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MULTIDISCIPLINARY STUDIES ON PRIMITIVE POPULATIONS IN LATIN AMERICA

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The history of the human species extends back approximately 1,500,000 years. During some 99 percent of this history, man has lived in small bands with a hunting-and-gathering type of economy. These are the circumstances under which most of human biological evolution has occurred. Because of the slowness with which genetic attributes change, there can be no doubt that many of the characteristics of present-day man were determined by thousands of years of selection under these primitive conditions. To the extent that human adaptability has genetically imposed limits, these limits have evolved under the psychological, disease, and dietary pressures of such cultures. It seems a reasonable hypothesis, then, that extensive and careful studies of the surviving groups of primitive man could provide some important insights into a variety of problems in contemporary human biology.

For instance, while it is generally assumed that man has been shaped by natural selection, very little is known about the precise manner of its action. It is frequently stated that natural selection is far less stringent today than earlier, largely due to modern medical care. We cannot, however, document this belief in any meaningful way. Since in the final analysis our measures to protect man against increased exposure to causes of mutation, such as radiation, will be to a certain degree determined by our understanding of how selection works, there are practical reasons for acquiring a greater understanding of how natural selection has operated in the past and operates today.

Likewise, there are many references to the emergence of the so-called "stress" and "autoimmune" diseases. In point of fact, however, few primitive

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groups have been studied in such a way as to determine the frequency of the stress and autoimmune diseases. Furthermore, assuming a change in the frequency of these diseases with the transition to civilization --man has always lived with stress-- what aspects of stress have changed recently?

Today populations largely untouched by civilization and adhering to a simple hunting-and-gathering economy, perhaps with minimal agricultural activities, are to be found in at least three continents, namely, South America, Australia, and Africa, as well as in a variety of islands, such as New Guinea, Borneo, and the Andaman Islands. These populations are disappearing at an ever accelerating rate, culturally, if not physically. Accordingly, their proper study has an urgency not common in biological problems. Unless in the near future we document these populations in a detail not yet achieved, we will have lost the opportunity forever. Furthermore, circumstances today are far more favorable than ever in the past for such studies. This is due to many developments, but especially to the provision of air strips and helicopter services in previously inaccessible areas, which permit, within hours after collection, the return of perishable biological specimens, especially blood, to a base laboratory.

Past studies of these groups have been fragmentary in nature. Foremost among the disciplines which have, often under great difficulties, made significant contributions is cultural anthropology. Other disciplines providing the basis for much of our present-day knowledge are physical anthropology, linguistics, medicine, and --most recently-- genetics. However, the potential interrelations and interactions between these disciplines have not been realized. This presentation will outline some of the opportunities which exist for multidisciplinary studies on primitive groups, with particular reference to the Americas. A further group of related studies which would extend the value of this type of field work will also be described. Although I shall approach these studies from the standpoint of the

population geneticist, and for convenience refer to this area of research as population genetics, it is apparent that the scope envisioned is broader than the term "population genetics" would imply to most.

1. Objectives of Studies on the Population Genetics of Primitive Groups

Studies on the population genetics of primitive groups may be conducted at a variety of levels. At the simplest level, they may be entirely descriptive. The investigator may describe the mating patterns of a group or determine the frequency of a number of genetic traits. The current trend, however, is towards more dynamic studies, which attempt to utilize a variety of descriptive data to understand the biological factors of importance to these populations. With respect to these latter objectives, a WHO Scientific Group on Research in the Population Genetics of Primitive Groups, convened in November of 1962, reported as follows:

> "Objectives of studies. The study of population genetics in primitive groups should clarify the following problems:
>
> "(a) The genetic component in mortality and fertility differences, through the study of familial factors on the one hand, and the study of variations in birth- and death-rates in relation to different genetic structures on the other.
>
> "(b) The biological consequences of inbreeding. Such populations also provide opportunities for examining the biological consequences of formal kinship and marriage systems.
>
> "(c) The disease pattern of relatively undisturbed primitive populations. Attempts should be made to relate disease susceptibilities to specific genetic structures.
>
> "(d) The possible evolutionary implications of differing disease patterns in males and females.
>
> "(e) The biological relationship of the group under study to neighbouring groups or to those more remote in time or space. This is likely to require collaborative study involving, for example, cultural, anthropological, linguistic, historical and archaeological investigations.

