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# METRICAL FEATURES OF ABORIGINAL CRANIA FROM COASTAL NEW SOUTH WALES, AUSTRALIA

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Figures 1-5

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## INTRODUCTION

The racial origin of the Australian Aboriginal is still the subject of much controversy, despite the considerable number of studies which have been made over the last 100 years. Past investigations have included many aspects of physical anthropology, archaeology, linguistics and social anthropology, but different approaches, techniques and interpretations have resulted primarily in two basically opposed hypotheses. These are: (a) The Aboriginal Australians are the descendants of a single basic stock which invaded the virgin continent. Local differences found to-day in the frequencies of some of their physical features are primarily the result of chance variations which became established in semi-isolated populations (cf. Abbie, 1951). (b) Successive waves of immigrants of different basic stock colonized the Australian continent. The frequency variations of certain features found between Aborigines inhabiting the different parts of the Australian continent are closely related to the varying proportions of the contributing stocks in these populations (cf. Birdsell, 1949 and 1950).

The current study deals with the variations in certain metrical features of Aboriginal crania from various parts of coastal New South Wales. With this as a basis, it is hoped to record, analyse and compare cranial data from Aboriginal populations of various other localised areas of Australia in an attempt to test, and possibly help resolve, the differences between the two currently held divergent views.

## MATERIALS

The material studied includes the crania of 65 males and 44 females recovered from various parts of coastal New South Wales, Australia. This area includes a strip up to 40 miles wide along the entire length of the coast of that State. The specimens thus all come from a region east of the Great Dividing Range. Figs. 1 and 2 show the localities from which the specimens come and it can be seen that, with very few exceptions, the crania actually come from places on or very close to the shore line.

The specimens used are all considered to come from fully adult individuals. In all of the crania the basioccipital-basisphenoid suture is synostosed. In addition, both M<sub>3</sub> teeth are fully erupted in both jaws or, where one or more is absent in either jaw or on either side, the attrition of the other teeth and the amount of suture closure generally indicated the congenital absence (or very considerably delayed eruption) of these teeth.

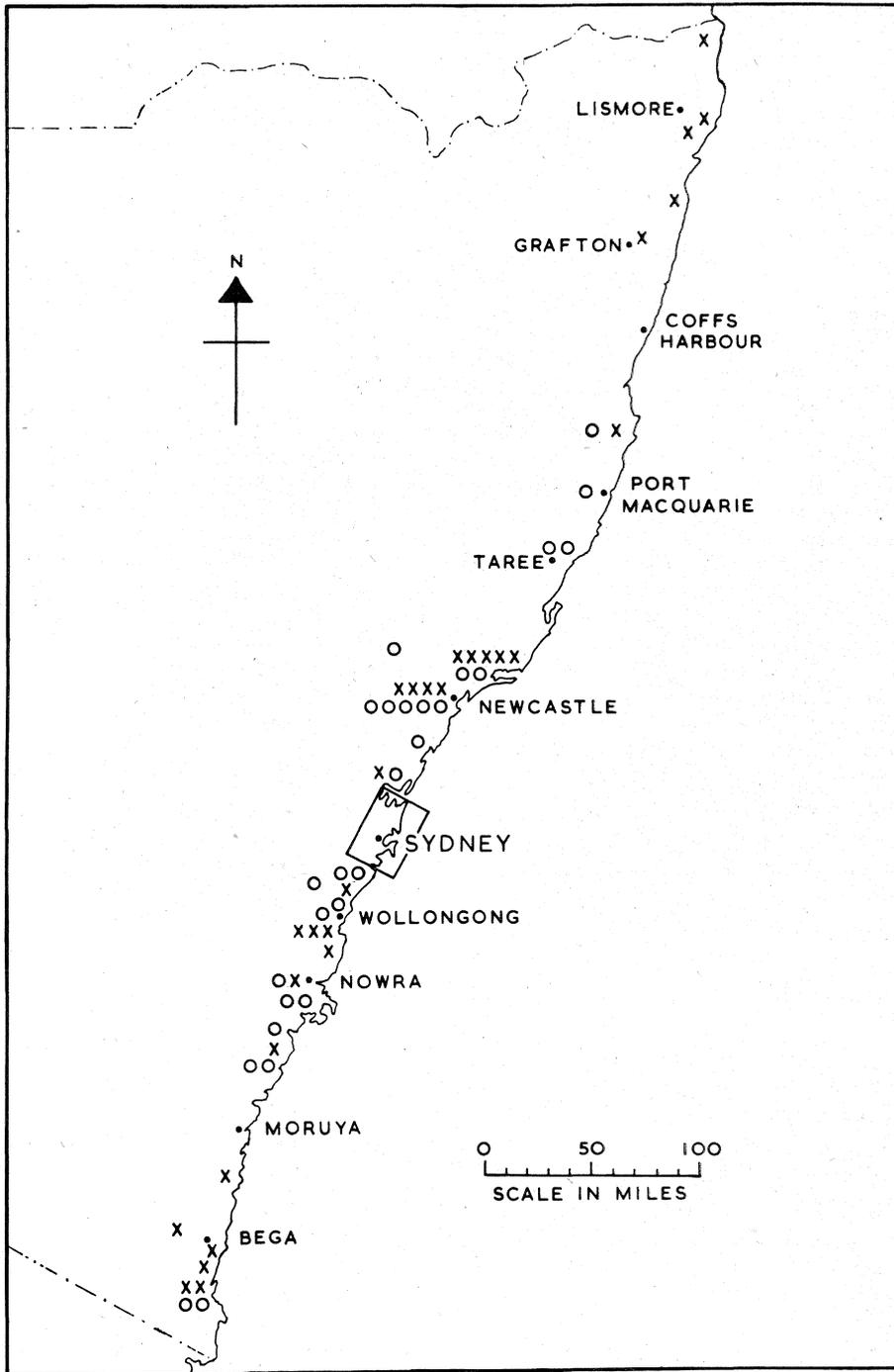


Figure 1.—Map of coastal New South Wales, Australia, showing the localities of the specimens used in the northern and southern groups. X = males; O = females.

