	10.46	15.61	41	79	1.20	0.730	0.04 ¹	0.972	SR	14	67.1	11.46	17.07	29	77	Biauricular breadth	AR	16	122.3	5.99	4.89	113	133	1.44	0.519	2.08	0.047	SR	14	118.1	5.01	4.24	108	124	Bisphenion	AR	16	105.8	5.88	5.55	91	111	1.11	0.857	1.20	0.241	SR	14	103.3	3.04	2.94	96	118	Nasion-bregma	AR	16	118.9	3.98	3.34	111	126	1.89	0.257	5.96	0.000	SR	14	111.4	2.90	2.60	105	117	Frontal subtense height	AR	16	17.2	2.78	16.16	13	22	1.17	0.760	5.66 ¹	0.000	SR	14	23.2	3.02	13.01	19	29	Nasion-frontal subtense	AR	16	58.2	11.66	20.03	41	83	1.17	0.781	2.78	0.010	SR	14	46.8	10.76	22.99	10	53	Opisthion-lambda	AR	16	102.7	4.29	4.17	96	113	1.43	0.519	6.60	0.000	SR	14	93.2	3.58	3.84	90	102	Bregma-lambda	AR	16	111.1	6.18	5.56	99	120	1.46	0.482	1.84 ¹	0.077	SR	14	115.7	7.46	6.44	105	132	Parietal subtense height	AR	16	31.1	3.54	11.38	22	37	1.46	0.499	3.98	0.001	SR	14	26.4	2.93	11.09	21	31	Bregma-parietal subtense	AR	16	60.3	4.25	7.04	55	68	1.71	0.321	1.03	0.313	SR	14	58.4	5.56	9.52	51	70	Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010	SR	14	65.4	5.40	8.25	56	76	Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																	
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	SR	14	100.7	3.93	3.90	95	107					Basion-nasospinale	AR	16	100.1	4.03	4.02	92	108	1.18	0.770	1.79	0.085	SR	14	97.6	3.71	3.80	90	106	Basion-prosthion	AR	11	105.8	4.29	4.05	100	113	1.16	0.783	1.90	0.071	SR	14	102.6	3.97	3.86	96	111	Basion-lambda	AR	16	122.7	8.67	7.06	102	131	1.28	0.666	4.33	0.000	SR	14	109.8	7.67	6.98	93	118	Basion-inion	AR	16	67.0	10.46	15.61	41	79	1.20	0.730	0.04 ¹	0.972	SR	14	67.1	11.46	17.07	29	77	Biauricular breadth	AR	16	122.3	5.99	4.89	113	133	1.44	0.519	2.08	0.047	SR	14	118.1	5.01	4.24	108	124	Bisphenion	AR	16	105.8	5.88	5.55	91	111	1.11	0.857	1.20	0.241	SR	14	103.3	3.04	2.94	96	118	Nasion-bregma	AR	16	118.9	3.98	3.34	111	126	1.89	0.257	5.96	0.000	SR	14	111.4	2.90	2.60	105	117	Frontal subtense height	AR	16	17.2	2.78	16.16	13	22	1.17	0.760	5.66 ¹	0.000	SR	14	23.2	3.02	13.01	19	29	Nasion-frontal subtense	AR	16	58.2	11.66	20.03	41	83	1.17	0.781	2.78	0.010	SR	14	46.8	10.76	22.99	10	53	Opisthion-lambda	AR	16	102.7	4.29	4.17	96	113	1.43	0.519	6.60	0.000	SR	14	93.2	3.58	3.84	90	102	Bregma-lambda	AR	16	111.1	6.18	5.56	99	120	1.46	0.482	1.84 ¹	0.077	SR	14	115.7	7.46	6.44	105	132	Parietal subtense height	AR	16	31.1	3.54	11.38	22	37	1.46	0.499	3.98	0.001	SR	14	26.4	2.93	11.09	21	31	Bregma-parietal subtense	AR	16	60.3	4.25	7.04	55	68	1.71	0.321	1.03	0.313	SR	14	58.4	5.56	9.52	51	70	Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010	SR	14	65.4	5.40	8.25	56	76	Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																				
Basion-nasospinale	AR	16	100.1	4.03	4.02	92	108	1.18	0.770	1.79	0.085																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	97.6	3.71	3.80	90	106					Basion-prosthion	AR	11	105.8	4.29	4.05	100	113	1.16	0.783	1.90	0.071	SR	14	102.6	3.97	3.86	96	111	Basion-lambda	AR	16	122.7	8.67	7.06	102	131	1.28	0.666	4.33	0.000	SR	14	109.8	7.67	6.98	93	118	Basion-inion	AR	16	67.0	10.46	15.61	41	79	1.20	0.730	0.04 ¹	0.972	SR	14	67.1	11.46	17.07	29	77	Biauricular breadth	AR	16	122.3	5.99	4.89	113	133	1.44	0.519	2.08	0.047	SR	14	118.1	5.01	4.24	108	124	Bisphenion	AR	16	105.8	5.88	5.55	91	111	1.11	0.857	1.20	0.241	SR	14	103.3	3.04	2.94	96	118	Nasion-bregma	AR	16	118.9	3.98	3.34	111	126	1.89	0.257	5.96	0.000	SR	14	111.4	2.90	2.60	105	117	Frontal subtense height	AR	16	17.2	2.78	16.16	13	22	1.17	0.760	5.66 ¹	0.000	SR	14	23.2	3.02	13.01	19	29	Nasion-frontal subtense	AR	16	58.2	11.66	20.03	41	83	1.17	0.781	2.78	0.010	SR	14	46.8	10.76	22.99	10	53	Opisthion-lambda	AR	16	102.7	4.29	4.17	96	113	1.43	0.519	6.60	0.000	SR	14	93.2	3.58	3.84	90	102	Bregma-lambda	AR	16	111.1	6.18	5.56	99	120	1.46	0.482	1.84 ¹	0.077	SR	14	115.7	7.46	6.44	105	132	Parietal subtense height	AR	16	31.1	3.54	11.38	22	37	1.46	0.499	3.98	0.001	SR	14	26.4	2.93	11.09	21	31	Bregma-parietal subtense	AR	16	60.3	4.25	7.04	55	68	1.71	0.321	1.03	0.313	SR	14	58.4	5.56	9.52	51	70	Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010	SR	14	65.4	5.40	8.25	56	76	Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																																							
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	SR	14	102.6	3.97	3.86	96	111					Basion-lambda	AR	16	122.7	8.67	7.06	102	131	1.28	0.666	4.33	0.000	SR	14	109.8	7.67	6.98	93	118	Basion-inion	AR	16	67.0	10.46	15.61	41	79	1.20	0.730	0.04 ¹	0.972	SR	14	67.1	11.46	17.07	29	77	Biauricular breadth	AR	16	122.3	5.99	4.89	113	133	1.44	0.519	2.08	0.047	SR	14	118.1	5.01	4.24	108	124	Bisphenion	AR	16	105.8	5.88	5.55	91	111	1.11	0.857	1.20	0.241	SR	14	103.3	3.04	2.94	96	118	Nasion-bregma	AR	16	118.9	3.98	3.34	111	126	1.89	0.257	5.96	0.000	SR	14	111.4	2.90	2.60	105	117	Frontal subtense height	AR	16	17.2	2.78	16.16	13	22	1.17	0.760	5.66 ¹	0.000	SR	14	23.2	3.02	13.01	19	29	Nasion-frontal subtense	AR	16	58.2	11.66	20.03	41	83	1.17	0.781	2.78	0.010	SR	14	46.8	10.76	22.99	10	53	Opisthion-lambda	AR	16	102.7	4.29	4.17	96	113	1.43	0.519	6.60	0.000	SR	14	93.2	3.58	3.84	90	102	Bregma-lambda	AR	16	111.1	6.18	5.56	99	120	1.46	0.482	1.84 ¹	0.077	SR	14	115.7	7.46	6.44	105	132	Parietal subtense height	AR	16	31.1	3.54	11.38	22	37	1.46	0.499	3.98	0.001	SR	14	26.4	2.93	11.09	21	31	Bregma-parietal subtense	AR	16	60.3	4.25	7.04	55	68	1.71	0.321	1.03	0.313	SR	14	58.4	5.56	9.52	51	70	Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010	SR	14	65.4	5.40	8.25	56	76	Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																																																										
Basion-lambda	AR	16	122.7	8.67	7.06	102	131	1.28	0.666	4.33	0.000																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	109.8	7.67	6.98	93	118					Basion-inion	AR	16	67.0	10.46	15.61	41	79	1.20	0.730	0.04 ¹	0.972	SR	14	67.1	11.46	17.07	29	77	Biauricular breadth	AR	16	122.3	5.99	4.89	113	133	1.44	0.519	2.08	0.047	SR	14	118.1	5.01	4.24	108	124	Bisphenion	AR	16	105.8	5.88	5.55	91	111	1.11	0.857	1.20	0.241	SR	14	103.3	3.04	2.94	96	118	Nasion-bregma	AR	16	118.9	3.98	3.34	111	126	1.89	0.257	5.96	0.000	SR	14	111.4	2.90	2.60	105	117	Frontal subtense height	AR	16	17.2	2.78	16.16	13	22	1.17	0.760	5.66 ¹	0.000	SR	14	23.2	3.02	13.01	19	29	Nasion-frontal subtense	AR	16	58.2	11.66	20.03	41	83	1.17	0.781	2.78	0.010	SR	14	46.8	10.76	22.99	10	53	Opisthion-lambda	AR	16	102.7	4.29	4.17	96	113	1.43	0.519	6.60	0.000	SR	14	93.2	3.58	3.84	90	102	Bregma-lambda	AR	16	111.1	6.18	5.56	99	120	1.46	0.482	1.84 ¹	0.077	SR	14	115.7	7.46	6.44	105	132	Parietal subtense height	AR	16	31.1	3.54	11.38	22	37	1.46	0.499	3.98	0.001	SR	14	26.4	2.93	11.09	21	31	Bregma-parietal subtense	AR	16	60.3	4.25	7.04	55	68	1.71	0.321	1.03	0.313	SR	14	58.4	5.56	9.52	51	70	Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010	SR	14	65.4	5.40	8.25	56	76	Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																																																																													
Basion-inion	AR	16	67.0	10.46	15.61	41	79	1.20	0.730	0.04 ¹	0.972																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	67.1	11.46	17.07	29	77					Biauricular breadth	AR	16	122.3	5.99	4.89	113	133	1.44	0.519	2.08	0.047	SR	14	118.1	5.01	4.24	108	124	Bisphenion	AR	16	105.8	5.88	5.55	91	111	1.11	0.857	1.20	0.241	SR	14	103.3	3.04	2.94	96	118	Nasion-bregma	AR	16	118.9	3.98	3.34	111	126	1.89	0.257	5.96	0.000	SR	14	111.4	2.90	2.60	105	117	Frontal subtense height	AR	16	17.2	2.78	16.16	13	22	1.17	0.760	5.66 ¹	0.000	SR	14	23.2	3.02	13.01	19	29	Nasion-frontal subtense	AR	16	58.2	11.66	20.03	41	83	1.17	0.781	2.78	0.010	SR	14	46.8	10.76	22.99	10	53	Opisthion-lambda	AR	16	102.7	4.29	4.17	96	113	1.43	0.519	6.60	0.000	SR	14	93.2	3.58	3.84	90	102	Bregma-lambda	AR	16	111.1	6.18	5.56	99	120	1.46	0.482	1.84 ¹	0.077	SR	14	115.7	7.46	6.44	105	132	Parietal subtense height	AR	16	31.1	3.54	11.38	22	37	1.46	0.499	3.98	0.001	SR	14	26.4	2.93	11.09	21	31	Bregma-parietal subtense	AR	16	60.3	4.25	7.04	55	68	1.71	0.321	1.03	0.313	SR	14	58.4	5.56	9.52	51	70	Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010	SR	14	65.4	5.40	8.25	56	76	Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																																																																																																
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	SR	14	118.1	5.01	4.24	108	124					Bisphenion	AR	16	105.8	5.88	5.55	91	111	1.11	0.857	1.20	0.241	SR	14	103.3	3.04	2.94	96	118	Nasion-bregma	AR	16	118.9	3.98	3.34	111	126	1.89	0.257	5.96	0.000	SR	14	111.4	2.90	2.60	105	117	Frontal subtense height	AR	16	17.2	2.78	16.16	13	22	1.17	0.760	5.66 ¹	0.000	SR	14	23.2	3.02	13.01	19	29	Nasion-frontal subtense	AR	16	58.2	11.66	20.03	41	83	1.17	0.781	2.78	0.010	SR	14	46.8	10.76	22.99	10	53	Opisthion-lambda	AR	16	102.7	4.29	4.17	96	113	1.43	0.519	6.60	0.000	SR	14	93.2	3.58	3.84	90	102	Bregma-lambda	AR	16	111.1	6.18	5.56	99	120	1.46	0.482	1.84 ¹	0.077	SR	14	115.7	7.46	6.44	105	132	Parietal subtense height	AR	16	31.1	3.54	11.38	22	37	1.46	0.499	3.98	0.001	SR	14	26.4	2.93	11.09	21	31	Bregma-parietal subtense	AR	16	60.3	4.25	7.04	55	68	1.71	0.321	1.03	0.313	SR	14	58.4	5.56	9.52	51	70	Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010	SR	14	65.4	5.40	8.25	56	76	Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																																																																																																																			
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Nasion-bregma	AR	16	118.9	3.98	3.34	111	126	1.89	0.257	5.96	0.000																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	111.4	2.90	2.60	105	117					Frontal subtense height	AR	16	17.2	2.78	16.16	13	22	1.17	0.760	5.66 ¹	0.000	SR	14	23.2	3.02	13.01	19	29	Nasion-frontal subtense	AR	16	58.2	11.66	20.03	41	83	1.17	0.781	2.78	0.010	SR	14	46.8	10.76	22.99	10	53	Opisthion-lambda	AR	16	102.7	4.29	4.17	96	113	1.43	0.519	6.60	0.000	SR	14	93.2	3.58	3.84	90	102	Bregma-lambda	AR	16	111.1	6.18	5.56	99	120	1.46	0.482	1.84 ¹	0.077	SR	14	115.7	7.46	6.44	105	132	Parietal subtense height	AR	16	31.1	3.54	11.38	22	37	1.46	0.499	3.98	0.001	SR	14	26.4	2.93	11.09	21	31	Bregma-parietal subtense	AR	16	60.3	4.25	7.04	55	68	1.71	0.321	1.03	0.313	SR	14	58.4	5.56	9.52	51	70	Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010	SR	14	65.4	5.40	8.25	56	76	Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																																																																																																																																																									
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	SR	14	93.2	3.58	3.84	90	102					Bregma-lambda	AR	16	111.1	6.18	5.56	99	120	1.46	0.482	1.84 ¹	0.077	SR	14	115.7	7.46	6.44	105	132	Parietal subtense height	AR	16	31.1	3.54	11.38	22	37	1.46	0.499	3.98	0.001	SR	14	26.4	2.93	11.09	21	31	Bregma-parietal subtense	AR	16	60.3	4.25	7.04	55	68	1.71	0.321	1.03	0.313	SR	14	58.4	5.56	9.52	51	70	Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010	SR	14	65.4	5.40	8.25	56	76	Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																																																																																																																																																																																																																		
Bregma-lambda	AR	16	111.1	6.18	5.56	99	120	1.46	0.482	1.84 ¹	0.077																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	115.7	7.46	6.44	105	132					Parietal subtense height	AR	16	31.1	3.54	11.38	22	37	1.46	0.499	3.98	0.001	SR	14	26.4	2.93	11.09	21	31	Bregma-parietal subtense	AR	16	60.3	4.25	7.04	55	68	1.71	0.321	1.03	0.313	SR	14	58.4	5.56	9.52	51	70	Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010	SR	14	65.4	5.40	8.25	56	76	Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																																																																																																																																																																																																																																					
Parietal subtense height	AR	16	31.1	3.54	11.38	22	37	1.46	0.499	3.98	0.001																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	26.4	2.93	11.09	21	31					Bregma-parietal subtense	AR	16	60.3	4.25	7.04	55	68	1.71	0.321	1.03	0.313	SR	14	58.4	5.56	9.52	51	70	Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010	SR	14	65.4	5.40	8.25	56	76	Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																																																																																																																																																																																																																																																								
Bregma-parietal subtense	AR	16	60.3	4.25	7.04	55	68	1.71	0.321	1.03	0.313																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	58.4	5.56	9.52	51	70					Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010	SR	14	65.4	5.40	8.25	56	76	Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																																																																																																																																																																																																																																																																											
Lambda-inion	AR	16	73.1	9.41	12.87	58	98	3.03	0.050 ²	2.82	0.010																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	65.4	5.40	8.25	56	76					Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026	SR	14	81.0	4.04	4.98	75	88	Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																																																																																																																																																																																																																																																																																														
Lambda-asterion	AR	16	85.5	6.28	7.34	75	96	2.42	0.117	2.36	0.026																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	81.0	4.04	4.98	75	88					Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019	SR	14	73.5	2.82	3.83	66	77	Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																																																																																																																																																																																																																																																																																																																	
Auriculare-opisthion	AR	16	76.8	4.24	5.52	69	85	2.25	0.149	2.50	0.019																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	73.5	2.82	3.83	66	77					Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008	SR	14	63.7	2.84	4.45	57	67	Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																																																																																																																																																																																																																																																																																																																																				
Auriculare-basion	AR	16	67.1	3.59	5.35	60	73	1.59	0.404	2.85	0.008																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	63.7	2.84	4.45	57	67					Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050	SR	14	53.6	3.25	6.06	49	59																																																																																																																																																																																																																																																																																																																																																																																							
Nasion-nasospinale	AR	16	55.9	2.60	4.65	50	59	1.56	0.410	2.06	0.050																																																																																																																																																																																																																																																																																																																																																																																																										
	SR	14	53.6	3.25	6.06	49	59																																																																																																																																																																																																																																																																																																																																																																																																														

Table 30 (continued)

Variable	Arawe/ Sepik River	n	\bar{x}	s	Coefficient of variation	Min.	Max.	Snedecor's variance F	Proba- bility	Student's t	Proba- bility																																																																																																																																																																																																																																																		
Nasion-prosthion	AR	12	71.5	4.60	6.43	65	82	1.33	0.621	0.96	0.346																																																																																																																																																																																																																																																		
	SR	14	69.9	3.99	5.70	64	77					Supraorbital breadth	AR	16	106.4	4.68	4.39	98	118	1.58	0.392	0.29 ¹	0.776	SR	14	107.0	5.88	5.49	96	116	Bizygion	AR	16	135.4	6.33	4.67	125	147	1.29	0.650	2.01	0.054	SR	14	131.0	5.56	4.24	123	143	Bizygomaxillare	AR	16	99.0	5.48	5.53	86	103	1.05	0.917	1.90	0.068	SR	14	95.1	5.62	5.91	90	109	Orbital height	AR	16	36.7	1.66	4.52	34	39	2.32	0.122	2.94	0.004	SR	14	34.4	2.53	7.35	29	37	Biectoconchion	AR	16	102.1	4.05	3.96	95	112	1.56	0.407	1.13	0.268	SR	14	100.2	5.06	5.05	91	108	Frontal arc	AR	16	128.6	5.24	4.07	120	138	1.77	0.308	2.07	0.048	SR	14	125.1	3.94	3.14	120	134	Parietal arc	AR	16	132.0	7.87	5.96	112	145	1.30	0.624	0.14	0.891	SR	14	131.6	8.97	6.81	118	151	Occipital arc	AR	16	113.5	4.56	4.01	106	123	1.57	0.403	2.06	0.050	SR	14	109.6	5.71	5.21	99	120	Frontal curvature index	AR	16	14.5	1.84	12.69	11	18	1.56	0.410	7.93	0.000	SR	14	20.9	2.27	10.86	17	26	Parietal curvature index	AR	16	28.8	3.12	10.83	22	33	3.18	0.049 ²	5.69	0.000	SR	14	22.9	1.73	7.55	20	27	Occipital curvature index	AR	16	19.2	3.32	17.29	13	24	1.87	0.253	4.36	0.000	SR	14	26.0	4.47	17.19	20	34	Gnathic index	AR	13	103.9	5.17	4.97	99	110	3.07	0.050 ²	1.19	0.213	SR	14	101.7	2.93	2.88	97	107	Foramen magnum- nasion ^o	AR	16	146.2	5.61	3.83	138	158	1.47	0.483	4.37	0.000	SR	14
Supraorbital breadth	AR	16	106.4	4.68	4.39	98	118	1.58	0.392	0.29 ¹	0.776																																																																																																																																																																																																																																																		
	SR	14	107.0	5.88	5.49	96	116					Bizygion	AR	16	135.4	6.33	4.67	125	147	1.29	0.650	2.01	0.054	SR	14	131.0	5.56	4.24	123	143	Bizygomaxillare	AR	16	99.0	5.48	5.53	86	103	1.05	0.917	1.90	0.068	SR	14	95.1	5.62	5.91	90	109	Orbital height	AR	16	36.7	1.66	4.52	34	39	2.32	0.122	2.94	0.004	SR	14	34.4	2.53	7.35	29	37	Biectoconchion	AR	16	102.1	4.05	3.96	95	112	1.56	0.407	1.13	0.268	SR	14	100.2	5.06	5.05	91	108	Frontal arc	AR	16	128.6	5.24	4.07	120	138	1.77	0.308	2.07	0.048	SR	14	125.1	3.94	3.14	120	134	Parietal arc	AR	16	132.0	7.87	5.96	112	145	1.30	0.624	0.14	0.891	SR	14	131.6	8.97	6.81	118	151	Occipital arc	AR	16	113.5	4.56	4.01	106	123	1.57	0.403	2.06	0.050	SR	14	109.6	5.71	5.21	99	120	Frontal curvature index	AR	16	14.5	1.84	12.69	11	18	1.56	0.410	7.93	0.000	SR	14	20.9	2.27	10.86	17	26	Parietal curvature index	AR	16	28.8	3.12	10.83	22	33	3.18	0.049 ²	5.69	0.000	SR	14	22.9	1.73	7.55	20	27	Occipital curvature index	AR	16	19.2	3.32	17.29	13	24	1.87	0.253	4.36	0.000	SR	14	26.0	4.47	17.19	20	34	Gnathic index	AR	13	103.9	5.17	4.97	99	110	3.07	0.050 ²	1.19	0.213	SR	14	101.7	2.93	2.88	97	107	Foramen magnum- nasion ^o	AR	16	146.2	5.61	3.83	138	158	1.47	0.483	4.37	0.000	SR	14	155.4	4.58	2.94	148	161														
Bizygion	AR	16	135.4	6.33	4.67	125	147	1.29	0.650	2.01	0.054																																																																																																																																																																																																																																																		
	SR	14	131.0	5.56	4.24	123	143					Bizygomaxillare	AR	16	99.0	5.48	5.53	86	103	1.05	0.917	1.90	0.068	SR	14	95.1	5.62	5.91	90	109	Orbital height	AR	16	36.7	1.66	4.52	34	39	2.32	0.122	2.94	0.004	SR	14	34.4	2.53	7.35	29	37	Biectoconchion	AR	16	102.1	4.05	3.96	95	112	1.56	0.407	1.13	0.268	SR	14	100.2	5.06	5.05	91	108	Frontal arc	AR	16	128.6	5.24	4.07	120	138	1.77	0.308	2.07	0.048	SR	14	125.1	3.94	3.14	120	134	Parietal arc	AR	16	132.0	7.87	5.96	112	145	1.30	0.624	0.14	0.891	SR	14	131.6	8.97	6.81	118	151	Occipital arc	AR	16	113.5	4.56	4.01	106	123	1.57	0.403	2.06	0.050	SR	14	109.6	5.71	5.21	99	120	Frontal curvature index	AR	16	14.5	1.84	12.69	11	18	1.56	0.410	7.93	0.000	SR	14	20.9	2.27	10.86	17	26	Parietal curvature index	AR	16	28.8	3.12	10.83	22	33	3.18	0.049 ²	5.69	0.000	SR	14	22.9	1.73	7.55	20	27	Occipital curvature index	AR	16	19.2	3.32	17.29	13	24	1.87	0.253	4.36	0.000	SR	14	26.0	4.47	17.19	20	34	Gnathic index	AR	13	103.9	5.17	4.97	99	110	3.07	0.050 ²	1.19	0.213	SR	14	101.7	2.93	2.88	97	107	Foramen magnum- nasion ^o	AR	16	146.2	5.61	3.83	138	158	1.47	0.483	4.37	0.000	SR	14	155.4	4.58	2.94	148	161																																	
Bizygomaxillare	AR	16	99.0	5.48	5.53	86	103	1.05	0.917	1.90	0.068																																																																																																																																																																																																																																																		
	SR	14	95.1	5.62	5.91	90	109					Orbital height	AR	16	36.7	1.66	4.52	34	39	2.32	0.122	2.94	0.004	SR	14	34.4	2.53	7.35	29	37	Biectoconchion	AR	16	102.1	4.05	3.96	95	112	1.56	0.407	1.13	0.268	SR	14	100.2	5.06	5.05	91	108	Frontal arc	AR	16	128.6	5.24	4.07	120	138	1.77	0.308	2.07	0.048	SR	14	125.1	3.94	3.14	120	134	Parietal arc	AR	16	132.0	7.87	5.96	112	145	1.30	0.624	0.14	0.891	SR	14	131.6	8.97	6.81	118	151	Occipital arc	AR	16	113.5	4.56	4.01	106	123	1.57	0.403	2.06	0.050	SR	14	109.6	5.71	5.21	99	120	Frontal curvature index	AR	16	14.5	1.84	12.69	11	18	1.56	0.410	7.93	0.000	SR	14	20.9	2.27	10.86	17	26	Parietal curvature index	AR	16	28.8	3.12	10.83	22	33	3.18	0.049 ²	5.69	0.000	SR	14	22.9	1.73	7.55	20	27	Occipital curvature index	AR	16	19.2	3.32	17.29	13	24	1.87	0.253	4.36	0.000	SR	14	26.0	4.47	17.19	20	34	Gnathic index	AR	13	103.9	5.17	4.97	99	110	3.07	0.050 ²	1.19	0.213	SR	14	101.7	2.93	2.88	97	107	Foramen magnum- nasion ^o	AR	16	146.2	5.61	3.83	138	158	1.47	0.483	4.37	0.000	SR	14	155.4	4.58	2.94	148	161																																																				
Orbital height	AR	16	36.7	1.66	4.52	34	39	2.32	0.122	2.94	0.004																																																																																																																																																																																																																																																		
	SR	14	34.4	2.53	7.35	29	37					Biectoconchion	AR	16	102.1	4.05	3.96	95	112	1.56	0.407	1.13	0.268	SR	14	100.2	5.06	5.05	91	108	Frontal arc	AR	16	128.6	5.24	4.07	120	138	1.77	0.308	2.07	0.048	SR	14	125.1	3.94	3.14	120	134	Parietal arc	AR	16	132.0	7.87	5.96	112	145	1.30	0.624	0.14	0.891	SR	14	131.6	8.97	6.81	118	151	Occipital arc	AR	16	113.5	4.56	4.01	106	123	1.57	0.403	2.06	0.050	SR	14	109.6	5.71	5.21	99	120	Frontal curvature index	AR	16	14.5	1.84	12.69	11	18	1.56	0.410	7.93	0.000	SR	14	20.9	2.27	10.86	17	26	Parietal curvature index	AR	16	28.8	3.12	10.83	22	33	3.18	0.049 ²	5.69	0.000	SR	14	22.9	1.73	7.55	20	27	Occipital curvature index	AR	16	19.2	3.32	17.29	13	24	1.87	0.253	4.36	0.000	SR	14	26.0	4.47	17.19	20	34	Gnathic index	AR	13	103.9	5.17	4.97	99	110	3.07	0.050 ²	1.19	0.213	SR	14	101.7	2.93	2.88	97	107	Foramen magnum- nasion ^o	AR	16	146.2	5.61	3.83	138	158	1.47	0.483	4.37	0.000	SR	14	155.4	4.58	2.94	148	161																																																																							
Biectoconchion	AR	16	102.1	4.05	3.96	95	112	1.56	0.407	1.13	0.268																																																																																																																																																																																																																																																		
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1 Sepik River mean value larger than that for the Arawe

2 Significant F value, Student's t calculated using separate variance estimate

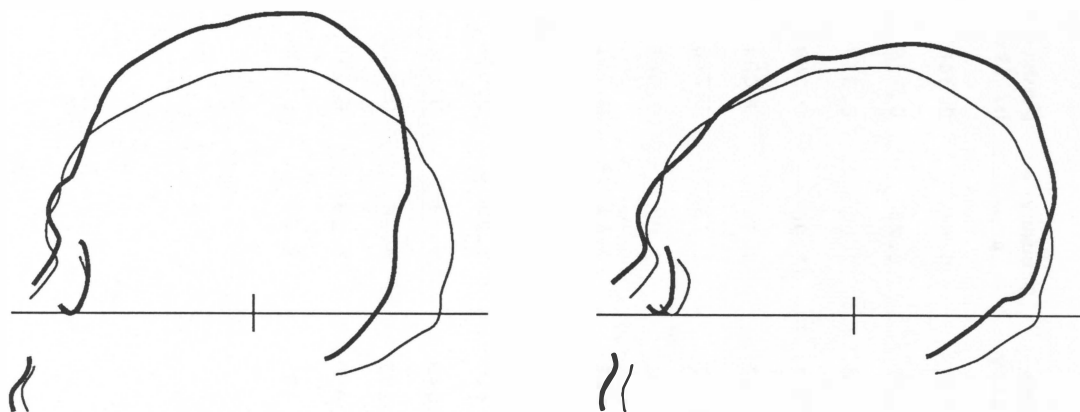


Figure 29 Midline cranial contours of two artificially deformed male Arawe (heavy lines) and an undeformed Tolai male from the Sepik River, northern New Britain

bone become more similar and the frontal subtense height decreases. However, the variable nature of the deformation process (pressure with which the bandages are applied and time period over which the process is continued) produces cranial vaults which are also varied in their morphological and metrical characteristics. For the Arawe males this has produced greater dispersion about the regression line, and a number of clear outliers, in the plot of frontal chord length (nasion-bregma) and subtense height.

Magitot (1885) found that artificially deformed European crania were often distinguished by a marked prebregmatic bulge, or eminence, and a series of lateral depressions bordering the midline, halfway between nasion and bregma. Marked prebregmatic eminences are present in four of the Arawe male crania, with slight bulges in five others. Lateral depressions bordering the midline, sometimes two on each side, are well developed in seven of the males. These features are not present in the Sepik River crania. With head-binding the depth of the postorbital ophryonic groove appears to be slightly increased, giving a superficial impression of a frontal torus in the more robust males. A large glabella, relative to other Melanesian populations, is a feature of male crania from New Britain (Bonin 1936) and this persists in the deformed crania. There is no apparent change in the size of the superciliary ridges with deformation.

Larnach (1974) demonstrated that in artificially deformed crania, pressure on the frontal resulted in an increase of curvature in the parietals. This change can be measured through the parietal curvature index. For this index the parietal chord (straight-line distance from bregma to lambda) and the parietal subtense

(maximum perpendicular distance from the parietal chord to the maximum projection of the parietal curvature) are measured with coordinate calipers. Larnach found that the mean parietal curvature index of his deformed series was significantly higher than that for undeformed crania and there was no overlap in range. He argued that this index could therefore be used to distinguish between deformed and undeformed crania. Although in this study the mean parietal curvature index of the Arawe is significantly higher than the Sepik River males ($P = .000$), thus supporting Larnach's general conclusions, there is considerable overlap in range for this index (Fig.31). The parietal curvature index remains an excellent indicator of artificial deformation but it cannot be used as the sole discriminator. The increased anteroposterior curvature of the parietals results in a marked reduction in parietal chord length (bregma-lambda), while the parietal arc dimension does not appear to be affected. Variation in the parietal curvature index is greater in the Arawe, than in the Sepik River series, with a significant value for Snedecor's F ($P = .049$).

Goldstein (1940) noted that, apparently as a result of concurrent frontal and occipital flattening, a saddle-like depression often occurred in the anterior third of the parietal bones, beginning just behind bregma. Parietal saddles were present in eight of the 16 Arawe male crania, with the maximum depth of the depression reaching 4 mm. Parietal saddles were not present in any of the undeformed crania, from either Melanesia or Australia.

Pressure on the sides of the vault during head-binding results in a lateral constriction of the Arawe parietals, with a reduction of maximum biparietal breadth. The lateral constriction

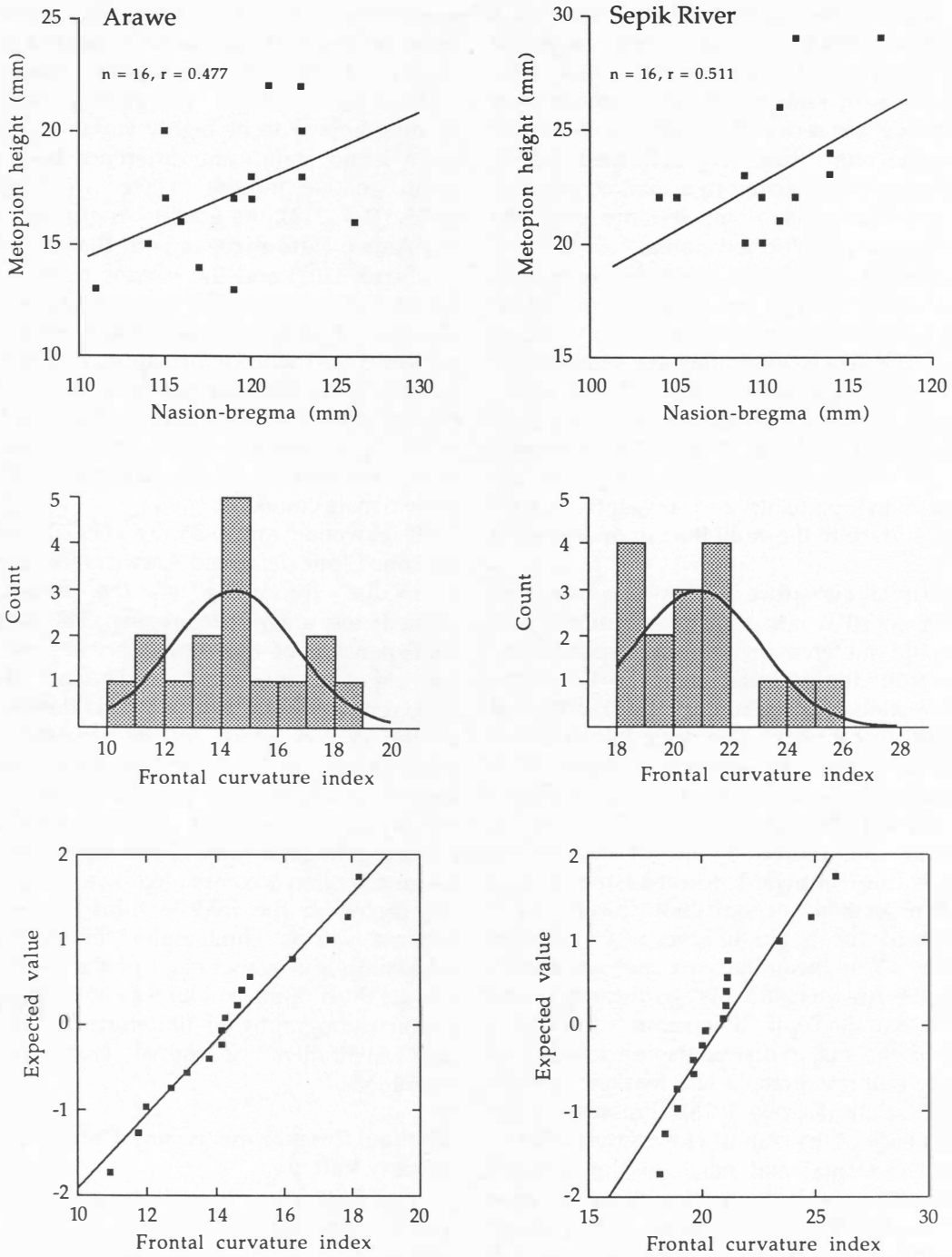


Figure 30 Scatterplots, histograms and normal probability plots of frontal length and curvature measures in male crania from Arawe and the Sepik River

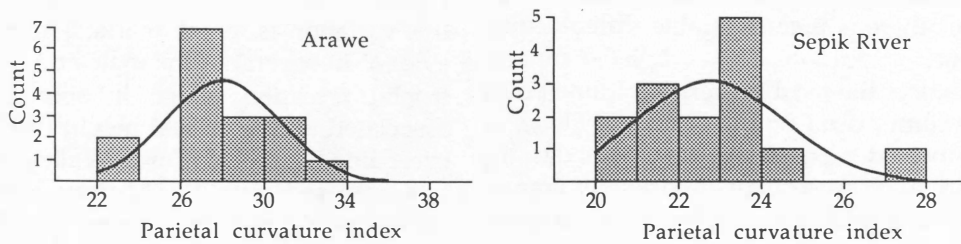


Figure 31 Distribution of parietal curvature indices in male crania from Arawe and the Sepik River

of the Arawe vaults, producing a somewhat conical neurocranium, does not extend far below the temporoparietal suture, with mean bi-auricular breadth being significantly greater than in the Sepik River series ($P = .047$) (Table 30). In some of the more extremely deformed Arawe crania the parietals narrow to a marked point at vertex and vertex has a much more posterior location than in undeformed crania.

As with the frontal and parietals, changes in occipital morphology resulting from head-binding are most evident in lateral aspect (Fig.29). The Arawe occipitals are significantly longer (opisthion-lambda, $P = .000$) and flatter than those in the undeformed series, with little evidence of an occipital bun. The deformed occipitals give the impression of being pushed up and under the parietals and present a flatter posterior surface to the vault than in undeformed crania.

An occipital curvature index was constructed using the chord length (opisthion-lambda) and the occipital subtense (maximum perpendicular distance from the occipital chord to the maximum projection of occipital curvature) measured by coordinate calipers. The occipital curvature index of the Arawe is significantly lower ($P = .000$) than in the Sepik River crania, with only a slight overlap in range (Table 30). With deformation the posterior edge of the *foramen magnum* is drawn upwards toward lambda. The upward movement of opisthion results in a reduction of the angle linking nasion-basion-opisthion. The mean *foramen magnum*-nasion angle in the Arawe (146.2°) is significantly lower ($P = .000$) than the Sepik River mean (155.4°).

One of the major distinguishing features of artificially deformed crania is a marked increase in cranial height (Kiszely 1978). Pressure on the front and back of the cranium forces the posterior third of the frontal and much of the parietals upwards. This results in the elevation of bregma and vertex (Fig.29). Arawe mean cranial height (basion-bregma) is significantly greater ($P = .002$) than that in the undeformed Sepik River crania (Table 30).

Mean maximum cranial length (glabella-opisthocranion) is not significantly greater in the Arawe, but there is a considerable difference in the mean location of opisthocranion. Opisthocranion, the most posterior midline point on the cranium, based on the Frankfurt Plane, is usually located posterior to lambda in Melanesian and Australian Aboriginal crania, especially those with a well developed occipital bun. In the Arawe the flattening of the occipital bone, combined with the upward and backward

movement of the parietals, results in opisthocranion being placed at lambda or up to 20 mm in front of it on the sagittal suture.

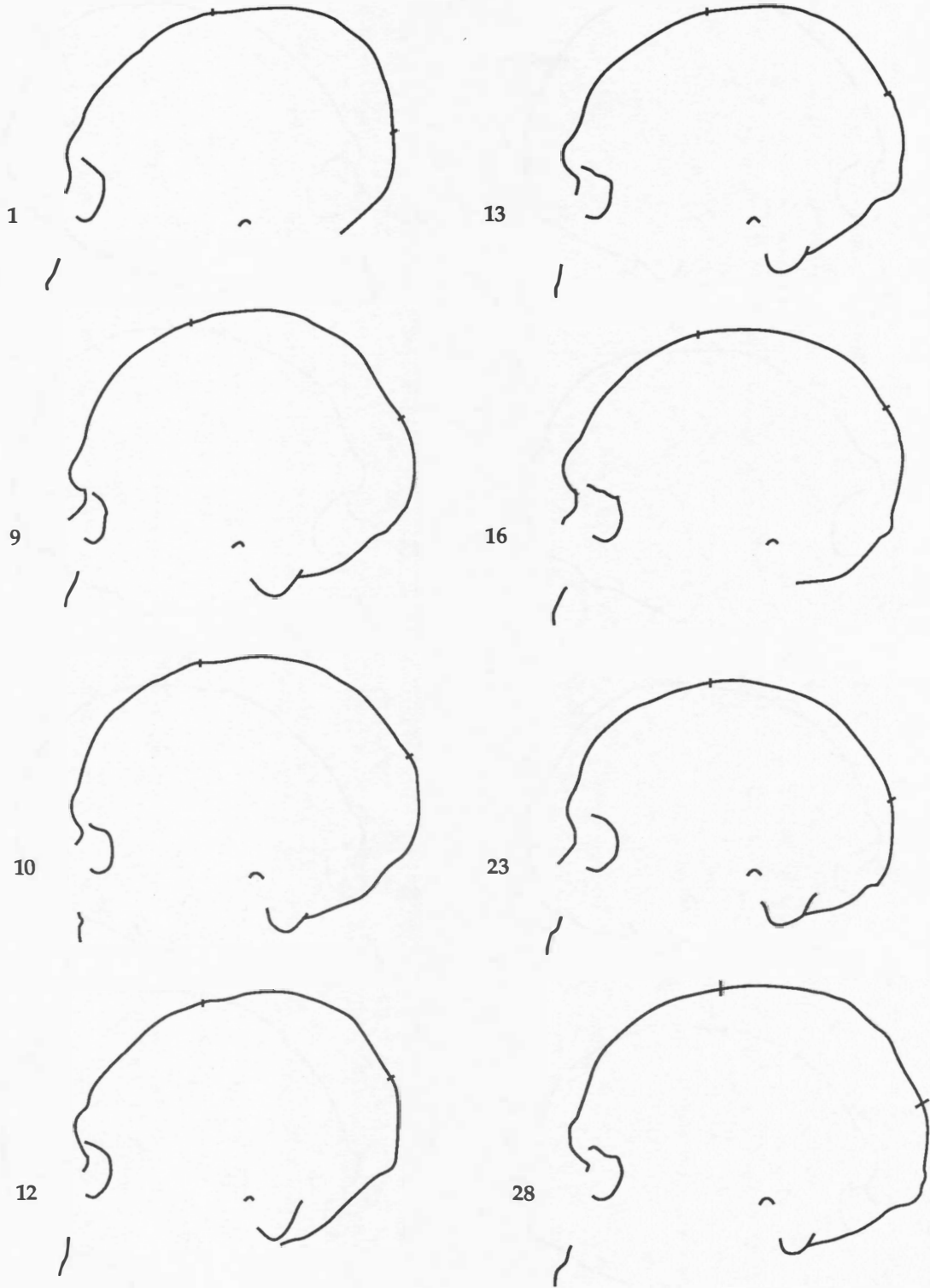
Changes in facial morphology with head-binding appear to be highly variable. Although there is no significant difference between the mean gnathic indices of the two Melanesian series ($P = .213$), the maximum gnathic index of the Arawe (116) exceeds both that recorded for the Sepik (107) and the maximum recorded for Aboriginal crania (112). There are no significant changes of facial breadth (supraorbital or bi-ectoconchion) with deformation, but there is an apparent increase in upper facial height (nasion-nasospinale, $P = .050$) and orbital height ($P = .004$). The upper margins of the orbits were noticeably displaced posteriorly in eight of the Arawe male crania.

Blackwood and Danby (1955) sagittally sectioned four deformed Arawe crania and noted a medial thickening of the frontal bone immediately anterior to bregma. This was due to an expansion of the diploë, accompanied by a bulging of the outer table of the vault; the inner table remaining undisturbed. It is this expansion of the diploë which, in its maximum form, corresponds to the prebregmatic eminence. Lateral radiographs of the Arawe crania displayed the variable development of this feature. An expansion of the diploë anterior of bregma is often accompanied by a constriction of the diploë in the middle third of the frontal squama. This combination of prebregmatic thickening and constriction of the diploë in the middle third of the frontal was not present in the lateral radiographs of undeformed Melanesian and Australian Aboriginal crania which I examined.

Coobool Creek, Kow Swamp-Cohuna and Murray Valley

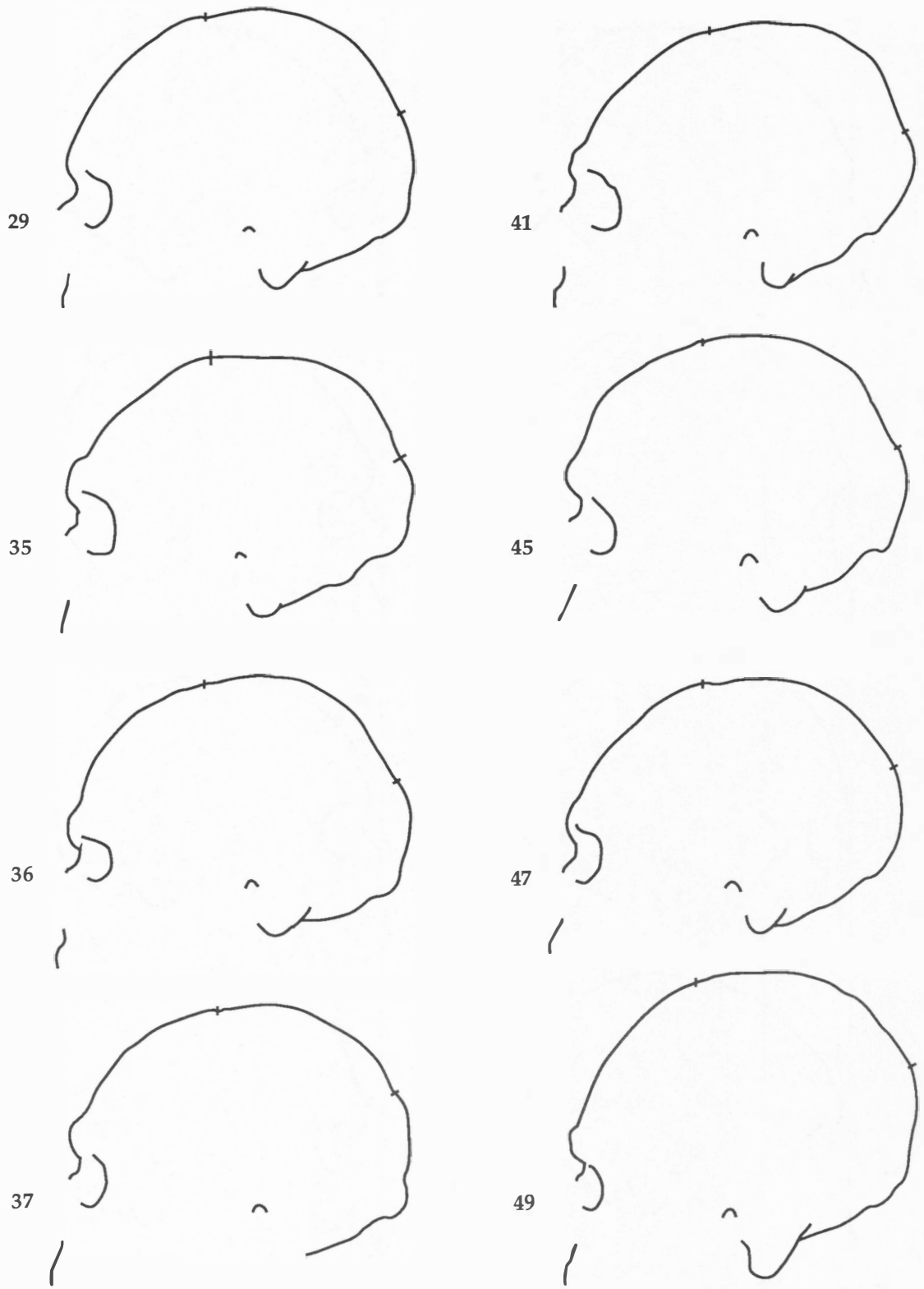
Descriptive and comparative statistical data for the Aboriginal samples can be found in Tables 4-5 and 8. Compared to the Murray Valley series, the Coobool Creek crania are characterised by significantly larger mean cranial dimensions and extreme morphological variation (Table 8, Figs 32-34). The most striking aspect of this variation is in the marked frontal recession evident in several of the male and female crania, frontal recession which in some instances is associated with a cranial height (basion-bregma) exceeding the recent Murray Valley range.

Compared with the Murray Valley frontals, the Coobool Creek frontals are greatly elongated and flattened. Both the mean frontal chord (nasion-bregma) and frontal arc length of the



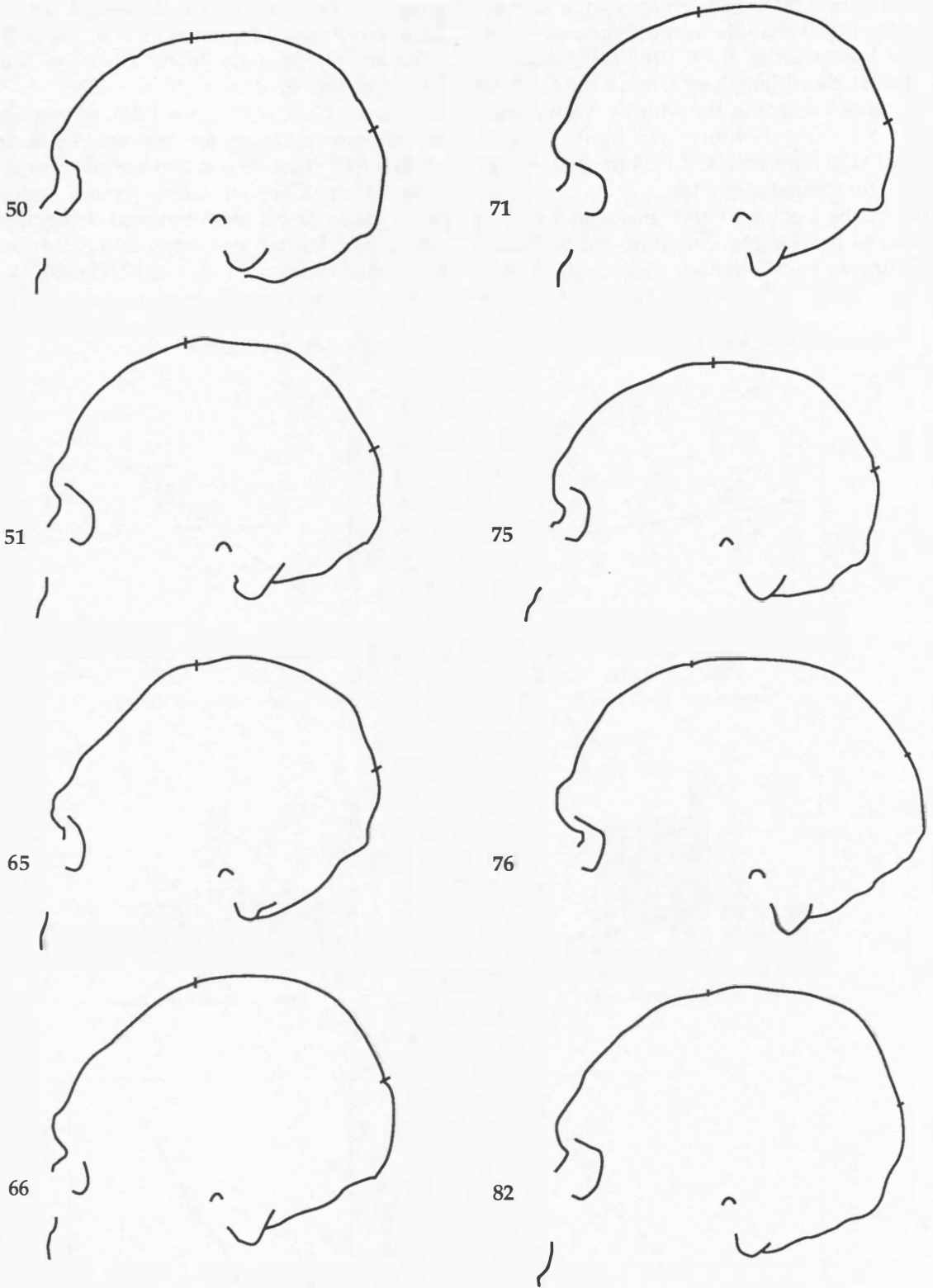
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Figure 32 Lateral profiles of Coobool Creek crania 1-28



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Figure 33 Lateral profiles of Coobool Creek crania 29-49



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Figure 34 Lateral profiles of Coobool Creek crania 50-82

Coobool Creek male and female crania are significantly longer than the respective sexes in the Murray Valley series ($P = .016-.000$) (Table 8). The frontal chord length of nine of the Coobool Creek males exceeding the Murray Valley male range. Similarly, Cohuna (126 mm), N1 (134 mm), N2 (126 mm) and KS7 (124 mm) also have particularly elongated frontals.

Ten of the Coobool Creek males and five of the females have frontal curvature indices below the Murray Valley range (males 20-26 and females 20-28). The mean frontal curvature

indices of the Coobool Creek sample (male $n = 22$, $\bar{x} = 19.7$, $s = 3.19$; female $n = 9$, $\bar{x} = 20.0$, $s = 3.28$) are significantly lower than the Murray Valley means (male $n = 47$, $\bar{x} = 22.6$, $s = 1.56$; female $n = 52$, $\bar{x} = 23.4$, $s = 1.84$), with a significant difference in variance indicated by Bartlett's χ^2 (Table 8). Histograms and normal probability plots of the Coobool Creek frontal curvature index data reveal distributional irregularities, with a long left tail and a gap in the distribution at a frontal curvature index of 17 (Fig.35). A plot of frontal chord length (nasion-bregma) against

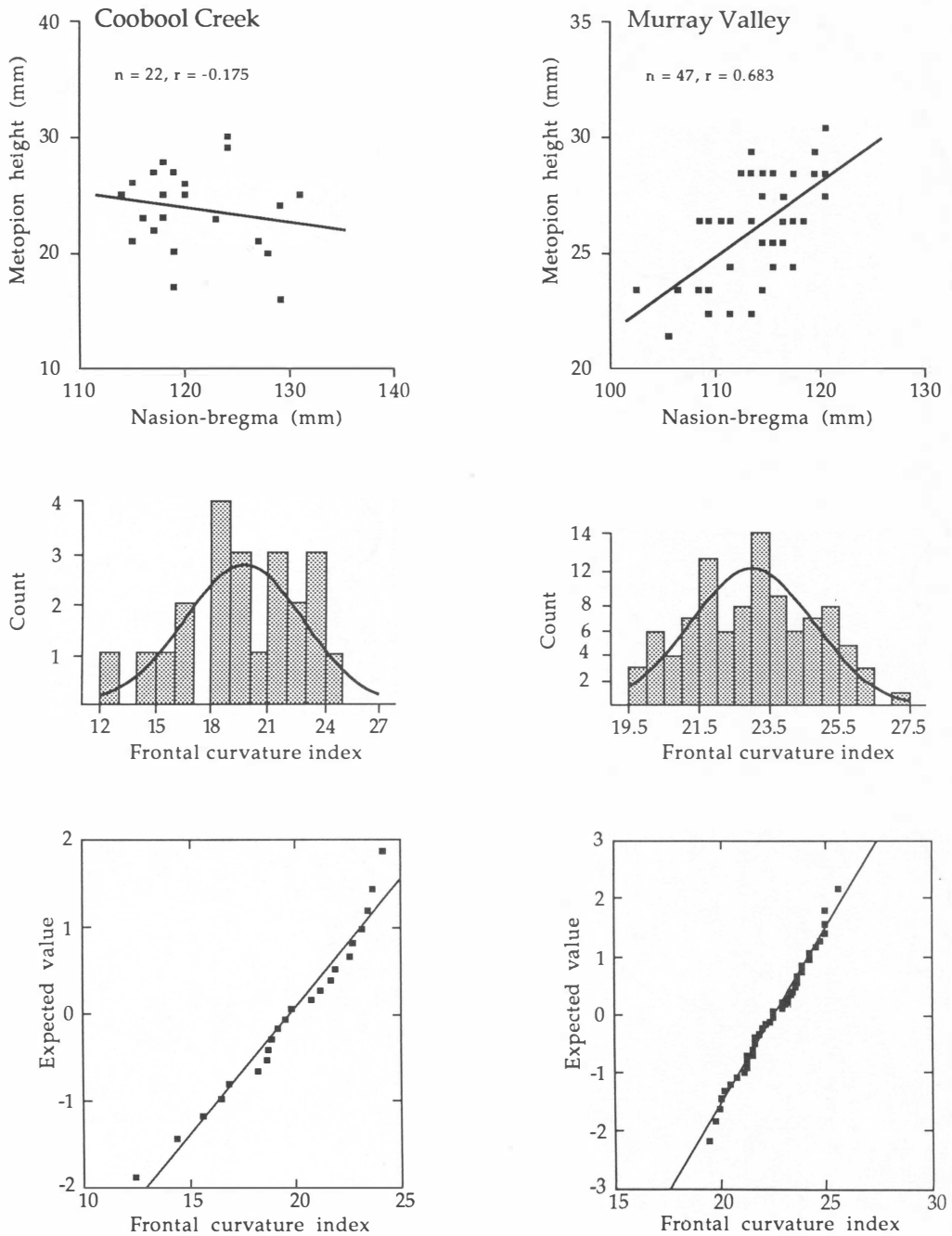


Figure 35 Scatterplots, histograms and normal probability plots of frontal length and curvature measures in male crania from Coobool Creek and the Murray Valley

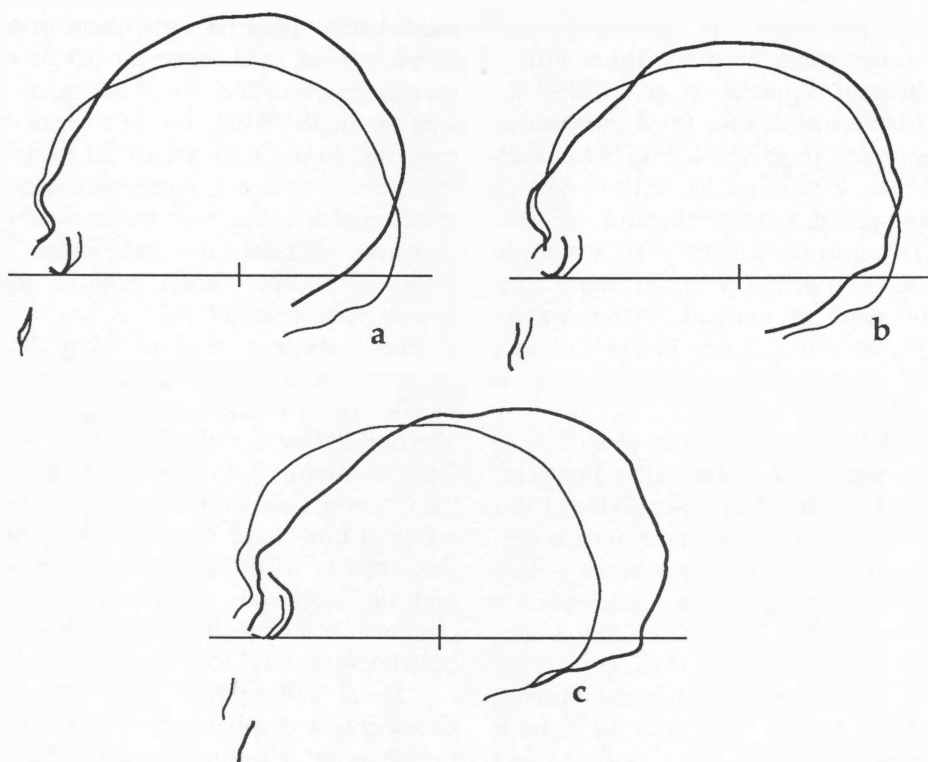


Figure 36 Midline cranial contours of Kow Swamp 5 (a), Coobool Creek 65 (b) and Nacurrie 1 (c), compared with a recent Murray Valley male (light line)

its subtense height (metopion) in the Murray Valley males, indicates a fairly linear association ($r = 0.683$) (Fig.35). As the length of the frontal increases there is a corresponding increase in subtense height. In the Coobool Creek crania the regularity of this association is lost ($r = -0.175$) and the points are widely dispersed about a regression line with a slightly negative slope. The distribution of the Coobool Creek data in Table 4 differs from that of the Arawe in Table 30. The Arawe share a matrix of morphological and metrical features which are consistent with each of the crania being artificially deformed. As a group they are far more uniform than the Coobool Creek sample and this is reflected in the reduced level of variation for their cranial dimensions and the indices which have been calculated from them. The extremely high level of variation in the Coobool Creek frontal curvature indices and length dimensions is consistent with a sample containing both artificially deformed and normal crania.

