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A Comparative Study of the Skulls of the Ontario Iroquoians and of Asiatic Populations

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It is widely accepted that the American Indians are generally Mongoloid in their physical characters, but their Mongoloid features are not so pronounced as those of their modern Asiatic relatives, because they were derived from the undifferentiated or incipient Mongoloid population of late Pleistocene age in northeastern Asia, such as represented by the Upper Cave skeletons from Choukoutien (e.g. BIRDSELL, 1951; GENOVÉS, 1967; HOWELLS, 1959; NEUMANN, 1952; STEWART, 1960; WEIDENREICH, 1938–39). The purpose of this study is to assess the degree of specialization of the American Indians as the Mongoloid by investigating their relative morphological distances to modern Asiatic Mongoloid and non-Mongoloid populations on the bases of cranial measurements and incidences of non-metric cranial variants. The actual data for analyses of the American Indians were obtained from a southern Ontario Iroquoian cranial series in the anthropological collection of the University of Toronto. They were compared with those of the Mongol, the Japanese, and the Ainu, published by DODO (1974), KOGANEI (1893), MITSUHASHI (1958), SHIMA (1941), and others. Similar comparative study of the Iroquoian postcranial skeletons will be published separately in the near future.

Materials

Of the large cranial collection in the Department of Anthropology, the University of Toronto, 92 well preserved adult crania (54 male, 38 female) from various ossuaries and other burial sites in southern Ontario were investigated. Most of the sites are located in the territories of the Iroquoians in its wider sense, such as the Hurons and the Neutrals. In addition, skeletal remains of more than 200 individuals, mostly disarticulated and fragmentary, excavated from an Iroquoian ossuary at Carton site, Halton County in southern Ontario in 1967, were also examined. Because of the secondary mass burial condition unfavorable for bone preservation, only fifty adult crania could be sexed with reasonable certainty. Fragmentary materials which remained unsexed were not measured but examined only for the non-metric variants.

Methods

Skulls in good condition of preservation were sexed by averaging the scores of

five discriminating characters: general size, frontal and parietal tubera, glabellar eminence, mastoid process, and features of facial skeleton.

Only those discriminated as male were measured, mostly in accordance with the definitions by MARTIN (MARTIN & SALLER, 1957). The items of measurement and calculated indices are shown in Table 1. Nasal height was measured from *nasion*, not to *nasospinale* as defined by MARTIN (No. 55, NH′), but to left *nariale* as recommended by Biometrika school (NH), since there were several cases where the *nasospinale* point was difficult to determine.

The following 23 non-metrical variants were recorded of the skulls of both sexes as well as of the unsexed cranial fragments.

1) Metopism.

2) Supra-orbital nerve groove (or frontal groove). (cf. DIXON, 1904; YAMAGUCHI, *et al.*, 1973).

3) Supra-orbital foramen. Any foramen on the superior margin of the orbit, including the supratrochlear foramen, was recorded under this head.

4) Occipito-interparietal fissure. Remains of the biasterionic (or transverse occipital) suture longer than 10 mm, including the complete transverse suture, were recorded.

5) Left side dominance of transverse sinus. Borderline cases were excluded.

6) Ossified apical ligament. Minute spinules were not counted.

7) The 3rd occipital condyle. Only those having articular facet were recorded.

8) Precondylar tubercle.

9) Divided hypoglossal canal.

10) Tympanic dehiscence. Only those over 0.5 mm in diameter were counted.

11) Auditory exostosis. Only those unequivocal and more than 1 mm high were recorded.

12) Parietal notch bone.

13) Ossicle at pterion.

14) Frontotemporal articulation. Both "I" and "K" types were recorded.

15) Pterygospinous foramen.

16) Pterygobasal foramen.

17) Palatine torus. Faint or incipient tori were not counted.

18) Medial palatine canal.

19) Lateral palatine canal.

20) Posterior remain of transverse zygomatic suture.

21) Mylohyoid canal. Lingular as well as bridge types were counted without distinction.

22) Multiple mental foramina. Accessory foramina, less than 0.5 mm in diameter or outside of the area between the two vertical lines drawn through C–P_1 boundary and middle of M_1, were neglected.

23) Rocker mandible.

Methods of comparative analyses will be described in the following chapters.

Comparative Analyses of the Cranial Measurements

Sizes of the sample (n), sample means (M), and unbiased estimates of standard deviation (s) of the measurements and indices of the Ontario Iroquoian male skulls are given in Table 1.

