A CEPHALOMETRIC ROENTGENOGRAPHIC DESCRIPTION OF 12-14 YEAR OLD NAVAJO INDIANS

by

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Introduction

During a two year assignment on the Navajo Indian Reservation while serving with the U.S. Public Health Service, many interesting differences between the Navajo and White populations were noted. These included the apparently obvious facial as well as a multitude of dental differences. Initially the shovel shaped incisors and the differences in occlusal anatomy held my interest. There also appeared to be a predominance of Class I molar relationships with considerable anterior crowding of the dental arches. The faces in general appeared convex, with very prominent teeth. A search through the available literature on the Navajo produced almost nothing. It seems there has been nothing recorded on the Navajo as far as dento-facial data is concerned and very little until recently on anything other than the tribal-social aspects.

Letters to the curators of all local and many national museums in search of Navajo skeletal material brought replies such as the following:

> "I would be delighted to know myself where and how to obtain any Navajo skulls." (Professor F. S. Hulse, Department of Anthropology, University of Arizona)[15]
>
> "I am afraid I haven't the slightest idea where you could get Navajo skulls for study. I very much doubt that you would be able to find enough to allow you to do a decent comparative study. The Navajos did not bury in cemeteries, and they have an extreme fear and horror of death and the dead, which makes anything to do with collecting their remains difficult in the extreme." (W. W. Howells, Chairman, Department of Anthropology, Harvard University)[14]
>
> "To the best of my knowledge, there is no collection extant of Navajo skulls either in private hands or in public museums. Unfortunately for anthropologists, Navajo burial methods were not conducive to the best interests of future skeletal studies." (Bertram S. Kraus, Professor of Physical Anthropology, University of Washington)[16]
>
> "Your letter of .... touches on a subject which has long interested me, namely, an adequate description of the Navajo skull. You will find that there are very few such skulls in any collection. I hope you will follow up this problem and assemble some usable information. (F. D. Stewart, Head Curator, Department of Anthropology, Smithsonian Institution, Washington, D.C.)[18]

And finally, from the Museum of New Mexico, came the suggestive reply:

> "As you probably realize in most of our salvage work we have purposely avoided Navajo burials in order to maintain proper relationships with the Navajo Tribe." (Alfred E. Dittert, Jr., Department of Anthropology, Museum of New Mexico)[9]

Insight into Navajo beliefs concerning death is provided by the following quotation:

> "Man is a composite of good and evil. At death the essence or spirit of life, his breath and 'that which stands within him' leave his body to blend with the cosmos and lose their identity, while the evil side of his personality remains as an unassimilated residue contaminating his corpse, the dwelling place in which he died, his possessions, and the place where he is buried. This evil remains as a ch'indii, potentially dangerous to the health, welfare and even the lives of those who come in contact with it. If he dies within his hogan, the dwelling becomes uninhabitable, and even its timbers become unusable. Sometimes the moribund are taken outside or to a hospital to die, and burial must follow prescribed rules of procedure and ritual if those concerned are to avoid contamination."[20]

The Navajo fear of the dead certainly does not encourage elaborate preparation of the body nor concern for preservation. This, combined with the fact that there are no specific burial grounds, tends to explain the reason for lack of Navajo skeletal material and its subsequent description.

Just as I was about to forget the idea of skeletal remains, I heard of a local high school boy with a small collection of skulls he had found on various field trips. After considerable talking he agreed to let me borrow them to x-ray. I hadn't had them in the office over two days when a Navajo Ranger called to confirm the report that I had "old bones" in my possession. I was informed that this was strictly forbidden and "our" collection was immediately confiscated. They decided not to prosecute since it was a first offense.

This was enough to convince me that study of the Navajos should be done by taking "pictures" of the living ones. I wasn't even sure I could safely call the roentgenographic headfilms "x-rays" rather than

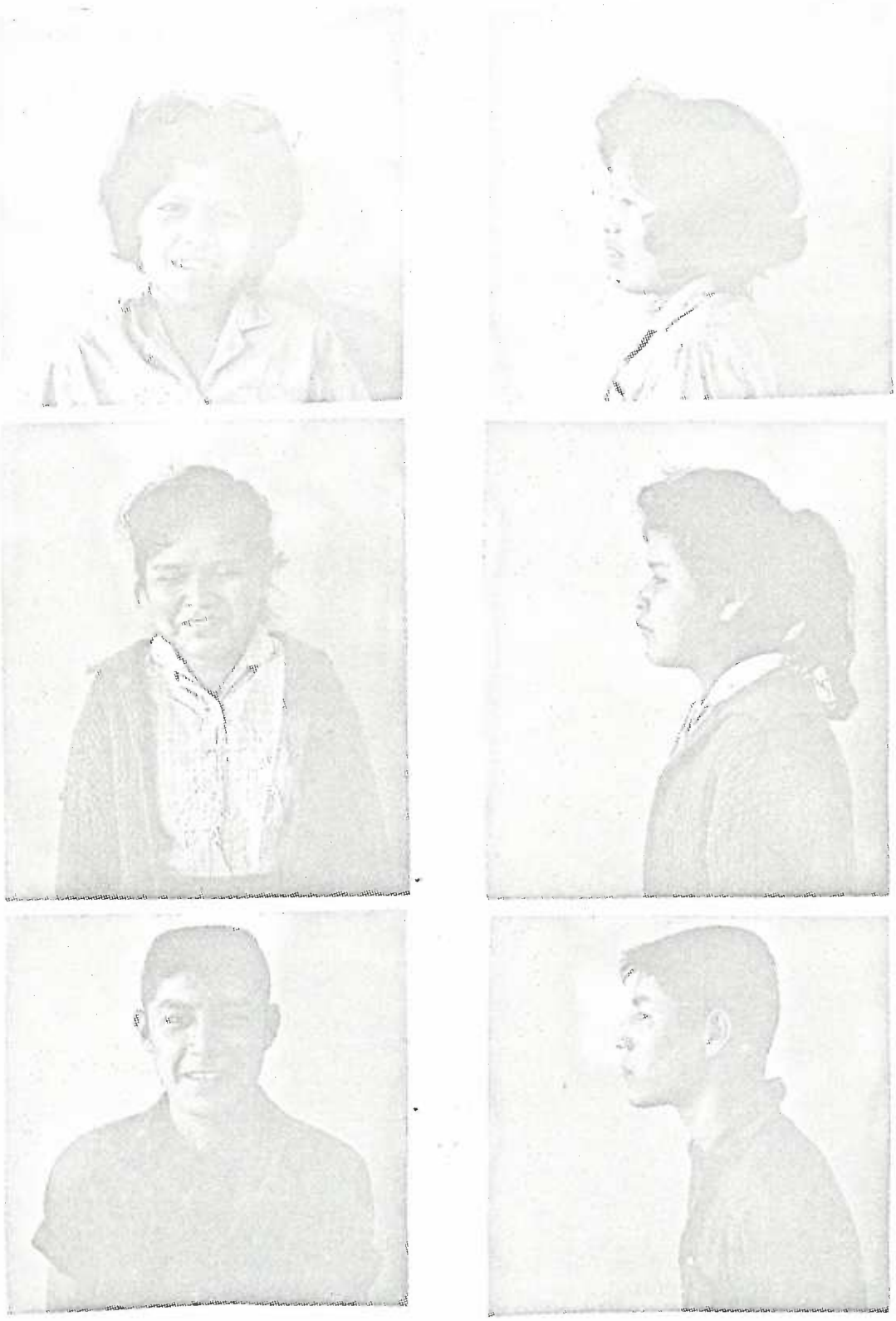
"pictures" or admit that they were for study rather than therapy without fear of future reprisals.

By this time, I was interested in obtaining any record possible on these people. There appeared to be many differences but were these real or imaginary? If they were real, what did they mean?

