

## Further Studies on the Xavante Indians

### I. Demographic Data on Two Additional Villages: Genetic Structure of the Tribe

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THE Akwẽ-Xavante are a tribe of Gê-speaking Indians of the Brazilian Mato Grosso, comprising some 1,500–2,000 individuals now divided into at least seven villages scattered along the Rio das Mortes and its environs, between latitudes 12° and 16° S. Our contacts with the tribe date back to 1958, when one of us (D. M.-L.) undertook an anthropological study of the village which is located at São Domingos near the Post Pimental Barbosa of the Indian Protective Service. A preliminary, multidisciplinary study of this same village was carried out in 1962 (Neel *et al.*, 1964). The present series of papers will report the results of multifaceted studies on two additional villages of this tribe, the field work having been performed in 1963 and 1964.

The Xavante (we shall omit the prefix) were chosen as subjects for study because they appeared to meet a rather exacting combination of prerequisites. All three of the villages studied are at a stage where their culture, although disturbed, is essentially intact; yet they are sufficiently acculturated

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Received November 14, 1966.

The investigations reported in this and subsequent papers in this series were supported in part by grants from the Pan American Health Organization, the U. S. Public Health Service, the U. S. Atomic Energy Commission, and the World Health Organization.

We are grateful to the Serviço de Proteção aos Índios for the necessary authorizations and facilities. It is a pleasure to acknowledge our debt to Mr. Girley V. Simões for technical assistance in the field and to Mr. Arthur McIntosh, pilot for Azas de Socorro, without whose staunch assistance this study might not have succeeded. We further acknowledge the generous hospitality of Sr. Pedro Vani de Oliveira, agent at the Post Simões Lopes of the Serviço de Proteção aos Índios, and Padre Mario Panziera, chief of the São Marcos Salesian Mission. Finally, we are indebted to Drs. C. A. B. Smith, W. J. Schull, F. B. Livingstone, and N. A. Chagnon for their careful reading of various of the manuscripts in this series.

as to be amenable to contacts of the type to be described. However, dietary, disease, and other patterns are being altered rather rapidly as the Xavante become less nomadic, to the extent that in another ten years we doubt whether these villages would be suitable for this type of study. We hasten to add a very necessary stricture, that we do not present this group as "untouched," but, rather, as about at that stage of acculturation compatible with achieving our objectives.

This first paper will present data on the pattern of population exchange between Xavante villages and then describe the vital statistics and breeding structure of the two additional villages, in an effort to elucidate the genetic parameters of a tribe enjoying a hunting-gathering-incipient agriculture type of economy. Subsequent papers in the series will describe the physical status of the group, the frequency of occurrence of a variety of genetic traits, and the results of biochemical and serological studies aimed at evaluating the biological pressures on the group. The final paper in the series will attempt a synthesis of the implications of the various papers, in the form of a series of propositions or hypotheses.

As will become apparent, the detailed scrutiny of populations of this type raises a number of far-reaching questions concerning the applicability of various commonly employed genetic statistics and concepts. In this series of papers, we shall be more concerned with defining these questions clearly than in proposing solutions based on the study of a single tribe. We and our collaborators have in progress studies on two other tribes at the cultural level of the Xavantes, namely, the Cayapo of Brazil and the Yanomama (Waica) of Venezuela and Brazil. It is anticipated that when the results of all these studies are combined, not only will we be in a sounder position to develop genetic models of human populations at this level and of their biological pressures, but there will be a corpus of data suitable for (1) defining the heritability in this environment of a range of human characteristics, (2) identifying new genetic traits, and (less surely) (3) contributing, through an analysis of fertility differentials and segregation ratios, to an understanding of the action of selection on specific genetic systems. The apparently greater uniformity of the environment at this cultural level may contribute to the realization of these various objectives, since a significant fraction of the "noise" present in more civilized cultural systems may be absent.

#### RECENT HISTORY OF THE XAVANTES

Detailed accounts of the history and culture of the Xavantes, as well as recent changes in their way of life, will be found in Maybury-Lewis (1965a,b, 1967; see also Neel *et al.*, 1964). We will present here only that background material essential to developing the genetic arguments which follow.

It is clear from historical references that at one time the Xavantes were found considerably to the east of their present distribution. It is doubtful that at that time their tribal distribution also included the area they now oc-

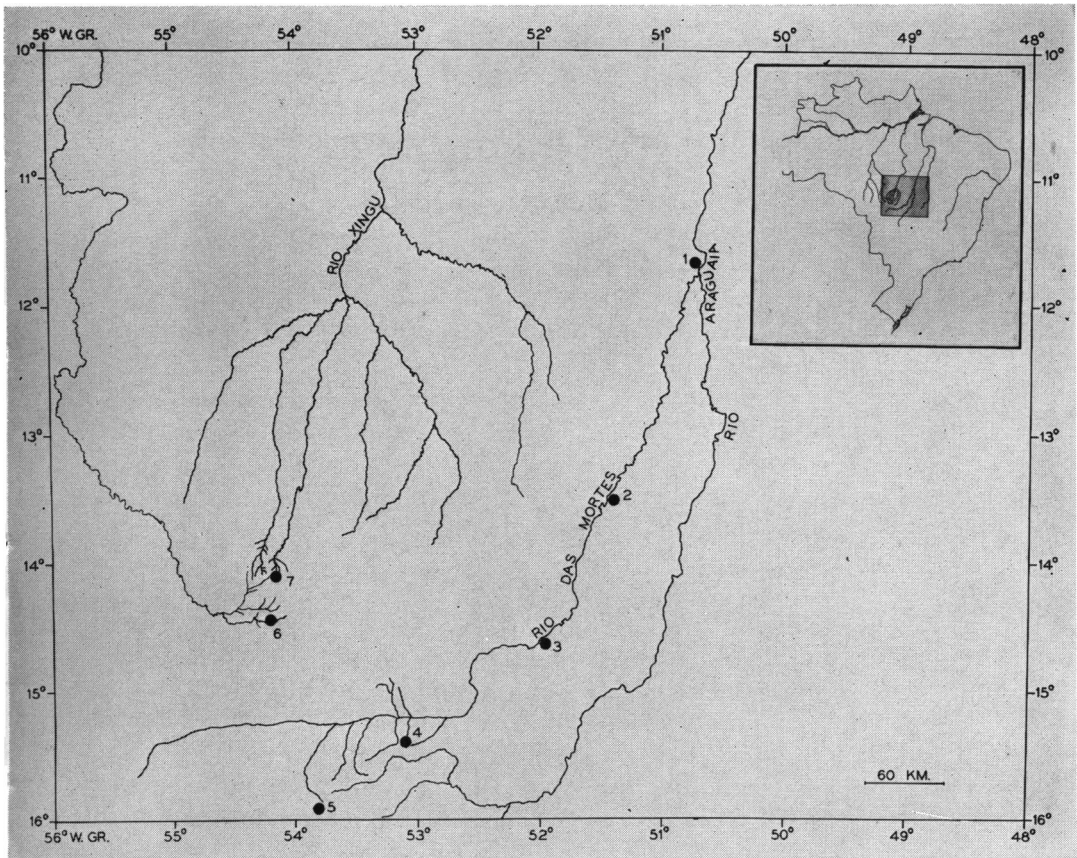


FIG. 1. The present location of the eight Xavante villages. Key: (1) São Felix (one small village near here, one larger some distance off, exact position unknown); (2) São Domingos; (3) Areoes; (4) São Marcos; (5) Sangradouro; (6) Simões Lopes; (7) Batoví.

copy. It is possible they have retreated into this area no more than a century ago, at that time perhaps displacing other Indian groups westwardly. After an initial period of peaceful contacts in the late eighteenth century, relations with neo-Brazilians deteriorated and were in general hostile during the nineteenth century and the first 40 years of this century. In 1941, in an effort at pacification, the Indian Protective Service located a Post (now known as Pimental Barbosa) on the Rio das Mortes at a place designated as São Domingos (see Fig. 1). Shortly thereafter, the Xavantes killed a party of six from the Post who were attempting to establish peaceful contacts, and it was not until 1946 that amicable contacts were established, although for the next five years these were rare and guarded. Only since 1951 has the Post been in a more-or-less permanent relationship with the Indians. During the last twenty

years, peaceful contacts have also been established with some six or seven other Xavante groups; it is difficult to be accurate because of the shifting character of Indian villages. Although there may be groups still uncontacted, this seems doubtful.