Table 1. Measurements of the Ontario Iroquoian male skulls.

Biometric symbol	Measurements and Indices (MARTIN's No.)	(n)	M	s
L	Maximum cranial length (1)	(59)	188.3	5.34
B	Maximum cranial breadth (8)	(58)	140.0	5.96
H′	Basibregmatic height (17)	(57)	137.8	3.80
B′	Minimum frontal breadth (9)	(59)	95.5	4.71
LB	Basinasal length (5)	(57)	106.1	3.85
S_1	Frontal arc (26)	(39)	128.2	5.49
S_2	Parietal arc (27)	(39)	125.2	6.60
(GL′)	Basiprosthion length (40)	(56)	102.5	4.95
J	Bizygomatic breadth (45)	(50)	140.3	5.11
GB	Bimaxillary breadth (46)	(47)	103.5	4.27
G′H	Upper facial height (48)	(53)	73.5	3.84
O_1	Orbital breadth, *mf* (51) left	(59)	43.8	1.47
O_1'	Orbital breadth, *d* (51a) left	(41)	41.2	1.64
O_2	Orbital height (52) left	(59)	34.7	1.98
NB	Nasal breadth (54)	(57)	27.2	2.11
NH	Nasal height	(57)	54.6	2.64
AH	Ramus height (70) left	(29)	60.1	4.95
AB	Ramus breadth (71) left	(39)	35.9	3.25
(L+B+H′)/3	Cranial modulus	(57)	155.5	3.59
(GL′+J+G′H)/3	Upper facial modulus	(44)	105.3	3.72
B: L	Length-breadth index (8: 1)	(58)	74.3	3.05
H′: L	Length-height index (17: 1)	(57)	73.3	2.56
H′: B	Breadth-height index (17: 8)	(56)	98.6	4.67
B′: B	Transverse frontoparietal index (9: 8)	(57)	67.9	3.05
S_2: S_1	Sagittal frontoparietal index (27: 26)	(41)	98.1	5.87
G′H: H′	Vertical craniofacial index (48: 17)	(52)	53.4	2.91
G′H: J	Upper facial index (48: 45)	(44)	52.7	2.70
GL′: LB	Gnathic index (40: 5)	(56)	96.8	3.71
O_2: O_1	Orbital index (52: 51)	(59)	79.2	4.80
NB: NH	Nasal index	(55)	49.9	3.85
AB: AH	Ramus index (71: 70)	(29)	59.9	6.77

The means and variances of the Iroquoian series are compared with those of the Hokkaido Ainu (KOGANEI, 1893, partly supplemented by the present author), Kanto Japanese (MITSUHASHI, 1958), and Shilingol Mongol (SHIMA, 1941) in Table 2. The means and variances of the three comparative series marked with asterisks are significantly different from those of the Iroquoians at the level of 5 percent. The number of significantly different means is the largest in the Mongol, the second in the Japanese, and the smallest in the Ainu.

Table 2. Metric comparison of the Iroquoian male skulls with those of three Asiatic populations.

