Paleoserologic Studies: ABO and Histocompatibility Antigens in Mummified American Indians

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The first genetic polymorphism to be described in man was the ABO blood group system. This system proved to be present as a membrane antigen of the cells of almost all organs of the body. In this it not only simulates histocompatibility antigens but also helps to determine ABO compatibility between organ recipients and their donors. The presence of the ABH and HL-A antigens in tissues and their stability on storage allows typing mummified bodies despite the passage of thousands of years.

The possibility that the ABO blood groups might be associated with diseases and subject to natural selection was considered soon after their discovery by Landsteiner, while the Herszfelds were the first to use the ABO blood groups as markers for studying ethnic differences as an aid to the study of evolution. Since retrospective paleoserologic studies of human populations using their remains are possible only when ABO groups are present on tissue cells of the organs, the discovery of the HL-A antigens was a welcome additional means of studies in mummies. This is mainly because the HL-A system proved to be the most highly polymorphic antigen system in man—a most helpful characteristic in studies of natural selection and evolution in human populations.

The paleoserologic studies reported here have been carried out to determine the frequency and distribution of the ABO and HL-A antigens in mummified bodies belonging to various cultural groups. The information is useful in the study of evolution of the American Indians.

Materials and Methods.

Mummified Tissue Samples. One hundred and eleven samples consisting of fragments of muscles from various parts of the bodies of mummies, but mainly from the psoas area, were tested; the mummies were obtained from known cemeteries which were excavated scientifically by archeologists and were dated by 14C in 20 cases. The mummies were placed in four groups: (a) the pre-Columbian, pre-Ceramic, (b) the pre-Columbian, Ceramic, (c) Chil-ean Colonials, and (d) Peruvian Colonials; the pre-Columbian mummies were further divided into the cultural groups: Paracas, Nazca, Huari, Inca, and Ica.

ABO Grouping Sera and Cells

The standard agglutination-inhibition technique was applied to determine the presence or absence of the A and B antigens or both in the mummified tissues. This has been previously described in detail.1

HL-A Typing

The lymphocytotoxicity-inhibition test was used to type the mummies. The procedure employed by Stastny8 was followed with some modifications.

The tests were performed on 109 of the samples only. Insufficient material prevented typing two of the tissues which belonged to the Ceramic group.

The tissues were typed for the following anti-

**Materials.**


3. **Tris-NH₄Cl.** Mix 1 part Tris Buffer (a) in 9 parts NH₄Cl (b).
   a. **Tris Buffer.** #T-1503 Trisma Base. Sigma Chemical Company, P.O. Box 14508, St. Louis, Mo. 63178.
      Use: 20.6 gm Tris/1000 cc distilled water. Make up a flask 1/2 to 3/4 volume and adjust pH with concentrated HCl to pH 7.2 to 7.4 (starting pH will be about pH 11.0). Do at room temperature. Transfer to volumetric flask and add distilled water to desired volume.
   b. **Amonium chloride.** Use 0.83 gm NH₄Cl/100 cc distilled water.

4. a. **Nylon.** E. I. DuPont de Nemours Company, Wilmington, Del. 19801. #67030 100% Nylon, staple, semi-dull, 1 to 1/2 inch length, 3 denier, type 200.
   b. **Dupanol.** #241900, Dupanol RA. Liquid 1–356. E. I. DuPont de Nemours Company, P.O. Box 1909, Charlotte, N.C. 28201.
      Use: heat to 65 C to 70 C for 30 minutes the following: 200 gm nylon, 4 liter water, and 20 cc dupanol. Stir continually to prevent scorching. Rinse overnight in tap water. Rinse thoroughly in distilled water seven or eight times. Let air dry. Comb and brush nylon to make fibers separate. Weigh out 0.7 gm of combed nylon and pack firmly into a small pasteur pipette. Cap with small rubber serum stopper.
   c. **Serum Stoppers.** #8826 small rubber serum stopper. 5 X 9 mm EDP No. 8753-D22. Arthur H. Thomas Co., P.O. Box 779, Philadelphia, Pa. 19105.