In the most extreme example of frontal flattening at Coobool Creek (CC65:Plate 6) the frontal is slightly concave in its middle third, with no evidence of a frontal boss and a prominent prebregmatic eminence. In this individual metopion is located only 47 mm in front of bregma. The frontals of N1 and 2, KS5

and 7 and Cohuna display similar flattening in their middle thirds, with a posterior location of metopion in N1 and 2, KS7 and Cohuna (Fig.36). There are moderate prebregmatic eminences in CC29 and 35, N1, KS7 and Cohuna. Prebregmatic eminences are not present in any of the Murray Valley crania or the mid-Holocene series from Barham. Lateral depressions bordering the midline of the frontal are well developed in CC1 and 41, N1 and KS5, with a slight development of this feature in CC12, 47 and 82 (Plates 1, 2, 8).

Viewed laterally, the Coobool Creek parietals vary in curvature with greater variance, significant in relation to the Coobool Creek females, than the Murray Valley series (Tables 4-5, 8). The parietal curvature indices of CC1 (24.6), CC41 (23.2), CC65 (23.4), Cohuna (22.4), and N1 and 2 (23.6) are towards the top of the Murray Valley range (17-24). There is also a high degree of anteroposterior curvature in the parietals of KS5, however, as bregma is not preserved the parietal curvature index can not be recorded (Fig.36). The parietal curvature indices of these crania from Coobool Creek, Nacurrie and Cohuna all fall within the lower limit for the Arawe (22-33). Parietal curvature in the Coobool Creek crania does not approach the extremes of the Arawe, with no evidence of either a marked pointing of the parietals towards vertex or lateral constrict-

tion. However, the degree of anteroposterior curvature in some crania, in association with a flattened midfrontal squama, is not found in recent or mid-Holocene crania from the central Murray Valley region (Figs 32-34, 36). Both mean biparietal and biauricular breadth in the Coobool Creek males and females are significantly greater ($P = .000-.001$) than in the Murray Valley sample (Table 8). There is no evidence of the lateral constriction of the vault as evident in the Arawe. Parietal saddles are not present in the Coobool Creek or Kow Swamp crania but there is a distinctive saddle in N2.

Variation in the Coobool Creek occipitals is at a similar level to that for their frontal and parietal bones. The mean length (basion-lambda) of the Coobool Creek male and female occipitals is significantly greater than that for the Murray Valley series ($P = .000$) (Fig.23). There is a tendency for the occipital curvature indices to be lower (Coobool Creek males $n = 21$, $\bar{x} = 28.5$, $s = 3.50$; females $n = 5$, $\bar{x} = 24.5$, $s = 6.42$) than the Murray Valley males ($n = 40$, $\bar{x} = 29.3$, $s = 3.45$), with curvature indices of CC7 (13.4), CC41 (22.8) and CC65 (19.6) being below the Murray Valley range (24.0-37.0) (Tables 4-5). In CC65 the posterior third of the *foramen magnum* has been drawn upward towards lambda, presenting a similar appearance to that seen in some of the Arawe.

One of the major distinguishing features of the Coobool Creek series is a high mean cranial height (basion-bregma) (Fig.37). Mean cranial height in the Coobool Creek male and female crania is significantly greater ($P = .000$) than the Murray Valley (Table 8), with the Murray Valley male maximum of 143 mm being exceeded by six of the Coobool Creek males and five of the Coobool Creek females exceeding the Murray Valley female maximum of 137 mm. The maxi-

mum basion-bregma dimension in the Coobool Creek crania, 153 mm for CC5, exceeds the maximum recorded for Aboriginal crania (150 mm for male BB102, author's observation). The great height of CC65, 49, 45, N1 (estimated) and 2 and KS5 (estimated), combined with a flattened midfrontal squama, high parietal curvature index and low occipital curvature index, gives these crania a midline cranial contour similar to the Arawe mean (Figs 29, 36).

The mean cranial length (glabella-opisthocranion) of the Coobool Creek male and female crania is significantly greater than in the Murray Valley series ($P = .002-.000$) (Table 8). Opisthocranion is located well below lambda in the Coobool Creek crania with either a prominent occipital bun or pronounced occipital torus. In those crania with high parietal curvature indices and flat occipitals (CC1, 49 and 65) opisthocranion is located at lambda. In KS5 opisthocranion is located just below lambda.

Lateral radiographs taken of the Coobool Creek crania display a marked thickening of the diploë anterior to bregma in the frontals of CC1, 29, 49 and 65. In CC65 it is this expansion of the diploë which results in a well developed pre-bregmatic eminence, with a maximum vault thickness of 14.1 mm at this point (measured directly as compared with the 12.1 mm obtained radiographically in Brown 1982:206). In CC1 and 65, as well as in KS5 and 7, Cohuna and N1, this posterior thickening of the diploë is preceded by a constriction of the diploë in the middle third of the frontal.

The distribution of the craniometric variables (modules and indices excluded) in the Coobool Creek and Murray Valley male samples was compared with that of a normal distribution using normal probability plots and the Shapiro-

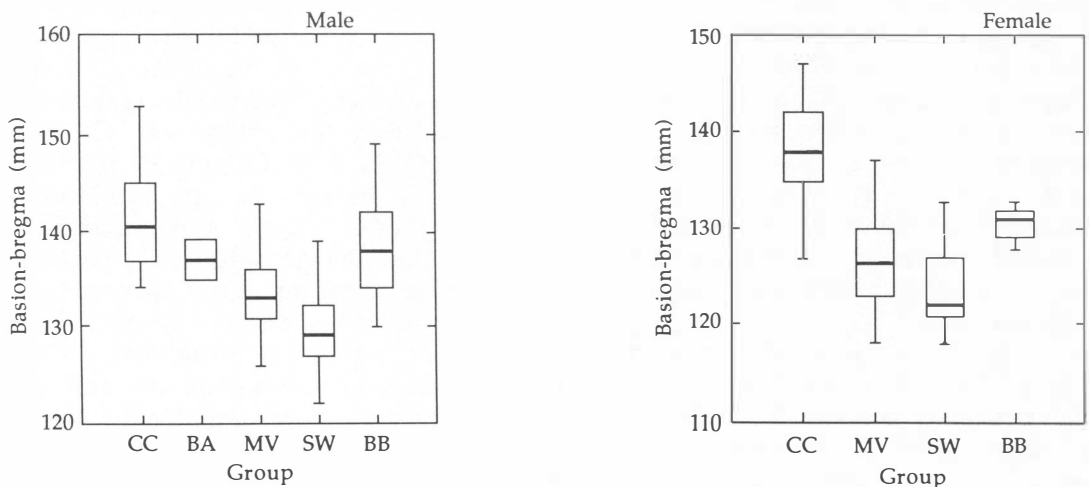


Figure 37 Box plots of cranial height (basion-bregma) dimensions in male and female Aboriginal crania from Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

Wilk statistic (Tables 4-5). Five cranial variables in the Murray Valley sample and 11 in the Coobool Creek series obtained significant values for W ($P = .01-.005$). Two variables, opisthion-lambda and basion-asterion, displayed non-normal distributions in both samples. Variables with distributional abnormalities in the Coobool Creek sample were length and breadth dimensions of the occipital (basion-inion, biasterion, lambda-opisthion, and lambda-inion), frontal length (glabella-bregma, nasion-bregma), cranial breadth (biauricular, biasterion, bisphenion) and the arc length of the parietal bones. Normal probability plots of the raw data (Fig.38) indicated that departures from normality were primarily associated with either bimodal distributions, or extended distributions with a number of outliers. One variable, basion-inion, is markedly leptokurtic with a sharp peak at the middle of the distribution and extended tails.

Levels of variation in the Coobool Creek male and female samples for the length and curvature dimensions of the frontal, parietal and occipital

bones, as signified by their coefficients of variation, are greater than those in the Murray Valley sample (Tables 4-5). Bartlett's M and its associated χ^2 test revealed that variation in frontal subtense height, inion-opisthion (males and females), parietal subtense height (females), frontal curvature index (males and females) and parietal curvature index (males) is significantly greater at Coobool Creek than in the Murray Valley (Table 8). The high levels of variation in these dimensions at Coobool Creek, combined with their unusual distributions, are what would be expected of a sample containing both artificially deformed and undeformed crania. Unfortunately, in common with the Arawe-Sepik River comparison, no single dimension or index clearly separates the Coobool Creek series into two discrete distributions one of which is clearly deformed, the other which is not. The morphometric extremes are easily identified by eye but the fairly evenly graduated series linking these extremes is much more difficult to allocate to either group.

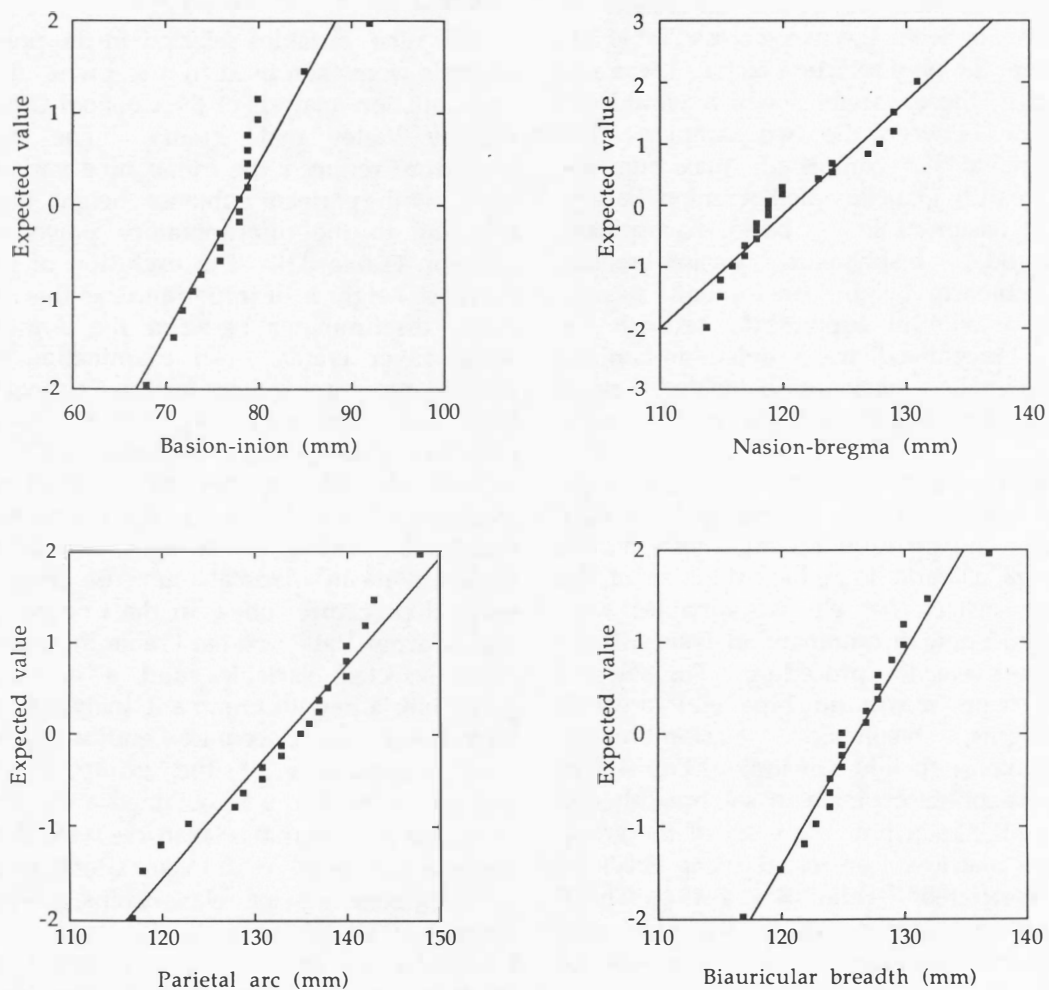


Figure 38 Normal probability plots of variables with non-normal distributions in male crania from Coobool Creek

DISCRIMINANT ANALYSIS

Arawe and Sepik River

The main aim of the discriminant analysis was data reduction, to isolate those variables which best discriminate between the deformed Arawe and undeformed Sepik River crania. The stepwise procedure of the discriminant analysis sought to maximise the Mahalanobis distance (D^2) between the two groups. A variable was considered for selection only if its partial multivariate F ratio was larger than a specified value. The partial F ratio measures the discrimination introduced by the variable after taking into account the discrimination achieved by the other selected variables. If the partial F is too small, the variable is rejected. This stepwise procedure results in the optimal set of discriminating variables (Nie *et al.* 1975:448).

For the initial discriminant run 18 variables were selected. These variables covered three general anatomical regions: the face, the cranial base and the vault. Although the majority of these variables had significant differences in mean values between the two groups (Table 30), this was not the only selection factor. I was also interested in those variables which would not discriminate between the two samples. The initial variable list comprised: maximum biparietal breadth, glabella-opisthocranium, basion-bregma, basion-nasion, basion-nasospinale, basion-lambda, bisphenion, nasion-bregma, frontal subtense height (metopion), nasion-metopion, maximum supraorbital breadth, bizygion, bizygomaxillare, opisthion-lambda, lambda-bregma, nasion-nasospinale, nasal breadth, orbital height and parietal subtense height.

The stepwise selection procedure reduced the initial 18 variables to nine in the final function. To ensure valid probabilities for F tests, Wilk's Lambda, χ^2 , D^2 and to reduce the size of the covariance matrix the selected variables were entered into a new discriminant analysis without the stepwise selection procedure. The selected variables were maximum biparietal breadth, basion-bregma, bisphenion, nasion-bregma, frontal subtense height (metopion), opisthion-lambda, nasion-nasospinale, nasal breadth and parietal subtense height. Equality of the group covariance matrices was tested using Box's M and its associated F ratio (Box 1949). The F statistic was not significant at the 0.05 level, so it can be assumed that the covariance matrices are similar (Table 31).

Table 32 lists the standardised coefficients for the nine discriminating variables. These reveal

that parietal subtense height was the best single discriminator, followed by opisthion-lambda and nasion-bregma. The remaining six variables were less important. This is in agreement with the univariate results, which demonstrate that parietal curvature and the length of the frontal bone are good discriminators between deformed and undeformed crania. The discriminant function correctly classified 100% of both groups, with a wide separation of the group centroids, large eigenvalue and small Wilk's Lambda (Fig.39, Table 33).

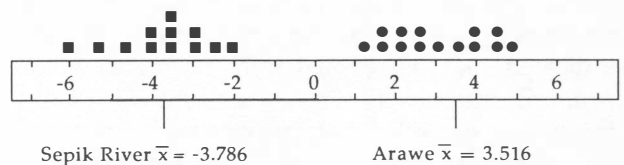


Figure 39 Canonical discriminant function score distribution for male crania from Arawe and the Sepik River

Coobool Creek and Murray Valley

The nine variables selected in the preceding analysis were then used in a stepwise discriminant function analysis of the Coobool Creek and Murray Valley male crania. The stepwise procedure reduced the initial nine variables to eight, with parietal subtense height not contributing to the discriminatory power of the function (Table 32). The exclusion of parietal subtense height is of importance, as this was the major discriminator between the Arawe and Sepik River crania. An examination of the parietal curvature indices for the Coobool Creek crania indicated that only two of the crania included in the discriminant analysis (CC41 and 65) had relatively high parietal curvature indices. In contrast to the Arawe-Sepik River comparison (Table 30) there is not a significant difference between mean parietal subtense height, or parietal curvature index, in the Coobool Creek and Murray Valley crania (Table 8). Using the eight selected variables and a non-stepwise procedure a new discriminant analysis was performed to calculate accurate significance levels.

A comparison of the group covariance matrices using Box's M obtained a significant F level and the covariance matrices were therefore unequal (Table 31). A major alteration in the normal pattern of size relationships between the individual skeletal elements is evident in the Coobool Creek crania. This is reflected in high levels of variation, skewed distributions and low, or negative, correlations between some variables. These results differ from the homogeneity of

Table 31 Test of equality of group covariance matrices using Box's M

	Box's M	F statistic	Degrees of freedom	Probability
Arawe-Sepik River	0.7195	0.9609	45, 2026.8	0.5465
Coobool Creek-Murray Valley	0.9755	2.0320	36, 2100.7	0.0003
Arawe-Sepik River-Coobool Creek-Murray Valley	0.2666	1.4250	135, 5599.1	0.0010

Table 32 Standardised canonical discriminant function coefficients

	Sepik River-Arawe	Coobool Creek-Murray Valley
Biparietal breadth	-0.8397	-0.5013
Basion-bregma	-0.4896	-0.3612
Bisphenion	0.6283	0.3571
Nasion-bregma	1.1671	-0.2377
Frontal subtense height	-1.4912	0.4226
Opisthion-lambda	0.9833	-0.3454
Nasion-nasospinale	-0.3428	-0.3227
Nasal breadth	0.6165	-0.3227
Parietal subtense height	1.4134	-

Table 33 Eigenvalues, Wilk's Lambda and canonical correlations for the three discriminant analyses

	Eigenvalue	Variance %	Canonical correlation	Wilk's Lambda	χ^2	Degrees of freedom	Probability
Sepik River-Arawe	28.356	100	0.982	0.0340	55.796	9	0.0000
Coobool Creek-Murray Valley	2.197	100	0.829	0.3127	72.660	8	0.0000
Sepik River-Arawe-Coobool Creek-Murray Valley							
Function 1	4.912	78	0.911	0.0602	209.240	27	0.0000
Function 2	1.034	16	0.713	0.3564	76.843	16	0.0000
Function 3	0.378	6	0.523	0.7254	23.913	7	0.0012

covariance demonstrated in the Arawe-Sepik River comparison. The high degree of variation in the Coobool Creek series, and the contrast with the Murray Valley, Sepik River and Arawe crania, reinforce the univariate and morphological results in suggesting that this is a mixed sample of deformed and undeformed crania.

The standardised coefficients computed for the discriminating variables (Table 32) indicate that maximum biparietal breadth is the most important discriminator, followed by frontal subtense height (metopion), with the remaining variables contributing fairly equally. A plot of the canonical discriminant function scores (Fig.40) demonstrates the greater dispersion in the Coobool Creek sample, as defined by the discriminating variables, compared to the Murray Valley series. All of the Coobool Creek crania

and 95.2% of the Murray Valley crania are correctly classified by this function. The dimensions which distinguish the Arawe from the Sepik River crania also clearly distinguish the Coobool Creek from the Murray Valley crania, although not to the same degree.

Murray Valley, Coobool Creek, Arawe and Sepik River

A four-way comparison was undertaken using the initial nine variables. The higher variance in the Coobool Creek group, relative to that in the Arawe, Sepik River and Murray Valley, resulted in inequalities in the covariance matrices and a significant F value for Box's M (Table 31). Three functions were developed, the initial function accounting for 77.6% of the variance, with a higher eigenvalue and lower

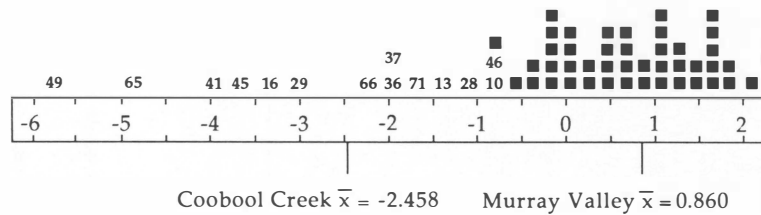


Figure 40 Canonical discriminant function score distribution for male crania from Coobool Creek and the Murray Valley

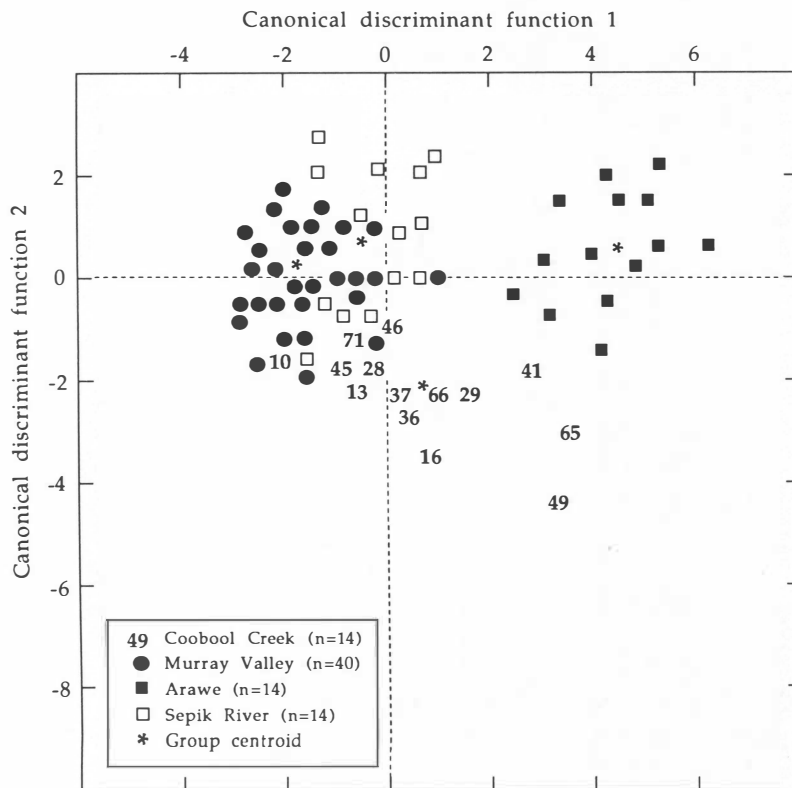


Figure 41 Canonical discriminant function score distribution for male crania from Coobool Creek, the Murray Valley, Arawe and the Sepik River

Wilk's Lambda, and the other two functions being of less importance (Table 33).

Of greatest interest here was a plot of the canonical discriminant function scores (Fig.41) and group classification results. The Murray Valley and Sepik River crania cluster together, with little distance between their respective group centroids. The Arawe and to a lesser extent the Coobool Creek crania can be clearly distinguished from these two groups. The probabilities of group misclassification indicated that three of the Coobool Creek crania (CC65, 49 and 41) were most likely to be classified with the Arawe after their own group.

DISCUSSION

Combining the morphological, univariate and multivariate analyses makes it clear that several of the crania from Coobool Creek, Kow Swamp/Cohuna and Nacurrie are artificially deformed. The crania which show obvious signs of deformation are Coobool Creek crania CC1, 41, 49, 65, 66 and 81, N1 and 2, Kow Swamp crania KS5 and 7 and Cohuna. Both the Arawe and Coobool Creek samples could be clearly distinguished in the discriminant analysis from the other two groups. Three of the Coobool Creek crania (CC41, 49 and 65) cluster closer to the Arawe mean than the Murray Valley. The features which differentiate these crania and the Arawe from undeformed crania are:

1. A long flat frontal bone. Flattening of the frontal is evident in the middle third with a posterior location of metopion. A pronounced thickening of the diploë occurs anterior to bregma, with a thinning of the diploë in the middle third of the frontal. Symmetrical depressions border the midline in the anterior two-thirds of the bone.
2. Great cranial height (basion-bregma).
3. The anteroposterior curvature of the parietal bones is increased (high parietal curvature index).
4. An occipital bone which when viewed laterally is elongated and flattened, with a low occipital curvature index and minimal development of the occipital bun. Opisthocranium is located near lambda and the posterior border of the *foramen magnum* may be orientated towards lambda resulting in a low nasion-*foramen magnum* angle. The area of attachment for the semispinalis capitis and trapezius muscles become more rugose and depressed.

The major features which distinguish the Arawe from crania such as KS5 and CC65 relate to the greater degree of deformation evident in the Arawe, especially in the parietals, and the well developed cranial breadth in the Australian crania. In the Arawe head-binding restricts the lateral development of the parietals, forcing them inward and upward. In direct contrast to this, the Australian crania which appear to have been

artificially deformed all have great biparietal breadth. This suggests that the Aboriginal crania could not have been deformed by a fixed series of head-bindings such as those employed by the Arawe.

I can find only three ethnographic references to intentional cranial deformation among Australian Aborigines. In 1841 G.A. Robinson (Kenyon 1928:165) recorded that a few of the children of the Burrumbeet of northern Victoria had their heads artificially flattened. Robinson does not describe the method by which the crania were deformed and makes no other reference to the practice. On the available evidence I am a little sceptical of Robinson's observation. There are over 1000 'recent' Aboriginal crania from northern Victoria and the Murray Valley in Australian museum collections. None of these show any evidence of being artificially deformed.

Brierly (1848-50) and Macgillivray (1852) both present detailed descriptions of infant head-pressing in Cape York. 'Pressure is made by the mother with her hands ... one being applied to the forehead and the other to the occiput, both of which are thereby flattened, while the skull is rendered proportionally broader and longer than it would naturally have been' (Macgillivray 1852:12). Further north, in the islands of Torres Strait, head-pressing was recorded by Miklouho-Maclay (1882) and Haddon (1912(4):7-9). In his report Haddon describes the head-pressed crania at Mabuag as being 'low in the forehead, flat at the back and not too well developed above'.

Head-pressing would produce a more subtle and variable deformation of the vault than head-binding and this is probably the method employed on the deformed crania from Coobool Creek, Nacurrie and Kow Swamp. At Coobool Creek and Kow Swamp there is a gradation from the crania that are obviously deformed into those which show no evidence of deformation. This creates problems of definition. Three crania at Coobool Creek (CC35, 41 and 66) and one at Kow Swamp (KS1) have long flat frontal bones without possessing great cranial height. The frontal curvature indices for each of these crania ($r = 14.3-15.8$) are well below the modern Murray Valley range (20-26, Table 5) and the length of the frontals (nasion-bregma chord 119-128 mm) is either at the top of, or exceeds, the modern range (102-120, Table 5). Cranial height (basion-bregma 139-142 mm), while towards the top of the modern range (126-143 mm, Table 5), is not great given the overall size of the crania. Parietal curvature indices in the three Coobool Creek crania ($r = 22-23$) are relatively high (Murray Valley male range 17-23, Table 5), while that in

KS1 is only moderate (19). The Coobool Creek occipitals are close to the modern mean in length (opisthion-lambda 98-105 mm) and curvature index ($r = 25-30$), with the occipital in KS1 suffering from postmortem damage and distortion.

Whether or not these four crania are classified as artificially deformed ultimately depends on subjective factors of weighting. It is conceivable that crania of this morphology could be produced by head-pressing, with gross deformation evident only in the frontals, but a survey of the literature on artificial cranial deformation does not reveal any similar crania. The difficulty is increased through the lack of adequate reference material. The artificially deformed crania in Australian museums were collected primarily for their novelty value, with the grossly deformed crania possibly being over-represented. A more complete study would look at the interpopulation gradation from the deformed to the undeformed range. Ethnographic accounts of artificial deformation all stress the great within-population variability in the shape of deformed crania (Dingwall 1931).

The isolation of anatomical regions unaffected by deformation is a necessary prerequisite to morphological analysis of comparative biological relationships. Although this area has received some attention in respect to artificially deformed American Indian crania (Shapiro 1928; Oetteking

1930; McNeil and Newton 1965; Hughes 1968; Cybulski 1975), similar analyses are not available for populations with differing modes of deformation.

Due largely to intrapopulation variation in the deformation process, with associated differences in adult head shape, analyses of the anatomical regions unaffected by deformation have produced conflicting results. McNeil and Newton (1965) document extensive alteration in cranial base morphology with deformation, while Hughes (1968) found that basal and facial measurements remain unaffected. Brothwell (1965:72) indicates that upper facial height is the only dimension unlikely to be influenced by cranial deformation. With extreme deformation, Cybulski (1975:65) argues that the effects extend throughout the entire cranium.

With the Coobool Creek and Kow Swamp crania the isolation of those anatomical regions least influenced by deformation is complicated by temporal factors, most notably the large size of the crania. Although the samples are small, some control on this can be gained through a comparison of the Coobool Creek crania which show some evidence of deformation (frontal curvature index below 19.0: CC16, 29, 35, 41, 49, 51, 65, 66 and 82), with those that do not (CC5, 8, 10, 13, 23, 28, 36, 37, 45, 46, 71, 75 and 76) (Table 34).

Table 34 Comparison of cranial indices and dimensions of the facial skeleton in undeformed ($n = 13$) and deformed ($n = 9$) Coobool Creek male crania

	<i>n</i>	\bar{x}	<i>s</i>	Student's <i>t</i>	Probability
Frontal curvature index	13	21.8	1.65	6.24	0.000
Parietal curvature index	13	19.7	1.66	1.61	0.123
Occipital curvature index	12	30.1	2.54	2.79	0.012
Gnathic index	9	105.7	3.71	1.09	0.292
Bizygomaxillare	6	103.7	2.63		
	8	101.0	5.18	0.48	0.637
	7	102.1	3.71		
Orbital height	11	31.6	2.83	0.06	0.952
	7	31.7	2.28		
Orbital breadth	11	44.3	2.32	1.41	0.177
	8	43.0	1.19		
Nasion-prosthion	9	74.3	3.20	0.88	0.390
	7	75.8	3.67		
Nasion-nasospinale	10	54.2	3.45	0.24	0.814
	7	54.5	2.63		
Nasal breadth	11	29.8	1.32	1.42	0.172
	8	28.8	1.55		
Alveolar length	9	65.7	2.29	1.54	0.143
	8	63.7	2.81		
Alveolar breadth	9	73.1	4.67	0.66 ¹	0.519
	7	71.8	1.95		

¹ significant difference in variance indicated by Bartlett's χ^2 ($P = .044$), Student's *t* calculated using separate variance estimate

Comparison of facial height, breadth and prognathism data for these two subsamples (Table 34) did not obtain significant differences between mean values. The same morphological pattern of low horizontal orbits, robust and deep malars, great supraorbital breadth, marked prognathism and broad palates is common throughout. As would be expected given the selection criteria, there are significant differences between the subgroup means for frontal curvature index and parietal curvature index. These results suggest that the effects of cranial deformation, at Coobool Creek, have had little influence on the growth and development of the associated oro-facial skeletons.

Temporal change in Murray Valley crania: correlation and discriminant function analysis

In their multivariate statistical comparison of the Kow Swamp crania with a 'modern' Victorian series, Thorne and Wilson (1977) found that the major morphological changes have occurred in the facial and frontal regions of Aboriginal crania from northern Victoria over the last 9000-10,000 years. Pietruszewsky (1979) obtained similar results. The most aberrant sample in his entire analysis was Kow Swamp, which failed to cluster with any of the other prehistoric or modern samples. The results of the analysis of cranial deformation indicate that in order to obtain biologically meaningful results, analysis of temporal change using the Coobool Creek and Kow Swamp crania should be restricted to those areas of the cranium unaffected by deformation. This has not been the procedure employed in some of the published multivariate comparisons of the Kow Swamp series (Thorne and Wilson 1977; Pietruszewsky 1979). In these analyses, variables which have been influenced by deformation, especially those relating to the length and curvature of the frontal bone have been included. Therefore, their results contain both a cultural and biological component (Brown 1987a). The difficulty in these analyses is to differentiate one from the other.

For the multivariate analysis of temporal change in the size and shape of crania from the Murray Valley, variables were selected from those areas of the oro-facial skeleton which did not appear to have been influenced by cranial deformation. An alternative approach, which would increase variable coverage, would have been to include only those crania which do not appear to be artificially deformed. There are major problems associated with this procedure however. Most importantly, due to the morphological gradation from the deformed to

the undeformed range, there is some degree of subjectivity involved in allocating crania to either group. This is particularly difficult with the fragmentary crania from Kow Swamp. In addition this procedure would severely restrict the size of the sample.

An initial series of 12 variables were examined. Five of these are measures of upper facial breadth (maximum supraorbital breadth, bizygomaxillare, biectoconchion, orbital breadth and nasal breadth), four of facial height (nasion-nasospinale, nasion-prosthion, nasospinale-prosthion and orbital height) and the final three variables were alveolar breadth, alveolar length and basion-nasospinale. The selection of these variables excluded Broadbeach from the analysis as I did not have orbital height or nasal breadth dimensions for this population. Each of these variables, by population and by sex, was compared with the normal distribution using the Shapiro-Wilk statistic and normal probability plots (Tables 4-6). Two variables obtained significant values for W ($P = .01-.005$). These variables are orbital height (Murray Valley males and females) and orbital breadth (Swanport and Coobool Creek males). In each instance, due to an inadequate measurement scale, the distributions showed a clustering of points around the median and abrupt tails (kurtosis). It would have been better to record these dimensions to the nearest 0.5 mm than to the nearest millimetre.

The association of the variables considered for discriminant function analysis was examined using Pearson's correlation coefficient. Correlation matrices were developed from the largest sample, the Murray Valley, to examine possible sex-based variation in correlation, the effect of the distance between the male and female means on the size of the correlation, topographical and biological correlation, and to assist in identifying possibly redundant variables (Tables 35-37).

Matrices were formed using the convention of listwise deletion of missing data, a procedure which excludes crania with missing data from the analysis. This reduced the size of the male group to 46, the pooled-sex series to 99, while the females remained at 53. For samples of 46-53 a correlation coefficient of $r = .288-.273$ is significant at the .05 level, while for the pooled-sex sample of 99 a correlation coefficient of $r = .195$ is significant at the .05 level. Scatterplots were produced for selected correlates and examined for distributional linearity, dispersion, the location of any outliers and, in the pooled-sex sample, the distance between the male and female clusters.

In each of the matrices there are high levels of correlation ($r = 0.70-0.85$) between the upper

Table 35 Pearson's linear correlation coefficient matrix for the 12 oro-facial variables considered for the discriminant function analyses, Murray Valley male (n = 46) crania

	2	3	4	5	6	7	8	9	10	11	12
1	0.22	-0.03	0.20	0.22	0.22	0.44	0.65	0.73	0.41	0.25	0.41
2	-	-0.06	0.15	0.07	0.51	0.09	0.25	0.37	0.32	0.65	0.06
3			0.49	0.06	0.03	0.04	-0.10	-0.19	-0.03	0.06	0.14
4				0.67	-0.10	0.24	0.04	0.09	0.28	0.41	0.32
5					-0.27	0.11	-0.03	0.07	0.26	0.14	0.20
6						0.17	0.21	0.32	0.30	0.42	0.21
7							0.27	0.32	-0.07	0.01	-0.02
8								0.80	0.38	0.31	0.26
9									0.35	0.32	0.36
10										0.45	0.49
11											0.21

1 Supraorbital breadth
2 Bizygomaxillare
3 Nasion-nasospinale
4 Nasion-prosthion
5 Nasospinale-prosthion
6 Nasal breadth
7 Orbital height
8 Orbital breadth
9 Biectoconchion
10 Alveolar length
11 Alveolar breadth
12 Basion-nasospinale

Table 36 Pearson's linear correlation coefficient matrix for the 12 oro-facial variables considered for the discriminant function analyses, Murray Valley female (n = 53) crania

	2	3	4	5	6	7	8	9	10	11	12
1	0.60	0.28	0.28	0.08	0.41	0.15	0.66	0.84	0.18	0.30	0.27
2		0.32	0.37	0.17	0.35	0.09	0.40	0.67	0.28	0.51	0.33
3			0.65	-0.04	0.23	0.31	0.18	0.26	0.01	0.24	0.31
4				0.70	0.25	0.35	0.37	0.40	0.53	0.56	0.33
5					0.12	0.20	0.32	0.28	0.72	0.55	0.13
6						0.05	0.37	0.50	0.20	0.33	0.23
7							0.25	0.31	-0.09	-0.05	0.05
8								0.79	0.39	0.49	0.21
9									0.30	0.49	0.34
10										0.51	0.42
11											0.31

1 Supraorbital breadth
2 Bizygomaxillare
3 Nasion-nasospinale
4 Nasion-prosthion
5 Nasospinale-prosthion
6 Nasal breadth
7 Orbital height
8 Orbital breadth
9 Biectoconchion
10 Alveolar length
11 Alveolar breadth
12 Basion-nasospinale

Table 37 Pearson's linear correlation coefficient matrix for the 12 oro-facial variables considered for the discriminant function analyses, Murray Valley pooled sex (n = 99) crania

	2	3	4	5	6	7	8	9	10	11	12
1	0.53	0.24	0.40	0.27	0.44	0.33	0.71	0.83	0.43	0.44	0.46
2		0.24	0.43	0.27	0.53	0.16	0.47	0.64	0.45	0.67	0.39
3			0.63	0.17	0.26	0.20	0.21	0.22	0.20	0.34	0.36
4				0.74	0.29	0.35	0.42	0.49	0.58	0.65	0.51
5					0.11	0.22	0.31	0.36	0.59	0.49	0.34
6						0.19	0.45	0.55	0.43	0.54	0.39
7							0.32	0.36	0.04	0.11	0.10
8								0.85	0.56	0.58	0.43
9									0.53	0.61	0.53
10										0.66	0.60
11											0.50

1 Supraorbital breadth
2 Bizygomaxillare
3 Nasion-nasospinale
4 Nasion-prosthion
5 Nasospinale-prosthion
6 Nasal breadth
7 Orbital height
8 Orbital breadth
9 Biectoconchion
10 Alveolar length
11 Alveolar breadth
12 Basion-nasospinale

facial breadth variables (supraorbital breadth, orbital breadth and biectococonchion). These are all dimensions of a closely related anatomical region, with 50-60% of the variation shared between them. The inclusion of each of these variables in a multivariate procedure would involve a good deal of redundancy. The facial height variables (nasion-prosthion, nasion-nasospinale and nasospinale-prosthion) tend to share moderate levels of correlation. Two of these variables share a common reference point, either nasion or nasospinale, but even so the levels of correlation are lower than I would have predicted. A probable source of variability is the ongoing functional change in the alveolar segment with deposition of alveolar bone in response to marked occlusal tooth wear and facial height adjustment (Murphy 1959). The single measure of facial prognathism, basion-nasospinale, maintained a consistently moderate level of correlation ($r = 0.42-0.60$) with alveolar length. For the remaining variables there is not a uniform pattern of association, apart from generally low levels of correlation. Overall, the size of the correlation coefficients were slightly increased in the pooled-sex sample due to the separation of the male and female means.

DISCRIMINANT FUNCTION ANALYSIS

A series of discriminant function analyses were performed to select the optimum set of discriminating variables and to eliminate any redundant information. Variable selection was constrained by the fragmentary condition of a number of the Coobool Creek facial skeletons. In particular, the female Coobool Creek sample is of small size ($n = 9$) and with missing data this group is reduced to five individuals. This small sample resulted in a singularity in the Coobool Creek covariance matrix in discriminant runs, which prevented comparison of the group covariance matrices and the calculation of Box's M. In order not to compromise the results of the final discriminant analysis, this analysis was restricted to the three male groups (Coobool Creek, Murray Valley and Swanport) with sufficiently large samples and complete data sets. Poor preservation and small sample sizes also excluded the Kow Swamp and Barham groups from the analyses.

A series of two-group discriminant function analyses was performed, using a stepwise selection procedure which maximised the Mahalanobis distance between groups and resulted in the optimum set of discriminating variables. In two-group comparisons the recovery and interpretation of the statistical

information developed by the analyses is simplified relative to analyses involving more than two groups, with more than one function produced. The initial variables were basion-nasion, supraorbital breadth, nasion-prosthion, alveolar length, alveolar breadth, orbital height and nasal breadth. The inclusion of alveolar breadth and nasal breadth did not improve the discriminatory power of the final functions in any of the comparisons with Coobool Creek and so they were excluded. A further series of discriminant analyses were performed using a fixed selection procedure and the variables basion-nasospinale, supraorbital breadth, nasion-prosthion, alveolar length and orbital height to calculate reliable significance levels for the associated statistics.

The initial discriminant function analysis is between male and female crania from the Murray Valley. This sex-based interpopulation variation is then contrasted with the intrapopulation variation between the male samples. The four two-group comparisons are followed by a three-group analysis containing the male groups. The purpose of this analysis is an examination of the probabilities of misclassification, matrix of pairwise F ratios, Mahalanobis distances (D^2), eigenvalues, Wilk's Lambda, canonical correlations and plots of the discriminant function scores.

Results

Homogeneity of covariance was tested in each of the discriminant analyses using Box's M (Table 38). None of the associated F values are significant at the 5% level, indicating that there are only minor inequalities in dispersion present. These results differ from those of Brown (1982:233) where a larger variable set obtained a significant value for Box's M in the Murray Valley male-female comparison.

Murray Valley male and female crania

These two groups are the second closest in the analysis ($D^2 = 3.71$) after the Murray Valley and Swanport males ($D^2 = 2.02$). A plot of their canonical discriminant function scores indicates that there is considerable overlap in range and little distance between the group means (Fig.42). The group classification results reveal that 78.38% of the male crania and 81.0% of the females were correctly allocated by the function. The relative importance of the final function is indicated by its associated Wilk's Lambda and canonical correlation. In this analysis the low canonical correlation and moderately high Wilk's Lambda demonstrate that this function is less successful at discriminating between the two groups than are the functions in the Coobool

Table 38 Test for the equality of group covariance matrices using Box's M

	Box's M	F statistic	Degrees of freedom	Probability
Murray Valley male-female	0.673	1.027	55, 27287.9	0.1427
Coobool Creek-Murray Valley male	0.832	0.930	55, 1343.9	0.5509
Coobool Creek-Swanport male	0.560	0.746	55, 1850.1	0.7951
Murray Valley-Swanport male	0.873	1.174	55, 2721.5	0.1572
Coobool Creek-Murray Valley-Swanport male	0.235	1.020	110, 3271.1	0.3150

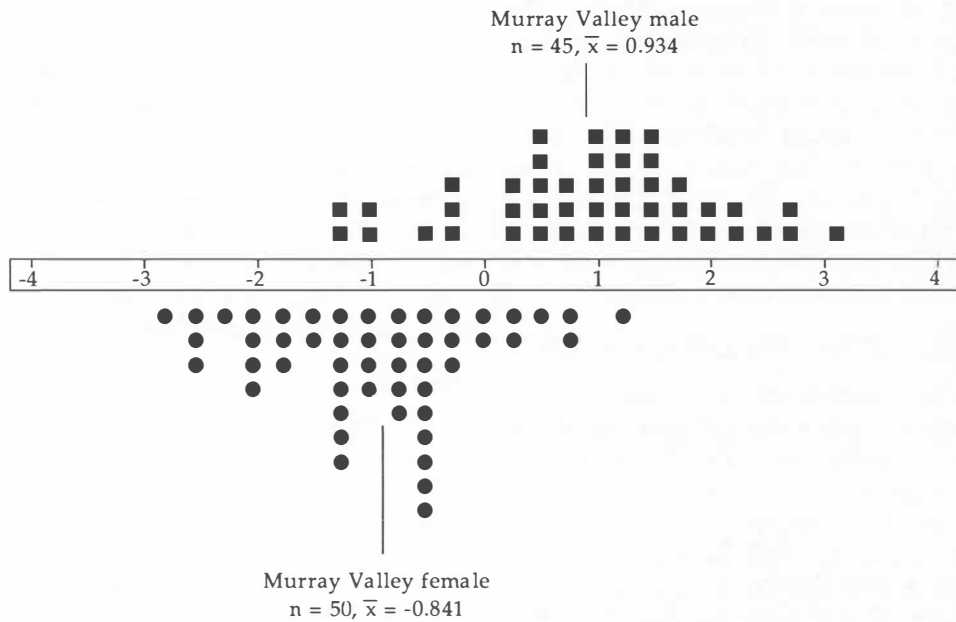


Figure 42 Canonical discriminant function score distribution for Murray Valley male and female oro-facial skeletons

Table 39 Canonical correlations, Wilk's Lambda, F statistic and χ^2 for the five discriminant analyses

	Canonical correlation	Wilk's Lambda	F statistic	χ^2	Degrees of freedom	Probability
Murray Valley male-female	0.667	0.555	14.277	53.300	5	0.000
Coobool Creek-Murray Valley	0.803	0.355	19.238	56.404	5	0.000
Coobool Creek-Swanport	0.888	0.212	22.339	48.903	5	0.000
Murray Valley-Swanport	0.552	0.695	5.355	22.745	5	0.000
Coobool Creek-Murray Valley-Swanport						
Function 1	0.755	0.308	11.860	89.460	10	0.000
Function 2	0.533	-	-	25.392	4	0.000

Creek-Murray Valley and Coobool Creek-Swanport analyses (Table 39). As these variables were not selected for their ability to sex crania, a particularly wide separation of the group means was not expected. The two major discriminating variables are alveolar length and nasion-prosthion (Table 40). Orbital height has contributed very little to the discriminatory power of the function.

Coobool Creek and Murray Valley male crania

A high level of discrimination is achieved in this analysis, with the group classification results correctly predicting the group membership of all but three of the Murray Valley crania (92.8%) and all of the Coobool Creek crania except CC66 (92.3%). CC66 has alveolar length (61 mm) and nasion-prosthion (70 mm) dimensions at the bottom of the Coobool Creek range. The classification probabilities give this individual a 69.5% chance of being drawn from the Murray Valley sample. The plot of the canonical discriminant function scores (Fig.43) demonstrates the wide separation of the group means and small overlap in range.

The standardised coefficients reveal that three variables (maximum supraorbital breadth, orbital height and alveolar length) are the major contributors to the discriminatory power of the function (Table 40). A combination of great supraorbital breadth, absolutely low orbital height and massive palates makes the Coobool Creek crania distinct from the recent Murray Valley series. The Coobool Creek male mean values for basion-nasion, supraorbital breadth and nasion-prosthion are all significantly greater than those for the Murray Valley, with no significant difference between these samples for alveolar length (Table 8).

This analysis produced the second largest D² (11.25) and canonical correlation of the two group analyses (Table 41). The distance between the Coobool Creek and Murray Valley males is greater than that produced by sexual dimorphism within the Murray Valley series and the dispersion of the Coobool Creek sample is relatively discrete.

Table 40 Standardised canonical discriminant function coefficients for the two-group analyses

	Murray Valley male-female	Coobool Creek Murray Valley	Coobool Creek Swanport	Murray Valley Swanport
Basion-nasospinale	0.239	0.270	0.593	0.300
Supraorbital breadth	0.206	1.025	0.274	0.408
Nasion-prosthion	0.445	0.379	1.050	-0.577
Alveolar length	0.477	-0.747	-0.441	-0.694
Orbital height	0.039	-0.763	-0.632	0.408

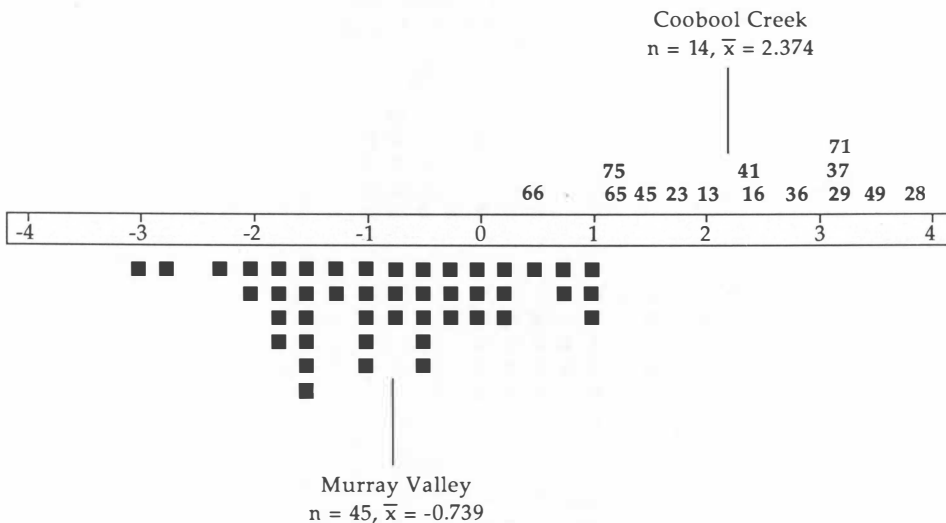


Figure 43 Canonical discriminant function score distribution for Coobool Creek and Murray Valley male orofacial skeletons

Coobool Creek and Swanport male crania

These two groups were the most easily differentiated pair in the analysis, with a wide separation of the group means and 100% correct group classification (Fig.44). As in the preceding comparison, the Coobool Creek cranium falling closest to the Swanport mean is CC66.

The major discriminating variables between these two groups are nasion-prosthion, orbital height, basion-nasospinale and alveolar length (Table 40). The univariate statistics indicate that the Coobool Creek means, for all but one of the dimensions used in the discriminant analysis, are significantly greater than those for Swanport (Table 8). The exception is orbital height, in which the Swanport mean is significantly greater than the Coobool Creek mean.

In keeping with the wide separation of the group means, this analysis obtained the largest

D2 (15.49), canonical correlation and smallest Wilk's Lambda (Table 39). These results are similar to those obtained with the mandibles, in which these two groups represented opposing morphological and metrical extremes. The Swanport oro-facial complex is extremely small and gracile relative to the robustness of the Coobool Creek series.

Murray Valley and Swanport male crania

These two groups are the most similar in the analysis. There is a considerable overlap in the distribution of their respective canonical discriminant function scores (Fig.45) and there is little distance between the group means. The group classification results allocated 11 (32.4%) of the Murray Valley sample to the Swanport series and four (22.2%) of the Swanport crania were allocated to the Murray Valley. As expected with

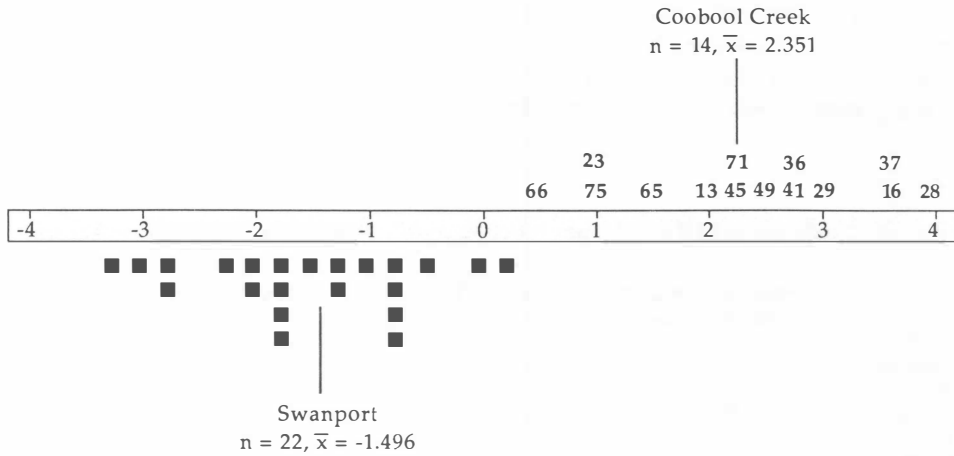


Figure 44 Canonical discriminant function score distribution for Coobool Creek and Swanport male oro-facial skeletons

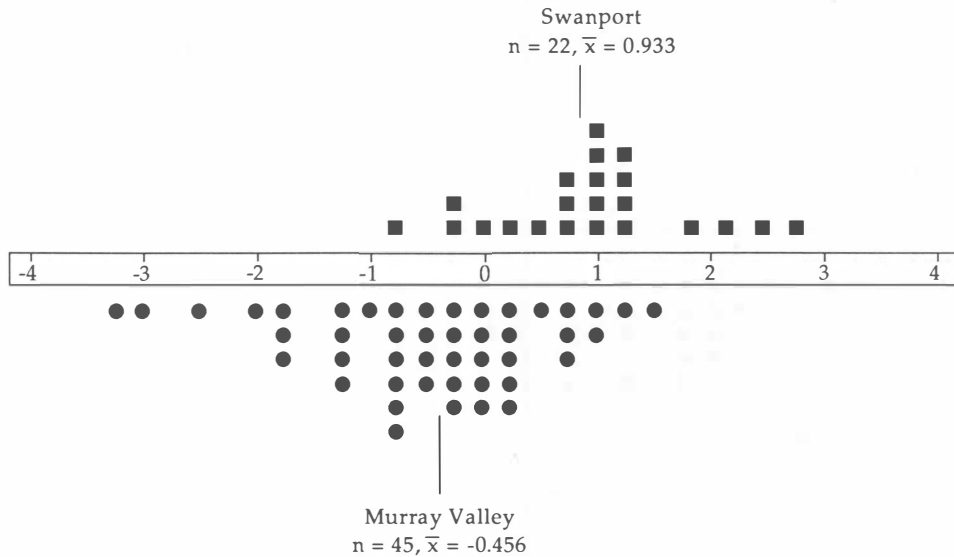


Figure 45 Canonical discriminant function score distribution for Swanport and Murray Valley male oro-facial skeletons

this overlap in distribution the smallest D^2 (2.02), canonical correlation and largest Wilk's Lambda are associated with this analysis (Table 39).

The standardised coefficients demonstrate that the major discriminating variables are alveolar length and nasion-prosthion, with the remaining three variables being slightly less important (Table 40). For two of the oro-facial variables, nasion-prosthion and alveolar length, the Murray Valley mean values are significantly greater than Swanport, while the Swanport series has significantly greater mean orbital height (Brown 1982:173-75).

Coobool Creek, Murray Valley and Swanport

The purpose of the three-group comparison was an examination of the matrix of pairwise F ratios, distance between group centroids and probabilities of misclassification. The matrix of pairwise F ratios consists of an F ratio for each pair of groups (Table 41). This F is the significance test for the Mahalanobis distance (D^2) between groups and may be used to test the equality of pairs of means (Nie *et al.* 1975:460).

Both the F ratios and the plot of the discriminant function scores (Table 41, Fig.46) demonstrate that the two closest groups in the analysis are the Swanport and Murray Valley series, with the Coobool Creek crania being more distinct.