"(f) The effects of contact with more advanced cultures, in particular the effect on gene frequencies, the emergence of new disease patterns and the possible relationship of these to genetic constitution, and the alteration in physical measurements and physiological and biochemical characteristics."

This same Scientific Group (in a report which will shortly be published) has outlined the types of observations necessary to solve these problems. In so doing, the Group was not attempting to devise an intellectual strait jacket to be forced upon the individual investigator, but to provide broad guidelines which, if followed, would introduce a measure of comparability into future studies. Among the types of data for which detailed suggestions will be given in the published report are the following: demography and socio-cultural environment; health status and disease pattern; genetic and other physical attributes; and physical and biological environment.

2. Primitive Groups in the Americas

A complete listing of the surviving and relatively unacculturated primitive groups in the Americas is not available. Such a listing, however, would be out of date almost as soon as drawn up, so rapidly are conditions changing. Be that as it may, the Table on page 18 attempts to name and locate some of these groups. This list draws heavily on the Bulletins of the International Committee on Urgent Anthropological and Ethnological Research, of the International Union of Anthropological and Ethnological Sciences; on the Handbook of South American Indians, edited by J.H. Steward and published by the Smithsonian Institution of Washington, D.C., and the Report of the WHO Scientific Group referred to earlier. There are undoubtedly many omissions, and it will be one of the chief tasks of the immediate future to correct these omissions.

3. Stages in the Investigation of a Primitive Group

Assuming the desirability of the comprehensive type of study envisioned, how does one proceed? It is convenient, if arbitrary, to recognize three scales of activity, which will generally be successive. At the first level is the exploratory, wherein a single individual, or several individuals, usually cultural anthropologists by training, establish contact with the group, learning its language and ways. In many respects, the cultural anthropologist is not only the spearhead of the approach, but remains in future operations the most indispensable member of the team. Many groups have customs, superstitions, beliefs, and taboos which must be scrupulously observed if success of the investigation is to be experienced. The cultural anthropologist is the person who best knows the ways of the group. Most of the studies carried out to date would fall in this exploratory category.

At the next level are pilot studies, in which a small team carefully constituted so that its personnel will complement one another, spends a brief but intensive period in the field with the group under study. Such a team will in general be composed of a cultural anthropologist, a physical anthropologist, a geneticist, a serologist, and several physicians. Backing this team must be laboratory facilities capable of extracting maximum information from the blood, urine, stool, and saliva specimens which are collected in the field. Relatively few studies of this type have been carried out.

Finally, we come to full-scale studies in the course of which the various leads which have developed from the pilot study are followed up by the appropriate field or laboratory specialists. A real problem when this stage is reached will be to avoid disruption of the small group under study (in general these will be small groups) so that observation of the primary picture is assured. It seems fair to say that no study has yet reached this level.

3.1 Description of a Pilot Study

For the immediate future, the need is for pilot studies. In an effort to render concrete the generalities which have characterized this report thus far, I should like to describe a recent pilot study of the Xavante Indians of the Brazilian Mato Grosso. My colleagues in this undertaking were Drs. F.M. Salzano and P.C. Junqueira of Brazil, Dr. F. Keiter of West Germany, and Dr. D. Maybury-Lewis of the United States.