Biometric symbol	Iroquoians			Ainu[1]			Japanese[3]			Mongol[4]		
	(n)	M	V	(n)	M	V	(n)	M	V	(n)	M	V
L	(59)	188.3	28.53	(87)	185.9*	35.21	(71)	181.7*	28.28	(105)	182.5*	33.73
B	(58)	140.0	35.50	(87)	141.3	15.94*	(71)	142.0	31.69	(102)	149.1*	27.62
H′	(57)	137.8	14.46	(66)[2]	138.1	23.69	(71)	139.1	21.28	(103)	132.3*	30.10*
B′	(59)	95.5	22.20	(87)	96.2	17.69	(71)	95.4	22.69	(107)	94.4	27.30
LB	(57)	106.1	14.83	(87)	105.4	18.19	(71)	103.1*	17.72	(104)	100.6*	17.06
S_1	(39)	128.2	30.10	(81)	128.3	28.76	(71)	127.7	30.02	(105)	128.7	36.95
S_2	(39)	125.2	43.53	(81)	124.5	35.36	(71)	126.9	56.75	(105)	122.3*	63.97
GL′	(56)	102.5	24.54	(71)	105.0*	23.17	(61)	100.4*	39.33	(72)	97.4*	19.90
J	(50)	140.3	26.09	(74)	137.3*	28.91	(71)	136.2*	26.07	(86)	142.1*	25.80
GB	(47)	103.5	18.26	(75)	102.1	32.93*	(71)	99.1*	25.87	(92)	104.5	26.40
G′H	(53)	73.5	14.71	(71)	69.7*	20.36	(58)	72.5	17.78	(75)	77.2*	15.10
O_1	(59)	43.8	2.152	(61)[2]	43.6	3.239	(71)	42.2*	3.662*	(98)	43.6	2.396
O_2	(59)	34.7	3.932	(61)[2]	34.3	3.618	(71)	34.5	4.180	(97)	35.8*	3.347
NB	(57)	27.2	4.453	(77)	25.7*	3.319	(71)	25.9*	3.700	(92)	27.4	4.501
AH	(29)	60.1	24.52	(46)[2]	58.8	25.38	(76)	64.5*	27.61	(12)	61.3	—
AB	(39)	35.9	10.57	(47)[2]	35.6	10.68	(76)	33.6*	12.56	(11)	35.7	—
B: L	(58)	74.3	9.309	(87)	76.0*	6.122	(71)	78.2*	13.22	(102)	81.8*	15.13*
H′: L	(57)	73.3	6.575	(66)[2]	74.1	6.043	(71)	76.8*	8.887	(103)	72.5	9.579
H′: B	(56)	98.6	21.79	(66)[2]	97.7	16.21	(71)	98.0	19.19	(100)	88.7*	27.00
B′: B	(57)	67.9	9.312	(87)	68.2	9.911	(71)	67.3	14.49	(102)	63.4*	11.06
S_2: S_1	(41)	98.1	34.46	(81)	97.5	27.80	(71)	99.7	50.13	(105)	95.2*	53.51
G′H: J	(44)	52.7	7.306	(66)	50.9*	12.02	(58)	53.2	9.716	(65)	54.6*	9.324
GL′: LB	(56)	96.8	13.76	(71)[2]	99.4*	12.70	(61)	97.3	20.22	(72)	97.0	17.05
O_2: O_1	(59)	79.2	23.04	(61)[2]	78.8	25.83	(71)	82.0*	18.75	(97)	82.2*	18.60
AB: AH	(29)	59.9	45.78	(46)[2]	60.4	24.14	(71)	52.0*	33.89	(11)	58.5	—

* significantly different from the Iroquoians at 0.05 level.

1) KOGANEI (1893). 2) supplemented by the present author. 3) MITSUHASHI (1958). 4) SHIMA (1941).

The cranial vault is the shortest in the Japanese and the Mongol, longer in the Ainu, and the longest in the Iroquoians. The cranial breadth is extremely large in the Mongol, and rather similarly small among the rest. Thus, the mean cranial index of the Mongol falls within brachycranial range, while that of the Iroquoians is dolichocranial, and those of the Japanese and the Ainu are mesocranial. With respect to the height of the vault, the Mongol is again extreme with their very low mean basibregmatic height. The rest resemble each other with rather high means. The Mongol is also distinguishable by their relatively narrow forehead, as demonstrated by significantly low mean of the transverse frontoparietal index. No differences are recognized among the rest. The Mongol is characterized also by very short basinasal diameter. The Iroquoians are lumped together with the Ainu in this respect with long cranial base. The Japanese is intermediate between the Iroquoian-Ainu cluster and the

Mongol. Very short parietal arc, both absolutely and relatively, again segregates the Mongol from the other three series. Thus, as far as the size and shape of the brain case is concerned, the Ainu and the Japanese, particularly the former, are much closer to the Iroquoians than the Mongol.

Turning to the facial skeleton, the situation is slightly different. The Mongol is characterized by the shortest, the broadest and the highest facial skeleton, whereas the Ainu has the longest and the lowest face and the Japanese the narrowest. In the three diameters of the facial skeleton, namely, longitudinal, horizontal and vertical, the Iroquoians occupy the intermediate position between the Ainu-Japanese cluster and the Mongol. However, the shape of the orbit lumps together the Japanese and the Mongol with high orbital indices on the one hand and the Ainu and Iroquoians with low indices on the other hand. Large nasal breadth brings the Iroquoians closer to the Mongol than to the Ainu and the Japanese with narrow nasal apertures. With respect to the mandibular ramus, the Japanese are separated with very low