One of the two villages studied in 1963–1964 is located near the Simões Lopes Post of the Indian Protective Service (see Fig. 1). This Post originally was established for the Bakairí Indians, who are now well acculturated. The Xavante first made contact here in 1955, but after a brief period of residence at the Post (and uncertain relations with the Bakairí) withdrew and established a village about 12 kilometers off. A few months earlier, another band of Xavantes had made contacts with an Indian Post at Batoví, some 40 kilometers to the north, originally established to attract the Waurá. The group at Simões Lopes was apparently an offshoot of the Batoví group, remaining on such cordial terms with the group that, as we will see, the two villages may be considered one breeding unit. A few of the oldest Xavantes at Simões Lopes claimed kinship with the community at São Domingos. There were approximately 230 persons in the Simões Lopes group in 1964.

The second of the villages studied in 1963–1964 is located in close proximity to the Salesian Mission of São Marcos. The group now settled there made contacts in 1956 with the Salesian Mission at Merure, originally established for the Bororo tribe. The Xavantes and the Bororos did not get along well, so in 1958 the Salesians set up a mission at São Marcos especially for the Xavante. This village now numbers about 400 persons.

In addition to these two villages, there are currently six other villages, as follows: (1) São Domingos, the village studied in 1962, current estimated population, 150; (2) Batoví, already mentioned, current estimated population, 200; (3) Sangradouro, current estimated population, 150; (4) Areoes, current estimated population, 170; (5) two villages near São Felix, one of 50 quite near the settlement and one of 250, the most isolated of all the Xavante villages today, more than 100 kilometers from São Felix, exact position unknown. The location of the villages is shown in Fig. 1.

One of our specific interests in this paper is to document the amount and nature of the genetic exchanges between Xavante villages. The material available for this purpose is of two types, namely, some rather inadequately supported information concerning events during the first 12 years after these groups began to establish peaceful contacts with neo-Brazilians and some more adequately documented material relating to events since 1958, the year in which one of us (D. M.-L.) first began anthropological studies of the group. In the field work of 1962, we were impressed by the relatively high degree of endogamy and isolation of the village at São Domingos. At the same time, it was recognized that the chief of that village was an unusually dominant figure, who might have discouraged exchange with other villages. In the course of that field work, it was found that the village had undergone a schism since the initial work in 1958, with the formation of an offshoot village (E Tõ) some 15 kilometers up-river from the parent village, and we were able to present some information concerning the biological lines along which

such a schism occurs. By good fortune, the present round of field studies has enabled us to document the results of this schism more accurately.

With respect to the inadequately documented events between 1946 and 1958, it should first be noted that Xavante villages are temporary in character and are readily moved as circumstances require. There is reason to believe that most of the villages mentioned above have assumed their present general location only recently. Padre Mario Panziera, head of the Salesian Mission at São Marcos since its founding, states that an aerial reconnaissance of the region north of Merure undertaken by the Salesians in 1946 revealed a very large Xavante village on the shores of a small lake to the north of the Rio das Mortes (the so-called Lagoa Group). The "twin villages" near Batoví and Simões Lopes are thought to be an offshoot of that village; the time of their departure from the mother village is uncertain. An article in the *Bolletino Salesiano* of January 1, 1954, concerns the recent arrival of a group of Xavantes at the town of Xavantina and includes an aerial photograph of the above-mentioned village, allegedly after these departures. Twenty-two houses can be counted, one of which is probably a bachelor's hut. If each house contains on the average 20 persons (a conservative estimate), this implies a population even then of some 400 persons. The band described above as first making contacts in 1956 with the Salesian Mission to the Bororo Indians located at Merure and then settling at São Marcos is thought by the Salesians also to have originated from the Lagoa group, as is a smaller group which made contacts in 1956 with the Salesian Mission at Sangradouro, originally established for the Bororos. In view of the numbers involved, the Lagoa group would have to have been unusually large to give rise to all four of the villages attributed to it, and it seems quite likely that additional groups may be involved in these developments. On the other hand, Sadock de Freitas (1955) states that there were 618 Xavantes at the village near São Domingos when he visited there in 1954, and the possibility of temporary groupings of this size cannot be discounted. This same author reports that while he was in contact with the village near São Domingos, it was visited by a band from the Lagoa group—an independent confirmation of the existence of this group.

Turning now to more adequately documented recent events, we mentioned above the schism involving the village at São Domingos (cf. Neel *et al.*, 1964). It now appears there have been two schisms since 1958, which have reduced the size of the village from approximately 220 persons to approximately 110. The schism reported in our paper of 1964 resulted in the establishment of a new village about 15 kilometers up-river from São Domingos (E Tõ). When we arrived in São Marcos in May, 1964, we determined that São Marcos had recently received an accretion from E Tõ. This latter village had now dissolved, one fragment coming to São Marcos and another joining the Areoes group located near Xavantina. A few individuals may have returned to the parent village at São Domingos. Twenty-six persons from this group were examined at São Marcos; there may have been a few more persons in this group who were not seen.

The São Marcos group also had received another larger addition since its

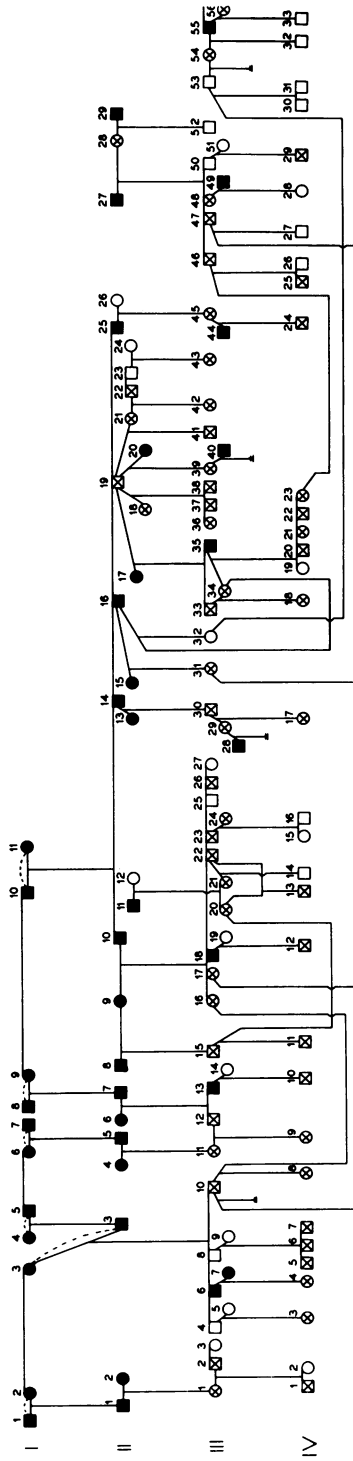


Fig. 2. The pedigree of Sebastião's group, as to whether the relationships should be reversed! Individuals indicated by solid symbols are deceased; those indicated by a X were examined.

founding, a group of approximately 90 under the leadership of one Sebastião. This group appears to have joined the São Domingos group about 1959, coming from a now dissolved village at Capitariquara, and to have "seceded" (in whole or part) from the São Domingos group in 1960, and therefore results from an earlier schism than that described above. After brief contacts with several other Xavante communities, this group had arrived at São Marcos that same year. Anyone familiar with both the linguistic and cultural problems inherent in obtaining precise histories of population movement under these circumstances will perhaps be sympathetic to our previous failure to recognize two schisms at São Domingos between 1958 and 1962, and to the difficulties in balancing the numbers involved. Furthermore, the one group came and went in the interval between our contacts; the Indians remaining in the village would regard them as "visitors" even if marital partners were exchanged.