Table 41 D^2 , F statistic and significance between pairs of groups

		Murray Valley	Coobool Creek
Coobool Creek	D^2	10.771	-
	F	14.273	-
	P	0.000	-
Swanport	D^2	2.334	10.284
	F	6.481	15.307
	P	0.000	0.000

D^2 = Mahalanobis distances
F = Significance
P = Probability

The group classification results correctly allocated all but one of the Coobool Creek crania, CC66. CC66 obtained a 51% probability of belonging to Swanport for this group of discriminating variables. Two of the Murray Valley series, and one from Swanport, were allocated to Coobool Creek (Table 42). There is a greater overlap between the Murray Valley and Swanport crania, with the lowest D^2 and smallest F statistic belonging to this pair.

Overall there is a high level of discrimination in this analysis, reflecting both regional and temporal variation. With the exception of orbital height, the Coobool Creek crania are distinguished from the two recent groups by the

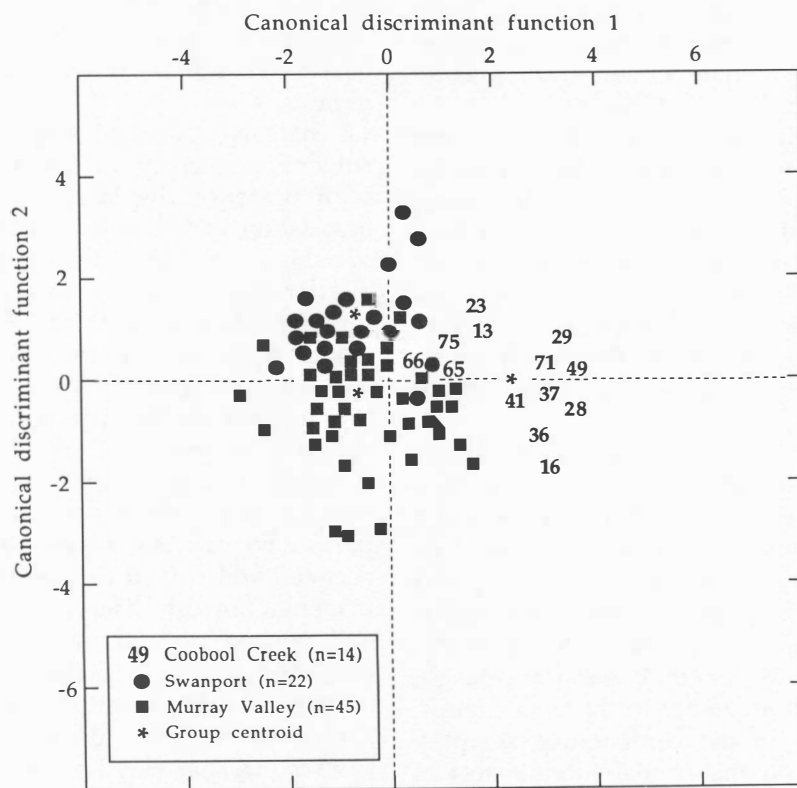


Figure 46 Canonical discriminant function score distribution for Coobool Creek, Murray Valley and Swanport male oro-facial skeletons

Table 42 Group classification results

	n	Coobool Creek		Murray Valley		Swanport	
		n	%	n	%	n	%
Coobool Creek	14	13	92.8	0	0	1	7.2
Murray Valley	45	2	4.4	32	71.2	11	24.4
Swanport	22	1	4.6	4	18.2	7	77.2

greater size of their oro-facial dimensions. Their faces combine low and rectangular orbits, with considerable midfacial height, great supraorbital breadth and large palates. The Swanport facial skeletons represent the contrasting morphological extreme in this analysis, with their relatively small palates, high orbits and moderate midfacial height. The Murray Valley crania are somewhat intermediate between the Coobool Creek and Swanport groups, although they cluster more closely with the Coobool Creek sample than do the Swanport crania.

SUMMARY

Morphological, univariate and multivariate comparisons distinguish the Coobool Creek crania from recent and mid-Holocene crania from the Murray Valley, as well as placing them within the Kow Swamp-Cohuna range of variation. Thorne's (1975) analysis of the Kow Swamp crania demonstrated that there were a series of morphological and metrical features, concentrated on the facial skeleton and frontal bone, which differentiated them from a large series of recent northern Victorian crania. Of the 15 statistically significant metrical differences between his two male groups, 12 related to the facial and frontal areas. To a substantial degree the poor preservation of the Kow Swamp crania actually restricted the multivariate analysis (Thorne and Wilson 1977) to fronto-facial variables, and it is likely that with more complete materials significant statistical differences would have been demonstrated for other anatomical regions as well.

The immediate impression that is gained with the Coobool Creek crania is of great overall size combined with extreme variability in the shape of the neurocranium. Facial skeletons are deep and broad with shallow rectangular orbits, broad nasal apertures, large palates and great supra-orbital breadth. Cranial vaults are extremely dolichocephalic with length, breadth and height dimensions which are either in the upper range, or exceed, those in the comparative samples. This is reflected in the cranial module results where the Coobool Creek male and female crania can clearly be distinguished from the two recent southeastern Australian samples from Swanport

and the central Murray Valley. Morphological variability in the Coobool Creek crania is most evident when they are viewed from a lateral aspect. In particular, the manner in which the extremes of anteroposterior curvature of the frontal, parietal and occipital bones are combined with great cranial height and length, in some of the Coobool Creek crania, distinguishes them from the comparative recent and mid-Holocene samples used in this analysis.

It was Brothwell (1975) who made the initial suggestion that the frontal recession evident in the Kow Swamp crania was too extreme to be natural and represented artificial deformation rather than the preservation of an 'almost unmodified eastern *erectus* form' until 13,000 years BP (Thorne and Macumber 1972:319). This analysis, combined with Brown (1981b, 1987a), strengthens and confirms Brothwell's hypothesis. Anatomical features which are indicative of artificial cranial deformation being practiced in the area bounded by Coobool Creek, Nacurrie and Kow Swamp, more than 9000 years ago, are concentrated on the frontal, parietal and occipital regions.

There is a marked recession of the frontal squama, especially in the anterior two-thirds, with posterior displacement of metopion. In association with this frontal recession there is a variable expansion of the diploë in the posterior quarter of the bone, with a constriction of the diploë in the middle third. The anteroposterior length of the bone is increased and a series of symmetrical depressions may border the midline. Pressure on the frontal and occipital regions, probably during the first 12 months of life, increases cranial height, with an associated increase in the anteroposterior curvature of the parietal bones. As a result of this pressure on the occipital and frontal regions there is an increase in cranial breadth. The occipital bone is flattened and pushed up and under the parietals, with little evidence of an occipital bun. There is an increase in the length of the occipital bone (basion-lambda) and the posterior third of the *foramen magnum* may be drawn upward toward lambda.

Although the evidence for artificial cranial deformation at Coobool Creek, Nacurrie and

Kow Swamp conflicts with some aspects of Thorne's interpretation of the Kow Swamp morphology (Thorne and Macumber 1972; Thorne and Wolpoff 1982), other aspects of cranial size and shape support conclusions about diachronic change within southeastern Australia in the period after 13,000 years BP (Thorne 1976; Brown 1987a). However, the evidence for greater skeletal mass in the terminal Pleistocene increases the difficulty associated with isolating those areas of the cranial vault and facial skeleton which are unaffected by deformation. The analysis of cranial deformation, combined with the preceding univariate and morphological comparisons, suggests that the area least likely to be influenced by deformation is the oro-facial skeleton.

The facial skeletons in the Coobool Creek, Kow Swamp and Nacurrie crania are characterised by an anatomical complex which is distinct from the mid-Holocene Barham sample, as well as the recent series from the Murray Valley, Swanport and Broadbeach. As for the cranial vault the most noticeable feature of the Coobool Creek facial skeletons is their great overall size. With the exception of orbital height, male and female facial dimensions at Coobool Creek are significantly greater than those in the comparative populations. The facial skeletons are high, broad and prognathic with great alveolar breadth and a morphological form which parallels their increased size relative to recent Murray Valley populations.

Subnasal development reflects the influence of the large anterior teeth, with their long thickened roots and large crowns. This has resulted in marked subnasal height, prognathism and breadth, with a relatively straight alignment of the uncrowded anterior teeth. The Coobool Creek palates, while variable in shape, are generally long, high and extremely broad, with a tendency for maximum alveolar breadth to be located posterior to the second molar.

The zygomatic bones are deep, thickened structures with prominent malar tuberosities and robust, pillar-like frontal processes. Their infero-posterior borders are particularly thickened with a broad area of masseteric attachment. Superiorly the orbits are absolutely shallow, especially given the great facial height, and are most often of rectangular shape with a fairly horizontal orientation. The naso-frontal articulation is extremely broad and there is a wide separation of the orbits. The nasal bones are broad and flattened and the nasal apertures are relatively large.

Although the Coobool Creek crania typically have great supraorbital breadth this is not generally equalled by correspondingly massive morphological development. There is relatively little depression at nasion and the glabellae are broad and low, rather than having an inflated prominent appearance. The long axis of the superciliary ridges runs parallel to the superior margins of the orbits and their lateral margins tend to merge with the zygomatic trigones. Distinct supraorbital tori are present in four of the Coobool Creek male crania (CC28, 35, 37 and 82). Laterally the zygomatic trigones are large and globose, often exceeding the development in the recent comparative sample.

Possibly associated with the increase in the overall vault dimensions at Coobool Creek the bones comprising the neurocranium are relatively and absolutely thickened. With the exception of thickness at vertex, male mean thickness dimensions at Coobool Creek are significantly greater than those in the recent Murray Valley series. To a lesser degree, increased cranial-vault thickness is also a feature of the skeletal material from Kow Swamp and Nacurrie. Although cranial-vault thickness dimensions normally display a high level of interpopulation variation there are specific aspects of this variation at Coobool Creek which appear to be associated with cranial deformation. Most noticeably there is an expansion of the diploë, anterior of bregma, forming a pronounced prebregmatic eminence and a constriction of the diploë in the middle third of the frontal.

Multivariate comparison of the oro-facial skeletons in the Coobool Creek, Murray Valley and Swanport samples, using a discriminant function technique, clearly distinguishes the Coobool Creek sample (in terms of size and morphology) from the two recent populations. Unfortunately postmortem damage and small sample sizes prevented the inclusion of the Kow Swamp, Barham and Broadbeach samples in the analysis, as well as restricting the analysis to the male groups. The Coobool Creek male faces are distinguished from those in the Murray Valley and Swanport by their greater supraorbital breadth and facial height, absolutely shallow orbits and larger palates. Both group classification and distance statistics indicate that the distance between Coobool Creek and the two recent populations is considerably greater than that shared by the two recent groups, or between the male and female Murray Valley samples.

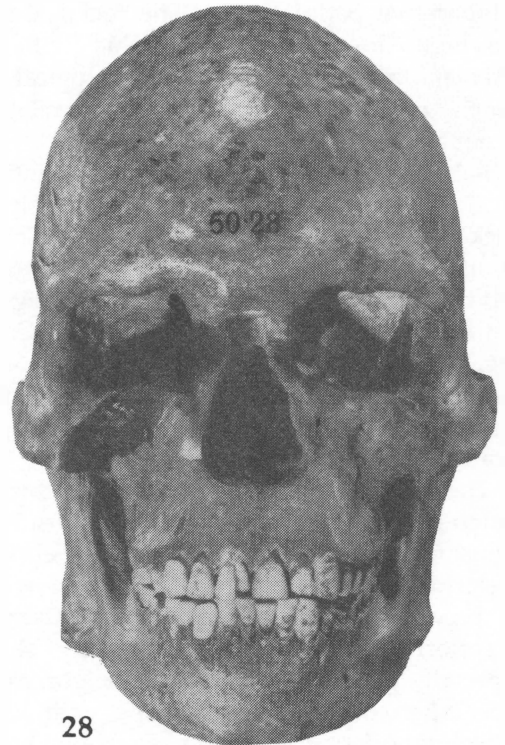
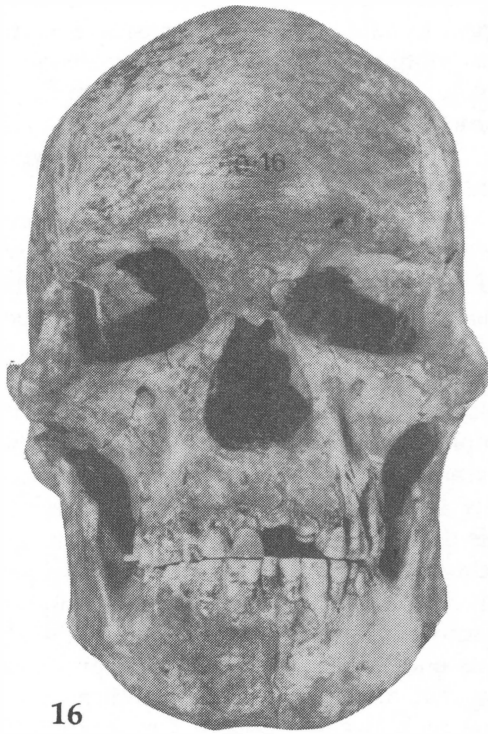
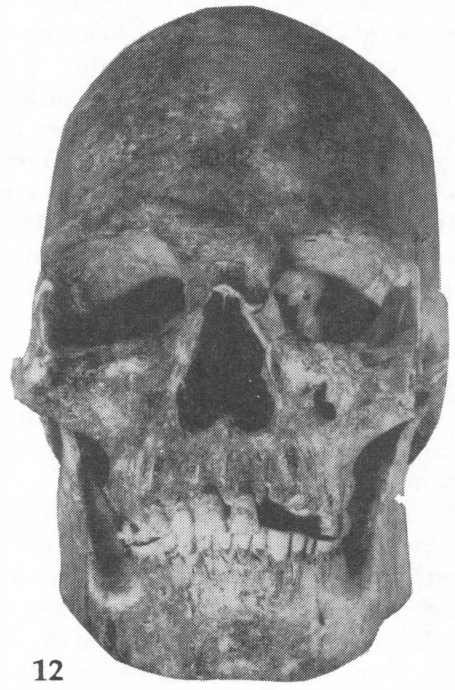
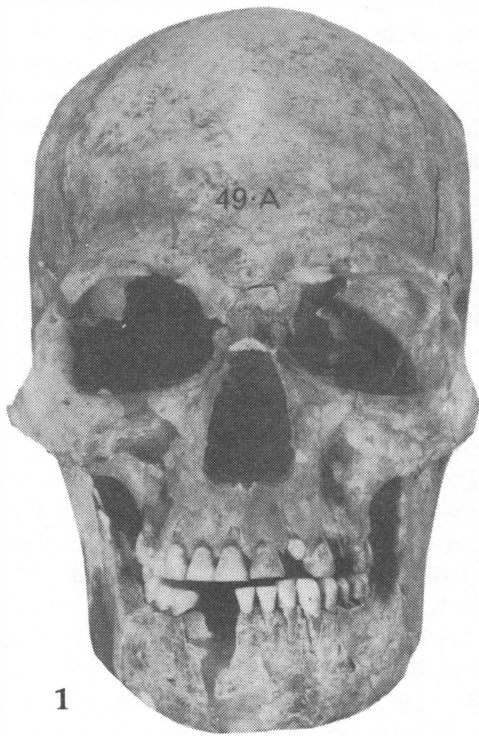
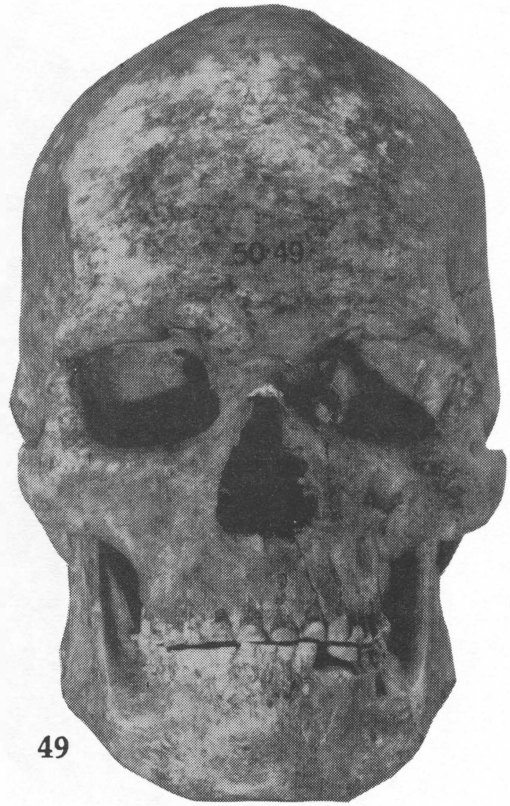


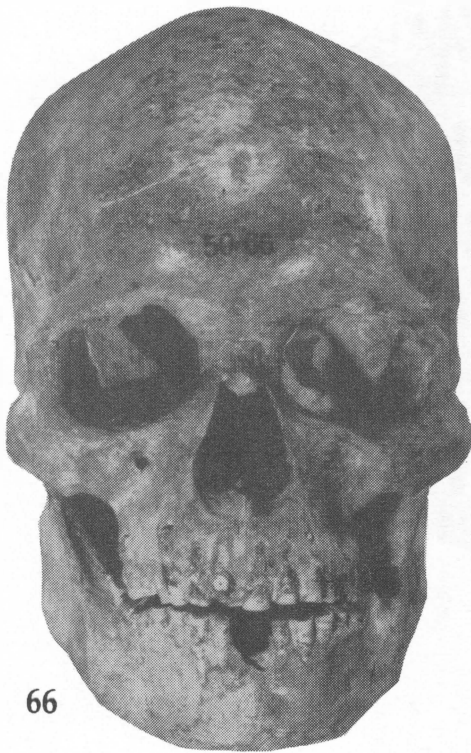
Plate 1 Facial views of Coobool Creek crania 1, 12, 16 and 28



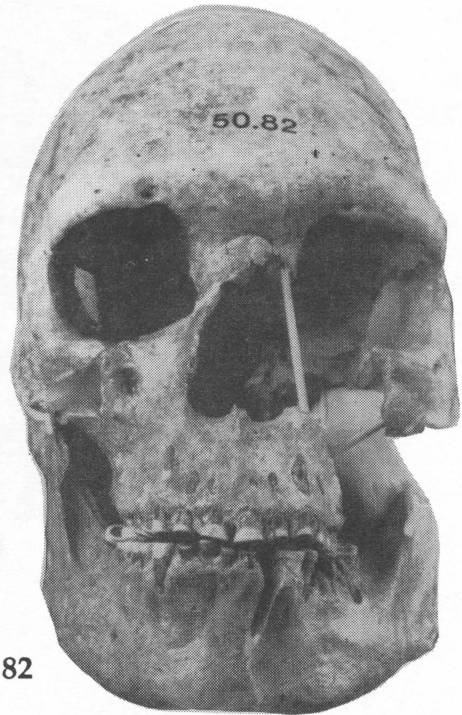
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82



Plate 2 Facial views of Coobool Creek crania 47, 49, 66 and 82

1



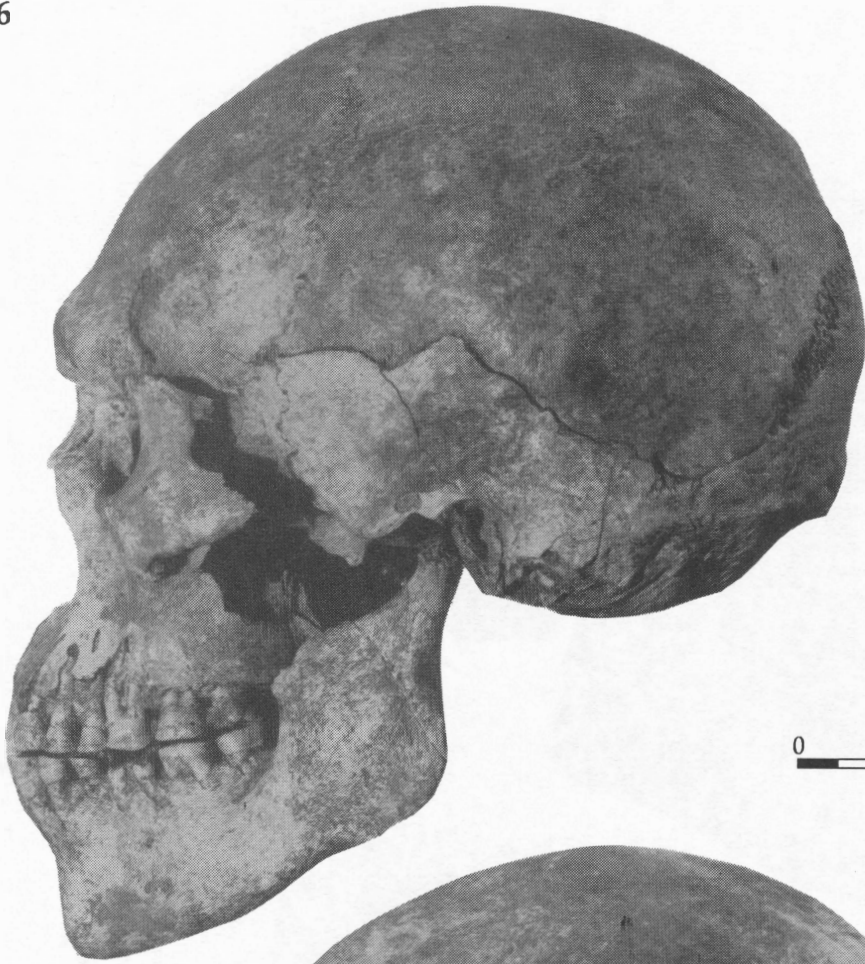
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Plate 3 Lateral views of Coobool Creek crania 1 and 12

16

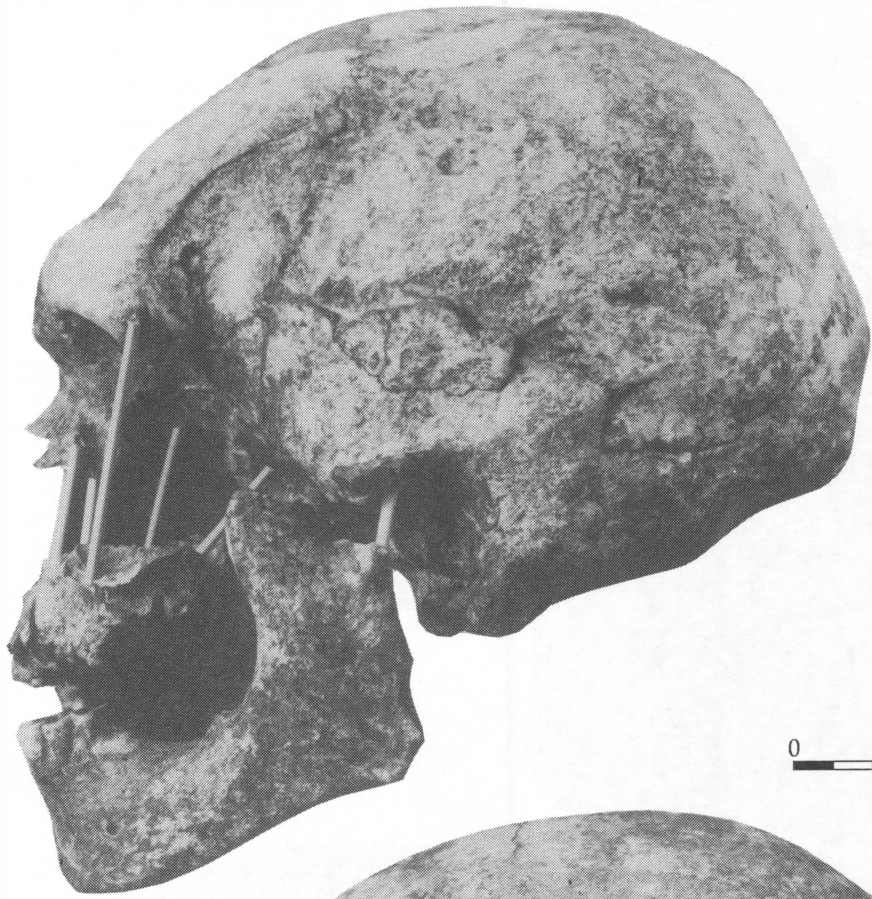


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Plate 4 Lateral views of Coobool Creek crania 16 and 23

35



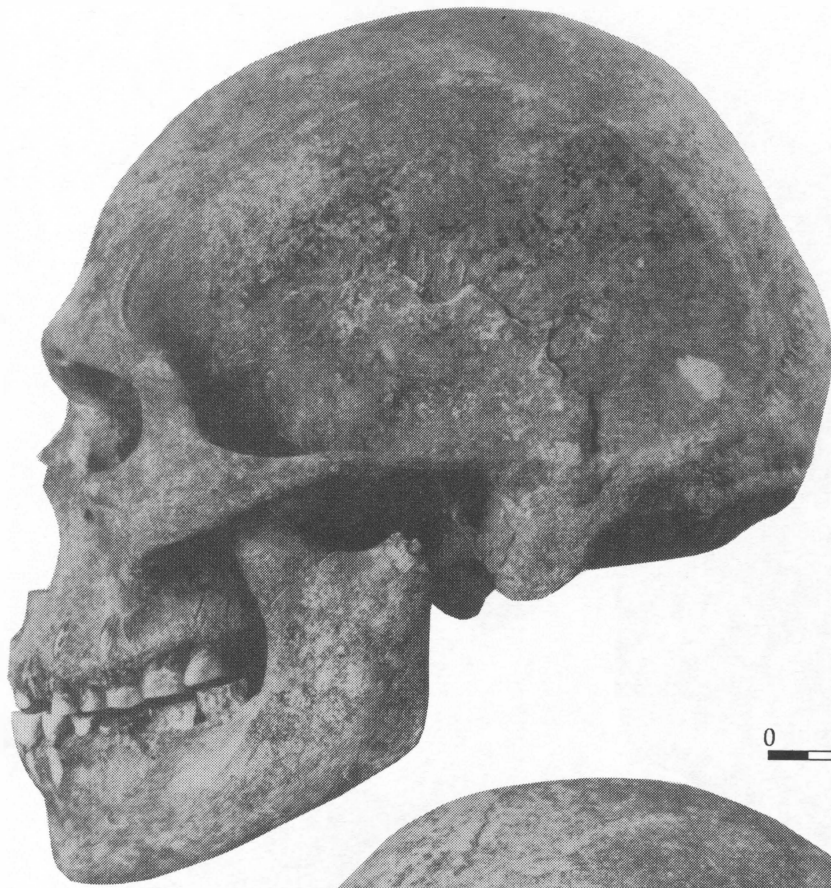
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Plate 5 Lateral views of Coobool Creek crania 35 and 45

50



65

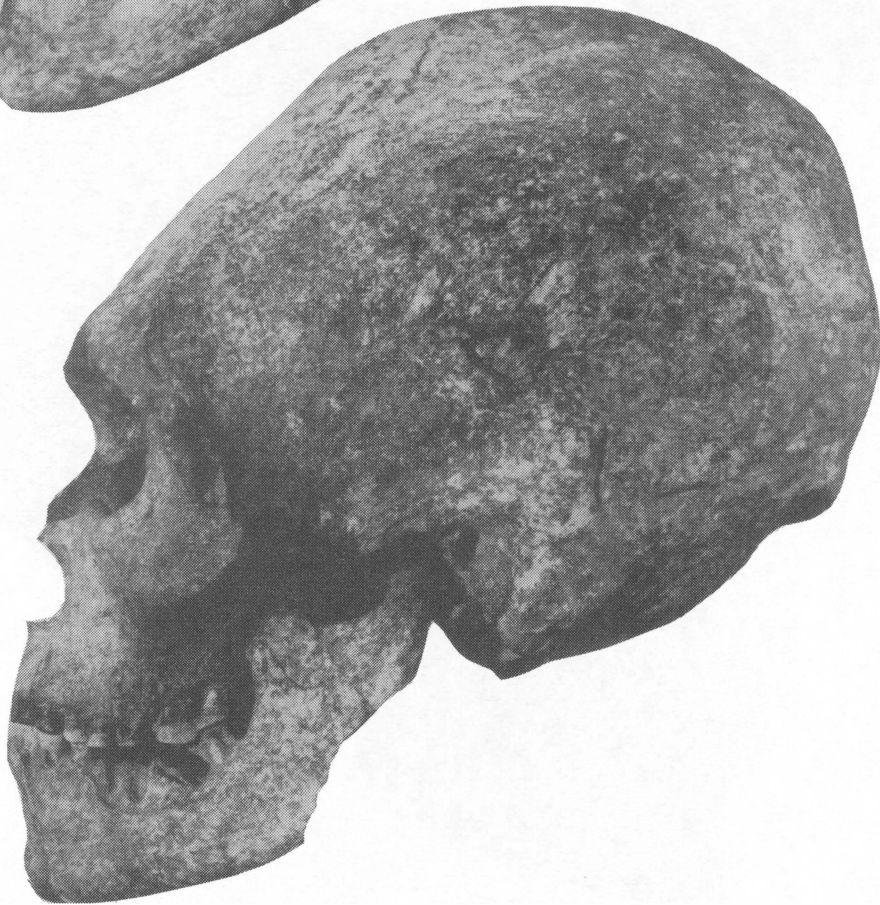


Plate 6 Lateral views of Coobool Creek crania 50 and 65

66



71

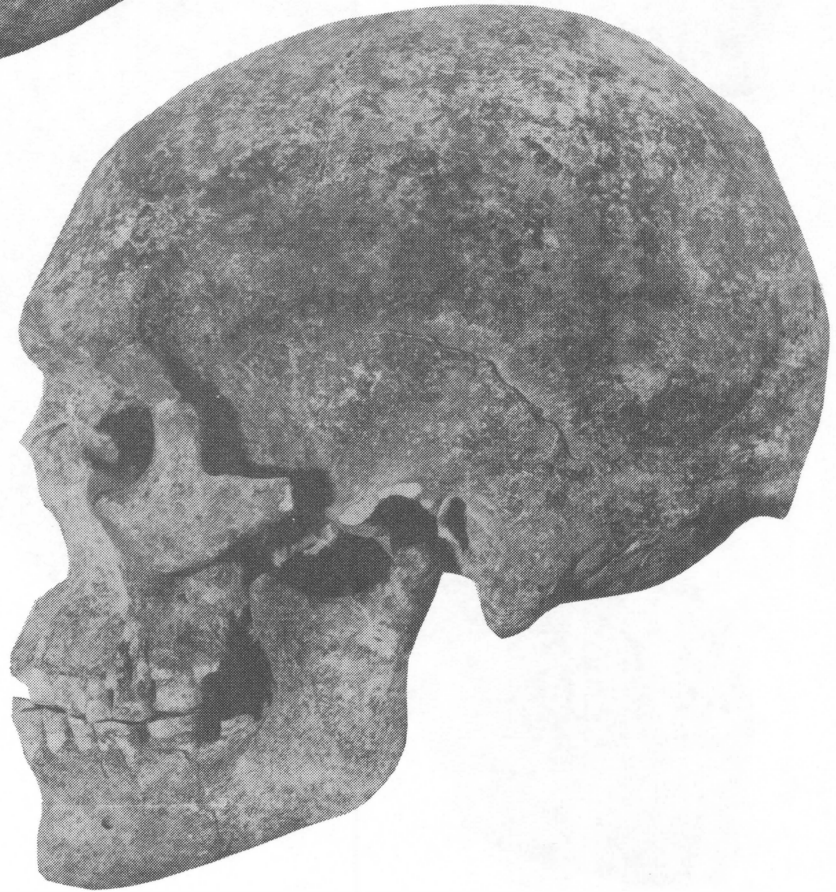
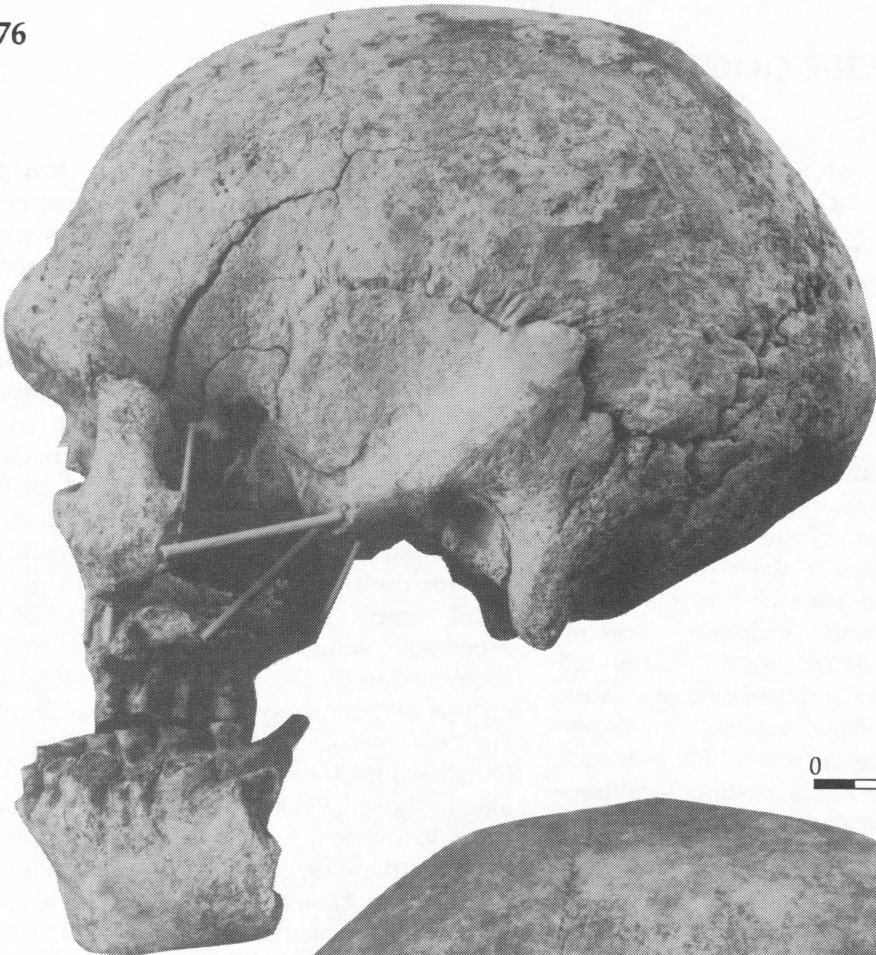


Plate 7 Lateral views of Coobool Creek crania 66 and 71

76



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82



Plate 8 Lateral views of Coobool Creek crania 76 and 82

IV

THE COOBOOL CREEK MANDIBLES

UNIVARIATE AND MORPHOLOGICAL
COMPARISON

Multivariate and univariate analyses of Aboriginal crania have detailed the marked regional variation in size and morphology throughout the continent (Hrdlička 1928; Larnach and Macintosh 1966, 1970; Giles 1976; Pietruszewski 1979, 1984). However, comparable analyses of Aboriginal mandibles are few, with detailed observations limited to those of Klaatsch (1908), Murphy (1957), Larnach and Macintosh (1971) and Freedman and Wood (1977). Of these Murphy (1957) provides a description of the symphyseal region and Larnach and Macintosh (1971) a thorough coverage of discrete and continuous mandibular morphology. Although restricted by a lack of published comparative data, Freedman and Wood's (1977) univariate analysis of the Broadbeach mandibles indicated that these mandibles formed a distinct local population which could be distinguished both from other Queensland samples and from mandibles from coastal New South Wales. Thorne (1975) presents a detailed morphological description of the Kow Swamp mandibles as does Freedman (1986) for the mandible of the Mossgiel skeleton.

For purposes of morphological description I have relied heavily on Larnach and Macintosh's work (1971). Larnach and Macintosh are able to grade the continuous features they describe by reference to standards of their own construction. I found the grading of continuous morphological features to be extremely subjective, and as I have no idea of their standards of reference, I have made no attempt to grade these features in the Coobool Creek mandibles for comparison with their data. Alternatively, to gain some idea of the relative development of these continuous features in the Coobool Creek mandibles, I have made continual reference to a series of 60 mandibles (30 male and 30 female) from Euston in the Murray Valley. These mandibles and their associated crania were formerly part of the 'Murray Black Collection' in the Australian Institute of Anatomy, Canberra, which is now located in the National Museum of Australia. The Coobool Creek mandibles were also directly compared with those from Kow Swamp. Morphological comparisons were not possible between the Coobool Creek mandibles and those from the Murray Valley (Department of Anatomy, University of Melbourne), Swanport

(South Australian Museum) and Broadbeach (Department of Anatomy, University of Queensland) series as these mandibles were not available in Canberra and Armidale for comparative purposes.

Univariate and bivariate metrical comparisons are made between the Coobool Creek mandibles and those from the Murray Valley, Swanport, Broadbeach, Barham and Kow Swamp, using the variables described in Chapter II: Methods. Post-depositional damage and age-related changes to the corpus, in the Coobool Creek and Broadbeach mandibles, limited the number of variables available for multivariate comparison. In particular, small sample sizes in the Coobool Creek and Broadbeach female groups repeatedly resulted in an inversion in the discriminant statistical procedure and severely compromised the results. For this reason the statistical analyses of the female samples were kept at a relatively simple, albeit robust, level and multivariate analyses confined to the male groups. The descriptive and comparative statistical data for these samples are presented in Tables 43-50. Lateral views of some of the reconstructed Coobool Creek mandibles can be found in Plates 3-8.

The mandibular corpus

The dominating feature of the symphyseal region in the Coobool Creek mandibles is their great symphyseal height. The male mean is significantly greater ($P = .000$) than that in the comparative series from Swanport, Broadbeach and the Murray Valley (Tables 43-50, Fig.47). The maximum figure for symphyseal height (45 mm in CC16) equals the maximum recorded by Hrdlička (1928) for Australian Aboriginal mandibles. Similarly the Coobool Creek female mean is significantly greater ($P = .017-.000$) than that in the comparative series, with the maximum (42 mm in CC2) exceeding Hrdlička's female maximum (39.5 mm) (Fig.47). There are significant differences between the male and female mean figures for symphyseal height in the Coobool Creek and recent comparative samples ($P = .000-.025$) (Table 47).

Murphy (1959, 1968) drew attention to the compensatory deposition of alveolar bone in the symphyseal region as a response to dental attrition and decreasing facial height. This results in an increase in symphyseal height with age. The two Coobool Creek mandibles with the greatest

Table 43 Descriptive statistics for the Coobool Creek male and female mandibles (mm)

	Sex	n	\bar{x}	s	Standard error	Coefficient of variation	Min.	Max.	Shapiro Wilk	Probability	χ^2	Probability	Student's t	Probability
Symphyseal height	♂	21	39.4	2.78	0.622	7.06	36	45	0.906	0.10				
	♀	9	36.7	3.04	1.014	8.28	33	42	0.958	0.50	0.089	0.765	2.381	0.025
Symphyseal thickness	♂	21	16.3	1.58	0.622	9.69	14	20	0.944	0.10				
	♀	9	14.3	2.25	0.500	15.73	12	17	0.915	0.10	0.033	0.856	3.138	0.004
Corpus height	♂	18	34.1	2.34	0.554	6.86	30	38	0.967	0.50				
	♀	9	30.9	2.31	0.772	7.47	12	17	0.865	0.10	0.002	0.963	3.376	0.002
Corpus thickness	♂	20	15.7	1.89	2.655	12.03	13	21	0.852	0.02				
	♀	9	14.6	1.66	0.556	11.37	12	17	0.888	0.10	0.177	0.674	1.487	0.149
Bicondylar breadth	♂	8	125.1	7.51	2.655	6.00	111	135	0.955	0.50				
	♀	0	-	-	-	-	-	-	-	-	-	-	-	-
Bigonial breadth	♂	15	111.0	7.36	1.902	6.63	101	122	0.918	0.10				
	♀	3	102.0	13.74	7.937	13.47	87	114	-	-	1.576	0.212	1.687	0.111
Mandibular length	♂	12	115.8	5.54	1.601	4.78	104	124	0.932	0.10				
	♀	5	113.2	7.19	3.216	6.35	107	122	-	-	0.426	0.533	0.795	0.439
Ramus height	♂	13	61.0	3.14	0.870	5.14	57	69	0.889	0.10				
	♀	6	55.5	9.79	3.998	17.63	45	71	0.957	0.10	10.226	0.002	1.880	0.077
Ramus maximum breadth	♂	12	47.4	3.50	1.011	7.38	43	53	0.934	0.10				
	♀	5	43.6	3.57	1.600	8.18	40	49	0.923	0.10	0.003	0.960	2.036	0.060
Ramus minimum breadth	♂	21	36.3	3.15	0.688	8.67	32	42	0.909	0.10				
	♀	9	34.9	3.66	1.218	10.48	30	40	0.911	0.10	0.250	0.617	1.098	0.282
M2 arch breadth	♂	16	66.5	3.09	0.775	4.65	61	71	0.935	0.10				
	♀	5	61.6	3.84	1.720	6.23	57	67	0.987	0.50	0.294	0.587	2.924	0.009

Table 44 Descriptive statistics for the Murray Valley male and female mandibles (mm)

	Sex	n	\bar{x}	s	Standard error	Coefficient of variation	Min.	Max.	Shapiro Wilk	Probability	χ^2	Probability	Student's t	Probability																																																																																																																																																																																																																																																					
Symphyseal height	♂	43	36.3	2.83	0.433	7.82	31	43	0.964	0.10	0.771	0.380	6.50	0.000																																																																																																																																																																																																																																																					
	♀	46	32.5	2.48	0.366	7.63	29	38	0.925	0.01					Symphyseal thickness	♂	44	15.8	1.14	0.172	7.22	13	19	0.895	<0.01	3.450	0.063	3.66	0.000	♀	46	14.8	1.51	0.223	10.20	12	20	0.882	<0.01	Corpus height	♂	40	31.0	2.16	0.342	6.84	28	36	0.935	0.02	0.015	0.904	7.36	0.000	♀	43	27.4	2.20	0.337	8.03	23	32	0.957	0.01	Corpus thickness	♂	42	14.1	1.60	0.244	11.35	11	18	0.925	0.01	0.318	0.573	1.58	0.117	♀	45	13.6	1.47	0.220	10.81	11	17	0.936	0.02	Bicondylar breadth	♂	34	120.1	6.12	1.051	5.10	108	132	0.946	0.10	2.690	0.100	4.06	0.000	♀	37	112.8	5.91	0.972	5.24	96	128	0.972	0.50	Bigonial breadth	♂	38	98.6	7.21	1.170	7.31	81	112	0.979	0.50	0.442	0.506	4.75	0.000	♀	44	91.9	6.40	0.965	6.96	74	103	0.971	0.50	Mandibular length	♂	42	114.0	5.31	0.819	4.80	104	126	0.965	0.10	0.782	0.376	6.25	0.000	♀	46	106.4	6.08	0.897	5.72	92	117	0.964	0.10	Ramus height	♂	43	56.4	4.84	0.738	8.58	46	66	0.965	0.10	5.790	0.016	6.40 ¹	0.000	♀	47	50.6	3.60	0.526	7.11	43	57	0.961	0.10	Ramus maximum breadth	♂	41	46.1	2.69	0.421	5.85	41	51	0.951	0.10	0.057	0.812	1.48	0.142	♀	46	45.5	2.79	0.412	6.13	41	53	0.949	0.05	Ramus minimum breadth	♂	43	34.8	2.47	0.373	7.10	28	41	0.982	0.50	1.016	0.313	4.96	0.000	♀	47	32.4	2.12	0.310	6.56	28	37	0.967	0.10	M2 arch breadth	♂	38	61.5	3.14	0.510	5.11	54	68	0.962	0.10	1.590	0.206	4.36	0.000	♀	40	58.7	2.55	0.404
Symphyseal thickness	♂	44	15.8	1.14	0.172	7.22	13	19	0.895	<0.01	3.450	0.063	3.66	0.000																																																																																																																																																																																																																																																					
	♀	46	14.8	1.51	0.223	10.20	12	20	0.882	<0.01					Corpus height	♂	40	31.0	2.16	0.342	6.84	28	36	0.935	0.02	0.015	0.904	7.36	0.000	♀	43	27.4	2.20	0.337	8.03	23	32	0.957	0.01	Corpus thickness	♂	42	14.1	1.60	0.244	11.35	11	18	0.925	0.01	0.318	0.573	1.58	0.117	♀	45	13.6	1.47	0.220	10.81	11	17	0.936	0.02	Bicondylar breadth	♂	34	120.1	6.12	1.051	5.10	108	132	0.946	0.10	2.690	0.100	4.06	0.000	♀	37	112.8	5.91	0.972	5.24	96	128	0.972	0.50	Bigonial breadth	♂	38	98.6	7.21	1.170	7.31	81	112	0.979	0.50	0.442	0.506	4.75	0.000	♀	44	91.9	6.40	0.965	6.96	74	103	0.971	0.50	Mandibular length	♂	42	114.0	5.31	0.819	4.80	104	126	0.965	0.10	0.782	0.376	6.25	0.000	♀	46	106.4	6.08	0.897	5.72	92	117	0.964	0.10	Ramus height	♂	43	56.4	4.84	0.738	8.58	46	66	0.965	0.10	5.790	0.016	6.40 ¹	0.000	♀	47	50.6	3.60	0.526	7.11	43	57	0.961	0.10	Ramus maximum breadth	♂	41	46.1	2.69	0.421	5.85	41	51	0.951	0.10	0.057	0.812	1.48	0.142	♀	46	45.5	2.79	0.412	6.13	41	53	0.949	0.05	Ramus minimum breadth	♂	43	34.8	2.47	0.373	7.10	28	41	0.982	0.50	1.016	0.313	4.96	0.000	♀	47	32.4	2.12	0.310	6.56	28	37	0.967	0.10	M2 arch breadth	♂	38	61.5	3.14	0.510	5.11	54	68	0.962	0.10	1.590	0.206	4.36	0.000	♀	40	58.7	2.55	0.404	4.35	55	67	0.917	<0.01																				
Corpus height	♂	40	31.0	2.16	0.342	6.84	28	36	0.935	0.02	0.015	0.904	7.36	0.000																																																																																																																																																																																																																																																					
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¹ Significant value for Bartlett's χ^2 , Student's t calculated using separate variance estimate

Table 45 Descriptive statistics for the Swanport male and female mandibles (mm)

	Sex	n	\bar{x}	s	Standard error	Coefficient of variation	Min.	Max.	Shapiro Wilk	Probability	χ^2	Probability	Student's t	Probability																																																																																																																																																																																																																																																					
Symphyseal height	♂	15	32.3	2.87	0.741	9.20	27	36	0.939	0.10	0.154	0.694	3.09	0.004																																																																																																																																																																																																																																																					
	♀	18	29.3	2.59	0.611	8.84	25	35	0.945	0.10					Symphyseal thickness	♂	16	14.3	1.09	0.273	7.55	13	16	0.880	0.02	0.317	0.573	0.53	0.601	♀	18	14.2	1.26	0.298	9.15	12	17	0.932	0.10	Corpus height	♂	16	27.5	2.65	0.665	9.60	22	33	0.962	0.50	4.960	0.026	3.49 ¹	0.002	♀	17	25.0	1.47	0.358	5.88	23	28	0.939	0.10	Corpus thickness	♂	16	14.3	1.61	0.403	11.05	12	18	0.943	0.10	0.110	0.740	0.96	0.346	♀	17	14.7	1.48	0.359	3.06	13	18	0.973	0.02	Bicondylar breadth	♂	13	120.7	3.81	1.058	3.42	116	130	0.926	0.10	0.340	0.561	5.68	0.000	♀	17	111.9	4.48	1.088	3.83	104	118	0.856	0.01	Bigonial breadth	♂	13	101.2	3.96	1.097	4.14	94	108	0.949	0.50	2.250	0.134	4.09	0.000	♀	16	93.1	6.09	1.520	6.87	80	103	0.915	0.10	Mandibular length	♂	14	108.7	4.49	1.202	4.04	101	116	0.949	0.10	0.105	0.746	2.62	0.014	♀	17	104.6	4.12	1.000	4.04	97	112	0.971	0.50	Ramus height	♂	15	61.9	3.42	0.883	5.51	57	69	0.934	0.10	1.853	0.173	5.38	0.000	♀	18	53.8	4.90	1.156	9.12	45	61	0.947	0.10	Ramus maximum breadth	♂	15	51.1	4.26	1.107	8.43	46	60	0.926	0.10	0.908	0.341	1.39	0.173	♀	18	49.2	3.33	0.786	6.77	43	57	0.965	0.50	Ramus minimum breadth	♂	15	36.5	3.18	0.822	8.66	31	44	0.972	0.50	0.514	0.473	0.73	0.469	♀	18	35.5	3.80	0.905	10.70	27	41	0.903	0.05	M2 arch breadth	♂	11	59.9	3.01	0.909	5.00	54	64	0.966	0.50	2.327	0.127	2.23	0.036	♀	14	57.7	3.60	0.507
Symphyseal thickness	♂	16	14.3	1.09	0.273	7.55	13	16	0.880	0.02	0.317	0.573	0.53	0.601																																																																																																																																																																																																																																																					
	♀	18	14.2	1.26	0.298	9.15	12	17	0.932	0.10					Corpus height	♂	16	27.5	2.65	0.665	9.60	22	33	0.962	0.50	4.960	0.026	3.49 ¹	0.002	♀	17	25.0	1.47	0.358	5.88	23	28	0.939	0.10	Corpus thickness	♂	16	14.3	1.61	0.403	11.05	12	18	0.943	0.10	0.110	0.740	0.96	0.346	♀	17	14.7	1.48	0.359	3.06	13	18	0.973	0.02	Bicondylar breadth	♂	13	120.7	3.81	1.058	3.42	116	130	0.926	0.10	0.340	0.561	5.68	0.000	♀	17	111.9	4.48	1.088	3.83	104	118	0.856	0.01	Bigonial breadth	♂	13	101.2	3.96	1.097	4.14	94	108	0.949	0.50	2.250	0.134	4.09	0.000	♀	16	93.1	6.09	1.520	6.87	80	103	0.915	0.10	Mandibular length	♂	14	108.7	4.49	1.202	4.04	101	116	0.949	0.10	0.105	0.746	2.62	0.014	♀	17	104.6	4.12	1.000	4.04	97	112	0.971	0.50	Ramus height	♂	15	61.9	3.42	0.883	5.51	57	69	0.934	0.10	1.853	0.173	5.38	0.000	♀	18	53.8	4.90	1.156	9.12	45	61	0.947	0.10	Ramus maximum breadth	♂	15	51.1	4.26	1.107	8.43	46	60	0.926	0.10	0.908	0.341	1.39	0.173	♀	18	49.2	3.33	0.786	6.77	43	57	0.965	0.50	Ramus minimum breadth	♂	15	36.5	3.18	0.822	8.66	31	44	0.972	0.50	0.514	0.473	0.73	0.469	♀	18	35.5	3.80	0.905	10.70	27	41	0.903	0.05	M2 arch breadth	♂	11	59.9	3.01	0.909	5.00	54	64	0.966	0.50	2.327	0.127	2.23	0.036	♀	14	57.7	3.60	0.507	3.93	53	60	0.953	0.50																				
Corpus height	♂	16	27.5	2.65	0.665	9.60	22	33	0.962	0.50	4.960	0.026	3.49 ¹	0.002																																																																																																																																																																																																																																																					
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Mandibular length	♂	14	108.7	4.49	1.202	4.04	101	116	0.949	0.10	0.105	0.746	2.62	0.014																																																																																																																																																																																																																																																					
	♀	17	104.6	4.12	1.000	4.04	97	112	0.971	0.50					Ramus height	♂	15	61.9	3.42	0.883	5.51	57	69	0.934	0.10	1.853	0.173	5.38	0.000	♀	18	53.8	4.90	1.156	9.12	45	61	0.947	0.10	Ramus maximum breadth	♂	15	51.1	4.26	1.107	8.43	46	60	0.926	0.10	0.908	0.341	1.39	0.173	♀	18	49.2	3.33	0.786	6.77	43	57	0.965	0.50	Ramus minimum breadth	♂	15	36.5	3.18	0.822	8.66	31	44	0.972	0.50	0.514	0.473	0.73	0.469	♀	18	35.5	3.80	0.905	10.70	27	41	0.903	0.05	M2 arch breadth	♂	11	59.9	3.01	0.909	5.00	54	64	0.966	0.50	2.327	0.127	2.23	0.036	♀	14	57.7	3.60	0.507	3.93	53	60	0.953	0.50																																																																																																																																																	
Ramus height	♂	15	61.9	3.42	0.883	5.51	57	69	0.934	0.10	1.853	0.173	5.38	0.000																																																																																																																																																																																																																																																					
	♀	18	53.8	4.90	1.156	9.12	45	61	0.947	0.10					Ramus maximum breadth	♂	15	51.1	4.26	1.107	8.43	46	60	0.926	0.10	0.908	0.341	1.39	0.173	♀	18	49.2	3.33	0.786	6.77	43	57	0.965	0.50	Ramus minimum breadth	♂	15	36.5	3.18	0.822	8.66	31	44	0.972	0.50	0.514	0.473	0.73	0.469	♀	18	35.5	3.80	0.905	10.70	27	41	0.903	0.05	M2 arch breadth	♂	11	59.9	3.01	0.909	5.00	54	64	0.966	0.50	2.327	0.127	2.23	0.036	♀	14	57.7	3.60	0.507	3.93	53	60	0.953	0.50																																																																																																																																																																										
Ramus maximum breadth	♂	15	51.1	4.26	1.107	8.43	46	60	0.926	0.10	0.908	0.341	1.39	0.173																																																																																																																																																																																																																																																					
	♀	18	49.2	3.33	0.786	6.77	43	57	0.965	0.50					Ramus minimum breadth	♂	15	36.5	3.18	0.822	8.66	31	44	0.972	0.50	0.514	0.473	0.73	0.469	♀	18	35.5	3.80	0.905	10.70	27	41	0.903	0.05	M2 arch breadth	♂	11	59.9	3.01	0.909	5.00	54	64	0.966	0.50	2.327	0.127	2.23	0.036	♀	14	57.7	3.60	0.507	3.93	53	60	0.953	0.50																																																																																																																																																																																																			
Ramus minimum breadth	♂	15	36.5	3.18	0.822	8.66	31	44	0.972	0.50	0.514	0.473	0.73	0.469																																																																																																																																																																																																																																																					
	♀	18	35.5	3.80	0.905	10.70	27	41	0.903	0.05					M2 arch breadth	♂	11	59.9	3.01	0.909	5.00	54	64	0.966	0.50	2.327	0.127	2.23	0.036	♀	14	57.7	3.60	0.507	3.93	53	60	0.953	0.50																																																																																																																																																																																																																												
M2 arch breadth	♂	11	59.9	3.01	0.909	5.00	54	64	0.966	0.50	2.327	0.127	2.23	0.036																																																																																																																																																																																																																																																					
	♀	14	57.7	3.60	0.507	3.93	53	60	0.953	0.50																																																																																																																																																																																																																																																									

¹ Significant value for Bartlett's χ^2 , Student's t calculated using separate variance estimate

Table 46 Descriptive statistics for the Broadbeach male and female mandibles (mm)

	Sex	n	\bar{x}	s	Standard error	Coefficient of variation	Min.	Max.	Shapiro Wilk	Probability	χ^2	Probability	Student's t	Probability
Symphyseal height	♂	17	33.8	3.12	0.757	9.23	28	39	0.941	0.10				
	♀	3	31.3	1.52	0.882	4.86	30	33	-	-	1.268	0.299	1.36	0.190
Symphyseal thickness	♂	24	15.5	1.61	0.330	10.39	12	19	0.961	0.10				
	♀	4	14.7	0.50	0.250	3.40	14	15	-	-	3.746	0.053	0.96	0.346
Corpus height	♂	24	30.0	2.29	0.468	7.63	25	35	0.974	0.50				
	♀	4	26.7	2.50	1.250	9.36	23	28	-	-	0.037	0.847	2.63	0.014
Corpus thickness	♂	24	14.7	1.45	0.296	9.86	12	17	0.909	0.02				
	♀	4	16.0	0.81	0.408	5.06	15	17	0.944	0.50	1.184	0.277	1.66	0.109
Bicondylar breadth	♂	19	119.8	5.20	1.194	4.34	109	129	0.958	0.50				
	♀	1	115.0	-	-	-	-	-	-	-	-	-	-	-
Bigonial breadth	♂	22	101.5	5.38	1.149	5.30	90	112	0.986	0.95				
	♀	3	94.0	2.64	1.528	2.91	92	97	-	-	1.091	0.296	2.35	0.027
Mandibular length	♂	24	116.3	5.08	1.039	4.37	106	126	0.977	0.50				
	♀	3	114.0	2.00	1.155	1.75	112	116	-	-	1.699	0.192	0.78	0.445
Ramus height	♂	24	58.0	4.81	0.983	8.59	50	66	0.958	0.10				
	♀	3	55.0	1.73	1.000	3.26	51	54	-	-	1.956	0.162	1.07	0.295
Ramus maximum breadth	♂	24	46.1	2.92	0.597	6.33	40	54	0.971	0.50				
	♀	3	44.0	1.73	1.000	3.93	43	46	-	-	0.652	0.419	1.22	0.234
Ramus minimum breadth	♂	25	34.1	2.78	0.558	8.15	28	40	0.977	0.50				
	♀	4	33.5	2.08	1.041	6.21	31	36	-	-	0.353	0.553	0.42	0.675
M2 arch breadth	♂	19	61.6	2.70	0.622	4.40	58	67	0.917	0.02				
	♀	3	57.3	2.30	1.333	4.01	56	60	-	-	0.072	0.788	2.62	0.016

Table 47 Comparison of male and female mandibular dimensions from Coobool Creek with those from the Murray Valley, Swanport and Broadbeach using Student's *t* test

	Murray Valley		Male Swanport		Broadbeach		Murray Valley		Female Swanport		Broadbeach	
	t	P	t	P	t	P	t	P	t	P	t	P
Symphyseal height	4.12	0.000	7.34	0.000	5.68	0.000	4.34	0.000	6.49	0.000	2.85	0.017
Symphyseal thickness	1.29	0.201	3.98	0.000	1.55	0.127	0.85 ¹	0.397	0.20	0.841	0.53 ¹	0.606
Corpus height	4.89	0.000	7.70	0.000	5.63	0.000	4.16	0.000	7.85	0.000	2.81	0.037
Corpus thickness	3.14	0.003	2.34	0.025	1.78	0.082	1.61	0.112	0.32 ¹	0.745	1.62 ¹	0.134
Bicondylar breadth	1.81	0.076	1.80 ²	0.088	2.08	0.047	-	-	-	-	-	-
Bigonial breadth	5.45	0.000	4.30 ²	0.000	4.51	0.000	2.44	0.019	1.90	0.074	0.99	0.378
Mandibular length	0.98	0.330	3.57	0.002	0.31 ¹	0.755	2.33	0.023	3.43	0.003	0.18 ¹	0.861
Ramus height	3.11 ²	0.003	0.69 ¹	0.493	1.99	0.054	2.40 ²	0.020	0.57 ²	0.571	0.08	0.935
Ramus maximum breadth	1.17	0.247	2.38 ¹	0.025	1.17	0.250	1.45 ¹	0.152	3.28 ¹	0.004	0.17 ¹	0.865
Ramus minimum breadth	2.02	0.047	0.12 ¹	0.902	2.52	0.015	2.75 ²	0.008	0.43 ¹	0.669	0.70	0.498
M2 arch breadth	5.36	0.000	4.49	0.000	4.90	0.000	2.28	0.027	2.98	0.008	1.71	0.138

1 Coobool Creek mean exceeded by Murray Valley, Swanport or Broadbeach mean
 2 Significant difference in variance indicated by Bartlett's χ^2 (P = .05-.01), Student's *t* calculated using separate variance estimate

Table 48 Dimensions of the Kow Swamp and Barham male mandibles (mm)

	n	\bar{x}	Kow Swamp			n	\bar{x}	Barham		
			s	Min.	Max.			s	Min.	Max.
Symphyseal height	2	38.0	-	37.0	39.0	3	31.0	1.00	30.0	32.0
Symphyseal thickness	5	16.8	1.30	16.0	19.0	5	16.0	0.70	15.0	17.0
Corpus height	2	34.5	-	34.0	35.0	2	25.5	0.70	25.0	26.0
Corpus thickness	5	15.0	2.12	12.0	18.0	3	13.5	1.32	12.5	15.0
Bicondylar breadth	1	135.0	-	-	-	2	124.0	-	120.0	128.0
Bigonial breadth	2	117.0	-	115.0	119.0	2	109.0	-	106.0	112.0
Mandibular length	2	115.0	-	110.0	120.0	3	108.7	6.80	101.0	114.0
Ramus height	2	68.5	-	67.0	70.0	3	56.7	5.51	51.0	62.0
Ramus maximum breadth	1	45.0	-	-	-	2	44.5	-	44.0	45.0
Ramus minimum breadth	2	35.5	-	35.0	36.0	3	38.7	4.72	35.0	44.0
M2 arch breadth	1	70.0	-	-	-	1	62.0	-	-	-

Table 49 Dimensions of the Kow Swamp and Barham female mandibles (mm)

	Kow Swamp					Barham				
	n	\bar{x}	s	Min.	Max.	n	\bar{x}	s	Min.	Max.
Symphyseal height	-	-	-	-	-	2	36.5	-	36.0	37.0
Symphyseal thickness	-	-	-	-	-	2	15.0	-	14.0	16.0
Corpus height	1	28.0	-	-	-	2	30.0	-	30.0	30.0
Corpus thickness	1	15.0	-	-	-	2	13.5	-	13.5	13.5
Bicondylar breadth	-	-	-	-	-	-	-	-	-	-
Bigonial breadth	-	-	-	-	-	1	103.0	-	-	-
Mandibular length	1	101.0	-	-	-	2	114.5	-	112.0	117.0
Ramus height	1	44.0	-	-	-	1	50.0	-	-	-
Ramus maximum breadth	1	38.0	-	-	-	1	44.0	-	-	-
Ramus minimum breadth	1	31.0	-	-	-	2	34.0	-	34.0	36.0
M2 arch breadth	1	65.0	-	-	-	1	69.0	-	-	-

Table 50 Dimensions of individual late Pleistocene and early Holocene Aboriginal male mandibles (mm)

	Nacurrie	Mossgiel	Lake Nitchie	Lake Mungo III	Kow Swamp 1 ¹	Kow Swamp 5 ¹
Symphyseal height	45	-	37	35	37	39
Symphyseal thickness	17	17	18	15	16	16
Corpus height	-	29	33	-	34	35
Corpus thickness	17	18	15	15	15	15
Bicondylar breadth	-	-	144	129	-	135
Bigonial breadth	109	-	101	106	119	115
Mandibular length	-	-	114	113	120	110
Ramus height	-	66	71	57	70	67
Ramus maximum breadth	-	53	45	40	-	45
Ramus minimum breadth	40	46	35	32	36	35
M2 arch breadth	-	64	69	-	70	-

¹ Dimensions influenced by post-depositional warping

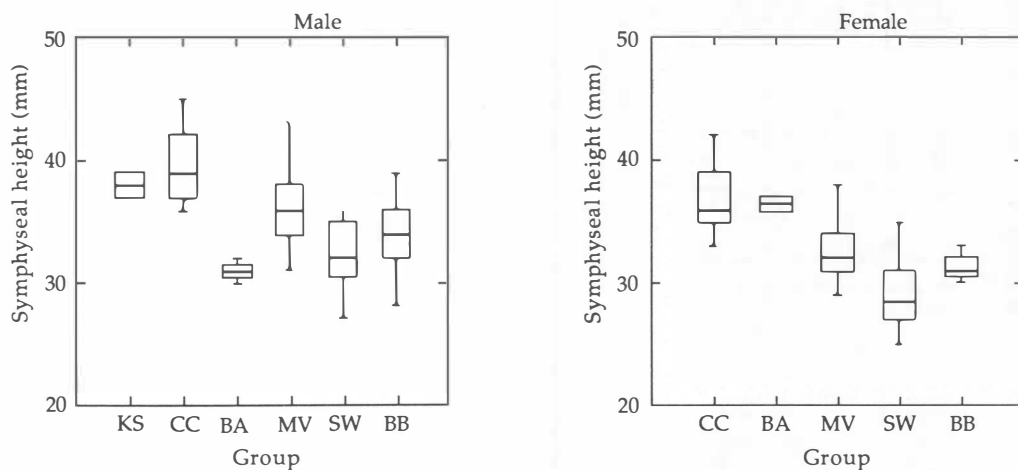


Figure 47 Box plots of distribution of symphyseal height in male and female samples from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

symphyseal height (CC16 and 28) have only moderate levels of anterior tooth wear but such wear in the Kow Swamp and Coobool Creek dentitions is generally relatively high. While it is possible that compensatory deposition of alveolar bone in these populations is more rapid than that in other areas, the increased height of the symphysis in the Coobool Creek mandibles is not confined to the alveolar segment but is evenly distributed between the alveolar and basal areas.