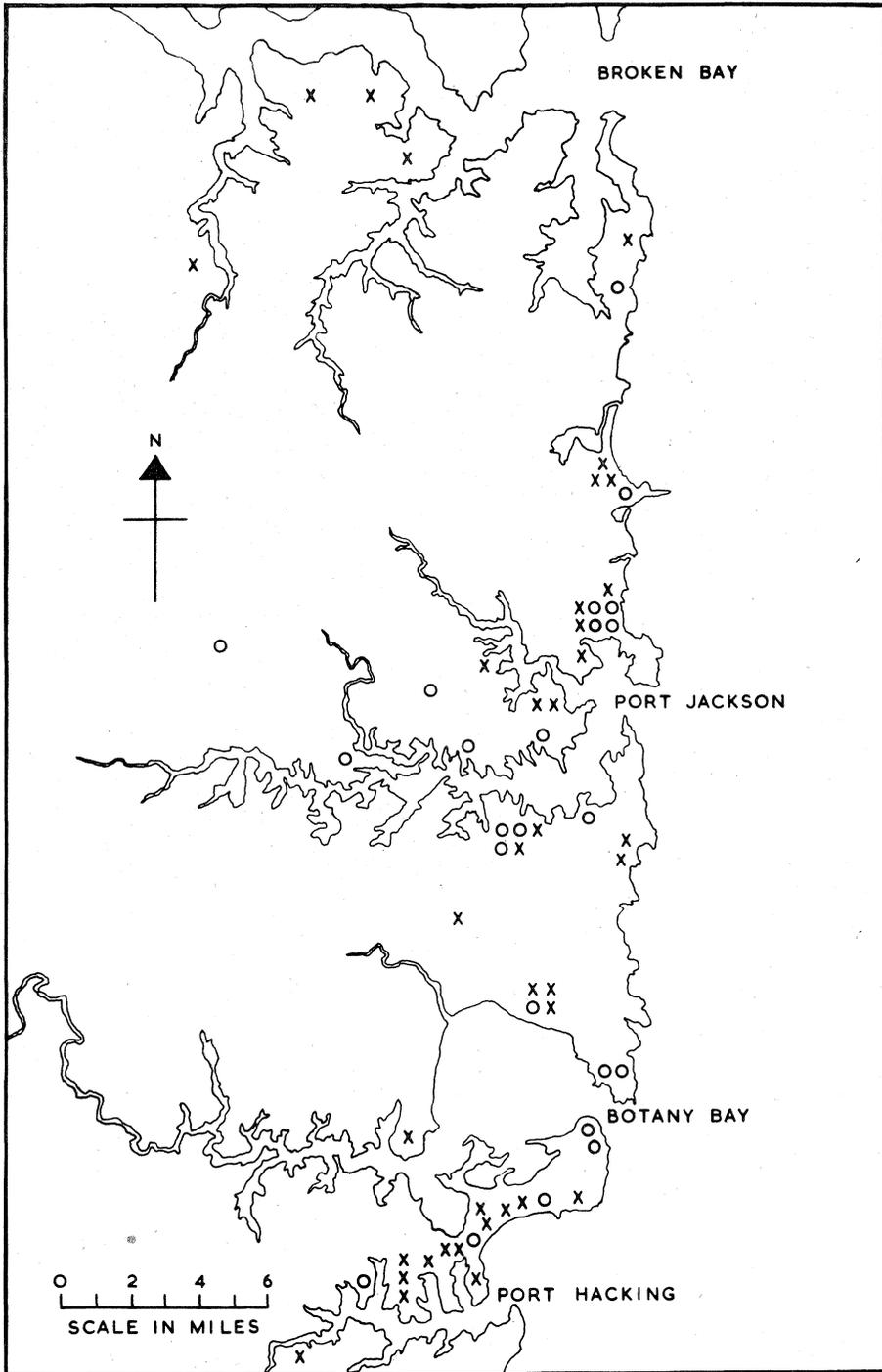


Figure 2.—Map of Sydney area (central group) showing the localities of the specimens used.  
X = male; O = female.

Sexing was done by assessing a combination of metrical and non-metrical features. Details of the technique and results have been described elsewhere (Larnach and Freedman, 1964). Despite the fact that the sexes of very few of the crania are definitely known from records and few post-cranial bones are available for checking the sexes of the remaining specimens, it is felt that a very high degree of accuracy of sexing (at least 90-95 per cent.) was obtained.

The crania used all appear to be from full-blooded Australian Aborigines, but the possibility of some being slightly hybridised can not be ruled out as, with very few exceptions, the specimens were recovered or excavated from unmarked graves or burials.

The specimens assembled for this study come from the collections of the Australian Museum, Sydney, and the Macleay Museum and Department of Anatomy, University of Sydney. Thanks are due to the above Institutions for the loan of material and also to the Division of Forensic Medicine, Department of Public Health, N.S.W., for the donation of a considerable number of specimens to the Department of Anatomy collection.

### METHODS

A relatively small number of measurements (16) have been taken on each of the series of coastal N.S.W. crania. From these dimensions nine indices have been calculated for each of the crania. (The metrical features of the palate, mandible and teeth will be dealt with in a separate paper, together with the non-metrical features of those parts). The craniometric points, measurements and indices are basically those described by Martin and Saller (1957), but with a number of modifications, mainly derived from Stewart (1952), Buxton and Morant (1933) and Morant (e.g. 1927). These modifications were necessary partly because of certain distinctive features of the Aboriginal skull, but also to make the measurements comparable to those of Hrdlicka (1928). The definitions of the measurements and indices are given in Appendix 1.