The composition of Sebastião's group is presented in detail in Fig. 2, to illustrate the biological interrelationships in such a group, as best they can be reconstructed. Deceased persons are shown only when they establish links of relationship. There may be presumed to be significant biological relationships between the individuals shown in generations 1 and 2 beyond those we were able to elicit. The striking feature of the group is the degree to which one sibship of five (of which one member is still alive) dominates the picture. We had hoped to compute the number of independent genomes present in the group, but the data are inadequate for this purpose.

Much additional data concerning the movement of other Xavante groups not involved in the present round of studies will be found in Maybury-Lewis (1965b, 1967). The picture which now emerges is of constant, continuing realignment among groups within the population, of such a degree that, although at any one moment there are many constraints upon the choice of a marriage partner, over a period of several generations there should be so much exchange between "villages" that the breeding unit approximates the entire tribe. *We do not know to what extent this is a recent phenomenon, in response to the increasing contacts with neo-Brazilians.* Further work on tribes even less disturbed in their social structure is obviously necessary. *In general, we believe that recent events have not created but only increased the internal mobility of the Xavantes.* If this is correct, then it is clear that one may derive a very biased picture of the tribal dynamics of this (and presumably any other) Indian tribe during the course of a brief contact.

#### DEMOGRAPHIC DATA

Demographic data on the villages at Simões Lopes and São Marcos were obtained as described by Salzano (1961, 1964) and Neel *et al.* (1964). In São Marcos, genealogies and reproductive histories were obtained independently by F. M. S. and D. M.-L., with a later comparison of the findings and attempt to resolve any discrepancies. Where final differences remained between the two sets of data, the findings of F. M. S. have been utilized, since, aside from the possibility of real discrepancy, the population base is shifting con-

TABLE 1. NUMBER OF ENDOGAMOUS AND EXOGAMOUS MARRIAGES IN THREE XAVANTE VILLAGES

Only those marriages are listed where one or both marital partners are living.

Tribe and locality		Both partners from same group	One partner from another group	Both from outside	Origin of one partner unknown	Total number of marriages
Simões Lopes	N	76	5	—	—	81
	%	93.8	6.2	—	—	
São Marcos	N	80	11	30	—	121
	%	66.1	9.1	24.8	—	
São Domingos	N	50	4	—	2	56
	%	89.3	7.1	—	3.6	
Total	N	206	20	30	2	258
	%	79.8	7.8	11.6	0.8	

stantly, and the data of F. M. S. correspond to the time of the detailed serological and medical studies. The relatively small discrepancies between the two sets of histories would in no way influence the general conclusions. In Simões Lopes, only F. M. S. collected demographic data. Ages have been estimated by visual inspection and from a knowledge of the age-set system (cf. Maybury-Lewis, 1967). While we believe these data are as accurate as can be obtained under the circumstances, it must be emphasized that the information is undoubtedly less precise, and certainly covers a shorter time space, than would be true in a literate culture. In particular, attention must be directed towards the difficulties which the general cultural milieu of this group, and especially a classificatory kinship system, creates for obtaining precise reproductive data. In a later paper we shall discuss how the extensive blood typings which were carried out enable one to check on the accuracy of the histories obtained.

In the tables to follow, we will routinely compare the findings in the Xavantes with the observations of Salzano (1961, 1964) in six Caingang communities in the States of Rio Grande do Sul and Santa Catarina. The Caingangs are also Gê-speaking "marginal" Indians whose culture formerly had important elements in common with that of the Xavantes (cf. Métraux, 1944). However, although largely intact genetically, they have now completely abandoned a nomadic existence and are settled on reservations where they live primarily by farming. We introduce the comparison in an effort to explore demographic changes in the transition from a hunting-gathering-incipient agriculture economy to a truly agricultural economy.

### *Isolation*

Table 1 summarizes the degree of endogamy for the three villages. Because of the internal mobility of Xavante society described earlier, it is difficult to use the term "endogamy" in a strict sense. As already mentioned, relations between the villages near Batóví and Simões Lopes were close, with the



TABLE 2. AGE AND SEX STRUCTURE OF THE THREE VILLAGES STUDIED, AS ESTABLISHED FROM AN INTERVIEW WITH AS MANY MARRIED COUPLES IN EACH VILLAGE AS POSSIBLE  
 Figures in parentheses are the per cent of total in each age group.

Tribe and locality		Age intervals (years)			Unknown age	Total
		0-14	15-30	31-		
<i>Xavantes</i>						
Simões Lopes	♂	60	41	16	7	124
	♀	39	43	15	5	102
	Total	99 (43.8)	84 (37.2)	31 (13.7)	12 ( 5.3)	226
	Sex ratio	153.8	95.3	106.7	140.0	121.6
São Marcos	♂	83	54	39	42	218
	♀	61	53	42	18	174
	Total	144 (36.7)	107 (27.3)	81 (20.7)	60 (15.3)	392
	Sex ratio	136.1	101.9	92.9	233.3	125.3
São Domingos	♂	29	35	3	17	84
	♀	39	31	8	16	94
	Total	68 (38.2)	66 (37.1)	11 ( 6.2)	33 (18.5)	178
	Sex ratio	74.4	112.9	37.5	106.3	89.4
Total	♂	172	130	58	66	426
	♀	139	127	65	39	370
	Total	311 (39.1)	257 (32.3)	123 (15.4)	105 (13.2)	796
	Sex ratio	123.7	102.4	89.2	169.2	115.1
<i>Caingang *</i>						
Total	♂	622	522	418	64	1626
	♀	634	547	367	54	1602
	Total	1256 (38.9)	1069 (33.1)	785 (24.3)	118 ( 3.7)	3228
	Sex ratio	98.1	95.4	113.9	118.5	101.5

\* Data from Salzano (1961, 1964).

Indians in the latter village appearing to regard themselves as an extension of the former, who for purposes of convenience were living near Simões Lopes. During the period we were there, exchanges between villages were almost daily. Accordingly, marital partners from Batoví were not considered as "outsiders" by the Indians in the Simões Lopes village but treated as from the same group, and we have been forced to do likewise in the tabulation. Where one partner was classified as "from the outside," this was usually a wife acquired peacefully from another Xavante village (other than Batoví). Unfortunately, despite special efforts, it has been impossible to place the origin of these outside spouses with certainty, presumably in large measure because of the young age at betrothal for women and the shifting character of Indian villages. No instance of wife-stealing from other tribes is known to us. The entry "both from outside," applicable only to São Marcos, refers to the marriages within Sebastião's group plus two marriages of persons from São Domingos.

The degree of endogamy of Simões Lopes (-Batoví) appears about equal to that of São Domingos, with São Marcos by contrast quite cosmopolitan. The recent accretions to São Marcos which result in the greater exogamy may reflect the favorable subsistence conditions created by the Mission. In addition to the data summarized in Table 1, eight adults in Simões Lopes reported siblings living in São Marcos (whose presence we did not detect), and in São Marcos, various adults mentioned siblings and other relatives living in São

Domingos, Areoes, Sangradouro, and Batoví, for a total of nine persons (two males, seven females).