These Indians were selected because they appeared to meet the combination of rather exacting circumstances which render studies of the type contemplated feasible and valid. There are only a few scattered references to the Xavantes in the literature on Central Brazil. We know they fought the settlers in the eighteenth century and that at least some of the ancestors of the present Xavante probably moved westwards into their present habitat about the middle of the nineteenth century. Since then they have reacted violently to anything which they consider encroachment on their territory, so that until the 1940's their contacts with western culture were largely hostile. Thus as late as 1941 the inhabitants of the village selected for study formed part of a band which killed an agent of the Indian Protective Service and five of his assistants who had been entrusted with the mission of establishing friendly contacts with the Xavante and setting up a "Post of Attraction" for them. The present chief of the village took part in that attack. However, as will be evident from the following, Xavante acceptance of outsiders has progressed rapidly in recent years. The group is accordingly at that critical point in its relations with the outside world when it is approachable but yet culturally intact. The agent of the Indian Protective Service assigned to the Post near the village studied, Mr. Ismael Leitão, is a man of uncommon ability who during his 14 years at this station (Post Pimentel Barbosa, Lat. 13°13'S, Long. 51°25'W. Gr.), has come to command the respect and confidence of the Indians, and

of course speaks their language. During 1958, one of the team (D.M.-L.) conducted the first detailed investigations of the group, directing his studies primarily towards kinship and political structure. There was thus the necessary background of experience and communication with the tribe. Finally, there is a small airstrip near the Post, providing the means for rapid transportation of blood samples to a base laboratory in Rio de Janeiro.

The specific objectives of the study, carried out during the summer of 1962, were: 1) to identify those cultural elements with particular biological implications; 2) to obtain a complete pedigree of a Xavante village for as many individuals as possible in the time available; 3) to perform physical examinations and anthropometric studies; 4) to obtain blood and saliva specimens and to extract the maximum amount of genetic and medical information from these specimens; and 5) to utilize these data to explore a variety of parameters of genetic interest. In passing, it would be well to emphasize the importance of making a determined effort, in investigations of this nature, to study all the members of the group (band or village) under consideration, rather than a haphazard sample thereof.

Since the Indian village selected for study is now located approximately one kilometer from the five houses of the Post, and since facilities at the Post were far better than in the village, all examinations were performed at the Post. Our subjects were seen on two different occasions. The first time a pedigree was obtained, and a physical examination and anthropometric study performed. On the second phase, a whole blood specimen was drawn, thick and thin blood films made, and dermatoglyphics obtained. Because the sample seen on the first phase does not correspond entirely to the sample seen on the second, observations are incomplete for some individuals. Although it would have been desirable to have completed the entire battery of observations on a single contact, the limited working facilities, the patience of the Indians, and the problem of minimizing the time interval between

drawing the blood and conducting the serological studies rendered this impossible.

In reviewing some of our findings, it must be emphasized that generalization from this preliminary study should be avoided. All findings are tentative and require substantiation.

Let us consider first the socia l and demographic structure of the Xavantes. There are three exogamous patriclans represented in most Xavante villages and these are in turn divided into named patrilineages. The chief's lineage, supported by the other lineages of his clan and by some people outside the clan, forms the dominant faction in the community. Inter-factional disputes, leading to accusations of sorcery and occasional fighting, may provoke secessions of groups from the village, which then take up residence elsewhere; otherwise inter-village migration is uncommon. The ideal marriage pattern is sororal polygamy since a husband is expected to take up residence in his wife's household, but a man may marry a number of unrelated wives. First marriages are regularly between boys in their teens and girls up to ten years younger.

The particular village studied had recently, because of internal dissension, undergone a schism, with a splinter group breaking away and forming a new village some miles down the Rio das Mortes. We attempted to obtain a pedigree which would represent the situation in the village before the split, with every member of the village identified and shown in his biological relationship to every other member. From this kind of a detailed census several interesting facts emerged.

Firstly, it is clear from the study of the pedigree that when the village split occurred, the people who left to start a new village were not what the geneticist would call a random sample. Rather, close relatives tended to leave together. Human nature being what it is, this is scarcely a surprising observation. However, if this is typical of what happens when primitive villages fragment, the inference is that the individuals comprising the founding stock of a new village are often related to one another.

Secondly, of 56 marriages represented in the village, in 50 both marital partners were from within the village. Moreover, even though genealogies were quite limited, we could show that 13 of the 56 marriages involved cousins. It seems reasonable to infer, especially when we consider the origins of a new village as described above, that primitive man was characterized, at least at certain times in his evolution, by a high degree of inbreeding.