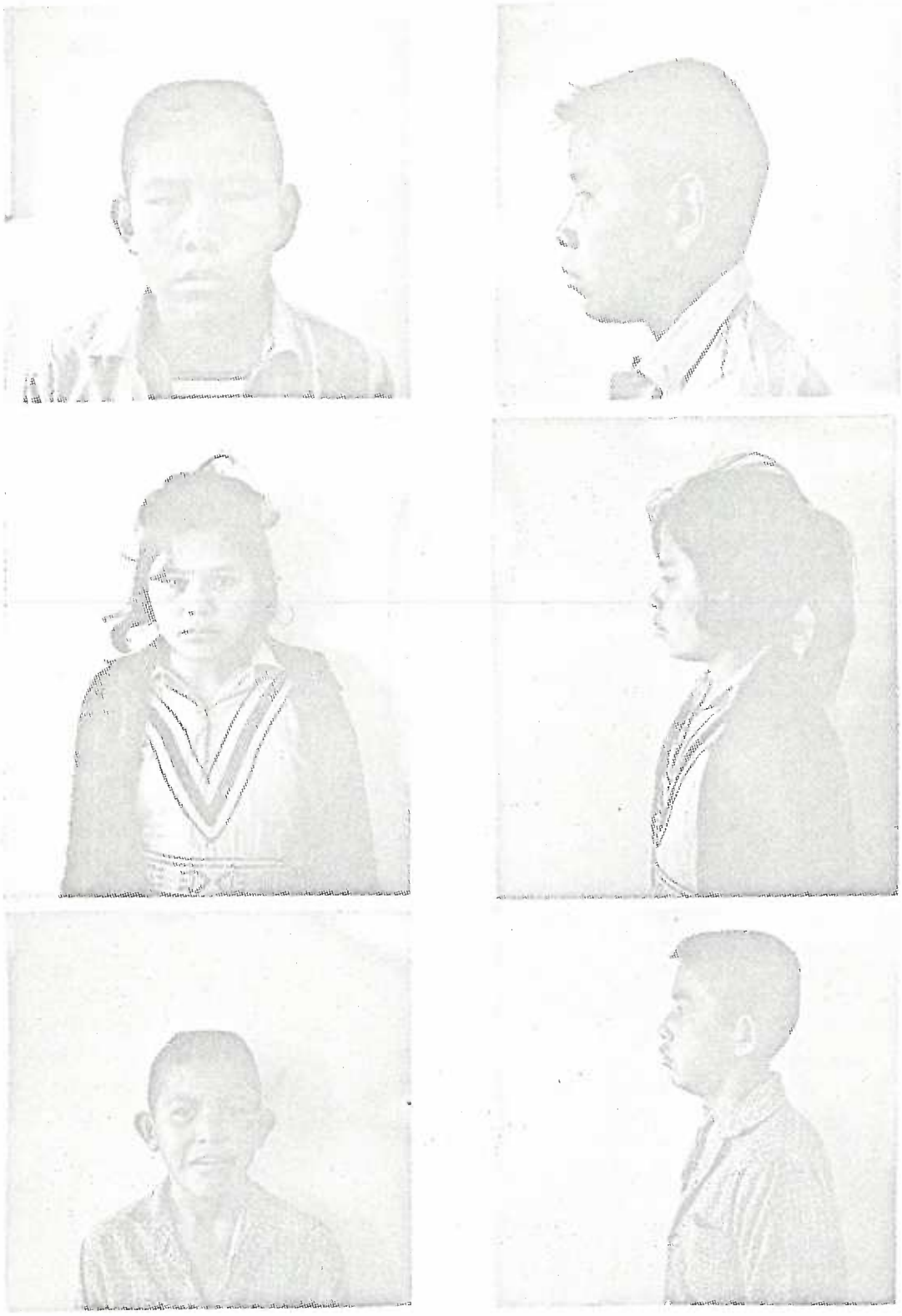
The study of racial differences has been of interest to investigators throughout the world for hundreds of years. The more outstanding ethnic differences have long been recognized and recorded - e.g. the slanted eyes of the Asian peoples and the long, straight nose of the Romans. Similarly there appear to be obvious facial differences between the Caucasians and Navajos whereas the Navajos appear more similar to the Chinese than any other ethnic group. This is probably as it should be, as the Navajos are of Mongoloid decent, having crossed the Bering Strait into North America some 20 to 30,000 years ago. There are other related tribes in Canada and North America including the Apache.

Photographs of representative Navajo boys and girls are shown on the following pages. These certainly do not represent the entire range of facial variation but are included for purposes of general information.

Physical anthropologists have recorded thousands of measurements on both skeletal and soft tissue of ancient and living races. Many of these are extremely well done and provide useful information. The problem of cranial and facial measurements has, however, inherent limitations. On living peoples, the problem of soft tissue thickness lends itself to measurement error as well as considerable difficulty in locating skeletal landmarks. Skeletal material provides problems, since often the age and medical history of the individuals are unknown as well as there being often some loss or destruction of skeletal structures. Physical anthropometry provides two types of data, direct and indirect. X-rays are of



Photographs of representative Navajo boys and girls.



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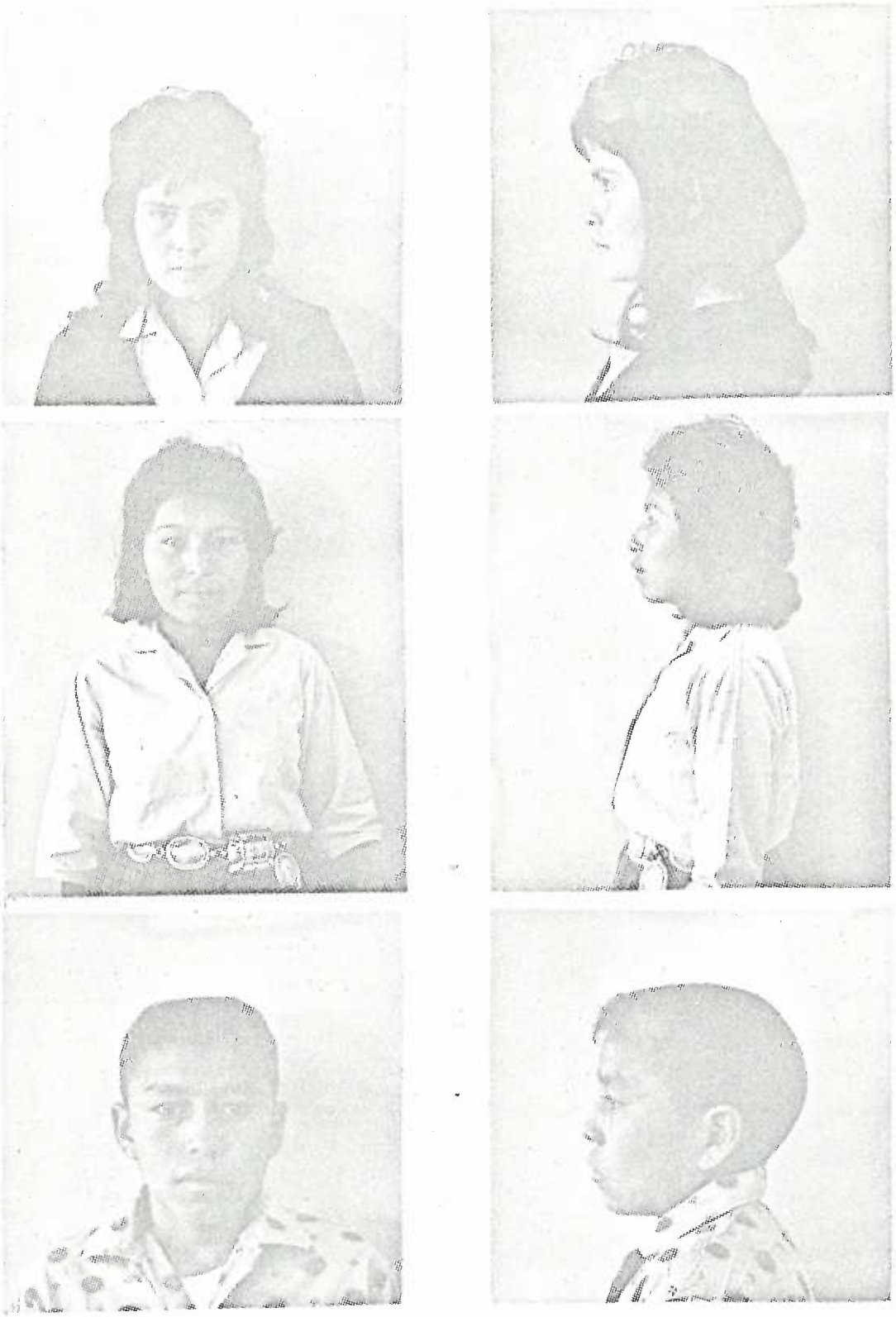

Photographs of representative Navajo boys and girls.

the indirect type.

It was not until discovery of the x-ray and the subsequent development of a standardized technique by Broadbent[1] in 1931, that it was possible to examine the facial structure of living peoples with any degree of reliability. In recent years several racial groups have been examined for comparative purposes using, however, a variety of cranial reference points and thus producing a variety of "norms". The problem of defining where or how one group differs from another is a matter of determining what groups have been studied, the methods of analysis, accuracy of the method, (sample size, raw data available, statistical methods) and finally, do the previous methods used actually indicate where the differences are (if there are any)?

Reasons for investigation of racial groups have been of a varied nature: some studied for purely academic interest, some for purposes of growth comparison, some in an effort to determine racial ancestry, and some in an effort to establish norms which might be an aid in clinical treatment.

Of the latter group, here again there are perhaps hundreds of combinations of cranio-facial reference points and lines that have been suggested, both linear and angular. All show the range of individual variation is quite wide, even in groups selected for specific traits. The question remains which measurements have been recorded for other groups that may be useful for purposes of comparison?

Review of the Literature

Comparable data on other racial groups is quite limited. In reviewing the literature, it appears that the most frequently used analysis for racial comparison is Down's[11] analysis. These particular measurements are available for the American Chinese,[7] American Negro,[7] Nesei,[19] Australian Aborigine[8,2] as well as Down's sample of North American Caucasians. For purposes of general information, the Navajo sample has been analyzed by this means.

The above studies, except that on the Australian Aborigine have followed criteria similar to that used by Down's; i.e. twenty individuals chosen for excellence of occlusion and good facial balance. Only the study by Takano on the Nesei has been subjected to statistical analysis. He found a statistically significant difference between the Caucasians and Nesei in the angle of convexity, the Y-axis and all the denture patterns except the cant of the occlusal plane.

For a more specific description, the method used by Bjork[3] in his study of Swedish males is useful since it employs linear as well as angular measurements. The selected sample of Navajo boys has also been studied by this method.