5. **Trypan Blue.** #TX 1580. General Scientific Corp., P.O. Box 2V, Richmond, Va. 23205.

Use: 1 gm/100 ml distilled water, filtered = 1% stock solution. For daily use: dilute 3 ml of 1% stock solution with 7 ml of 2% EDTA solution = 0.3% Trypan (occasional filtration of stock solution is needed).

6. **EDTA.** #1-8993 Disodium EDTA, Dihydrate VWR. P.O. Box 5195, Baltimore, Md. 21203.


8. **Rabbit Complement.** Grand Island Biological Co., 3175 Staley Road, Grand Island, N.Y. 14072.


    Use: Hypaque 37.77% (with 0.1% Na Azide). Make up 1000 ml in vol. flask. Take 755.4 ml of 50% Hypaque and add 1 ml of 10% Na Azide. Top up to 1 liter with distilled water and mix thoroughly with magnetic stirrer.

11. **Ficoll.** #F-4375 Sigma Chemical Co., P.O. Box 14508, St. Louis, Mo. 63178.
    Use: Ficoll 9% (wt/vol) (with 0.1% Na Azide). Make up 3000 ml in vol. flasks. In 3000 ml flask put 270 gm Ficoll, 3 ml of 10% Na Azide, top up to 3 liters with distilled water. Mix 1/2 hour with magnetic stirrer.

12. **Ficoll-Hypaque.** Take 1 part Hypaque 37.77% (50 ml) with 3 parts Ficoll 9% (1500 ml). Mix one hour, check and adjust density with hydrometer in a 250 ml graduated cylinder [optical density (O.D.) 1.077 to 1.079]. Store in dark bottles and refrigerate.

13. **Membrane Dializer.** Union Carbide Corporation, Food Products Division, 6733 West 65th Street, Chicago, Ill. 60638.

14. **Albumin Stock Solution.** Stock No. 905-10. Sigma Chemical Co., P.O. Box 14508, St. Louis, Mo. 63178.

18. Solution A. 20 gm Na₂CO₃, 4.0 gm NaOH, 0.2 gm Na, K, tartrates, Dilute to 1 liter with distilled water.
19. Solution B. 5 gm CuSO₄, 5 H₂O. Dilute 1 liter with distilled water.
21. Panel of H L-A antigens prepared from donors at the Department of Surgery, Medical College of Virginia, Richmond, Va.

Methods.

A. Cell Preparation.
1. Collect 10 cc of heparinized blood (25 units hep/ml blood) and pass it through a column containing 0.5 to 1.0 gm of nylon into 10 ml test tube. Then wash the column with barbital buffer for maximum cell yield. Addition of blood and washing are performed at room temperature.
2. Add an equal volume of barbital buffer and mix, leaving enough room in tube for the addition of 2 to 3 ml of Ficoll-Hypaque.
3. Layer cells over 2 to 3 ml of Ficoll-Hypaque.
4. Centrifuge at 2800 rpm for 15 to 20 minutes using International Centrifuge.
5. With pipette remove lymphocytes from the interface between the blood plasma and Ficoll-Hypaque, place in a 10 × 75 mm tube, then wash cells with barbital buffer in a table centrifuge spinning at 1400 rpm for six minutes.
6. Remove any red blood cells by adding warm Tris-NH₄Cl for five minutes. Spin cells at 1000 rpm for six minutes.
7. Reconstitute cells in McCoy’s media with 5% fetal calf serum to 2 million cells per ml and store at 4 C. These cells are usable after a maximum of four days of storage.
8. Test for cell viability by addition of a small amount of 1% Trypan blue in 0.5 cc of cell suspension and look for blue cells (dead cells) under the microscope. This procedure should be done at the time of testing. If cell viability is less than 90% to 95%, discard the cell suspension.