In all of the statistical tables, males and females have been treated separately and in the first analysis (Tables 1-4), the material of each sex has been further subdivided into a northern, central and southern group. Figs. 1 and 2 show the boundaries of these groups and the actual localities of the specimens used. The central group (Broken Bay to Port Hacking) covers a relatively short length of coast, approximately 40 miles, compared to 400 miles for the northern group and 250 miles for the southern group. This arrangement was unfortunately necessary in order to build up the numbers in the northern and southern groups. Comparisons between the material in these three groups for each sex have been made (Figs. 3, 4 and 5) and the findings are discussed. Finally, the basic statistics of the measurements (Table 5) and the indices (Table 6) for all of the males and all of the females separately, from the whole of coastal N.S.W., were calculated. These latter figures include the northern, central and southern groups, plus another 13 crania received after the initial analysis had been completed.

In each group in the various tables, the mean ( $\bar{x}$ ), number of specimens (N), standard deviation (s), standard error of the mean ( $s_{\bar{x}}$ ), coefficient of variation ( $V$ ) and observed range (O.R.) are given for each measurement or index.

### ANALYSIS OF DATA

The basic statistics of the various measurements are given separately for the northern, central and southern groups in Table 1 (males) and Table 2 (females). The amount of variation of each character in a sex of each of the three groups is not

TABLE 1. Male coastal N.S.W. Aboriginal crania: Basic statistics of the measurements (in mm.) for northern, central and southern groups.

Group and Statistic	Max. cran. length	Max. cran. br.	Basi-breg. ht.	Basion -alv. pt.	Basion to nasion	Bizygo -maxil.	Bi-zygion	Supra-orbital br.	Min. frontal br.	Nasion -alv. pt.	Nasion to nariale	Nasal br.	Orb. br.	Orb. ht.	Maxil. alv. length	Maxil. alv. br.
NORTH	N	15	14	13	10	14	11	14	14	11	12	12	14	13	11	15
	$\bar{x}$	186.67	131.36	133.31	104.00	101.29	92.18	132.43	110.36	97.57	68.82	48.83	38.98	34.21	59.64	67.87
	s	5.79	6.05	4.77	3.80	3.45	6.88	6.24	3.34	3.32	4.42	3.30	2.91	1.41	2.16	2.46
	$s_{\bar{x}}$	1.49	1.62	1.32	1.20	0.92	2.07	2.36	0.89	0.89	1.33	0.95	0.84	0.37	0.60	0.74
	V	3.10	4.60	3.58	3.65	3.41	7.47	4.71	3.03	3.40	6.43	6.75	10.21	3.60	6.31	4.13
O.R.		196	142	141	111	107	103	138	116	103	76	53	34.7	41.0	37.9	63
		175	123	128	98	94	83	122	105	91	59	42	23.3	36.7	30.9	56
CENTRAL	N	30	27	27	23	27	21	10	28	29	23	24	25	25	25	30
	$\bar{x}$	185.70	133.55	134.19	103.13	100.55	92.62	134.20	110.14	96.52	69.48	50.29	39.20	33.60	61.12	68.17
	s	6.94	3.52	4.36	5.05	4.31	3.87	3.19	3.47	4.53	3.19	2.42	1.73	1.39	3.21	2.57
	$s_{\bar{x}}$	1.27	0.70	0.84	1.05	0.83	0.84	1.01	0.66	0.84	0.67	0.49	0.33	0.28	0.37	0.47
	V	3.74	2.71	3.25	4.89	4.29	4.17	2.38	3.15	4.70	4.59	4.82	6.39	3.54	5.24	3.78
O.R.		200	140	143	112	110	104	140	120	105	74	55	31.5	41.6	37.4	66
		171	127	126	94	94	85	129	105	86	65	45	23.4	36.6	30.4	56
SOUTH	N	11	10	9	6	9	8	7	11	11	7	10	9	9	6	9
	$\bar{x}$	189.18	133.40	135.78	102.83	102.33	98.13	137.29	110.91	97.00	70.29	49.20	39.69	34.13	59.50	69.67
	s	5.96	3.81	4.24	4.92	4.69	6.06	7.97	6.50	5.88	4.07	3.73	2.59	1.54	3.02	3.28
	$s_{\bar{x}}$	1.80	1.20	1.41	2.01	1.56	2.14	3.01	1.96	1.77	1.54	1.18	0.61	0.86	0.51	1.23
	V	3.15	2.85	3.12	4.78	4.58	6.17	5.81	5.86	6.06	5.79	7.59	7.10	6.52	4.50	5.07
O.R.		198	139	141	110	112	107	151	126	109	75	54	30.3	44.7	36.1	64
		179	127	128	96	97	87	126	106	91	65	42	24.4	36.7	31.7	56

TABLE 2. Female coastal N.S.W. Aboriginal crania: Basic statistics of the measurements (in mm.) for northern, central and southern groups.