The most prominent feature on the anterior surface of the symphysis is the mental trigone which Larnach and Macintosh (1971:9) define as a 'triangular eminence with its base directed downwards and situated anteriorly across the lower half, or two thirds, of the symphysis'. As Thorne (1975) noted, the apparent development

of the trigone depends on the morphology of the surrounding structures. In mandibles with marked incurvature above the trigone, the trigone appears prominent although it may not be especially large (Figs 48-49). The size and morphology of the trigone varies considerably in the Coobool Creek and Euston mandibles. In CC49 the trigone is large and continuous towards a jutting inferior border, extending laterally into well developed lateral tubercles. In this specimen the impression of size is heightened by the marked incurvature between the trigone and the alveolar ridge (Fig.48). Small low trigones are present in CC28 and 66. The degree of incurvature above the trigone has its maximum development in CC12 and 49, while in CC46 and 65 the symphyseal area is relatively flat.

Larnach and Macintosh (1971) present a three-

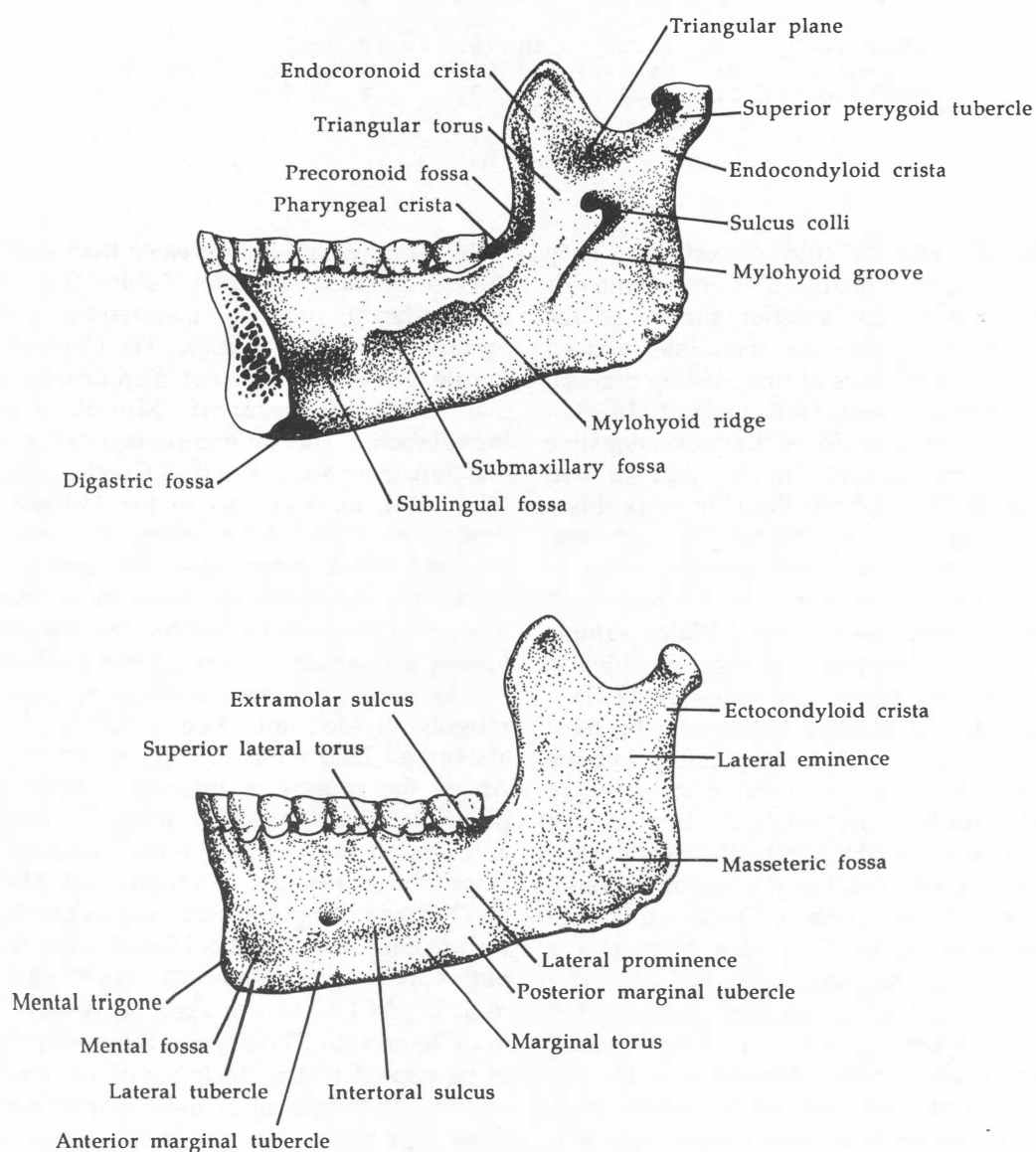


Figure 48 Medial and lateral views of an adult Aboriginal male mandible

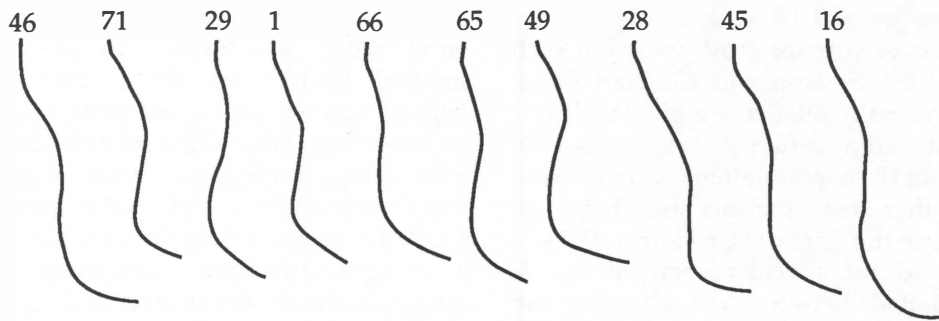


Figure 49 Chin projection and incurvature of symphyseal region in 10 of the Coobool Creek mandibles

Table 51 Chin projection in mandibles from coastal New South Wales, Euston and Coobool Creek

	New South Wales ¹		Euston		Coobool Creek	
	n	%	n	%	n	%
Negative	56	37.9	38	79.2	18	75.0
Neutral	81	54.7	9	18.8	4	16.7
Positive	11	7.4	1	2.0	2	8.3

¹ Larnach and Macintosh (1971)

grade classification of chin projection. They consider this area negative if its most anterior point falls behind the anterior surface of the medial incisors (with the mandible viewed laterally while held in its normal resting occlusal position), and positive if it falls in front. In 18 of the Coobool Creek mandibles the chin is negative (75%), four are neutral (16.7%) and in two individuals (CC29 and 49) the chin is positive. The four Kow Swamp mandibles complete enough for assessment have negative chins as does Nacurrie. Compared to Larnach and Macintosh's coastal New South Wales sample there is a higher frequency of negative chins in the Euston and Coobool Creek series (Table 51).

The position of the chin relative to the most anterior point on the alveolar process, and the visual impression of a negative or positive relationship between the two, is to a large degree a product of the size of the teeth, their supportive alveolar structures and the degree of subnasal prognathism. In the Coobool Creek crania with large dentitions, marked alveolar development and substantial subnasal prognathism (for example CC16 and 26) the external surface of the symphyseal region presents a receding profile. Where there are smaller dentitions, with less alveolar support and reduced subnasal prognathism, the chin tends to form a more projecting eminence (for example CC13 and 49).

The mean thickness of the Coobool Creek

male symphyses, while greater than that in the three comparative samples (Tables 43-47, Fig.50), is significant only in comparison with the Swanport males ($P = .000$). The Coobool Creek female symphyses are not significantly thicker than those at Swanport, Murray Valley or Broadbeach. The difference between the male and female means at Coobool Creek is significant ($P = .004$), as it is also in the Murray Valley sample ($P = .000$). The maximum thickness of the Coobool Creek symphyses (20 mm in CC46) equals the maximum recorded in the comparative series (Murray Valley) and exceeds the Kow Swamp maximum (19 mm in KS7) (Tables 43-49).

The posterior surface of the symphysis can be roughly divided into two portions, the areas above and below the superior transverse torus. Above the transverse torus is a large sloping plane, the alveolar plane. In the Coobool Creek and Euston samples this plane varies in depth, slope and curvature. Larnach and Macintosh (1971) grade this plane according to the degree of inclination. In the Coobool Creek series the slope of this area varies from nearly vertical in the aged individual CC10 to a marked backwards decline in CC46 and 75. The slope of this feature appears to be related to the thickness of the symphysis and the development of the superior transverse torus. The thicker the symphysis, the greater the departure of the slope from the vertical. A slight transverse torus is present in CC45 and 76 with a

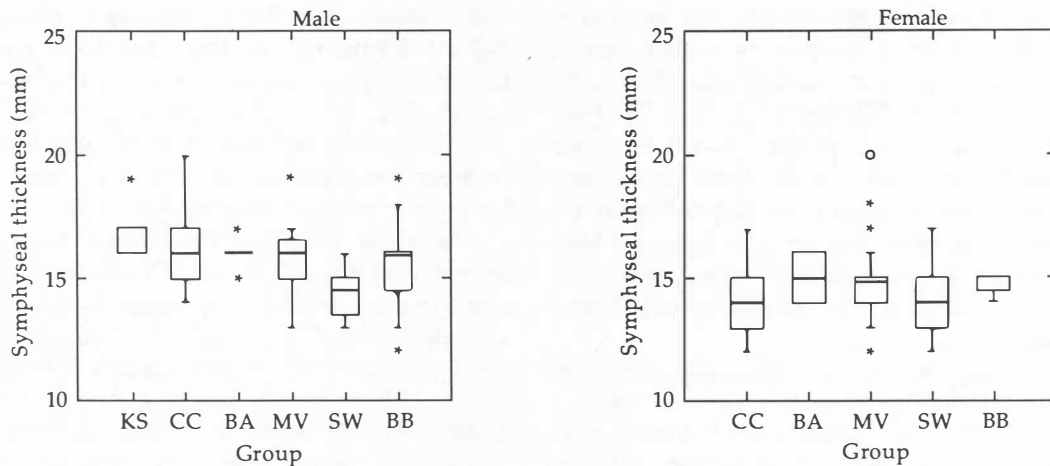


Figure 50 Box plots of distribution of symphyseal thickness in male and female samples from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

moderate torus in CC66 and 75. Thorne (1975) records very slight tori in KS1 and 5 with moderate development in KS14.

The genial pit is a depression which may be present immediately above the genial spines. Shallow genial pits are present in CC1, 12, 16, 23, 29, 35, 38, 40 and 60. In five of these (CC1, 16, 23, 38 and 40) a small foramen, the *foramen supraspinosum* of Weidenreich (1936:85), lies at the base of the pit. In general the area surrounding the genial spines and the inferior border of the posterior surface of the symphysis are not well preserved in the Coobool Creek mandibles, with slight erosion removing the detail from this region. The genial spines in the Coobool Creek mandibles do not project as far as those in the Euston sample but the base of the spines is generally more robust. The digastric fossae in the Euston series typically present deep, rugose areas with sharp raised borders. Preservation of this area in the Coobool Creek mandibles is poor. Compared to the Euston sample the Coobool Creek digastric fossae appear moderate in size, with the exception of CC46 and 82 in which the fossae are marked. Thorne (1975) records all the Kow Swamp fossae as marked.

The most noticeable feature on the lateral surface of the corpus is the extremely well developed lateral prominence in most of the Coobool Creek mandibles. This feature has a maximum development in CC28, 49 and 82 which exceeds that at Euston. Larnach and Macintosh (1971) subdivide the lateral prominence, with the inferior portion called the posterior marginal tubercle (Fig.48). In the Coobool Creek mandibles the lateral prominence is more often a pronounced rounded bulge

extending continuously from the intertoral sulcus down to the inferior border of the corpus. However, a prominent marginal tubercle is present in CC40. The maximum lateral extent of the prominence is usually located in the inferior half of the body, level with the interdental septum for the second and third molars. The development of the prominence has little influence on corpus thickness, which is measured anterior to its maximum development. The mean thickness of the mandibular corpus in the Coobool Creek male mandibles is significantly greater ($P = .003-.025$) than that in the Murray Valley and Swanport samples (Tables 43-47). The Coobool Creek mean, while higher than that at Broadbeach, is not significantly so. The Coobool Creek female mean is significantly greater than Swanport ($P = .004$) but not Broadbeach and the Murray Valley (Tables 43-47). Maximum corpus thickness in the Coobool Creek males (21 mm for CC76) exceeds the maxima in the recent comparative samples as well as that for Kow Swamp (18 mm for KS1 and 14) and Barham (Tables 43-49).

Running between the alveolar ridge medially and the lateral prominence is a furrow of varying development, the extramolar sulcus (Fig.48). This feature is extremely varied in the Coobool Creek and Euston mandibles and to some extent appears related to overall size. This furrow is broad and deep in CC49, short and shallow in CC1 and absent in the aged individual CC10 which has marked alveolar resorption in association with extensive posterior tooth loss.

Larnach and Macintosh (1971:5-6) found that the lateral prominence gives rise to two branches running anteroposteriorly along the lateral surface of the corpus, the superior and marginal

lateral tori. Their results indicate that the occurrence of the superior torus is more common in Aborigines than is the marginal torus. Similarly, in the Kow Swamp (Thorne 1975) and Coobool Creek mandibles the superior branch is more pronounced. In both the Coobool Creek and Euston mandibles there is great variability in the development of these tori and the sulcus which runs between them. The intertoral sulcus is shallow to indistinct in the Coobool Creek mandibles.

The *mental foramen* was most often located under the interval between the second premolar and first molar in Larnach and Macintosh's (1971) coastal New South Wales sample. Due to the combined effects of interproximal tooth wear and compensatory mesial migration of the teeth within the dental arch (Murphy 1964) the position of the *mental foramina*, in relation to the teeth, can be expected to change with increasing age. In aged individuals the posterior teeth will tend to be closer to the *mental foramina*. Similar results were obtained with the Coobool Creek and Euston mandibles to those reported by Larnach

and Macintosh (1971), although the second highest frequency in the Coobool Creek and Euston samples was located under the first molar rather than below the second premolar (Table 52). This may be indicative of age differences between the samples. A well developed double foramen is present bilaterally in CC16.

The mean height of the corpus, measured at the interval M1-M2, in the Coobool Creek male and female samples is significantly greater ($P = .003-.000$) than that in the Murray Valley, Swanport and Broadbeach samples (Tables 43-47, Fig.51). Great corpus height is one of the major distinguishing features of the Coobool Creek mandibles. In the three Kow Swamp mandibles in which corpus height is preserved (males 34 mm for KS1 and 35 mm for KS7, female 28 mm for KS16) their dimensions are close to the Coobool Creek mean. There are significant differences between the male and female means for corpus height at Coobool Creek ($P = .002$) and also in the Murray Valley, Swanport and Broadbeach series ($P = .002-.000$) (Tables 43-46).

Medially the Coobool Creek corpora have

Table 52 Location of the *mental foramen* in mandibles from coastal New South Wales, Euston and Coobool Creek

Teeth	Coastal New South Wales ¹		Euston		Coobool Creek	
	n	%	n	%	n	%
PM1-PM2	2	1.5	1	2.1	-	-
PM2	49	37.0	7	14.6	5	20.8
PM2-M1	65	48.8	28	58.3	13	54.2
M1	17	12.7	12	25.0	6	25.0

¹ Larnach and Macintosh (1971)

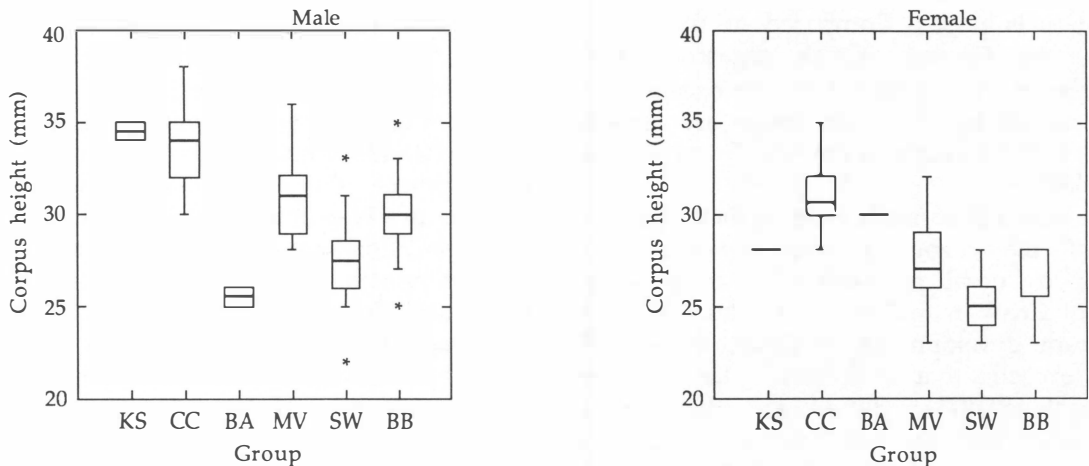


Figure 51 Box plots of distribution of corpus height in male and female samples from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

mylohyoid ridges which are less prominent than those in the Euston sample. Marked mylohyoid ridges are present in only four of the Coobool Creek mandibles (CC32, 40, 66 and 76). In the Euston mandibles the mylohyoid ridges typically have sharp, well defined mylohyoid lines below the molar region, from which the mylohyoid ridge drops away abruptly towards the submaxillary fossae. In the Coobool Creek mandibles, as in KS5 and 8 (Thorne 1975), this region is represented by a low, smooth curve running downwards to the submaxillary fossae and the inferior border of the corpus. This morphology is found in 15 of the Coobool Creek mandibles. Where an abrupt mylohyoid ridge is present it is located posteriorly, adjacent to the third molars.

Inferiorly the submaxillary and submandibular fossae are of varied development. The sublingual fossae in the Coobool Creek mandibles are generally shallow, relative to those in the Euston mandibles. Deep fossae are present in CC1, 12, 28, 40 and 51. The submaxillary fossae are more developed, with marked fossae in CC32, 45, 66, 71 and 76. Age-related changes in some of the Coobool Creek and Euston mandibles result in great morphological change in the medial surface of the corpus. Tooth loss and associated alveolar resorption may remove the mylohyoid ridge and the sublingual and submaxillary fossae (CC10).

Campbell (1925) and Larnach and Macintosh (1971) were unable to find a true mandibular torus in the Aboriginal mandibles they examined. The only example that I have observed in Aboriginal skeletal material is the large, tubular torus in a Tasmanian mandible from Eagle Hawk Neck (Tasmanian Museum, A EH2214). Although the alveolar region adjacent to the canines and premolars often presents a raised surface in the Euston and Coobool Creek mandibles, true mandibular tori are not present. There are no mandibular tori in the Kow Swamp mandibles and they were also not evident in the mandibles from Roonka, Swanport, Broadbeach, Barham and the Murray Valley which I examined.

The mandibular ramus

The Coobool Creek rami give a superficial impression of fragility relative to the large size of the corpus. The rami are tall, vertical structures with high, arched coronoid processes which exceed the condyles in height. The mean height of the Coobool Creek male rami is significantly greater ($P = .054-.003$) than the male means for the Murray Valley and Broadbeach samples

(Tables 43-47). The Coobool Creek female mean is significantly greater ($P = .020$) than the Murray Valley comparative series (Tables 43-47). In the Murray Valley sample the difference between the male and female means for ramus height is significant ($P = .000$) but there is not a significant level of dimorphism for this dimension in any of the other groups. The resting height of the ramus is influenced by the degree of anteroposterior curvature present in the mandibular corpus and the angle at which the ramus meets the body of the mandible. All of these features are highly variable and ramus height displays consistently large coefficients of variation in each of the populations examined. The maximum height of the Coobool Creek rami (71 mm for CC50) exceeds the maximum dimension at Kow Swamp (70 mm for KS1) and the maxima in the comparative samples.

Although giving a visual impression of relative narrowness, the minimum breadth of the Coobool Creek male rami is actually significantly greater than the mean in the Murray Valley and Broadbeach samples ($P = .047-.015$) (Tables 43-47). Mean minimum ramus breadth in the Coobool Creek females is significantly greater than that in the Murray Valley ($P = .008$) but not Swanport and Broadbeach (Tables 43-47). The Swanport males and females have rami which are slightly broader than those at Coobool Creek. The difference between the male and female means is significant only in the Murray Valley series ($P = .000$). Two of the Kow Swamp male mandibles (KS1 and 5) have this area preserved and their minimum ramus breadths (36 mm and 35 mm respectively) are close to the Coobool Creek male mean of 36.3 mm, while the female KS16 has a relatively narrow minimum ramus breadth of 31 mm.

Mean maximum ramus breadth in Coobool Creek males slightly exceeds that at Broadbeach and the Murray Valley but is significantly less than that at Swanport ($P = .025$). The small Coobool Creek female sample ($n = 5$) have rami which are significantly narrower than those at Swanport ($P = .004$), as well as having a mean dimension which is less than the Murray Valley and Broadbeach. There is little sex-based dimorphism in this dimension, with no significant differences between the male and female means in the comparative samples. The maximum ramus breadth in the Coobool Creek series (53 mm for CC47) is exceeded by both the male and female Swanport maxima (60 mm for male and 57 mm for female). Few of the Kow Swamp mandibles have this feature preserved, the maximum of 45 mm is in KS1 (Tables 48-49).

The lateral surface of the ramus in the Coobool Creek mandibles is distinguished by large, often deeply depressed, masseteric fossae. Both the overall size and depth of the fossae are greater in the Coobool Creek males than in the females and this is consistent with the male and female comparative mandibles. In males there is often marked eversion of the angle of the mandible, with pronounced tubercles on the inferoposterior border, and a generally rugose area of attachment for the masseter muscles. In three of the Coobool Creek males (CC28, 46 and 82) the depth and overall size of the masseteric fossae, with marked thickening of the inferior borders, exceed the development in the Euston and Kow Swamp mandibles. Larnach and Macintosh's (1971) data indicates that eversion of the angle of the mandible has a higher incidence in males (40.9%) than in females (3.5%). Similar results were obtained with the Coobool Creek and Euston mandibles. In contradiction to the general pattern for Coobool Creek, there is a slight inversion of the angle in the male CC36 and the females CC1 and 9.

Subcondyloid tubercles were found on the lateral edge of the condyle in five of the 15 Coobool Creek mandibles in which this area is preserved. In two of these there are small bilateral tubercles and in the third (CC28) marked bilateral tubercles are present. The mandibular condyles in the Coobool Creek mandibles are broad (mediolaterally) and narrow (anteroposteriorly), with the mean maximum breadth of the male sample ($n = 7$, $\bar{x} = 23.4$, $s = 2.07$) being significantly greater than that in the Murray Valley males ($n = 36$, $\bar{x} = 20.8$, $s = 1.86$, $t = 3.27$, $P = .002$) and Broadbeach ($n = 23$, $\bar{x} = 21.1$, $s = 1.49$, $t = 3.19$, $P = .003$). The Coobool Creek male mean is greater than that at Swanport ($n = 11$, $\bar{x} = 21.8$, $s = 1.47$) but not significantly so ($P = .071$). In the Kow Swamp mandibles the condyles are preserved in four individuals and they are also tall and narrow.

Degenerative arthritis of the temporomandibular joint in Aborigines is highly correlated with tooth wear and the increasing 'occlusal stress' that results from it (Richards and Brown 1981a). Although dental attrition is marked in the majority of the Coobool Creek mandibles in which the condyles are preserved, degenerative changes in the surface of the condyle, as well as in the articular tubercle of the temporal bone, are generally slight. Using the grading system developed by Richards and Brown (1981a), seven of the 15 Coobool Creek mandibles with condyles (CC23, 28, 36, 38, 49, 51 and 71) correspond to their Class 0 (normal),

with no evidence of degenerative changes either in the condyles or temporal fossae. Five of the Coobool Creek mandibles (CC10, 12, 29, 45 and 47) have slight localised erosion of the condylar and temporal surfaces (Richards and Brown's Class 1). In two of these (CC10 and 12) there is acute dental attrition with associated malocclusion and abscess development. The remaining three mandibles (CC13, 46 and 65) have more extensive degeneration, with greater plastic change in the temporal segment. These temporomandibular joints correspond with Richards and Brown's Class 2 (localised proliferation). The degenerative changes in the Coobool Creek temporomandibular joints do not approach the condition evident in their Classes 3 (generalised proliferation) and 4 (eburnation). Thorne (1975) observed similarly low levels of degenerative change in the Kow Swamp temporomandibular joints.

Slightly below the medial edge of the condyle a small tubercle, the superior pterygoid tubercle, may be present (Fig.48). Larnach and Macintosh (1971) found this tubercle present as a trace in 8.1% and marked in 8.8% of their coastal New South Wales sample. Small tubercles are present in Coobool Creek mandibles CC12 and 65.

The coronoid process in the Coobool Creek mandibles are tall and broad with pronounced thickening along the anterior border. Where both coronoid processes and condyles are preserved, the coronoid process exceeds the condyle in height in all but two of the mandibles. Measurement of the sigmoid notch was undertaken using the procedure defined by Larnach and Macintosh (1971) (Fig.5). In the 12 Coobool Creek mandibles where sigmoid notch depth can be measured, four (CC1, 28, 29 and 76) have sigmoid notches which can be classified under Larnach and Macintosh's scheme as 'deep'. There are similar frequencies for the three size grades of sigmoid notch depth in the Euston and coastal New South Wales sample (Table 53) while the small Coobool Creek sample has a higher frequency of 'deep' sigmoid notches. The maximum depth of the notch in the Euston sample (15.4 mm) is exceeded by CC28 (16 mm) and CC29 (17 mm).

The posterior continuation of the alveolar margin, behind the third molar, runs into a marked thickening of bone, the triangular torus. This torus, which bifurcates to form the endocondyloid crista posteriorly and the endocoronoid crista anteriorly (Fig.48), is the most prominent feature on the medial surface of the Euston and Coobool Creek rami. In the Coobool Creek rami the thickness of the ramus at the

Table 53 Depth of the sigmoid notch in mandibles from coastal New South Wales, Euston and Coobool Creek

Measurement mm	New South Wales ¹		Euston		Coobool Creek	
	n	%	n	%	n	%
<10	35	23.3	13	27.7	1	8.33
10-13	94	67.1	29	61.7	7	58.33
>13	13	9.6	5	10.6	4	33.33

¹ Larnach and Macintosh (1971)

point at which the torus bifurcates (13 mm in CC46 and 49) is greater than that in the Euston rami (9.7 mm). The anterior branch of the triangular torus, the endocoronoid crest, is generally more pronounced than the posterior branch in the Coobool Creek series. There is, however, considerable variation in the morphology of these crests in both the Euston and Coobool Creek material.

Lying immediately above the triangular torus is a flattish area of bone, the triangular plane (Fig.48), limited posteriorly and anteriorly by the endocondyloid and endocoronoid crests. The size of this feature is determined by the depth of the sigmoid notch, the breadth of the ramus and the morphology of the triangular torus. Relatively and absolutely large triangular planes are found in the Coobool Creek mandibles CC28, 29, 40, 45 and 46. Larnach and Macintosh (1971) describe this plane as being either flat or forming a shallow fossa. They found that fossae were more often present in female than in male mandibles. Slight fossae are evident in CC13, 32, 35, 38, 47, 65, 66 and 75, with relatively deep fossae in CC28, 35 and 45. An unusual feature in CC32 and to a lesser extent in CC28, 35 and 65 is found in the anterior half of the fossa where there is a deeply depressed roughened area of

tendinous insertion for the temporal muscle.

The fibres of the medial pterygoid are attached by strong tendinous laminae to the lower and posterior part of the medial surfaces of the ramus and the angle of the mandible. In the Coobool Creek mandibles this area is often extremely rugged and elevated, with a series of pronounced tubercles reaching from the edge of the ramus inwards and upwards to the mylohyoid groove and sulcus colli. The size of this area in the Coobool Creek male mandibles exceeds that in the Euston series, with CC28, 46, 71 and 82 being particularly rugose. The Coobool Creek females do not have a similar degree of development but still fall within the robust end of the Euston range.

One of the most distinctive features of the mandibles from Coobool Creek and Kow Swamp is their great posterior breadth. The mean bigonial breadth in the Coobool Creek male mandibles is significantly greater ($P = .000$) than that in the comparative male series (Tables 43-47, Fig.52). There is a similar trend in the small Coobool Creek female sample ($n = 3$) but not to the same degree ($P = .378-.019$). Maximum bigonial breadth in the Coobool Creek mandibles (122 mm for CC46) is considerably higher than the maximum recorded in the Murray Valley,

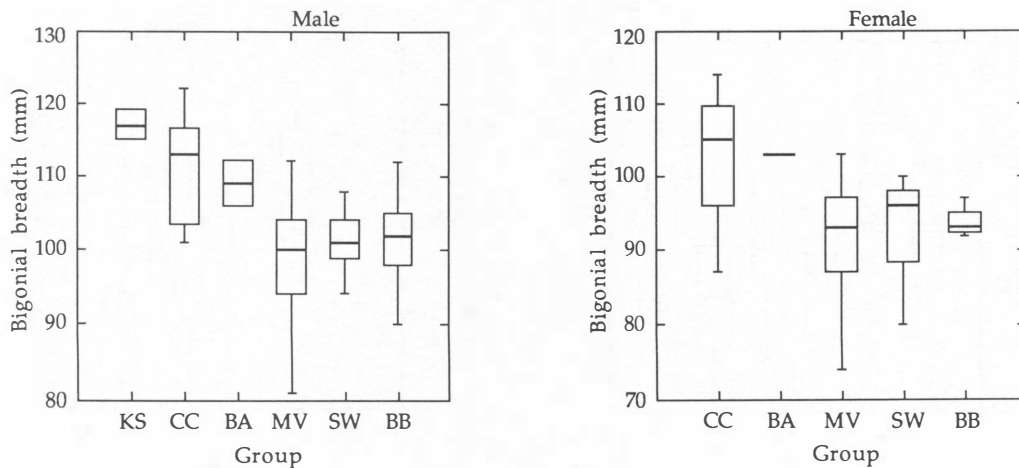


Figure 52 Box plots of distribution of bigonial breadth in male and female samples from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

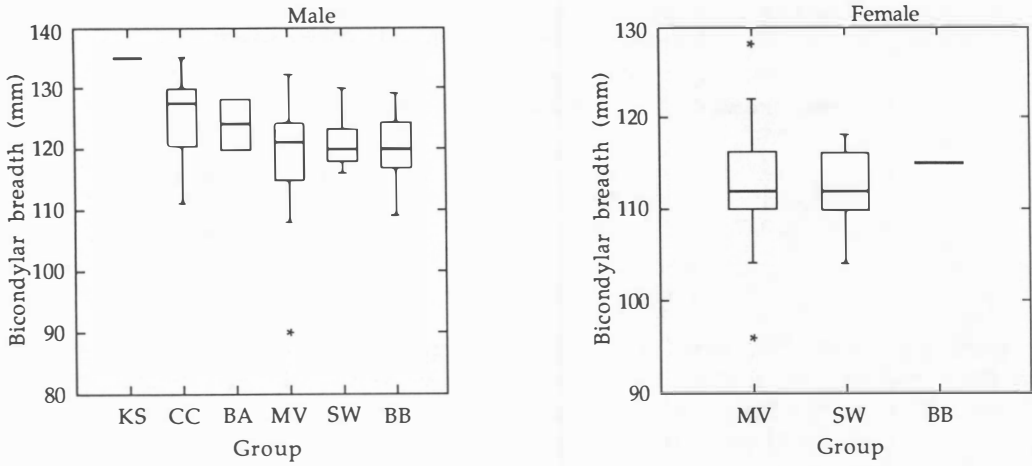


Figure 53 Box plots of distribution of bicondylar breadth in male and female samples from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

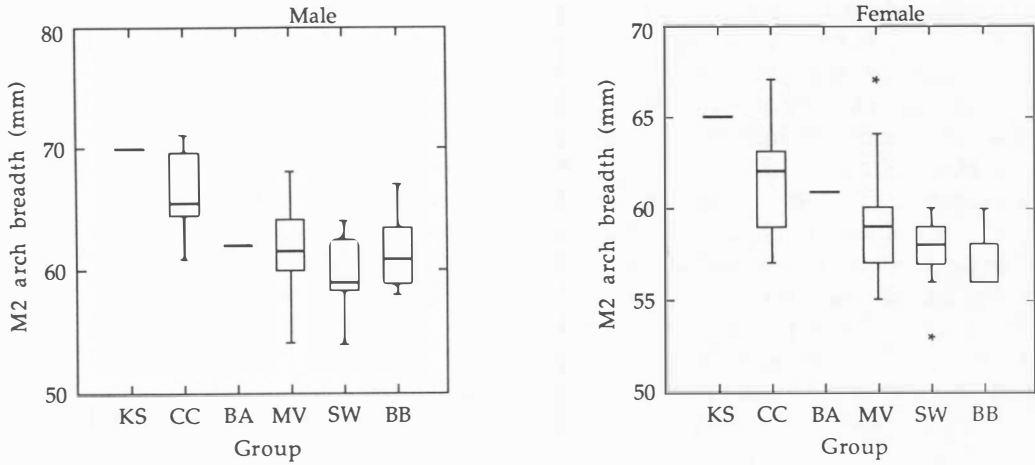


Figure 54 Box plots of distribution of M2 arch breadth in male and female samples from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

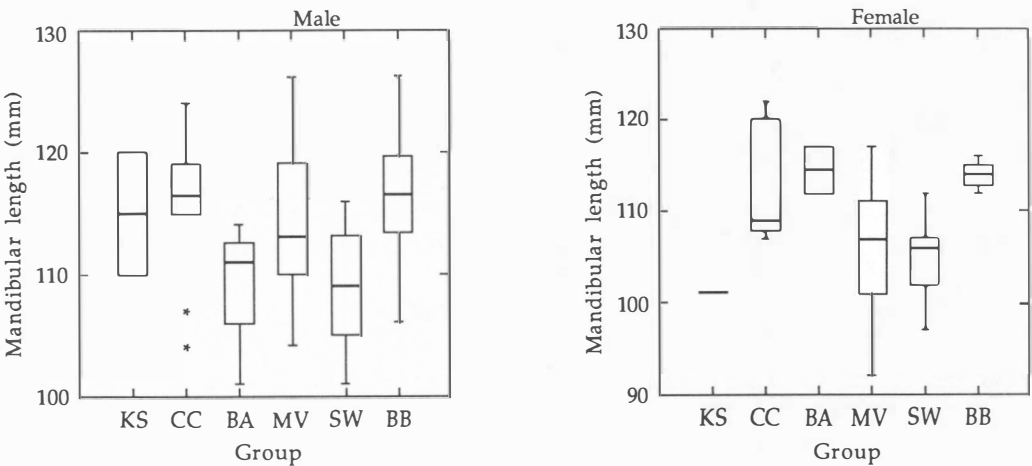


Figure 55 Box plots of distribution of mandibular length in male and female samples from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

Swanport and Broadbeach samples (112 mm) and Kow Swamp (119 mm for KS1, but this is an inflated figure due to the effects of post-depositional warping) (Tables 48-50). Sexual dimorphism in this dimension is pronounced, with the difference between the male and female means in the Swanport and Murray Valley samples (the only two samples with a large female component) being significant ($P = .001-.000$) (Tables 43-45).

This great bigonial breadth is repeated to a lesser degree in the maximum breadth across the condyles in the Coobool Creek mandibles (Tables 43-47, Fig.53). The maximum bicondylar breadth in the Coobool Creek males (135 mm for CC28) equals the Kow Swamp maximum (KS5) and exceeds the maximum in the Murray Valley series (132 mm). As for bicondylar breadth there is a significant difference between the male and female means for this dimension in the Murray Valley and Swanport series ($P = .000$) (Tables 44-45).

Anteriorly this great breadth is also evident in the Coobool Creek mandibular dental arch, where maximum arch breadth at the second molar (71 mm for CC40) exceeds the maximum recorded at Kow Swamp (70 mm for KS1, figure inflated due to post-depositional warping) (Table 48), and the Murray Valley maximum of 68 mm. M2 arch breadth in the Coobool Creek male sample is significantly greater ($P = .000$) than that in the comparative male samples (Tables 43-47, Fig.54). The Coobool Creek females have similarly broad dental arches and are significantly broader than the Murray Valley and Swanport females ($P = .027-.008$). Levels of sexual dimorphism for dental arch breadth are high with significant differences between each of the male and female means ($P = .036-.000$) (Tables 43-46).

Although the Coobool Creek mandibles are extremely broad, they are not especially long. Mean mandibular length in the Coobool Creek males is significantly greater than that at Swanport ($P = .002$) but similar to the Murray Valley and Swanport (Tables 43-47, Fig.55). Maximum mandibular length at Coobool Creek (124 mm for CC49) and Kow Swamp (120 mm for KS1) are exceeded by the Murray Valley and Broadbeach maximum (126 mm). The difference between the male and female means in the Murray Valley and Swanport samples is significant ($P = .014-.000$) (Tables 44-45).

Correlation

To explore structural (biological) associations between the Coobool Creek mandibular dimen-

sions, and to avoid redundancy in the discriminant function analysis, correlation matrices (Pearson's r) and scatterplots were produced from the Murray Valley and Coobool Creek data sets. It has been my experience that samples >200 are needed to obtain reproducible results in correlation analyses as the position of a few outlying points can have an undue influence in samples of smaller size. Unfortunately, samples of human skeletal material from the terminal Pleistocene and early Holocene of Australia of this size are unavailable. Even though every effort was made to examine data at an individual level (dispersion and linearity examined in scatterplots and the overall relationship of outliers explored in the original cases) I would not wish to emphasise these results too strongly. Correlation matrices were developed from the Murray Valley sample to examine possible sex-based variation in correlation, the effect of the distance between the male and female means on the size of the correlation coefficient and the topographical and biological associations between the variables. The Murray Valley sample was chosen for the initial analysis due to the relatively large size of both the male and female sample.

Matrices were formed using the convention of listwise deletion of missing data. With this method mandibles with one or more missing variables are excluded from the analysis. Missing data reduced the size of the Murray Valley mandible sample to 23 males and 22 females. Correlation matrices were developed for the male, female and pooled-sex samples (Tables 54-56). For samples of 22-23 a correlation coefficient of 0.34-0.35 is significant at the .05 level, while for the pooled-sex sample ($n = 45$) a correlation coefficient of 0.24 is significant at the 0.05 level. Rather than simply accepting fairly arbitrary levels of significance as conveying some sense of biological relationship it is the manner in which the variables are associated (form of the regression line, dispersion and position of outliers) which provides the greatest insight. Scatterplots were produced for each pair of variables and examined for distributional linearity and, in the pooled sample, the distance between the male and female clusters.

Correlation matrices were then developed for the Coobool Creek pooled-sex data using the convention of pairwise deletion of missing data (Table 57). The incomplete condition of the Coobool Creek mandibles made pairwise deletion the only practical choice, as listwise deletion would have reduced the size of the sample to four. Using pairwise deletion a potentially

Table 54 Pearson's correlation coefficient matrix for the Murray Valley male mandibular dimensions

	2	3	4	5	6	7	8	9	10	11
1	0.47	0.71	0.56	0.46	0.59	0.62	0.32	0.46	0.19	0.34
2		0.23	0.64	0.01	0.36	0.36	0.50	0.04	0.37	0.30
3			0.25	0.36	0.32	0.66	0.38	0.59	-0.01	0.21
4				0.40	0.35	0.37	0.35	0.24	0.38	0.50
5					0.62	0.47	0.09	0.58	0.06	0.39
6						0.50	0.05	0.44	0.29	0.31
7							0.38	0.55	0.08	0.44
8								0.26	0.36	0.28
9									0.31	0.18
10										0.08

n = 23, r = 0.34, P = 0.05

1 Symphyseal height	4 Corpus thickness	8 Ramus height
2 Symphyseal thickness	5 Bicondylar breadth	9 Ramus maximum breadth
3 Corpus height	6 Bigonial breadth	10 Ramus minimum breadth
	7 Mandibular length	11 M2 arch breadth

Table 55 Pearson's correlation coefficient matrix for the Murray Valley female mandibular dimensions

	2	3	4	5	6	7	8	9	10	11
1	0.32	0.53	-0.18	0.07	-0.17	0.66	0.03	0.28	0.12	0.02
2		0.28	0.05	-0.02	0.12	0.34	0.23	0.01	0.09	0.40
3			-0.19	0.08	0.03	0.46	0.26	0.22	0.37	0.22
4				-0.20	0.52	0.23	0.06	0.29	0.32	0.18
5					0.24	0.20	-0.31	0.18	0.09	-0.21
6						0.12	-0.38	0.04	0.13	0.10
7							0.12	0.45	0.43	0.12
8								-0.04	0.11	0.33
9									0.62	0.07
10										0.25

n = 22, r = 0.35, P = 0.05

1 Symphyseal height	4 Corpus thickness	8 Ramus height
2 Symphyseal thickness	5 Bicondylar breadth	9 Ramus maximum breadth
3 Corpus height	6 Bigonial breadth	10 Ramus minimum breadth
	7 Mandibular length	11 M2 arch breadth

Table 56 Pearson's correlation coefficient matrix for the pooled sex Murray Valley mandibular dimensions

	2	3	4	5	6	7	8	9	10	11
1	0.49	0.75	0.30	0.51	0.39	0.75	0.48	0.39	0.40	0.40
2		0.41	0.34	0.18	0.30	0.47	0.47	0.07	0.35	0.43
3			0.17	0.40	0.32	0.71	0.58	0.41	0.43	0.41
4				0.25	0.46	0.38	0.32	0.29	0.42	0.42
5					0.55	0.54	0.29	0.44	0.32	0.37
6						0.41	0.09	0.31	0.33	0.33
7							0.52	0.48	0.47	0.46
8								0.19	0.49	0.47
9									0.45	0.18
10										0.32

n = 45, r = 0.24, P = 0.05

1 Symphyseal height	4 Corpus thickness	8 Ramus height
2 Symphyseal thickness	5 Bicondylar breadth	9 Ramus maximum breadth
3 Corpus height	6 Bigonial breadth	10 Ramus minimum breadth
	7 Mandibular length	11 M2 arch breadth

Table 57 Pearson's correlation coefficient matrix for the pooled sex Coobool Creek mandibular dimensions

	2	3	4	5	6	7	8	9	10	11
1 n	29	27	28	8	18	17	19	16	28	21
r	0.21	0.77	0.29	0.51	0.38	0.48	0.16	0.61	0.30	0.18
P	.08	.00	.05	.09	.09	.04	.28	.01	.22	.24
2 n		27	29	8	18	17	19	16	29	21
r		0.25	0.37	0.10	0.61	-0.12	0.61	0.53	0.41	0.45
P		.09	.03	.36	.00	.33	.00	.00	.01	.02
3 n			27	7	16	16	18	15	26	21
r			0.23	-0.06	0.48	0.31	0.27	0.59	0.28	0.09
P			.14	.44	.03	.11	.15	.01	.45	.39
4 n				8	17	17	19	16	28	21
r				0.68	0.19	-0.08	0.43	0.23	0.33	0.43
P				.03	.25	.37	.03	.14	.09	.03
5 n					6	8	8	7	8	7
r					-0.23	-0.10	-0.08	0.25	0.12	0.18
P					.44	.45	.43	.34	.39	.35
6 n						13	13	11	18	16
r						-0.05	0.54	0.39	0.35	0.32
P						.36	.05	.15	.12	.10
7 n							17	14	17	15
r							-0.04	0.12	0.08	-0.14
P							.41	.39	.38	.42
8 n								16	19	15
r								0.52	0.60	0.45
P								.01	.00	.06
9 n									17	12
r									0.92	0.25
P									0.00	.14
10 n										20
r										-0.12
P										.30

n = number, r = range, P = probability
 1 Symphyseal height
 2 Symphyseal thickness
 3 Corpus height

4 Corpus thickness
 5 Bicondylar breadth
 6 Bigonial breadth
 7 Mandibular length

8 Ramus height
 9 Ramus maximum breadth
 10 Ramus minimum breadth
 11 M2 arch breadth

different subset is used for each correlation and so each of the sample sizes are listed, with their correlations, in Table 57. Although with large samples trends may be apparent at low levels of correlation ($r = 0.25-0.35$), experience with scatterplots developed from the Murray Valley data indicated that only correlation coefficients greater than 0.399 displayed an association that could be considered directional. To reduce this discussion to a manageable level attention will be focused on the small number of moderate to high order correlations (0.39-1.0) that were obtained between the pairs of mandibular dimensions. It should be kept in mind that although correlation coefficients of 0.39 may be significantly greater than zero, and show a directional trend in bivariate plots, they only account for 15% of shared variation.

Murray Valley males

Of 78 correlations in the Murray Valley male matrix only 21 were greater than $r = 0.39$. The highest positive correlation ($r = 0.71$) is between symphyseal height and corpus height, followed by the correlation between corpus height and the

length of the mandible ($r = 0.66$). Corpus height and ramus minimum breadth have the only negative correlation ($r = -0.01$) (Table 54).

Summary (correlation coefficients greater than 0.39)

1. Symphyseal height: correlated with symphyseal thickness, corpus height, corpus thickness, mandibular length, bicondylar and bigonial breadth and maximum breadth of the ramus.
2. Symphyseal thickness: correlated with symphyseal height, corpus thickness and ramus height.
3. Corpus height: correlated with symphyseal height, length of the mandible and maximum breadth of the ramus.
4. Corpus thickness: correlated with symphyseal height, symphyseal thickness, bicondylar breadth and M2 arch breadth.
5. Bicondylar breadth: correlated with symphyseal height, corpus thickness, bigonial breadth, mandibular length and maximum breadth of the ramus.
6. Bigonial breadth: correlated with bicondylar breadth, length of the mandible and maximum ramus breadth.
7. Mandibular length: correlated with corpus height, bicondylar breadth and bigonial breadth.

8. Ramus height: correlated with symphyseal thickness.
9. Ramus maximum breadth: correlated with symphyseal height, corpus height, bicondylar and bigonial breadth.
10. Ramus minimum breadth: no correlation greater than $r = 0.39$.
11. M2 arch breadth: correlated with corpus thickness.

Murray Valley females

There is a lower overall level of correlation in the Murray Valley female matrix than that for the Murray Valley males. Only eight of the 78 correlations were greater than $r = 0.39$. The highest correlation ($r = 0.66$) is between symphyseal height and the length of the mandible, followed by the correlation between maximum and minimum ramus breadth ($r = 0.62$) (Table 55).

Summary (correlation coefficients greater than 0.39)

1. Symphyseal height: correlated with corpus height and length of mandible.
2. Symphyseal thickness: correlated with M2 arch breadth.
3. Corpus height: correlated with symphyseal height and length of mandible.
4. Corpus thickness: correlated with bigonial breadth.
5. Bicondylar breadth: no correlation coefficients greater than 0.39.
6. Bigonial breadth: correlated with corpus thickness.
7. Mandibular length: correlated with corpus height and maximum and minimum ramus breadths.
8. Ramus height: no correlation coefficients greater than 0.39.
9. Maximum ramus breadth: correlated with minimum ramus breadth and mandibular length.
10. Minimum ramus breadth: correlated with maximum ramus breadth and mandibular length.
11. M2 arch breadth: correlated with symphyseal thickness.

Pooled male-female sample

The level of correlation in the pooled sample increased substantially with 31 of the 78 correlation coefficients exceeding 0.39 (Table 56). The highest correlations ($r = 0.75$) are between symphyseal height and corpus height and symphyseal height and mandibular length, followed by corpus height and mandibular length ($r = 0.71$). All of the remaining correlation coefficients are less than $r = 0.60$. There are no negative correlations.

An examination of scatterplots for these data indicated that the increased level of correlation

was to some degree an artifact of the distance between the male and female means rather than an overall pattern of covariance (Fig.56). A general exception to this is found in the variables correlated with mandibular length which show a large overlap between the male and female distributions and an increase in covariance in the pooled sample (Fig.56).

Summary (correlation coefficients greater than 0.39)

1. Symphyseal height: correlated with symphyseal thickness, corpus height, bicondylar breadth, mandibular length, ramus height, ramus minimum breadth and M2 arch breadth.
2. Symphyseal thickness: correlated with symphyseal height, mandibular length, ramus height and M2 arch breadth.
3. Corpus height: correlated with symphyseal height, mandibular length, ramus height, maximum and minimum ramus breadth and M2 arch breadth.
4. Corpus thickness: correlated with bigonial breadth, ramus minimum breadth and M2 arch breadth.
5. Bicondylar breadth: correlated with bigonial breadth, mandibular length and maximum breadth of ramus.
6. Bigonial breadth: correlated with bicondylar breadth and length of mandible.
7. Mandibular length: correlated with symphyseal height, symphyseal thickness, corpus height, bicondylar breadth, bigonial breadth, ramus height, maximum and minimum ramus breadth and M2 arch breadth.
8. Ramus height: correlated with symphyseal height, symphyseal thickness, corpus height, mandibular length, ramus minimum breadth and M2 arch breadth.
9. Ramus maximum breadth: correlated with corpus height, bicondylar breadth, mandibular length and minimum ramus breadth.
10. Ramus minimum breadth: correlated with symphyseal height, corpus height, corpus thickness, mandibular length, ramus height and maximum breadth of ramus.
11. M2 arch breadth: correlated with symphyseal height, symphyseal breadth, corpus height, corpus thickness, mandibular length and height of ramus.