B. Preparation of Mummy Extracts.
1. Press the mummy tissue through a stainless steel sieve to obtain a fine powder.
2. Extract 2 gm of tissue powder twice in 10 cc saline with constant stirring at 37 C for 30 minutes.
3. Combine with two extracts and transfer them to a dialysis membrane tube. Immerse the membrane in 4 C distilled water overnight.
4. Use the dialized fluid, rich in protein, for protein determination as follows:
   a. Prepare standards (three each) containing 200 mg, 500 mg, and 1000 mg of Bovine Serum Albumin.
   b. Prepare two 0.1 ml aliquotes of each tissue extract.
   c. Bring volume of all tubes (standard and samples) to 1.0 ml using distilled water.
   d. Prepare solution C by mixing 50 parts of solution A to 1 part of solution B (see Materials for solutions A and B.)
   e. Add 5 ml of solution C to each tube.
   f. Prepare Folin Howerey reagent (Folin-Ciocalteu) by adding 5 ml phenol reagent 2N solution to 7 ml distilled water.
   g. Quickly add 0.6 ml of reagent to each tube and shake vigorously.
   h. Read at 420 mµ after 30 minutes, using spectrophotometer.
   i. Plot optical density (O.D.) vs concentration.
   j. Blank contains 1 ml H₂O, 5 ml solution C, and 0.6 ml phenol reagent.
5. Each sample is then freeze-dried and dissolved in Dulbecco’s Modified Eagle Modified media.

C. Lymphocytotoxicity Inhibition Procedure.
1. Prepare a stock solution containing 24 mg mummy protein/ml. This stock solution is then used to prepare three working solutions, containing 6, 12, and 18 mg/ml respectively.
2. Titrate the antiserum to be used using lymphocytes known to carry the corresponding HL-A antigens to determine the endpoint
which is to be used as the working antiserum.

3. Add 1 lambda of antiserum and 1 lambda mummy tissue extract with protein concentrations of 18, 12, and 6 mg/ml into separate wells of the Falcon with a Hamilton syringe. The mixture is incubated for one hour at 22 C and then incubated overnight at 4 C.

4. Next day, 1 lambda of cell suspension is added to the above mixture and left to incubate at room temperature for 30 minutes. (Use a thin wire to mix volumes not mixed in the cell dispensing process).

5. The wells are then filled with barbital buffer, using a thinly drawn Pasteur pipette, and allowed to settle for ten minutes. Remove buffer by flicking the plate with a quick motion of the wrist.

6. Five lambda of rabbit complement which is previously titered are then added to each well. Make sure volumes are mixed. Plates are incubated at room temperature for one hour.

7. The complement must be removed by flicking the plates before staining the cell for testing. Using a thinly drawn Pasteur pipette, fill each well with a drop of trypan blue in EDTA. Let stand for ten minutes to allow cells to settle. Flick well once.

8. The wells are filled with barbital buffer and allowed to settle ten minutes.

9. Add cover glass. Read.

10. The determinations are made by placing the plate under an inverted phase microscope at 150X (10X objectives, 15X ocular) and judging the percentage of inhibition using the following formula:

\[
\% \text{ inhibition} = 100 \times \frac{\% \text{ cell killed in presence of inhibitor}}{\% \text{ cell killed in absence of inhibitor}}
\]

11. The following controls were added to each test system, which consisted of target lymphocytes incubated with:
   a. antiserum without mummy antigen.
   b. with antiserum and mummy antigen, but without complement.
   c. with complement alone.
   d. with mummy antigen alone.

All test and controls should be made in duplicate.

12. If percentage inhibition is low or absent, the amount of protein concentration should be increased for a higher percentage inhibition (protein concentration in mummy tissue extracts does not represent antigen concentra-

### Table 1
Percentage Distribution of ABO Antigens in 111 Pre-Columbian and Colonial Mummies and in Seven American Indian Tribal Populations