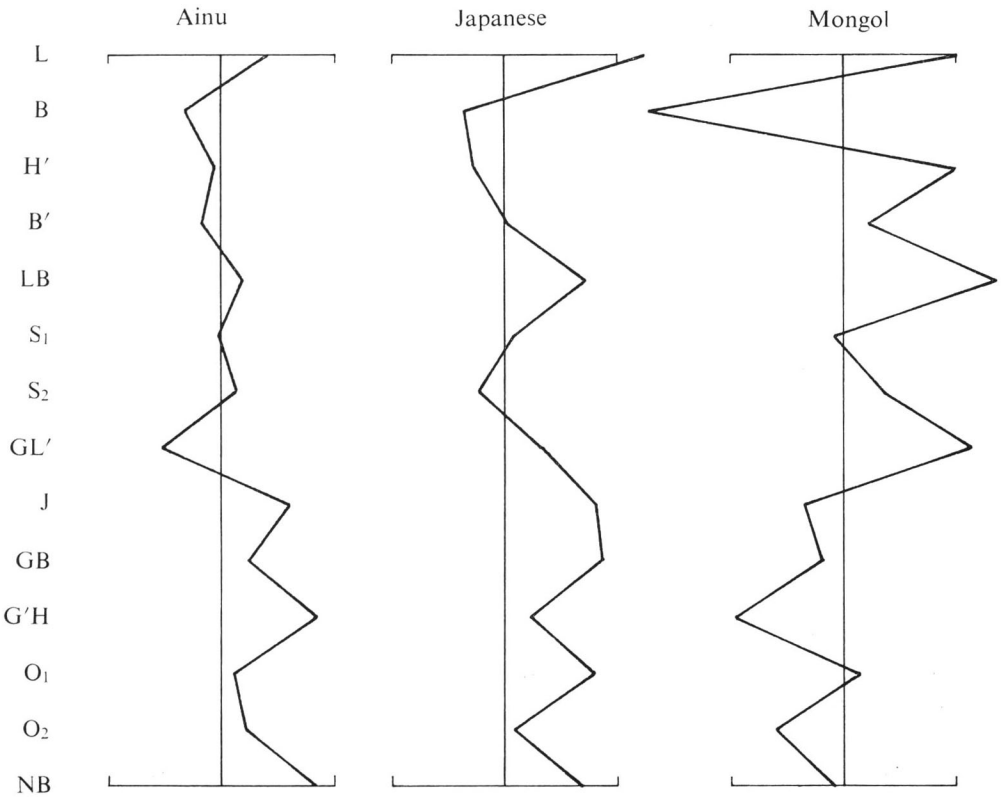

Fig. 1. Craniometric deviations of the Iroquoian male series from three Asiatic series. The vertical and horizontal lines represent the respective mean and ±1 S.D. range of the comparative series.

ramus index from the rest, which have similarly robust ramus with high index values.

Among the three Asiatic cranial series compared with the Iroquoians, the Ainu crania are the closest, as a whole, the Japanese the second, and the Mongol the remotest to the Iroquoians. In other word, the Iroquoians are metrically closer to non-Mongoloid population in Asia, as represented by the Ainu in Hokkaido, than to the Mongoloid populations such as the Japanese and the Mongol.

The general patterns of similarity and dissimilarity between the Iroquoian and the three Asiatic cranial series are illustrated by deviation polygons in Fig. 1. The PENROSE shape distances, calculated for 14 measurements by the formula (CONSTANDSE-WESTERMANN, 1972)

$$C_z^2=\frac{1}{r-1}\left\{\sum d_i^2-\frac{(\sum d_i)^2}{r}\right\}$$

where r is 14 and d_i is difference between two means standardized by S.D. of the Iroquoian series, confirm the above conclusion (Table 3).

Table 3. PENROSE's shape distances (C_z^2) based on 14 cranial measurements.

	Iroquoians	Ainu	Japanese	Mongol
Iroquoians	—	0.157	0.292	0.779
Ainu	0.157	—	0.272	1.140
Japanese	0.292	0.272	—	0.875
Mongol	0.779	1.140	0.875	—

Comparative Analyses of the Incidences of Non-Metric Cranial Variants

Incidences of 23 minor morphological variants in the Iroquoian cranial series are given in Table 4. Skull incidences and side incidences in male and female skulls and unsexed cranial fragments are shown separately as well as in total. The incidences in the material from Carton ossuary alone given in the fifth column are intended to provide basic data for analyses of Iroquoian inter-site skeletal variation in the future.