Thirdly, the data suggest that completed family size and infant mortality may be lower in these groups than in many agricultural populations. As compared to many agricultural groups, death from contagious disease is probably less common, but traumatic death, from accidents of war or the chase, is more common. The infectious diseases may thus be less important agents of biological selection in hunters-and-gatherers than in many agriculturalists.

Fourthly, differential fertility, especially for the male, may be more marked than in contemporary society. The number of wives a man can hold is determined by his social status. In general, the village chief has the greater number. In the village under study, the chief, who had held power for an exceptionally long time, had taken five wives. He had 23 surviving children, almost 1/3 of the next generation. Now then,the chief is chosen because he is the best all-around leader, the man most versed in tribal lore, the most skilled orator, the best hunter and wrestler, etc. If there is a genetic basis for these traits, then this chief is transmitting the genetic basis for these favorable traits to a large number of the next generation. Although this must be an unusual case, in general the chief may leave more children than any other man. This constitutes sexual selection in the Darwinian sense.

Morphological studies, involving 91 Indians of both sexes and all ages, included 11 measurements, a determination of skin and hair color and iris color and texture, finger and palm prints and a direct reading of toe dermatoglyphics,

and five standardized photographs from which 41 qualitative or semi-qualitative traits were scored. Blood specimens were obtained from 79 persons and examined independently in two laboratories for variation with respect to the following 18 genetically controlled systems: the ABO, MNS s, Rh, Kidd, Kell, Lutheran, Duffy, Diego, P, Wright blood groups; the serum haptoglobins, transferrins, Gm groups, and groups specific (Gc) component; and erythrocyte non-specific esterases, erythrocyte lactic dehydrogenases, erythrocyte glucose-6-phosphate dehydrogenases, and hemoglobin type. Secretor type was determined from saliva specimens. Incidentally, these traits represent close to the totality of the genetic traits which can now be studied in a blood sample. It is important to extract the maximum genetic information possible under these circumstances.

All of these measurements enable us to classify the Xavantes with respect to other South American Indians. But they have a more important function than that. They enable us to express in exact terms the amount of variation within such an isolated and inbreeding group. In this connection, it is recalled that many explorers write of tribes all of whose members look alike. It is our impression that once one adjusts to the uniformity of skin, hair, and eye color in the Xavantes, and the similar hair styles, there is a wealth of genetic variability in such a group as this, despite the inbreeding. A question for the future is how this is maintained. Moreover, we can use these determinations in the same way blood groups are used in paternity problems, to determine whether there are discrepancies between the given and the actual parentage. In this particular tribe, our very preliminary evidence suggests the bonds of matrimony are well observed.

Physical examination of 78 persons revealed marked differences between the sexes. Males were well-muscled, almost caries free, and, with few exceptions, without cardiac murmurs or spleno- or hepatomegaly. Females showed more caries, often had soft apical systolic murmurs, and about one-third had hepato- or splenomegaly. Both sexes had slow pulses and low blood pressures. In short, the males were superb

physical specimens, whereas the females showed evidences of greater biological pressures, to the extent that one is impressed by the differing medical worlds of the sexes at this cultural level.

Laboratory studies revealed relatively low hemoglobin values in both sexes, but especially in females. Differential leukocyte counts revealed a marked eosinophilia. Total cholesterol values were low (127 $\pm$ 30 mg/100 ml in adult males, 165 $\pm$ 47 mg/100 ml in adult females). Serum protein determinations were high (7.9 $\pm$ 0.5 g/100 ml in adult males, 8.0 $\pm$ 0.9 g/100 ml in adult females), due primarily to high gamma-globulin levels. Serological and hematological studies concerned with an evaluation of disease pressures and epidemiologic characteristics revealed no syphilis, malaria parasites in 3 out of 76 thin blood films, and a high proportion of persons with antibodies to measles, pertussis, poliomyelitis types I, II, and III, and Salmonella types A, B, C_2, and D. Antibodies to strain A_2 of influenza were not detected, but 8 of 63 persons tested had antibodies to strain B. These findings regarding antibodies raise a number of fundamental questions concerning the manner of acquisition, whether by overt or sub-clinical disease, and also the degree of contact, direct or indirect, which this group has already had with the diseases of civilization.