<table>
<thead>
<tr>
<th>Populations</th>
<th>Number Tested</th>
<th>O</th>
<th>A</th>
<th>B</th>
<th>AB</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUMMIES (present study)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-Columbian Pre-Ceramic</td>
<td>8</td>
<td>50</td>
<td>37.5</td>
<td>0</td>
<td>12.5</td>
</tr>
<tr>
<td>Pre-Columbian Ceramic</td>
<td>40</td>
<td>60.98</td>
<td>17.07</td>
<td>2.44</td>
<td>19.51</td>
</tr>
<tr>
<td>Peruvian Colonial</td>
<td>45</td>
<td>89</td>
<td>8.78</td>
<td>0</td>
<td>2.22</td>
</tr>
<tr>
<td>Chilean Colonial</td>
<td>18</td>
<td>94.44</td>
<td>5.56</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AMERICAN INDIANS*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aymara</td>
<td>37</td>
<td>97</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Warao</td>
<td>*</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Quechua</td>
<td>90</td>
<td>85.5</td>
<td>13.6</td>
<td>0.9</td>
<td>0</td>
</tr>
<tr>
<td>Ixil</td>
<td>79</td>
<td>58.4</td>
<td>41.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Zuni</td>
<td>*</td>
<td>84.36</td>
<td>13.36</td>
<td>1.63</td>
<td>0.65</td>
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<tr>
<td>Papago</td>
<td>101</td>
<td>93.83</td>
<td>6.17</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Pima</td>
<td>*</td>
<td>78.35</td>
<td>20.62</td>
<td>1.03</td>
<td>0</td>
</tr>
<tr>
<td>EUROPEAN CAUCASIANS*</td>
<td>*</td>
<td>45</td>
<td>41</td>
<td>10</td>
<td>4</td>
</tr>
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</table>

* Number tested not given
Table 2
Number and Frequency in Percent (#/%) of HL-A Antigens Detected in Four Groups of Mummies

<table>
<thead>
<tr>
<th>Group</th>
<th>Number Tested</th>
<th>Number/Percent of HL-A Antigens Detected</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>PRE-COLOMBIAN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-Ceramic</td>
<td>8</td>
<td>0/0 1/12.5 2/25 3/37.5 2/25</td>
</tr>
<tr>
<td>Ceramic</td>
<td>38</td>
<td>12/31.6 8/21 14/36.8 3/7.9 1/2.7</td>
</tr>
<tr>
<td>COLONIAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chilean</td>
<td>18</td>
<td>6/33.33 5/27.78 5/27.78 1/5.56 1/5.56</td>
</tr>
<tr>
<td>Peruvian</td>
<td>45</td>
<td>16/35.56 13/28.98 10/22.22 6/13.33 0/0</td>
</tr>
</tbody>
</table>

Results.

ABO Typing

The results of testing the 111 mummies by the agglutination-inhibition technique are given in Table 1 as a percentage distribution of the ABO groups among the four groups to which the mummies belonged. For comparison purposes, we have included in this table the percentage distribution of the ABO groups in seven contemporary American Indian groups.

HL-A Typing

Table 2 shows the number of mummies in each group that gave positive tests for 0, 1, 2, 3 or 4 HL-A antigens. Positive results for at least one histocompatibility antigen were obtained in 75 (68.8%) of the 109 mummies tested for 16 HL-A antigens. All samples from the pre-Ceramic group, which were the oldest to be tested, showed positive reactions with one or more of the 16 HL-A antisera employed. However, 12 of the 38 pre-Columbian Ceramic, 6 of the 18 Colonial Peruvian, and 16 of the 45 Colonial Chilean groups showed none of the 16 antigens for which they were tested. Thus 31.2% of the mummies were nonreactive.

The amount of tissue needed to neutralize an HL-A antiserum varied from mummy to mummy. Only 6 mg/ml of antigen from certain mummies were needed to completely inhibit a certain antiserum while other mummies were able to do so only with the highest concentration of the antigen (24 mg/ml). None of the powders surrounding mummies produced a positive inhibition test.

The percentage distribution of the HL-A antigens in the 75 positive mummies is given in Table 3. The reported percentage distribution of these antigens in seven contemporary American Indian tribes is given in Table 4 for comparison purposes.

