ISSN. 0972 - 8406
The NEHU Journal Vol. ***XVII,*** *No. 1 (January - June) and No. 2 (July - December) 2019, pp. 1-10*

Index of opportunity for natural selection among the Idu Mishmi of Dibang Valley district, Arunachal Pradesh

[*]D.K. Limbu and Dolly Gogoi

Department of Anthropology,
North-Eastern Hill Univerisity
Shillong
[*]Corresponding author: dhruba_limbu@yahoo.co.in

Abstract

The index of opportunity for selection was calculated to understand the nature and extent of natural selection operating in the Idu Mishmi population. The main objective of this study is to estimate the index of selection intensity in the Idu Mishmi, a homogenous tribal group inhabiting the Dibang valley district of Arunachal Pradesh and further the findings of the present study is to compare with the related findings obtained from the published data on other mongoloid populations of Northeast India. Considering the range of Indian population, the index of total selection intensity (I) calculated in the present population was found to be very low. It seems that in shaping the genetic make-up of the Idu Mishmi population, natural selection is operating with very low intensity and it contributes more through differential mortality than differential fertility. Low socio-economic status of the people and difficulties in percolating the medical felicities up to the grass root level could be the probable reason for higher contribution of mortality for the evolution mechanism of the present population through natural selection.

Keywords: Fertility, mortality, index of total selection intensity, Darwinian fitness, Idu Mishmi

Introduction

Natural Selection is a major evolutionary force, which can bring about changes in the genetic make-up of a population over generations. In order to understand how selection is operating in this population, the index of opportunity for selection has been calculated according to the formula given by Crow (1958) as well as by the modified formula of Johnston and Kensinger (1971). It is well-understood that fertility and mortality are the two vital events through which natural selection operates. In the given environment, the function of these two demographic variables operates singly or jointly to determine fitness (Darwinian fitness) of a particular population. The fitness of a population is measured through selection intensity which is expresses in terms of differential fertility and differential mortality that the birth and death rates are all selective. Variables such as age-specific fertility and mortality bring changes in the intensity of natural selection. Thus, several studies have suggested that the above demographic components are directly responsible for the rate and direction of human evolution (Wright, 1943; Cavalli-Sforza

et al., 1966).

It is well-known that selection is a major evolutionary force that can bring about changes in the genetic make-up of a population. Crow (1958) was first to interpret the Fisher's fundamental theory of Natural selection in human population by using demographic data. Taking into account the differential fertility and differential mortality, Crow proposed the index of total selection intensity (now the index of opportunity for selection). In order to understand how selection is operating in human population, the index of opportunity for selection has been calculated according to the formula given by Crow (1958) as well as by the modified formula of Johnston and Kensinger (1971). Since then, a large number of studies have been carried out on various populations of the world to demonstrate the role of natural selection in imposing characteristic fertility and mortality in them (Murty and Ramesh, 1978; Tripp-Reimer, 1980; Rao and Murty, 1984; Jorde and Durbize, 1986; Basu *et al*., 1988; Sengupta, 2004; Kapoor and Kaur, 2012; Sarma, 2013).

Objective

The objective of the present study was to estimate the index of selection intensity (opportunity for selection) in the Idu Mishmi population and also to compare the present findings with those existing on other populations, particularly with those reported for the mongoloid populations of Northeast India. Further, Dibang valley district, the home for the Idu Mishmi has the lowest population density in the entire country (1person / km^2) (Census, 2011). Information on some related demographic parameters were also collected with the idea that these data might throw some light in understanding both genetic composition and extra-somatic factors influencing the study population.

Materials and Methods

The present study is based on a fieldwork conducted among the Idu Mishmi, one of the major tribal populations of Dibang Valley district of Arunachal Pradesh. A total number of 103 married women were randomly interviewed under the present study. Demographic data were collected through in-depth interview with each of the married women using structured fertility schedule following recommendations of the World Health Organization (1964 and 1968) which includes data on individual records, fertility, mortality and marriage pattern. Data collected on fertility and mortality was as follows: number of conceptions, number of live births, birth order, age, sex and marital status of each offspring, number of dead children, age at death, causes of death and reproductive wastage (abortions and still births).

Data analysis

For analyzing fertility, data on the four important measures such as mean number of live-births and surviving children to all married women of all ages, child-woman ratio, completed family size, and total fertility rate were collected which are the important measures on fertility. Similarly for mortality, the parameters included were infant mortality

(death before 1 year of life); juvenile or premature mortality (death before 15 year of age) and reproductive wastage. Crow's formula (1958) and the modified formula suggested by Johnston and Kensinger (1971) were applied to calculated the index of total selection intensity. Since fertility declines drastically after 40 years of age, only those mothers who had reached 40 years and above were included in the present study. The parameters used in calculating selection intensity of the study population are presented in Table 1.