It should be emphasized once again how preliminary our own studies are. It should also be emphasized that some of the suggestions just advanced are not original, that hints along the same lines emerge from other studies. One of the reasons for introducing the foregoing speculations has been to point out the directions in which future inquiries might go.

4. Associated Studies on the Indian

We turn now to a group of studies related to the above. The American Indian represents a unique experiment in the history of mankind. It appears that

some 30,000-40,000 years ago small bands of nomads from Eastern Siberia entered this continent by way of the Aleutian chain, then much more of a land bridge than now. These bands then fanned out over a vast area in all directions, rapidly subdividing into many tribes. There is no other situation in which we can so precisely date the arrival of the human species in a specific area. Much remains to be learned about the origins of the American Indian, but substantial progress is being made. This situation provides a truly unique opportunity to study the time scale of human evolution, since most of the differences between the representatives of various tribes presumably arose after the ancestors of those tribes reached America. The proper study of this problem involves the combined efforts of the archeologist, cultural anthropologist, and geneticist. Here one is interested not only in primitive groups but in acculturated groups as well, providing there has been little or no racial admixture. Such groups are to be found in all the countries of North, Central, and South America. For instance, the United States, which has relatively no unacculturated Indians left, does have relatively "pure" representatives of some 30 to 40 tribes. Although in recent years most of the exciting discoveries concerning our species have seemed to center in Africa, there are really equally exciting opportunities, albeit of a different type, here in the Americas.

A second problem has to do with shifting disease patterns in the Indian and their significance. In the Western World the biological adjustments involved in the transition from a nomadic existence to the Atomic Age have extended over thousands of years. In the Indian, this transition will be compressed into a relatively few generations. Accordingly, many phenomena difficult to study in a civilized group may be more amenable to investigation in these groups in transition. There are in the principal cities of the Americas, Indian groups whose ancestors were living very differently indeed only a few years ago. What

is the transition to sedentary, city-life doing to the frequency of diabetes mellitus and cardiovascular disease, and what does this tell us about the etiology of those same diseases in Caucasian populations?

Much has been written about the devastating impact of the White Man's Diseases on the Indian. While there is no doubt this is so, the reasons even today are very obscure. Why are measles and influenza so often fatal to the Indian? We know that there is nothing wrong with the antibody-producing capacities of the Indian --his gamma-globulin levels are twice as high as ours. Is his disease susceptibility inherent, or secondary to some aspect of his culture? An answer to this question would have important implications for our outlook on the epidemiology of a variety of infectious diseases.

5. Humanitarian Aspects

Thus far this presentation has been couched in coldly scientific terms: what can we learn from the Indian? Let us consider the potential profit of these studies to the Indian. Certainly much will be learned about disease patterns in the Indian which cannot help but influence the pattern of medical services. With special reference to the primitive groups, perhaps it will be possible to prevent to some extent the usual deleterious effects of the first contacts with Western Culture. In this connection, it is a fact that few of the countries in the Americas (and of course I include my own) has cause to be proud of the history of its relations with the indigenous inhabitants of the land. While the past cannot be undone, it is not too late for additional improvements in policies, and substantial contributions can be made by physicians and life scientists.

6. Resources Available for Studies of the Population Genetics of the American Indian

It was requested that this Report include some assessment of the resources in Latin America for the conduct of the program of study just outlined. This is a very difficult assignment, which should not be entrusted to one individual. Unlike the tactical situation in the study of certain virus diseases, where one can pinpoint the laboratories with the requisite facilities with no difficulty, the resources for the type of study discussed in this report are much more diffuse. Thus, every country of Latin America has cultural anthropologists and ethnologists interested in the Indian of that country, and many countries have Bureaus of Indian Affairs or their equivalent, which are storehouses of knowledge in localizing tribes of maximum interest. Most countries also have well trained physical anthropologists, and, of course, physicians. The person who is in shortest supply is the population geneticist. PAHO might wish to give consideration to establishing a number of training fellowships in this specific area, and also encouraging member countries, perhaps assisted by a special committee, to prepare rosters of the various types of personnel with an announced interest in the Indian.