Statement of the Problem

The purpose of this study is to describe the mean dento-facial pattern of the 12-14 year old Navajo Indians and compare them to other previously described ethnic groups. Statistical analysis is employed to determine whether there is a real difference between the groups for the particular angular and linear measurements used.

Methods and Materials

Navajo children enrolled at the Bureau of Indian Affairs Boarding School in Shiprock, New Mexico were selected for study. This school had a total enrollment of about 1,300 students, believed to be representative of Navajos throughout the reservation. That these children are "pure-blood" Navajos cannot be established since the major qualification for receipt of government benefits is to be of at least one-fourth Navajo ancestry.

The selection of ages for study also presented difficulties. Upon questioning, many students did not know their age or the date of their birthday. For this reason, the school roster was used in selection of the sample. Every third name of the 12-14 age range was selected and the student called for records.

A total of 117 records, consisting of lateral cephalometric head plates and impressions were obtained. Impressions were taken with Jeltrate and poured immediately using one-half plaster and one-half albastone. The cephalometric headplates were taken using a constant 60 inch distance between the target and the mid-saggital plane. A constant fixed distance between the mid-saggital plane and the film was maintained. A scale placed in the mid-saggital plane allowed for correction of enlargement of all mid-saggital structures. Enlargement was calculated as 1.103 and this correction factor has been applied to all linear measurements.

From the 117 records, 23 (11 boys and 12 girls) were selected on the basis of their occlusions. The occlusions were considered at least acceptable if not ideal; certainly orthodontic treatment was not indicated or advisable on the basis of occlusions alone.

Photographs of five of the twenty-three Navajos described in this

study are shown on the following pages.

A survey of all casts provides the following information, which is included to provide a general idea of the more commonly noted dental conditions and to allow comparison of the 23 in the selected group with the remainder of the sample.

The Angle classification of molar occlusion yields the following results: (1) Class I - 84, including all 23 of the selected sample. (2) Class II - 27, including 12 individuals that had lost upper permanent teeth thus encouraging the Class II molar relationship. There were also 6 individuals with unilateral Class II and one with a cusp to cusp relationship. Only 8 individuals exhibited a full cusp, bilateral Class II molar relationship. (3) Class III - 4, including three that had lost upper anterior teeth.

The selected group had a mean overjet of 1.9 mm. with a range of 0 to 3 mm.; a mean overbite of 0.96 mm. and a range of 0 to 2 mm. The remainder (N=94) had a mean overjet of 3.0 mm. with a range of -2 to +9 mm.; the overbite mean was 1.2 mm. with a range of -5 to +6 mm.

The lateral headplates of the 23 selected boys and girls were traced on acetate film, once in the manner described by Downs and a second time for purposes of comparison with Bjorks' Swedish boys. All angular measurements were recorded to the nearest 0.5 degree. All linear measurements were recorded to the nearest 0.01 mm. using a John Bull scale.

Measurement error was not computed since the objective of the study was to obtain sample means for comparison with other sample means. It has been assumed that measurement error is randomly distributed in this as well as those studies used for comparison.

Figure 1 indicates the reference points used in the analysis of the Navajo material. A diagram and definitions of reference points for

Photographs of 2 boys of the 23 Navajos described in this study.

Photographs of 3 girls of the 23 Navajos described in this study.

Down's analysis is not included as this material is readily available if not familiar to most readers.

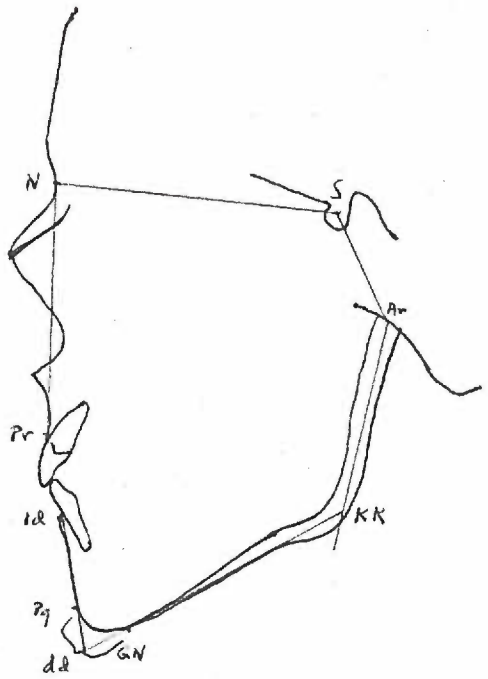

Figure 1.

Reference points identified in description of Navajo Indians (after Bjork[3]).

Ar Articulare. "The point of intersection of the dorsal contours of processus articularis mandibulae and os temporale. The mid-point is used where double projections give rise to two points."[3]

GN Gnathion. "The deepest point of the chin."[3]

KK "The point of intersection between the base and ramus tangents to the mandible. The mid-point, KK, is used where double projections give rise to two points, KK, and KK_2."[3]

N Nasion. "The anterior limit of suturo nasofrontalis."[3]

Pg Pogonion. "The most prominent point of the chin."[3]

Pr Prosthion. "The transition point between the crown of the most prominent medial maxillary incisor and the alveolar projection."[3]

id Infradentale "The point of transition from the crown of the most prominent mandibular medial incisor to the alveolar projection."[3]

S "The centre of sella turcica. (The mid-point of the horizontal diameter.)"[3]

dd "The most prominent point of the chin in the direction of measurement."[3]

Statistical Methods

Mean $(\bar{x}) = \frac{\Sigma x}{n}$

Range = highest and lowest values, by observation.

Standard Deviation (S.D. or S) = $\sqrt{s^2}$

Variance = $(s^2) = \frac{\{x^2 - \frac{(\Sigma x)^2}{n}}{n-1}$

For evaluation of differences in means, the variances were first tested for differences using the "F" test: $F = \frac{v_1}{v_2}$ where v_1 = variance of the first sample and v_2 = the variance of the second sample. These were tested at the 95 percent level of confidence and accept the hypothesis that $\sigma_1^2 = \sigma_2^2$ if $\frac{S_1^2}{S_2^2}$ is between the two percentiles of this F distribution, $F_{\frac{\alpha}{2}(.025)}(N_1-1, N_2-1) < \frac{S_1^2}{S_2^2} < F_{1-\frac{\alpha}{(.975)}}(N_1-1, N_2-1)$ where n -1 and n -1 establish the degrees of freedom. Since the variances were found to be equal they were then pooled to provide an unbiased estimate using the formula: $Sp^2 = \frac{(N_1-1)S_1^2 + (N_2-1)S_2^2}{N_1 + N_2 - 2}$. The pooled variance was then used in the "t" test to determine significant differences between means: $t = \frac{\bar{X}_1 - \bar{X}_2}{Sp\sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$. Since not all previous studies had determined the S.D. but provide only the mean and range, a substitute test for "t" that has high efficiency for small sample sizes has been used: $T_d = \frac{\bar{X}_1 - \bar{X}_2}{\frac{1}{2}(W_1 + W_2)}$. Correlation coefficient scattergrams were made for various measurements but the patterns were so broad as to negate the value of computing the coefficient, r.

The Standard Error of the Mean, $\mathcal{E}(\bar{x})$, is calculated as $\frac{S.D.}{\sqrt{N}}$ and indicates the range in which the true mean is located.

Results and Discussion

The values computed for the Navajo using Down's analysis are given in Table 1, which also includes similar data on all other groups known to have been studied by this method.

A cephalometric wigglegram of this data is also included to indicate graphically the mean pattern. It should be noted that the Australian Aborigine sample is not strictly comparable in that it was not selected by the same criteria or of equal size.

The results of the "t" test of all samples with established standard deviations is shown in Table 2. This provides a comparison of means between the Caucasian group selected by Down's, the Nesei, and the Navajo.

By this method of analysis there is apparently a very real difference between the Navajo and Caucasians in all measurements of this analysis except the A-B plane. This difference is significant at the t_{995} level of confidence. This means that there is one chance in 250,000 of this difference being by chance. The Navajos are also significantly different from the Nesei in facial measurements, except again in the A-B Plane measurement. There are, however, no significant differences in the dental measurements of the Navajo and Nesei except for the cant of the occlusal plane.

Using the substitute test for "t" employing the range, comparisons of means are given in Table 3 for the Navajo, Caucasian, Negro, Nesei, Chinese and Australian Aborigine.

