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## Microevolution in human Chilean populations

### IV. Shovel shape, mesial-palatal version and other dental traits in Pewenche Indians<sup>1</sup>

By **Francisco Rothhammer, Enrique Lasserre, Rafael Blanco, Edmundo Covarrubias and Monty Dixon**

With 7 tables in the text

As the genetical structure of the Chilean population has two main components, Caucasoid and Amerindian, it seems of evolutionary interest to describe genetic traits in the stem groups, particularly the Indians, whose genetic and demographic structure is undergoing rapid change (COVARRUBIAS, 1965).

This study presents the distribution of some dental traits of genetic value in a sample of Indians from the Pedregoso Reservation. They belong to the Pewenche, a branch of the Araucanian Indians living in the central Chilean Andes by the raising of cattle and farming. By previous studies it was shown that Pedregoso is a genetically isolated community (NAGEL & ETCHEVERRY, 1964; COVARRUBIAS, 1965). One-fourth of the marriages are consanguineous, and the mean inbreeding coefficient of the population was estimated as 0.0105 (COVARRUBIAS et al., 1965).

A total of 190 voluntary subjects received a clinical dental examination. This group was composed of 104 females and 86 males with mean ages and standard deviations of  $32.7 \pm 15.50$  and  $33.5 \pm 17.75$  respectively. From these a subsample of 73 subjects were taken for dental casts selecting those individuals with a majority of their molars present and not severely affected with carious lesions. However, the effect of this criteria is reflected in an unbalanced distribution of both sex and age: 46 males and 27 females with the respective mean ages and standard deviations of  $29.6 \pm 15.23$  and  $19.3 \pm 9.44$ . They are comprised of 27 unrelated persons and the following sibships: ten of two individuals, three of three, three of four and one of five persons. Six individuals descended from first cousin marriages.

#### Incisors

Two polymorphic traits of the incisors seem to be particularly useful to distinguish between Mongoloid and Caucasoid populations: shovel shape and

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Table 1. Frequency distributions of the shovel-shape indexes for central and lateral superior incisors.

	N	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70
Central incisors	Males	2.8	5.6	2.8	2.8	2.8	11.1	8.3	11.1	22.2	2.8	16.7	—	2.8	2.8	—	5.6	—	—
	Females	—	—	—	4.2	8.3	4.2	4.2	12.5	12.5	16.7	4.2	16.7	—	—	—	4.2	4.2	8.3
	Totals	1.7	3.3	1.7	3.3	5.0	8.3	6.7	11.7	18.3	8.3	11.7	6.7	1.7	1.7	—	5.0	1.7	3.3
Lateral incisors	Males	12.9	22.6	6.5	9.7	9.7	19.4	9.7	6.4	—	3.2	—	—	—	—	—	—	—	—
	Females	21	4.8	23.8	4.8	14.3	28.6	14.3	—	—	—	—	—	—	—	—	—	—	—
	Totals	52	9.6	17.3	13.5	7.7	11.5	23.1	11.5	3.8	—	1.9	—	—	—	—	—	—	—

mesial-palatal version. However, both have been generally treated as classificatory traits, which implies a clinical judgement not easy to define. One of our main efforts has been to develop an objective method of measurement for these characteristics as related to the clinical classification.

The shovel shape of incisors is highly frequent in Mongoloids including Amerindians (80—100 %), as contrasted with Caucasoid and Negroid populations which score less than 20 % (COON, 1962). In a sample of 376 Araucanian Indians it was found that 56.9 % of the individuals presented the trait in the superior central incisors (MUÑOZ, 1936).

DAHLBERG (1949) has pointed out the difficulties for obtaining a uniform criteria when analyzing the trait. We have chosen to measure it with a caliper graduated at 0.10 mm. In order to quantify the shovel-shape character, we measured the thickness of each superior incisor at the site of maximal depth in the palatal face and the lateral ridges at the same level. An index was obtained using the difference between the values of the mean lateral thickness and the central one.

Sixty casts had both central incisors in condition for appropriate study, while seven had only one and six neither of them. Concerning the lateral incisors, 61 of the casts had both of them studiable, eight of which presented barrel shaping or microformation, and the remaining 12 had one or both absent.

The sex specific distributions of the shovel-shape indexes separately for central and lateral incisors are given in Table 1. The mean values and the standard deviations for the central indexes are: for the males  $0.74 \pm 0.34$  and for the females  $0.94 \pm 0.45$ .