As has been brought out, these studies also require extensive laboratory resources: immunological, serological, biochemical, and --a point not yet emphasized-- statistical. The pilot study team will need free access to those laboratory resources. Should the PAHO become interested in facilitating studies of the type discussed, then PAHO might wish to give consideration to financing in whole or in part a number of regional laboratories, which could serve not only for analysis but as repositories for precious samples which can never again be duplicated.

6.1 Cost of Programs

Some estimate of program costs has also been requested. This too is rather difficult to provide on the basis of present experience. The exploratory studies, involving as they do the maintenance of one or two men in the field for several years, are relatively inexpensive. The pilot studies are more costly. Much depends on the distances the individuals concerned must travel in order to engage in the studies, whether their salaries for the period of the field work are already assured or must be met from the project budget, and on the equipment already available. In round terms, one may place the budget for the field expenses of a pilot study at between $10,000 and $30,000. However, the cost of the necessary laboratory studies which follow may be as great as the cost of the the field work. I would estimate the overall expense of a good pilot study at $30,000 - $40,000 if all expenses were met from the project budget. Of course, in many instances various laboratories will be glad to perform certain specialized studies on blood, urine, saliva, and stool, as an aspect of their own research program.

Finally, it is impossible to estimate the expense of a really full scale study. The chief reason for this is that certain important questions of procedure remain to be solved. Perhaps the outstanding question is whether for a full scale study one should attempt to locate a substantial laboratory in the area under investigation, or whether, with the ease of air transportation and the increasing complexity of laboratory investigations, it would be better to attempt to utilize existing laboratories in major population centers. For instance, it seems clear that studies of serum antibodies will be an important facet of any program. Should special laboratories be created for this purpose, or should existing facilities be utilized?

6.2 The International Biological Program

As is now common knowledge, plans for an International Biological Program are under formulation. While many details remain to be clarified, it would appear that this program will have two principal scientific components, namely, studies of the potential for food productivity of both land and water, and studies of human adaptability, both physiological and genetic. The Sub Committee of the International Union of Biological Sciences which is charged with formulating the studies of genetic adaptability has recommended that as one aspect of the program a special effort be made to conduct studies on the surviving primitive groups of the type under discussion. The Committee was influenced in this recommendation not only by scientific considerations but also by the fact, referred to above, that without forceful action at this time, the opportunity for such studies will have slipped away from us within a few years.

7. Conclusion

In conclusion, it is important to recognize that the type of program under consideration is far more nebulous than the usual PAHO programs. In contrast to the tangibility of mapping the distribution of a disease, or planning specific measures to curb a disease, this program involves an attempt to gain understanding of the forces that have shaped man, and thereby a better insight into man himself. Much remains to be done on the methodology of this program. It is not at all clear that we have or can formulate the scientific questions, which, if answered, will yield the insight we seek. On the other hand, it is abundantly clear that unless the effort is made soon, the opportunity may be lost.

It seems evident that, with the present activity in the field of population genetics, an increased effort in this direction will be forthcoming. We must now devise the means to make that effort most effective.

TABLE

Surviving Primitive Groups in the Americas

GROUP	LOCATION
Ulva Sumu	Nicaragua
Choco	Panama-Colombia border
Guahibo	Venezuela and Colombia
Wai-wai	Brazil-British Guiana border
Waika Shiriana	Brazil-Venezuela border
Maku Cayapó Gorotire Kuben-Kran-Keng Xavante Uruku Asurini Suya Sheta	Brazil
Pakasnovas	Brazil-Bolivia border
Amahuaca Yaminahua Mashco	Peru

(OVER).-

Surviving Primitive Groups in the Americas. .(cont'd)

GROUP	LOCATION
Guayaki	Eastern Paraguay
Siriono	Bolivia
Morotoko	Argentinian Chaco