Table1. Parameters used in calculating total selection intensity

Parameter	Frequency
Number of mothers age 40 years and above	46
Number of reported pregnancies	248
Number of live-births	235
Number of surviving children	355
Number of deaths before 15 years	25
Number of embryonic deaths	13
Proportion of survivors to birth(P_b)	0.9476
Proportion of child death (i.e., deaths before 15 years)($P_{d)}$	0.1064
Proportion of embryonic deaths(P_{ed})	0.0524
Mean number of live-births per mother of completed fertility (i.e.,≥40years)(±$\bar{x}$)	5.1087
Variance in the number of live-births due to fertility,(V_f)	2.6186

In order to estimate the total selection intensity, two statistical formulae viz., formula proposed by Crow (1958) and subsequently modified by Johnston and Kensinger (1971) have been applied by taking into consideration the prenatal mortality.

Crow's index is separated into two components, known as the index due to fertility and the index due to mortality. Then, Crow has combined the two indices to calculate the index of opportunity for selection, which is as follows:

Crow's index:

$$I = I_m + (I_f / P_{s)}$$

$$I_m = P_d / P_s$$

$$I_f = V_f / (\bar{\mathbf{x}})^2$$

$$P_s = 1\text{-}P_d$$

where, I is the index of total selection intensity; I_m is the index of selection due to infant mortality; I_f is the Index of selection due to fertility; $\bar{x}$ is the mean number of live births per women of completed fertility (i.e., ≥40years) ;V_f is the Variance in

the number of live-births due to fertility; P_d is the Proportion of premature deaths (deaths before 15years of age); and P_s is the Proportion of survivors ($P_s = 1\text{-}P_d$).

Johnston and Kensinger's index:

The above formula, proposed by Crow (1958), has been modified by Johnston and Kensinger (1971). They have taken into consideration prenatal mortality and suggested the following formula:

$$I = I_{me} + I_{mc} / P_b + I_f / P_b P_s$$

$$I_{me} = P_{ed} / P_b$$

$$I_{mc} = P_d / P_s$$

$$I_f = V_f / (\bar{x})^2$$

where, I is the index of total selection intensity; I_{me} is the index of selection due to embryonic mortality (i.e., prenatal mortality); I_{mc} is the index of selection due to child mortality (i.e., mortality before 15years of age); I_f is the index of selection due to fertility; $\bar{x}$ is the mean number of live births per women of completed fertility (i.e., ≥40years); P_{ed} is the proportion of embryonic deaths (i.e., prenatal deaths); $P_b = 1 - P_{ed}$ is the proportion of survivors to birth; P_d = proportion of child deaths (i.e., death before 15 years of age); V_f is the variance in number of live births due to fertility; and $P_s = 1 - P_d$ is the proportion of survivors i.e., birth to reproductive age.

Results and Discussion

The results of the analysis of fertility and mortality data of 46 women who have completed their reproductive lifespan are presented in Table1.This table depicts the parameters used in calculating the indices of total selection intensity according to the Crow's and modified formula of Johnston and Kensinger. Table1 shows that there were 46 mothers aged ≥40 years. The mean number of live births to such mothers was recorded to be 5.1087 with the corresponding variance of 2.6186.The proportion of child mortality before reproductive age and the proportions of embryonic deaths were 0.1064 and 0.0524 respectively.

Table 2. Parameters used in calculating total selection intensity among four mongoloid populations of Northeast India

Parameter	Populations			
Frequency	Idu Mishmi (Present study)	Mishing (Sarma 2013)	Minyong (Sarma 2013)	Semsa (Ghosh and Limbu 2000)
Number of mothers age above 40 years and above	46	77	74	80
Number of reported pregnancies	248	554	561	537
Number of live-births	235	462	487	521
Number of surviving children	355	387	378	138
Number of deaths before 15 years	25	75	109	167
Number of embryonic deaths	13	92	74	17
Proportion of survivors to birth(Pb)	0.9476	0.8377	0.7762	0.9634
Proportion of child death (i.e., deaths before 15 years of age)(Pd)	0.1064	0.1623	0.2238	0.3205
Proportion of embryonic deaths(Ped)	0.0524	0.1661	0.1319	0.0366
Mean number of live-births per mother of				
Completed fertility(i.e.,≥40years)±$\bar{x}$	5.1087	6.00±0.31	6.58±0.33	6.5125
Variance in the number of live-births due to fertility,(Vf)	2.6186	3.03	4.67	4.1748