Table 3
Frequency in Percent of 16 Antigens in 75 Mummified Pre-Columbian and Colonial Tissues Giving at least One Positive Test

<table>
<thead>
<tr>
<th>Group</th>
<th>First Segregant Series</th>
<th>Second Segregant Series</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HL-A 1 2 3 9 11 19</td>
<td>W 28 5 7 8 12 13 5 14 15 17</td>
</tr>
<tr>
<td>PRE-COLOMBIAN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-Ceramic (Huacho)</td>
<td>0 75 0 0 12 62 12 50 0 0 0 50 0 0 0 25</td>
<td></td>
</tr>
<tr>
<td>Ceramic</td>
<td>0 69 4 23 0 15 19 23 9 4 0 4 15 0 8 4</td>
<td></td>
</tr>
<tr>
<td>COLONIAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chilean</td>
<td>0 83 0 8 0 17 8 50 9 9 25 0 0 0 0 0 0</td>
<td></td>
</tr>
<tr>
<td>Peruvian</td>
<td>0 58 7 14 0 27 0 52 0 0 7 10 0 0 3 0</td>
<td></td>
</tr>
</tbody>
</table>
Table 4

<table>
<thead>
<tr>
<th>Cultural Group</th>
<th>AMERICAN INDIANS</th>
<th>ESKIMOS</th>
<th>EASTER ISLANDERS</th>
<th>CAUCASIANS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 9 11 19 28</td>
<td>5 7 8 12 13 5 14 15 17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aymara</td>
<td>2 74 5 24 0 66 5</td>
<td>35 0 0 0 0 5 0 56 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warao</td>
<td>0 74 0 31 0 42 19</td>
<td>58 0 0 0 0 4 0 71 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quechua</td>
<td>2 85 1 37 1 12 20</td>
<td>7 6 1 3 1 58 3 34 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ixil</td>
<td>3 66 0 30 10 —</td>
<td>38 17 0 7 0 64 3 3 0.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zuni</td>
<td>0 76 0 50 1 27 5</td>
<td>16 0 0.7 0 0 50 0 7 0.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Papago</td>
<td>0 76 1 56 1 22 0</td>
<td>10 2.7 1.3 4 0 30 0 0 2.7</td>
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<td></td>
</tr>
<tr>
<td>Pima</td>
<td>0 68 4 67 0 0 0</td>
<td>5 3 0 1 0 12 5 0 0</td>
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<td></td>
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<tr>
<td>Eskimos</td>
<td>2.3 29 2.8 89 3.4 4</td>
<td>25 29 3 3 3 0 14 0.6 40 1.7</td>
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<td></td>
</tr>
<tr>
<td>Easter Islanders</td>
<td>0 32 0 69 47 36 0</td>
<td>0 0 0 36 0 0 0 0 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasians</td>
<td>38 51 27 21 11 13 5</td>
<td>19 32 27 28 4 3 4 7 6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion.

There are several basic types of population studies using genetic markers, one of which makes use of differences in gene frequencies to assess the relationships between populations and so to trace phylogeny. It is generally agreed that the use of gene frequencies for well-defined polymorphic genetic marks provides the only satisfactory approach to the study of evolutionary relationships between populations. The more closely related are two populations, the more similar their gene frequencies are expected to be. The frequencies detailed in this study allow us to make conclusions as to the evolution and possibly the migration of the ancient Indian tribes.

Determination of the ABO blood groups and HL-A types and their distribution in various ethnic populations have been the subjects of many reports. However, similar studies on mummified populations are scarce and they were made on small samples compared to the number examined in this report.

The presence of the B and A antigens in the Paracas Indians of the oldest pre-Columbian Ceramic group has been reported by Boyd.3 However, as indicated in Table 1, with time the pre-Columbian Indians began to lose the B gene resulting in almost complete absence of the antigen in the more recent populations such as the Peruvian and Chilean Colonial descendents of these people. Boyd2 suggested that the group B might have been eliminated by natural selection. Earlier studies from our laboratories in which the mummies were grouped according to geographic area tended to support this postulate, as it showed a gradual decline in frequency and concomitant increase in the proportion of group O as one moves south from the provinces of Nazca and Pisco in the Department of Ica in Peru to Chile.1

In all cultural groups originating in various excavation sites some extracts were reactive. Unexpectedly, 100% of the specimens from the pre-Ceramic group (the oldest, about 2500 B.C.) were reactive, while the more recent Ceramic and Colonials showed varying degrees of nonreactivity. However, this might have been due to the small sample of the pre-Ceramic group.