The same data for the lateral indexes are as follows: for the males  $0.36 \pm 0.23$  and for the females  $0.40 \pm 0.20$ . In the central incisors a significant difference exists between the means of the sexes ( $t_{(58)} = 6.068$ ), which does not occur

with the laterals ( $t_{(51)} = 0.413$ ). The total distributions for central and lateral incisors do not separate significantly from the corresponding normal distributions as tested by a goodness-of-fit method:  $\chi^2_{(6)} = 12.198, 0.05 < P < 0.10$  for the centrals and for the laterals  $\chi^2_{(5)} = 6.492, 0.20 < P < 0.30$ .

Table 2. Two way analysis of variance for testing the reproducibility of a method for measuring the shovel-shape trait, separately for the central and lateral incisors.

Source of variation	Central Incisors				Lateral Incisors			
	Sum of Squares	Degrees of Freedom	Mean Square	F	Sum of Squares	Degrees of Freedom	Mean Square	F
1st. vs. 2nd measurement	0.4775	1	0.4775	2.640	0.0015	1	0.0015	0.0180
Observers	0.6734	2	0.3367	1.8612	0.8909	2	0.4454	5.4053
Interaction	0.0910	2	0.0455	0.2515	0.1102	2	0.0551	0.6690
Among groups	1.2419	5	0.2484	1.3731	1.0026	5	0.2005	2.4330
Intra groups	20.6199	114	0.1809	—	9.3904	114	0.0824	—
Total	21.8618	119	—	—	10.3930	119	—	—

The consistency of our method of measurement of the shovel-shape index was tested by a small factorial experiment. Ten casts were measured by the first three named investigators individually, and this process was repeated one week later. Two factors of variation and their interaction were tested: first versus second measurement and the difference among the investigators (Table 2). None of them reached the 5% level of significance for the central indexes, while it was clear

Table 3. Frequencies of the shovel-shape clinical classes for central and lateral superior incisors.

		N	Clinical Shovel Shape Classes			
			0	1	2	3
Central Incisors	Males	38	7.9	23.6	39.5	28.9
	Females	27	—	14.8	51.9	33.3
	Totals	65	4.6	20.0	44.6	30.7
Lateral Incisors	Males	29	17.9	32.1	39.2	10.7
	Females	21	4.7	33.3	57.1	4.7
	Totals	50	12.0	32.0	46.0	8.0

that the observers differed significantly among themselves concerning the lateral indexes ( $F_{(2, 114)} = 5.405, 0.005 < P < 0.01$ ).

The clinical classification into four groups according to the degree of the trait is shown in Table 3. All of the studiable female subjects and 92.1% of the males presented the trait of shovel shaping in the central superior incisors. For the lateral incisors 95.2% of the females and 82.1% of the males showed the

trait. Again the consistency of the clinical method was examined by an analysis of variance, this time covering all the studiable models, but testing only for one factor — the observers. For this purpose subjects with a marked degree of the trait were given a value of three, those with a moderate degree valued as two, a slight degree as one, and those without the trait were valued as zero. As shown in Table 4 the observers were consistent enough only for central incisors, while they differed significantly concerning the lateral ones. Finally we calculated the correlation coefficient,  $r$ , for the shovel-shape indexes of the central incisors as 0.84, significantly different from zero at the 0.001 level.

Table 4. Analysis of variance for testing the reproducibility of the clinical method for the shovel-shape trait, separately for the central and lateral incisors.

Source of variation	Central Incisors				Lateral Incisors			
	Sum of Squares	Degrees of Freedom	Mean Square	F	Sum of Squares	Degrees of Freedom	Mean Square	F
Among groups	3.0333	2	1.5167	1.7806	2.50	2	1.2500	3.2757
Intra groups	48.5500	57	0.8518		21.75	57	0.3816	
Total	51.5833	59			24.25	59	—	—

Of the three individuals presenting barrel-shaped laterals, one was bilateral and two were unilateral. This trait has been associated to the shovel-shape complex (DAHLBERG, 1949). In our sample only the individual with bilateral barrel-shaped incisors showed an extreme type of shoveling in the central incisors. One cast presented a transitional form, a microformed barrel-shaped lateral. There was congenital absence of the laterals in two individuals: one bilateral and one left unilateral. Another subject had the right lateral microformed and the last subject had both the lateral and the canine microformed.