Of the 23 variants, 17 variants had been investigated with identical or very similar criteria on the cranial series of the Ainu, Japanese, and Mongol by various authors. The sizes of the samples and the proportions of the 17 variants in the Iroquoian and three comparative Asiatic series are shown in Table 5. For bilateral traits, only the incidences on the left side are given. Incidences of the male series alone are given for the occipito-interparietal fissure and the pterygospinous foramen, since the sex differences in the incidences of these two traits had been demonstrated to be significant by the chi-square analysis (DODO, 1974). For other traits, male and female incidences are pooled. In case of zero incidence, the proportion 0 is replaced by 1/4n and shown in parentheses. Those proportions marked with asterisks are significantly different from the Iroquoian at the level of 5 percent. The significance of differences was determined by the χ^2 or the FISHER exact probability test.

Table 4. Incidences of non-metrical variants in the Ontario Iroquoian skulls.

Variants	*	Male	Female	Unsexed	Total	Carton series
1) Metopism	S	0/76 (0.000)	1/66 (0.015)	2/86 (0.023)	3/228 (0.013)	3/136 (0.022)
2) Supra-orbital nerve groove	S	36/66 (0.545)	28/54 (0.519)	—	64/120 (0.533)	17/36 (0.472)
	R	32/71 (0.451)	25/57 (0.439)	23/49 (0.469)	80/177 (0.452)	40/90 (0.444)
	L	28/69 (0.406)	24/57 (0.421)	33/67 (0.493)	85/193 (0.440)	48/108 (0.444)
3) Supra-orbital foramen	S	49/72 (0.681)	42/58 (0.724)	—	91/130 (0.700)	27/38 (0.711)
	R	41/72 (0.569)	33/62 (0.532)	44/72 (0.611)	118/206 (0.573)	68/114 (0.596)
	L	37/73 (0.507)	33/61 (0.541)	45/80 (0.563)	115/214 (0.537)	67/122 (0.549)
4) Occipito-interparietal fissure	S	20/73 (0.274)	2/59 (0.034)	4/42 (0.095)	26/174 (0.149)	8/82 (0.098)
	R	20/73 (0.274)	1/59 (0.017)	7/73 (0.096)	28/205 (0.137)	11/113 (0.097)
	L	7/73 (0.096)	1/62 (0.016)	5/59 (0.085)	13/194 (0.067)	6/102 (0.059)
5) Left side dominance of transverse sinus	S	12/64 (0.188)	11/58 (0.190)	40/143 (0.280)	63/265 (0.238)	49/183 (0.268)
6) Ossified apical ligament	S	5/69 (0.072)	2/56 (0.036)	7/98 (0.071)	14/223 (0.063)	7/134 (0.052)
7) The 3rd occipital condyle	S	3/69 (0.043)	0/56 (0.000)	2/98 (0.020)	5/223 (0.022)	2/134 (0.015)
8) Precondylar tubercle	S	2/63 (0.032)	1/54 (0.019)	2/54 (0.037)	5/171 (0.029)	2/85 (0.024)
	R	2/64 (0.031)	1/55 (0.018)	2/76 (0.026)	5/195 (0.026)	2/108 (0.019)
	L	1/65 (0.015)	0/54 (0.000)	2/74 (0.027)	3/193 (0.016)	2/105 (0.019)
9) Divided hypoglossal canal	S	17/69 (0.246)	17/59 (0.288)	—	34/128 (0.266)	10/37 (0.270)
	R	6/70 (0.086)	13/60 (0.217)	19/140 (0.136)	38/270 (0.141)	24/179 (0.134)
	L	15/70 (0.214)	8/60 (0.133)	31/127 (0.244)	54/257 (0.210)	39/166 (0.235)
10) Tympanic dehiscence	S	28/69 (0.406)	27/55 (0.491)	—	55/124 (0.444)	16/34 (0.471)
	R	21/72 (0.292)	29/61 (0.475)	83/163 (0.509)	133/296 (0.449)	102/205 (0.498)
	L	24/70 (0.343)	25/56 (0.446)	85/157 (0.541)	134/283 (0.473)	99/192 (0.516)
11) Auditory exostosis	S	2/70 (0.029)	0/56 (0.000)	—	2/126 (0.016)	0/34 (0.000)
	R	2/73 (0.027)	0/61 (0.000)	2/159 (0.013)	4/293 (0.014)	2/201 (0.010)
	L	0/70 (0.000)	0/57 (0.000)	0/155 (0.000)	0/282 (0.000)	0/190 (0.000)
12) Parietal notch bone	S	18/63 (0.286)	14/55 (0.255)	—	32/118 (0.271)	9/29 (0.310)
	R	11/70 (0.157)	12/60 (0.200)	2/81 (0.025)	25/211 (0.118)	11/120 (0.092)
	L	11/65 (0.169)	7/56 (0.125)	1/82 (0.012)	19/203 (0.094)	7/113 (0.062)