Discussion

Pearson and Davin (1924) distinguished between 'spurious' and 'organic' correlations in their examination of the levels of correlation between cranial variables. They demonstrated that the presence of common components in two indices produced a spurious correlation between the index variables. Solow (1966) was able to quantify the expected levels of correlation between cranial measurements sharing common reference points or covering similar anatomical

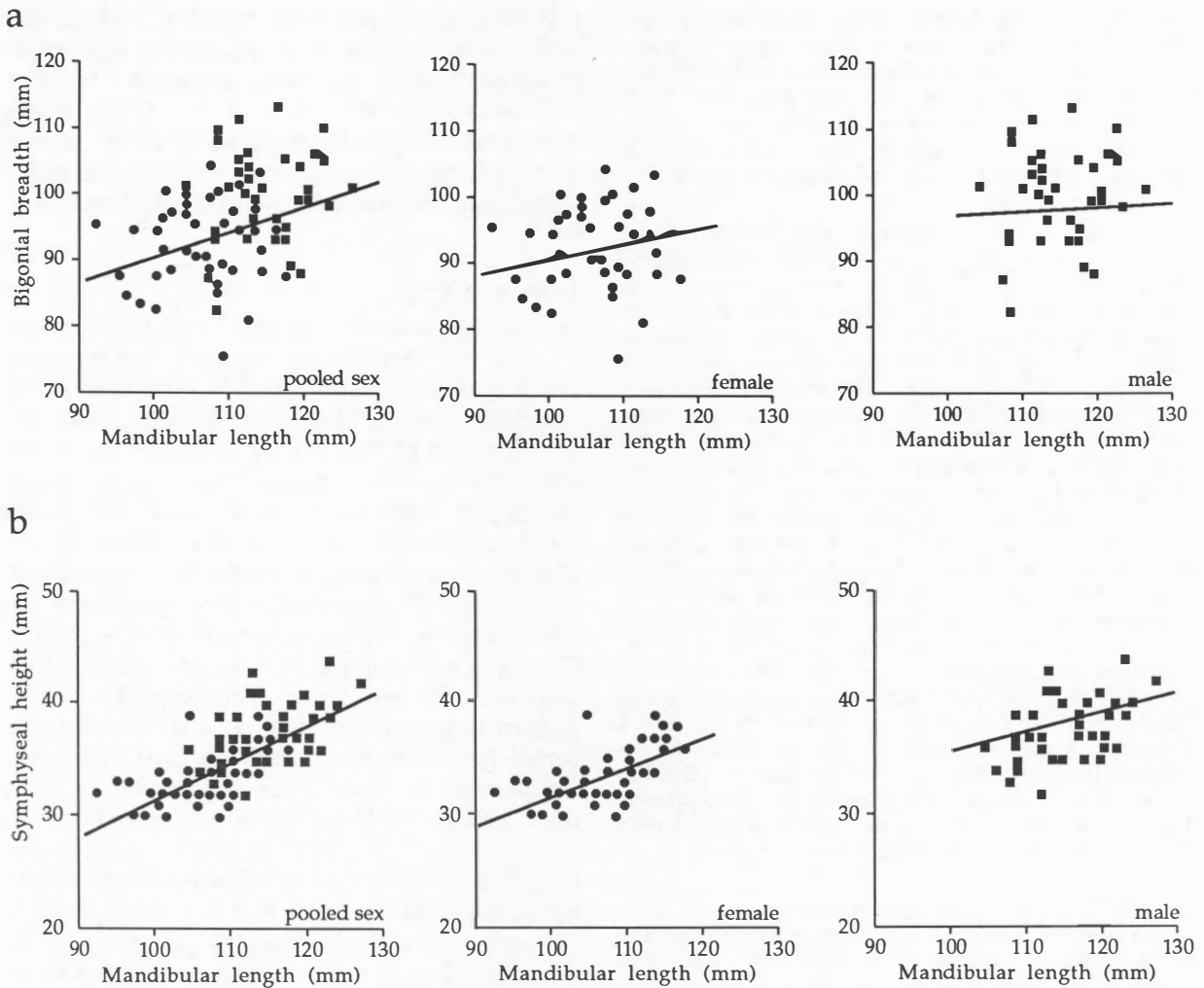


Figure 56 Influence of distance between male and female means on Pearson's correlation coefficient. In (a) the increased level of correlation in the pooled-sex sample is an artifact of the male and female distributions while (b) displays a moderate level of covariation with less distance between the male and female group means

regions. He distinguished between 'topographical' (variables sharing common reference points) and 'non-topographical' correlation (coordinated variation of reference points that are not common to both variables). 'An observed correlation between variables that are not topographically related, with no reference point in common, may be considered to reflect a biological co-ordination' (Solow 1966:24). Brown's (1973) factor analysis of Aboriginal crania paid particular attention to the spurious correlation between variables covering the same anatomical region. With the variables used in the present analysis a moderate level of spurious correlation is to be expected as several measurements cover the same anatomical region. Cases of this sort are:

1. Symphyseal height and corpus height: these two variables measure the same general anatomical region,

the height of two parts of the mandibular body from the inferior to its superior border. It is not surprising therefore that high levels of correlation were found between these two variables in each of the three matrices, with between 28 and 56% of their variation being accounted for by their shared linear relationship. Least squares regression using these two variables resulted in a singularity due to colinearity (one variable a scaled representative of the other) and it would be pointless to include both of these variables in a discriminant analysis due to the redundancy involved.

2. Symphyseal thickness and corpus thickness: these two dimensions measure a related anatomical region, the thickness of different parts of the mandibular body. These two regions are, however, differentiated anatomically by a number of apparently unrelated anatomical features which influence the mesial-lateral and anterior-posterior dimensions at these points (size of the mental trigone, development of the lateral prominence, size and morphology of the mylohyoid ridge). The only high correlation involving these two

variables is in the Murray Valley male sample ($r = 0.64$). In both the female and pooled-sex samples, scatterplots of these data displayed considerable dispersion (standard error of estimate males 1.009, females 1.480 and pooled-sex sample 1.331) with a regression equation for the males $x = 10.640 + 0.368y$, females $x = 12.688 + 0.161y$ and pooled-sex sample of $x = 10.940 + 0.318y$.

3. Bicondylar breadth, bigonial breadth and M2 arch breadth: just as there is an obvious morphological association between breadths of the zygomatic arches and cranial vault, brought about by their anatomical relationship (Brown 1973:42), a similar correlation could be expected between these mandibular variables. Bicondylar and bigonial breadths were moderately correlated in the male and pooled samples. Bone growth at gonion and in the region surrounding, and including, the masseteric fossa is linked to muscle development and masticatory function. The functional links between bigonial breadth and muscle development probably account for the lower than expected correlations between bicondylar and bigonial breadth. The independence of these two dimensions is supported by the relatively large standard errors calculated in regression equations involving these two variables (male SE 4.645, female SE 7.359 and pooled sex SE 6.299). M2 arch breadth was not highly correlated with these two variables in any of the matrices. Breadth of the dental arch at the second molar appears to be an independent measure of breadth, unrelated to the bicondylar and bigonial dimensions. It is apparent that individuals with broad mandibular dental arcades do not have necessarily great posterior breadth in the mandible.

4. Maximum and minimum ramus breadths: these two variables cover a related anatomical region and some spurious correlation is expected. Moderate levels of correlation were found between these two variables in the Murray Valley male and pooled-sex samples. The maximum ramus breadth dimension used in this analysis may be influenced by functional and age-related changes in the morphology of the coronoid process, mandibular condyle and angle of the mandible. Scatterplots and least squares regression involving these variables, although having a generally linear trend, had considerable dispersion and little predictive value (male SE 2.269 with $x = 13.527 + 0.459y$, female SE 1.760 with $x = 13.527 + 0.459y$ and pooled sex SE 2.244 with $x = 10.764 + 0.496y$). It is clear that these variables are not simply scaled representatives of each other and the inclusion of both of them in a multivariate procedure should provide additional information.

The broadly allometric relationship of the mandibular dimensions is apparent from the pooled-sex sample. With increasing mandibular length there is an increase in symphyseal and corpus height, the rami increase in height and breadth and there is an increase in the posterior breadth of the mandible. Both bicondylar and bigonial breadths have lower levels of correlation with the other mandibular variables than does mandibular length. It is possible for a mandible to be relatively small in terms of length and the dimensions of the corpus and ramus but have

relatively great posterior breadth. Mandibles with great length and proportionally small posterior breadth were also apparent. Bigonial and bicondylar breadth, and to a lesser extent mandibular length, have higher levels of correlation with cranial dimensions than do the other mandibular variables (Brown 1982:Appendices 4-6).

Coobool Creek

To maximise the use of the Coobool Creek data the male and female mandibles were pooled and a pairwise deletion method employed when calculating the correlation coefficients. However, for purposes of Pearson's correlation coefficient and least squares regression the sample is still extremely small ($n = 6-29$) and too much emphasis should not be placed on these results. The influence of sampling effects on correlation coefficients is highlighted by a comparison of the correlation coefficients obtained with the present Coobool Creek sample in contrast to the smaller sample in Brown (1982). Although the overall pattern is similar, conflicts at a detail level are somewhat alarming. Nineteen correlations are significant at the 0.05-0.001 level. Not unexpectedly the highest positive correlation ($n = 27$, $r = 0.78$, $P = .001$) is between symphyseal height and corpus height followed, surprisingly, by symphyseal thickness and ramus height ($n = 19$, $r = 0.70$, $P = .001$) (Table 57). Nineteen correlation coefficients are greater than 0.39 and there are eight low negative correlations ($r = -0.28$ to -0.05).

Summary (correlation coefficients greater than 0.39)

1. Symphyseal height: correlated with corpus height, bigonial breadth and ramus maximum breadth.
2. Symphyseal thickness: correlated with bigonial breadth, ramus height, maximum and minimum ramus breadth and M2 arch breadth.
3. Corpus height: correlated with symphyseal height, bigonial breadth and maximum ramus breadth.
4. Corpus thickness: correlated with bicondylar breadth, ramus height and M2 arch breadth.
5. Bicondylar breadth: correlated with corpus height.
6. Bigonial breadth: correlated with symphyseal height, symphyseal thickness, corpus height, ramus height and ramus maximum breadth.
7. Mandibular length: no correlations greater than 0.34.
8. Ramus height: correlated with corpus thickness, bigonial breadth, ramus maximum breadth and M2 arch breadth.
9. Ramus maximum breadth: correlated with symphyseal height, symphyseal thickness, corpus height, bigonial breadth, ramus height, ramus minimum breadth and M2 arch breadth.

10. Ramus minimum breadth: correlated with symphyseal thickness and ramus maximum breadth.
 11. M2 arch breadth: correlated with symphyseal thickness, corpus thickness, ramus height and ramus maximum breadth.

Discussion

In interpreting the Coobool Creek mandibular correlation coefficients it should be noted that the sample consists of 21 reasonably complete male mandibles and nine more fragmentary female mandibles. Although the female contribution to the pooled correlation coefficient matrix is less than the males, the correlations will still have been increased by the distance between the male and female means. One or two outlying points can greatly increase, or decrease, the size of a correlation coefficient and there are a number of examples of this in the pooled-sex matrix. Even within the limitations of this analysis it is apparent that one of the Coobool Creek correlation series is unusual. In the Murray Valley matrices there are generally moderate to high correlations (especially in the male and pooled-sex samples) between mandibular length and the other variables. In the Coobool Creek matrix five of the correlation coefficients involving mandibular length are between -0.17 and 0.01 and only two correlations exceed 0.39 (ramus height and ramus maximum breadth). In this sample there appears to be no allometric association between the length of the mandible and symphyseal and corpus thickness, bicondylar and bigonial breadth and ramus minimum breadth.

DISCRIMINANT FUNCTION ANALYSIS

The small size of the female sample in both the Coobool Creek and Broadbeach series resulted in the discriminant analysis being confined to the male samples. By sex and by population, variables were compared with a standard normal distribution using the Shapiro-Wilk test (W) and normal probability plots (Tables 43-46). Dimensions which repeatedly obtained low to significant values for W ($P = .02-.000$) are corpus thickness (Coobool Creek males, Murray Valley males and females, Swanport females and Broadbeach males) and symphyseal thickness (Murray Valley males and females and Swanport males). Symphyseal height (Murray Valley females), corpus height (Murray Valley males and females) and M2 arch breadth (Murray Valley females and Broadbeach males) also have distributions which deviated from the normal. Normal probability plots of the symphyseal and corpus dimensions all displayed peaked, abrupt distributions (kurtosis) (Fig.57a). These dimensions had been recorded to the nearest 1 mm which resulted in the clustering of the cases around too few points. A measurement scale with a greater number of intervals (0.5 mm divisions) would have been more appropriate. The distribution of M2 arch breadth has a marked right skew (Fig.57b). Although corpus height in males could be easily excluded from the discriminant analyses, as symphyseal height covered a closely related anatomical region, there were no variables which could substitute for M2 arch breadth. In this instance, complying with the distributional assumptions of discriminant analysis and discarding M2 arch breadth would have restricted the amount of biological information obtained.

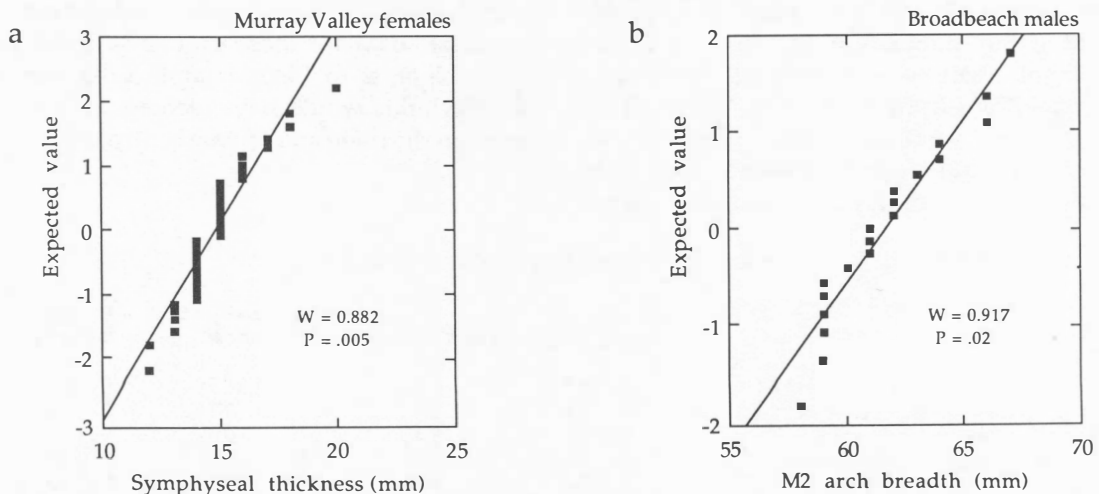


Figure 57 Normal probability plots of symphyseal thickness and M2 arch breadth. Symphyseal thickness has a peaked distribution due to an inappropriate measurement scale, while the distribution of M2 arch breadth is skewed to the left

The other major criteria influencing variable selection, as well as the retention of M2 arch breadth, was preservation. All of the mandibular data sets are incomplete. The Coobool Creek mandibles, in particular, commonly have damaged mandibular condyles and rami. Although there are procedures which substitute data for missing values (either by using estimates obtained in least squares regression or by inserting the mean of the actual observations) these techniques tend to reduce sample variation and compromise the final results. For this reason the discriminant analyses were confined to real data. In order to maximise the number of mandibles included in the analyses, variables were selected which had a high incidence of preservation, appeared to discriminate between the samples in univariate comparisons and if possible were also normally distributed. The selected variables are symphyseal height, corpus thickness, mandibular length, ramus height, minimum ramus breadth and M2 arch breadth. The selection of these six variables reduced the size of the male sample to Coobool Creek ($n = 10$), Murray Valley ($n = 35$), Swanport ($n = 10$), Broadbeach ($n = 12$). None of the Barham mandibles, and just KS1 from Kow Swamp, were complete enough to be included. Of the isolated terminal Pleistocene and early Holocene mandibles only Lake Nitchie has the selected variables preserved (Table 50).

A series of two-group discriminant analyses were performed followed by a four-group comparison. The purpose of the two-group analyses was to maximise the descriptive information that could be recovered. Also the interpretation of several statistics associated with the discriminant procedure is more straightforward when there are only two groups included, with only one function produced. To gain some idea of the extent of within-population variation the initial discriminant analysis was between male and female mandibles from the Murray Valley. This interpopulation variation could then be contrasted with that found between the male populations. Covariance matrices were

generated for each group and a test for equality of the matrices (Box's M) employed. Mahalanobis distance (D^2), Wilk's Lambda, canonical correlations, standardised coefficients and probabilities of misclassification were examined for each group.

Results

Homogeneity of covariance was tested in each of the discriminant runs using Box's M (Box 1949). In each comparison the F values were not significant at the 5% level indicating that the dispersion in each of the groups was reasonably similar (Table 58).

Murray Valley males and females

Although the variables included in this analysis were not selected for their ability to discriminate between male and female mandibles, a high level of discrimination was obtained in this comparison. The classification results indicated that 80.6% of the male mandibles and 85.0% of the female mandibles were correctly classified by the function. There is, however, a large area of overlap between the male and female distributions and little distance between the respective group centroids (Fig.58). The standardised canonical coefficients indicate that the major discriminating variables between these two groups are symphyseal height and ramus height with the remaining variables contributing less to the discriminatory power of the function (Table 59). The small negative standardised coefficient for corpus thickness (-0.192) indicates that the female mean value slightly exceeded that for males in this sample and supports the Student's t test results for the complete Murray Valley series which show a low level of sexual dimorphism for this dimension (Table 44). An examination of the univariate data for these groups suggests that if either bigonial or bicondylar breadth had been included, this would have increased the distance between the male and female centroids.

Table 58 Test for equality of the group covariance matrices

	Box's M	F statistic	Degrees of freedom	Proba- bility
Murray Valley male-female	0.240	1.045	21, 19658.6	0.402
Coobool Creek-Murray Valley	0.236	0.785	21, 773.2	0.739
Coobool Creek-Swanport	0.307	0.882	21, 1032.9	0.615
Coobool Creek-Broadbeach	0.168	0.529	21, 1042.8	0.959
Murray Valley-Swanport	0.272	0.946	21, 1005.2	0.529
Murray Valley-Broadbeach	0.207	0.679	21, 1362.5	0.857
Swanport-Broadbeach	0.206	0.679	21, 1362.5	0.856
Coobool Creek-Murray Valley- Swanport-Broadbeach	0.669	0.798	63, 2777.6	0.875

Table 59 Canonical coefficients standardised by conditional (within groups) standard deviations for each of the two-group analyses

	Murray Valley- male-female	Coobool Creek- Murray Valley	Coobool Creek- Swanport	Coobool Creek- Broadbeach	Murray Valley- Swanport	Murray Valley- Broadbeach	Swanport- Broadbeach
Symphyseal height	0.546	0.552	0.614	0.759	0.784	-0.925	0.402
Corpus thickness	-0.192	-0.120	0.395	-0.131	-0.339	0.748	0.976
Mandibular length	0.162	-0.228	0.407	-0.158	0.423	0.554	0.932
Ramus height	0.400	0.288	-0.115	0.259	-0.770	0.441	-0.218
Ramus minimum breadth	0.282	0.298	-0.086	0.465	0.109	-0.478	-0.989
M2 arch breadth	0.265	0.705	0.491	0.828	0.076	-0.141	0.182

Table 60 Eigenvalues, canonical correlations and Wilk's Lambda for the eight discriminant analyses

	Eigenvalue	Variance %	Canonical correlation	Wilk's Lambda	χ^2	Degrees of freedom	Proba- bility
Murray Valley male-female	1.170	100	0.734	0.460	55.013	6	0.0000
Coobool Creek-Murray Valley	0.720	100	0.661	0.563	23.010	6	0.0014
Coobool Creek-Swanport	5.054	100	0.913	0.167	26.837	6	0.0003
Coobool Creek-Broadbeach	2.918	100	0.848	0.280	21.620	6	0.0002
Murray Valley-Swanport	1.587	100	0.783	0.386	38.972	6	0.0000
Murray Valley-Broadbeach	0.696	100	0.640	0.589	24.321	6	0.0005
Swanport-Broadbeach	3.478	100	0.881	0.223	29.998	6	0.0000
Coobool Creek-Murray Valley-Swanport- Broadbeach							
Function 1	1.056	54	0.748	0.228	90.230	18	0.0000
Function 2	0.579	30	0.547	0.484	40.155	10	0.0000
Function 3	0.306	16	0.511	0.765	18.490	4	0.0018

Coobool Creek and Murray Valley males

The canonical discriminant functions calculated from the six mandibular variables correctly predicted the group membership of all but two of the Coobool Creek mandibles (80%) and 86.1% of the Murray Valley sample (Fig.59). The second lowest canonical correlation and eigenvalue were associated with this function, indicating the relative closeness of the two variable sets defining group membership (Table 60). Some similarity of the Coobool Creek and Murray Valley mandibles is to be expected given that they come from the same general geographic area and there is a lack of temporal control in both samples.

The standardised coefficients indicate that the principal discriminating variable was M2 arch breadth followed by symphyseal height. In the univariate results there are significant differences between the Coobool Creek and Murray Valley male means for each of these dimensions ($P = .000$) (Table 59). Five Coobool Creek mandibles (CC29, 36, 45, 49 and 71) fall within the extremes of the Murray Valley range of variation. The classification results assigned probabilities of 65% and 61% for CC45 and 49 being drawn from the Murray Valley sample, while the other three mandibles were clearly allocated to the Coobool Creek group (81-90% probability). The Coobool Creek mandible at the greatest distance from the Murray Valley centroid is CC46. Only one of the Kow Swamp mandibles (KS1) is complete enough to be classified using the standardised coefficients produced by this analysis and it obtains a discriminant function score similar to CC65 (Fig.59). However, breadth dimensions in KS1 (bigonial, bicondylar and M2 arch breadth) have been greatly increased by post-depositional warping and there is also some expansion of the bone within the corpus. As three of the dimensions used in this analysis (symphyseal height, corpus thickness and M2 arch breadth) have been inflated by taphonomic processes in KS1 its pre-depositional, or biological, location in Figure 59 would have been closer to the Murray Valley group mean, but probably still within the Coobool Creek range of variation.

Coobool Creek and Swanport males

In terms of the selected variables these two groups are the least similar in the two-group analyses combining a large eigenvalue and canonical correlation with a relatively small Wilk's Lambda (Table 60). A plot of the discriminant function scores displays the wide separation of the group means (centroids) and the discrete distribution of each sample (Fig.60).

These two samples were the most easily differentiated pair in the analysis with the largest value for D^2 and its associated F statistic (Table 61).

Within the range of variation defined by the univariate statistics these two groups represent opposing morphometric extremes for a number of variables (Table 59). The standardised coefficients indicate that the most important discriminator is symphyseal height, with M2 arch breadth, mandibular length and corpus thickness being slightly less important. The general trend for greater size at Coobool Creek is reversed for ramus height and minimum ramus breadth at Swanport.

Coobool Creek and Broadbeach males

The results of this analysis are similar to the Coobool Creek-Swanport comparison, with a plot of the canonical discriminant function scores displaying the wide separation of the group centroids (Fig.61). Only one of the Coobool Creek mandibles (CC45) falls within the Broadbeach range of variation. A comparison of these results with the Coobool Creek-Swanport data reveals that the group centroids are closer in this analysis and this is reflected in the lower eigenvalue and D^2 associated with the function (Tables 60-61). This is a product of the larger size of the Broadbeach mandibles relative to those from Swanport, with greater symphyseal height, mandibular length and M2 arch breadth (Tables 45-46).

M2 arch breadth, symphyseal height and minimum ramus breadth are the major discriminators in this function with the remaining variables being far less important (Table 59). The general trend for greater size in the Coobool Creek mandibles is slightly reversed for mandibular length and corpus thickness in the selected Broadbeach sample, with low negative standardised coefficients (Table 59). The Coobool Creek mean values for the three major discriminating variables are significantly greater than the Broadbeach means ($P = .015-.000$).

Murray Valley and Swanport males

A surprisingly high level of discrimination was achieved in this analysis, with the final function correctly predicting the group membership of 91.7% of the Murray Valley sample and 100% of the Swanport group. The discriminant function scores of the two groups, as defined by the discriminating variables, do not overlap and there is a moderate separation of the group centroids (Fig.62).

The standardised coefficients indicate that

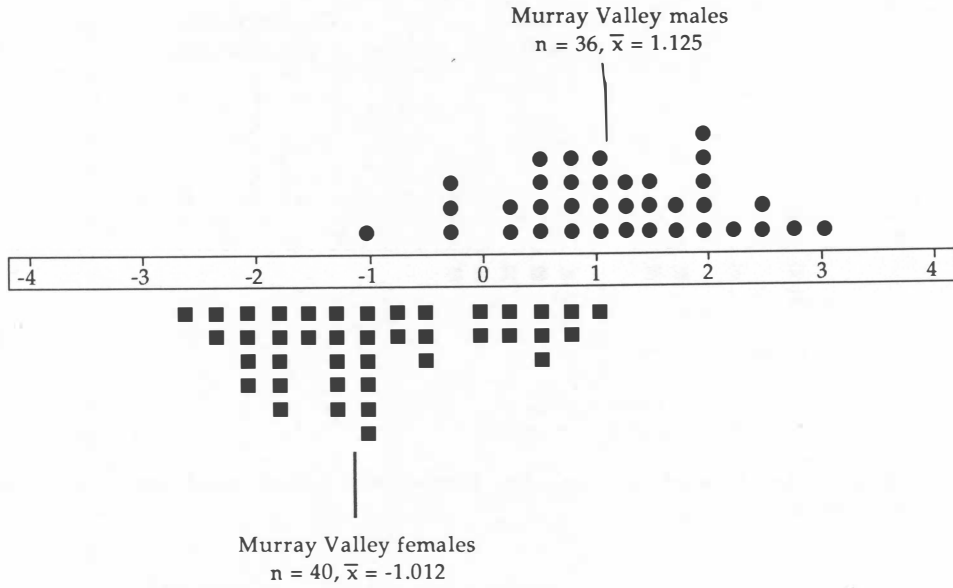


Figure 58 Canonical discriminant function score distribution for male and female mandibles from the Murray Valley

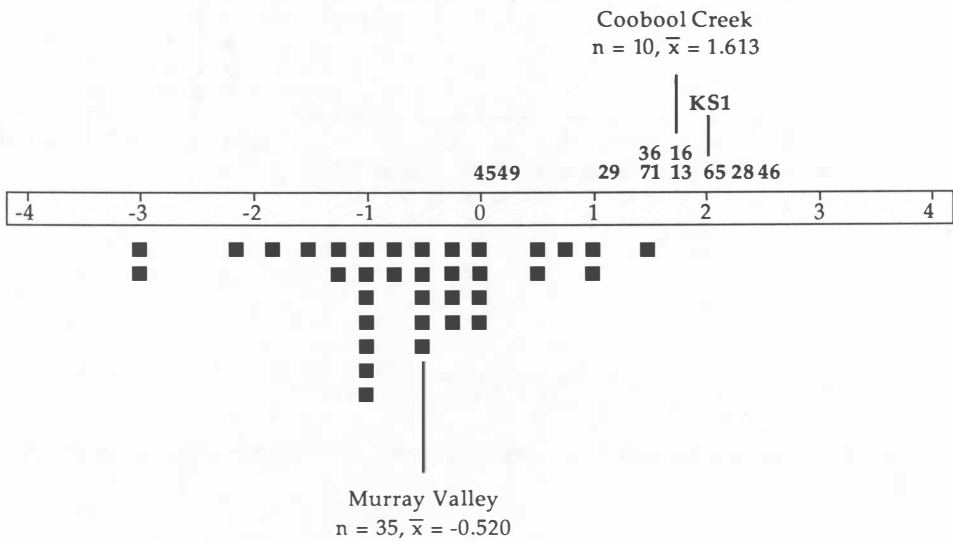


Figure 59 Canonical discriminant function score distribution for male mandibles from Coobool Creek and the Murray Valley

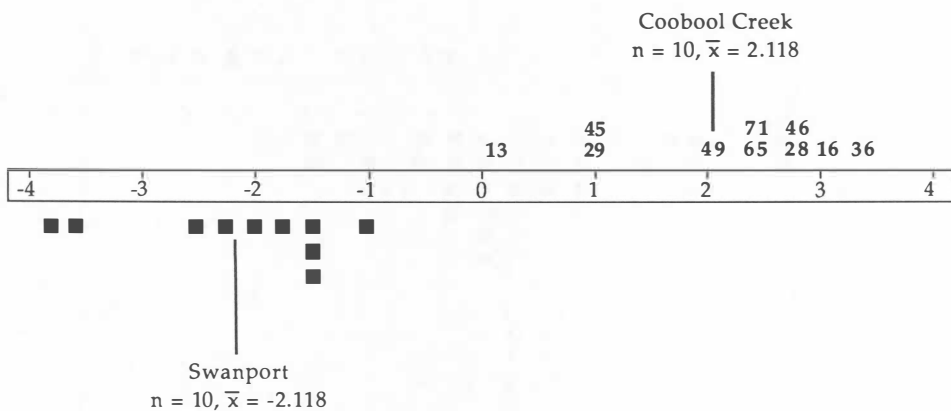


Figure 60 Canonical discriminant function score distribution for male mandibles from Coobool Creek and Swanport

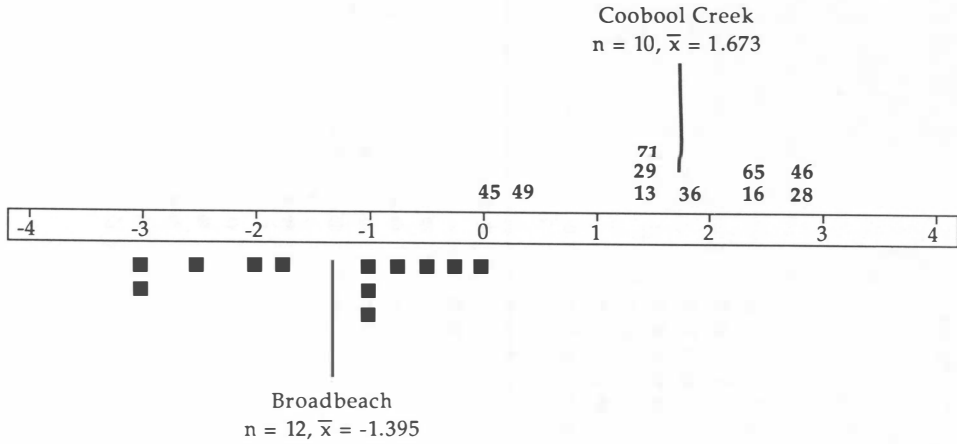


Figure 61 Canonical discriminant function score distribution for male mandibles from Coobool Creek and Broadbeach

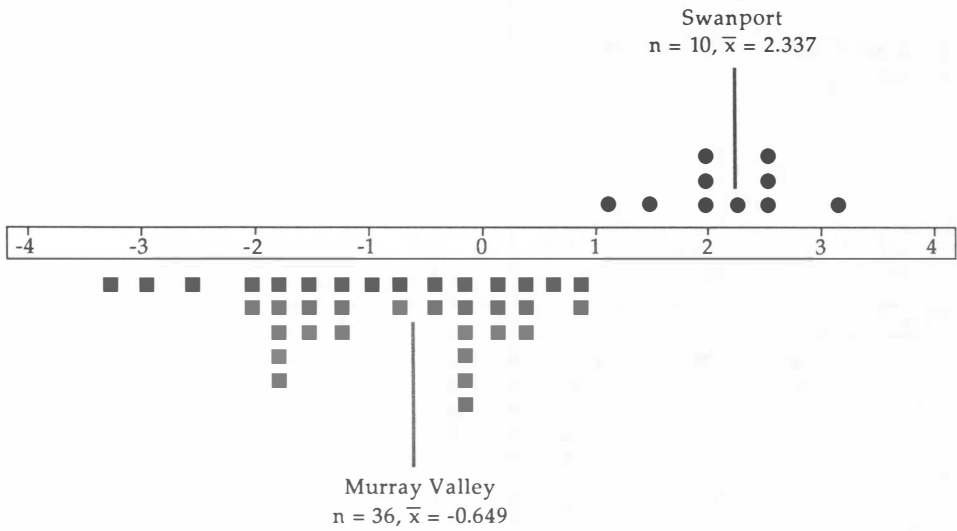


Figure 62 Canonical discriminant function score distribution for male mandibles from the Murray Valley and Swanport

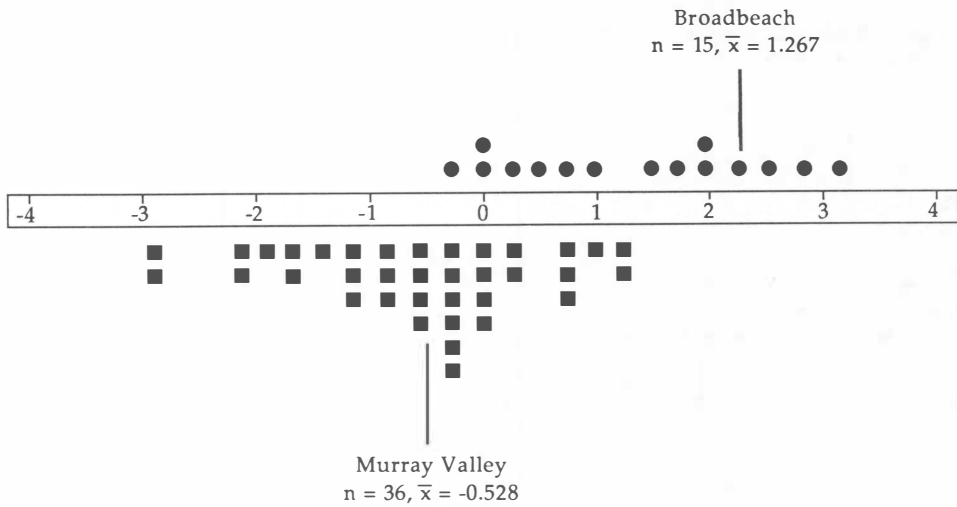


Figure 63 Canonical discriminant function score distribution for male mandibles from the Murray Valley and Broadbeach

there are three major discriminating variables in the analysis: symphyseal height, ramus height and mandibular length (Table 59). The Swanport mandibles combine a symphyseal height and mandibular length which are at the lower end of the Aboriginal range with a ramus height which exceeds that recorded for most other populations. Student's *t* indicates that the differences between the mean values, at Swanport and the Murray Valley, for the three primary discriminators are significant (symphyseal height *t* = 4.30, *P* = 0.000; ramus height *t* = -4.17, *P* = .000; mandibular length *t* = 3.36, *P* = 0.001).

Murray Valley and Broadbeach males

Of the groups included in these analyses these two were the most similar. Even so the canonical function correctly predicted the group membership of 83.3% of the Murray Valley sample and 73.3% of the Broadbeach series. There is a moderate degree of overlap in the distribution of the two groups, with less distance between the group centroids than in the other analyses (Table 61, Fig.63). The lowest eigenvalue, canonical correlation and *D*² are associated with this function,

however, Wilk's Lambda and its associated χ^2 are still significant (Tables 60-61).

The major discriminating variable is symphyseal height, with corpus thickness, minimum ramus breadth and ramus height being slightly less important (Table 59). The difference between the Murray Valley and Broadbeach means is significant for only one of the discriminating variables, symphyseal thickness (*t* = 2.84, *P* = .006).

Swanport and Broadbeach males

There is a wide separation of the group centroids formed by the canonical discriminant function, with only a small overlap between the distributions of the two groups (Fig.64). A relatively large eigenvalue and canonical correlation indicate the importance of this function, with 90% of the Swanport mandibles and 100% of those from Broadbeach being correctly classified. The standardised coefficients demonstrate that the three major discriminating variables (minimum ramus breadth, corpus thickness and mandibular length) discriminate between these groups fairly equally (Table 59). Comparison of

Table 61 Mahalanobis distances (*D*²), *F* statistics and significance between pairs of groups

		Murray Valley	Coobool Creek	Swanport
Coobool Creek	<i>D</i> ²	5.221	-	-
	<i>F</i>	5.191	-	-
	<i>P</i>	0.0002	-	-
Swanport	<i>D</i> ²	5.659	14.280	-
	<i>F</i>	8.583	9.557	-
	<i>P</i>	0.0000	0.0000	-
Broadbeach	<i>D</i> ²	2.941	8.346	5.924
	<i>F</i>	4.547	7.705	6.192
	<i>P</i>	0.0007	0.0000	0.0000

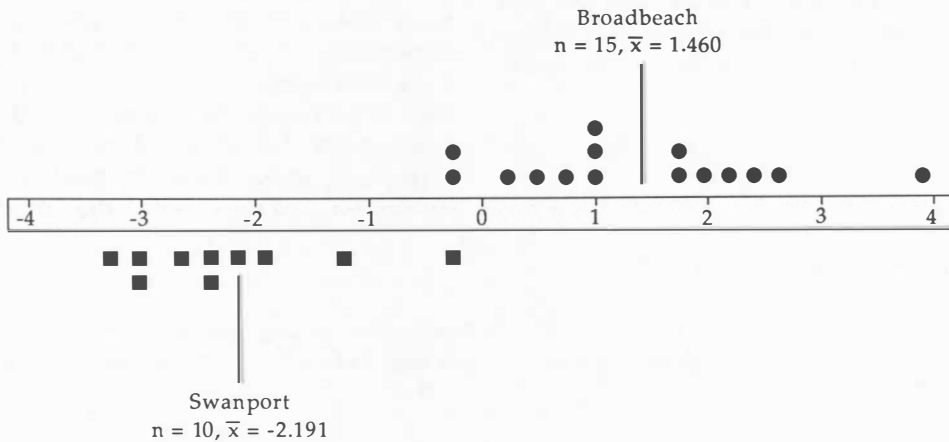


Figure 64 Canonical discriminant function score distribution for male mandibles from Broadbeach and Swanport

the mean values for each of these variables using Student's *t* obtained significant results for mandibular length and minimum ramus breadth (corpus thickness $t = 0.90$, $P = 0.373$; mandibular length $t = 4.90$, $P = 0.012$; ramus height $t = 4.27$, $P = 0.000$). The Broadbeach mandibles combine a mandibular length which is at the top of the Australian range with relatively narrow, and low, rami. The Swanport mandibles are short in their anteroposterior dimension with relatively broad and high rami.

Coobool Creek, Murray Valley, Swanport and Broadbeach males

The purpose of the four-way comparison was an examination of the matrix of pairwise F ratios, distance between group centroids and the probabilities of misclassification. The matrix of pairwise F ratios consists of an F ratio for each pair of groups (Table 61). This F is the significance test for the Mahalanobis distance between groups and a test for the equality of pairs of centroids (Nie *et al.* 1975:460). Mahalanobis distances and their associated F statistics indicate that the closest groups in the analysis are Murray Valley and Broadbeach, followed by Murray Valley and Coobool Creek and Broadbeach and Swanport. The most distant pairs in the analysis are Coobool Creek and Swanport and Murray Valley and Swanport.

Group classification results (Table 62) support the F ratios in demonstrating that the most distinctive mandibles in the analysis come from Swanport, with the discriminant procedure correctly assigning all but one of the Swanport mandibles (90%). This was followed by Broadbeach (75%) which has a 25% overlap with the Murray Valley, and Coobool Creek (70%), with one mandible allocated to each of the other samples. A plot of the discriminant function scores (Fig.65) has the Murray Valley and Broadbeach centroids in fairly close association, while Coobool Creek and Swanport are more distinct.

GEOGRAPHIC AND TEMPORAL VARIATION IN MANDIBULAR SIZE AND MORPHOLOGY

The results of the univariate and discriminant analyses demonstrate that regional variation, at a similar level to that described for Aboriginal crania, is also present in the mandible. The distances between several populations (Swanport and Murray Valley, Swanport and Broadbeach) exceed the interpopulation, sex-based variation found within the Murray Valley sample. Canonical discriminant functions calculated from the Murray Valley, Swanport and Broadbeach mandibles are able to distinguish between these samples with an accuracy ranging from 77-100% in two-way comparisons and 61-90% in the four-way comparison. The most distinctive mandibles in the discriminant analysis are the Swanport series. The major variable distinguishing these mandibles from the Murray Valley and Broadbeach is mandibular length. The Swanport mandibles combine a mandibular length at the lower end of the Australian range, with a low corpus and absolutely large rami. Although short in their anteroposterior dimension the Swanport mandibles have dental arches which are as broad as the larger mandibles from the Murray Valley and Broadbeach. The maximum resting length of a mandible is influenced by the anteroposterior curvature of the inferior border of the corpus and the angle at which the rami ascend from the gonial region. As the Swanport mandibles tend to have particularly vertical rami this has tended to reduce their mandibular length in respect to the Murray Valley and Broadbeach mandibles which appear to have a more posterior inclination of their rami.

In the discriminant analysis Murray Valley mandibles tended to occupy the middle ground. For a number of variables (corpus thickness, mandibular length, ramus breadth and M2 arch breadth) the Murray Valley means fall closer to the overall sample means than do the Swanport and Broadbeach mandibles. In the four-way comparison this group displayed the greatest dispersion about their centroid and had the maximum overlap with the other samples.

Table 62 Group classification results

Actual group	n	Coobool Creek		Predicted group membership				Broadbeach	
		n	%	Murray Valley	Swanport	Broadbeach	n	%	
				n	%	n	%	n	%
Coobool Creek	10	7	70.0	1	10.0	1	10.0	1	10.0
Murray Valley	35	6	17.2	22	62.8	2	5.7	5	14.3
Swanport	10	-	0.0	-	0.0	9	90.0	1	10.0
Broadbeach	12	-	0.0	3	25.0	-	0.0	9	75.0

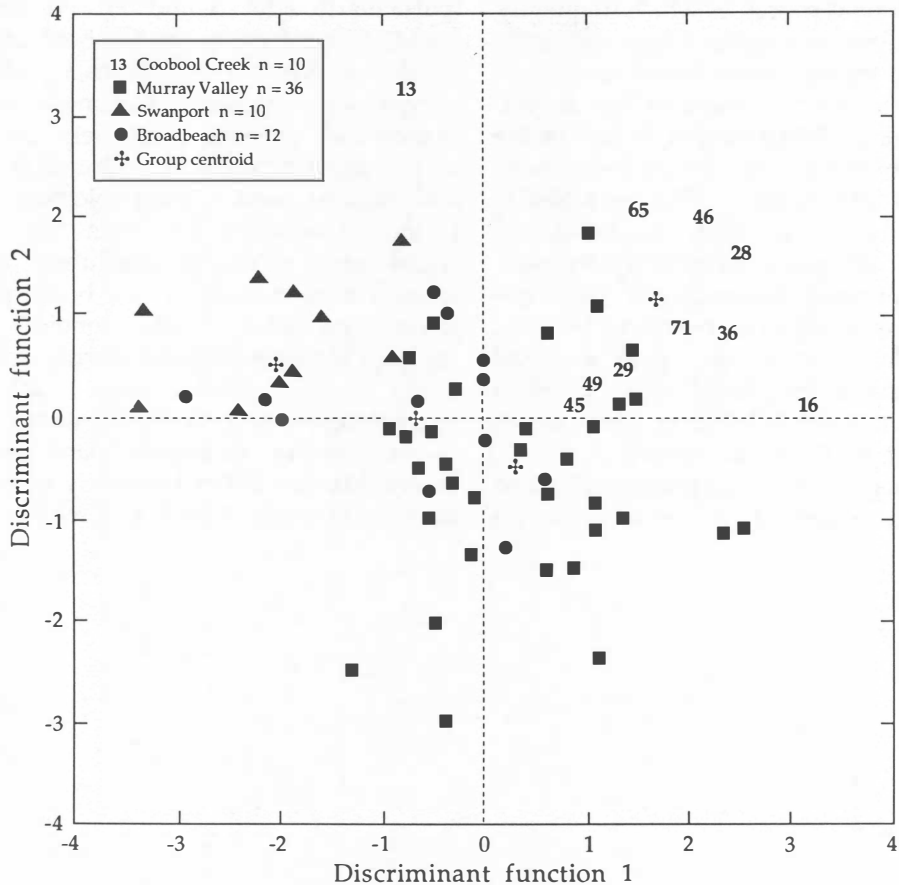


Figure 65 Canonical discriminant function score distribution for male mandibles from Coobool Creek, Murray Valley, Swanport and Broadbeach

Thirty-seven per cent of the Murray Valley mandibles were allocated to groups other than their own. I suspect that to some degree this is an artifact of the temporal and geographic origins of the Murray Black collection from which this sample originated. The Swanport and Broadbeach skeletons were each recovered from single cemeteries (Stirling 1911; Haglund 1976). One of these, Broadbeach, appears to have been in use for more than 1000 years, while the time period in which the Swanport site was in use is unknown. Morphological similarity, an unusually high frequency of some masticatory pathologies (interproximal cervical caries and arthritic modification of the temporomandibular joint), combined with the unique position they occupy in statistical analyses (Pietrusewsky 1979, 1984), suggests that the Swanport skeletons form part of a closely related biological unit. Contrasting with Swanport and Broadbeach the Murray Valley series used in this analysis stems from a much larger geographic area (Sunderland and Ray 1959) and is without any form of temporal control. Although highly variable, as a group the Murray Valley mandibles can be

identified, to a lesser degree, by the same features which distinguish the Coobool Creek mandibles. They have greater overall size, high symphyses, great bigonial breadth and narrower rami.

Temporal variation within a specific geographic region, the central Murray Valley, can be examined through a comparison of the terminal Pleistocene mandibles from Coobool Creek and Kow Swamp, with the mid-Holocene series from Barham and the 'recent' Murray Valley series. A complex of morphological and metrical features clearly distinguish the Coobool Creek mandibles from the recent Aboriginal mandibles from the Murray Valley, as well as Swanport and Broadbeach. There is great height in the corpus, both at the symphysis and posteriorly between the first and second molars. This is combined with generally extreme development of the lateral prominence on the lateral surface of the corpus. Medially the mylohyoid ridge passes in a low smooth curve downwards to the submaxillary fossa and the inferior border, rather than dropping away abruptly below the mylohyoid line. The rami are tall and broad with

high, robust coronoid processes which frequently exceed the condyles in height. There are large, deep masseteric fossae on the lateral surface of the rami, with marked eversion of the angles, especially in males. On the medial surface of the ramus is a large and rugose area of attachment for the medial pterygoids. The mandibular condyles are broad in their medial-lateral dimension and narrow anteroposteriorly with little evidence of temporomandibular joint dysfunction. There is massive posterior breadth, both bigonial and bicondylar, with a broad dental arch. Several individuals from Coobool Creek exceed the mid-Holocene and recent Aboriginal range for these dimensions.

To a large degree, both morphologically and metrically, the small Kow Swamp series

(particularly KS1, 5 and 7) and the Nacurrie mandible, conform to the Coobool Creek pattern (Tables 48-50). They all have tall, receding symphyseal regions, thickened and robust mandibular corpora, extremely broad dental arches, great bigonial breadth and relatively tall and narrow rami. Morphological similarities include functional attributes like large and rugose areas of muscle attachment, a thickened lateral prominence, deep and broad precoronoid fossae, prominent endocoronoid crista and mylohyoid ridges without sharply defined mylohyoid lines. Individually, each of these morphological and metrical features are present in more recent Aboriginal mandibles from the central Murray Valley but rarely in the combination that is found at Coobool Creek.

V

COOBOOL CREEK TOOTH SIZE

INTRODUCTION

The earliest descriptions of the Aboriginal dental complex were limited to brief comments on tooth morphology, tooth size and attrition (Turner 1884; Topinard 1872; Duckworth 1904). The first detailed comparative statements were the astute, though brief, observations of Klaatsch (1908) who combined morphological and metrical description of the teeth and palate with a general account of occlusion and the helicoidal plane in Aborigines.

In 1925 Campbell published his extensive description of the Aboriginal dentition and palate. Over the next decade, increasing interest in functional and epidemiological issues (Campbell and Lewis 1926; Campbell 1928, 1937, 1938a, 1938b; Campbell and Gray 1936) resulted in Campbell's second major work (Campbell 1939), in which he examined the functional relationship between diet and the Aboriginal dentition. These two publications (Campbell 1925, 1939) remain the classic studies in the anthropological literature on the dentition of the Australian Aborigines.

Campbell (1925) was the first to present the mesiodistal and buccolingual crown dimensions of a large sample of Aboriginal dentitions. Using a pooled male and female sample, drawn primarily from South Australia ($n = 340$) and the Northern Territory ($n = 150$), he presented a survey of 'approximately 630' individuals. Unfortunately, as Freedman and Lofgren (1981) note, the subsequent value of these data has been reduced by the pooling of the sample, both in terms of sex and locality, and the limited statistical data published.

Subsequent analyses of Aboriginal tooth size have concentrated on aspects of sexual dimorphism (Barrett *et al.* 1963; Barrett *et al.* 1963a; Barrett *et al.* 1964; Macintosh and Barker 1965; Hanihara 1976; Brown and Townsend 1979; Freedman and Lofgren 1981; Smith *et al.* 1981), regional variation (Brace 1979, 1980; Freedman and Lofgren 1981; Smith *et al.* 1981), the relative contributions of genetic and environmental factors to the variability in tooth size (Townsend and Brown 1978a, 1978b), and the possibility of temporal reduction in Aboriginal tooth size (Thorne and Macumber 1972; Thorne 1975; Freedman and Lofgren 1979a; Brace 1980; Brown 1987a).

Although a considerable amount of information is available on Aboriginal tooth size, there is still an inadequate picture of two of the major areas of contemporary anthropological interest, regional and temporal variation. Until recently these issues have been compounded by problems associated with some of the published data. As noted above for Campbell's work, several studies provide only limited geographical control, combined with no subdivision of the sample according to sex and these shortcomings persist in more recent research (Gabriel 1955; Macintosh and Barker 1965). To some degree the apparent limitations of much of the early work are simply a reflection of recent changes in emphasis and the ongoing sampling problems associated with collections of Australian skeletal material. In this respect it is particularly unfortunate that one of the most recent, and potentially most useful, regional surveys of Aboriginal tooth size, that of Brace (1980), is so methodologically flawed that few reliable conclusions can be drawn from the results (Brown and Townsend 1980; Koritzer 1980).

The most comprehensive and detailed descriptions of Aboriginal tooth size relationships stem from the longitudinal growth study of the Walbiri and Pintubi peoples at Yuendumu (Barrett *et al.* 1963; Barrett *et al.* 1963a; Barrett *et al.* 1964; Townsend and Brown 1978a, 1978b, 1979b). Other sexed regional data are provided by Freedman and Lofgren (1981) for 52 male and 29 female skeletons from Western Australia, Smith *et al.* (1981) for Broadbeach, Roonka, Swanport, Anson Bay and Melville Island, and Brown (1987a) for Coobool Creek, the Murray Valley and Swanport. As Freedman and Lofgren note (1981:87), 'such data are, of course, necessary for the analysis of dental variation within Australia and for comparison with the now extensive amount of recent fossil cranial material available from various parts of the continent'.

Tooth size data have also been presented for some of the 'fossil' Australian crania. Smith (1918) and Macintosh (1952c) both describe the dentition of the Talgai cranium, Macintosh (1952b) the teeth and palate of the Cohuna cranium, and Adam (1943) those of the Keilor cranium, while Davies (1968) presents a detailed description of the isolated maxillary medial incisor from Devil's Lair in Western Australia

dated to between 12,000 and 8000 years BP. Although a detailed comparison of the Kow Swamp dentitions has not been published, Thorne and Macumber (1972) provide data for KS1 and 5. Most recently Freedman and Lofgren (1979a) compare the odontometric data for the Cossack skeleton with data recorded for other Australian prehistoric skeletal material. Brown (1987a) provides data for Coobool Creek, Keilor, Talgai and LMIII, while Smith *et al.* (1988) presents a description of the Roonka dentitions. Unfortunately, the limited statistical presentation of data in this latter paper, without standard deviations for the dental dimensions, precludes other researchers from following up aspects of their analysis and discussion.

My approach to the description of the Coobool Creek dentitions, and the eventual restriction of this to a comparison of buccolingual breadths, was dictated by the nature of the material. Dental attrition is marked in most of the reconstructed Coobool Creek specimens, with large areas of dentine exposed on the occlusal surfaces of the teeth, combined with great interproximal attrition. With two exceptions (the young adult females CC1 and 9) this high degree of attrition has removed most of the surface morphological detail from the teeth. Information as to cusp number, occlusal fissure pattern, degree of shovelling of the anterior maxillary incisors and the presence of hyperplastic abnormalities is not preserved. For this reason no attempt was made to present a detailed morphological description of the dentitions.

The rate and extent to which tooth wear is a response to a combination of factors of both biological and cultural origin (Richards and Brown 1981b). Biological factors include tooth morphology and occlusion and the physical and chemical properties of the dental hard tissues. The principal cultural factors include diet, the physical properties of the food bolus, the extent to which food has been prepared prior to mastication and the use of the teeth in non-masticatory contexts (Campbell 1925, 1939; Howell and Brudevold 1950; Anderson and Picton 1957; Molnar 1971; Xhonga 1977; Richards and Brown 1981b).

Initial descriptions of the Australian dentition (Turner 1884) noted the high degree of tooth wear, with the rapid loss of hard tissue in the deciduous and permanent dentition (Campbell 1925:65; Murphy 1964). This is primarily a function of the abrasiveness of the traditional Aboriginal diet, minimal pre-masticatory preparation of food (Beveridge 1883:36-38; Curr 1883:238-50; Campbell 1939), and the use of the

teeth as tools (Kreffft 1865:361; Beveridge 1883:42; Curr 1883:283; Gould 1968; Barrett 1977).

In Aborigines from traditional situations, as soon as the first permanent molar reaches occlusion, interproximal facets begin to develop on the mesial surface of the crown through contact with the deciduous molar. This interproximal wear, which is also found in the deciduous dentition, is a feature of permanent Aboriginal dentitions prior to the introduction of refined European foods. Murphy (1964) described the reduction in the size of the dental arch in Aborigines which results from interproximal wear and mesial migration. For the permanent canines, premolars and molar teeth this interproximal wear results in a rapid reduction of the length of the crown. The morphology of the maxillary and mandibular incisors results in a reduction of their mesiodistal crown dimensions through the combined effects of occlusal and interproximal attrition.

As a result of this interproximal reduction in crown length, the only reliable figures for the mesiodistal dimension in Aboriginal dentitions appear to be those recorded for the Yuendumu series (Barrett *et al.* 1963a; Townsend and Brown 1979b). Most of the dental casts from Yuendumu have been taken from young adult and subadult individuals, who, probably as a result of the large component of refined European foods in the diet (Campbell and Barrett 1953), generally have only slight interproximal wear.

In contrast to the dental casts from Yuendumu, there was invariably a high degree of interproximal wear, in infants and adults, in the dentitions from Coobool Creek, Murray Valley, Swanport, Roonka, Broadbeach and Kow Swamp which I examined. By the time the second permanent molars have moved into occlusion, at approximately 11.5-12.0 years of age, as much as 5% of the occlusal surface of the first molar may be comprised of exposed dentine, with large interproximal facets on the functional permanent teeth. As a result of this interproximal wear the only dental dimension recorded for this analysis was the buccolingual crown diameter. The buccolingual crown diameter was defined, after Townsend and Brown (1979b:20) as 'the greatest distance between the labial or buccal surface and the lingual surface of the tooth crown measured with a sliding caliper held at right angles to the mesiodistal crown diameter of the tooth'. Although there is variation between teeth, due to differing morphology, position in the dental arcade and occlusion, this dimension is generally not influenced by tooth wear until occlusal attrition is quite advanced. This makes the

buccolingual dimension more suitable for intrapopulation comparison than the mesiodistal dimension.

Materials and methods

Adult and juvenile Aboriginal dentitions from Coobool Creek, Kow Swamp, Murray Valley, Roonka, Barham, Swanport and Broadbeach were examined, as well as the serial dental casts recorded as part of the longitudinal growth study of the Walbiri and Pintubi peoples of Yuendumu (Barrett *et al.* 1964). With the exception of the Yuendumu series, the buccolingual crown dimensions were recorded for the left and right maxillary and mandibular permanent dentitions using a modified Mitutoyo dial caliper with fine, sharpened beaks. Measurements were recorded to the nearest 0.1 mm. Teeth in which the maximum buccolingual dimension has been influenced by occlusal attrition or postmortem damage were excluded from the analysis, as were teeth with anomalous crown morphology. If a tooth was rotated or otherwise malpositioned, measurement was modified accordingly.

With the Coobool Creek, Murray Valley, Swanport, Kow Swamp, Barham and Broadbeach populations the individuals included in the analysis of tooth size are the same as those examined in the analyses of cranial and mandibular size and morphology (Chapters III and IV). In the material excavated from Kow Swamp there are a number of isolated teeth. As these have not been assigned to particular individuals, which may in turn provide information as to sex, they were excluded from the analyses. Although I examined all of the dentitions from Roonka, I include here only the dental statistics for eight male crania that can be assigned to Roonka Phase II, which is dated to the period 4000-7000 BP (Pretty 1977). Other comparative data which will be included in the analysis are those recorded for Yuendumu by Barrett *et al.* (1964) and Townsend and Brown (1979a).