The comparative accuracy of this test was evaluated by computing again the same values for Navajo-Caucasian and Navajo-Nesei. It is interesting to note that both tests indicate significant differences for the same measurements at approximately the same level of confidence. Having

Table 1

VALUE	Amer. White	Amer. Negro	Nisei	Aust. Aborig.	Amer. Chinese	Navajo Indians
Facial angle	87.9 85 to 95	87.25 80 to 91	88.25 83 to 94	91.5 87 to 100	77.5 73 to 89	82.69 77 to 86.5
Angle of convexity	0.0 10 to 8.5	9.6 4 to 20	3.65 12 to -1	8.4 0 to 17.5	7.5 1.5 to 14	6.19 0 to 16
AB plane to facial plane	-4.7 0 to -9	-7.7 -3 to -15	-4.35 -1 to -7	-2.65 -9 to +2	-5.7 -2 to -10	-5.33 -1.5to-11
Mandibular plane angle	21.9 17 to 28	27.25 17 to 35	24.3 14 to 33	21.9 9 to 31	32.4 22 to 44	32.8 25 to 42
Y-Axis	59.3 53 to 66	63.3 57 to 69	62.1 56 to 68	54.5 45 to 61	67.1 59 to 75	67.29 62.5to74.5
Cant. of Occ. Pl.	9.2 1.5 to 14	11.8 8 to 17	9.65 2 to 19	7.2 -1 to 12.5	16.9 8 to 25	14.2 5.0 to 20
$\underline{i}$ to $\bar{i}$ (inter-incisal)	135.4 130to150.5	123.0 105to144	126.4 114to152	114.5 100.5to129.5	120.8 105to137	121.62 111to134
$\bar{i}$ to occlusal plane	14.5 3.5 to 20	22.5 12 to 35	21.5 8 to 31	29.1 21.5 to 40	22.2 13 to 29	23.60 15 to 36.5
$\bar{i}$ to mandibular plane	1.5 -8.5 to 7	6.6 -3.5 to 22	6.55 -6 to 13	14.1 1.5 to 31	7.8 0 to 18	5.44 16 to -4
$\underline{i}$ to AP plane (mm)	3.1 -1 to 5	8.5 6 to 11	6.6 2 to 10	10.9 7 to 14	7.6 3 to 12	7.89 3 to 13.5

Table 1. Mean values for all groups known to have been studied using Down's analysis.

Table 2

Value		Navajo Indians	Caucasians (Down's)	Navajo-Caucn. "t" value	Nisei	Navajo-Nesei "t" value
Facial plane	$\bar{x}$	82.69 [+]	87.9 [+]	5.53 [1]	88.25	6.80 [1]
	S.D.	2.58	3.57		2.77	
Convexity	$\bar{x}$	6.19 [+]	0.0 [+]	14.0 [1]	3.65	2.054 [2]
	S.D.	4.147	5.09		3.91	
A-B plane	$\bar{x}$	-5.33	4.7	.733	-4.35	1.27
	S.D.	2.93	2.67		1.95	
Mandibular plane	$\bar{x}$	32.8	22.9	8.05 [1]	24.3	5.79 [1]
	S.D.	4.615	3.24		4.99	
Y-axis	$\bar{x}$	67.29	59.3	7.83 [1]	61.1	7.15 [1]
	S.D.	8.045	3.82		2.84	
Occlusal plane	$\bar{x}$	14.2	9.2	4.23 [1]	9.65	3.70 [1]
	S.D.	3.87	3.83		4.17	
Interincisal	$\bar{x}$	121.625	135.4	7.95 [1]	126.4	1.88
	S.D.	7.18	5.76		9.45	
$\top$ to occlusal plane	$\bar{x}$	23.60	14.5	6.45 [1]	21.5	1.16
	S.D.	5.39	3.48		6.52	
$\top$ to mandibular plane	$\bar{x}$	5.455	1.5	2.88 [1]	6.55	0.708
	S.D.	4.99	3.78		5.24	
$\perp$ to A-P plane	$\bar{x}$	7.895	3.1	7.43 [1]	6.6	1.83
	S.D.	2.39	1.73		2.21	

The above "t" values were calculated using the test: $t = \frac{\bar{x}_1 - \bar{x}_2}{Sp\sqrt{\frac{1}{N_1} + \frac{1}{N_2}}}$ where Sp is the pooled variance.

1. Differences between means is significant at t_{995}, i.e. above 2.70.
2. Differences between means is significant at t_{975}, i.e. above 2.02.

Table 3

	Navajo Caucasian	Negro Navajo	Negro Caucasian	Navajo Chinese	Navajo Nesei	Nesei Chinese	Navajo Aust. Abor.	Caucasian Chinese	Caucasian Nesei	Negro Chinese	Negro Nesei
Facial plane	.53[1]	.45[1]	.06	.407[1]	.542[1]	.796[1]	.78[1]	.800[1]	.033	.722[1]	.090
Convexity	.358[1]	.197[2]	.55[1]	.091	.175[2]	.302[1]	.132	.484[1]	.232[2]	.147	.410[1]
A-B plane	.06	.22[2]	.28[1]	.042	.126	.192[2]	.261[1]	.118	.046	.200	.372[1]
Mandibular plane	.78[1]	.317[1]	.37[1]	.020	.472[1]	.395[1]	.559[1]	.636[1]	.160	.257[1]	.159
Y-axis	.59[1]	.268[1]	.32[1]	.012	.399[1]	.263[1]	.852[1]	.518[1]	.224[2]	.271[1]	.100
Occlusal plane	.36[1]	.200[2]	.241[1]	.168	.284[1]	.426[1]	.491[1]	.522[1]	.030	.392[1]	.165
Interincisal	.63[1]	.044	.416[1]	.036	.156	.160	.274[1]	.898[1]	.307[1]	.062	.088
to occlusal plane	.48[1]	.049	.405[1]	.083	.094	.035	.275[1]	.474[1]	.354[1]	.015	.043
to mand. plane	.221[2]	.050	.248[1]	.124	.057	.067	.349[1]	.376[1]	.292[1]	.055	.002
to AP	.58[1]	.078	.981[1]	.029	.139	.117	.344[1]	.600[1]	.500[1]	.128	.292[1]

The above values were calculated using the substitute "t" test of microstatistics:

$$Td = \frac{\bar{X}_1 - \bar{X}_2}{\frac{1}{2}(W_1 + W_2)}$$

1. Differences are statistically significant at $P_{99.95}$, i.e. higher than 0.24.
2. Differences are statistically significant at $P_{99.5}$, i.e. higher than 0.175.

established that differences between means can be determined with comparable accuracy by this test, the Navajo means were then compared to the means of other groups. Perhaps the most outstanding result is the comfirmation that the Navajos do resemble the Chinese more than any other group. The only difference is in the facial plane angle.

The Navajos resemble the Australian Aborigine or Caucasians as little as the Negroes resemble Caucasians. No significant differences are noted in the dental measurements (except the cant of the occlusal plane) between the Navajo and Negro or Nesei. As mentioned, no differences between the Navajo and Chinese dental measurements were noted.

Additional information is provided through use of the method employed by Bjork. The values for 11 angular and 8 linear measurements are provided in Table 4. Statistical differences between means has not been determined for this data.

From this data, however, a mean facial diagram has been constructed for Navajo boys (Figure 2). This has been superimposed on the mean facial diagram derived by Bjork in his study of 12 year old Swedish boys. Figure 3 shows this superimposition of diagrams registered at nasion while figure 4 is registered at sella.

Gross evaluation of the superimposed mean facial diagrams indicate the following: Superimposed on the S-N line, registered at N, the relative prognathism of the Navajo is quite apparent. The increased chin angle of the Navajo is well demonstrated. Superimposed on S-N, registered at S, the relative differences in cranial base angles may be noted.

The Navajo facial diagram tends to support the findings of Bjork in evaluation of prognathism. Bjork[5] states that prognathism may be due to the following:

Table 4

Angular Measurement	Navajo boys Age 12-14, N=11 $x \pm \mathcal{E}(x)$	Swedish 12 year old boys. N=322 Most Prognathic N=168	Least Prognathic N=154
Ar-N-Pr	69.89 ± 0.40	67.92 ± ---	62.80 ± ---
Ar-N-Pg	62.36 ± 0.51	62.24 ± 0.21	59.03 ± .023
N-S-Ar (Saddle Angle)	127.5 ± 0.92	122.46 ± 0.37	123.38 ± 0.40
S-Ar-KK (Joint Angle)	143.82 ± 1.21	142.13 ± 0.50	143.87 ± 0.49
Ar-KK-Gn (Jaw Angle)	125.77 ± 1.03	130.97 ± 0.49	131.21 ± 0.47
KK-Gn-id (Chin Angle)	75.00 ± 1.39	69.99 ± 0.38	67.05 ± 0.43
N-Pr-Pg (Profile Angle)	162.32 ± 1.28	164.78 ± 0.41	167.85 ± 0.45
Ar-N-S (Cranial Base Angle)	17.5 ± 0.40	19.10 ± 0.13	18.33 ± 0.15
N-Ar-MP	53.68 ± 1.01	53.65 ± 0.37	56.87 ± 0.41
S-N-Pr	87.5 ± 0.51 (S.D.)	83.68 3.67 (S.D.)	(N=322)
S-N-Pg	80.45 ± 0.61 2.93 (S.D.)	78.92 3.62 (S.D.)	(N=322)
Linear Measurement			
N-S	62.90 ± 0.69	68.38 ± 0.39	69.03 ± 0.58
N-Ar	87.44 ± 0.99	91.16 ± 0.52	93.63 ± 0.53
S-Ar	33.67 ± 0.51	33.31 ± 0 38	35.73 ± o.48
Ar-KK	44.20 ± 1.06	44.81 ± 0.52	39.47 ± 0.55
KK-Pg	74.60 ± 1.16	74.59 ± 0.68	72.72 ± 0.74
Ar-dd	104.85 ± 1.47	104.68 ± 0.36	101.11 ± 0.37
N-Pr	66.11 ± 0.97	65.26 ± 0.26	66.55 ± 0.28
N-Gn	114.70 ± 1.41	112.55 ± 0.40	113.74 ± 0.45

Table 4. Mean angular and linear values for Navajo boys. Bjork's data for these measurements on Swedish boys is included for comparison.