Table 4. (Continued)

Variants	*	Male	Female	Unsexed	Total	Carton series
13) Ossicle at pterion	S	6/42 (0.143)	8/41 (0.195)	—	14/83 (0.169)	4/19 (0.211)
	R	0/50 (0.000)	5/51 (0.098)	0/2 (0.000)	5/103 (0.049)	4/34 (0.118)
	L	6/48 (0.125)	6/49 (0.122)	1/3 (0.333)	13/100 (0.130)	3/28 (0.107)
14) Frontotemporal articulation	S	0/42 (0.000)	1/41 (0.024)	—	1/83 (0.012)	0/19 (0.000)
	R	0/50 (0.000)	1/51 (0.020)	0/2 (0.000)	1/103 (0.010)	0/34 (0.000)
	L	0/48 (0.000)	0/49 (0.000)	0/3 (0.000)	0/100 (0.000)	0/28 (0.000)
15) Pterygospinous foramen	S	4/66 (0.061)	3/57 (0.053)	—	7/123 (0.057)	1/32 (0.031)
	R	2/71 (0.028)	2/59 (0.034)	0/35 (0.000)	4/165 (0.024)	0/74 (0.000)
	L	3/54 (0.056)	1/61 (0.016)	0/43 (0.000)	4/173 (0.023)	1/81 (0.012)
16) Pterygobasal foramen	S	2/66 (0.030)	3/57 (0.053)	—	5/123 (0.041)	2/32 (0.063)
	R	1/71 (0.014)	2/59 (0.034)	0/35 (0.000)	3/165 (0.018)	1/74 (0.014)
	L	2/69 (0.029)	1/61 (0.016)	0/43 (0.000)	3/173 (0.017)	1/81 (0.012)
17) Palatine torus	S	13/65 (0.200)	5/50 (0.100)	8/111 (0.072)	26/226 (0.115)	12/137 (0.088)
18) Medial palatine canal	S	1/57 (0.018)	2/46 (0.043)	—	3/103 (0.029)	1/22 (0.045)
	R	1/62 (0.016)	1/47 (0.021)	0/55 (0.000)	2/164 (0.012)	0/79 (0.000)
	L	1/58 (0.017)	1/48 (0.021)	1/63 (0.016)	3/169 (0.018)	2/87 (0.023)
19) Lateral palatine canal	S	0/62 (0.000)	0/49 (0.000)	—	0/111 (0.000)	0/24 (0.000)
	R	0/65 (0.000)	0/51 (0.000)	0/86 (0.000)	0/202 (0.000)	0/112 (0.000)
	L	0/64 (0.000)	0/50 (0.000)	0/73 (0.000)	0/187 (0.000)	0/98 (0.000)
20) Posterior remain of transverse zygomatic suture	S	5/37 (0.135)	9/29 (0.310)	—	14/66 (0.212)	3/11 (0.273)
	R	8/49 (0.163)	6/36 (0.167)	3/115 (0.026)	17/200 (0.085)	4/129 (0.031)
	L	5/47 (0.106)	7/35 (0.200)	0/110 (0.000)	12/192 (0.063)	3/126 (0.024)
21) Mylohyoid canal	R	5/13 (0.385)	3/12 (0.250)	30/142 (0.211)	38/167 (0.228)	30/142 (0.211)
	L	6/13 (0.462)	3/12 (0.250)	30/133 (0.226)	39/158 (0.247)	30/133 (0.226)
22) Multiple mental foramina	R	1/14 (0.071)	0/12 (0.000)	10/146 (0.068)	11/172 (0.064)	10/146 (0.068)
	L	1/14 (0.071)	2/12 (0.167)	12/149 (0.081)	15/175 (0.086)	12/149 (0.081)
23) Rocker mandible	S	1/13 (0.077)	3/12 (0.250)	12/117 (0.103)	16/142 (0.113)	12/117 (0.103)

* S: skull incidence, R: right side incidence, L: left side incidence.

Table 5. Comparison of the proportions of 17 non-metric variants in the cranial series of the Iroquoians and three Asiatic populations.