### *Age and Sex Distribution*

As described previously, the estimation of age among the Xavantes presents problems and all ages are approximate. For most of the following comparisons, three age classes are recognized, namely, 0–14 years (the pre-reproductive group), 15–30 years (vigorous young adults), and over 30 years (senior citizens, usually grandparents). Age was estimated only for persons actually interviewed. Persons not seen but reported to be in the village (or temporarily away) were usually siblings (and their children) of informants. These people comprise the “unknown age” column. The information summarized in Table 2 establishes the following points:

1. The base of the age pyramid is broad, suggesting a population replacing itself. This suggestion is borne out by the detailed reproductive data to follow.
2. There appears to be a deficiency of females (or excess of males) in Simões Lopes and São Marcos, involving the younger age groups rather than the older. Although this is statistically significant in only one village, we direct attention to it because it may result from phenomena we have not yet identified (rather than chance). The reproductive histories obtained, and on which Table 7 is based, fail to suggest any excess mortality for females prior to age 14. Because of the widespread practice of female infanticide among various American Indians, the possibility must be raised, but no history of such was obtained. In Simões Lopes, where physical examinations were performed on as many persons as possible, it was clear the deficiency involved only the adolescent and preadolescent girls (36 males but only 16 females in the estimated age range 6–15 years). Physical examinations were not routinely carried out at São Marcos and we cannot place the deficiency with equal accuracy. In this latter village, the “young men’s house” had recently been located in very close proximity to the Mission and had fallen under the supervision of the Mission. The boys slept there at night and were fed by the Mission. There was thus a much greater degree of “control” over young males than females. It is possible that the latter were more timid and retreated from contacts, but in our opinion the co-operation of the parents and chiefs was such that this is an unlikely explanation. Beyond this, the apparent differences between villages could in part be explained by the movement of betrothed young females between villages, but, if so, this fact did not emerge from the histories taken. Finally, the especially great discrepancy in the numbers of the two sexes in the “age unknown” category may be related to preferential recall of male relatives in a male-dominated society. Unfortunately, we did not detect this inequality in the two sexes in the field, and so failed to pursue certain obvious lines of inquiry.

3. Of the Xavantes whose age is known, 17.8% are 31 years or older, in contrast to 25.2% for the Caingangs. In view of the medical data to be presented later, we view this as reflecting a greater probability of traumatic death in the Xavantes rather than the better health of the Caingangs.

*Polygyny*

Polygyny is common, as shown in Table 3. There is no apparent difference among villages. Of 184 married men in the three villages studied, 40.2% were polygynous. The most common type of polygynous union involved two wives. The women in these cases were commonly related to each other as sisters, half-sisters, or first cousins. Approximately 70% of the surviving offspring were the issue of polygynous unions, but this figure must be used with caution because it is usually the older men (whose reproductive career is more nearly completed) who have the multiple wives.

In the study at São Domingos, "child marriages," involving prepubertal girls, comprised 28.6% of the marriages reported. By contrast, only one such marriage was acknowledged at Simões Lopes, and none at São Marcos. However, the difference in the rate of child marriages in the three villages is not reflected in the figures on polygyny. We suspect the difference between villages in this respect may be more apparent than real, originating in concealment of such betrothals (or the persons concerned?) in an effort to meet the admonitions of priests and Indian agents, but, if this is so, then it seems unusual that the proportions in the various polygyny classes do not appear to differ in the three villages. On the other hand, if this alleged difference in marital practices is real, it is tempting to relate it to the apparent deficiency of young girls at Simões Lopes and São Marcos, but we have no evidence in favor of this suggestion. Alternatively, of course, we must consider the possibility of a true difference in the polygyny structure of the villages.

In all three villages studied, it was the chief and the heads of clans who enjoyed the highest degrees of polygyny. The six men with four or five wives had 57 surviving offspring, an average of 9.5. Three of these men had probably completed reproduction; three probably had not. As we will see later, the average number of surviving children for Xavante men 40 years of age or over is 3.6. In round terms, then, these highly polygynous individuals produce two to three times as many children as other males. We shall come later to the possible genetic consequences of this mating structure. It may be noted here that polygyny was widespread among Indian tribes, although its quantitative aspects have seldom been documented as here (cf. Steward, 1946-1950).

The betrothal of the women occurs at a very early age (even in the absence of child marriages); the husband is commonly five to ten years the senior of his wife. The data of Table 3 indicate that 184 married men had had a total of 287 wives (some now deceased). Some of these wives are premenarchial, and marriage is a "holding operation" on the part of older males. The young male counterparts of these premenarchial wives are not in fact being deprived of a functional wife.

If an adult male dies leaving wives in the reproductive period—as not infrequently happens—remarriage of these widows occurs almost at once. Some idea of the frequency of death and remarriage can be derived from the fact that among the 175 married women interviewed in the three villages combined, 30 (17.2%) had been married twice and 6 (3.4%) three times. In

TABLE 3. NUMBER AND RELATIONSHIP OF WIVES REPORTED BY MARRIED XAVANTE MALES  
 Numbers greater than one are usually accounted for by polygamy, but in some instances successive marriages are involved.

Localities	Number of men	Biological relation of wives in polygamous marriages										Number of surviving offspring	
		Sisters	Half sisters	First cousins	2 unrelated	2 sisters unrelated	1 half sister	2 half sisters	2 sisters unrelated	2 sisters unrelated	Unknown	Unknown	
<i>Simões Lopes</i>													
Men with one wife	34(58.6)	--	--	--	--	--	--	--	--	--	--	--	45(27.1)
Men with two wives	16(27.6)	9	1	2	--	--	--	--	--	--	--	4	61(36.8)
Men with three wives	7(12.1)	--	--	--	1	5	--	--	--	--	--	--	54(32.5)
Men with four wives	1(1.7)	--	--	--	--	--	1	--	--	--	--	--	6(3.6)
<i>São Marcos</i>													
Men with one wife	55(61.8)	--	--	--	--	--	--	--	--	--	--	--	65(33.3)
Men with two wives	27(30.3)	6	1	--	--	--	--	--	--	16	--	4	90(46.2)
Men with three wives	4(4.5)	--	--	--	--	3	--	--	--	--	--	--	18(9.2)
Men with four wives	2(2.3)	--	--	--	--	--	--	--	--	--	1	--	11(5.7)
Men with five wives	1(1.1)	--	--	--	--	--	--	--	--	--	--	1	11(5.6)
<i>São Domingos</i>													
Men with one wife	21(56.8)	--	--	--	--	--	--	--	--	--	--	--	24(27.0)
Men with two wives	10(27.0)	6	1	--	--	--	--	--	--	--	--	3	23(25.9)
Men with three wives	4(10.8)	2	--	--	--	--	1	--	--	--	--	1	13(14.6)
Men with four wives	1(2.7)	--	--	--	--	--	--	--	--	--	1	--	6(6.7)
Men with five wives	1(2.7)	1	--	--	--	--	--	--	--	--	--	--	23(25.8)
<i>Tetã</i>													
Men with one wife	110(59.8)	--	--	--	--	--	--	--	--	--	--	--	134(29.8)
Men with two wives	53(28.8)	21	3	2	--	--	--	--	--	23	--	4	174(38.7)
Men with three wives	15(8.1)	2	--	--	1	8	2	--	--	1	--	1	85(18.9)
Men with four wives	4(2.2)	--	--	--	--	--	1	--	--	--	--	--	23(5.1)
Men with five wives	2(1.1)	1	--	--	--	--	--	--	--	--	--	1	34(7.5)

interpreting this figure, it must be remembered that this, like the figure for polygyny, is a cross section in time—the figure for those who have completed the reproductive period will be higher. Divorce in the usual sense of the word seems uncommon among the Xavantes (cf. Maybury-Lewis, 1967). Thus, among 36 women married more than once, in only two instances was a previous husband alive. We are aware of no true polyandry. No instance was encountered in the three villages of an adult woman who had never been married. Since, as we will see later, sterility is uncommon, one may almost say categorically that all adult women are contributing to the next generation.