Tooth wear, plus postmortem tooth loss and damage, resulted in the full variable set being recorded for very few dentitions. As a result of the incomplete data set, statistical analyses were confined to univariate and bivariate comparisons of tooth breadth. Even so, several groups (Broadbeach females, Kow Swamp and Barham) have total sample sizes which are too small for meaningful statistical comparison. In my initial analysis of these data (Brown 1982) only teeth from the left side of the arch were used. In this analysis dental dimensions of teeth from the left

side of the arch are used, but with the right side substituted where the left was not preserved. This has increased the size of the samples and, in some instances, slightly altered the results of the descriptive and comparative statistics relative to those in Brown (1982). Student's *t* test is used to assess the significance of differences in the group means, and Bartlett's *M*, and its associated χ^2 value, differences in variance. Where there is a statistical significance in variance, Student's *t* is calculated using the formula based on a separate variance estimate. Coefficients of variation ($CV = s \times 100/\bar{x}$) and sex differences in tooth size (male \bar{x} -female \bar{x} /female $\bar{x} \times 100$) (Garn *et al.* 1964) are calculated for each sample.

Tooth breadth data could not be tested against the normal distribution as the samples were too small (<50) to obtain meaningful results for skewness and kurtosis (Pearson and Hartley 1972) and the Shapiro-Wilk program (*W*) for testing normality in small samples (<50) would not operate with decimalised data (program SHPWLK, Y. Pittelkow, Coombs Computing Unit, Australian National University). As the high frequency of missing data, especially in the Coobool Creek sample, precluded multivariate comparison of the samples, I did not consider that it was essential to demonstrate distributional normality.

Measurement error

Townsend and Brown (1979b:21) examine experimental error in tooth measurement. They find that measurement procedures are subject to error of two types: 'systematic errors arising from limitations in the materials and instruments used and accidental errors dependent on the consistency with which repeated determinations can be made by the same observer'.

Human teeth are difficult to measure accurately. They are irregularly shaped objects and in order to obtain reproducible measurements at fine tolerances (0.1 mm) it is essential to standardise measurement procedure and equipment. Fortunately an accurate test of both equipment and procedure is provided by replicability studies (Hunter and Priest 1960; Townsend and Brown 1979b). Forty crania and mandibles, with reasonably complete dentitions, were selected from the Murray Black Collection of the Australian Institute of Anatomy, Canberra. I measured the teeth of these specimens in 1979 and again in 1981. The available number of paired observations ranged between 14-37. Differences between the first and second determinations were analysed by computing the standard deviation of a single determination

Table 63 Experimental error in the measurement of the buccolingual crown diameter in 40 crania and mandibles from the Murray Valley determined by the method of Dahlberg (1940)

Teeth	Maxilla		Mandible	
	n	error	n	error
I1	15	.08	14	.09
I2	24	.08	22	.08
C	23	.07	28	.08
P1	25	.06	28	.04
P2	28	.08	27	.04
M1	28	.09	31	.06
M2	35	.07	37	.06
M3	31	.15	32	.10
Mean		.09		.07

(Dahlberg 1940) (Table 63). These results were then compared with those obtained in other replicability studies.

The magnitude of measurement error using Dahlberg's statistic ranged from 0.04-0.17 mm, with 19 of the 32 observations being less than 0.09 mm. I found that the most difficult teeth on which to obtain reproducible measurements were the maxillary and mandibular third molars, where error ranged from 0.09-0.17 mm. This is undoubtedly a result of the great morphological variation in these teeth. The mean error for the combined maxillary and mandibular buccolingual crown dimensions is 0.09 mm. This compares favourably with the mean error obtained for the buccolingual dimension in other studies: Moorrees *et al.* (1957) .09 mm, Barrett *et al.* (1963a) 0.13 mm, Townsend and Brown (1979b) 0.11 mm, and for deciduous teeth (Margetts and Brown 1978) 0.15 mm. In relation to the size of the teeth in this analysis, measurement error is extremely low, ranging from 0.04 mm for the right maxillary P1 and P2 to 0.17 mm for the right mandibular M3. A comparison of the mean crown dimensions recorded in 1979 with those recorded for the same teeth in 1981, using Student's *t* test, did not produce any significant results.

SEXUAL DIMORPHISM

The degree of sexual dimorphism in the buccolingual crown dimension was examined in the Coobool Creek, Murray Valley, Swanport and Yuendumu samples (Tables 64-67). The Broadbeach female sample ($n = 4$) was considered too small for meaningful comparison, so this series was excluded from the analysis.

Coobool Creek

The mean values for male tooth breadths in the Coobool Creek maxillary and mandibular

dentitions exceed all of the female means, with significant differences between the means for the maxillary and mandibular canines, premolars and molars (Table 65).

Individual dimorphism values range from 12.17% (mandibular M1) to 3.75% (maxillary central incisor). Sexual dimorphism is most clearly expressed in the mandibular M1, I1, P1 and P2 and the maxillary P1 (Table 64). However, the samples for several of these comparisons are extremely small and too much emphasis should not be placed on the results. The average dimorphism figure for the maxillary teeth is 6.86% and mandibular teeth 9.04%.

Murray Valley

In this comparison the male means exceed the female means for each tooth and in each instance the differences between the mean values are statistically significant (Table 66). Dimorphism values range from a maximum of 10.0% (mandibular canine) to a minimum of 3.03% (mandibular I2) (Table 64). Sexual dimorphism was most clearly expressed by the mandibular and maxillary canines, the remaining teeth being much less dimorphic. Average dimorphism figures for the maxillary (6.33%) and mandibular (5.38%) teeth are less than those for Coobool Creek.

Swanport

At Swanport, as in the Coobool Creek and Murray Valley samples, the male mean values exceed the female means for each tooth. Significant differences between the male and female means are present for the maxillary I2, C, P1, P2, M2 and M3 and the mandibular C, P1 and M3 (Table 67). Individual dimorphism values range from 10.22% (mandibular P1) to 1.66% (mandibular M1) (Table 64). The most dimorphic teeth in this comparison are the mandibular first

Table 64 Sexual dimorphism in the buccolingual crown dimensions of Aboriginal populations

Teeth	Coobool Creek		Murray Valley		Swanport		Yuendumu ¹		Yuendumu ²		Mean	
	D%	R	D%	R	D%	R	D%	R	D%	R	D%	R
<i>Maxillary dentition</i>												
I1	3.75	16	5.12	11	5.12	12	6.00	3	5.80	2	5.15	12
I2	4.05	15	5.97	8	8.95	4	5.08	6	5.00	4	5.81	6
C	7.77	8	9.09	2	6.81	9	5.19	5	6.60	1	7.09	2
P1	10.00	4	6.00	7	6.00	11	2.77	13	2.80	16	5.51	9
P2	8.00	7	7.07	3	6.12	10	2.78	12	3.00	14	5.39	11
M1	6.25	12	4.76	13	2.38	15	3.43	8	4.10	9	4.18	16
M2	7.75	9	6.15	6	7.14	7	3.30	10	4.60	5	5.78	8
M3	7.37	10	6.55	4	7.62	6	9.01	1	3.50	12	6.80	3
\bar{x}	6.86		6.33		6.26		4.69		4.42		5.71	
<i>Mandibular dentition</i>												
I1	11.11	2	3.12	15	8.06	5	6.67	2	4.30	8	6.65	4
I2	6.06	14	3.03	16	3.55	13	5.73	4	4.40	6	4.55	14
C	9.63	6	10.00	1	10.00	2	3.23	11	5.20	3	7.61	1
P1	10.22	3	5.74	9	10.22	1	1.61	16	3.60	11	6.27	5
P2	10.00	4	4.54	14	6.97	8	2.34	9	3.20	13	5.41	10
M1	12.17	1	5.08	12	1.66	16	3.58	7	3.00	14	5.09	13
M2	6.89	11	5.17	10	3.09	14	2.74	14	4.10	9	4.39	15
M3	6.25	12	6.36	5	9.80	3	2.24	15	4.40	6	5.81	6
\bar{x}	9.04		5.38		6.66		3.51		4.02		5.72	

D% = Dimorphism per cent

R = Rank

1 = Yuendumu figures calculated from data in Barrett et al. (1964)

2 = Yuendumu data from Townsend and Brown (1979a)

Table 65 Buccolingual crown dimensions of the maxillary and mandibular teeth in Coobool Creek males and females (mm)

Teeth	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	D%	Rank	χ^2	Proba- bility	Student's t	Proba- bility
<i>Maxillary dentition</i>													
I1	♂	10	8.3	0.26	3.01	7.9	8.7	3.75	16	2.46	0.117	1.74	0.103
	♀	6	8.0	0.49	6.12	7.5	8.8						
I2	♂	12	7.7	0.42	5.45	6.9	8.5	4.05	15	0.00	0.988	1.53	0.143
	♀	7	7.4	0.42	5.67	6.8	7.9						
C	♂	15	9.7	0.50	5.15	8.7	10.6	7.77	8	0.05	0.810	2.96	0.008
	♀	7	9.0	0.46	5.11	8.5	9.8						
P1	♂	11	11.0	0.38	3.45	10.6	11.8	10.00	4	0.69	0.405	4.13	0.001
	♀	6	10.0	0.53	5.30	9.2	10.7						
P2	♂	14	10.8	0.46	4.25	10.2	11.7	8.00	7	1.92	0.165	2.87	0.009
	♀	8	10.0	0.73	7.30	9.4	11.3						
M1	♂	15	13.6	0.44	3.23	12.8	14.2	6.25	12	1.65	0.198	3.03	0.007
	♀	6	12.8	0.70	5.46	12.1	13.9						
M2	♂	14	13.9	0.79	5.68	12.7	15.3	7.75	9	0.02	0.866	3.16	0.005
	♀	8	12.9	0.75	5.81	12.0	13.8						
M3	♂	17	13.1	0.86	6.56	10.8	14.4	7.37	10	1.32	0.249	2.09	0.048
	♀	7	12.2	1.26	10.32	10.0	13.5						
<i>Mandibular dentition</i>													
I1	♂	3	7.0	0.11	1.57	6.9	7.1	11.11	2	3.82	0.054	1.96 ¹	0.097
	♀	5	6.3	0.70	11.11	5.9	7.4						
I2	♂	10	7.0	0.45	6.42	6.4	7.6	6.06	14	0.16	0.681	1.67	0.117
	♀	5	6.6	0.54	8.18	6.2	7.5						
C	♂	15	9.1	0.49	5.38	8.2	9.8	9.63	6	0.01	0.898	4.22	0.000
	♀	9	8.3	0.47	5.66	7.6	8.9						
P1	♂	16	9.7	0.55	5.67	8.6	10.7	10.22	3	0.19	0.658	3.77	0.001
	♀	9	8.8	0.55	6.25	7.9	9.6						
P2	♂	16	9.9	0.53	5.35	9.1	11.0	10.00	4	0.59	0.441	4.40	0.000
	♀	9	9.0	0.41	4.55	8.2	9.5						
M1	♂	8	12.9	0.38	2.94	12.1	13.3	12.17	1	0.15	0.690	5.46	0.000
	♀	4	11.5	0.46	4.00	11.1	12.1						
M2	♂	11	12.4	0.47	3.79	11.8	13.2	6.89	11	0.23	0.628	3.65	0.002
	♀	8	11.6	0.55	4.74	10.9	12.3						
M3	♂	17	11.9	0.72	6.05	10.2	12.8	6.25	12	0.15	0.691	2.47	0.021
	♀	9	11.2	0.64	5.71	9.8	11.7						

¹ Significant difference in variance indicated by Bartlett's χ^2 , Student's t calculated using separate variance estimate

Table 66 Buccolingual crown dimensions of the maxillary and mandibular teeth in Murray Valley males and females (mm)

Teeth	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	D%	Rank	χ^2	Probability	Student's t	Probability
<i>Maxillary dentition</i>													
I1	♂	32	8.2	0.44	4.63	7.1	9.1	5.12	11	0.71	0.397	4.24	0.000
	♀	34	7.8	0.38	4.87	6.6	8.5						
I2	♂	44	7.1	0.37	5.36	6.3	8.0	5.97	8	0.15	0.693	3.91	0.000
	♀	41	6.7	0.39	5.82	5.8	7.7						
C	♂	42	9.6	0.65	6.77	8.7	11.2	9.09	2	1.88	0.170	6.27	0.000
	♀	43	8.8	0.52	5.90	7.7	10.0						
P1	♂	40	10.6	0.57	5.37	9.5	12.0	6.00	7	0.00	0.980	4.74	0.000
	♀	42	10.0	0.56	5.60	8.4	11.3						
P2	♂	44	10.6	0.61	5.75	9.4	12.4	7.07	3	0.84	0.358	5.20	0.000
	♀	49	9.9	0.53	5.35	9.1	11.4						
M1	♂	39	13.2	0.65	4.92	11.4	14.7	4.76	13	2.18	0.139	4.12	0.000
	♀	46	12.6	0.52	4.12	11.8	13.9						
M2	♂	44	13.8	0.77	5.58	12.3	15.7	6.15	6	1.21	0.271	5.25	0.000
	♀	50	13.0	0.65	5.00	11.5	14.6						
M3	♂	42	13.0	0.86	6.61	11.4	16.4	6.55	4	0.16	0.682	4.59	0.000
	♀	50	12.2	0.80	6.55	9.7	14.1						
<i>Mandibular dentition</i>													
I1	♂	31	6.6	0.40	6.06	6.0	7.8	3.12	15	0.72	0.395	2.21	0.031
	♀	22	6.4	0.34	5.46	5.7	7.0						
I2	♂	34	6.8	0.44	6.47	6.0	7.8	3.03	16	1.02	0.311	1.62	0.109
	♀	33	6.6	0.53	8.03	5.8	8.8						
C	♂	41	8.8	0.60	6.81	7.6	10.1	10.00	1	5.08	0.024	7.58 ¹	0.000
	♀	41	8.0	0.41	5.12	7.2	9.1						
P1	♂	39	9.2	0.45	4.89	8.5	10.4	5.74	9	1.91	0.167	4.23	0.000
	♀	40	8.7	0.57	6.55	7.6	9.6						
P2	♂	38	9.2	0.62	6.73	8.1	10.7	4.54	14	0.18	0.670	2.59	0.011
	♀	37	8.8	0.58	6.59	7.3	10.0						
M1	♂	29	12.4	0.57	4.59	11.4	13.5	5.08	12	0.00	0.942	3.54	0.001
	♀	32	12.2	0.69	5.65	10.9	13.6						
M2	♂	32	12.2	0.69	5.65	10.9	13.6	5.17	10	0.83	0.361	3.52	0.001
	♀	36	11.6	0.59	5.08	10.2	12.9						
M3	♂	25	11.7	0.68	5.81	9.9	13.0	6.36	5	0.22	0.635	4.08	0.000
	♀	43	11.0	0.74	6.72	9.2	12.7						

¹ Significant difference in variance indicated by Bartlett's χ^2 , Student's t calculated using separate variance estimate

Table 67 Buccolingual crown dimensions of the maxillary and mandibular teeth in Swanport males and females (mm)

Teeth	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	D%	Rank	χ^2	Proba- bility	Student's t	Proba- bility
<i>Maxillary dentition</i>													
I1	♂	8	8.2	0.62	7.56	7.3	9.2	5.12	12	0.66	0.415	1.22	0.239
		10	7.8	0.46	5.89	7.3	8.7						
I2	♂	13	7.3	0.61	8.35	6.5	8.4	8.95	4	0.21	0.646	2.83	0.008
		17	6.7	0.54	8.06	5.8	7.8						
C	♂	18	9.4	0.66	7.02	8.0	10.6	6.81	9	2.34	0.126	2.74	0.010
		19	8.8	0.47	5.34	8.1	9.7						
P1	♂	17	10.6	0.70	6.60	9.5	12.1	6.00	11	2.01	0.156	2.64	0.013
		16	10.0	0.48	4.80	8.7	10.5						
P2	♂	20	10.4	0.89	8.55	8.8	12.3	6.12	10	7.76	0.005	2.54 ¹	0.015
		22	9.8	0.48	4.89	8.8	10.8						
M1	♂	20	12.9	0.71	5.50	11.5	14.2	2.38	15	0.48	0.488	1.28	0.208
		19	12.6	0.58	4.60	11.9	14.1						
M2	♂	23	13.5	0.84	6.22	12.3	16.2	7.14	7	1.37	0.241	3.76	0.000
		23	12.6	0.61	4.84	11.7	14.0						
M3	♂	22	12.7	0.90	7.08	10.8	14.9	7.62	6	0.36	0.545	3.38	0.002
		19	11.8	0.76	6.44	10.2	13.0						
<i>Mandibular dentition</i>													
I1	♂	7	6.7	0.48	7.16	6.0	7.3	8.06	5	0.28	0.595	1.88	0.084
		7	6.2	0.38	6.12	5.9	6.9						
I2	♂	10	6.7	0.34	5.07	6.3	7.2	3.55	13	0.00	0.949	1.10	0.285
		9	6.4	0.35	5.41	6.1	7.2						
C	♂	11	8.8	0.67	7.61	7.8	10.0	10.00	2	1.15	0.282	2.61	0.016
		13	8.0	0.48	6.00	7.6	9.3						
P1	♂	13	9.7	0.48	4.94	8.9	10.3	10.22	1	0.01	0.918	4.00	0.001
		12	8.8	0.46	5.22	8.1	9.8						
P2	♂	13	9.2	0.67	7.28	7.7	10.1	6.97	8	0.69	0.404	2.01	0.057
		11	8.6	0.51	5.93	7.9	9.6						
M1	♂	12	12.2	0.63	5.16	11.0	13.6	1.66	16	0.24	0.620	1.14	0.265
		13	12.0	0.55	4.58	11.1	13.2						
M2	♂	13	12.0	0.91	7.58	10.5	13.5	3.09	14	1.03	0.309	1.12	0.269
		16	11.6	0.68	5.84	10.7	13.2						
M3	♂	12	12.1	0.94	7.76	10.4	13.9	9.80	3	0.01	0.925	2.68	0.013
		13	11.0	0.92	8.34	9.9	12.6						

¹ Significant difference in variance indicated by Bartlett's χ^2 , Student's t calculated using separate variance estimate

premolar, canine and third molar and the maxillary lateral incisor. Overall levels of dimorphism at Swanport are comparable to those in the Murray Valley, but less than Coobool Creek. Mean dimorphism for the maxillary teeth is 6.26% and 6.66% for those from the mandible.

Discussion

Comparison of the results obtained with the Coobool Creek, Murray Valley and Swanport dentitions with those for Yuendumu (Barrett *et al.* 1964; Townsend and Brown 1979b) suggest that there may be some regional variation in tooth size dimorphism. However, a possibly more likely explanation of the variation in dimorphism scores is that these data are extremely sensitive to sampling effects. This issue can be explored directly through comparing tooth size data obtained in two separate studies of dental casts collected as part of the longitudinal growth study of Aboriginal people at Yuendumu in central Australia.

In 1964 Barrett *et al.* reported the buccolingual breadth dimensions of 85 male and 81 female Aborigines from Yuendumu. Although dental casts taken from over 80 males and females were used for the analysis, due to the age structure of the contributors the sample sizes for all but six of the tooth classes (mandibular and maxillary premolars and first molars) were less than 42. The smallest sample (male mandibular M3) consisted of 29 teeth. Sexual dimorphism figures calculated from their mean data are listed in Table 64. More recently, using an enlarged series of dental casts, 208 males and 184 females, Townsend and Brown (1979b:Table 5) list sexual dimorphism percentages and tooth class ranks for the same population. These data are also listed in Table 64. Although there are some broad similarities between the two data sets, with low levels of dimorphism for the maxillary premolars and a high level of dimorphism for the maxillary central incisor, at a detailed level there is little agreement. In the initial study the most dimorphic tooth is the maxillary third molar (9.01%) followed by the mandibular central incisor (6.67%). With the larger sample the most dimorphic tooth class is the maxillary canine, followed by the maxillary medial incisor and maxillary canine (Table 64).

Moreover, comparison of the mean buccolingual tooth dimensions in Barrett *et al.* (1964) with those of Townsend and Brown (1979b) using Student's *t* test obtains significant differences between the mean values for the female maxillary first molar (Y1 $n = 81$, $\bar{x} = 12.21$, $s = 0.57$; Y2 $n = 183$, $\bar{x} = 12.06$, $s = 0.54$; $t = 2.17$, P

$= 0.05$) and second molar (Y1 $n = 36$, $\bar{x} = 12.42$, $s = 0.67$; Y2 $n = 144$, $\bar{x} = 12.21$, $s = 0.61$; $t = 2.14$, $P = 0.05$), male mandibular medial incisor (Y1 $n = 41$, $\bar{x} = 6.87$, $s = 0.57$; Y2 $n = 206$, $\bar{x} = 6.60$, $s = 0.45$; $t = 3.85$, $P = 0.001$), lateral incisor (Y1 $n = 41$, $\bar{x} = 8.39$, $s = 0.48$; Y2 $n = 183$, $\bar{x} = 8.23$, $s = 0.50$; $t = 2.79$, $P = 0.01$) and canine (Y1 $n = 41$, $\bar{x} = 8.39$, $s = 0.48$; Y2 $n = 183$, $\bar{x} = 8.23$, $s = 0.50$; $t = 2.50$, $P = 0.01$), and female mandibular canine (Y1 $n = 36$, $\bar{x} = 8.03$, $s = 0.38$; Y2 $n = 36$, $\bar{x} = 7.82$, $s = 0.42$; $t = 4.11$, $P = 0.001$), first premolar (Y1 $n = 81$, $\bar{x} = 8.69$, $s = 0.55$; Y2 $n = 177$, $\bar{x} = 8.51$, $s = 0.53$; $t = 2.68$, $P = 0.01$) and second molar (Y1 $n = 36$, $\bar{x} = 11.29$, $s = 0.42$; Y2 $n = 159$, $\bar{x} = 11.08$, $s = 0.56$; $t = 3.62$, $P = 0.001$). The difference between these two sets of data are unlikely to be simply the result of intraobserver error. One observer was common to both projects and the measurement techniques were consistent throughout. What these data appear to reflect are the high levels of intrapopulation variation in tooth size and the need for large samples. Sample sizes, which on the whole, are unavailable in Australian archaeological and palaeoanthropological situations.

Therefore, comparison of the results for the four Australian samples indicates either that there is great variation in the expression of sexual dimorphism for the buccolingual crown dimension in Aboriginal populations, or that these are simply chance fluctuations due to individual sampling events (Tables 64-67). The only pattern to the individual tooth rankings is that the maxillary M1 and the mandibular M2 consistently display less dimorphism than the other teeth. Ranking of the overall mean dimorphism values yields some surprising results. As expected the most dimorphic teeth are the mandibular and maxillary canines but they are closely followed by the maxillary third molar and mandibular central incisor. Sexual dimorphism for the buccolingual crown dimension is greatest in the Coobool Creek sample, with the least dimorphism at Yuendumu. The other groups are intermediate, though slightly closer to Yuendumu than Coobool Creek. It should be noted that the Coobool Creek series is by far the smallest sample in the analysis and these results may be an artifact of sampling.

COOBOOL CREEK BUCCOLINGUAL TOOTH DIMENSIONS

The descriptive statistical data for the Coobool Creek, Murray Valley, Swanport and Broadbeach series are presented in Tables 65-68, with box plots of these data in Figures 66-69. Tables 64 and 65 allow comparison of Coobool Creek mean buccolingual tooth dimensions with those

Table 68 Buccolingual crown dimensions of the maxillary and mandibular teeth in Broadbeach males and females (mm)

Teeth	Sex	n	\bar{x}	s	Coefficient of variation	Min.	Max.	D%	Rank	χ^2	Proba- bility	Student's t	Proba- bility
<i>Maxillary dentition</i>													
I1	♂	11	8.1	0.51	6.29	7.2	8.8	17.39	1	0.15	0.698	2.94	0.013
	♀	2	6.9	0.35	5.07	6.7	7.2						
I2	♂	17	7.0	0.47	6.71	6.1	7.8	6.06	14	1.06	0.303	1.54	0.139
	♀	4	6.6	0.27	4.09	6.3	6.9						
C	♂	19	9.5	0.73	7.68	8.2	11.1	10.46	5	0.00	0.967	1.95	0.065
	♀	3	8.6	0.75	8.72	8.1	9.5						
P1	♂	19	10.6	0.64	6.03	9.4	11.8	12.76	2	0.98	0.320	2.48	0.023
	♀	2	9.4	0.21	2.23	9.3	9.6						
P2	♂	16	10.6	0.75	7.07	9.5	11.5	11.57	3	0.06	0.808	1.73	0.101
	♀	2	9.5	0.91	9.57	8.9	10.2						
M1	♂	20	12.9	0.60	4.65	11.6	14.1	4.87	15	0.05	0.820	1.90	0.070
	♀	4	12.3	0.67	5.44	11.8	13.3						
M2	♂	21	13.5	0.73	5.40	12.1	14.9	9.57	6	0.12	0.729	3.00	0.006
	♀	4	12.3	0.85	6.89	11.2	13.2						
M3	♂	22	12.9	0.98	7.59	10.9	14.6	11.20	4	0.40	0.525	2.39	0.025
	♀	4	11.6	0.71	6.12	11.1	12.7						
<i>Mandibular dentition</i>													
I1	♂	17	6.6	0.40	6.06	5.8	7.4	6.45	11	0.20	0.655	1.99	0.061
	♀	3	6.2	0.30	4.83	5.9	6.5						
I2	♂	18	6.8	0.45	6.61	6.1	7.6	6.25	12	1.08	0.307	1.39	0.180
	♀	2	6.4	0.14	2.18	6.3	6.5						
C	♂	22	8.7	0.50	5.74	7.5	9.5	6.09	13	0.01	0.931	1.60	0.122
	♀	3	8.2	0.52	6.34	7.6	8.6						
P1	♂	22	9.2	0.51	5.54	8.2	10.2	9.52	7	1.17	0.279	2.88	0.008
	♀	4	8.4	0.80	9.52	7.3	9.1						
P2	♂	18	9.4	0.66	7.02	8.2	10.4	8.04	10	0.09	0.756	1.85	0.078
	♀	4	8.7	0.75	8.62	7.8	9.5						
M1	♂	18	12.0	0.54	4.50	10.9	13.0	4.34	16	0.00	0.963	1.83	0.082
	♀	4	11.5	0.55	4.78	11.1	12.3						
M2	♂	22	11.8	0.68	5.76	10.5	13.5	8.25	9	0.01	0.913	2.64	0.014
	♀	4	10.9	0.64	5.87	10.1	11.6						
M3	♂	24	11.5	0.62	5.39	10.1	12.4	9.52	7	4.54	0.033	2.68 ¹	0.013
	♀	3	10.5	0.10	0.95	10.4	10.6						

1 Significant difference in variance indicated by Bartlett's χ^2 , Student's t calculated using separate variance estimate

Table 69 Buccolingual tooth dimensions of Aboriginal skeletons from Kow Swamp, Barham and Roonka (mm)

Teeth	Sex	n	Kow Swamp				n	\bar{x}	Barham				n	\bar{x}	Roonka ¹			
			\bar{x}	s	Min.	Max.			s	Min.	Max.	s			Min.	Max.		
<i>Maxillary dentition</i>																		
I1	♂	2	8.25	0.07	8.2	8.3	2	8.45	0.07	8.4	8.5	4	8.1	0.50	7.6	8.7		
	♀	2	8.05	0.63	7.6	8.5	1	7.70	-	7.7	7.7							
I2	♂	2	7.80	0.28	7.6	8.0	3	7.00	0.70	6.4	7.8	8	7.1	0.44	6.4	7.9		
	♀	3	7.30	0.51	6.9	7.9	0	-	-	-	-							
C	♂	2	9.35	0.07	9.3	9.4	3	9.20	0.58	8.8	9.9	8	9.2	0.26	8.8	9.6		
	♀	3	8.70	0.61	8.2	9.4	1	9.60	-	9.6	9.6							
P1	♂	2	10.60	0.00	10.6	10.6	2	11.10	0.00	11.1	11.1	8	10.6	0.37	9.9	11.1		
	♀	3	10.30	0.26	10.0	10.5	1	11.10	-	11.1	11.1							
P2	♂	2	10.15	0.49	9.8	10.5	3	10.90	0.56	10.5	11.6	8	10.8	0.51	10.2	11.6		
	♀	3	10.40	0.46	10.1	10.9	1	11.20	-	11.2	11.2							
M1	♂	1	13.20	-	13.2	13.2	2	13.70	0.42	13.4	14.0	6	13.0	0.61	12.4	14.1		
	♀	3	12.80	0.75	12.3	13.7	2	12.90	0.56	12.5	13.3							
M2	♂	-	-	-	-	-	4	13.60	0.64	13.0	14.4	8	13.5	0.70	12.7	14.9		
	♀	2	13.55	0.21	13.4	13.7	2	13.30	1.13	12.5	14.1							
M3	♂	2	13.15	0.21	13.0	13.3	3	13.60	0.96	12.6	14.5	6	12.7	0.99	11.2	14.2		
	♀	-	-	-	-	-	2	12.75	0.91	12.1	13.4							
<i>Mandibular dentition</i>																		
I1	♂	-	-	-	-	-	2	8.45	0.07	8.4	8.5	4	6.5	0.14	6.3	6.6		
	♀	2	6.25	0.35	6.0	6.5	1	7.70	-	7.7	7.7							
I2	♂	-	-	-	-	-	2	6.95	0.63	6.5	7.4	4	6.8	0.10	6.7	6.9		
	♀	2	6.50	0.28	6.3	6.7	-	-	-	-	-							
C	♂	2	8.75	0.21	8.6	8.9	2	8.60	0.70	8.1	9.1	8	8.4	0.40	7.8	8.9		
	♀	1	7.70	-	7.7	7.7	2	8.35	0.77	7.8	8.9							
P1	♂	2	9.30	0.56	8.9	9.7	2	9.05	0.49	8.7	9.4	8	8.9	0.32	8.5	9.4		
	♀	1	8.60	-	8.6	8.6	2	8.75	0.91	8.1	9.4							
P2	♂	2	9.15	0.35	8.9	9.4	2	10.05	0.21	9.9	10.2	8	9.1	0.62	8.1	9.9		
	♀	1	9.10	-	9.1	9.1	2	9.15	0.35	8.9	9.4							
M1	♂	-	-	-	-	-	2	12.35	0.35	12.1	12.6	5	12.2	0.55	11.6	13.0		
	♀	2	12.00	0.70	11.5	12.5	1	12.90	-	12.9	12.9							
M2	♂	-	-	-	-	-	2	12.55	0.49	12.2	12.9	7	11.7	0.69	11.1	13.3		
	♀	1	11.40	-	11.4	-	1	12.70	-	12.7	12.7							
M3	♂	2	11.90	0.42	11.6	12.2	2	11.45	0.49	11.1	12.9	7	11.2	0.73	9.6	11.8		
	♀	1	11.50	-	11.5	11.5	1	11.90	-	11.9	11.9							

¹ Roonka data for the eight male skeletons which on the basis of Pretty (1977) can be assigned to Phase II of the site, 4000-7000 years BP

Table 70 Comparisons of mean buccolingual tooth dimensions from Coobool Creek with those from the Murray Valley, Swanport and Broadbeach using Student's *t* test (Broadbeach female sample too small for meaningful comparison)

Teeth		Male			Female	
		Coobool Creek- Murray Valley	Coobool Creek- Swanport	Coobool Creek- Broadbeach	Coobool Creek- Murray Valley	Coobool Creek- Swanport
<i>Maxillary dentition</i>						
I1	t	0.789	0.771 ¹	1.368	1.150	0.611 ¹
	P	0.434	0.452	0.187	0.255	0.551
I2	t	5.829	1.919	4.226	4.120	3.030
	P	0.000	0.067	0.000	0.000	0.006
C	t	0.417	1.543	0.812	1.000	0.829
	P	0.678	0.133	0.423	0.319	0.415
P1	t	1.931	1.752 ¹	1.828	0.106	0.192
	P	0.059	0.092	0.078	0.916	0.850
P2	t	1.238	1.705 ¹	1.135	0.530	1.190
	P	0.221	0.098	0.266	0.598	0.242
M1	t	2.125	3.310	3.459	0.613	0.665
	P	0.038	0.002	0.002	0.543	0.513
M2	t	0.563	1.606	1.547	0.737 ²	0.679
	P	0.575	0.117	0.131	0.464	0.503
M3	t	0.378	1.414	0.815	0.090	0.932
	P	0.707	0.166	0.421	0.928	0.361
<i>Mandibular dentition</i>						
I1	t	1.620	0.991	1.495	0.576 ²	0.000
	P	0.115	0.351	0.152	0.570	1.000
I2	t	1.300	1.789	1.000	0.129	0.236
	P	0.200	0.090	0.326	0.898	0.818
C	t	1.650	1.495	2.633	1.857	0.450
	P	0.105	0.148	0.013	0.070	0.657
P1	t	3.320	0.073	2.167	0.645	0.452
	P	0.002	0.942	0.037	0.522	0.652
P2	t	4.170	3.335	2.381	0.988	1.606
	P	0.000	0.002	0.023	0.329	0.126
M1	t	2.260	2.594	4.031	1.096 ²	1.430
	P	0.030	0.018	0.000	0.281	0.173
M2	t	1.290	1.245	2.575	0.110	0.535
	P	0.202	0.226	0.015	0.913	0.598
M3	t	1.090	0.665	2.130	0.737	0.236
	P	0.278	0.512	0.040	0.465	0.816

t = Student's *t*

P = Probability

1 Significant difference in variance indicated by Bartlett's χ^2 ,
Student's *t* test calculated using separate variance estimate

2 Mean value greater than Coobool Creek mean

Table 71 Comparison of the buccolingual crown dimensions of permanent teeth from Coobool Creek with those recorded for other Aboriginal populations (mm)

Teeth		Coobool Creek	Kow Swamp	Barham	Roonka ¹	Murray Valley	Swanport	Broadbeach	Yuendumu ²	Western Australia ³
<i>Male maxillary dentition</i>										
I1	n	10	2	2	4	32	8	11	41	18
	\bar{x}	8.3	8.2	8.4	8.1	8.2	8.2	8.1	7.9 ⁵	7.9 ⁵
	s	0.26	0.07	0.07	0.50	0.44	0.62	0.51	0.36	0.53
I2	n	12	2	3	8	44	13	17	41	30
	\bar{x}	7.7	7.8	7.0	7.1 ⁴	7.1 ⁵	7.3	7.0 ⁵	7.0	7.0
	s	0.42	0.28	0.70	0.44	0.37	0.61	0.47	0.51	0.44
C	n	15	2	3	8	42	18	19	41	39
	\bar{x}	9.7	9.3	9.2	9.2 ⁴	9.6	9.4	9.5	9.1 ⁴	9.1 ⁴
	s	0.50	0.07	0.58	0.26	0.65	0.66	0.73	0.56	0.56
P1	n	11	2	2	8	40	17	19	85	42
	\bar{x}	11.0	10.6	11.1	10.6	10.6	10.6	10.6	10.4 ⁵	10.3 ⁴
	s	0.38	0.00	0.00	0.37	0.57	0.70	0.64	0.61	0.49
P2	n	14	2	3	8	44	20	16	85	44
	\bar{x}	10.8	10.1	10.9	10.8	10.6	10.4	10.6	10.3 ⁵	10.3 ⁵
	s	0.46	0.49	0.56	0.51	0.61	0.89	0.75	0.56	0.55
M1	n	15	1	2	6	39	20	20	85	48
	\bar{x}	13.6	13.2	13.7	13.0 ⁴	13.2 ⁴	12.9 ⁵	12.9 ⁵	12.6 ⁵	12.8 ⁵
	s	0.44	-	0.42	0.61	0.65	0.71	0.60	0.54	0.63
M2	n	14	-	4	8	44	23	21	41	48
	\bar{x}	13.9	-	13.6	13.5	13.8	13.5	13.5	12.8 ⁵	12.9 ⁵
	s	0.79	-	0.64	0.70	0.77	0.84	0.73	0.73	0.71
M3	n	17	2	3	6	42	22	22	32	47
	\bar{x}	13.1	13.1	13.6	12.7	13.0	12.7	12.9	12.1 ⁵	12.2 ⁴
	s	0.86	0.21	0.96	0.99	0.86	0.90	0.98	0.82	0.82
<i>Female maxillary dentition</i>										
I1	n	6	2	1	5	34	10	2	36	13
	\bar{x}	8.0	8.0	7.7	7.6	7.8	7.8	6.9	7.5	7.4
	s	0.49	0.63	-	-	0.38	0.46	0.35	0.36	0.44
I2	n	7	3	-	6	41	17	4	36	19
	\bar{x}	7.4	7.3	-	6.8	6.7 ⁵	6.7 ⁵	6.6 ⁴	6.7 ⁵	6.7 ⁵
	s	0.42	0.51	-	-	0.39	0.54	0.27	0.49	0.50
C	n	7	3	1	5	43	19	3	36	24
	\bar{x}	9.0	8.7	9.6	8.7	8.8	8.8	8.6	8.7	8.4 ⁴
	s	0.46	0.61	-	-	0.52	0.47	0.75	0.38	0.45
P1	n	6	3	1	6	42	16	2	81	22
	\bar{x}	10.0	10.3	11.1	10.1	10.0	10.0	9.4	10.1	9.8 ⁴
	s	0.53	0.26	-	-	0.56	0.48	0.21	0.56	0.66
P2	n	8	3	1	6	49	22	2	81	23
	\bar{x}	10.0	10.4	11.2	9.7	9.9	9.8	9.5	10.0	9.7
	s	0.73	0.46	-	-	0.53	0.48	0.91	0.60	0.68

Table 71 (continued)

Teeth		Coobool Creek	Kow Swamp	Barham	Roonka ¹	Murray Valley	Swanport	Broadbeach	Yuendumu ²	Western Australia ³
M1	n	6	3	2	7	46	19	4	81	25
	\bar{x}	12.8	12.8	12.9	12.3	12.6	12.6	12.3	12.2 ⁴	12.1 ⁵
	s	0.70	0.75	0.56	-	0.52	0.58	0.67	0.57	0.52
M2	n	8	2	2	7	50	23	4	36	26
	\bar{x}	12.9	13.5	13.3	12.4	13.0	12.6	12.3 ⁴	12.4 ⁴	12.2 ⁴
	s	0.75	0.21	1.13	-	0.65	0.61	0.85	0.67	0.60
M3	n	7	-	2	3	50	19	4	30	17
	\bar{x}	12.2	-	12.7	9.4	12.2	11.8	11.6 ⁴	11.9	11.6 ⁴
	s	1.26	-	0.91	-	0.80	0.76	0.71	0.83	0.62
<i>Male mandibular dentition</i>										
I1	n	3	-	2	4	31	7	17	41	12
	\bar{x}	7.0	-	8.4	6.5	6.6	6.7	6.6	6.9	6.7
	s	0.11	-	0.07	0.14	0.40	0.48	0.40	0.57	0.60
I2	n	10	-	2	4	34	10	18	41	19
	\bar{x}	7.0	-	6.9	6.8	6.8	6.7	6.8	7.0	6.7
	s	0.45	-	0.63	0.10	0.44	0.34	0.45	0.53	0.48
C	n	15	2	2	8	41	11	22	41	24
	\bar{x}	9.1	8.7	8.6	8.4 ⁴	8.8	8.8	8.7 ⁴	8.4 ⁵	8.7 ⁴
	s	0.49	0.21	0.70	0.40	0.60	0.67	0.50	0.48	0.47
P1	n	16	2	2	8	39	13	22	85	24
	\bar{x}	9.7	9.3	9.0	8.9 ⁵	9.2 ⁵	9.7	9.2 ⁴	8.8 ⁵	8.9 ⁵
	s	0.55	0.56	0.49	0.32	0.45	0.48	0.51	0.59	0.65
P2	n	16	2	2	8	38	13	18	85	25
	\bar{x}	9.9	9.1	10.0	9.1 ⁵	9.2 ⁵	9.2 ⁵	9.4 ⁴	9.2 ⁵	9.0 ⁵
	s	0.53	0.35	0.21	0.62	0.62	0.67	0.66	0.60	0.54
M1	n	8	-	2	5	29	12	18	83	27
	\bar{x}	12.9	-	12.3	12.2 ⁴	12.4 ⁴	12.2 ⁴	12.0 ⁵	11.9 ⁵	12.0 ⁵
	s	0.38	-	0.35	0.55	0.57	0.63	0.54	0.61	0.69
M2	n	11	-	2	7	32	13	22	41	29
	\bar{x}	12.4	-	12.5	11.7 ⁴	12.2	12.0	11.8 ⁴	11.6 ⁵	11.7 ⁵
	s	0.47	-	0.49	0.69	0.69	0.91	0.68	0.66	0.77
M3	n	17	2	2	7	25	12	24	29	30
	\bar{x}	11.9	11.9	11.4	11.2 ⁴	11.7	12.1	11.5 ⁴	11.4	11.4
	s	0.72	0.42	0.49	0.73	0.74	0.92	0.10	0.71	0.72

Table 71 (continued)

Teeth		Coobool Creek	Kow Swamp	Barham	Roonka ¹	Murray Valley	Swanport	Broadbeach	Yuendumu ²	Western Australia ³
<i>Female mandibular dentition</i>										
I1	n	5	2	1	5	22	7	3	36	13
	\bar{x}	6.3	6.2	7.7	6.2	6.4	6.2	6.2	6.4	5.9
	s	0.70	0.35	-	-	0.34	0.38	0.30	0.32	0.27
I2	n	5	2	-	5	33	9	2	36	16
	\bar{x}	6.6	6.5	-	6.4	6.6	6.4	6.4	6.6	6.3
	s	0.54	0.28	-	-	0.53	0.35	0.14	0.40	0.45
C	n	9	1	2	4	41	13	3	36	16
	\bar{x}	8.3	7.7	8.3	7.8	8.0	8.0	8.2	8.0	7.8 ⁴
	s	0.47	-	0.77	-	0.41	0.48	0.52	0.38	0.42
P1	n	9	1	2	5	40	12	4	81	19
	\bar{x}	8.8	8.6	8.7	8.6	8.7	8.8	8.4	8.7	8.5
	s	0.55	-	0.91	-	0.57	0.46	0.80	0.55	0.50
P2	n	9	1	2	6	37	11	4	81	16
	\bar{x}	9.0	9.1	9.1	8.8	8.8	8.6	8.7	8.9	8.8
	s	0.41	-	0.35	-	0.58	0.51	0.75	0.51	0.52
M1	n	4	2	1	7	32	13	4	80	15
	\bar{x}	11.5	12.0	12.9	11.6	12.2	12.0	11.5	11.4	11.4
	s	0.46	0.70	-	-	0.69	0.55	0.55	0.51	0.73
M2	n	8	1	1	5	36	16	4	36	15
	\bar{x}	11.6	11.4	12.7	11.5	11.6	11.6	10.9	11.3	11.2
	s	0.55	-	-	-	0.59	0.68	0.64	0.42	0.69
M3	n	9	1	1	3	43	13	3	30	17
	\bar{x}	11.2	11.5	11.9	11.3	11.0	11.0	10.5	11.2	11.0
	s	0.64	-	-	-	0.74	0.92	0.95	0.57	0.93

1 Female data for Roonka IIIa (Smith *et al.* 1988)

2 Yuendumu data (Barrett *et al.* 1964)

3 Western Australia data (Freedman and Lofgren 1981)

4 Mean value exceeded by Coobool Creek mean (P = .05-.01)

5 Mean value exceeded by Coobool Creek mean (P = .009-.001)

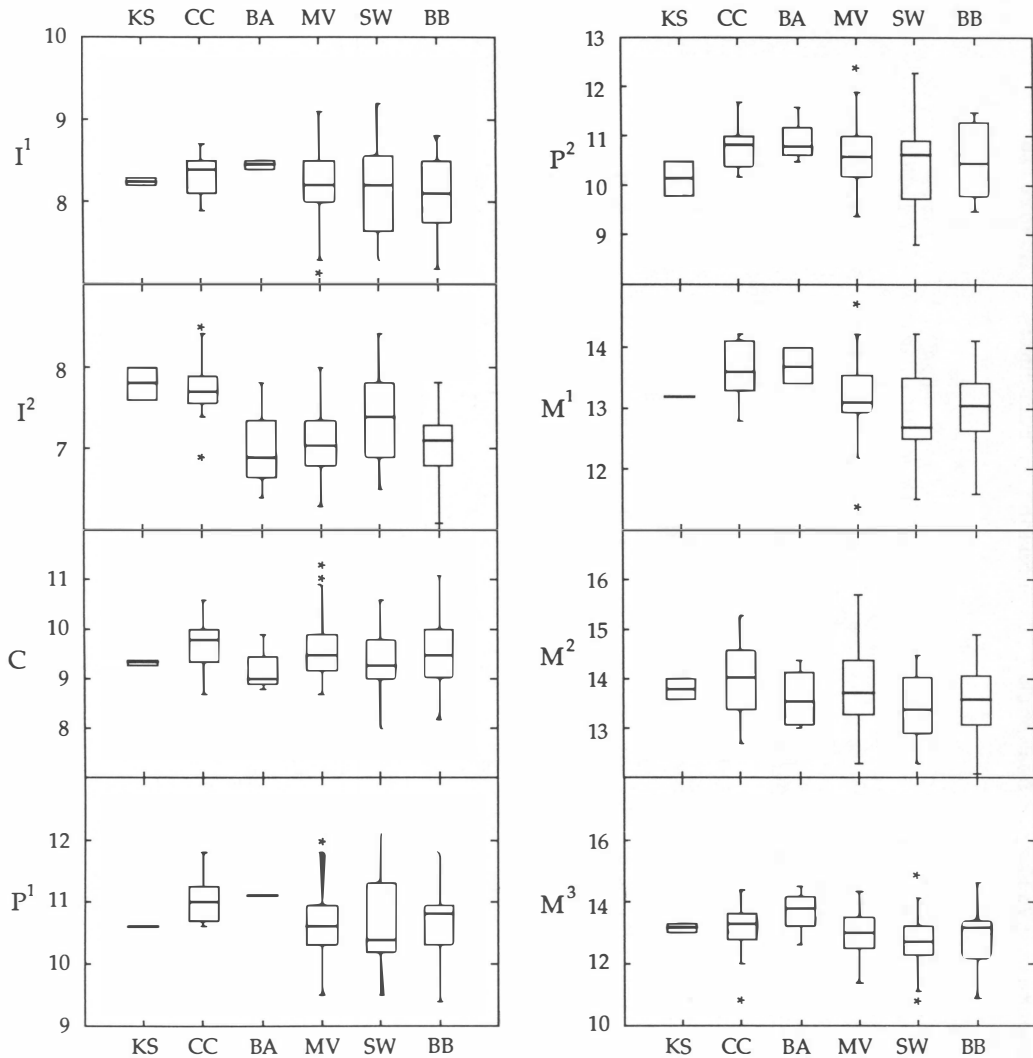


Figure 66 Box plots of buccolingual crown dimensions (mm) in male maxillary teeth from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

obtained for other sexed Australian series. Descriptive statistical data for the terminal Pleistocene and mid-Holocene series from Kow Swamp, Barham and Roonka are listed in Table 69.

Maxillary medial incisor

The Coobool Creek medial incisors are large with a prominent cingulum on the lingual surface. The roots are long, robust and conical, in some specimens reaching to within a few millimetres of the nasal aperture. The degree of shovelling on the lingual surface of the central and lateral incisors can be assessed in six of the Coobool Creek maxillae (CC1, 12, 16, 28, 40 and 45). There is moderate development of the lingual fossa, with slight marginal ridges in CC1. In this specimen the shovelling is more marked on the remaining lateral incisor, which has a distinct lingual tubercle. Shovelling in the

remaining individuals varies from a trace (CC28, 40 and 45) to absent (CC12 and 45). In each instance the fossae are more developed on the lateral incisors.

The Coobool Creek male mean buccolingual dimension ($n = 10$, $\bar{x} = 8.3$) is exceeded by the small sample from Barham ($n = 2$, $\bar{x} = 8.45$), but is greater than those in the other comparative samples, although not significantly so (Tables 70-71). A similar result was obtained in the Coobool Creek females where their mean buccolingual dimension ($n = 6$, $\bar{x} = 8.0$) is only exceeded by the Kow Swamp females ($n = 2$, $\bar{x} = 8.05$). Maximum medial incisor breadth in the Coobool Creek males (8.7 mm) is exceeded by the maximum figures for the Swanport, Murray Valley and Broadbeach series (8.8-9.2 mm) (Tables 65-68). The Coobool Creek female maximum (8.8 mm) exceeds the maxima for the comparative populations (Tables 65-68).

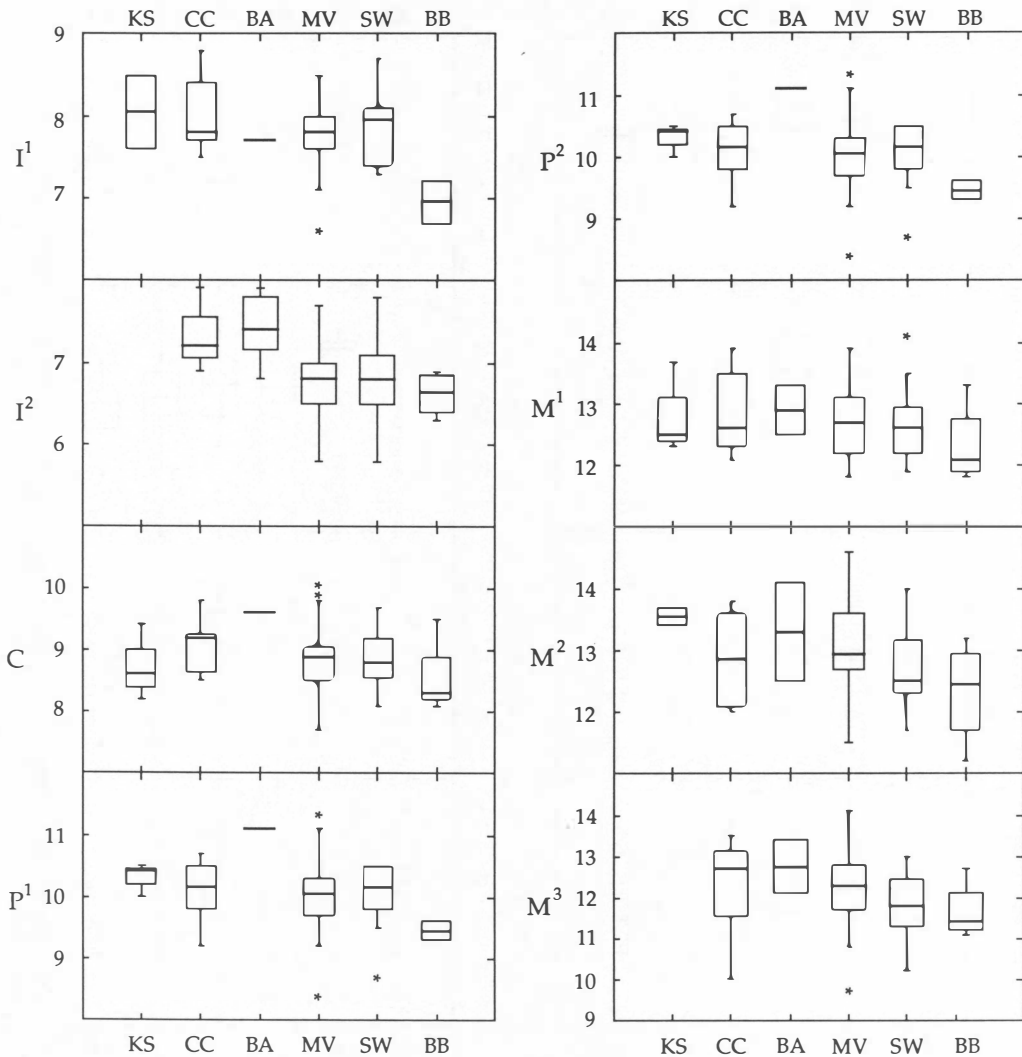


Figure 67 Box plots of buccolingual crown dimensions (mm) in female maxillary teeth from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

Maxillary lateral incisor

The Coobool Creek lateral incisors are distinctive. In both size and morphology they are more similar to the Coobool Creek medial incisors than are the lateral incisors in the recent comparative samples which I examined. They are large, well formed teeth with a prominent cingulum on the lingual surface and a broad cervical margin. The roots are long and thickened. Similarly the few preserved lateral incisors from Kow Swamp are also large and robust teeth. The right lateral incisor in CC37 was probably congenitally absent.

With the exception of the Coobool Creek and Swanport male comparison ($t = 1.919$, $P = 0.067$), the mean buccolingual crown dimensions for the Coobool Creek male and female lateral incisors are significantly greater than those in the comparative male and female series ($P = .05-.001$) (Tables 65-70). Maximum lateral incisor breadth

in this analysis has been obtained by the Coobool Creek males (8.5 mm) and females (7.9 mm). Box plots of these data (Figs 67-68) highlight the large size of the Coobool Creek lateral incisors, with the central 50% of the male and female distributions being above the corresponding part of the distributions in all but one (Swanport males) of the comparative recent and mid-Holocene populations.

Maxillary canine

In the Coobool Creek dentitions these teeth are distinguished by their great breadth at the cervical margin, with a prominent cingulum and long, column-like roots. Occlusal attrition has removed the cusps from most of the Coobool Creek canines, exposing large areas of dentine, though in most instances tooth wear has not proceeded past the cemento-enamel junction.

Mean canine breadth in the Coobool Creek

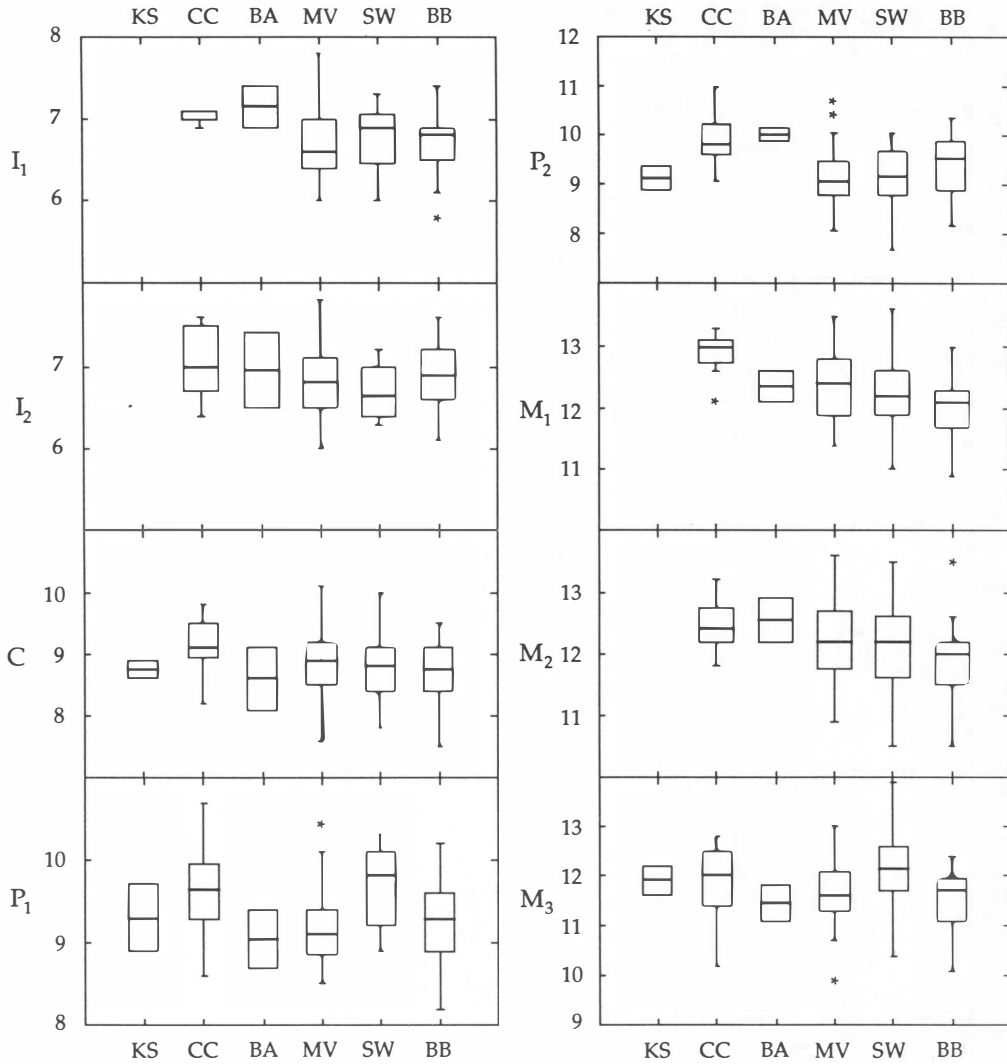


Figure 68 Box plots of buccolingual crown dimensions (mm) in male mandibular teeth from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

males is greater than that in the comparative samples but this is significant only when compared with the Yuendumu and Western Australian males ($P = .05-.01$) (Tables 65-71). Similarly, the Coobool Creek female mean is greater than that for the other female samples. This is significant only when compared with the Western Australian females ($P = .05-.01$) (Tables 65-71).