Variants	†	††	Iroquoians		Ainu[1]		Japanese[1]		Mongol[2]	
			n	*P*	n	*P*	n	*P*	n	*P*
1) Metopism	MF	S	228	*0.013*	184	*0.033*	180	*0.089**	204	*0.054**
3) Supra-orbital for.	MF	L	214	*0.537*	170	*0.135**	180	*0.372**	203	*>0.522*
4) Occipito-interpar. f.	M	L	73	*0.096*	104	*0.202*	128	*0.094*	132	*0.152*
5) Left dom.transv.sin.	MF	S	265	*0.238*	62[3]	*0.194*	120[8]	*0.117**	199	*0.201*
6) Ossif. apical lig.	MF	S	223	*0.063*	272[4,5]	*0.103*	420[9]	*0.010**	190	*0.032*
7) 3rd occ. cond. facet	MF	S	223	*0.022*	183	*0.071**	178	*(0.001)*	190	*(0.001)**
8) Precondylar tub.	MF	S	171	*0.029*	109[4]	*0.028*	100[4]	*0.070*	190	*0.095**
9) Div.hypogloss.can.	MF	L	257	*0.210*	178	*0.236*	180	*0.106**	190	*0.147*
10) Tympanic dehisc.	MF	L	283	*0.473*	177	*0.169**	179	*0.285**	194	*0.129**
12) Parietal notch b.	MF	L	203	*0.094*	175	*0.137*	172	*0.203**	200[11]	*0.145*
13) Ossicle at pterion	MF	L	100	*0.130*	130	*0.208*	154	*0.214*	196	*0.163*
14) Fr.-temp. articul.	MF	L	100	*(0.003)*	200[6]	*0.005*	399[10]	*0.020*	196	*0.026*
15) Pterygospinous for.	M	L	54	*0.056*	87	*0.092*	129	*0.023*	122	*0.033*
18) Med.palatine canal	MF	L	169	*0.018*	151	*0.172**	177	*0.040*	161	*0.019*
19) Lat. palatine canal	MF	L	187	*(0.001)*	127[7]	*0.063**	328[7]	*0.015*	161	*0.006*
20) Post.re.tr.zyg.sut.	MF	L	192	*0.063*	96	*0.271**	167	*0.090*	180[12]	*0.194**
22) Mult. mental for.	MF	L	175	*0.086*	52[3]	*0.077*	341[10]	*0.026**	25	*0.040*

† sex. †† S: skull incidence, L: left side incidence.

* significantly different from the Iroquoian proportion at 0.05 level.

1) DODO (1974), unless noted. 2) SHIMA (1941), unless noted. 3) Present author's data. 4) WATANABE (1936). 5) KOGANEI (1893). 6) ITO (1941). 7) ADACHI (1894). 8) NAKAHARA (1953). 9) HORI (1924). 10) AKABORI (1933). 11) ONISHI & SUZUKI (1941). 12) ONISHI (1940).

Unlike the metrical comparisons in Table 2, it is rather difficult to disclose the characteristics of the Iroquoians from this table. The Iroquoians are the closest to the Ainu in the incidences, for instance, of the metopism, the precondylar tubercle, the frontotemporal articulation, and other traits, whereas they are also closest to the Mongol in the incidences of the supra-orbital foramen, left side dominance of the transverse sinus, the ossicle at pterion, and so on. However, in the incidences of the hyperostotic variants (OSSENBERG, 1970), such as the ossified apical ligament, the third occipital condyle, the divided hypoglossal canal, and the pterygospinous foramen, which occur more frequently to the Ainu than to the Japanese and Mongol (DODO, 1974), the Iroquoians are intermediate between the Ainu and the Asiatic Mongoloid populations. It can also be generalized from this table that the sutural anomalies are generally rarer in the Iroquoians than in other series.

In order to visualize the relative distances among these four series, each proportion (p) in Table 5 was transformed, following C. A. B. SMITH's method (BERRY & BERRY, 1967; SJØVOLD, 1973), into radian (θ) by the formula $\theta = \arcsin(1-2p)$, and the mean measure of divergence was calculated as below between each pair of the series.

$$\bar{X}=\frac{1}{r}\sum\left[(\theta_1-\theta_2)^2-\left(\frac{1}{n_1}+\frac{1}{n_2}\right)\right]$$

Results are shown in a matrix form in Table 6. Differing from the distance pattern based on the cranial measurements, the Iroquoians are away from the Ainu and much closer to the cluster of Asiatic Mongoloid composed of the Japanese and the Mongol. The Ainu are now isolated from three others.

Table 6. SMITH's mean measures of divergence based on the incidences of 17 non-metric cranial variants.