#### *Number of Surviving Children Per Marriage*

One of the crudest indices to the reproductive structure of a population is the number of surviving children per marriage for all marriages at time of census, but this crude figure, influenced as it is by the age and marriage structure of the population, is often the only one available for comparison. The data on the Xavante and Caingang are presented in Table 4. In the present instance, we observe no difference among the three Xavante villages but a significant difference between Xavantes ( $1.7 \pm 0.1$ ) and Caingangs ( $2.3 \pm 0.1$ ). Only 3.9% of Xavante families contained six or more surviving children, whereas this was the case for 9.9% of Caingang families. Holmberg (1950) reports that in one band of the nomadic Siriono of Eastern Bolivia, the average number of children in 17 “nuclear families” was 2.3, while in a second band the average number in 14 families was 1.6, but adds that “since the latter band had had considerable contact with the whites, a number of their children had been stolen from them.” However, seven of these 31 “nuclear families” were polygynous; the data are not given for individual females. The figure for the first band, with intuitive allowance for polygyny, is quite similar to that for the Xavante.

#### *Fertility and Survival*

Tables 5, 6, 7, and 8 present data on fertility and survival. In the compilation of these tables, certain difficulties have arisen. For genetic purposes, the most pertinent data concern completed fertility and number of offspring reaching adulthood. The ideal approach, involving a cohort, is not possible under these circumstances. We thus are forced to attempt to approximate completed performance on the basis of cross-sectional data. Each adult was questioned about his or her reproductive performance and that of any deceased spouses. Unfortunately, the culture does not permit the accurate estimation of age at death; nothing more precise than a division into “death before 40” and “death after 39” seems justified, and even in this case we must sometimes be arbitrary.

Table 5 presents data on number of livebirths, subdivided as just described. The data are a mixture of complete and incomplete families. For living women, there is by history about one birth every five years between the ages of 15 and 40 years. We will compare this later with the findings on physical exam-

TABLE 4. NUMBER OF SURVIVING CHILDREN PER MARRIAGE IN THE THREE VILLAGES, FOR MARRIAGES WHERE AT LEAST ONE MARITAL PARTNER SURVIVES

This figure does not include "child" (prepubertal) marriages.

Tribe and locality	Number of children														Number of families	Average number of children ( $M \pm \sigma_M$ )
	0	1	2	3	4	5	6	7	8	10	14					
<i>Xavantes</i> Simões Lopes	N	17	30	16	8	2	3	2	2	—	—	—	—	—	80	1.7 ± 0.2
	%	21.3	37.5	20.0	10.0	2.5	3.7	2.5	2.5	—	—	—	—	—	—	—
São Marcos	N	21	41	25	13	4	4	1	—	—	—	—	—	—	109	1.6 ± 0.1
	%	19.3	37.6	22.9	11.9	3.7	3.7	0.9	—	—	—	—	—	—	—	—
São Domingos	N	10	12	7	4	2	1	2	1	1	—	—	—	—	40	2.0 ± 0.3
	%	25.0	30.0	17.5	10.0	5.0	2.5	5.0	2.5	2.5	—	—	—	—	—	—
Total	N	48	83	48	25	8	8	5	3	1	—	—	—	—	229	1.7 ± 0.1
	%	21.0	36.2	21.0	10.9	3.5	3.5	2.2	1.3	0.4	—	—	—	—	—	—
<i>Caingang</i> * Total	N	148	140	107	101	63	35	31	24	8	1	1	1	659	2.3 ± 0.1	
	%	22.5	21.2	16.2	15.3	9.6	5.3	4.7	3.6	1.2	0.2	0.2	0.2	—	—	—

\* Data from Salzano (1961, 1964).

TABLE 5. NUMBER OF LIVEBIRTHS PER MARRIED INDIVIDUAL OVER THE AGE OF 15, BY AGE GROUPS  
 There were no births to parents less than an estimated age of 15.

Tribe and locality	Ages (years)										All ages	Dead	
	15- 19	20- 29	30- 39	40- 49	50- 59	60-	Probably < 40	Probably ≥ 40					
<i>Xarointes</i>													
Simões Lopes	19	22	12	5	2	—	60	12	—				
Mean number livebirths	0.9	2.9	4.6	5.8	5.0	—	2.9 ± 0.3	3.4	—				
Number of males	3	20	17	4	—	—	44	4	10				
Mean number livebirths	0.3	2.4	4.1	6.5	—	—	3.3 ± 0.4	3.5	5.8				
<i>São Marcos</i>													
Number of females	10	32	15	15	7	—	79	9	—				
Mean number livebirths	1.1	2.2	3.3	5.2	6.3	—	3.2 ± 0.2	3.6	—				
Number of males	—	27	15	15	—	2	59	11	14				
Mean number livebirths	—	1.7	3.2	5.1	—	12.0	3.3 ± 0.4	1.9	4.9				
<i>São Domingos</i>													
Number of females	14	9	2	4	1	1	31	4	—				
Mean number livebirths	1.2	2.8	8.5	7.0	8.0	1.0	3.1 ± 0.5	3.2	—				
Number of males	2	13	3	2	—	1	21	7	1				
Mean number livebirths	0.5	2.2	4.0	3.0	—	24.0	3.4 ± 1.1	3.7	11.0				
Total													
Number of females	43	63	29	24	10	1	170	25	—				
Mean number livebirths	1.1	2.5	4.2	5.6	6.2	1.0	3.1 ± 0.2	3.4	—				
Number of males	5	60	35	21	—	3	124	22	25				
Mean number livebirths	0.4	2.1	3.7	5.1	—	16.0	3.3 ± 0.3	2.8	5.5				
<i>Caingang</i> *													
Number of females	61	189	109	88	40	44	531	25	20				
Mean number livebirths	1.2	3.0	5.4	7.0	6.0	6.1	4.5 ± 0.1	3.6	5.4				

\* Data from Salzano (1961, 1964).

ination. The number of livebirths reported by males 40 years and above and the number reported by spouses for those males estimated to have died after 40 are comparable, lending some credence to the validity of the data for deceased males. On the other hand, no males reported their deceased wives had been 40 or over at the time of death, so that this same comparison is not possible for females. The reason is probably found in the usual age disparity between husband and wife—men whose wives had died at age 40 or greater would themselves often be expected to be 50 years or greater. There are few such males in the village.

The three Xavante villages do not differ from one another in the average number of livebirths per married female for all ages, whether for living or deceased persons. The greater number of liveborn offspring reported by males than reported by the spouses themselves of course reflects the polygamy structure of the village. However, it must be remembered that many of these fertilities are incomplete; in a closed system of polygamy where the sexes are equal in number, the mean number of offspring produced by males must equal the mean number produced by females.

In our earlier paper, we commented on the "intermediate" fertilities of the Xavantes. This finding is confirmed by the new statistics. Table 5 reveals that for four of the five age intervals where the numbers are large enough for meaningful comparisons, the number of livebirths was greater in Caingang than in Xavante. Table 6 shows that the average number of livebirths to Xavante women whose reproduction is complete or nearing completion by virtue of an age over 39 or death is (mean and standard deviation)  $4.7 \pm 2.4$ ; for the Caingang it is  $6.1 \pm 3.8$ . This is the mean and standard deviation, as best we can estimate it, for all reproducing women whose reproduction is complete or nearly so. For living women over the age of 39 for the two groups, the figures are  $5.7 \pm 2.4$  and  $6.6 \pm 3.8$ . The difference is of course due to the fact that the former figure includes women whose reproductive performance was cut short by death. In future work, we shall attempt to base these figures on women who have completed the menopause, a reproductive milestone more difficult to establish at this cultural level than our own. Also, specific attention will be directed to the possibility of concealed infanticide.

