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Genetic Load in an Isolated Tribal Population of South India

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Summary. The Kota of Nilgiri Hills, Tamilnadu, are an isolated tribal population and occupy the lowest stratum in the local social hierarchy. They have developed an economic symbiotic relationship with other tribes of the Nilgiri Hills (e.g., Toda, Kurumba, Badaga), but have almost no social relationship with other communities, such as the Hindu and Muslim, communities, etc. The total population of the Kota is about 1200. Consanguineous marriages are highly favoured in this group.

This paper presents data on prenatal, infant and adolescent mortality in relation to the degree of inbreeding. No perceptible difference has been found in mortality figures between consanguineous and non-consanguineous marriages. This may be due to the long history of inbreeding among the Kota. No case of visible congenital malformation has been noticed.

The estimates of genetic load as revealed by inbreeding data indicate that genetic load in the Kota is low (perhaps about 1 lethal equivalent per gamete); it is also low in comparison with that in other Indian populations.

Introduction

The Kota are a small tribal population, comprising 1203 individuals (as of 1966) distributed in seven villages in the Nilgiri Hills, Tamilnadu. The actual history of the Kota migration to the Nilgiri Hills is not known. Whatever assumptions have been made about their origin and migration to the present habitat are based on anthropological findings. Mandelbaum (1956) writes that the Kota know they have been living in the Nilgiri Hills, along with the Toda, Kurumba, and Badaga (the last of whom arrived in Nilgiri Hills much later than the others) since time immemorial. With the opening up of this area during the 19th century by the British administrators, people of other communities also migrated there (Mandelbaum, 1941; Verghese, 1974).

The four above-mentioned tribal groups may perhaps be considered as original inhabitants of this area, and they live in social and economic symbosis

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among themselves (Mandelbaum, 1941). They have developed hardly any social relationships with the other neighbouring communities, e.g., Hindu, Muslim, etc., who are very recent migrants by comparison. The four symbiotic tribal populations of the Nilgiris are also arranged hierarchically—the Toda occupy the highest social position, while the Kota are in the lowest social stratum since they are carrion eaters (Verghese, 1974; Francis, 1908; Thurston, 1909; Mandelbaum, 1956; Gates, 1961).

The demographic and genetic structures of this population have already been described (Ghosh, 1970, 1972, 1973, 1976; Ghosh et al., 1977). Among the Kota consanguineous marriages are highly favoured (Ghosh, 1972, 1976). It has been reported that the admixture rate among the Kota is as low as 0.29% in the present generation, which indicates almost complete biological isolation (Ghosh, 1976).

The purpose of the present study is to examine the effect of inbreeding on prenatal, infant, and adolescent mortality, to report the inbreeding load in the population in terms of the lethal equivalents per gamete, and to compare our findings with those available from other Indian populations.

Genetic load is defined as the proportion of relative decrease in average fitness of a genotype in comparison with the maximum fitness of the genotype. Morton et al. (1956) have proposed a method of estimating genetic load in human populations, as disclosed by inbreeding, in terms of lethal equivalents; according to them, the genetic load is 'a small group of mutant genes of such number that, if dispersed in different individuals, they would cause on the average one death, e.g., one lethal mutant, or two mutants each with 50% probability of causing death, etc.'. The two parameters, A and B, of the genetic load model of Morton et al. (1956) indicate the random mating load and the inbreeding load, respectively. The total load is therefore A + B. A low value of the B:A ratio indicates that the load is segregational, while a high value indicates that the load is mutational. A great deal of controversy exists over the interpretation of the B:A ratio (e.g., Sanghvi, 1963; Schull and Neel, 1965; Friere-Maia et al., 1971). We shall not enter into this controversy here, however.

Materials and Methods

The present data on the Kota of Nilgiri Hills were collected between May, 1966 and January, 1968. Extensive genealogies were drawn for the members of every Kota household. The methodology used in collecting demographic information has already been described by Ghosh (1976). It may be noted that in the calculation of inbreeding coefficients by the path-coefficient method, only the closest relationships between spouses were considered (Ghosh, 1972).

The A and B parameters of the genetic load model, proposed by Morton et al. (1956), were estimated by the weighted least-squares method proposed by Smith (1967). Certain errors in the formulas derived by Smith (1967) have subsequently been corrected (Smith, 1969); these corrections were incorporated in the present study.