Group and Statistic	Max. cran. length	Max. cran. br.	Basi-breg. ht.	Basion -alv. pt.	Basion to nasion	Bizygo -maxil.	Bi-zygion	Supra-orbital br.	Min. frontal br.	Nasion -alv. pt.	Nasion to nariale	Nasal br.	Orb. br.	Orb. ht.	Maxil. alv. length	Maxil. alv. br.
NORTH																
N	9	8	8	7	8	7	8	9	9	7	8	8	8	8	9	10
$\bar{x}$	177.22	129.37	131.00	99.71	96.50	85.71	125.63	103.89	93.67	62.14	44.75	25.24	37.11	32.35	56.22	63.20
s	6.12	3.66	4.63	3.25	4.14	3.59	4.31	2.67	3.28	3.62	2.37	1.10	1.59	2.86	3.03	3.58
$s_x$	2.04	1.29	1.64	1.23	1.46	1.36	1.52	0.89	1.09	1.37	0.84	0.39	0.56	1.01	1.01	1.13
V	3.45	2.83	3.53	3.26	4.29	4.19	3.43	2.57	3.50	5.83	5.31	4.37	4.28	8.83	5.39	5.67
O.R.	185 169	133 123	136 124	106 97	101 90	90 82	131 118	107 100	98 88	69 58	49 42	26.3 23.0	38.9 35.2	36.9 29.1	62 52	71 58
CENTRAL																
N	18	17	15	14	15	16	8	16	16	15	18	18	18	18	15	17
$\bar{x}$	178.61	129.29	129.73	101.14	96.87	87.44	124.50	103.06	92.13	65.53	46.94	25.89	37.92	33.18	60.00	62.82
s	6.55	4.10	5.02	5.27	3.68	5.25	4.31	2.46	3.16	3.81	2.36	1.60	1.55	1.49	2.62	2.72
$s_x$	1.55	0.99	1.30	1.41	0.95	1.31	1.52	0.61	0.79	0.99	0.56	0.38	0.37	0.35	0.68	0.66
V	3.67	3.17	3.87	5.21	3.80	6.01	3.46	2.39	3.43	5.82	5.03	6.17	4.09	4.49	4.36	4.33
O.R.	188 166	136 122	140 122	111 94	104 91	98 80	130 116	108 98	96 87	71 58	50 42	28.5 23.3	39.9 35.3	36.0 29.4	64 56	67 58
SOUTH																
N	10	10	9	8	9	9	4	10	10	9	10	10	8	8	8	9
$\bar{x}$	180.20	130.60	130.55	97.00	96.00	92.44	126.00	104.50	93.00	64.22	47.80	25.29	37.50	33.70	57.13	63.22
s	6.61	5.32	3.61	3.16	4.21	3.78	3.74	4.79	3.86	2.63	2.70	0.88	1.48	1.77	1.73	2.63
$s_x$	2.09	1.68	1.20	1.12	1.40	1.26	1.87	1.51	1.22	0.88	0.85	0.28	0.52	0.63	0.61	0.88
V	3.67	4.07	2.76	3.26	4.39	4.09	2.97	4.58	4.15	4.10	5.65	3.48	3.94	5.26	3.02	4.17
O.R.	191 170	140 121	134 122	101 92	102 89	98 87	131 122	109 96	99 86	67 60	54 45	26.9 23.8	40.1 35.8	39.5 31.6	60 54	67 58

unduly great. There are only two rather high values for the coefficient of variation, nasal breadth in the northern males and orbital height in the northern females, and even these are not excessively high. Inspection of the mean values in Tables 1 and 2 shows few differences of considerable size between the characters in males or females of adjacent areas. The only measurements showing fairly large differences are: bizygomaxillare between central and southern males and the females from the same two groups: basion-alveolar point between central and southern females; maximum cranial length between central and southern males; maxillo-alveolar length between northern and central, and central and southern females; nasion-alveolar point between northern and central females. None of the above differences seem of particular importance taken on their own and no group in the males or in the females is larger in all its dimensions than any other group of the same sex. Further, it is not immediately obvious on comparison of the mean figures if the crania of one group are larger than those of any other group of the same sex in the majority of their mean dimensions or in average overall size.

To assess the size relationships between the crania of the three groups in each sex, the following techniques were used:—

(a) For each character, values of 3, 2 and 1 were assigned to the groups having the largest, middle and smallest mean dimensions respectively. These values were then totalled separately for males and females of each group, and the three sets of figures for each sex were subtracted in pairs. The resulting inter-relationships are shown in Fig. 3, in which the directions of the arrows indicate smaller to larger values and the included figures are the actual differences found.

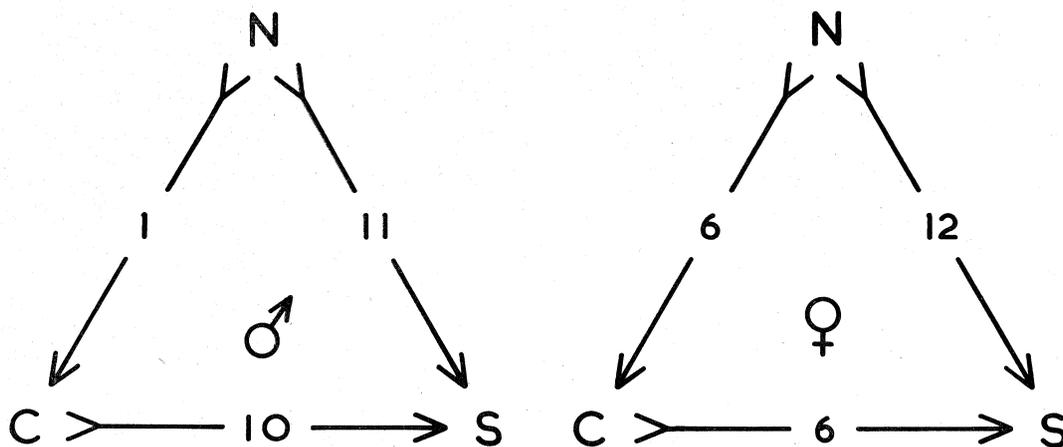


Figure 3— Inter-relationships between northern, central and southern groups of males and females, using 3, 2, 1 weighting for largest, middle and smallest mean values.

(b) Using a modification of Czekanowski's method (1909), the mean values of a character for each of the three groups of a sex were subtracted in pairs, the subtraction always being made in the same direction, e.g., southern minus central. Positive and negative figures thus resulted. The differences for all the characters of each pair in each sex were then totalled separately. These results are shown in Fig. 4, where the arrows again indicate smaller to larger values and the included figures are the differences.