Mesial-palatal version, also described as a wing-like appearance of the upper central incisors, is a trait characterizing Mongoloid populations with a relatively high frequency as contrasted with the Caucasoid ones. For example, DAHLBERG (1959) found in white people living in the Chicago region 3% of the trait, while in some Amerindian groups the frequency oscilated between 22% and 38%. A frequency of 9.6% was reported in the Japanese (ENOKI & NAKAMURA, 1959). Only 0.25% of the individuals presented mesial-palatal version in the aforementioned study of Araucanian Indians (MUÑOZ, 1936).

As mesial-palatal version seems to vary continuously, we decided to measure it as the angle formed by intersection of the sagital line of the maxilla with the incisal border of each superior incisor separately, which permitted us to avoid errors due to asymmetry. The mean value of both median incisors is considered an index of mesial-palatal version. The angle measurements were performed with a specially adapted protractor.

The distribution of the mesial-palatal version indexes (Table 5) does not differ from a normally fitted one ( $\chi^2_{(8)} = 7.822$ ;  $0.30 < P < 0.50$ ). The means and standard deviations are: for males  $93.6 \pm 9.48$  and for females  $90.8 \pm 23.25$ .

Table 5. Frequency distributions of the mesial-palatal version indexes for central superior incisors.

	N	66 70	71 75	76 80	81 85	86 90	91 95	96 100	101 105	106 110	111 115	116 120	121 125	126 130
Males	44	—	2.3	6.8	11.3	20.5	13.6	20.5	20.5	—	2.3	2.3	—	—
Females	28	3.6	3.6	3.6	10.7	25.0	17.8	10.7	7.2	3.6	7.1	—	—	7.1
Totals	72	1.4	2.8	5.6	11.1	22.2	15.3	16.7	15.3	1.4	4.1	1.4	—	2.8

There does not exist a significant difference between the means of the sexes ( $t_{(12)} = 0.586$ ). Subjects with an angle of more than  $90^\circ$  were considered to present the trait. In this way a total of 26 males (57.8%) and 15 females (55.6%) were positive for mesial-palatal version, results which are very similar with those obtained by clinical judgment (males, 53.3% and females, 55.6%). A correlation coefficient,  $r = 0.4559$ , significant at the 0.001 level, was found between the right and left central measurements.

The repeatability was studied, as in the shovel-shape trait, by a factorial analysis of variance (Table 6). No significant difference was detected either between the first and second measurements or among the various observers.

Table 6. Two way analysis of variance for testing the reproducibility of a method for measuring the mesial-palatal version.

Source of variation	Sum of Squares	Central Incisors		F
		Degrees of Freedom	Mean Square	
1st. vs. 2nd. measurement	78.41	1	78.41	0.807
Observers	15.26	2	7.63	0.079
Interaction	13.37	2	6.68	0.069
Among groups	107.04	5	21.41	0.220
Intra groups	11,073.43	114	97.14	—
Total	11,180.47	119	—	—

A correlation between shoveling and mesial-palatal version of central superior incisors was sought using 60 models. The value obtained 0.149 was not significantly different from zero.

### Molars

As the subject of molar morphology is somewhat complex, we do not intend to define here the various types of molar patterns nor to make a thoroughly comparative description of racial variability. For the study of occlusal patterns of

upper molars we used DAHLBERG's classification based on various authors (1949). For the lower molars we applied the criteria of SCHUMANN and BRACE which includes the Y6 pattern (COMAS, 1957). Comprehensive reviews of racial distribution of the trait have been published by DAHLBERG (1949) and COON (1962), who summarize the main characters of the principal races. From these we would like to mention those that appear of interest for the present study.

Caucasoid populations are characterized by a low percentage of the Y6 hexacuspoid pattern of the lower molars (0.4 %), while the frequency among Mongoloids is described as comparatively higher (3 % to 4.5 %) (COMAS, 1957). Of 81 studiable inferior first molars we found 8.6 % with the Y6 hexacuspoid pattern. Similarly there appear some wrinkled types among Mongoloids which have not been mentioned in Caucasoids (COON, 1962). Three of our casts presented the wrinkled type. One of them showed this trait symmetrically on the first molars; the other two have only one wrinkled type each. DAHLBERG (1949) reported in Caucasoid populations a high frequency of CARABELLI's cusp, which ranged from 11 % to 72 %. We found only one subject with CARABELLI's cusp (1.5 %), which contrasts strongly with the 36.6 % observed by MUÑOZ (1936) in Araucanians.

Table 7a. Frequencies of lower molar patterns.