We are aware of only two other sets of data of this latter type for relatively undisturbed primitive groups, those of Grey (1841) on postmenopausal Australian aborigines (mean of 4.6 for 41 women) and of Ranke (1898) for Indian women estimated to be over age 39, in the Upper Xingu region of Brazil (mean of 5.3 for 24 women). Neel (1958) has summarized similar data on completed family size in "simple" agricultural populations in East Pakistan, Ghana, and Liberia; the means and standard deviations are, respectively,  $6.5 \pm 3.2$ ,  $7.0 \pm 3.3$ , and  $5.5 \pm 3.9$ . The last figure is depressed by the fact that 11.9% of the women interviewed had been sterile. It seems clear that both the mean and variance of number of children ever born to fertile women who have completed childbearing tends to be smaller in nomadic cultures depending significantly on hunting and gathering than in more settled, agricultural groups.



TABLE 6. NUMBER OF LIVEBORN OFFSPRING IN COMPLETED SIBSHIPS

	Number of children																Number of women	Average number of children	
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			16
<i>Xarante</i>																			
Alive ( $\geq 40$ years)	—	1	—	6	3	9	7	1	4	1	1	2	—	—	—	—	—	35	$5.7 \pm 2.4$
Dead (est. $< 40$ years)	—	6	4	3	5	2	2	3	—	—	—	—	—	—	—	—	—	25	$3.4 \pm 2.1$
Total	—	7	4	9	8	11	9	4	4	1	1	2	—	—	—	—	—	60	$4.7 \pm 2.4$
<i>Caingang</i>																			
Alive ( $\geq 40$ years)	10	11	12	7	12	11	25	14	13	12	20	8	7	6	1	2	1	172	$6.6 \pm 3.8$
Dead (est. $< 40$ years)	1	7	3	2	4	1	1	4	1	1	—	—	—	—	—	—	—	25	$3.6 \pm 2.7$
Dead ( $\geq 40$ years)	2	2	2	2	1	1	1	2	3	1	1	1	—	1	—	—	—	20	$5.4 \pm 3.9$
Total	13	20	17	11	17	13	27	20	17	14	21	9	7	7	1	2	1	217	$6.1 \pm 3.8$

Turning now to the average number of surviving offspring per woman or man who had at least one liveborn child, again we see no significant difference among the three Xavante villages (Table 7). The average number of surviving children per fertile female is greater for Caingang women than for Xavante women. Since the percentage of children lost when all ages are considered together is very similar for the two groups, it follows that the greater number of living children of the Caingang is due to a higher birth rate rather than better survival of their children. However, Caingang mothers over 29 years of age have lost a higher percentage of children than Xavante mothers, but the reverse is true under this age. Assuming that the recall of the two sets of mothers is the same, this trend, although not statistically significant, suggests that prior to contacts with neo-Brazilians, the Xavante had lower (intermediate) infantile and childhood mortalities than the Caingang, but that the results of these contacts are already reflected in the vital statistics (see section on special mortality statistics).

Of particular genetic interest is the mean and variance in number of surviving offspring of those whose reproductive performance is certainly or probably complete or nearly so. These data are given in Table 8, based on living persons whose age was estimated to be over 39 years plus recently deceased husbands or wives, as the case might be. Although the means are the same for the two sexes—as expected in a polygynous society with equal numbers of the two sexes—the male variance is significantly greater than the female ( $F = 3.10$ ). A single unusual male makes a disproportionate contribution to this variance; with his exclusion, the male variance is 5.9 and the difference between the male and female variances no longer significant ( $F = 1.51$ ). Assuming for the moment that this trend is valid, it follows that the relatively excessive reproductive performance of the few highly polygynous males is offset by the very poor performance of a larger number of males, presumably those who died in early manhood or who had difficulty obtaining wives—although it is rare for a man never to find a wife (Maybury-Lewis, 1965a, 1967).

We will return later to the question of how well this reported structure corresponds to the actual facts as revealed by genetic markers (Shreffler and Steinberg, 1967).

A mean of 3.6 surviving children per completed family implies a rapidly expanding population. This figure is of course an over-estimate of the number reaching sexual maturity, since many of these children are still quite young. On the other hand, it would appear the Xavante are not at this moment a "dying" tribe. Of especial importance in the theory of population genetics is the ratio of variance to mean, here 1.08 for females. If this ratio remains relatively constant as other primitive groups are studied and if the difference between sexes persists, it will seem to constitute a valid parameter throughout temporal fluctuations in the reproductive performance of the tribe as a whole.

The question of stillbirths was not pursued with the same intensity in the early studies of the Caingang that it was in the later studies or for the Xavantes. Thus, although both figures are probably underestimates, the error is greater for the Caingang. Among the Xavantes, eight of 614 births in the

TABLE 7. AVERAGE NUMBER OF SURVIVING OFFSPRING PER FEMALE AND MALE WHO HAD AT LEAST ONE LIVEBORN CHILD, BY AGE GROUPS

Tribe and locality	Alive										Dead	
	15-19	20-29	30-39	40-49	50-59	60-	All ages	Probably < 40	Probably ≥ 40			
<i>Xavantes</i>												
Simões Lopes												
Number females	13	21	12	5	2	—	53	12	—			
Average number surviving offspring	0.8	1.6	3.1	3.8	3.5	—	2.0 ± 0.2	2.3	—			
Decrease as % of livebirths	11.1	44.8	32.6	34.5	30.0	—	31.0	32.4	—			
Number males	1	17	16	5	—	—	39	4	10			
Average number surviving offspring	—	1.5	2.5	4.0	—	—	2.2 ± 0.3	2.7	3.8			
Decrease as % of livebirths	100.0	37.5	39.0	38.5	—	—	33.3	22.9	34.5			
São Marcos												
Number females	10	31	15	15	7	—	78	9	—			
Average number surviving offspring	0.7	1.5	1.9	2.9	4.0	—	2.0 ± 0.2	2.1	—			
Decrease as % of livebirths	36.4	31.8	42.4	44.2	36.5	—	37.5	41.7	—			
Number males	—	27	13	14	—	2	56	11	14			
Average number surviving offspring	—	1.4	1.8	3.1	—	7.0	2.1 ± 0.2	0.8	3.2			
Decrease as % of livebirths	—	17.6	43.8	39.2	—	41.7	39.4	57.9	34.7			
São Domingos												
Number females	12	9	2	4	1	1	29	4	—			
Average number surviving offspring	0.7	1.8	7.5	4.8	8.0	—	2.3 ± 0.5	3.0	—			
Decrease as % of livebirths	41.7	35.7	11.8	31.4	—	100.0	25.8	6.2	—			
Number males	1	12	3	2	—	1	19	7	1			
Average number surviving offspring	1.0	1.2	3.0	2.5	—	23.0	2.8 ± 1.1	2.6	7.0			
Decrease as % of livebirths	—	45.5	25.0	16.7	—	4.2	17.6	29.7	36.4			
Total												
Number females	35	61	29	24	10	1	160	25	—			
Average number surviving offspring	0.7	1.6	2.8	3.4	4.3	—	2.0 ± 0.1	2.4	—			
Decrease as % of livebirths	36.4	36.0	33.3	39.3	30.6	100.0	35.5	29.4	—			
Number males	2	56	32	21	—	3	114	22	25			
Average number surviving offspring	0.5	1.4	2.3	3.2	—	12.3	2.2 ± 0.2	1.7	3.6			
Decrease as % of livebirths	20.0	33.3	37.8	37.3	—	23.1	33.3	39.3	34.5			
Cairang *												
Number females	49	181	106	89	39	39	503	24	19			
Average number surviving offspring	1.1	2.0	3.3	4.1	3.7	3.6	2.8 ± 0.1	2.2	2.8			
Decrease as % of livebirths	8.3	33.3	38.9	41.4	38.3	41.0	37.8	38.9	48.1			

\* Data from Salzano (1961, 1964).