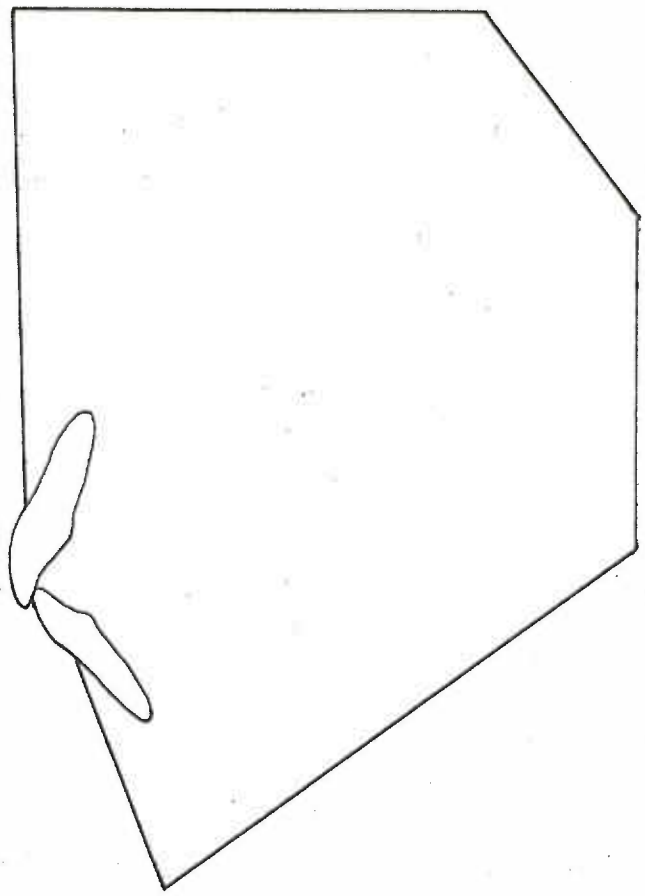

Figure 2.

Facial diagram constructed from mean values for 11 selected Navajo boys. Natural size diagram.

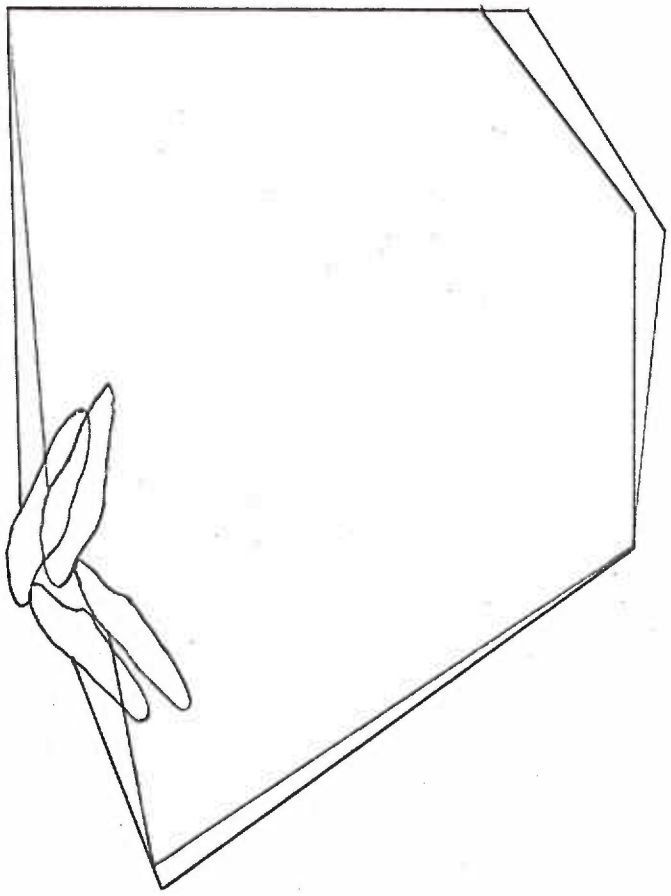

Figure 3.

Mean facial diagrams of Navajo boys and Swedish boys superimposed on SN, registered at nasion.

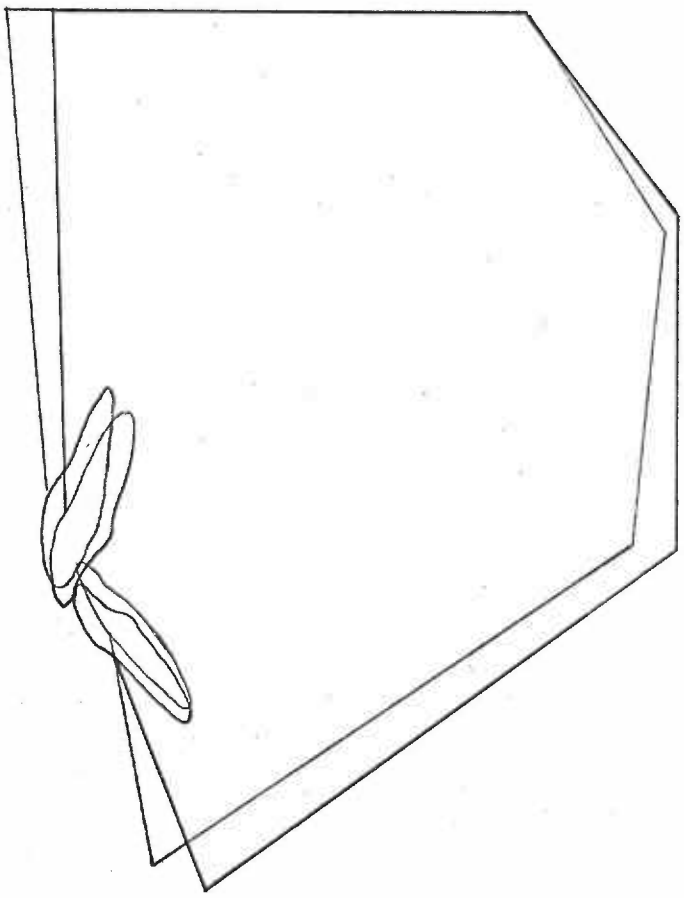

Figure 4.

Mean facial diagrams of Navajo boys and Swedish boys superimposed on SN, registered at sella.

1. shortening of the cranial base.
2. an angular deflection of the cranial base
3. changes in the shape of the facial skeleton resulting in a diminished angle between the ramus and cranial base
4. increased jaw length.

The Navajo mean facial diagram indicates that this group is more prognathic than the most prognathic half of the Swedish boys. This is also indicated by the angle Ar-M-Pr in Table 4. The Navajo cranial base (N-S and N-Ar) is shorter as well as there being more angular deflection of the cranial base (N-S-Ar). However, the angle between the ramus and cranial base is nearly identical in both groups. A difference in length of the jaws was not observed. The Navajo mandibular length (Ar-dd) was also almost identical to that of the more prognathic Swedish boys.

The role of the cranial base in facial form is also discussed by Coben,[6] who concludes that "a severe flexure of the base without a corresponding reduction in the mandible might lead to mandibular prognathism. An obtuse cranial base may so increase the depth of the upper face as to result in mandibular retrusion. A relatively horizontal anterior cranial base may position the entire posterior face at such a high level as to effect an abnormally steep mandibular plane and mandibular retrusion. Conversely, a very steep inclincation of the anterior cranial base might position the posterior face at such a low level as to result in a horizontal inclination of the mandibular plane. Any and all combinations and degrees of variations are possible and do exist."

A number of scattergrams were constructed in an attempt to determine possible correlations between measurements. The scattergrams were, however, so widely distributed that correlation coefficients were not calculated.

Whether definite relationships between various facial structures can be determined for ethnic groups, not to mention individuals, appears quite

improbable at this time, at least by this means. This view was also taken by Coben, who states, "When one considers the variation seen in the cranial base and the variation in every structure composing the dentofacial complex, it would seem that there could not be any rigid combination of factors associated with any particular type of malocclusion. The adjustments and combinations are infinite and it is the integration of these variables which determines harmony or disharmony."

Summary

Little is known about "ancient" Navajo skeletal structures, largely due to their beliefs concerning the dead. For this reason any knowledge of this nature on the Navajo must be limited to the present generations.

A cephalometric description of 23 Navajo Indians, ages 12-14, is presented by utilization of Down's analysis. This analysis is the only one presently available for comparison of several ethnic groups by roentgenographic means.

Differences between the mean values for Navajos, Caucasians, American Negroes, American Chinese, Nesei and the Australian Aborigine have been tested statistically. The Navajos most nearly resemble the American Chinese, with the only significant difference being the facial plane angle.

Using both the linear and angular measurements proposed by Bjork, a mean facial diagram was constructed for Navajo boys and compared with that for Swedish boys. The observation that a shorter cranial base and a more obtuse cranial base angle are associated with increased prognathism appears to be confirmed by this study on the Navajo. Final conclusions, however, cannot be made at this time.