Table 2 shows the parameters used in calculating the index of total selection intensity among the four mongoloid populations of Northeast India. It may be noted that the average number of live births per mother of the Idu Mishmi is found to be 5.1087, which is much lower than rest of the tribes compared viz., the Mishing (6.00 ± 0.31), Semsa (6.5125) and the Minyong (6.58±0.33). Similarly the proportion of embryonic deaths (abortion and stillbirth) is also very low in Semsa (0.0366) and the Idu Mishmi (0.0524) compared to the Mishing (0.1661) and the Minyong (0.1319). Moreover, in respect of the proportion of premature deaths up to pre-reproductive age, (i.e., deaths before 15 years of life) the present population shows lowest value (0.1064) when compared with the Mishing (0.1661), Minyong (0.2238) and the Semsa (0.3205). However, it is interesting to note that in respect of the proportion of survivors up to 15 years of age and above, the Semsa (0.9634) and Idu Mishmi (0.9476) show higher values than the Mishing (0.8377) and the Minyong (0.7762).Table 3 presents data on the demographic variables i.e., fertility and mortality of the Idu Mishmi population which are applied for determining their selection intensity.

Table 3. Fertility and mortality data following parameters recommended by WHO (1964 and 1968)

Fertility							
Marriage age	Marriage	Fertility	Completed family size				TFR
at Marriage ±SE(Years)	age at firstchild birth ±SE(Years)	ratio/100 women	Average no. of live births/ mother	Average no. of surviving children/ mother	Average no. of live births/ mother of present age	Average no. of surviving children of present age group	
Male: 25.56 ±0.23	27.88 ±0.37						
Female:20.07 ±0.23	22.17 ±0.15	37.43	5.11	4.57	3.86	3.45	3.9423

Mortality(infant, juvenile and reproductive wastages) Parameters	
Total number of mothers	103
Total number of pregnancies	416
Total number of live births	398
Total number of deaths before 1year of age	25
Total number of abortions	15
Total number of still births	6
Total number of reproductive wastage	21
Death before 1year of age (%)	6.28
Death between 1and 4 years of age (%)	0.50
Abortion (%)	3.60
Still birth (%)	1.44
Reproductive wastage (%)	3.04

TFR: Total Fertility Rate; SE: Standard Error; WHO: World Health Organization

To find out the nature and extent of natural selection operating in the Idu Mishmi population, the index of total selection intensity was calculated by considering that certain differences in fertility and mortality are heritable. For this purpose, methods given by both Crow (1958) and Johnston and Kensinger(1971) were applied as given in Table 4.

According to Crow's formula, the values of I, I_f and I_m were 0.2067, 0.1003 and 0.1191 respectively. When the selection intensity was calculated using the modified method of Johnston and Kensinger; the I_{me}, I_{mc}, I_f and I, the respective values were found to be 0.553, 0.1191, 0.1003 and 0.2535.

Based on all these indices, the total selection intensity I calculated according Johnston and Kensinger's formula was found slightly higher than that found according to Crow's formula as the embryonic mortality was included in the modified formula of the former.

However, by using both the methods, it still showed that natural selection was acting with very low intensity on this population and was operating more due to differential mortality than due to differential fertility.

Table 4. Indices of Selection intensity

According to Crow (1958)			According to Johnston and Kensinger (1971)			
I_m	I_f	I	I_{me}	I_{mc}	I_f	I
0.1191	0.1003	0.2067	0.0553	0.1191	0.1003	0.2535

Cavalli-Sforza and Bodmer (1971) reported that among most agrarian and tribal societies, mortality contributes more towards selection rather than fertility which supports the findings of the present study. Similarly, studies on many Indian populations indicate that deaths prior to pre-reproductive age contribute more to the process of natural selection. The successful adaptation of a group inhabiting to its environment is reflected by its fertility and mortality rates. For example, a higher mortality rate may be indicative of poor environmental conditions besides influence of extra-somatic factors such as poor nutrition, large family size, unhygienic living conditions, higher incidence of diseases and lack of proper medical facility. Thus, it is not only the genetic composition of a population group, but extra-somatic factors that can also contribute to the fluctuating values of the selection intensity.