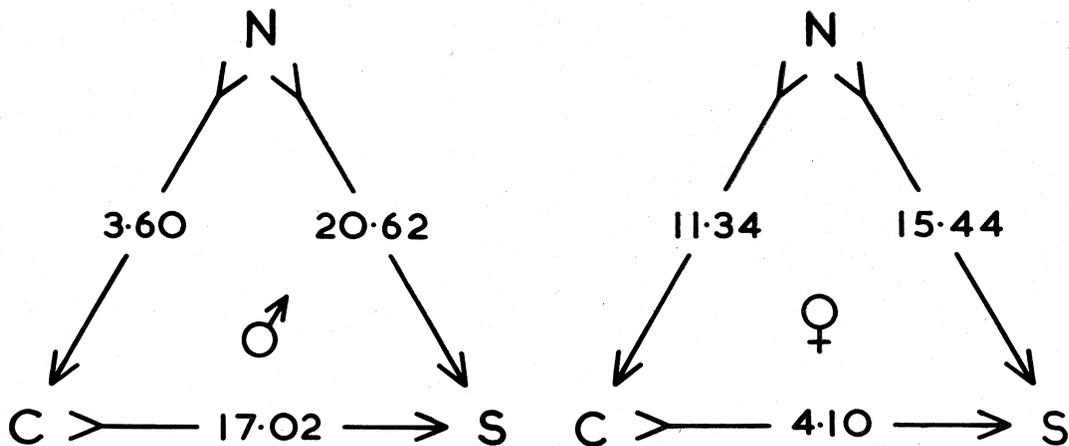


Figure 4— Inter-relationships between northern, central and southern groups of males and females using modified Czekanowski method.

(c) Employing a variation of Clarke's extension of the coefficient of divergence (Clarke, 1952), the difference for each character between each pair obtained in (b) above by subtracting the two relevant means was multiplied by two and then divided by the sum of the same two means, i.e.,  $2(\bar{x}_1 - \bar{x}_2)/(\bar{x}_1 + \bar{x}_2)$ . The resulting figures for each pair of groups in each sex were totalled, taking cognizance of the signs. Using the same system described above (b), these figures were diagrammed in Fig. 5.

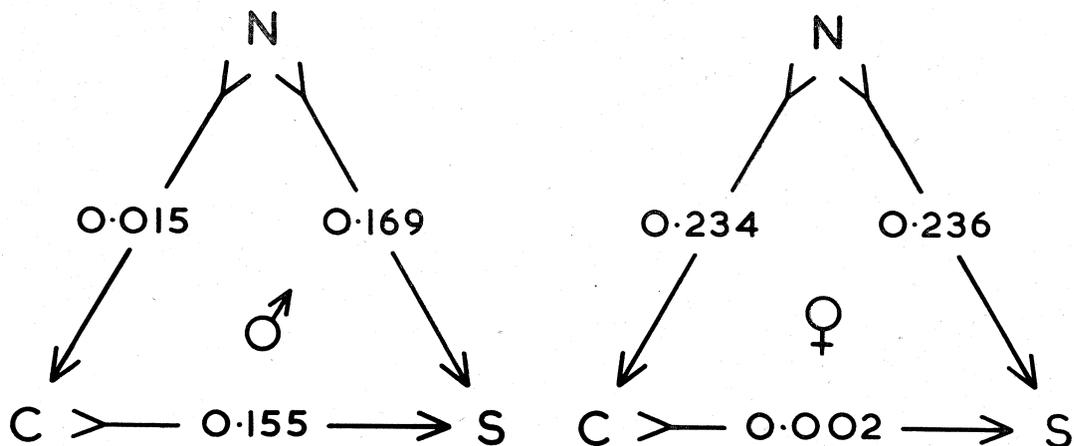


Figure 5— Inter-relationships between northern, central and southern groups of males and females, using modified extension of coefficient of divergence.

Each of the six results indicates a similar basic set of inter-relationships between the three groups: Thus, on number of larger characters and overall mean size, in both males and females, northern < central < southern. In the male comparisons, the central-northern group difference is far smaller than the southern-central group difference by all three methods—although the relative difference by method (b) is only about half of that found by methods (a) and (c). In the females the three methods give different relative results for the central-northern to southern-central group relationships. This appears to be mainly due to the very low figure for the basion-alveolar point dimension in the southern group and the rather high figure for the maxillo-alveolar length measurement in the central group. However, assessing the female results as they stand, by methods (b) and (c) the central-northern group difference is greater than the southern-central figure. This is the exact opposite to the result found for the males. Even assuming method (a) to give a better set of inter-relationships between the three groups in the females, there is still only equality between the central-northern and southern-central figures for this sex.

In addition to the above methods of analysis, the conventional form of Czekanowski's method (1909) was used to compare the crania of the three groups. By this method the "direction" of the differences between the pairs of groups for each character is ignored (smaller is always subtracted from larger) and the figure obtained by summing these differences is thus a measure of the *total* amount of difference between the two groups. This total difference figure is divided by the number of characters used to give the "durchschnittliche differenz", or DD as it is generally known. The results obtained for the three groups of N.S.W. crania were:—

Male:	northern-southern,	1.68;
	northern-central,	0.95;
	central-southern,	1.46.
Female:	northern-southern,	1.51;
	northern-central,	1.36;
	central-southern,	1.53.

From these results it can be seen that the northern-central figure is smaller than the central-southern figure for both males and females. This may at least in part be due to the distribution of the material (Fig. 1), as the majority of the northern specimens lie near to the central group, while those of the southern group are spread more evenly down the coast. The other point of interest is the fact that while the northern-central figure is smaller than the northern-southern in both sexes, northern-southern is greater than the central-southern in the males, but the reverse is true in the females.