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Form No. 999 — 20 Squares to Inch
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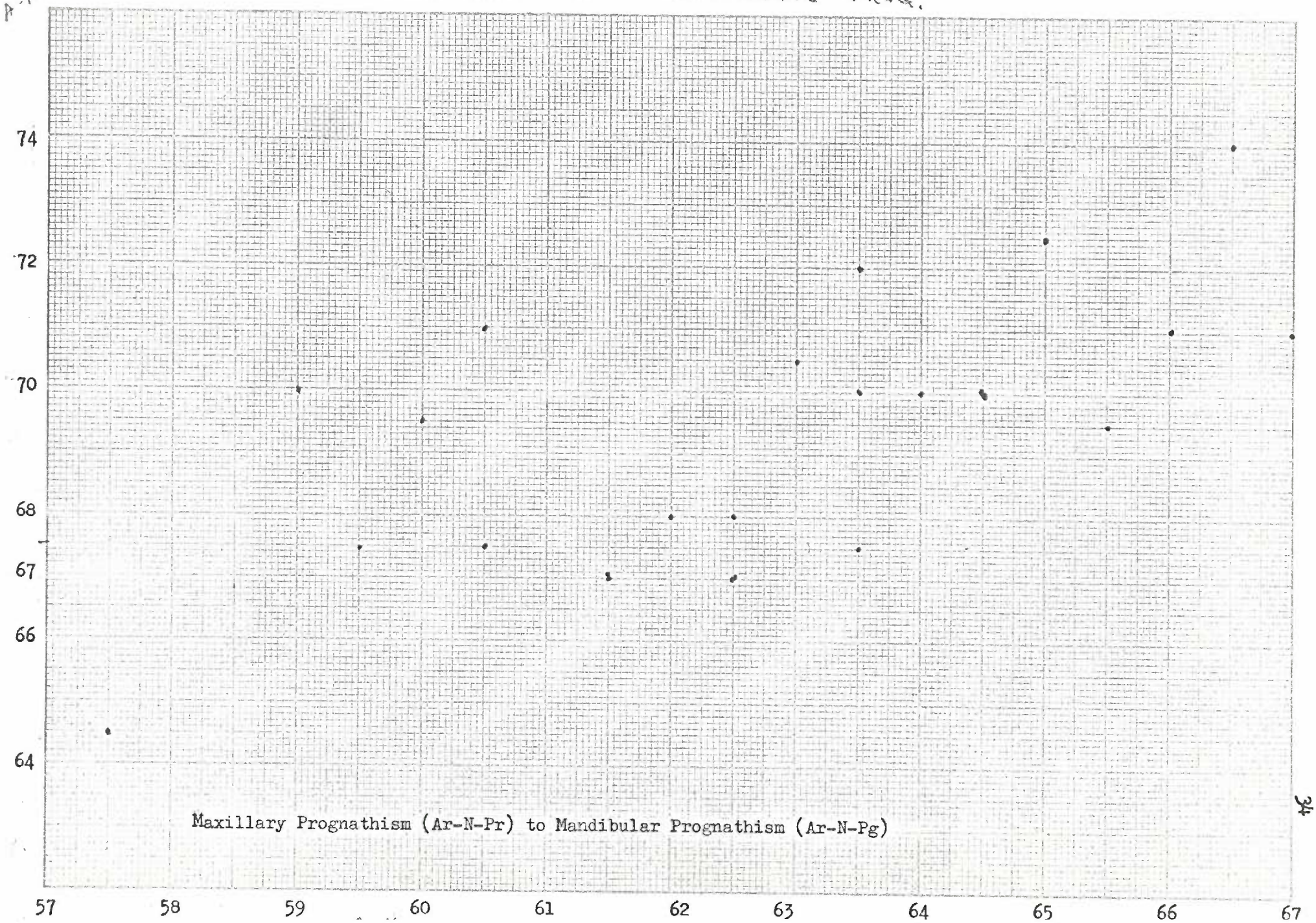
(BJORK - r = .67)

MAX PROG. TO MANDIBULAR PROG.



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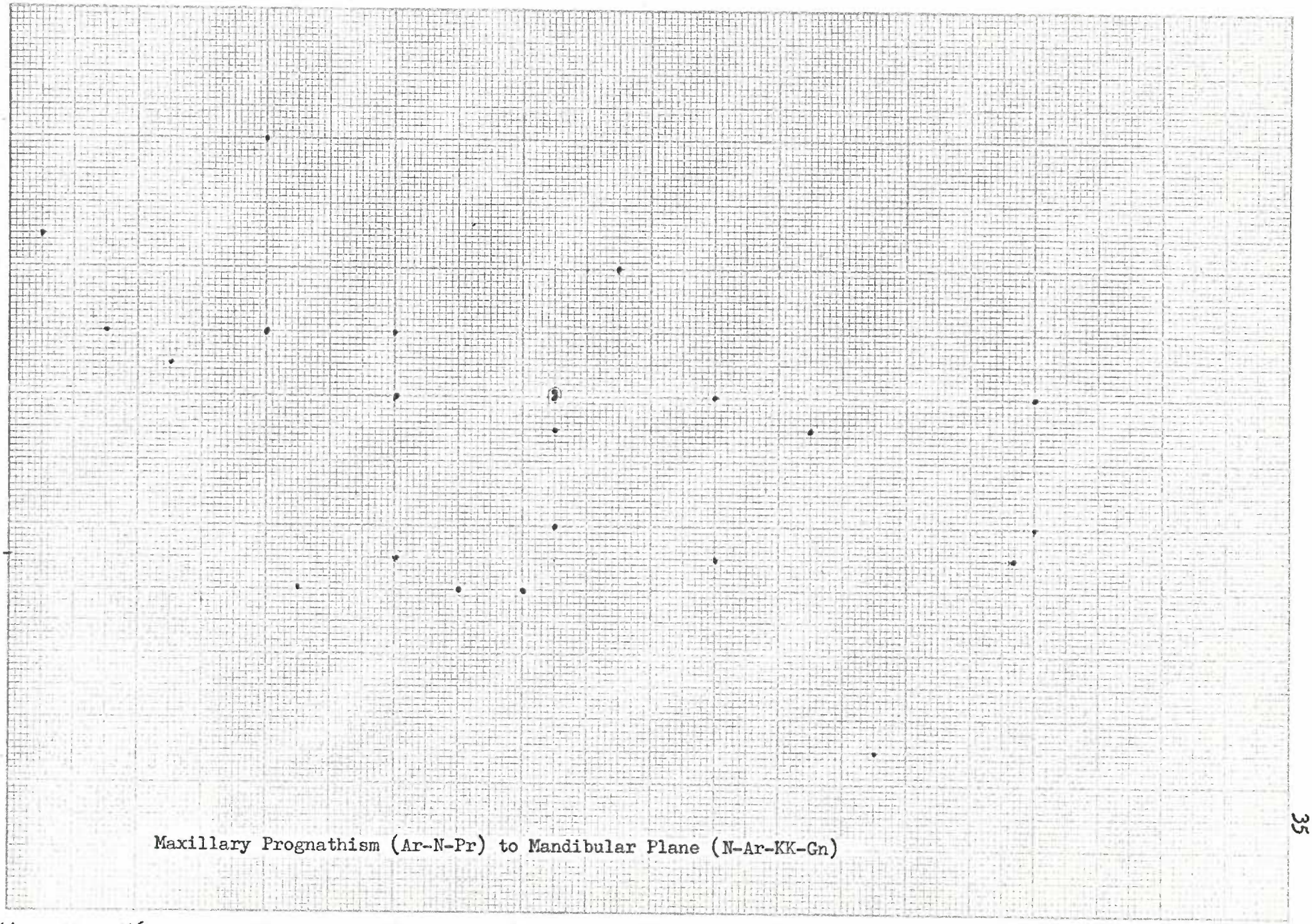
AMERICAN PAD & PAPER CO., HOLYOKE, MASS.