	Iroquoians	Japanese	Mongol	Ainu
Iroquoians	—	0.0536	0.0559	0.1273
Japanese	0.0536	—	0.0200	0.0978
Mongol	0.0559	0.0200	—	0.0936
Ainu	0.1273	0.0978	0.0936	—

Discussion and Conclusion

The pattern of the relative distances among the four cranial series based on the measurements shown in Table 3 is different from that based on the non-metrical variants shown in Table 6. In the former, the Iroquoians are the closest to the Ainu and form a loose cluster with the Ainu and the Japanese, leaving the Mongol as an isolate. In the latter, however, the two Asiatic Mongoloid series form a tight cluster, leaving the Ainu as an remote isolate, and the Iroquoians are much closer to the Mongoloid cluster than to the Ainu. Metrically, the Iroquoians are rather un-Mongoloid, but, non-metrically, they are definitely Mongoloid.

To settle this inconsistency, a third distance analysis was introduced. Eight representative cranial measurements, i.e.

1) Maximum cranial length (L)
8) Maximum cranial breadth (B)
9) Minimum frontal breadth (B′)
17) Basibregmatic height (H′)
5) Basinasal length (LB)
45) Bizygomatic breadth (J)
48) Upper facial height (G′H)
40) Basiprosthion length (GL′)

of the four cranial series were transformed into uncorrelated variables by the following eight linear equations which had been constructed after the procedure of RAO (1952, p. 347–349) from the pooled variance-covariance matrix of the Iroquoian, Ainu, and Japanese series (see Appendix.).

$y_1=0.1807(\mathrm{L})$
$y_2=-0.0501(\mathrm{L})+0.2283(\mathrm{B})$

$y_3 = -0.0338(L) - 0.0760(B) + 0.2441(B')$
$y_4 = -0.0699(L) + 0.0051(B) + 0.0005(B') + 0.2246(H')$
$y_5 = -0.0631(L) + 0.0374(B) - 0.0524(B') - 0.1138(H') + 0.3084(LB)$
$y_6 = -0.0323(L) - 0.0928(B) - 0.0476(B') + 0.0273(H') - 0.1486(LB) + 0.2725(J)$
$y_7 = -0.0298(L) - 0.0420(B) - 0.0094(B') - 0.0066(H') - 0.0288(LB) - 0.0243(J) + 0.2533(G'H)$
$y_8 = -0.0337(L) + 0.0297(B) + 0.0255(B') + 0.0214(H') - 0.2094(LB) - 0.0288(J) - 0.0681(G'H) + 0.2988(GL')$

Then, SALOMÉ's shape components of D^2 (CONSTANDSE-WESTERMANN, 1972) were calculated from the four sets of transformed means by the formula

$$\sqrt{\sum d_{tr}^2 - \frac{(\sum d_{tr})^2}{r}}$$

where r is 8 and d_{tr} is the difference between two transformed means. The results shown in Table 7 are again different from the previous ones. The closest to the Iroquoians are now the Japanese, and the latter is immediately followed by the Ainu. From the standpoint of the Mongol, the closest is the Japanese, then the Iroquoians, and the Ainu is the remotest.

Table 7. Shape components of D^2 based on 8 cranial measurements.

	Iroquoians	Japanese	Ainu	Mongol
Iroquoians	—	3.56	3.72	9.18
Japanese	3.56	—	2.86	8.35
Ainu	3.72	2.86	—	13.96
Mongol	9.18	8.35	13.96	—

In all distance matrices, the Ainu is always the farthest from the Mongol, and the Iroquoians and the Japanese are inbetween. It seems thus fairly safe to conclude that the Iroquoians are neither so typically Mongoloid as the Mongol nor so un-Mongoloid as the Ainu, but they are just moderately Mongoloid as the recent Japanese are.

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Appendix. Pooled variance and covariance matrix based on 50 Ainu, 50 Japanese, and 44 Iroquoian male crania.

	L	B	B′	H′	LB	J	G′H	GL′
L	30.6312	6.7267	6.3327	9.3589	9.9761	11.5299	7.4381	11.3709
B		20.6636	7.3661	1.6073	0.7125	9.3467	5.5104	0.6170
B′			19.9504	1.7557	4.4385	8.9872	4.1177	3.0672
H′				22.6968	10.3937	5.3545	3.7178	7.7669
LB					17.0550	10.4579	4.6674	13.9537
J						24.7524	6.9423	10.5173
G′H							18.8201	7.9043
GL′								24.1989