In an attempt to analyze the data further, the six most northern male crania and the six most southern male crania were compared with each other and also with the rest of the male crania treated as a single central group. This approach gave a completely inconclusive result and in fact even failed to confirm the northern < central < southern finding described above. However, in view of there being only six specimens in each of the new northern and southern groups (and thus for most measurements five and in some cases only four specimens), this was perhaps not too unexpected.

Table 3 (males) and Table 4 (females) include the basic statistics of the indices calculated for the three groups separately. The mean indices are very similar for the three groups in both males and females. The greatest amounts of variation between the mean indices are found in the nasal and maxillo-alveolar indices in both males and females. Relationships between the indices of the three groups differ in the two sexes and are not clear even within each sex. No useful generalizations from the indices thus appear possible at this stage.

TABLE 3. Male coastal N.S.W. Aboriginal crania: Basic statistics of the indices for northern, central and southern groups.

Group and Statistic	Cranial	Length/height	Breadth/height	Cranial module	Upper facial	Orbital	Nasal	Maxillo/alveolar	Gnathic
<b>NORTH</b>									
N	14	13	12	12	5	13	12	11	10
$\bar{x}$	70.48	71.78	102.01	149.88	51.10	87.36	58.41	113.89	103.23
s	3.16	2.25	4.45	4.20	2.29	3.51	5.48	4.50	3.23
$s_{\bar{x}}$	0.85	0.62	1.28	1.21	10.3	0.97	1.58	1.36	1.02
V	4.48	3.13	4.36	2.80	4.49	4.02	9.38	3.95	3.13
O.R.	77.7 66.7	75.7 68.9	106.8 94.2	157.0 144.0	53.3 48.4	93.3 82.0	72.3 52.9	122.0 107.0	108.2 99.1
<b>CENTRAL</b>									
N	27	27	24	24	9	25	24	25	23
$\bar{x}$	71.77	72.44	101.07	151.21	52.19	85.76	54.06	111.79	102.75
s	2.60	2.55	3.15	4.09	2.61	4.68	4.86	5.66	3.78
$s_{\bar{x}}$	0.50	0.49	0.64	0.83	0.87	0.94	0.99	1.13	0.79
V	3.62	3.52	3.11	2.70	5.00	5.46	8.99	5.06	3.67
O.R.	77.0 66.7	79.5 69.4	107.1 95.0	159.6 143.6	55.9 48.6	94.2 76.2	70.0 45.0	121.0 100.0	112.0 97.9
<b>SOUTH</b>									
N	10	9	8	8	4	9	10	6	6
$\bar{x}$	70.30	72.12	101.34	153.04	49.87	86.15	55.65	117.43	101.50
s	3.00	2.02	3.75	3.69	1.76	3.93	4.57	9.82	4.52
$s_{\bar{x}}$	0.95	0.67	1.33	1.31	0.88	1.31	1.45	4.01	1.85
V	4.27	2.80	3.70	2.41	3.52	4.56	8.21	8.36	4.45
O.R.	74.3 64.8	74.9 69.1	109.4 97.7	158.0 146.0	52.5 48.9	89.9 77.6	63.3 49.8	130.3 109.4	106.1 9.60

TABLE 4. Female coastal N.S.W. Aboriginal crania: Basic statistics of the indices for northern, central and southern groups.

Group and Statistic	Cranial	Length/height	Breadth/height	Cranial module	Upper facial	Orbital	Nasal	Maxillo/alveolar	Gnathic
<b>NORTH</b>									
N	8	8	8	8	7	8	8	9	7
$\bar{x}$	72.69	73.59	101.27	146.15	49.61	87.05	56.50	112.19	102.96
s	3.17	2.89	2.71	3.59	2.87	4.51	3.11	6.40	5.19
$s_{\bar{x}}$	1.12	1.02	0.96	1.27	1.08	1.59	1.10	2.13	1.96
V	4.36	3.92	2.67	2.46	5.78	5.18	5.50	5.70	5.04
O.R.	78.7	80.5	104.8	151.3	54.8	94.9	60.7	120.0	106.5
	68.7	71.6	96.1	141.3	47.3	81.9	52.3	101.7	97.0
<b>CENTRAL</b>									
N	17	15	14	14	7	18	18	14	14
$\bar{x}$	72.54	73.03	99.99	145.23	50.57	87.59	55.26	105.89	104.69
s	3.56	3.55	5.81	2.86	1.76	4.99	3.99	4.99	4.45
$s_{\bar{x}}$	0.86	0.92	1.55	0.77	0.67	1.17	0.94	1.33	1.19
V	4.90	4.87	5.81	1.97	3.48	5.69	7.22	4.71	4.25
O.R.	79.9	81.9	109.0	150.6	52.0	99.7	62.0	115.5	113.7
	66.3	66.5	89.7	141.3	46.8	79.7	46.6	96.9	97.9
<b>SOUTH</b>									
N	10	9	9	9	4	8	10	8	8
$\bar{x}$	72.52	72.89	100.23	146.70	51.20	89.87	53.00	110.75	100.59
s	3.10	2.69	4.93	3.80	2.31	3.01	2.52	4.80	2.78
$s_{\bar{x}}$	0.98	0.90	1.64	1.27	1.15	1.06	0.80	1.70	0.98
V	4.27	3.69	4.91	2.59	4.50	3.34	4.75	4.34	2.76
O.R.	76.5	76.5	110.7	152.3	53.2	94.8	57.1	117.5	104.2
	67.0	68.9	94.6	142.3	48.0	84.3	49.8	101.7	96.0

TABLE 5. Male and female coastal N.S.W. Aboriginal crania: Basic statistics of the measurements (in mm.) for whole region.