TABLE 8. SURVIVING OFFSPRING IN COMPLETED FAMILIES

Data based on living individuals age 40 years and older plus recently deceased individuals for whom information was supplied by surviving spouse.

	Number of children											Number of individuals	Average number of children	Variance ( $s^2$ )	
	0	1	2	3	4	5	6	7	8	9	11				23
<i>Xavantes</i> (Total)															
Females	1	7	7	7	7	7	4	3	1	—	—	—	44	3.6	3.9
Males	4	12	14	7	7	6	2	7	—	1	1	1	62	3.6	12.1

three villages reportedly terminated in stillborn infants ( $1.3 \pm 0.5\%$ ), whereas among the Caingang, 83 of 2,646 births were stillborn ( $3.1 \pm 0.3\%$ ). Accordingly, despite the bias in favor of higher rates in the Xavante, the stillbirth rate is significantly higher in the Caingang ( $\chi^2 = 6.0$ ,  $df = 1$ ,  $0.02 > P > 0.01$ ). If stillbirths are added to the data on death prior to age of reproduction, the differences between Xavantes and Caingangs in deaths prior to the age of reproduction are accentuated.

### *Infertility*

After the age of 15 years, all Xavante women were married. In the case of multiple (successive) marriages, a woman is scored as fertile if there have been children by any of the marriages. After the second decade, only one of the 195 Xavante women for whom histories are available ( $0.51 \pm 0.51$ ) had not borne a child! The figure for the Caingangs is 23 of 576 women ( $4.0 \pm 0.82$ ). Thus, infertility appears to be less common in the Xavante than in the populations of simple agriculturists for whom we have data, where it averages 3–5% (review in Neel, 1958).

### *Inbreeding*

Every effort was made to establish as complete a pedigree as possible for each marriage, but the combination of a linguistic barrier, short life span, illiteracy, early betrothal with subsequent emphasis on clan affiliation, and a classificatory kinship system render estimations of inbreeding levels unsatisfactory. Thus, for only 18 out of a total of 257 Xavante marriages do we have a satisfactory identification of all four grandparents. Conversely, for 21 marriages we are unsure of the identity of one or more of the parents of the spouses.

Table 9 reveals that, taken at face value, there is more than a ten-fold difference in the frequency of consanguineous marriages in the three villages. However, the figures for São Domingos are based on 39 adult and 16 child marriages, whereas child marriages were reported only once in the other two villages. In São Domingos, consanguinity could be established for five of 39 adult marriages ( $F = 0.006$ ) but for eight of the 16 child marriages ( $F = 0.019$ ). We believe the apparently higher frequency in the latter to be in part misleading, simply because information is usually available for an additional generation in the case of child marriages. On the other hand, the dis-

TABLE 9. FREQUENCY OF CONSANGUINEOUS MARRIAGES IN THE THREE XAVANTE VILLAGES  
 GPK = all four grandparents known; PK = parents known, incomplete information on  
 grandparents; I = incomplete information about the spouses' parents.

Degree of relationship	Xavante Simões Lopes <sup>1</sup>			Xavante São Marcos			Xavante São Domingos <sup>2</sup>			Xavante Total			Gaingang Total <sup>3</sup>		
	GPK	PK	I	GPK	PK	I	GPK	PK	I	Total No.	%	Total No.	%	Total No.	%
Uncle/niece	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
First cousins	—	4	—	—	—	—	—	4	—	—	—	—	—	—	—
once removed	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—
Double first cousins	1	—	—	—	—	—	2	4	—	—	—	—	—	—	—
once removed	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Second cousins	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—
Half-double	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
second cousins	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Second cousins	—	—	1	—	—	—	—	2	—	—	—	—	—	—	—
once removed	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Double second cousins	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Third cousins	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other <sup>4</sup>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—
Number marriages	2	8	81	—	9	103	9	103	9	121	121	13	23.6	6	18
Inbreeding coefficient	4	73	4	—	—	—	—	—	—	—	—	—	—	—	—
											0.0005		0.009		0.004

<sup>1</sup> Includes one "child" marriage.

<sup>2</sup> Includes sixteen "child" marriages.

<sup>3</sup> Data from Salzano (1961, 1964).

<sup>4</sup> Since the exact degree of relationship is not known in these cases, they were not included in the calculation of the inbreeding coefficient.

proportionately large contribution of Chief Apewê to the young adult generation in São Domingos may have increased the likelihood of consanguinity among the child marriages. We are thus left with the impression that the apparently higher frequency of consanguineous marriages at São Domingos may be in part real (excessive reproduction of Chief Apewê) and in part spurious or at least of recent origin (absence of reported child marriages in the other two villages).

As noted, there are 18 marriages in the three villages for which all four grandparents can be identified; six of these are consanguineous, the mean coefficient of inbreeding for all 18 being 0.013. Earlier, we suggested that the true coefficient of inbreeding for the São Domingos village might be four or five times the recorded 0.009 (Neel *et al.*, 1964). This impression was based in part on the apparent high endogamy at that village; on the basis of these more recent data, this estimate would appear high for the entire tribe. We shall for subsequent purposes use a figure of 0.02–0.03. Precise data on other Indian tribes are highly desirable. The coefficient of inbreeding for the three Xavante villages combined (0.004) is essentially the same as that established by Salzano (1961, 1964) for the Caingang.

#### *Mean Coefficient of Relationship*

A descriptive parameter which helps characterize a population such as this is the mean coefficient of relationship. Like the coefficient of inbreeding, it suffers in this instance from the obvious defects in the genealogical data, but to a lesser extent, since the proximal generation, predominantly unmarried, enters into this calculation but not into the coefficient of inbreeding.

The mean coefficient of relationship has been calculated in two ways. Firstly, balls representing each person in a village from whom a blood specimen was obtained were placed in a container, and 20 were drawn without replacement. The mean coefficient was calculated on the basis of the 190 possible relationships among these 20 individuals. Secondly, pairs of balls were drawn 190 times, with replacement after each drawing, and the coefficient calculated from these 190 pairs. For São Domingos the resulting value with the first procedure was 0.078, and for the second, 0.082. Since the close relationships are for the most part known, this is much less an underestimate than the coefficient of inbreeding. We conjecture that in view of the inadequate pedigrees the true coefficient of relationship may be as high as 0.125, i.e., a randomly selected pair of individuals would on the average bear a relationship equivalent to first cousins. For Simões Lopes and São Marcos, the observed figures are 0.020 and 0.027, and 0.005 and 0.017, respectively; the true value may be about 0.032 and 0.016.

The differences between villages parallel the differences in coefficients of inbreeding and are in part real and in part spurious. Earlier, we have described the recent decrease in size of São Domingos, as dissident groups slipped away, and the increase in size at São Marcos, as groups joined the

village. It seems probable that in São Domingos there has been a tendency for the close clansmen of the chief to remain in the village. On the other hand, on the basis of origin we recognize at least three distinct subpopulations in São Marcos. Within these groups the coefficient of relationship will be much higher than for the village as a whole (see Fig. 1), but across subpopulations, it will usually be quite low. This fact is not reflected in the derivation of a single statistic for the entire village.