	N	Y 6	+ 6	Y 5	+ 5	Y 4	+ 4	W
M <sub>1</sub> Males	48	8.3	—	85.4	2.0	—	4.1	—
M <sub>1</sub> Females	33	9.0	—	81.8	—	—	—	9.0
Total	81	8.6	—	83.9	1.2	—	2.4	3.7
M <sub>2</sub> Males	46	2.1	—	8.7	6.5	—	82.6	—
M <sub>2</sub> Females	25	—	—	4.0	8.0	—	84.0	4.0
Total	71	1.4	—	7.0	7.0	—	83.1	1.4

Table 7b. Frequencies of upper molar patterns.

	N	4	— 4	— 3	3
M <sub>1</sub> Males	71	62.0	35.2	1.4	1.4
M <sub>1</sub> Females	49	51.0	42.9	2.0	4.1
Total	120	57.5	38.3	1.7	2.5
M <sub>2</sub> Males	66	1.5	19.7	13.6	65.2
M <sub>2</sub> Females	38	—	18.4	13.2	68.4
Total	104	1.0	19.2	13.5	66.4

The upper and lower molar patterns for our sample are listed in Table 7a and 7b. The variable numbers of studiable molars for each entry are due to the different distribution of absences and carious lesions.

### Comment

Methods for measuring the shovel shape and mesial-palatal version traits have been tried in this work which appear to be easy to employ and are

deprived enough of subjective error to be repeated accurately by the same experimenter or by a group of them. In the case of shoveling this was true only for the central incisors. As a good correlation exists between the shoveling indexes of the central incisors, an estimation of the trait in an individual could be obtained if only one incisor were measured. The same is valid for the mesial-palatal version.

Until now mesial-palatal version and shoveling have been treated as qualitative traits. A quantitative method such as ours adds precision that can be helpful for studies concerning the genetics of these characteristics. However, in order to compare populations among themselves, both the clinical and the quantitative approaches to the traits should be employed at this stage.

A criticism of our results derives from the small sample size with males over-represented and the including of sibships of varying sizes. The distributions could be distorted for both these reasons. Nonetheless, the frequencies of the traits we obtained by clinical classification agree fairly well with what has been previously reported on Amerindian populations (opus cit.). The fact that women have higher mean indexes of shoveling than men may be merely due to sampling.

The study of the frequencies of seven genetic traits in some Araucanian reservations has shown the existence of gradients related to the geographic isolation of these communities. The frequency gradients are better interpreted as the result of gene flow from Causasoid populations (COVARRUBIAS, 1965). The dental data so far obtained are consistent with such assumptions.

The Araucanian sample taken by MUÑOZ in 1936 was probably highly mixed as it presented a large number of subjects with CARABELLI'S cusp, a frequency of shoveling intermediate between the Amerindian and Causasoid populations, and lack of mesial-palatal version. According to these same standards, the Pewenche of Pedregoso, a more isolated area, constitute an example of relatively unmixed Indians.

### Summary

Seventy-three dental casts taken from a sample of Pewenche Indians were studied for some dental traits of anthropological interest. Quantitative methods were employed for measuring the degree of shoveling and mesial-palatal version of superior incisors, showing distributions which do not differ significantly from normal ones. According to the clinical classification 95.3% and 87.7% of the subjects presented the shovel-shape character in the central and lateral incisors respectively; 55.5% of them had mesial-palatal version of the central superior incisors. The frequencies of occlusal molar patterns are given. Only one subject had a CARABELLI'S cusp. Data are consistent with the relative genetical isolation of this community and agree with what has been reported in other Amerindian groups.

### Zusammenfassung

Einige Zahnmerkmale von anthropologischem Interesse werden an dreiund-siebzig Dental-Modellen von Pehuenche-Indianern untersucht.



Die schaufelförmigen oberen mittleren Schneidezähne und die mesial-palatinal Drehung derselben, sind mittels quantitativer Methoden gemessen worden. Beide Merkmale zeigten Verteilungen, die sich statistisch nicht von normalen unterschieden. Der klinischen Klassifikation folgend, hatten 95,3 % der Fälle schaufelförmige mittlere und 87,7 % seitliche obere Incisivi. An 55,5 % der untersuchten Modelle konnte klinisch eine mesial-palatinal Drehung der oberen mittleren Schneidezähne festgestellt werden. Die Frequenz der Bißflächenmuster der oberen und unteren Molaren wird gegeben. Tuberculum CARABELLI wurde nur in einem Fall gefunden. Die Ergebnisse bestärken die Annahme, daß diese Gemeinschaft relativ genetisch isoliert ist, und stimmen mit den in anderen amerikanischen Indianergruppen beschriebenen überein.

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