A-N-Pr

MAX. PROG. TO MANDIBULAR PLANE



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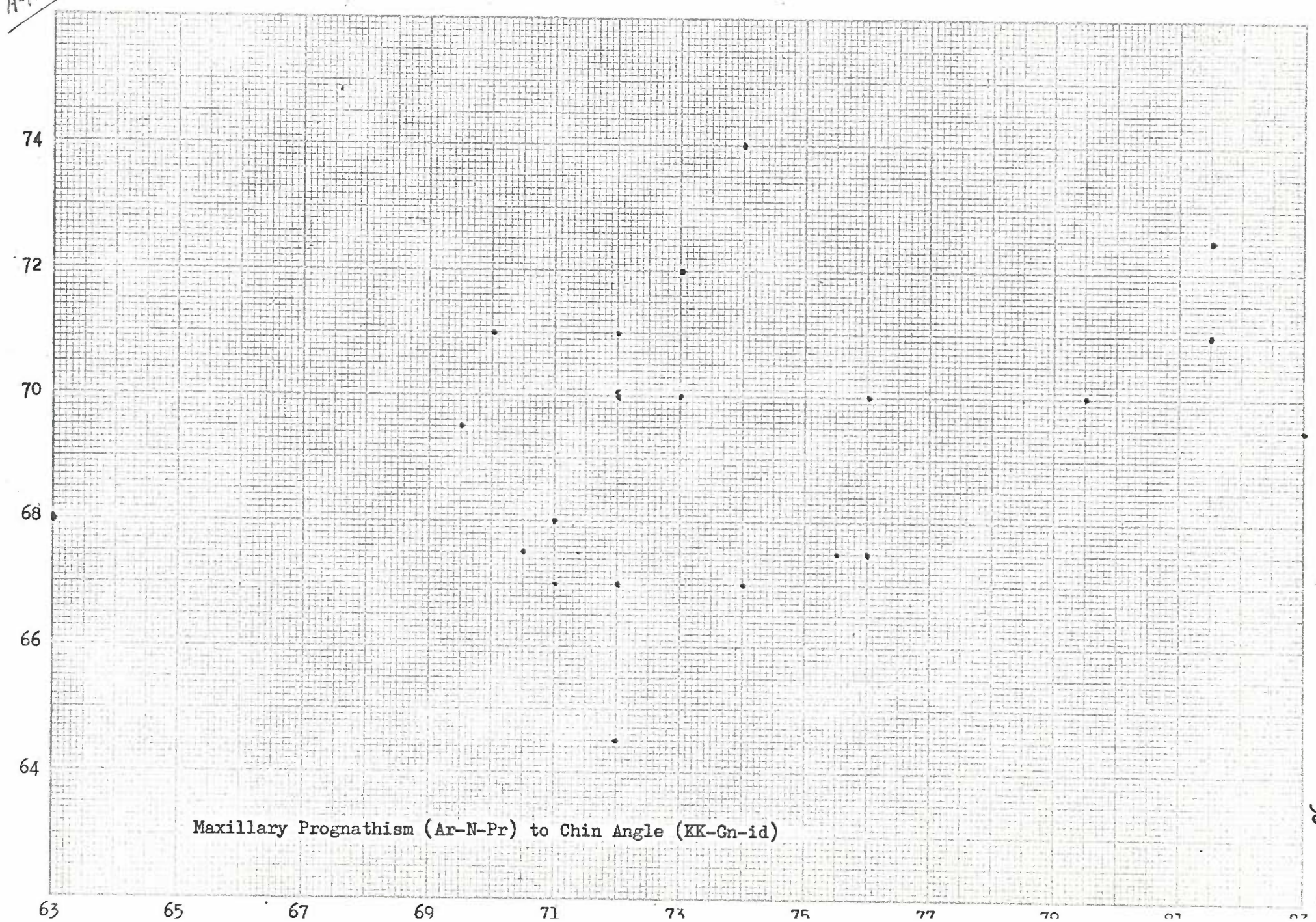
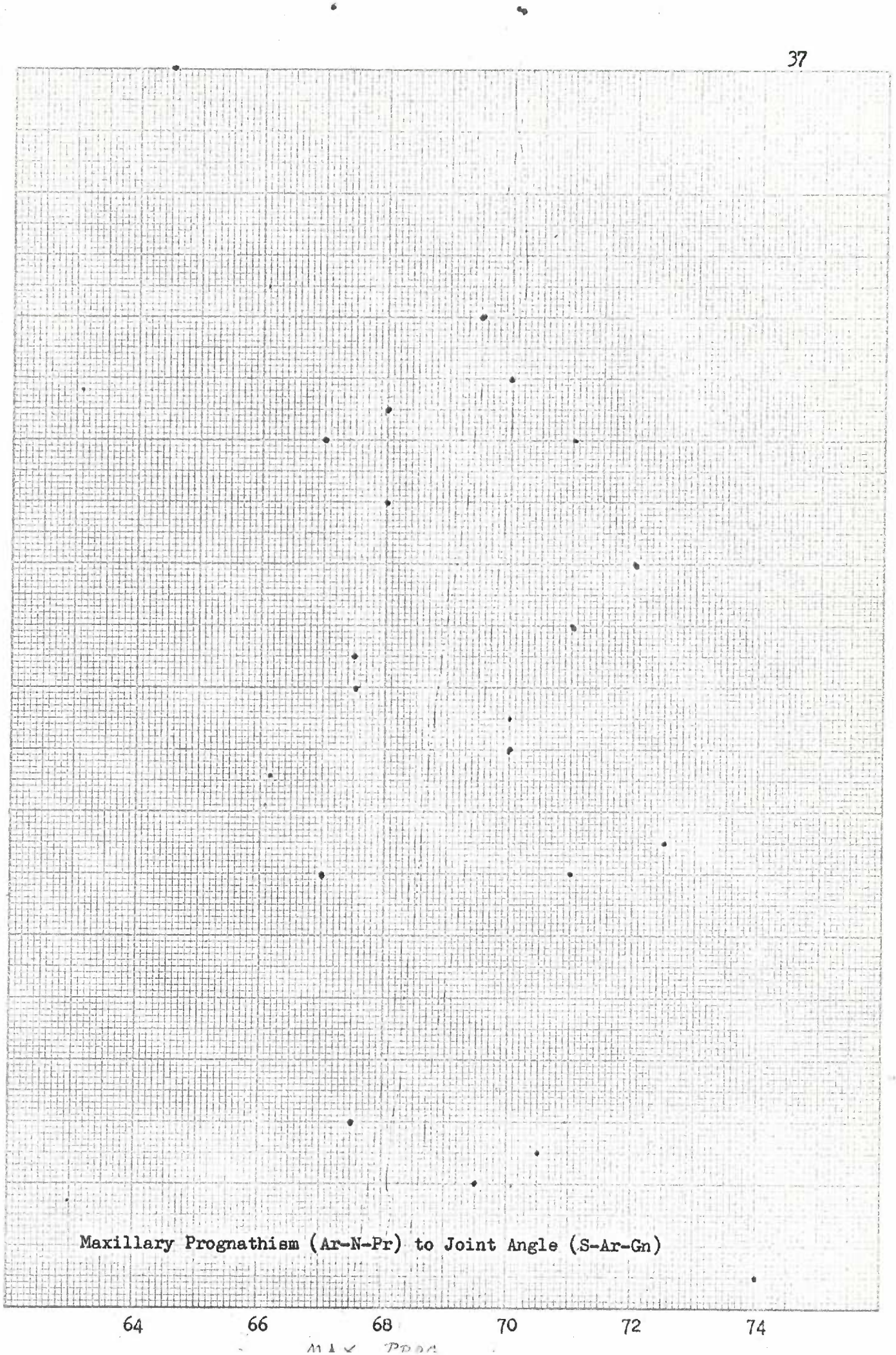
A-N-Pr

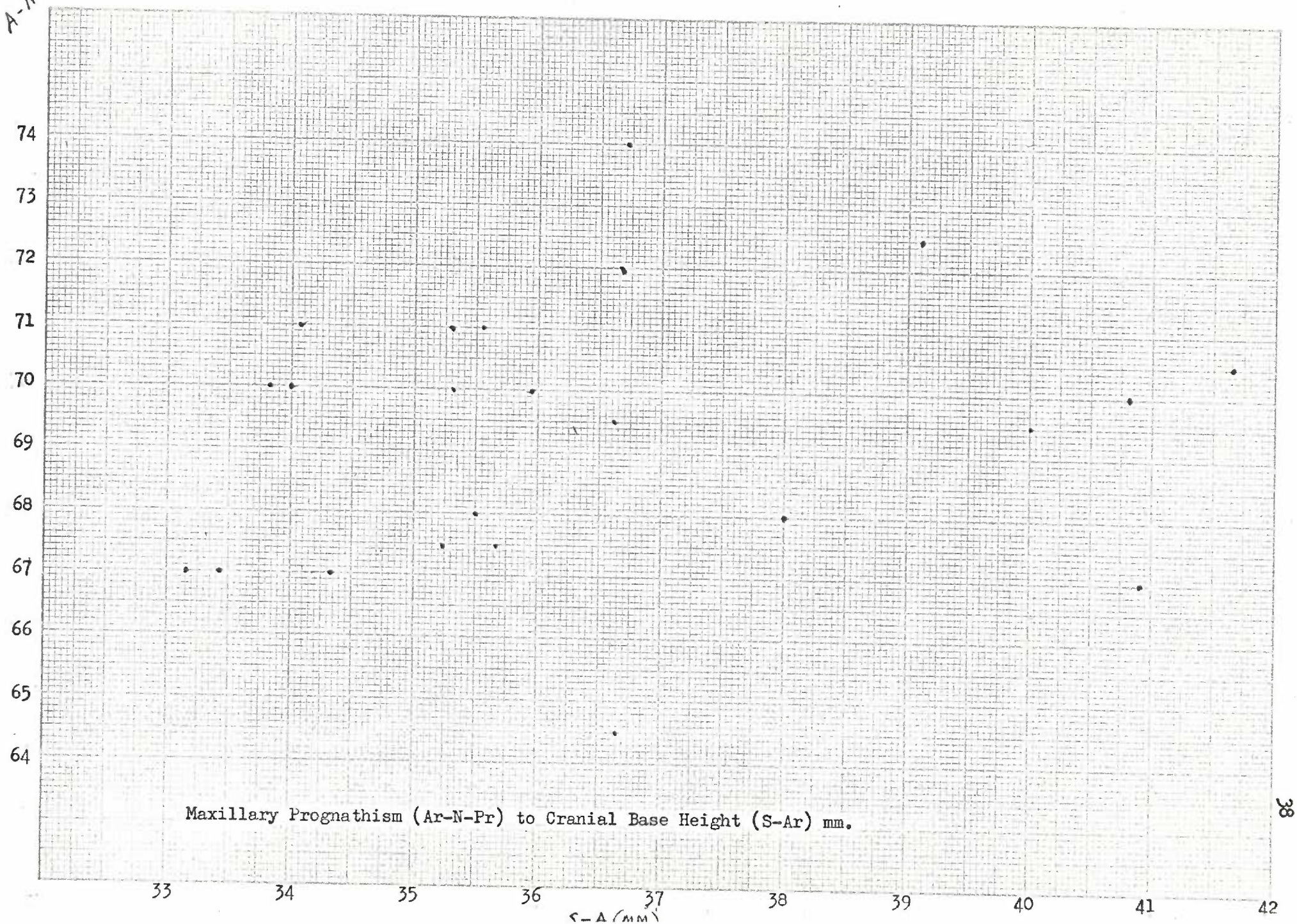
MAX. PROG. TO CHIN ANGLE.