Maximum canine breadth in the Coobool Creek males (10.6 mm) is exceeded by the maxima in the Murray Valley (11.2 mm) and Broadbeach (11.1 mm) males. The Coobool Creek female maximum (9.8 mm) is exceeded by the Murray Valley female maximum (10.0 mm).

Maxillary premolars

In Aboriginal dentitions the crowns of the two maxillary premolars are generally of similar size

and morphology, with the first premolars slightly larger than the second and often with a slightly larger buccal cusp. The Coobool Creek premolars are similar in size and morphology. Occlusal attrition has removed the cusps in most specimens, exposing varying amounts of dentine. The left maxillary P2 in CC45 is rotated and displaced lingually.

Mean premolar breadths in the Coobool Creek males are greater than that in the comparative male samples, with a significant result for P1 and P2 in comparisons with the Yuendumu and Western Australian samples ($P = .05-.01$) (Tables 65-71). The Coobool Creek female premolars are larger than the other female samples but not significantly so.

Maximum premolar breadth in the Coobool Creek males (P1 11.8 mm, P2 11.7 mm) is exceeded by the maxima in the Swanport (P1 12.1

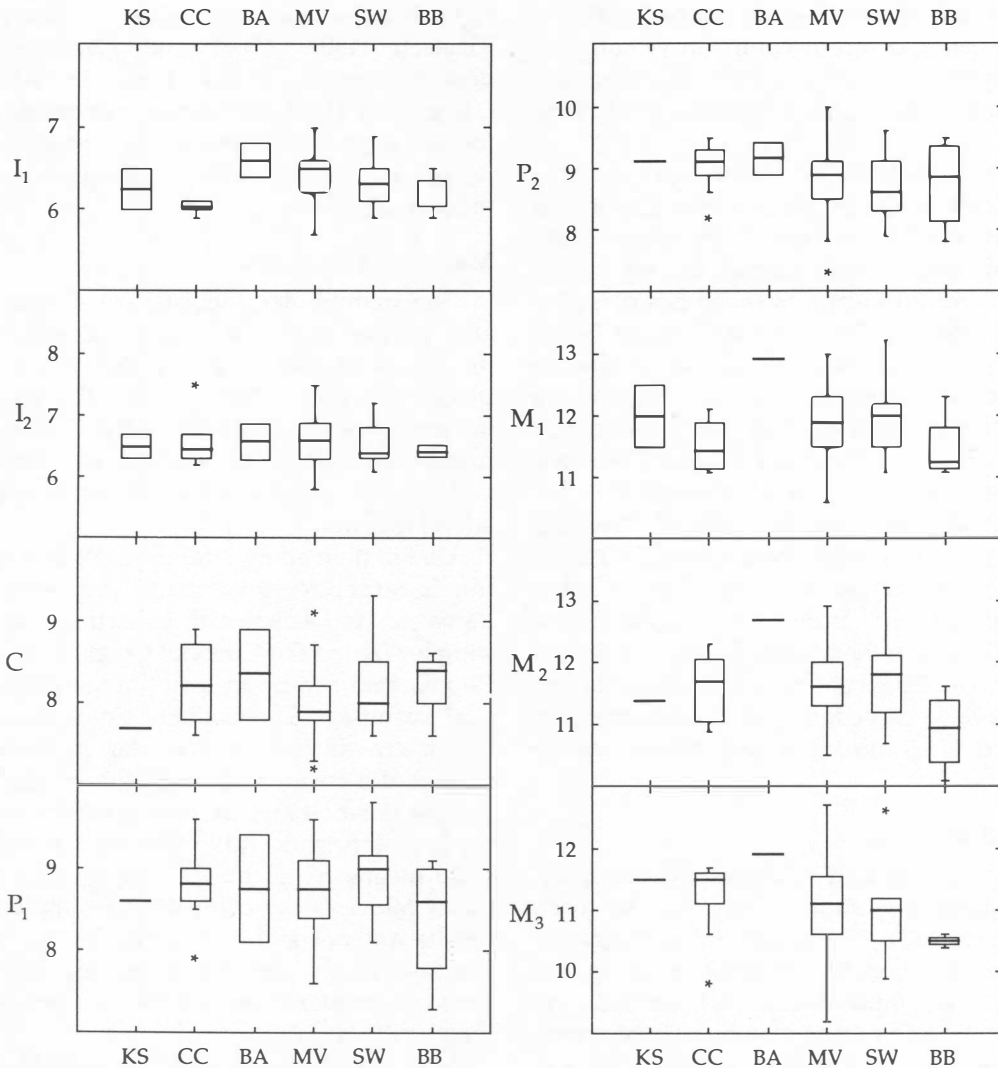


Figure 69 Box plots of buccolingual crown dimensions (mm) in female mandibular teeth from Kow Swamp, Coobool Creek, Barham, the Murray Valley, Swanport and Broadbeach

mm, P₂ 12.3 mm) and Murray Valley (P₁ 12.0 mm, P₂ 12.4 mm) males. The maximum pre-molar dimensions in the Coobool Creek females (P₁ 10.7 mm, P₂ 11.3 mm) are exceeded by the maxima in the Murray Valley series (P₁ 11.3 mm, P₂ 11.4 mm). Premolar breadth dimensions in the Kow Swamp males and females are towards the bottom of the Coobool Creek range (Tables 65, 69).

Maxillary first molar

In the Coobool Creek series the large mean breadths of the maxillary first molars make these teeth distinct (Figs 66-67). The mean buccolingual dimension of these teeth in the Coobool Creek males is significantly greater than that in the comparative recent male samples ($P = .038-.002$) (Tables 65-70). The Coobool Creek female

mean, while larger than that in the comparative female samples, is significant only in comparison with the Yuendumu and Western Australian series ($P = .05-.01$) (Tables 65-71). There is less variation in the breadth of the first maxillary molar in the Coobool Creek males than in the recent male samples.

Maximum first molar breadth in the Coobool Creek males (14.2 mm) is exceeded by the Murray Valley males (14.7 mm). The Coobool Creek female maximum (13.9 mm) is less than the Swanport female maximum (14.1 mm).

Maxillary second molar

For the buccolingual dimension in Aboriginal dentitions, the second molar is typically the largest tooth in the molar series (Campbell

1925:12). A similar result was obtained with the Coobool Creek and recent comparative samples in this analysis, although to a lesser degree in the female groups than in males (Tables 65-68, Figs 66-67).

The mean breadth of these teeth in the Coobool Creek males is greater than that in the comparative samples but this is significant only when compared with the small molars in the Yuendumu and Western Australian samples ($P = .009-.001$) (Tables 65-71). In the Coobool Creek female sample the mean buccolingual dimension of their second molars is less than that for the Murray Valley females, but is significantly greater than the Yuendumu and Western Australian means ($P = .05-.01$) (Tables 65-71).

The maximum second molar breadth recorded for the Coobool Creek males (15.3 mm) seems slight in comparison with that recorded for one massive tooth from Swanport (16.2 mm) and is also less than the Murray Valley maximum (15.7 mm). The Coobool Creek female maximum (13.8 mm) is also exceeded by the female maxima at Swanport (14.0 mm) and the Murray Valley (14.6 mm).

Maxillary third molar

In terms of size and morphology this tooth shows the greatest variation in the maxillary arch (Campbell 1925:12). Although there is greater variation in the breadth of these teeth in the Coobool Creek sample than in M1 and M2, the majority have large robust crowns. There are no reduced, peg-like third molars, although there is a congenital absence of the right maxillary M3 in CC65.

Mean breadth of the maxillary third molar in the Coobool Creek males and females either exceeds, or equals, those in the comparative recent populations, but is below the mean figures for Kow Swamp and Barham (Tables 65-71). The Coobool Creek male mean is significantly greater than the Yuendumu and Western Australian male means ($P = .05-.001$), while the Coobool Creek female mean is significantly greater than that for the Western Australian females ($P = .05-.01$) (Table 71).

Maximum third molar breadth in the Coobool Creek males (14.4 mm) is less than the maximum in the comparative samples (Murray Valley 16.3 mm) and the Coobool Creek female maximum (13.5 mm) is also less than the Murray Valley female maximum (14.1 mm).

Supernumerary maxillary teeth

The only supernumerary tooth in the reconstructed Coobool Creek dentitions is a unilateral

right fourth molar in CC46. Turner (1884), Klaatsch (1902, 1908) and Campbell (1925) describe fourth molar teeth in Aborigines. Campbell's (1925:25) survey indicated that the fourth molar was the most frequent supernumerary tooth, with a frequency in 600 individuals of 1%.

Mandibular incisors

The mandibular incisors are similar in size and morphology in Aboriginal dentitions, with the lateral incisor generally slightly larger than the medial one. Crowding of the mandibular incisors is present in four of the Coobool Creek mandibles (CC1, 12, 16 and 28), with both buccal and lingual displacement of the medial and lateral incisors.

Due to their short, straight roots and relatively fragile structure, these teeth are often lost or damaged in Australian collections and their sample sizes in the Coobool Creek, Kow Swamp, Roonka and Swanport series are small for statistical purposes. The Coobool Creek male medial and lateral incisors are similar in their buccolingual dimensions, though the medial incisor sample is small and there is greater variation in the lateral incisors (Table 65). The Coobool Creek male means for I1 and I2 are greater than the mean values in the comparative samples but the results are not significant (Tables 70-71). The Murray Valley female mean for the medial incisor is greater than that for the Coobool Creek females (Table 70).

Maximum breadth in the Coobool Creek male mandibular incisors (I1 7.1 mm, I2 7.6 mm) is less than the maxima in the Murray Valley male sample (I1 7.8 mm, I2 7.8 mm). The Coobool Creek female maximum for I2 (7.5 mm) is less than the Murray Valley female maximum (8.8 mm).

Mandibular canine

The large size of the Coobool Creek mandibular canines makes these teeth distinctive. They have great breadth at the cervical margin, with moderate cingula on the lingual surface and long, thickened roots. Mean canine breadth in the Coobool Creek males is significantly greater than that in the Roonka, Broadbeach, Yuendumu and Western Australian males ($P = .05-.001$) (Tables 70-71). The Coobool Creek female mean, while larger than the comparative samples, is significant only when compared with the Western Australian female mean ($P = .05-.01$) (Tables 70-71). Maximum canine breadth in the Coobool Creek male (9.8 mm) and female (9.8

mm) sample is exceeded by the Murray Valley males (10.1 mm) and females (9.1 mm).

Mandibular premolars

There is considerable variation in size and morphology in Aboriginal mandibular premolars. The second premolar generally has a greater maximum buccolingual crown dimension than the first, though the first premolar, which may be slightly sectorial, may have a greater mesiodistal crown dimension.

The Coobool Creek mandibular premolars, particularly those in males, are distinguished by their great size (Figs 68-69). The second premolar is particularly distinct. This tooth tends to be slightly molariform, with a marked lingual extension of the crown and two prominent lingual cusps (CC9, 16, 28, 32, 40 and 71). The first premolar, while also extremely broad, is in some instances slightly elongated and sectorial, with a more prominent buccal cusp than in the second premolar (CC9, 28 and 45).

The mean breadth of the first premolar in Coobool Creek males is significantly greater than the mean values for the Murray Valley, Broadbeach, Roonka, Yuendumu and Western Australian samples ($P = .05-.001$) (Tables 70-71, Fig.68). In Coobool Creek females the mean breadth of P1 equals the Swanport female mean and is not significantly greater than any of the comparative female samples (Tables 70-71, Fig.69). The maximum breadth of P1 in the Coobool Creek males (10.7 mm) exceeds the maximum recorded for the comparative male samples (10.2 mm Broadbeach and Swanport). The Coobool Creek female maximum (9.6 mm) is also greater than that recorded for the comparative female samples (9.4 mm Swanport).

The mean breadth of P2 in the Coobool Creek males is significantly greater than the means for the comparative male groups ($P = .05-.001$), with the exception of the small Kow Swamp sample (Tables 70-71). In the Coobool Creek females the mean breadth of this tooth is greater than the mean values for the other samples, but not to a significant degree (Tables 70-71). The maximum buccolingual crown dimension for the Coobool Creek male second premolars (11.0 mm) exceeds the maximum recorded for the other male samples (10.4 mm Broadbeach and Murray Valley). The Coobool Creek female maximum (9.5 mm) is less than the Murray Valley female maximum (10.0 mm).

Mandibular first molar

The mandibular first molars in the Coobool Creek series are large and robust teeth with great

buccolingual breadth. The mean breadth of this tooth in the Coobool Creek male sample is significantly greater than that in all of the comparative male groups ($P = .05-.001$), with the exception of the small Roonka sample ($n = 4$) (Tables 70-71, Fig.68). Variation in first molar breadth in the Coobool Creek males is considerably less than that recorded for the other male groups. The Coobool Creek female sample is small ($n = 4$) and the mean breadth for M1 in this group is less than that in the Murray Valley. Maximum first molar breadth in the Coobool Creek males (13.3 mm) is less than the maximum dimensions recorded for Swanport (13.6 mm) and the Murray Valley (13.5 mm). The Coobool Creek female maximum (12.1 mm) is less than the maxima recorded for the comparative female samples (Swanport 13.2 mm).

Mandibular second molar

This is also a large, well formed tooth in the Coobool Creek sample, with less variance for the buccolingual crown dimension than in the comparative samples (Tables 65-68, Figs 68-69).

Mean second molar buccolingual breadth in the Coobool Creek males is significantly greater than the mean values recorded for Roonka, Broadbeach, Yuendumu and Western Australia ($P = .05-.001$) (Tables 70-71). The Coobool Creek male mean is greater than the Murray Valley and Swanport male means but not significantly so. There are equal mean values for this dimension in the Coobool Creek, Murray Valley and Swanport females (Table 70).

Maximum second molar breadth in the Coobool Creek males (13.2 mm) is less than the maximum dimensions recorded for the comparative male samples (Murray Valley 13.6 mm, Swanport 13.5 mm). Similarly the Coobool Creek female maximum (12.3 mm) is exceeded by the Murray Valley (12.9 mm) and Swanport (12.8 mm) samples.

Mandibular third molar

The mandibular third molar exhibits greater morphological variation than the preceding two molars and it is generally the smallest tooth in the mandibular molar series. The Coobool Creek third molars are all large, well formed and functional teeth, with no evidence of gross morphological anomalies or congenital absence.

Mean buccolingual breadth of the Coobool Creek male third molars is equal to the maximum mean of the comparative samples (Swanport) and is significantly greater than the Roonka mean ($P = .05-.01$) (Table 71). The Coobool Creek female mean is greater than the

comparative female means, but not significantly so.

Maximum third molar breadth in the Coobool Creek males (12.8 mm) is less than the maximum figures recorded for the Swanport (13.9 mm) and Murray Valley (13.0 mm) males. The Coobool Creek female maximum (11.7 mm) is also exceeded by the maximum values at Swanport (12.6 mm) and the Murray Valley (12.7 mm).

SUMMARY

The Coobool Creek male dentitions, and to a lesser degree those of the Coobool Creek females, have greater mean buccolingual crown dimensions than the recent Aboriginal series examined. Although the Coobool Creek dentitions have a mean size which is greater than the comparative samples, they exceed the maximum buccolingual crown dimensions recorded for these recent groups for only two teeth: the first and second mandibular premolars. The tooth breadth complex which clearly distinguishes the Coobool Creek sample from the comparative series is concentrated on the mandibles, which have significantly larger canines, first and second premolars and first and second molars than the comparative samples. The mandibular P2 is relatively molariform with a lingual expansion of the crown and prominent lingual cusps.

The Coobool Creek male means are significantly greater than the recent and mid-Holocene male samples for the following teeth:

Maxillary

I2: Roonka, Murray Valley, Broadbeach, Yuendumu and Western Australia.

C: Roonka, Yuendumu and Western Australia.

P1 and P2: Yuendumu and Western Australia.

M1: Roonka, Murray Valley, Swanport, Broadbeach, Yuendumu and Western Australia.

M2 and M3: Yuendumu and Western Australia.

Mandibular

C: Roonka, Broadbeach, Yuendumu and Western Australia.

P1: Roonka, Murray Valley, Broadbeach, Yuendumu and Western Australia.

P2: Roonka, Murray Valley, Swanport, Broadbeach, Yuendumu and Western Australia.

M1: Roonka, Murray Valley, Swanport, Broadbeach, Yuendumu and Western Australia.

M2: Roonka, Broadbeach, Yuendumu and Western Australia.

M3: Roonka and Broadbeach.

The Coobool Creek female sample is small for statistical purposes and few significant results were obtained in comparisons with the other female groups. The Coobool Creek female mean values for the buccolingual crown dimension are significantly greater than those recorded for the comparative samples for the following teeth:

Maxillary

I2: Murray Valley, Swanport, Broadbeach, Yuendumu and Western Australia.

C: Western Australia.

P1: Western Australia.

M1 and M2: Yuendumu and Western Australia.

M3: Broadbeach and Western Australia.

C: Western Australia.

TOOTH BREADTH, CRANIAL SIZE AND STATURE ASSOCIATIONS

For the buccolingual crown dimension the Coobool Creek dentitions have larger mean values for most teeth than the recent Australian samples used in this analysis. However, the Coobool Creek series is also distinguished from these comparative populations by the larger mean size of their associated crania and mandibles. It is therefore possible that the large size of the Coobool Creek dentitions simply reflects an allometric association between tooth size and the size of the cranium, or generally large body proportions.

The relationship between tooth size, cranial size, stature and body weight has received considerable attention in the anthropological and dental literature (Gabriel 1955; Garn and Lewis 1958; Filipson and Goldson 1963; Garn *et al.* 1968a, Garn *et al.* 1968b; Lavelle 1974, 1977; Henderson and Corruccini 1976; Anderson *et al.* 1977; Gingerich 1977; Wood 1979). The original assumption appears to have been that 'in most cases, and especially in Primates, large teeth necessitate large jaws, and large jaws a large body' (Weidenreich 1946:60).

Given that the fossil record of several primate taxa consists almost exclusively of teeth, the allometric association between tooth size and body size/weight has been examined with the intention of constructing predictive models for the calculation of body size from tooth size (Gould 1975; Kay 1975; Gingerich 1977; Wood 1979). Although there is some evidence for an allometric association between molar crown areas and body size/weight for several primate genera (Gingerich 1977) there is little evidence for such a relationship in *Homo sapiens*.

Garn and Lewis (1958:878) using a modern European sample, found that 'with a mean r of -0.03 , the hypothesis that tooth-size and body-size are related receives very little support'. Similarly low correlations between stature (most often the length of the femur or humerus) and tooth size have been obtained by Filipson and Goldson (1963), Garn *et al.* (1968a), Anderson *et al.* (1975) and Anderson *et al.* (1977). Low, but significant correlations between tooth size and body size were recorded by Henderson and Corruccini (1976) and moderate correlations (M1 $r = 0.38-0.42$; M2 $r = 0.29-0.32$; M3 $r = 0.51-0.54$) between molar crown areas and femur length in a pooled-sex British sample (Lavelle 1977). Using a sexed sample of South African Bantu skeletons, Wood (1979) found only low levels of correlation between tooth breadth and femur length, with a slightly negative allometric association between molar crown area and femur length. Higher correlations were obtained in the pooled-sex samples as a result of a wide separation of the male and female means, rather than any general pattern of covariance (1979:193-94).

The association between tooth size and the size of the cranium has been examined by Filipson and Goldson (1963), Lavelle (1974) and Wood (1979). Filipson and Goldson (1963) recorded a low correlation ($r = 0.20$) between incisor width and head width. Lavelle, using a pooled-sex sample, obtained low correlations (maximum $r = 0.31$) between tooth breadth, cranial length and cranial breadth, with very few significant correlations. Low levels of correlation for tooth breadth and cranial length, in single-sex samples, were obtained by Wood (1979) (male $\bar{x} r = 0.15$, female $\bar{x} r = 0.18$, pooled sex $\bar{x} r = 0.34$). Only three out of the 16 correlations in the single-sex samples were significant ($P = .05-.01$) and one of these was a significant negative correlation.

The relationship between the maxillary buccolingual crown dimensions and the size of the cranial vault, size of the palate and stature (femur length) were examined using the only Aboriginal series with a large number of associated postcranial skeletons, the Murray Valley. In addition, due to discrepancies in the published literature over the magnitude of tooth size/cranial size/stature associations and the possibility of population specific patterns of correlation, the connection between these variables was also examined using two non-Aboriginal populations, modern southern Chinese and Romano-British males. The modern southern Chinese skeletons, the majority from Guangzhou, are in the collection of the Department of Anatomy, University of Hong

Kong. The Romano-British skeletons were excavated from the Poundbury cemetery and are located in the British Museum of Natural History, London.

In Tables 72-75 maxillary buccolingual dimensions are correlated with cranial length (glabella-opisthocranion), cranial height (basion-bregma), maximum biparietal breadth, alveolar length, alveolar breadth and maximum femur length in the Murray Valley male and female, southern Chinese male and Romano-British male samples. Due to the large number of missing teeth in each group correlation matrices were calculated using the convention of pairwise deletion of missing data. This maximised the number of individuals included in each correlation. The alternative approach, listwise deletion, would have reduced the size of all of the batches to less than 20.

Tooth breadth and vault size

In the Murray Valley male and female samples the levels of correlation between the maxillary buccolingual tooth dimensions and cranial length (glabella-opisthocranion), cranial height (basion-bregma) and maximum biparietal breadth are of a low order, particularly those involving biparietal breadth (Tables 72-73). The highest correlation is between the canine buccolingual crown dimension and glabella-opisthocranion in males. However, with an r^2 of 0.190 , only 19% of the variation in the canine dimension is due to shared variation with cranial length. The other correlation coefficients are all below 0.382 . No single tooth consistently gains higher levels of correlation with the cranial dimensions than any other.

There are similarly low levels of correlation between these dimensions in the southern Chinese and Romano-British male samples (Tables 74-75). Correlation coefficients involving the buccolingual tooth dimensions and biparietal breadth tend to oscillate, in a seemingly random manner, between -0.20 and 0.20 . There are higher correlations between the tooth dimensions and glabella-opisthocranion and basion-bregma but all of these are below an r^2 of 0.246 . The highest correlation coefficient ($r = 0.496$) is for the association between the buccolingual breadth of the maxillary third molar and glabella-opisthocranion in the southern Chinese male sample. Standard regression procedure involving these data obtained an equation for the regression line of $y = 123.610 + 5.080x$, with a standard error of 5.630 . A standard error of this magnitude encompasses approximately 50% of the southern Chinese male range for glabella-opisthocranion (171-196 mm) and would not

Table 72 Pearson's correlation coefficient matrix (Pearson's *r* and sample size) for dental, cranial and femur dimensions in male skeletons from the Murray Valley

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.000													
	38													
2	0.342	1.000												
	38	44												
3	0.546	0.366	1.000											
	38	41	42											
4	0.169	0.013	0.655	1.000										
	36	39	39	40										
5	0.279	0.034	0.638	0.787	1.000									
	37	42	41	39	44									
6	0.340	0.204	0.485	0.637	0.563	1.000								
	31	37	34	32	37	39								
7	0.439	0.123	0.624	0.614	0.756	0.786	1.000							
	35	41	39	37	41	37	44							
8	0.229	0.113	0.573	0.659	0.687	0.371	0.541	1.000						
	34	40	38	36	40	36	41	42						
9	0.349	0.009	0.436	0.175	0.281	0.200	0.342	0.279	1.000					
	38	44	42	40	44	39	44	42	47					
10	0.013	-0.130	0.110	0.140	0.109	0.071	0.114	0.339	0.316	1.000				
	36	42	40	38	42	37	42	40	45	45				
11	0.183	-0.056	0.104	0.034	0.173	0.056	0.125	-0.014	0.143	-0.068	1.000			
	37	43	41	39	43	38	44	42	46	44	46			
12	0.364	0.050	0.353	0.222	0.405	0.490	0.658	0.389	0.369	0.018	-0.033	1.000		
	38	44	42	40	44	39	44	42	47	45	46	47		
13	0.122	-0.113	0.324	0.326	0.389	0.350	0.593	0.319	0.292	0.212	0.053	0.472	1.000	
	38	44	42	40	44	39	44	42	47	45	46	47	47	
14	0.164	0.335	0.278	0.071	0.091	0.092	0.276	0.117	0.635	0.239	-0.165	0.396	0.290	1.000
	20	24	23	21	25	21	23	22	25	24	24	25	25	25

- 1 Buccolingual breadth I¹
- 2 Buccolingual breadth I²
- 3 Buccolingual breadth C
- 4 Buccolingual breadth P¹
- 5 Buccolingual breadth P²
- 6 Buccolingual breadth M¹
- 7 Buccolingual breadth M²
- 8 Buccolingual breadth M³
- 9 Glabella-opisthocranion
- 10 Basion-bregma
- 11 Biparietal breadth
- 12 Alveolar length
- 13 Alveolar breadth
- 14 Femur length

Table 73 Pearson's correlation coefficient matrix (Pearson's r and sample size) for dental, cranial and femur dimensions in female skeletons from the Murray Valley

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.000													
	34													
2	0.375	1.000												
	33	41												
3	0.616	0.692	1.000											
	33	40	43											
4	0.669	0.628	0.641	1.000										
	30	37	40	42										
5	0.492	0.584	0.552	0.795	1.000									
	34	41	43	42	49									
6	0.529	0.529	0.590	0.493	0.462	1.000								
	32	38	41	41	45	46								
7	0.449	0.487	0.556	0.587	0.642	0.690	1.000							
	33	40	43	42	47	46	50							
8	0.308	0.256	0.300	0.283	0.434	0.345	0.547	1.000						
	34	41	43	42	48	46	49	50						
9	0.277	0.262	0.224	0.087	0.203	0.144	0.269	0.336	1.000					
	34	40	42	41	48	45	49	49	52					
10	0.304	0.229	0.113	0.232	0.367	0.104	0.382	0.265	0.079	1.000				
	32	39	40	39	46	43	47	47	49	50				
11	0.206	0.286	0.183	0.134	0.033	-0.071	-0.038	-0.037	0.321	0.062	1.000			
	32	39	41	40	47	44	48	48	50	48	51			
12	0.209	0.415	0.464	0.305	0.394	0.464	0.568	0.338	0.376	0.193	0.039	1.000		
	34	41	43	42	46	44	50	50	52	50	51	53		
13	0.127	0.160	0.278	-0.100	0.075	0.267	0.317	0.277	0.448	0.168	0.128	0.512	1.000	
	34	41	43	42	49	46	50	50	52	50	51	53	53	
14	0.075	-0.125	-0.105	-0.105	-0.093	-0.242	-0.156	0.047	0.349	0.261	0.094	0.175	0.241	1.000
	26	33	35	34	40	38	42	41	43	42	42	44	44	44

- 1 Buccolingual breadth I¹
- 2 Buccolingual breadth I²
- 3 Buccolingual breadth C
- 4 Buccolingual breadth P¹
- 5 Buccolingual breadth P²
- 6 Buccolingual breadth M¹
- 7 Buccolingual breadth M²
- 8 Buccolingual breadth M³
- 9 Glabella-opisthocranion
- 10 Basion-bregma
- 11 Biparietal breadth
- 12 Alveolar length
- 13 Alveolar breadth
- 14 Femur length

Table 74 Pearson's correlation coefficient matrix (Pearson's r and sample size) for dental, cranial and femur dimensions in male Romano-British skeletons from Poundbury

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.000													
	21													
2	0.768	1.000												
	20	21												
3	0.803	0.713	1.000											
	20	20	24											
4	0.690	0.702	0.623	1.000										
	20	20	22	22										
5	0.694	0.660	0.585	0.862	1.000									
	21	21	22	22	23									
6	0.693	0.666	0.726	0.636	0.613	1.000								
	21	21	22	22	23	25								
7	0.663	0.652	0.726	0.638	0.624	0.935	1.000							
	24	24	24	25	22	24	25							
8	0.449	0.419	0.535	0.347	0.251	0.529	0.533	1.000						
	22	22	22	23	20	22	23	23						
9	0.004	0.304	0.105	0.015	0.092	0.319	0.259	0.217	1.000					
	26	26	26	27	23	25	25	23	27					
10	0.270	0.426	0.311	0.145	0.060	0.360	0.318	0.291	0.458	1.000				
	26	26	26	27	23	25	25	23	27	27				
11	-0.006	0.268	-0.045	0.094	-0.021	0.075	0.003	-0.225	0.514	0.340	1.000			
	26	26	26	27	23	25	25	23	27	27	27			
12	0.523	0.452	0.496	0.438	0.667	0.464	0.423	0.560	0.200	0.357	-0.250	1.000		
	26	26	26	27	23	25	25	23	27	27	27	27		
13	0.356	0.479	0.456	0.469	0.557	0.641	0.548	0.196	0.428	0.367	0.321	0.388	1.000	
	24	24	24	25	22	24	25	23	25	25	25	25	25	25
14	0.640	0.742	0.651	0.606	0.600	0.659	0.650	0.382	0.272	0.311	0.137	0.518	0.602	1.000
	25	25	26	26	22	24	24	22	26	26	26	26	24	26

- 1 Buccolingual breadth I¹
- 2 Buccolingual breadth I²
- 3 Buccolingual breadth C
- 4 Buccolingual breadth P¹
- 5 Buccolingual breadth P²
- 6 Buccolingual breadth M¹
- 7 Buccolingual breadth M²
- 8 Buccolingual breadth M³
- 9 Glabella-opisthocranion
- 10 Basion-bregma
- 11 Biparietal breadth
- 12 Alveolar length
- 13 Alveolar breadth
- 14 Femur length

Table 75 Pearson's correlation coefficient matrix (Pearson's r and sample size) for dental, cranial and femur dimensions in male southern Chinese skeletons

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.000													
	21													
2	0.754	1.000												
	20	21												
3	0.812	0.735	1.000											
	20	20	24											
4	0.552	0.649	0.503	1.000										
	20	20	22	22										
5	0.357	0.388	0.511	0.692	1.000									
	21	21	22	22	23									
6	0.424	0.373	0.491	0.736	0.788	1.000								
	21	21	22	22	23	23								
7	0.534	0.493	0.517	0.771	0.755	0.829	1.000							
	20	20	22	21	22	22	23							
8	0.374	0.303	0.451	0.620	0.436	0.724	0.558	1.000						
	15	15	16	16	17	17	16	17						
9	0.154	0.102	0.192	0.336	0.199	0.372	0.208	0.496	1.000					
	21	21	24	22	23	23	23	17	28					
10	0.317	0.432	0.408	0.366	0.338	0.294	0.230	0.105	0.380	1.000				
	21	21	24	22	23	23	23	17	28	28				
11	0.044	0.408	-0.058	0.027	0.045	0.091	0.083	0.076	0.230	0.479	1.000			
	21	21	24	22	23	23	23	17	28	28	28			
12	0.530	0.477	0.432	0.176	0.241	0.105	0.136	0.058	0.363	0.336	0.042	1.000		
	21	21	23	22	23	23	23	17	24	24	24	24		
13	0.104	0.367	0.113	0.214	0.119	-0.046	0.013	0.180	0.057	0.204	0.225	0.425	1.000	
	21	21	22	22	23	23	22	17	23	23	23	23	23	23
14	0.392	0.353	0.256	0.529	0.261	0.411	0.435	0.628	0.455	0.550	0.468	0.074	0.436	1.000
	11	11	14	12	13	13	13	10	17	17	17	14	13	17

- 1 Buccolingual breadth I¹
- 2 Buccolingual breadth I²
- 3 Buccolingual breadth C
- 4 Buccolingual breadth P¹
- 5 Buccolingual breadth P²
- 6 Buccolingual breadth M¹
- 7 Buccolingual breadth M²
- 8 Buccolingual breadth M³
- 9 Glabella-opisthocranion
- 10 Basion-bregma
- 11 Biparietal breadth
- 12 Alveolar length
- 13 Alveolar breadth
- 14 Femur length

provide a worthwhile basis for prediction. Overall the four correlation coefficient matrices provide little support for a firm allometric association between the size of the cranial vault and the buccolingual dimensions of the maxillary teeth.

Tooth breadth and palate size

There is clearly a functional relationship between the maxillary tooth breadths and the length of the alveolar process. Moderate correlations predominate for these variables in all of the samples (Tables 72-75). In the Murray Valley male and female matrices there is only one correlation coefficient below 0.209, with a mean correlation between alveolar length and the buccolingual dimensions of 0.366 in males and 0.394 in females. The male and female maxillary second molars obtained the highest levels of correlation (male $r = 0.658$, female $r = 0.568$) with alveolar length. There are generally higher levels of correlation between these dimensions in the Romano-British series, with a mean of $r = 0.502$. Lower levels of correlation, especially for the posterior teeth, are present for the southern Chinese males ($\bar{x} r = 0.269$).

Using the Murray Valley male data the regression equation for the association between alveolar length and the buccolingual dimension of the maxillary second molar is, $y = 16.460 + 3.441x$, with a standard error of 3.078. Applying this equation to the minimum (12.7 mm), maximum (15.3 mm) and mean (13.9 mm) buccolingual dimensions of the Coobool Creek male maxillary second molars obtains alveolar lengths of 69.07 mm, 64.25 mm and 60.13 mm respectively, which are remarkably close to the actual associated alveolar lengths of 69.0 mm, 64.7 mm and 63.0 mm. Although there may be some geographic variation in the details of this association these data clearly support Weidenreich's contention that 'large teeth necessitate large jaws' (1946:60).

To some extent measurements of alveolar length are also measures of tooth size and reflect the topographical relationship between these variables. However, there is also an ongoing biological relationship between the teeth and their alveolar support. Large teeth need a correspondingly large area of alveolar bone to provide adequate developmental space for the tooth, and when the tooth reaches occlusion, to provide support for the tooth roots and sufficient space for the correct occlusion of the crown. In aged individuals with marked interproximal wear, mesial migration and alveolar bone

resorption the consistency of this relationship would be lost.

However, the association between the breadth of the alveolar process and the buccolingual dimensions of the maxillary teeth are of a lower order, and less consistent, than the alveolar length correlations (Tables 72-75). In the Murray Valley males and females, and the southern Chinese males, the correlations between the dental dimensions and alveolar breadth are primarily below 0.35, with several low negative correlations. Contrasting with this, there is a consistently moderate level of correlation between the buccolingual dimensions and alveolar breadth in the male Romano-British sample, with all but two correlation coefficients exceeding 0.45.

Tooth breadth and stature (femur length)

There is a firm, albeit population and sex specific, relationship between maximum femur length and adult stature, with a predictive accuracy of ± 30 -40 mm for most human populations (Krogman 1962). With few exceptions, studies of the relationship between tooth size and stature (most often femur length) have obtained only low levels of correlation. The highest correlations ($r = 0.28$ -0.54) were obtained by Lavelle (1977) using a pooled-sex British sample where the distance between the male and female means would have inflated the level of correlation.

In the Murray Valley male and female groups there are only low levels of correlation between the maxillary buccolingual tooth dimensions and femur length, with six of the eight female correlations ranging between -0.093 and -0.242 (Tables 72-73). It would appear that there is little support for the notion that taller Aborigines from the Murray Valley necessarily have larger teeth than their shorter contemporaries. Scatterplots of the association between these dimensions have a broad dispersion, without a clear linear trend (Fig.70).

However, this does not appear to be true for the southern Chinese and Romano-British males (Tables 74-75; Fig.71). In the Romano-British males all but one of the correlation coefficients for the dental dimensions and femur length are greater than 0.49. The single exception is for the morphologically and metrically variable third molar ($r = 0.382$). In the southern Chinese males there is greater variation in the pattern of correlation, although moderate levels of correlation still predominate.

Both the southern Chinese and Romano-British samples are smaller than those for the

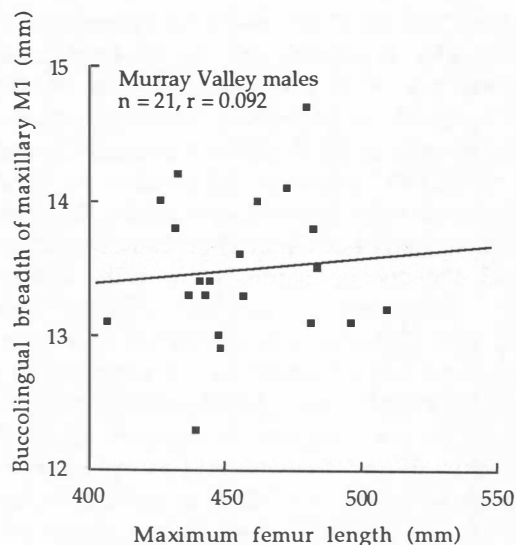


Figure 70 Scatterplot of association between the buccolingual dimension of the maxillary first molar and femur length in Murray Valley males

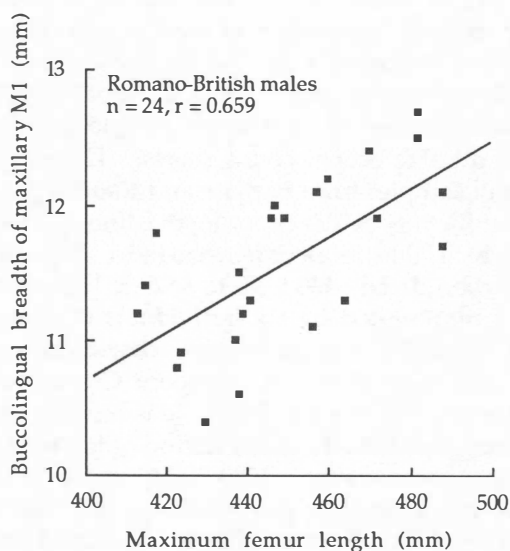


Figure 71 Scatterplot of association between the buccolingual dimension of the maxillary first molar and femur length in Romano-British males

Murray Valley, with only 14 of the southern Chinese skeletons having associated femora. Correlation coefficients can be highly susceptible to sample size fluctuations and much larger samples would be needed to make a definitive statement about the pattern of association between these dimensions. These data while providing some support for an allometric association between stature and tooth size, highlight the presence of marked interpopulation variation in this relationship.

DISCUSSION

Bivariate plots for each set of correlates were examined. For the single-sex plots of individual tooth dimensions, with either cranial length (glabella-opisthocranion), cranial height (basion-bregma) or biparietal breadth, the plotted points were widely scattered and without a convincing linear relationship. No one tooth consistently gained higher correlations with the cranial dimensions than any other. In a pooled-sex Murray Valley series the level of correlation was increased due to the wide separation of the male and female means, rather than to any overall pattern of covariance. These data support Wood's (1979) observations and indicate that there is little evidence of an allometric association between tooth breadth and the size of the vault in *Homo sapiens*.

The Coobool Creek dentitions can be distinguished from those in both recent and prehistoric Australian populations by the greater mean buccolingual dimensions of the maxillary and mandibular teeth and the suggestion of greater sexual dimorphism. Given the low correlation between tooth breadth and vault size in Aborigines, the greater mean tooth breadths in the Coobool Creek sample are unlikely to be a product of tooth and vault-size allometry. Although it is possible that allometry may account for a slight overall increase in tooth size, it would not produce areas of specific increase, such as Coobool Creek maxillary lateral incisors or mandibular second premolars.

Significant features of the Coobool Creek dentitions are: (a) the large mean size of the maxillary lateral incisors, which in size and morphology are closer to the medial incisors than are the lateral incisors in recent Australian populations; (b) a large and robust maxillary first molar; (c) great breadth in the mandibular canines, premolars and first and second molars; (d) the Coobool Creek second premolars are distinctly molariform, with a lingual extension of the crown and prominent lingual cusps; (e) the maximum buccolingual crown dimensions of the mandibular first and second premolars exceed the comparative Australian range.

Townsend and Brown's (1978a, 1978b) examination of tooth size heritability in Aborigines from Yuendumu concluded that additive genetic variance accounted for about 64% of total phenotypic variability, common environment contributed about 6%, and within family environment the remaining 30% (1978b:501). Environmental effects may be either prenatal or postnatal in origin (Holloway *et al.*

1961; Bailit and Sung 1968; Keene 1971; Townsend and Brown 1978a, 1978b). Low birth weight, prenatal stress and uterine competition amongst twins may result in decreased tooth crown size (Keene 1971; Garn *et al.* 1965) while those with higher birth weights tend to have larger teeth (Garn *et al.* 1979). It has also been argued that the intake of fluoride or molybdenum during dental development can influence crown size and morphology (Kruger 1962; Goose and Roberts 1979). For example, high fluoride levels in drinking water is probably a factor in the relatively microdont condition of the Aborigines from Yuendumu (Williamson and Barrett 1972; Brown and Townsend 1980). Where tooth size is increased through local environmental factors this would be indicated either by an overall increase in size, or an increase restricted to particular developmental categories. Neither of these conditions is supported by the pattern of tooth size increase at Coobool Creek, where there are no specific developmental links between the categories represented.

Areas of specific tooth size increase in the Coobool Creek series (maxillary I2 and M1, mandibular P1, P2 and M2) are more likely to be indicative of phyletic relationship than environmental effects. Unfortunately little can be said about the dental characteristics of the Australian human skeletal materials predating Coobool Creek and Kow Swamp. The facial skeletons and dentitions of LMI and III are extremely fragmentary, while WLH 50 is without associated dental remains. The LMI teeth are represented by root fragments and crowns from which the enamel has been exfoliated due to the cremation procedure and subsequent burial. Reliable dental dimensions can not be recorded for this individual. In the more complete LMIII it is possible to record the buccolingual dimensions of a mandibular first premolar, second premolar and third molar (Brown 1987a). With a buccolingual dimension of 9.0 mm the first premolar is within the male range at Coobool Creek (8.6-10.7 mm) and Kow Swamp (8.9-9.7 mm). The second premolar is a larger tooth and its buccolingual dimension (9.5 mm) is greater than the Kow Swamp maximum (9.4 mm) but less than the Coobool Creek male mean (9.9 mm). Finally, the buccolingual dimension of the third molar (12.0 mm) is slightly greater than the Coobool Creek (11.9 mm) and Kow Swamp (11.8 mm) male means. All of the buccolingual dimensions for the LMIII teeth are close to the mean dimensions for the recent populations from Swanport and the Murray Valley. These data shed little light on the dental characteristics of Australian populations

predating Coobool Creek and Kow Swamp.

Although it is possible that the Coobool Creek dentitions are a direct representation of the dental complex in Australia's founding population it is equally likely that they represent the end result of 30,000 years of adaptation to local cultural, and environmental, conditions. It is also conceivable that the dental characteristics of the terminal Pleistocene samples from the central Murray Valley region (Coobool Creek, Kow Swamp and Cohuna) are specific to that place and time and not representative of Australia as a whole. Amongst recent Aboriginal populations there are marked regional variations in tooth size, occlusion and the size and morphology of the oro-facial skeleton. There is nothing in the Australian human skeletal record to suggest that this geographic variation is of comparatively recent development.

Perhaps the only certainty about the dental dimensions from Coobool Creek is in the evidence it provides for a post-Pleistocene reduction in tooth size in the central Murray Valley region. Comparison of the box plots (Figs 66-69) and statistical data (Tables 65-69) reveals the greater overall size of the Coobool Creek dentitions relative to their recent, and to a lesser degree mid-Holocene, counterparts. However, the small samples from Barham and Roonka provide conflicting evidence as to the time period over which this reduction occurred. Barham, radiocarbon dated 5400 ± 90 to 4679 ± 110 years BP and represented by six individuals (4 males and 2 females), has tooth size characteristics which are most similar to Coobool Creek and Kow Swamp. If this small sample is representative it suggests that the major period of tooth size reduction was after 4000-5000 years BP. Contrasting with this, the relatively microdont dentitions from Roonka Phase II, dated to between 4000-7000 years BP, imply that there was significant reduction in tooth size prior to the burial of R48 at 3930 ± 120 years BP.

VI CONCLUSION

THE COOBOOL CREEK AND KOW SWAMP MORPHOLOGICAL PATTERN

Morphological, univariate and multivariate comparisons of the crania, mandibles and dentitions from Coobool Creek and Kow Swamp have distinguished these samples from recent, and mid-Holocene, Australian populations (Thorne and Macumber 1972; Thorne and Wilson 1977; Pietrusewsky 1979; Brown 1981b, 1987a). The combined effects of large size and a shared cultural practice (artificial cranial deformation) gives several of the crania from Coobool Creek, Nacurrie and Kow Swamp-Cohuna a visual and statistical appearance which is apparently unique to the central Murray Valley region during the terminal Pleistocene.

The Coobool Creek, Nacurrie and Kow Swamp mandibles combine great corpus height, both at the symphysis and between the first and second molars, with a particularly thickened corpus. The rami are tall and broad with robust, elongated coronoid processes and massive condyles. The masseteric fossae are large and deep, with marked eversion of the angles, especially in males. On the medial surface of the corpus the mylohyoid ridge passes in a low, smooth curve downwards to the submaxillary fossae and inferior border, rather than dropping away abruptly below the mylohyoid line. The maximum dimensions for symphyseal height, corpus height, corpus thickness, bigonial breadth and bicondylar breadth exceed the maxima recorded for other Australian samples of any age.

One of the major distinguishing features of the crania from Coobool Creek, Nacurrie and Kow Swamp is their great size. Of the 48 variables in the Coobool Creek and Murray Valley male and female comparisons, 33 have mean values which are significantly greater ($P = .05-.000$) in the Coobool Creek males and 27 in the Coobool Creek females (Table 8). Similar results were obtained in comparisons with the male and female crania from Swanport and Broadbeach. Box plots of these data demonstrate the greater size of the Coobool Creek and Kow Swamp crania relative to those from Barham and the recent Australian samples. There was clearly a post-Pleistocene reduction in the overall size of the cranium in the central Murray Valley region prior to the use of the Barham cemetery at 5500-4500 years BP.

It is from a lateral aspect that several of the crania from Coobool Creek and Kow Swamp appear particularly distinctive. These crania combine marked recession of the frontal squama with great cranial height, a relatively great anterior-posterior curvature of the parietal bones and a flattened occipital bone. These features in association with several others are indicative of artificial deformation. Morphological and statistical comparisons suggest that the area least likely to be influenced by the deformation process is the oro-facial skeleton. Detailed comparisons of temporal and regional variation, involving the Coobool Creek and Kow Swamp crania, should therefore be restricted to this general anatomical region.

The Coobool Creek crania are markedly dolichocephalic, with broadly flaring zygomatic arches creating large temporal fossae. The frontal bones are large, with great supraorbital and postorbital breadths. The glabella region is low and broad, with relatively slight depression at nasion. The zygomatic trigones are often globose and thickened, exceeding the development in the comparative Australian samples.

The facial skeletons are large and robust. The nasal bones are broad and flattened, exhibiting great breadth at the naso-frontal articulation. Absolutely shallow orbits are placed above massive, robust zygomatic bones. The zygomatic bones combine a maximum depth which exceeds the comparative Australian range with prominent malar tuberosities, a thickened inferior border and a column-like frontal process.

Inferiorly the subnasal region is dominated by the large size of the incisor and canine roots. The subnasal area is elongated and prognathic, with a relatively straight alignment of the incisor and canine roots. The canine eminences are extremely prominent. Maximum alveolar breadth in the Coobool Creek palates expands the recorded Australian range. Other features distinguishing the Coobool Creek and Kow Swamp crania include a tendency for maximum cranial breadth to be located towards the cranial base, rather than on the parietal bones. There is great mean thickness in the bones of the cranial vault, although some crania (CC1 and 66) are at the opposite end of the Australian range for this feature. The glenoid fossae are deep with prominent articular eminences.

The Coobool Creek dentitions are distin-

guished from the comparative recent and other prehistoric Australian samples by their greater mean buccolingual crown dimensions. The mean breadths of the Coobool Creek maxillary lateral incisors, first molars, mandibular canines, first and second premolars and first and second molars are significantly greater than the comparative Australian samples. The most distinctive teeth in the Coobool Creek sample are the large and robust maxillary lateral incisors and the molariform mandibular second premolars. Although there are few teeth preserved from Kow Swamp, the available data supports the Coobool Creek results.

In summary the Coobool Creek and Kow Swamp individuals share a similar morphological pattern in their crania, mandibles and dentitions. This suite of features distinguishes them from recent and other prehistoric skeletal samples from the Murray Valley region.

AN INITIAL CHRONOLOGY FOR THE COOBOOL CREEK REMAINS

The human skeletal materials from Coobool Creek were collected without regard to their archaeological or stratigraphic provenance and there are no radiocarbon dates from the site. In 1982 an effort was made to obtain radiocarbon dates on bone collagen from postcranial and cranial skeletal material from Coobool Creek. This attempt was frustrated by the immersion of all bone in a gelatin bath, as a preservative coating, shortly after recovery. Contamination by this modern collagen has completely masked any prehistoric collagen which may have been present. In the long term it may have been possible to isolate the amino acids of human origin, from those of non-human origin, and date the human ones. Unfortunately, in 1984 the implementation of amendments to the *Victorian State Relics Legislation*, combined with the transfer of the 'Murray Black Collection' to the custodianship of the Museum of Victoria and the subsequent embargo on research access, prevented further research on this issue.

At present, the only radiometric date associated with the Coobool Creek skeletons is a uranium thorium date on an innominate fragment from CC65 of $14,300 \pm 1000$ years BP (LLO-416). Uranium thorium ($^{234}\text{U}/^{230}\text{Th}$) dating of bone, particularly bone which is less than 20,000 years old, is likely to yield problematic results. The mechanisms of uranium uptake and fixation to bone are poorly understood and in some instances there is continued migration of uranium after fossilisation (Charalambous and Papastefanou 1977; Rae and Ivanovich 1986;

Chen and Yuan 1988). In addition, the original ^{234}U concentration in groundwater is variable and with a half-life of 300,000 years the sensitivity of measurement equipment is exceeded with materials younger than 10,000 years BP. Even though a date of 13,000-15,000 years BP complies with my own expectations, without the support of at least one associated radiocarbon date I would not choose to emphasise these results. Therefore assessments of the possible age of the Coobool Creek sample rest largely on comparative cranial morphology and/or cultural evidence.

Morphological dating involves a comparison of specimens from a site without firm chronological control with specimens from a sequence of known age. Morphological dating has been misused, as original estimations of the age of Talgai (Smith 1918) and WLH 50 (Flood 1983:67-68; Delson 1985; Wolpoff 1985a, in press; Caddie *et al.* 1987) crania demonstrate. However, 'morphological evolution did occur, and on average, samples from different times can be distinguished from one another' (Wolpoff 1980:12).

Perhaps the best guide to the absolute age of some of the Coobool Creek skeletons is provided by the presence of artificial cranial deformation. Although there is an ethnographic account of cranial deformation from northern Victoria (Kenyon 1928:165), there is no evidence of the morphological pattern associated with deformation in the several thousand 'recent' crania from Victoria, South Australia and New South Wales in Australian museum collections. There is also no evidence of cranial deformation in the prehistoric samples from Roonka (7000 years BP-European contact period) (Pretty 1977; Prokopec 1979; Pietruszewsky 1979, 1984), the mid-Holocene Barham series (Daley 1986) or the Murray Valley group excavated at Wentworth by Blackwood and Simpson (1973) and dated to 6000-750 years BP. In Australia, artificially deformed crania have only been recovered from Kow Swamp, Nacurrie and Coobool Creek. These sites are in close geographic proximity and the Kow Swamp skeletons are bracketed by dates of $13,000 \pm 280$ (ANU-1236) and 9300 ± 220 (ANU-619b) years BP (Thorne 1975). The presence of artificially deformed crania in these three sites, and their absence from mid-Holocene and recent sites in the same area, suggest that they share a common cultural and chronological association.

As the Coobool Creek series can be subdivided into crania which show evidence of being artificially deformed and those that do not,

it is possible that this variation reflects the use of the cemetery by two different populations. If so it would seem more probable that these groups were temporally circumscribed, rather than just culturally distinct. If the ethnohistorical ties between cemeteries and land ownership (Meehan 1971; Pardoe 1988) can be extended into the prehistoric period, then it is unlikely that more than one descent group would be using a given cemetery at the same point in time. Either way, a subdivision of the Coobool Creek sample based on neurocranial variation is not supported by morphological and metrical comparisons of their oro-facial skeletons (Brown 1987a). The oro-facial skeletons form a morphologically and metrically homogeneous group with low rectangular orbits, large nasal apertures, great alveolar breadth, marked subnasal prognathism, and coefficients of variation which are generally lower than those for the comparable dimensions in the Murray Valley, Swanport and Broadbeach samples (Tables 5-8).

Rather than indicating that the cemetery contains the remains of two discrete populations, morphological variation within the Coobool Creek series follows a similar pattern to that recorded for other groups which artificially altered the shape of their children's heads (Dingwall 1931). Intentional cranial deformation may be undertaken for purely aesthetic reasons or as a method of group identification and distinction. In common with other, less permanent, aspects of personal adornment the rigour with which a group practices cranial deformation will vary with fluctuations in custom, fashion and circumstance.

Additional sources of variation are provided by the mechanics of the deformation process, the dedication of the individual applying the procedure, the receptiveness of the individual to which it is being applied, and individual variation in the genetically determined pattern of cranial growth. These culturally and biologically induced sources of variation may result in a population which practices cranial deformation having some members who either have not had their heads deformed, or deformed to a lesser (or greater) degree than the average (Dingwall 1931; Blackwood and Danby 1955; Kiszely 1978). The pattern of morphological and metrical variation in the Coobool Creek cranial vaults conforms with these conditions. It is also possible that the Coobool Creek cemetery, in common with Kow Swamp, was in use for several thousand years. Some fluctuation in attitudes towards cranial deformation might be expected over such an extended period.

On the available evidence from the central Murray Valley region the Coobool Creek sample is older than Barham burial K2/1 dated to 5400 ± 90 BP (Daley 1986) and the Wentworth crania excavated by Blackwood and Simpson (1973:105) dated to 5900 ± 550 years BP (GaK-1430). The crania excavated from these two sites, Barham and Wentworth, are morphologically indistinguishable from recent Aboriginal crania from the same area. Similarly, the Coobool Creek and Kow Swamp osteological complex is not present at Roonka Phase II (8000-7000 years BP), with marked skeletal and dental reduction at Roonka relative to Coobool Creek and Kow Swamp (Smith *et al.* 1988). The morphological and cultural affiliations of the Coobool Creek series are clearly with the Kow Swamp population, which is dated to between 13,000 and 9000 years BP.

DIACHRONIC CHANGE WITHIN THE MURRAY VALLEY

Morphological and statistical comparisons of the Kow Swamp crania have distinguished their fronto-facial skeletons from those in a 'recent' northern Victorian series (Thorne 1976; Thorne and Wilson 1977; Pietrusewsky 1979). Thorne and Wilson (1977) argue these differences indicate that there were major morphological changes in the facial and frontal regions of Aboriginal crania over the last 10,000 years. Data obtained from the Coobool Creek series both extend and modify their argument. The evidence for cranial deformation in the Coobool Creek and Kow Swamp samples reveals that diachronic changes in frontal bone morphology are largely of cultural origin (Brown 1981b, 1987a). However, the additional data available for the facial skeleton, mandible and dentition from Coobool Creek add support to aspects of Thorne and Wilson's argument.

Under ideal circumstances an analysis of post-Pleistocene change in osteological and dental features would draw on a large skeletal sample from a single site, with a continuous period of post-Pleistocene occupation. The Australian skeletal series which most closely approximates these conditions comes from 800 km to the northwest of Coobool Creek at Roonka Flat (Pretty 1977). Unfortunately much of the skeletal material from Roonka is poorly preserved and the stratigraphic relationship, and age, of the burials remains uncertain (Pretty 1977; Prokopec 1979; Prescott 1983; Head 1986; Smith *et al.* 1988). There are also problems with the central Murray Valley samples used in this analysis. The two most securely dated groups, Kow Swamp and Barham, combine small numbers with inade-

quate preservation, and the 'recent' Murray Valley series is without chronological or archaeological context.

These samples while adequate for identifying a post-Pleistocene reduction in hard tissue mass, and related changes in skeletal morphology, are insufficient for documenting either the rate or precise timing of the events involved. Morphological and metrical comparisons of the Coobool Creek and Kow Swamp crania with the mid-Holocene samples from Roonka and Barham suggest that the major period of structural reduction was between 13,000 and 5000-6000 years BP. The Coobool Creek-Kow Swamp osteological complex is absent from both Roonka Phase II and Barham, with the skeletal and dental characteristics of Roonka and Barham falling within the recent Aboriginal range (Pietrusewsky 1979, 1984; Daley 1986; Smith *et al.* 1988).

During this period there is an overall reduction in the size of the oro-facial skeleton, cranial vault and dentition. There is a marked reduction in facial height, supraorbital breadth and mid-facial breadth (bizygion). The zygomatic bones become shallower, with a thinning of the inferior border and a less robust frontal process. In association with the reduced size of the incisor and canine roots, the subnasal region becomes shallower and less prognathic. Mean palate size decreases, although the reduction is more in evidence for alveolar breadth than length. The breadth of the interorbital region decreases and there is an apparent increase in the height of the orbits. The nasal root becomes increasingly depressed and the glabellae take on a more inflated, prominent appearance. There is a general reduction in the size of the teeth and of their supportive alveolar bone, and the lower face becomes less robust.