#### *Some Special Birth and Mortality Statistics Obtained at Simões Lopes*

The agent for the Simões Lopes Post of the Indian Protective Service, Sr. Pedro Vani de Oliveira, has made an unusually conscientious effort to keep a record of births and deaths in the nearby Xavante village since contacts were first made and has also compiled an annual census. He has recorded a total of 90 births, 38 male and 52 female, between 1957 and 1963. Forty-three of these children (47.8%), 16 males and 27 females, have subsequently died, 30 during the first year of life. The observed mortality among these children appears higher than that reported in Tables 7 and 8. Assuming that the probability of ascertaining a livebirth is unrelated to the subsequent death of the child, this permits either of two interpretations, namely, under-reporting on the part of mothers, especially the older ones, or a recent increase in infant and childhood mortality, as already suggested by the data of Table 7.

Both explanations are probably correct. In 1960, the village experienced an epidemic of pertussis, followed by pneumonia, and in 1962, an epidemic of measles. Of 62 deaths recorded by Sr. Pedro between 1958 and 1963 (including these 43), 29 were attributed to measles, 11 to pertussis, seven to pneumonia, seven to diarrhea, two to bronchitis, one to inflammation of the ovary, and five to unknown causes. While it cannot be assumed that none of the children dying of measles and pertussis would have succumbed in the absence of these diseases, it does seem clear that these two diseases of civilization have resulted in an increased mortality in recent years. With respect to the under-reporting of births associated with deaths, this is an ever present possibility, the importance of which is difficult to assess accurately.

#### *Extramartial Conceptions*

The sexual practices of Indian tribes vary greatly. From the genetic standpoint, what is important is not the occurrence of extramarital or premarital sexual relationships but the extent to which these result in children. Among Indian tribes, the Xavante would appear to be relatively restrained in extramarital relationships (Maybury-Lewis, 1967). On the other hand, the *wai'a* ceremony, involving the ceremonial rape of selected women by the officiating age-set, is a prominent feature of their culture. We have therefore felt it mandatory in this effort to describe breeding structure in quantitative rather than qualitative terms, to attempt to obtain data on premarital and extra-

marital conceptions, using the various genetic marker systems. A detailed account of the techniques and findings will be deferred for later papers. Suffice it to say that among 107 children who were studied with respect to phenotype for 12 genetic systems in which variation was present and both of whose parents were similarly studied, there were nine apparent "exclusions," some of whom, however, may be the result of the difficulties in obtaining accurate genealogical data (in the biological sense) in this culture.

#### DISCUSSION AND SUMMARY

We do not present these data as characteristic of the demography and vital statistics of an "untouched" hunting-gathering-incipient agriculture group but only as a reasonable approximation thereto, to be utilized with due caution. On the other hand, we know of no better data from which to begin to derive a picture of the genetic structure of a population at this cultural level. Outstanding among the present findings are (1) the high degree of intratribal mobility, of such a degree that regardless of the situation at any one moment, over a time span of a relatively few generations the entire tribe probably may be regarded as the breeding unit; (2) a high frequency of marriage and a low occurrence of sterility, such that with few exceptions every adult female must be regarded as a member of the reproducing population; (3) a mean and variance for number of livebirths and number of surviving offspring per adult female significantly below those observed at the next cultural levels (simple agriculturalists or pastoralists); (4) a system of polygyny which permits of the disproportionate reproduction of a selected few; and, as a corollary, (5) similar means but a significantly greater variance for number of surviving offspring for males whose reproduction is completed than for similar females.

But, although the main outlines of present Xavante demography appear clear, many details are lacking. For instance, while the structure of the age pyramid and the number of surviving offspring per female whose reproductive performance is complete ( $M = 3.6$ ,  $\sigma = 2.0$ ) suggests an expanding population, some of those surviving children are still very young and will undoubtedly die prior to the age of reproduction. We also have very inadequate data on the death of young males (and females) early in the reproductive period from trauma and war. The present study provides the basis for a cohort-type approach to a variety of demographic questions—but, unfortunately, it is clear that any cohort we might define at present will be subjected to so many new influences that we can never hope to extrapolate with any precision to the past.

One ultimate objective of these studies is to develop realistic genetic models for populations at this level, both as a basis for insights into population structure during the course of human evolution and as a basis for understanding the changes introduced by recent cultural developments. Such models are prerequisite to attempts to define the relative roles of genetic drift and selection in human evolution. A basic parameter in many of the



formulations is effective population size ( $N_e$ ) in the sense of Wright (1931). This number, so useful in the abstract, is extremely difficult to derive in actual life, both because of gaps in our knowledge of populations and mathematical difficulties in combining the effects of all the various factors which reduce the estimate of  $N_e$  below that derived from a single count of the reproducing individuals at any time point. A critical question concerns the limits to place on the distribution of the breeding unit. In the case of the Xavantes, it appears that on any kind of time span the unit must be considered to be the tribe as a whole. Interchange with adjacent tribes, for which we have no evidence, would of course extend the boundaries of the unit. In the three villages studied in detail so far, of 691 persons for whom age is known, the breeding fraction may be equated to the 139 males age 20–45 years and the 167 females age 15–40 years. Thus, 44% of the head count is reproductive. A first approximation to  $N_e$  results from multiplying this per cent by the estimated tribal size, say 1,800 persons. The resulting figure is 792.

Kimura and Crow (1963; formulae [18] and [20]) have derived formulae for correcting this crude figure for the effects of inbreeding, unequal numbers of the two sexes in the breeding population, and different variances of number of offspring surviving to reproduction for males and females. In order to obtain a general idea of how much the demographic data on the Xavante will reduce  $N_e$  below the figure obtained by a simple count, we make the following approximations:

1.  $\alpha$ , the measure of departure from Hardy-Weinberg proportions, is here equated to the estimated  $F$  value for the population of 0.03. We entertain a number of objections to this approximation, but regard it as sufficiently accurate for present purposes.

2. The numbers of the sexes in the breeding unit are as given above.

3. Mean surviving offspring = 3.6 for males and females (Table 8). This is too high as, probably, are the variances given below because some of the children on whom this figure is based will die prior to reproduction. Further, if number of sexes in the breeding pool is unequal, the mean number of offspring cannot be the same for both, but we shall ignore this in the approximation.

4. Variance of offspring surviving to reproduction is 3.9 for females but either 5.9 or 12.1 for males, the lower figure resulting from the exclusion from the calculations of the chief with 23 offspring described earlier. This variance has been equated to the  $S_k^2$  of Kimura and Crow (1963).

With these assumptions and approximations, the figure of 792 reduces to either 470 or 661, depending on which variance is employed for the males. Inbreeding contributes relatively little to this reduction; the important factor is polygyny. While at the tribal size of the Xavante, this reduction does not greatly alter the role one assigns to deterministic factors in gene frequencies, at the smaller size which must obtain in the early period of the evolution of a tribe, this much reduction would lower  $N_e$  to a point where nondeterministic factors are of greater relative importance.

There are four additional factors which would tend to reduce  $N_e$  for which

not even approximate allowance can be made. The first is the restriction on mate selection within the population. Although over a time span of, say, ten generations, the internal mobility of the tribe will permit a high degree of exchange between villages, at any one instant in time an inhabitant of village 1 has very limited access to an inhabitant of village 2 (cf. Fig. 1). Furthermore, any one of these "tribal pseudopods" may be snipped off by war or other calamities. The effect of this is surely to reduce  $N_e$ , probably considerably, but neither the necessary data nor the precise formulation is available. Secondly, fluctuations in population numbers, as a result of war, famine, or disease, probably overshadow in their impact on  $N_e$  those factors we can now measure. Thirdly, the probable concentrations of relatives in the founding group will also reduce  $N_e$ . Finally, as Nei and Murata (1966) have recently demonstrated, if fertility per se is inherited, this also reduces effective population size. Little is to be accomplished in efforts to refine estimates of  $N_e$  until more is known both about these four factors and the final ratio of variance in surviving (reproducing) offspring to mean surviving offspring for males and females separately.

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