Group and Statistic	Max. cran. length	Max. cran. br.	Basi-breg. ht.	Basion -alv. pt.	Basion to nasion	Bizygo -maxil.	Bi-zygion	Supra-orbital br.	Min. frontal br.	Nasion -alv. pt.	Nasion to nariale	Nasal br.	Orb. br.	Orb. ht.	Maxil. alv. length	Maxil. alv. br.
<b>MALE</b>																
N	64	59	56	46	57	47	30	61	62	49	54	57	56	55	50	62
$\bar{x}$	186.77	133.20	134.46	103.37	101.30	93.19	134.80	110.41	97.06	69.14	49.67	27.43	39.33	33.81	60.38	68.19
s	6.44	4.52	4.70	4.37	4.09	5.34	5.62	4.12	4.38	3.67	3.11	2.05	1.61	1.99	2.93	2.79
s <sub>-</sub>	0.81	0.59	0.63	0.65	0.54	0.78	1.03	0.53	0.56	0.53	0.42	0.27	0.21	0.27	0.41	0.35
$\bar{x}$																
V	3.45	3.39	3.50	4.23	4.04	5.73	4.17	3.74	4.51	5.31	6.26	7.48	4.09	5.90	4.86	4.09
O.R.	200 171	142 123	144 126	112 94	112 94	107 83	151 122	126 104	109 86	76 59	56 42	34.7 23.3	44.7 36.6	37.9 28.7	66 55	75 61
<b>FEMALE</b>																
N	43	41	38	34	38	38	25	41	41	36	42	42	40	40	37	42
$\bar{x}$	178.91	129.54	130.11	99.56	96.39	88.66	125.56	103.54	92.80	64.33	46.64	25.74	37.45	33.00	58.13	63.12
s	6.21	4.18	4.42	4.52	3.87	5.08	3.93	3.15	3.40	3.63	2.54	1.38	1.59	1.88	3.14	2.77
s <sub>-</sub>	0.95	0.65	0.72	0.77	0.63	0.82	0.79	0.49	0.53	0.60	0.39	0.21	0.25	0.30	0.52	0.43
$\bar{x}$																
V	3.47	3.23	3.39	4.54	4.01	5.73	3.13	3.05	3.66	5.63	5.44	5.35	4.25	5.69	5.40	4.39
O.R.	191 166	140 121	140 122	111 92	104 88	98 80	132 116	109 96	99 86	71 58	54 42	28.7 23.0	40.1 34.7	36.9 29.1	64 52	71 58

TABLE 6. Male and female coastal N.S.W. Aboriginal crania: Basic statistics of the indices for whole region.

Group and Statistic	Cranial	Length/height	Breadth/height	Cranial module	Upper facial	Orbital	Nasal	Maxillo/alveolar	Gnathic
MALE									
N	59	56	51	51	24	55	54	50	46
$\bar{x}$	71.25	72.29	101.26	151.38	51.09	85.84	55.42	113.07	102.41
s	2.90	2.36	3.67	4.19	2.39	4.39	5.07	6.09	3.68
$\frac{s}{\bar{x}}$	0.38	0.31	0.51	0.59	0.49	0.59	0.69	0.86	0.54
V	4.07	3.26	3.63	2.77	4.67	5.12	9.15	5.39	3.60
O.R.	77.7	79.5	109.4	160.0	55.9	94.2	72.3	130.3	112.0
	64.8	68.9	93.4	143.6	46.0	75.9	44.6	100.0	96.0
FEMALE									
N	41	38	37	37	22	40	42	36	34
$\bar{x}$	72.40	72.90	100.39	145.91	50.61	88.17	55.31	109.22	103.28
s	3.14	2.91	4.52	3.33	2.65	4.36	3.57	6.01	4.46
$\frac{s}{\bar{x}}$	0.49	0.47	0.74	0.55	0.57	0.69	0.55	1.00	0.77
V	4.33	4.00	4.50	2.28	5.23	4.94	6.46	5.51	4.32
O.R.	79.9	81.9	110.7	152.3	56.9	99.7	62.9	120.0	113.7
	66.3	66.5	89.7	139.0	46.8	79.7	46.6	96.9	96.0

The measurements for all the male and all the female crania separately from the whole of coastal N.S.W. are statistically summarized in Table 5. Features which show the greatest differences between the means for the two sexes (as determined by male mean minus female mean divided by the male mean plus female mean) are: maxillo-alveolar breadth, nasion to alveolar point, bizygion, nasal breadth, supra-orbital breadth and nasion to nariale. The differences between the means of these six dimensions are, by the technique used, quite considerably more than those between any of the other features.

Table 6 lists separately the basic statistics of the indices for all of the male and female crania from the whole of coastal N.S.W. The mean indices are very similar in the two sexes except that the orbital index is greater in the females, reflecting the fact that the orbit is relatively high in that sex; the maxillo-alveolar index is greater in males, a result of the breadth dimension being considerably larger in the males; the cranial module is considerably larger in the males, as might have been expected. The gnathic index is only very slightly larger in the females.

### DISCUSSION

As mentioned in the introduction, numerous studies of the Australian Aborigine have been made over the past 100 years and these include several in which metrical data on the cranium were recorded or/and analyzed. Prominent amongst these are the studies by Morant (1927), Hrdlicka (1928) and Wagner (1937). In these studies, the analyses generally consisted of comparisons between material from different whole states of Australia and comparisons of material from the whole of Australia with that from other areas. The results and conclusions from these are not always fully in agreement [e.g., Morant (1927) and Wagner (1937), who both compared metrical data by using the coefficient of racial likeness], but certain important results, such as the difference between crania from the Northern Territory and the rest of Australia, have emerged.