Results

Table 1 gives the data on prenatal mortality (reproductive wastage, i.e., abortions and stillbirths), infant mortality (deaths before 1 year of age), and adolescent mortality (deaths before 15 years of age), classified according to degree of con-

Table 1. Frequency of marriages, pregnancies, reproductive wastage and infant mortality among the Kota

Relationship	F	No. of marriages	No. of pregnancies	No. of stillbirths and abortions	Mortality	
					Infant	Adolescent
Uncle-niece	0.1250	2	4	0	0	1
Full first cousin	0.0625	25	89	8	16	24
Full first cousin once removed	0.0312	6	3	1	0	2
Half-first cousin	0.0312	4	17	0	2	6
Half-first cousin once removed	0.0156	1	1	0	0	0
Full second cousin	0.0156	11	24	1	3	3
Full second cousin once removed	0.0078	2	4	2	0	0
Full third cousin	0.0039	2	8	2	3	3
Full third cousin once removed	0.0020	3	16	0	2	5
Full third cousin twice removed	0.0010	1	2	0	0	0
Total	—	57	168	14	26	44
Unrelated	0.0000	392	995	83	140	284

Table 2. Estimates of A and B among the Kota

Cause	A	B	B/A	χ^2	*d.f.*
Stillbirth and abortions	0.088 ± 0.009	-0.076 ± 0.471	-0.864	22.265	7
Infant mortality	0.152 ± 0.013	0.350 ± 0.697	2.303	7.199	7
Adolescent mortality	0.334 ± 0.019	-0.250 ± 0.977	-0.749	6.530	7

sanguinity. There is no statistically significant difference in the proportion of reproductive wastage, infant mortality, and adolescent mortality between consanguineous and non-consanguineous marriages. It may also be noted that no case of visible congenital malformation has been noticed among the Kota.

The estimates of the load parameters A and B are set out separately for stillbirths and abortions, infant mortality, and adolescent mortality in Table 2. The goodness-of-fit χ^2 values given in column 5 of Table 2 indicate that at the 5% level with 7 *d.f.* the infant and adolescent mortality figures are in good agreement with those predicted from the model of Morton et al. (1956), while the figures for reproductive wastage are not.

Comparison of our data with the existing data from other Indian populations reveals that Kumar et al. (1967) reported higher frequencies of reproductive wastage and infant mortality among the offspring of consanguineous marriages in Kerala. Chakraborty and Chakravarti (1977) found that the incidence of major malformations and prenatal mortality (stillbirths and mortality during the first few days of life) are significantly higher in the inbred offspring than in the non-inbred ones. Similar observations have also been reported from Andhra Pradesh (Dronamaraju and Meera Khan, 1963; Murty and Jamil, 1972). A recent study conducted in the North Arcot district of Tamilnadu (Rao and Inbaraj, 1977), however, has shown that there is no significant difference between the consanguineous and non-consanguineous marriages with respect to total foetal loss neonatal, infant, prenatal, and extended first-year mortality rates. It may also be mentioned that strictly speaking the infant mortality data of the different studies are not comparable, as no standard definition was followed for infant mortality.

Discussion

As has already been mentioned, there is no perceptible effect of inbreeding on reproductive wastage and infant mortality among the Kota. Sanghvi (1974) postulated that inbreeding has little effect in populations that have been practising it for a long period, since in such populations the frequency of deleterious alleles declines considerably faster than in other groups. Sanghvi went on to predict that in South India, where consanguineous marriages have been in vogue for more than 2,000 years, the effects of inbreeding would be imperceptible. Sanghvi and Perin (1974) demonstrated the validity of the above-mentioned contention with data on birth records collected from a Bombay hospital. Rao and Inbaraj's (1977) recent study in Tamilnadu also lends support to Sanghvi's contention. The Kota probably also have a long history of inbreeding. Therefore, the fact that in this population the effects of inbreeding are not pronounced may be in keeping with Sanghvi's (1974) contention. It may be noted, however, that the fate of deleterious genes in small populations such as the Kota is largely a random phenomenon. Therefore, the imperceptibility of inbreeding effects in such populations may be wholly unrelated to the history of inbreeding. Until further work is done in this line, taking account of the finiteness of the populations, the validity of Sanghvi's model cannot be confirmed.

As is evident from Table 2, nothing very conclusive emerges from the genetic load analysis. In the case of infant deaths before 1 year of age, the estimated value for genetic damage, B, is higher than that for A. The total genetic damage may be about 1 lethal equivalent per gamete, or about 2 per zygote. The estimates of B for stillbirths and abortious and for adolescent mortality are ambiguous. Theoretically, the value of B cannot be less than zero. Since no sampling was done in this study, the negative value of B that has been found cannot be due to sampling fluctuations. However, it is possible that in a finite population such as the Kota, the operation of random genetic drift may cause the value of B to be negative. It is also possible that since environmental factors, e.g., infectious diseases, play a major role in determining the number of infant deaths after 1 year of age, the estimate of B may get distorted if such data are used for estimation. In any case, under the circumstances we are not able to offer any explanation for the negative values of B.

On the basis of a very large heterogeneous sample from Bombay, Chakraborty and Chakravarti (1977) have estimated the number of lethal equivalents per zygote as 1.13 for the total series. Murty and Jamil (1972) reported that the mortality load among newborn in Hyderabad is about 2 lethal equivalents per individual and the malformation load at birth is half the mortality load, while Kumar et al. (1967) found a load of 3—4 lethal equivalents for stillbirths and neonatal deaths in Kerala. It may be pointed out that in all earlier reports the estimate of B is much higher than that in the present study.

Finally, it appears that the genetic load in the Kota population, as revealed by inbreeding, is rather low; it is also low in comparison with those in other Indian populations.

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