36



ANGLE A-N-Pr



Maxillary Prognathism (Ar-N-Pr) to Cranial Base Height (S-Ar) mm.

Form No. 990 — 20 Squares to Inch
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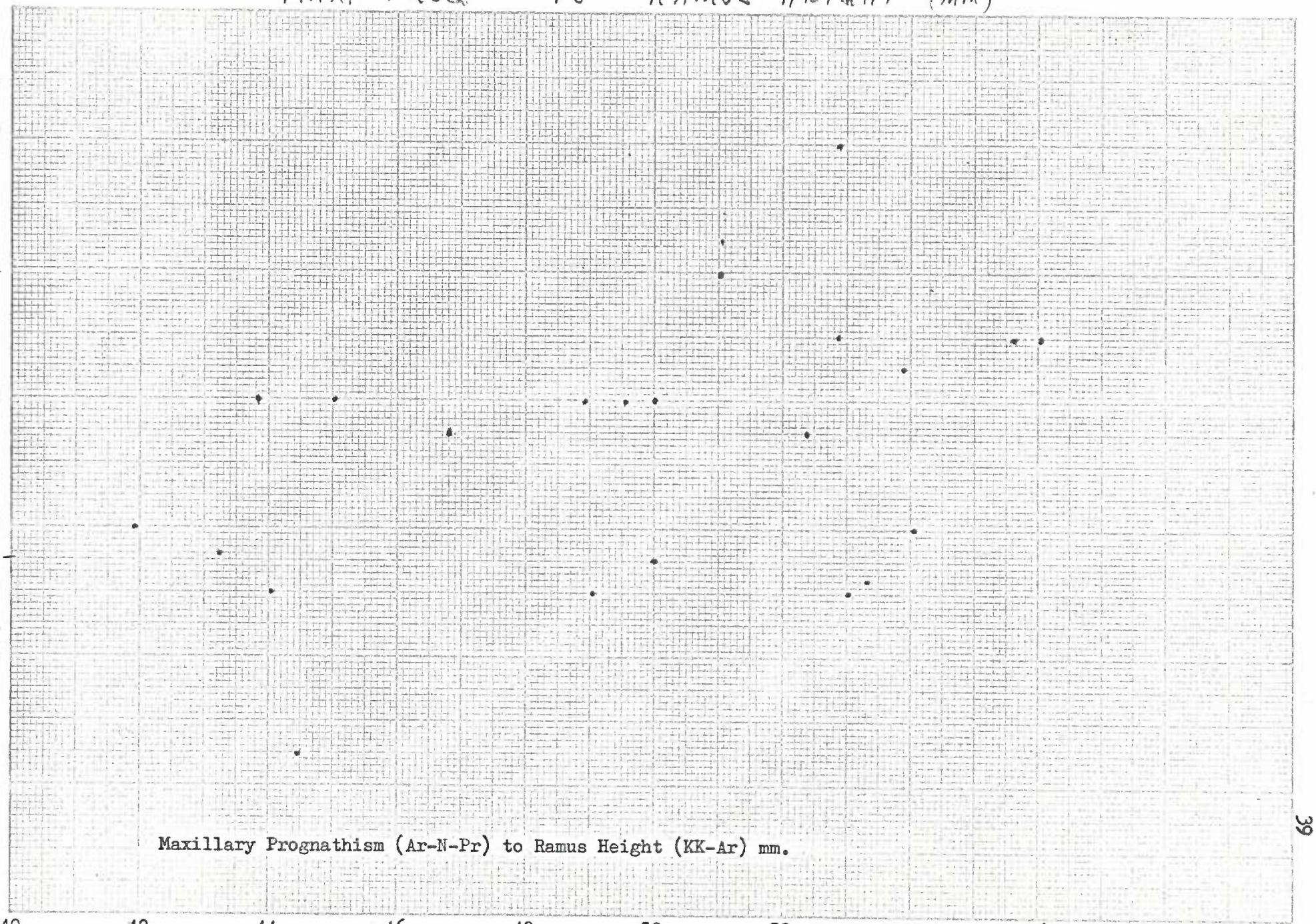
A-N-Pr

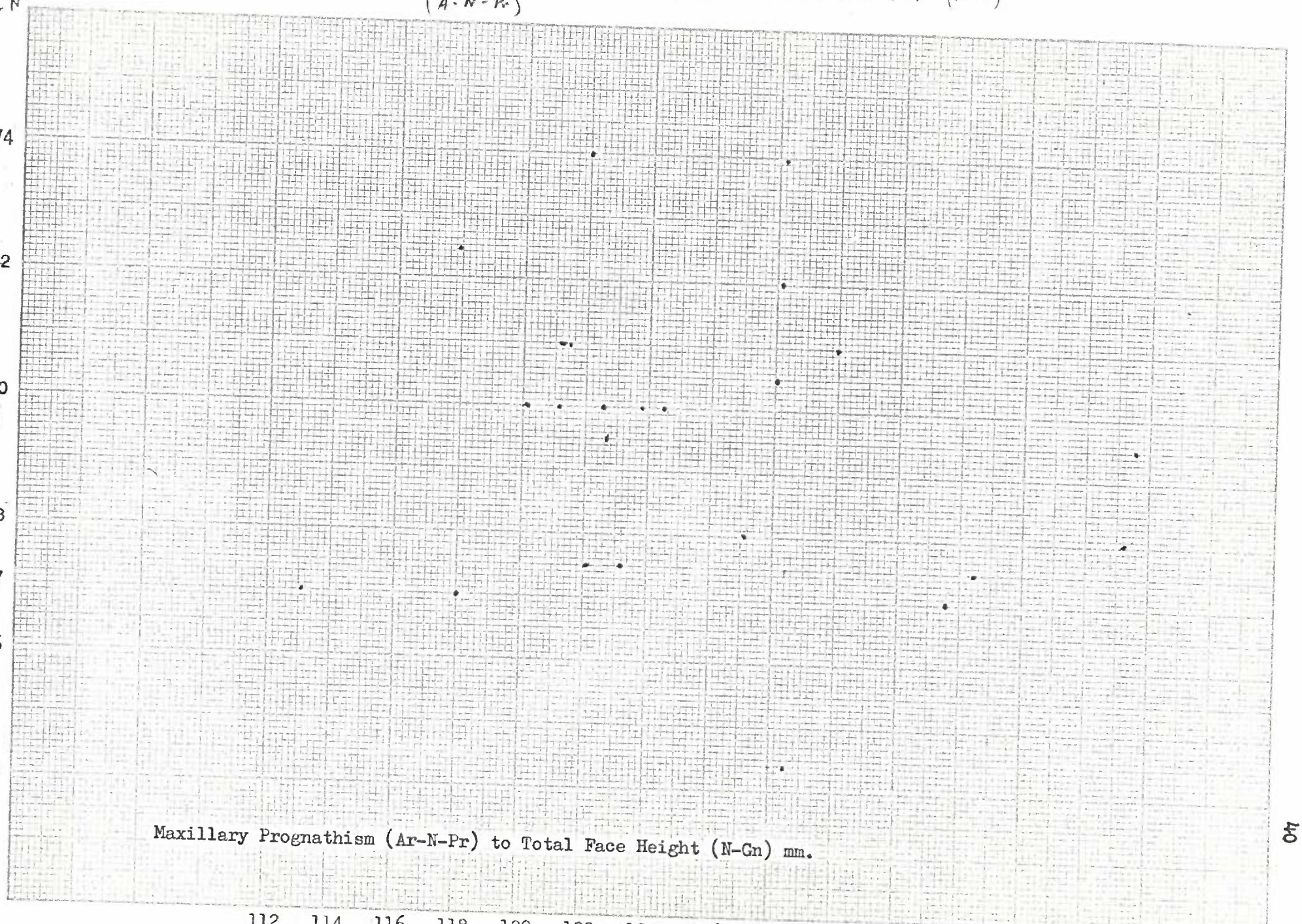
MAX. PROG. TO RAMUS HEIGHT (mm)



Maxillary Prognathism (Ar-N-Pr) to Ramus Height (KK-Ar) mm.

ANGLE
A-N-Pr

MAX PROG. TO TOTAL FACE HEIGHT (MM)
(A-N-Pr)



Maxillary Prognathism (Ar-N-Pr) to Total Face Height (N-Gn) mm.

40