In the present paper an attempt has been made to study and compare groups of Aboriginal crania from more localized regions of Australia, bounded by natural geographic features and subdivided to facilitate the study of trends and inter-relationships. The region studied is bounded to the west by the Great Dividing Range and to the east by the sea. The northern and southern limits are the boundaries of N.S.W., but it is hoped to extend the study in both directions in the future. The three groups artificially defined from north to south within this narrow, natural, geographic region enable the cranial size relationships within the southern one-third of the east coast plain of Australia to be studied. The methods used for making comparisons between the data are of simple type and one of them is based on Czekanowski (1909). Huizinga (1962) has shown that Czekanowski's simple method can give results similar to those obtained by the more sophisticated statistical techniques.

The analysis of N.S.W. coastal Aboriginal crania made in this paper has shown that there appears to be a decrease in overall size of the cranium from south to north in the region sampled for both males and females. This finding suggests that continued micro-studies of this sort may reveal other informative clines or pockets which will give further pointers of value in the study of the origin and composition of the Australian Aborigines. It would not seem advisable to attempt to correlate the present findings with the main theories about the origin of the Australian Aborigine until they have been tested against the findings based on the non-metrical features of the skull and the metrical and non-metrical features of the jaws and teeth. Similarly, it does not seem that any useful purpose would be served at present by making comparisons with previously described data from whole States of Australia where micro-differences of the sort described in this paper would probably be obscured.

### SUMMARY

1. Sixteen metrical features and nine indices of 65 male and 44 female Aboriginal crania from coastal N.S.W., Australia, have been studied in three sub-groups (northern, central and southern) and for the region as a whole.
2. An overall cranial size decrease from south to north was found.
3. The importance of analyzing and comparing physical anthropological data from small, geographically—or ecologically—meaningful areas of Australia is stressed.

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## APPENDIX I

(a) The following table summarizes the most important features of the measurements taken:—

<i>Measurement</i>	<i>Remarks</i>	<i>Instrument</i>
Maximum cranial length (L).	Maximum glabella-occipital length.	Spreading caliper
Maximum cranial breadth (B).	Maximum excluding temporal and supramastoid crests.	Spreading caliper.
Basi-bregmatic height (H').	“ Basion ” = <i>lowest</i> median point on external surface of anterior margin (ectobasion). Bregma: where sagittal and coronal sutures depressed, point used was on frontal, just anterior to bregma.	Spreading caliper.
Basion-alveolar point (GL).	“ Basion ” = median point on the <i>internal</i> surface of the anterior margin (endobasion). “ Alveolar point ” = most <i>anterior</i> point between the median incisors (prosthion).	Spreading caliper
Basion-nasion (LB).	“ Basion ” = endobasion.	Spreading caliper.
Bizygomaxillare (GB)	Zygomaxillare = lowest point on suture between zygomatic and maxilla, externally.	Sliding caliper
Bizygion (J) (Bizygomatic).	Zygion = most lateral points on zygomatic arches	Spreading caliper
Supra-orbital breadth (SOB).	Maximum breadth of brow ridges on the frontal bone	Sliding caliper
Minimum frontal (B').	Minimum breadth between temporal crests	Spreading caliper
Nasion-alveolar point (G'H).	“ Nasion ” is often a depressed groove up to 1 mm. in breadth-midpoint used. “ Alveolar point ” = <i>lowest</i> point between median incisors.	Sliding caliper
Nasion-nariale (NH).	Nariale = point where a tangent to lowest points on crista spinalis (paraseptal ridge) meets midsagittal plane (= nasospinale). The actual point used was usually just lateral to the nasal spine.	Sliding caliper
Nasal breadth (NB).	Greatest breadth of pyriform aperture.	Sliding int. caliper
Orbital breadth (O <sup>1</sup> ).	Dacryon = point of meeting of frontal, maxillary and lacrimal bones. Lateral orbital margin very much rounded. Point used was the <i>beginning</i> of the rounding <i>internally</i> .	Sliding int. caliper
Orbital height (O <sup>2</sup> ).	Maximum at right angles to breadth.	Sliding int. caliper
Maxillo-alveolar breadth (MA <sup>1</sup> ).	Maximum external breadth of palate on maxilla, usually at M <sup>2</sup> .	Sliding caliper
Maxillo-alveolar length (MA <sup>2</sup> ).	Prosthion = most anterior point between median incisors. Tangent to posterior border of alveolar processes (maxillary tuberosities).	Sliding caliper

*Notes on Measurements*

(1) Where damage to an area to be measured was only slight, an estimate was made. An adjustment was also made at alveolar point (prsthion) when one I<sup>1</sup> was missing; when both I<sup>1</sup> teeth were missing no measurement was taken from this point.

(2) For the measurements of the orbits the left and right dimensions were averaged.

(3) Orbital breadth: This measurement was modified because of the greatly rounded orbital margin, and conforms with that taken by Hrdlicka (1928). The outer plane of the lumen of the orbit is aimed at by this author. Compared to the pencilled midline of the rounding, it was usually 1.5-2.5 mm. less. With this dimension, as in the case of most of the other modifications made above, the changes to the "standard" points and measurements were necessary because of the special anatomical features of the Aboriginal cranium.

(4) All measurements were taken to the nearest mm. except for nasal breadth, orbital breadth and orbital height, which were taken to the nearest 0.1 mm.

**(b) The following are the formulae of the various indices calculated:—**

Cranial:  $B/L \times 100.$

Length/Height:  $H'/L \times 100.$

Breadth/Height:  $H'/B \times 100.$

Cranial Module:  $L + B + H' \div 3.$

Upper facial:  $G'H/J \times 100.$

Orbital:  $o^2/o^1 \times 100.$

Nasal:  $NB/NH \times 100.$

Maxillo-alveolar:  $MA^1/MA^2 \times 100.$

Gnathic:  $GL/LB \times 100.$

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