In the mandible there is a marked reduction in the height and thickness of the corpus and in bigonial and bicondylar breadth. In association with a decrease in tooth size there is a reduction in the alveolar segment of the mandible making the chin region appear more prominent. On the medial surface of the corpus, the mylohyoid ridge becomes more sharply defined, with a prominent elongated mylohyoid line. The areas of attachment for the masseters and pterygoids become less rugose and depressed. The rami decrease in height and there is a proportional increase in the breadth of the rami relative to their height.

Comparing Coobool Creek with the 'recent' Murray Valley series there is a reduction in the mean buccolingual crown dimensions of the male maxillary teeth of 2.6% and mandibular

teeth of 4.1%, with an overall reduction of 3.3%. The two teeth which display the greatest size reduction are the maxillary lateral incisors (8.4%) and mandibular second premolars (7.6%). This reduction in tooth size is not as evident in comparisons between the female samples from Coobool Creek and the Murray Valley. In females there is a reduction in the maxillary teeth of 2.1% and mandibular teeth 0.2%, with an overall reduction of 1.2%. The tooth which shows by far the greatest degree of reduction in the female sample are the maxillary lateral incisors (10.4%).

Outside Australia similar changes in the size and morphology of the oro-facial complex and dentition over the last 15,000-10,000 years have been recorded for sub-Saharan Africa (Rightmire 1974, 1975), Nubia (Van Gerven *et al.* 1973; Carlson and Van Gerven 1977; Calcagno 1986), the Mediterranean (Le Blanc and Black 1974), Europe (Brace 1967; Brace and Mahler 1971; Brose and Wolpoff 1971; Frayer 1977), Sri Lanka (Kennedy *et al.* 1987), India (Kennedy 1984; Lukacs 1984) and East Asia (Brace 1978). Only in one instance (Scott 1979), where pooled-sex and small sample-size data were used, has a conflicting trend been recorded. However, there is considerable debate covering the mechanism involved, especially in relation to the reduction of tooth size in the European Palaeolithic and Mesolithic. A major issue, as with most instances of temporal change in human anatomy, is whether this is a product of internal adaptation and evolution or whether the changes simply reflect gene pool alteration through migration (Howells 1976b).

The argument which has been pursued with the greatest vigour sees the overall trend towards reducing tooth size as a response to the relaxation of selection pressure for large teeth (Brace 1963, 1964; Wolpoff 1969; Brace and Mahler 1971). In particular it is increasing pre-masticatory preparation of food resulting from technological change, and decreasing use of the teeth in functions unrelated to mastication (as tools), which are seen as the major causal agents. According to this model the rate at which the dentition, or masticatory system in general, reduces in size can be expected to increase with the introduction of agriculture and soft, refined carbohydrate staples. Although there is an inverse relationship between tooth size and technology, at least for Europe over the last 20,000 years (Brace 1967; Bordes 1972; Brose and Wolpoff 1971; David 1973), this in itself does not demonstrate a causal relationship.

Brace (1963) proposed that structural reduc-

tion in the facial skeleton and dentition through the European Palaeolithic and Neolithic was a result of the 'probable mutation effect'. This hypothesis refers to the accumulation of recessive genes which result from the relaxation of selection pressure for a structure or configuration of structures. Brace argues that the accumulation of these recessive genes results in directional structural reduction. Criticisms of Brace's hypothesis (Prout 1964; Wright 1964; Brues 1966; Holloway 1966; Bailit and Friedlander 1966; Suarez 1974) have pointed out that while the accumulation of random mutations could be expected to result from a relaxation of selection, with a subsequent increase in morphological variation (Guthrie 1965), there is no reason why this should result in directional change.

Structural reduction is a particularly controversial area in evolutionary genetics and several competing hypotheses have been proposed. Wright (1964:66), in reply to Brace (1964), argued that structural reduction is

due largely to selection for pleiotropic effects of newly favoured alleles of the genes that had been involved in the development of the organ in question ... the substitution of new alleles would on average tend to bring about reduction of the organ after its maintenance had ceased to be an object of natural selection.

Others have proposed a developmental interaction, involving dental field theory and allometric relationships between decreasing size in the facial skeleton and the developmental areas of the teeth (Sofaer *et al.* 1971; Anderson *et al.* 1975; Gould 1975), or a straightforward allometric relationship between tooth size and body size (Pilbeam and Gould 1974; Wolpoff 1973).

An interesting argument has been presented by Prout (1964), who suggests that a non-functioning structure still requires a great expenditure of metabolic energy to create and maintain, and hence will be selected against. This theory assumes that an organism expending energy for an unnecessary structure will be at a selective disadvantage. Decisive experimental support is lacking for each explanation of structural reduction, although the interaction between developmental fields and the oro-facial skeleton appears to be the most promising (Sofaer 1973). All the theoretical approaches to structural reduction envisage the process as a result of the relaxation of selection. For the human dentition it is a reduction in the selective factors for large tooth size.

In this respect the trend towards structural reduction in the size of the dental complex in the Murray Valley over the last 10,000 years is of

importance. In Europe reduction in tooth size has been accompanied by marked cultural changes from the Palaeolithic to the Neolithic, with the development of agriculture and sedentary life styles (Brose and Wolpoff 1971). Australia during the same period of time is distinguished by relative cultural conservatism. Although there were some post-Pleistocene developments in stone-tool and food-preparation technology (White and O'Connell 1982) these do not appear to have had a significant influence on masticatory function.

One of the most distinctive features of Aboriginal dentitions, from the terminal-Pleistocene to the European contact period, is marked occlusal and interproximal tooth wear. In their analysis of the Roonka dentitions Smith *et al.* (1988:35) concluded that 'the similarity of attrition scores in all periods at Roonka suggests that no observable change in dental function took place over time but was uniformly severe'. Similarly acute tooth wear (dentine and pulp exposure with subsequent apical abscess development and tooth loss) is also a feature of adult dentitions from Coobool Creek, Kow Swamp, Barham, Swanport and the 'recent' Murray Valley series. In the European contact period, for which there are reasonable descriptions of diet and non-masticatory tooth use in the central Murray Valley region (Kreffft 1865; Beveridge 1883; Curr 1883), selection must have continued to favour large, slow-wearing teeth. Prior to the 19th century introduction of European foodstuffs, I find it difficult to believe that there was a meaningful relaxation in the selection pressure for a robust masticatory system, and large teeth, in the Murray Valley region.

It is possible that change within the Murray Valley, rather than reflecting internal processes of selection and adaptation, indicates gene flow into this area from regions with smaller mean tooth size. Analyses of Aboriginal tooth size (Townsend and Brown 1979b; Freedman and Lofgren 1981; Smith *et al.* 1981; Brown 1987a) reveal that there is considerable intrapopulation variation in tooth size within the continent. Areas of maximum tooth size are centred on the central Murray Valley, with samples from northern, central and western Australia obtaining significantly smaller mean dimensions. Brace (1980) argues for the presence of tooth size clines, primarily running north-south, but possible sampling bias resulting from the pooling of the male and female individuals compromises these results. Data from Townsend and Brown (1979b), Freedman and Lofgren (1981), Smith *et*

al. (1981) and Brown (1987a), while highlighting the variation within Australia, are insufficient to demonstrate the presence of a clinal distribution for tooth size. A greater amount of sexed regional data are needed, especially since Townsend and Brown (1978b) have demonstrated that there is a larger environmental component in tooth size than was previously suspected.

The post-Pleistocene reduction in the size and robusticity of Murray Valley crania and their associated dentitions is unlikely to be the result of gene flow into Australia during the Holocene. Genetic (Simmons 1976; Keats 1977; Kirk 1981; Serjeantson 1985) and linguistic data (Dixon 1980; Tryon 1985) combined with technological information from archaeological sites (White and O'Connell 1982) emphasise the uniqueness of Australian Aboriginal people in terms of other populations in the Pacific and Asia. Similarly Aboriginal skeletal materials recovered from both terminal Pleistocene and recent sites show a continuity in anatomical detail which is identifiably Australian (Thorne and Macumber 1972; Brown 1987a). With the exception of the introduction of the dingo, *Canis familiaris*, between 4000 and 3000 years BP (Gollan 1984), and cultural and genetic evidence of limited contact with Indonesian fishermen and Torres Strait Islanders (Kirk 1981), for much of its human history Australia has been an isolated place. Where indisputable evidence of genetic, or cultural, contact with populations outside Australia is present, it is confined to the extreme north of the continent.

Many living species exhibit clinal geographic variation, systematic changes in size, form, or other attributes along gradients in the environment. The most commonly applied explanations of these clines are based on the 19th century bioclimatic rules of Bergmann (1847) and Allen (1877). Bergmann's Rule relies on the observation that the body size of homeothermic species increases with decreasing mean annual temperature (or increasing latitude) and that this is a common feature of the pattern of variation in many modern mammals and birds (Mayr 1963). Allen's Rule predicts that the length of the extremities will be less in colder environments. The generalisations involved in Bergmann's Rule, in particular, have evoked considerable debate. The first detailed criticism was by Scholander (1955) who argued that many species did not follow Bergmann's Rule and of those that did their clinal increases in body weight were not necessarily physiologically important.

Although many species with extensive

geographic distributions display an inverse relationship between body size and environmental temperature (Newman 1953; Rosenzweig 1968; Brown and Lee 1969; Peters 1983) the explanation of this relationship is in dispute. The accepted explanation rests on the observation that larger animals, with their smaller surface-to-volume ratios, lose less heat per gram of body weight to the environment than smaller conspecifics (Gordon *et al.* 1977). Consequently, the larger members of a given species are thought to be better adapted to cold climates. At a general level difficulties are presented by the behavioural and physiological mechanisms employed by many homeotherms as a method of thermoregulatory adjustment.

There are a variety of alternative explanations for Bergmann's observations. Beginning with the most unusual, Klopfer (1962) argued that large size was associated with increased learning capacity. Assuming that environmental stability is inversely related to latitude, he points out the probable need for increased organismic flexibility, hence, learning power, in animals farther and farther from the equator. Animals get larger to be smarter! Alternative explanations are that body size increases due to particular reproductive and developmental strategies, for instance seasonality, gestation times and K selection (Peters 1983; Murphy 1985), in response to decreasing interspecific competition and prey size (McNab 1971), and home range size, population density and environmental productivity (Rosenzweig 1968; Peters and Raelson 1984).

Recently Yom-Tov and Nix (1986) examined the climatological correlates for body size in five species of Australian mammals (brushtail possum, eastern and western grey kangaroo, echidna and red kangaroo). They concluded that all five species show trends in body size that conform with Bergmann's Rule, individuals from colder environments were larger than those from warmer areas. The eastern and western grey kangaroo also conformed with Allen's Rule, the relative size of their extremities being larger in warmer areas. However, there was a difficulty in that in four of the five species (not the red kangaroo) body size is also correlated with indices of biomass productivity. As biomass productivity and ambient temperature are related to some extent, it is difficult to separate the effects of these factors.

There have been several surveys of the correlation between general body form, head size and climate in living humans, with world surveys by Schreider (1964, 1975), Roberts (1978) and Coon (1982), and continental surveys by Newman

(1953), Schreider (1963), Hiernaux (1968) and Crognier (1981). Indeed the 'demonstration that species-wide variation in the human body correlates with environmental factors is one of the clear achievements of physical anthropology in this century' (Carey and Steegman 1981:313). Overall, Bergmann and Allen's Rules appear to predict the geographic distribution of human body proportions with a high degree of accuracy. Anthropometric traits with apparent thermoregulatory associations include head shape and endocranial volume (Coon 1955; Beals 1972; Beals *et al.* 1983, 1984); body build and weight (Roberts 1953; Crognier 1981; Coon 1982), cranial size (Guglielmino-Matessi *et al.* 1979) and nose shape and facial form (Wolpoff 1968; Steegman 1970; Carey and Steegman 1981). Macho and Freedman (1987:53-54) found that the overall temperature range of the coldest month (July) is an important determining factor in Aboriginal morphology. Features which they found were most influenced by climatic conditions were interorbital breadth and nose shape.

The results of some of this research can be briefly summarised as follows. An increase in mean annual temperature, or in the means of the coldest and hottest months are related to a decrease in general body size. Cephalic measurements are also negatively related with temperature and positively with precipitation. Head breadth is greater in cold and/or wet places and smaller in hot and/or dry places. Morphological facial height and bizygomatic breadth both increase where temperature is lower and where rainfall is abundant. Low profile, relatively wide noses are found where seasonal absolute humidity is high and protrusive, relatively narrow ones where the air contains little moisture. Applying these data to the morphological and metrical features which distinguish the Barham skeletons from those at Coobool Creek and Kow Swamp (smaller body size, smaller crania with a lower cephalic index, and reduced cranial breadth, facial height and bizygomatic breadth) you would predict that the Barham people were better adapted to higher temperatures and reduced humidity.

If selection is favouring a reduction in the size of the body, cranium and oro-facial skeleton, as part of a long-term thermoregulatory adjustment, this may ultimately influence tooth size. In an extension of Sofaer's (1973) developmental field argument I have argued (Brown 1987a:62) that where selection is favouring the evolution of a smaller oro-facial skeleton, large teeth, if present, may have difficulty moving into normal occlusion. This in turn could influence physio-

logical function and the general health of the masticatory system. Under these conditions selection should, therefore, favour a slight reduction in tooth size to form a balanced occlusion. Alternatively, the post-Pleistocene reduction in the size of the oro-facial skeleton and teeth in the Murray Valley specimens may be more directly linked to the patterns of scaling between body weight, stature and tooth size (length, breadth and area) reported by Wolpoff (1985b) for Aborigines from Yuendumu. Either way the driving force behind a reduction in tooth size (either positive selection for smaller teeth or a reduced body size) is unlikely to have been changes in food preparation technology and masticatory function.

For archaeologists in search of a more anthropologically palatable story an alternative explanation may be provided by a connection between increasing population density and body size reduction. One of the principal disadvantages of large body size is that it requires more matter and energy per individual, per unit time, than a smaller one (Gordon *et al.* 1977). If the demand for calories slightly exceeds supply then individuals may not achieve their genetic potential for body mass and stature. Recently, Lourandos (1983) and Ross (1985) have argued for increasing population density, increasing social complexity and more intense use of resources by Aboriginal communities in south-eastern Australia during the middle to late Holocene. Ross concludes that this 'increase seems to have begun around 4000 BP, but does not peak until closer to 2500-2000 BP' (1985:87). The archaeological evidence for intensification, and the way it should be interpreted, have been the subject of some debate (Beaton 1985; Lourandos 1985). Pardoe (1988) argues that added support for the mid-Holocene intensification hypothesis is provided by the distribution of cemeteries in the Murray Valley corridor, where he suggests an increase in grave density through time. However, the extended use of the cemeteries at Kow Swamp and Roonka, combined with the large number of burials collected at Coobool Creek, undermine the conclusions that Pardoe draws from his data (1988:Fig.2).

Irrespective of whether this proposed middle to late Holocene change in population structure has a basis in historical fact it would appear to be unrelated to the post-Pleistocene reduction in skeletal and dental mass. Comparisons between the terminal Pleistocene skeletal materials from Kow Swamp and Coobool Creek with the mid-Holocene groups from Barham and Roonka make it clear that the major period of structural reduc-

tion was prior to 7000 years BP. The skeletal and dental materials from both Roonka and Barham are morphologically and metrically indistinguishable from late-Holocene samples. At Roonka there is some evidence to suggest an increasing use of the cemetery after 4000 years BP (Pretty 1977), but there is no detectable change in skeletal and dental size and morphology (Smith *et al.* 1988), or the frequency of trauma and disease, in the period between 7000 years and the European contact period. If the frequency of osteological trauma (depressed fractures on the cranial vault, 'shield' fractures of the radius and ulna, and so forth) is any indication of increasing population density, competition for limited resources, and a breakdown in social fabric, then there appears to have been no consistent change in the Murray Valley region in the post-Pleistocene period.

To what extent the Coobool Creek and Kow Swamp morphological and metrical matrix (excluding those features associated with cranial deformation) is restricted to the Murray Valley region, or representative of greater Australia, during the terminal Pleistocene is unknown. With the exception of the Talgai cranium (Smith 1918), and the isolated incisor tooth from Devil's Lair (Davies 1968), all of the recorded terminal Pleistocene human skeletal remains come from the southeastern corner of the continent. All of the male crania in this group (Cohuna, Keilor, LMIII and Mossgiel) are of relatively large size, with thickened cranial vaults and an oro-facial morphology which is consistent with Coobool Creek and Kow Swamp (Brown 1987a). The single exception is the female cremation LMI which combines a relatively delicate build with small size (Thorne 1976).

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APPENDIX 1

COOBOOL CREEK RAW DATA FILE

VARIABLE LIST

The raw data file contains information on the individual specimen numbers and the dimensions for the cranial, mandibular and dental variables. Missing data are signified by (.) and blank spaces by (-). There are 100 variables, the majority allocated five to a line. To assist in the identification of individual specimens each line begins with a case number. The variables are listed in the following order:

Case n.	1	2	3	4	5
Case n.	6	7	8	9	10
Case n.	11	12	13	14	15
Case n.	16	17	18	19	20
Case n.	21	22	23	24	25
Case n.	26	27	28	29	30
Case n.	31	32	33	34	35
Case n.	36	37	38	39	40
Case n.	41	42	43	44	45
Case n.	46	47	48	49	50
Case n.	51	52	53	54	55
Case n.	56	57	58	59	-
Case n.	-	-	60	61	62
Case n.	63	64	65	66	67
Case n.	68	69	70	71	72
Case n.	73	74	75	76	77
Case n.	78	79	80	81	82
Case n.	83	84	85	86	87
Case n.	88	89	90	91	-
Case n.	-	-	-	92	93
Case n.	94	95	96	97	98
Case n.	99	100			

VARIABLE NUMBERS AND VARIABLE NAMES

Cranial variables

1. Series number
2. Sex (1 = male, 2 = female)
3. Specimen number
4. Biparietal
5. Glabella-opisthocranion
6. Glabella-lambda
7. Basion-bregma
8. Basion-nasion
9. Basion-nasospinale
10. Basion-prosthion
11. Basion-lambda
12. Basion-inion
13. Biauriculare
14. Biasterion
15. Bifrontosphenoid
16. Glabella-bregma
17. Nasion-bregma
18. Metopion height
19. Frontal curvature index

20. Supraorbital breadth
21. Postorbital constriction
22. Minimum distance between temporal lines on frontal bone
23. Minimum distance between temporal lines on parietal bones
24. Bizygion
25. Bizygomaxillare
26. Bistephanion
27. Bistenionic
28. Opisthion-inion
29. Opisthion-lambda
30. Opisthion-asterion
31. Opisthion-glabella
32. Basion-sphenobasion
33. Basion-asterion
34. Basion-mastoidale
35. Basion-staphylion
36. Bregma-lambda
37. Parietal subtense height
38. Bregma-subtense
39. Parietal curvature index
40. Lambda-inion
41. Lambda-asterion
42. Occipital subtense height
43. Lambda-subtense
44. Occipital curvature index
45. Nasion-nasospinale
46. Nasion-prosthion
47. Nasospinale-prosthion
48. Nasal breadth
49. Orbital height
50. Orbital breadth
51. Biectoconchion
52. Alveolar length
53. Alveolar breadth
54. Bicanine breadth
55. Palate index
56. Mastoid length
57. Frontal arc
58. Parietal arc
59. Occipital arc

Buccolingual dimensions of maxillary teeth

60. I1
61. I2
62. C
63. P1
64. P2
65. M1
66. M2
67. M3

Mandibular dimensions

68. Symphyseal height
69. Symphyseal thickness
70. Corpus height (M1-M2)

- 71. Corpus height (M2-M3)
- 72. Bicondylar breadth
- 73. Bigonial breadth
- 74. Mandibular length
- 75. Ramus height
- 76. Maximum ramus breadth
- 77. Minimum ramus breadth
- 78. Dental arch breadth

Buccolingual dimensions of mandibular teeth

- 79. I1
- 80. I2
- 81. C
- 82. P1
- 83. P2
- 84. M1
- 85. M2
- 86. M3

Additional cranial dimensions and indices

- 87. Auriculare-bregma
- 88. Auriculare-nasion
- 89. Auriculare-nasospinale
- 90. Auriculare-prosthion
- 91. Auriculare-zygomaxillare
- 92. Auriculare-lambda
- 93. Auriculare-inion
- 94. Auriculare-opisthion
- 95. Auriculare-basion
- 96. Auriculare-glabella
- 97. Gnathic index
- 98. Cranial module
- 99. Nasal index
- 100. Orbital index

DATA FILE

Case 1	5.000	1.000	50010.000	136.000	193.000
Case 1	186.000	141.000	104.000	97.000	.
Case 1	122.000	79.000	120.000	112.000	109.000
Case 1	113.000	114.000	25.000	21.900	112.000
Case 1	98.000	98.000	.	.	98.000
Case 1	117.000	67.000	45.000	102.000	67.000
Case 1	141.000	21.000	81.000	55.000	49.000
Case 1	115.000	21.000	61.000	18.300	72.000
Case 1	91.000	29.000	47.000	28.431	51.000
Case 1	.	.	29.000	31.000	44.000
Case 1	104.000
Case 1	28.000	130.000	131.000	123.000	-
Case 1	-	-	.	.	.
Case 1	13.300
Case 1	37.000	15.000	34.000	15.000	129.000
Case 1	108.000	104.000	65.000	46.000	35.000
Case 1	70.000	.	6.700	.	.
Case 1	-
Case 1	-	-	-	112.000	118.000
Case 1	.	77.000	123.000	101.000	74.000

Case 1	63.000	53.000	117.000	.	156.667
Case 1	56.863	70.455	.	.	.
Case 2	5.000	1.000	50005.000	144.000	207.000
Case 2	207.000	153.000	109.000	.	.
Case 2	125.000	79.000	128.000	111.000	.
Case 2	128.000	131.000	25.000	19.100	122.000
Case 2	107.000	92.000	.	150.000	107.000
Case 2	98.000	76.000	47.000	99.000	65.000
Case 2	151.000	26.000	79.000	55.000	.
Case 2	129.000	27.000	70.000	20.900	66.000
Case 2	90.000
Case 2	.	.	.	34.000	42.000
Case 2	112.000
Case 2	34.000	112.000	148.000	143.000	-
Case 2	-	-	.	.	.
Case 2
Case 2
Case 2	.	.	.	53.000	41.000
Case 2
Case 2	-
Case 2	-	-	-	117.000	.
Case 2	.	82.000	132.000	102.000	79.000
Case 2	68.000	56.000	126.000	.	168.000
Case 2	.	80.952	-	-	-
Case 3	5.000	1.000	50008.000	134.000	185.000
Case 3	181.000	146.000	100.000	.	.
Case 3	118.000	78.000	125.000	109.000	.
Case 3	114.000	118.000	28.000	23.700	115.000
Case 3	103.000	103.000	.	.	.
Case 3	110.000	67.000	44.000	98.000	63.000
Case 3	144.000	24.000	77.000	55.000	.
Case 3	121.000	24.000	57.000	19.800	60.000
Case 3	81.000	26.000	46.000	26.531	.
Case 3
Case 3
Case 3	28.000	135.000	133.000	115.000	-
Case 3	-	-	.	.	9.100
Case 3	.	10.900	14.100	15.100	13.400
Case 3	38.000	14.000	30.000	15.000	.
Case 3	.	.	61.000	43.000	34.000
Case 3
Case 3	9.900	12.600	12.300	12.400	-
Case 3	-	-	-	109.000	.
Case 3	.	.	118.000	98.000	80.000
Case 3	70.000	45.000	117.000	.	155.000
Case 3
Case 4	5.000	1.000	50013.000	133.000	190.000
Case 4	184.000	134.000	105.000	109.000	114.000
Case 4	115.000	73.000	130.000	108.000	100.000
Case 4	113.000	116.000	23.000	19.800	112.000
Case 4	94.000	85.000	.	.	.
Case 4	96.000	71.000	40.000	96.000	62.000
Case 4	148.000	25.000	74.000	52.000	57.000
Case 4	110.000	22.000	55.000	20.000	65.000

Case 4	86.000	27.000	53.000	28.125	53.000
Case 4	70.000	17.000	31.000	30.000	42.000
Case 4	.	63.000	73.000	49.000	45.990
Case 4	30.000	130.000	123.000	113.000	-
Case 4	-	-	.	.	.
Case 4	10.600	10.400	13.200	12.700	12.400
Case 4	36.000	19.000	33.000	17.000	121.000
Case 4	.	107.000	69.000	47.000	39.000
Case 4	65.000
Case 4	.	.	11.800	12.800	-
Case 4	-	-	-	111.000	125.000
Case 4	132.000	77.000	124.000	101.000	82.000
Case 4	68.000	53.000	119.000	108.571	152.333
Case 4	58.491	71.429			
Case 5	5.000	1.000	50016.000	136.000	188.000
Case 5	183.000	138.000	106.000	103.000	111.000
Case 5	123.000	76.000	128.000	114.000	110.000
Case 5	113.000	115.000	21.000	18.200	114.000
Case 5	97.000	92.000	.	.	104.000
Case 5	106.000	79.000	45.000	110.000	70.000
Case 5	148.000	20.000	82.000	57.000	48.000
Case 5	107.000	18.000	61.000	16.800	75.000
Case 5	90.000	29.000	60.000	26.364	57.000
Case 5	78.000	21.000	32.000	29.000	42.000
Case 5	105.000	68.000	74.000	51.000	50.320
Case 5	32.000	128.000	117.000	127.000	-
Case 5	-	-	8.100	7.600	10.000
Case 5	10.700	11.000	13.800	14.600	13.800
Case 5	45.000	15.000	38.000	15.000	129.000
Case 5	114.000	120.000	58.000	.	38.000
Case 5	64.000	6.900	6.400	9.400	9.600
Case 5	10.400	.	13.200	12.500	-
Case 5	-	-	-	118.000	124.000
Case 5	135.000	77.000	120.000	95.000	80.000
Case 5	70.000	50.000	123.000	104.717	154.000
Case 5	56.140	69.048			
Case 6	5.000	1.000	50028.000	133.000	202.000
Case 6	199.000	139.000	111.000	109.000	120.000
Case 6	118.000	80.000	128.000	114.000	100.000
Case 6	121.000	124.000	29.000	23.400	118.000
Case 6	99.000	95.000	.	145.000	109.000
Case 6	106.000	74.000	47.000	98.000	65.000
Case 6	150.000	25.000	80.000	54.000	.
Case 6	124.000	26.000	65.000	20.900	66.000
Case 6	89.000	32.000	54.000	32.653	51.000
Case 6	75.000	24.000	31.000	28.000	44.000
Case 6	112.000	69.000	76.000	53.000	52.440
Case 6	29.000	142.000	137.000	120.000	-
Case 6	-	-	8.500	.	10.600
Case 6	11.800	11.700	14.100	15.300	14.400
Case 6	43.000	18.000	34.000	17.000	135.000
Case 6	113.000	116.000	61.000	52.000	42.000
Case 6	65.000	7.100	7.500	9.800	10.000
Case 6	10.600	.	12.400	11.400	-
Case 6	-	-	-	119.000	125.000

Case 6	138.000	81.000	127.000	105.000	79.000
Case 6	67.000	55.000	124.000	108.108	158.000
Case 6	60.784	63.636			
Case 7	5.000	1.000	50029.000	137.000	201.000
Case 7	198.000	145.000	106.000	100.000	106.000
Case 7	129.000	79.000	124.000	109.000	107.000
Case 7	120.000	123.000	23.000	18.700	116.000
Case 7	96.000	96.000	.	141.000	102.000
Case 7	102.000	70.000	40.000	105.000	68.000
Case 7	151.000	22.000	86.000	55.000	46.000
Case 7	127.000	27.000	60.000	21.200	77.000
Case 7	86.000	31.000	54.000	29.524	56.000
Case 7	76.000	20.000	27.000	31.000	42.000
Case 7	106.000	61.000	71.000	42.000	43.310
Case 7	34.000	137.000	140.000	125.000	-
Case 7	-	-	.	6.900	8.700
Case 7	10.700	10.200	13.000	13.100	13.000
Case 7	38.000	16.000	35.000	13.000	111.000
Case 7	120.000	118.000	61.000	49.000	38.000
Case 7	65.000	.	.	8.200	8.600
Case 7	.	12.100	11.800	11.300	-
Case 7	-	-	-	112.000	122.000
Case 7	130.000	76.000	130.000	100.000	84.000
Case 7	70.000	62.000	118.000	100.000	161.000
Case 7	48.214	73.810			
Case 8	5.000	1.000	50032.000	.	.
Case 8
Case 8
Case 8
Case 8
Case 8
Case 8
Case 8
Case 8
Case 8
Case 8
Case 8
Case 8
Case 8
Case 8
Case 8
Case 8	41.000	17.000	37.000	14.000	.
Case 8	34.000
Case 8	.	.	7.600	9.800	10.700
Case 8	11.000	13.200	13.100	12.700	-
Case 8	-	-	-	.	.
Case 8
Case 8
Case 8
Case 9	5.000	1.000	50037.000	140.000	198.000
Case 9	198.000	141.000	106.000	105.000	112.000
Case 9	127.000	92.000	.	120.000	111.000
Case 9	115.000	118.000	23.000	19.500	118.000
Case 9	98.000	99.000	.	148.000	96.000
Case 9	108.000	75.000	55.000	101.000	68.000
Case 9	150.000	24.000	86.000	56.000	50.000

Case 9	124.000	24.000	64.000	19.400	65.000
Case 9	96.000	33.000	54.000	32.673	52.000
Case 9	78.000	26.000	29.000	32.000	44.000
Case 9	114.000	66.000	72.000	47.000	47.520
Case 9	31.000	131.000	140.000	122.000	-
Case 9	-	-	8.000	7.600	9.900
Case 9	11.000	10.800	.	12.800	12.700
Case 9
Case 9
Case 9
Case 9	-
Case 9	-	-	-	117.000	124.000
Case 9	134.000	81.000	130.000	109.000	78.000
Case 9	69.000	51.000	123.000	105.660	159.667
Case 9	55.769	72.727			
Case 10	5.000	1.000	50041.000	143.000	200.000
Case 10	197.000	140.000	104.000	100.000	107.000
Case 10	129.000	71.000	125.000	105.000	106.000
Case 10	117.000	119.000	17.000	14.300	114.000
Case 10	97.000	97.000	.	.	.
Case 10	107.000	76.000	39.000	105.000	64.000
Case 10	143.000	21.000	79.000	54.000	50.000
Case 10	125.000	29.000	62.000	23.200	75.000
Case 10	89.000	24.000	61.000	22.857	52.000
Case 10	76.000	24.000	28.000	31.000	45.000
Case 10	106.000	63.000	73.000	47.000	45.990
Case 10	35.000	129.000	142.000	120.000	-
Case 10	-	-	.	7.500	9.800
Case 10	10.700	10.200	12.800	13.400	10.800
Case 10
Case 10
Case 10
Case 10	-
Case 10	-	-	-	115.000	120.000
Case 10	130.000	74.000	129.000	94.000	76.000
Case 10	68.000	49.000	120.000	102.885	161.000
Case 10	53.846	68.889			
Case 11	5.000	1.000	50045.000	141.000	198.000
Case 11	193.000	145.000	109.000	104.000	112.000
Case 11	120.000	74.000	124.000	114.000	101.000
Case 11	116.000	120.000	26.000	21.700	117.000
Case 11	100.000	99.000	.	.	94.000
Case 11	104.000	70.000	42.000	100.000	66.000
Case 11	151.000	23.000	83.000	56.000	53.000
Case 11	126.000	28.000	69.000	22.200	67.000
Case 11	83.000	28.000	54.000	28.000	59.000
Case 11	77.000	19.000	28.000	35.000	48.000
Case 11	110.000	67.000	67.000	45.000	44.890
Case 11	30.000	136.000	143.000	119.000	-
Case 11	-	-	8.700	8.400	9.300
Case 11	11.400	11.400	14.100	14.100	12.000
Case 11	39.000	15.000	35.000	15.000	126.000
Case 11	101.000	117.000	60.000	48.000	38.000
Case 11	61.000	.	.	9.000	10.200
Case 11	9.800	13.000	12.300	10.200	-

Case 11	-	-	-	117.000	122.000
Case 11	132.000	73.000	125.000	99.000	78.000
Case 11	67.000	59.000	122.000	102.752	161.333
Case 11	47.458	72.917			
Case 12	5.000	1.000	50046.000	133.000	190.000
Case 12	187.000	136.000	102.000	101.000	110.000
Case 12	117.000	80.000	125.000	103.000	107.000
Case 12	110.000	115.000	26.000	22.600	.
Case 12	102.000	90.000	.	.	.
Case 12	106.000	72.000	50.000	101.000	64.000
Case 12	146.000	20.000	80.000	54.000	46.000
Case 12	118.000	24.000	62.000	20.300	64.000
Case 12	79.000	30.000	52.000	29.703	57.000
Case 12	78.000	21.000	30.000	35.000	.
Case 12	.	68.000	75.000	49.000	51.000
Case 12	33.000	135.000	131.000	122.000	-
Case 12	-	-	8.200	7.800	10.200
Case 12	11.100	10.700	13.300	14.000	13.500
Case 12	41.000	20.000	32.000	15.000	.
Case 12	122.000	115.000	62.000	.	33.000
Case 12	70.000	.	.	.	9.700
Case 12	10.100	12.900	12.800	12.600	-
Case 12	-	-	-	116.000	126.000
Case 12	137.000	85.000	119.000	98.000	76.000
Case 12	66.000	55.000	126.000	107.843	153.000
Case 12	52.632	.			
Case 13	5.000	1.000	50049.000	142.000	203.000
Case 13	201.000	151.000	100.000	99.000	108.000
Case 13	142.000	78.000	130.000	114.000	112.000
Case 13	124.000	127.000	21.000	16.500	120.000
Case 13	106.000	106.000	.	143.000	109.000
Case 13	113.000	73.000	43.000	120.000	71.000
Case 13	142.000	26.000	87.000	55.000	.
Case 13	125.000	25.000	62.000	20.000	91.000
Case 13	100.000	31.000	65.000	25.833	55.000
Case 13	75.000	20.000	29.000	30.000	44.000
Case 13	111.000	66.000	72.000	46.000	47.520
Case 13	36.000	139.000	138.000	142.000	-
Case 13	-	-	.	8.000	9.800
Case 13	.	.	14.100	14.600	13.600
Case 13	38.000	16.000	35.000	15.000	.
Case 13	117.000	124.000	60.000	43.000	34.000
Case 13	65.000	.	7.400	9.300	10.600
Case 13	10.700	13.300	12.700	12.500	-
Case 13	-	-	-	110.000	120.000
Case 13	131.000	74.000	144.000	106.000	83.000
Case 13	72.000	61.000	115.000	108.000	165.333
Case 13	52.727	68.182			
Case 14	5.000	1.000	50065.000	136.000	195.000
Case 14	194.000	149.000	102.000	101.000	105.000
Case 14	129.000	85.000	127.000	106.000	112.000
Case 14	126.000	129.000	16.000	12.400	112.000
Case 14	88.000	76.000	.	.	103.000
Case 14	87.000	73.000	47.000	102.000	68.000

Case 14	149.000	24.000	84.000	57.000	.
Case 14	121.000	28.000	72.000	23.400	60.000
Case 14	86.000	20.000	46.000	19.608	57.000
Case 14	74.000	17.000	30.000	33.000	42.000
Case 14	108.000	62.000	73.000	52.000	45.260
Case 14	30.000	141.000	140.000	111.000	-
Case 14	-	-	.	.	.
Case 14	.	.	13.300	.	.
Case 14	39.000	18.000	32.000	17.000	130.000
Case 14	.	115.000	61.000	50.000	39.000
Case 14	68.000	.	6.400	9.100	9.900
Case 14	.	.	.	11.100	-
Case 14	-	-	-	112.000	124.000
Case 14	131.000	78.000	127.000	100.000	80.000
Case 14	70.000	63.000	116.000	102.941	160.000
Case 14	52.632	78.571			
Case 15	5.000	1.000	50066.000	137.000	196.000
Case 15	192.000	139.000	104.000	103.000	109.000
Case 15	121.000	78.000	125.000	113.000	104.000
Case 15	124.000	128.000	20.000	15.600	109.000
Case 15	87.000	85.000	.	.	99.000
Case 15	96.000	71.000	43.000	96.000	65.000
Case 15	145.000	24.000	81.000	52.000	51.000
Case 15	119.000	26.000	60.000	21.900	63.000
Case 15	86.000	29.000	50.000	30.208	50.000
Case 15	70.000	20.000	29.000	32.000	44.000
Case 15	108.000	61.000	68.000	48.000	41.480
Case 15	27.000	140.000	133.000	115.000	-
Case 15	-	-	8.500	7.400	.
Case 15
Case 15	36.000	17.000	33.000	14.000	.
Case 15	116.000	.	.	.	34.000
Case 15	69.000	.	.	9.100	9.100
Case 15	9.200	.	.	12.100	-
Case 15	-	-	-	111.000	119.000
Case 15	128.000	74.000	127.000	103.000	79.000
Case 15	68.000	57.000	117.000	104.808	157.333
Case 15	58.000	72.727			
Case 16	5.000	1.000	50071.000	141.000	194.000
Case 16	192.000	140.000	110.000	100.000	108.000
Case 16	118.000	79.000	129.000	113.000	114.000
Case 16	115.000	118.000	25.000	21.200	121.000
Case 16	106.000	98.000	.	.	103.000
Case 16	111.000	75.000	43.000	95.000	64.000
Case 16	156.000	21.000	65.000	54.000	.
Case 16	119.000	26.000	59.000	21.900	64.000
Case 16	88.000	28.000	55.000	29.474	59.000
Case 16	76.000	17.000	29.000	33.000	48.000
Case 16	113.000	66.000	83.000	53.000	54.780
Case 16	32.000	134.000	135.000	114.000	-
Case 16	-	-	.	.	.
Case 16	.	11.300	13.600	14.300	14.100
Case 16	39.000	17.000	33.000	15.000	.
Case 16	101.000	115.000	57.000	43.000	32.000
Case 16	69.000	.	7.000	9.200	9.000

Case 16	9.700	13.000	12.600	12.000	-
Case 16	-	-	-	121.000	124.000
Case 16	133.000	73.000	122.000	97.000	80.000
Case 16	70.000	49.000	127.000	98.182	158.333
Case 16	49.153	68.750			
Case 17	5.000	1.000	50040.000	.	.
Case 17
Case 17
Case 17
Case 17
Case 17
Case 17
Case 17
Case 17
Case 17	.	18.000	31.000	.	.
Case 17	.	64.000	75.000	.	48.000
Case 17	-
Case 17	-	-	8.400	7.800	9.400
Case 17	10.700	11.000	13.600	13.700	13.000
Case 17	36.000	15.000	31.000	17.000	.
Case 17	103.000	.	.	.	34.000
Case 17	71.000	7.100	6.900	9.000	9.800
Case 17	9.700	13.000	12.100	11.200	-
Case 17	-	-	-	.	.
Case 17
Case 17
Case 17
Case 18	5.000	1.000	50035.000	144.000	199.000
Case 18	194.000	141.000	104.000	.	.
Case 18	127.000	76.000	132.000	113.000	114.000
Case 18	113.000	119.000	20.000	16.800	122.000
Case 18	109.000	109.000	.	.	.
Case 18	119.000	73.000	55.000	102.000	66.000
Case 18	148.000	25.000	85.000	55.000	.
Case 18	124.000	28.000	55.000	22.600	59.000
Case 18	88.000	29.000	50.000	28.431	.
Case 18
Case 18
Case 18	34.000	132.000	137.000	120.000	-
Case 18	-	-	.	.	10.000
Case 18	11.400
Case 18	37.000	15.000	.	.	.
Case 18	110.000	.	.	.	33.000
Case 18	.	.	7.000	9.600	9.500
Case 18	9.900	.	.	.	-
Case 18	-	-	-	120.000	.
Case 18	.	.	126.000	95.000	78.000
Case 18	70.000	62.000	127.000	.	161.333
Case 18	.	.			
Case 19	5.000	1.000	50036.000	138.000	197.000
Case 19	189.000	142.000	101.000	101.000	107.000
Case 19	128.000	79.000	123.000	114.000	107.000
Case 19	117.000	120.000	25.000	20.800	112.000
Case 19	98.000	95.000	.	139.000	100.000

Case 19	106.000	72.000	42.000	108.000	68.000
Case 19	146.000	25.000	87.000	51.000	47.000
Case 19	117.000	24.000	55.000	20.500	81.000
Case 19	89.000	38.000	63.000	35.185	50.000
Case 19	73.000	24.000	30.000	26.000	43.000
Case 19	105.000	64.000	73.000	47.000	46.720
Case 19	29.000	136.000	129.000	135.000	-
Case 19	-	-	.	7.800	9.700
Case 19	.	10.300	13.500	13.600	13.900
Case 19	43.000	14.000	35.000	16.000	.
Case 19	104.000	121.000	60.000	45.000	34.000
Case 19	66.000	.	.	8.900	9.800
Case 19	9.400	.	.	11.700	-
Case 19	-	-	-	112.000	126.000
Case 19	133.000	72.000	122.000	99.000	78.000
Case 19	69.000	55.000	120.000	105.941	159.000
Case 19	60.000	60.465			
Case 20	5.000	1.000	50075.000	136.000	186.000
Case 20	183.000	135.000	104.000	107.000	115.000
Case 20	113.000	72.000	122.000	111.000	107.000
Case 20	118.000	119.000	27.000	22.700	113.000
Case 20	101.000	98.000	.	.	.
Case 20	105.000	73.000	43.000	96.000	69.000
Case 20	144.000	27.000	82.000	51.000	56.000
Case 20	112.000	21.000	59.000	18.800	65.000
Case 20	77.000	29.000	52.000	30.208	57.000
Case 20	70.000	13.000	32.000	31.000	43.000
Case 20	103.000	66.000	69.000	47.000	45.540
Case 20	29.000	137.000	120.000	116.000	-
Case 20	-	-	8.400	.	9.300
Case 20	.	10.500	.	.	12.800
Case 20	37.000	16.000	32.000	14.000	.
Case 20	115.000	.	.	.	37.000
Case 20	62.000	.	.	8.700	9.400
Case 20	9.600	.	.	.	-
Case 20	-	-	-	113.000	124.000
Case 20	133.000	79.000	120.000	95.000	76.000
Case 20	66.000	66.000	121.000	110.577	152.333
Case 20	56.140	72.093			
Case 21	5.000	1.000	50076.000	145.000	211.000
Case 21	203.000
Case 21	.	.	137.000	129.000	107.000
Case 21	122.000	124.000	30.000	24.200	129.000
Case 21	110.000	108.000	.	.	.
Case 21	108.000	64.000	39.000	113.000	72.000
Case 21	168.000
Case 21	115.000	19.000	68.000	16.500	87.000
Case 21	106.000	32.000	54.000	28.319	.
Case 21	.	.	28.000	.	42.000
Case 21
Case 21	33.000	.	.	.	-
Case 21	-	-	.	.	.
Case 21	13.600
Case 21	43.000	17.000	38.000	21.000	.
Case 21

Case 21	70.000	.	.	9.700	9.500
Case 21	10.100	.	.	12.800	-
Case 21	-	-	-	119.000	.
Case 21	.	.	129.000	105.000	89.000
Case 21	.	53.000	129.000	.	.
Case 21
Case 22	5.000	1.000	50082.000	139.000	200.000
Case 22	198.000
Case 22	.	.	127.000	116.000	115.000
Case 22	125.000	129.000	24.000	18.600	116.000
Case 22	101.000	92.000	.	136.000	98.000
Case 22	106.000	68.000	44.000	109.000	69.000
Case 22	147.000
Case 22	120.000	26.000	64.000	21.700	75.000
Case 22	90.000	27.000	61.000	24.771	55.000
Case 22	82.000	27.000	28.000	36.000	42.000
Case 22	111.000	67.000	.	45.000	.
Case 22	32.000	143.000	136.000	125.000	-
Case 22	-	-	7.900	7.600	9.500
Case 22	11.000	11.000	13.400	.	.
Case 22	43.000	17.000	37.000	18.000	.
Case 22	119.000	.	.	.	40.000
Case 22	64.000	.	.	8.300	9.200
Case 22	9.100	.	.	11.800	-
Case 22	-	-	-	111.000	125.000
Case 22	140.000	80.000	137.000	104.000	81.000
Case 22	.	56.000	118.000	.	.
Case 22	50.909	85.714	.	.	.
Case 23	5.000	1.000	50023.000	129.000	182.000
Case 23	179.000	134.000	104.000	101.000	108.000
Case 23	111.000	68.000	117.000	106.000	104.000
Case 23	113.000	117.000	27.000	23.100	115.000
Case 23	96.000	84.000	.	.	101.000
Case 23	95.000	72.000	35.000	93.000	63.000
Case 23	145.000	24.000	79.000	51.000	.
Case 23	109.000	19.000	55.000	17.400	68.000
Case 23	79.000	30.000	58.000	32.258	53.000
Case 23	72.000	20.000	31.000	33.000	47.000
Case 23	107.000	62.000	70.000	49.000	43.400
Case 23	31.000	135.000	118.000	109.000	-
Case 23	-	-	8.600	8.500	10.400
Case 23	.	.	14.200	14.100	13.100
Case 23	39.000	16.000	.	13.000	120.000
Case 23	102.000	117.000	58.000	50.000	41.000
Case 23	.	.	7.500	.	.
Case 23	9.800	.	.	11.800	-
Case 23	-	-	-	116.000	123.000
Case 23	132.000	85.000	111.000	86.000	71.000
Case 23	63.000	45.000	121.000	103.846	148.333
Case 23	58.491	70.213	.	.	.
Case 24	5.000	1.000	50051.000	137.000	188.000
Case 24	184.000	135.000	104.000	.	.
Case 24	115.000	76.000	124.000	115.000	113.000
Case 24	114.000	117.000	22.000	18.800	115.000

Case 24	93.000	93.000	.	.	100.000
Case 24	.	72.000	44.000	100.000	66.000
Case 24	143.000	22.000	80.000	56.000	.
Case 24	116.000	22.000	58.000	18.900	67.000
Case 24	84.000	30.000	54.000	30.000	.
Case 24	.	.	28.000	.	43.000
Case 24	108.000	62.000	72.000	48.000	44.640
Case 24	29.000	129.000	128.000	119.000	-
Case 24	-	-	.	.	.
Case 24
Case 24	.	15.000	.	17.000	.
Case 24	33.000
Case 24
Case 24	-
Case 24	-	-	-	116.000	.
Case 24	.	.	120.000	98.000	77.000
Case 24	66.000	50.000	122.000	.	153.333
Case 24
Case 25	6.000	2.000	49001.000	130.000	182.000
Case 25	182.000	142.000	.	.	.
Case 25	.	.	118.000	96.000	98.000
Case 25	113.000	120.000	19.000	15.800	110.000
Case 25	94.000	90.000	.	.	92.000
Case 25	100.000	67.000	.	.	.
Case 25
Case 25	110.000	28.000	55.000	24.600	55.000
Case 25	80.000	.	.	.	50.000
Case 25	69.000	19.000	25.000	34.000	43.000
Case 25	104.000	57.000	65.000	46.000	37.050
Case 25	.	127.000	131.000	.	-
Case 25	-	-	7.900	7.000	9.300
Case 25	10.500	11.000	12.600	12.800	12.800
Case 25	36.000	15.000	30.000	17.000	.
Case 25	40.000
Case 25	62.000	6.100	6.700	8.200	9.600
Case 25	9.100	11.700	11.200	11.500	-
Case 25	-	-	-	107.000	117.000
Case 25	128.000	77.000	120.000	101.000	.
Case 25	.	46.000	110.000	.	151.333
Case 25	50.000	79.070	.	.	.
Case 26	6.000	2.000	50007.000	135.000	181.000
Case 26	175.000	127.000	90.000	91.000	99.000
Case 26	111.000	75.000	124.000	109.000	108.000
Case 26	112.000	115.000	29.000	25.200	109.000
Case 26	112.000	103.000	.	.	.
Case 26	107.000	67.000	45.000	97.000	63.000
Case 26	130.000	36.000	75.000	49.000	.
Case 26	113.000	24.000	61.000	21.200	62.000
Case 26	83.000	13.000	.	13.402	45.000
Case 26	63.000	18.000	25.000	35.000	46.000
Case 26	.	59.000	.	44.000	.
Case 26	28.000	134.000	126.000	116.000	-
Case 26	-	-	7.700	6.800	8.500
Case 26	9.800	9.900	12.100	12.100	10.000
Case 26	33.000	13.000	28.000	14.000	.

Case 26	87.000	120.000	46.000	40.000	30.000
Case 26	59.000	6.000	6.300	7.600	8.600
Case 26	9.200	11.200	10.900	9.800	-
Case 26	-	-	-	116.000	115.000
Case 26	125.000	73.000	117.000	93.000	76.000
Case 26	65.000	48.000	110.000	110.000	147.667
Case 26	55.556	76.087			
Case 27	6.000	2.000	50009.000	137.000	189.000
Case 27	184.000	143.000	100.000	97.000	104.000
Case 27	122.000	78.000	128.000	113.000	101.000
Case 27	114.000	117.000	22.000	18.800	.
Case 27	100.000	100.000	.	.	.
Case 27	109.000	.	39.000	99.000	65.000
Case 27	144.000	39.000	80.000	53.000	44.000
Case 27	121.000	25.000	55.000	20.600	71.000
Case 27	90.000	29.000	50.000	29.293	53.000
Case 27	69.000	16.000	28.000	33.000	44.000
Case 27	107.000	60.000	70.000	50.000	42.000
Case 27	30.000	129.000	135.000	121.000	-
Case 27	-	-	.	7.300	9.200
Case 27	10.700	10.400	13.500	13.800	13.400
Case 27	39.000	14.000	32.000	14.000	.
Case 27	31.000
Case 27	.	.	.	8.200	7.900
Case 27	9.500	.	11.900	11.400	-
Case 27	-	-	-	109.000	118.000
Case 27	126.000	72.000	128.000	98.000	81.000
Case 27	70.000	52.000	116.000	104.000	156.333
Case 27	52.830	75.000			
Case 28	6.000	2.000	50002.000	136.000	195.000
Case 28	187.000	139.000	100.000	97.000	107.000
Case 28	119.000	81.000	126.000	113.000	98.000
Case 28	109.000	115.000	28.000	24.300	112.000
Case 28	97.000	97.000	.	134.000	98.000
Case 28	109.000	69.000	49.000	102.000	68.000
Case 28	143.000	34.000	81.000	56.000	50.000
Case 28	121.000	21.000	62.000	18.200	64.000
Case 28	84.000	.	.	.	54.000
Case 28	76.000	21.000	29.000	33.000	44.000
Case 28	103.000	70.000	67.000	51.000	46.900
Case 28	31.000	135.000	134.000	125.000	-
Case 28	-	-	8.800	7.900	9.800
Case 28	.	11.300	.	13.400	13.500
Case 28	42.000	13.000	34.000	14.000	.
Case 28	.	122.000	61.000	49.000	37.000
Case 28	.	.	.	8.900	9.300
Case 28	9.300	.	12.200	11.700	-
Case 28	-	-	-	115.000	127.000
Case 28	139.000	83.000	119.000	98.000	77.000
Case 28	67.000	48.000	124.000	107.000	156.667
Case 28	53.704	75.000			
Case 29	6.000	2.000	50012.000	119.000	179.000
Case 29	176.000	136.000	98.000	98.000	104.000
Case 29	123.000	79.000	119.000	102.000	99.000

Case 29	106.000	109.000	20.000	18.300	108.000
Case 29	92.000	81.000	.	.	98.000
Case 29	97.000	68.000	47.000	100.000	65.000
Case 29	137.000	36.000	65.000	53.000	47.000
Case 29	110.000	24.000	56.000	21.800	62.000
Case 29	80.000	26.000	46.000	26.000	54.000
Case 29	71.000	17.000	29.000	30.000	42.000
Case 29	101.000	60.000	66.000	47.000	39.600
Case 29	28.000	122.000	123.000	115.000	-
Case 29	-	-	7.500	7.400	8.600
Case 29	10.100	9.400	.	12.100	11.300
Case 29	38.000	15.000	35.000	13.000	.
Case 29	.	109.000	57.000	.	35.000
Case 29	57.000	5.900	6.300	7.800	8.800
Case 29	8.900	11.100	10.900	10.600	-
Case 29	-	-	-	103.000	117.000
Case 29	125.000	70.000	119.000	94.000	78.000
Case 29	68.000	51.000	110.000	106.122	144.667
Case 29	53.704	71.429			
Case 30	6.000	2.000	50018.000	135.000	192.000
Case 30	188.000	147.000	108.000	.	.
Case 30	127.000	75.000	125.000	111.000	.
Case 30	111.000	115.000	26.000	22.600	.
Case 30	98.000
Case 30	.	72.000	35.000	104.000	69.000
Case 30	150.000	39.000	84.000	58.000	.
Case 30	120.000	24.000	66.000	20.000	81.000
Case 30	84.000
Case 30	.	19.000	32.000	.	.
Case 30	.	61.000	65.000	46.000	39.650
Case 30	25.000	132.000	130.000	122.000	-
Case 30	-	-	8.400	7.800	9.200
Case 30	10.200	9.700	13.900	13.800	12.700
Case 30	39.000	15.000	30.000	15.000	.
Case 30	37.000
Case 30	.	7.400	7.500	8.700	9.000
Case 30	9.400	.	12.300	11.600	-
Case 30	-	-	-	117.000	.
Case 30	.	.	119.000	94.000	79.000
Case 30	70.000	46.000	123.000	.	158.000
Case 30	.	.			
Case 31	6.000	2.000	50050.000	138.000	190.000
Case 31	185.000	135.000	105.000	99.000	105.000
Case 31	119.000	77.000	124.000	112.000	100.000
Case 31	102.000	108.000	21.000	19.400	113.000
Case 31	89.000	89.000	.	137.000	105.000
Case 31	95.000	70.000	42.000	102.000	69.000
Case 31	151.000	40.000	82.000	55.000	46.000
Case 31	120.000	24.000	60.000	20.000	69.000
Case 31	84.000	29.000	58.000	28.431	50.000
Case 31	69.000	19.000	28.000	34.000	44.000
Case 31	107.000	61.000	72.000	48.000	43.920
Case 31	26.000	121.000	133.000	120.000	-
Case 31	-	-	.	.	.
Case 31

Case 31	33.000	17.000	29.000	15.000	.
Case 31	.	.	71.000	45.000	39.000
Case 31	.	.	.	8.600	8.500
Case 31	8.600	.	.	11.700	-
Case 31	-	-	-	116.000	122.000
Case 31	129.000	80.000	121.000	97.000	81.000
Case 31	69.000	52.000	122.000	100.000	154.333
Case 31	56.000	77.273			
Case 32	6.000	2.000	50040.000	137.000	176.000
Case 32	171.000	128.000	97.000	91.000	99.000
Case 32	114.000	73.000	129.000	112.000	102.000
Case 32	107.000	113.000	21.000	18.600	111.000
Case 32	99.000	99.000	.	.	97.000
Case 32	117.000	73.000	46.000	103.000	64.000
Case 32	138.000	34.000	77.000	54.000	46.000
Case 32	100.000	16.000	50.000	16.000	69.000
Case 32	84.000	.	.	.	48.000
Case 32	65.000	17.000	27.000	32.000	.
Case 32	102.000	58.000	66.000	45.000	38.280
Case 32	26.000	124.000	108.000	123.000	-
Case 32	-	-	7.700	7.800	8.700
Case 32	9.200	9.500	12.300	12.000	11.800
Case 32	35.000	12.000	30.000	12.000	.
Case 32	105.000	108.000	45.000	41.000	31.000
Case 32	63.000	6.100	6.200	8.700	8.900
Case 32	8.200	12.100	11.500	11.100	-
Case 32	-	-	-	109.000	109.000
Case 32	117.000	66.000	120.000	96.000	66.000
Case 32	75.000	51.000	115.000	102.062	147.000
Case 32	56.250	.			
Case 33	6.000	2.000	50047.000	132.000	191.000
Case 33	186.000	138.000	103.000	102.000	108.000
Case 33	127.000	72.000	120.000	110.000	95.000
Case 33	115.000	118.000	20.000	16.900	109.000
Case 33	90.000	89.000	.	.	105.000
Case 33	92.000	69.000	40.000	109.000	67.000
Case 33	143.000	34.000	80.000	54.000	53.000
Case 33	110.000	20.000	55.000	18.200	78.000
Case 33	62.000	28.000	56.000	25.688	46.000
Case 33	67.000	21.000	29.000	31.000	43.000
Case 33	105.000	58.000	71.000	48.000	41.180
Case 33	29.000	126.000	120.000	129.000	-
Case 33	-	-	.	.	.
Case 33	.	9.500	12.600	12.900	.
Case 33	35.000	15.000	30.000	17.000	.
Case 33	114.000	107.000	53.000	43.000	34.000
Case 33	67.000	.	.	7.800	8.800
Case 33	9.100	.	11.900	11.600	-
Case 33	-	-	-	109.000	119.000
Case 33	129.000	77.000	128.000	92.000	77.000
Case 33	67.000	50.000	115.000	104.854	153.667
Case 33	63.043	72.093			