The absence of detectable HL-A antigens in 31.2% of the mummies is probably related to denaturation of the antigens, because of poor preservation. On the other hand, it may be partly related to the failure to use antisera with additional specificities; another contributory factor is the presence of histocompatibility antigens yet to be discovered. These factors and homozygosity could be the reasons underlying the detection of less than four antigens in some of the remaining 68.8%.

The reaction of those mummies that showed more than one antigen was in concordance with the rules of inheritance of the antigens of the first and second segregant HL-A alleles.7 In other words, at no time was there inheritance of more than two antigens of either series of alleles.

As in the case of ABO, there is a fair similarity in the frequency of the HL-A antigens in the mummified prehistoric and in the contemporary American Indian populations. Like Stastny,7 we found HL-A1, HL-A3, HL-A7, HL-A8, and HL-A12 either absent or of low incidence (4% or less) in the pre-Columbian
mummies. In addition, we found W14 to be absent in all mummies tested. This distribution pattern is similar to that found among contemporary North and South American Indians as well as in Eskimos. In contrast, with the exception of W14, Europeans have a significantly higher incidence of these antigens. The similarity between pre-Columbian and present-day Indians in contrast to Europeans can also be seen from the relatively higher incidence of HL-A2, HL-A5, W19, and W28 in the Indian groups compared to Europeans. These results are also in agreement with those of Stastny. Furthermore, like most contemporary American Indians, HL-A11 was absent in all but 12% of the pre-Ceramic group. The Huacho group thus has an HL-A11 distribution similar to that of the Ixil Indians in whom the antigen is present in 10%. In Europeans, the frequency is similar (11%), while it is prevalent among the Easter Islanders (47%). Significant dissimilarities between ancient and contemporary Indians include the much higher distribution of W15 among the Warao, Quechua, and Aymara tribes (34% to 71%) than in the mummies in which only 8% had the antigen. There were also differences in the distribution of some antigens between the pre-Ceramic and the Ceramic and Colonials. HL-A11, HL-A13, W17, and W19 were present in much higher frequency in the pre-Ceramic than in the Ceramic group. The frequency of most antigens in the Chilean and Peruvian Colonials was similar. However, HL-A12 was significantly higher in Chilean (25%) than in Peruvian Colonials (7%), while HL-A13 was absent in the former, but present in 10% of the latter group. Unlike Stastny, we did not find HL-A9 to be of a higher frequency in the mummies than in the Europeans.

Summary.

One hundred and eleven mummies were ABO typed by the antibody absorption test. The mummies belonged to the pre-Columbian pre-Ceramic, the pre-Columbian Ceramic, the Colonial Peruvian, and the Colonial Chilean cultural groups. The frequency of the A, B, AB, and O blood groups was found to be similar to that among contemporary American Indians. Although the B and AB groups were found among early pre-Columbian Indians, the B antigen became almost extinct in the Colonial mummies. The group O constituted the majority among all Indians (pre-Columbians and Colonials). There was suggestive evidence that with time the pre-Columbian Indians began to lose the B gene resulting in complete absence of the antigen in more recent Indian populations. Of the 111 mummies, 109 were typed for 16 HL-A antigens using a modified lymphocytotoxicity-inhibition technique. Analogous similarities between the distribution of several HL-A antigens were found between the mummies and contemporary American Indians. HL-A1 and HL-A7 were absent in all mummies and HL-8 and HL-A11 present in low frequency only in the Ceramic and pre-Ceramic groups, respectively. Frequencies significantly higher than in Caucasians were found for HL-A2, W19, and W28 in all but the Chilean Colonial mummies. These antigens are also of relatively high frequency among most contemporary American Indians.

REFERENCES