Table 5. Indices of Selection Intensity among some populations of Northeast India

Population (N)	Crow's index (1958)			Source
	I_m	I_f	I	
Idu Mishmi (46)	0.1192	0.1003	0.2067	Present study
Bod-Kachari (NA)	0.110	0.130	0.250	Guha and Mukherjee (1990)
Sonowal- Kachari(72)	0.1676	0.1638	0.3589	Sengupta and Kalita (1996)
Khampti (29)	0.179	0.113	0.312	Sarkar *et al*. (1994)
Mishing (77)	0.1937	0.0842	0.2942	Sarma (2013)
Minyong(74)	0.2883	0.1078	0.4272	Sarma (2013)
Gallong (36)	0.750	0.180	0.170	Chakravarty and Ahmed (1989)
Singpho(143)	0.437	0.406	1.020	Padmanabham and Jaswal (1982)
Muklom(40)	0.107	0.188	0.315	Sarkar (1997)
Apatani(Guth)(120)	0.440	0.312	0.889	Padmanabham and Jaswal (1982)
Apatani (Guchi)(64)	0.435	0.195	0.710	Padmanabham and Jaswal (1982)
Semsa (80)	0.471	0,0984	0.6165	Ghosh and Limbu (2000)

Figures in parentheses indicates number of women (≥ 40 years) : NA: Not available

Table 5 depicts the indices of selection intensity among some mongoloid populations of Northeast India. The values of I in the Idu Mishmi tend more toward the lower limit of the range. Except Gallong (0.170), the value of *I* found much lower in the present population (0.2067). A similar trend is observed with I_m and I_f which are at the lower limit of the range of Indian populations as reported by Reddy and Chopra (1990). In respect of I_m, the Idu Mishmi (0.1192) shows lower value than all the populations considered for comparison except the Boro-Kachari (0.110) of Assam and the Muklom (0.107) of Arunachal Pradesh. Other than the Mishing (0.0842) and the Semsa (0.0984), the value of I_f in the study population (0.1003) observed to be much lower than all the populations compared. Except the Bodo-Kacharis, in all the populations compared, the index of selection due to mortality component is contributing more to the total index of selection intensity. Further, it may be noted that selection is operating with very low intensity in the present population.

Reddy and Chopra (1990) have compiled all the results, reported on 96 Indian populations on the indices of selection intensity, calculated according to the formula of Crow. It is found that the index of total selection intensity varies from 0.258 in a sub-group of Yanadi tribe (Vasulu, 1987) to 2.250 in Kota (Basu, 1972). Comprising with the Indian range, it seems that the total selection intensity in the Idu Mishmi falls towards the lower limit of the range.

Conclusion

From the findings of the present study, it appears that selection is operating with very low intensity and contributes more through differential mortality than differential fertility. This trend might be due to poor socio-economic status and lack of proper health-care facility available to the study population. These factors have negative impact on the higher contribution of mortality for the evolution mechanism through natural selection. Livingstone and Spuhler (1965) have suggested that if the index of total selection intensity comes to zero, it means that there will be no change in the genetic make-up of a population through selection. Therefore, in the light of the present findings it can be concluded that the role played by natural selection in influencing the genetic variation of the study population cannot be ignored.

References

Basu, A.1972. A demographic study of the Kota of Nilgiri Hills. *Journal of Indian Anthropological Society*, 7:29-45.

Basu, S.K., Kshatriya, G.K. and Jindal, A.1988. Fertility and mortality differentials among the tribal population groups of Bastar district, Madhya Pradesh, India. *Human Biology*, 60:407-416.

Cavalli-Sforza, L.L., Kimura, M. and Barrai, I. 1966. The probability of consanguineous Marriages. *Genetics*, 54:37-60.

Cavalli-Sforza, L.L. and Bodmer, W.F.1971. *The Genetics of Human Populations*. San Francisco: W.H. Freeman.

Census of India, 2011. *Provisional Population Total, New Delhi, Registrar General & Census Commissioner, India*. From http: //www.censusindia. govt.in. on 18/5/2020.

Chakravarty, S. and Ahmed, S.H. 1989. Body dimensions, fertility and selection in section of the Gallong with endemic hyperthyroidism and congenital defects of the central nervous system. In: K.S.Singh (ed.), *Genetical Demography of Indian Population, Calcutta: Anthropological Survey of India*: 1-5.

Crow, J.F. 1958. Some possibilities for measuring selection intensities in man. *Human Biology*, 30:1–13.

Geneva: WHO, 1964. WHO. Research in Population Genetics of Primitive Groups. *WHO Technical Report Series No. 279*.

Geneva: WHO,1968. WHO. Research in Human Population Genetics. *WHO Technical Report Series No. 387.*

Ghosh, A.K. and Limbu, D.K. 2000. The Semsa : a bio-demographic study. *International Journal of Anthropology*,15(1-2):09-24.

Guha, A. and Mukherjee, D.P. 1990. Influence of cultural traditions and social movements on the genetic structure of the Boro-Kachari population. *Journal of Indian Anthropological Society*, 25:73–81.

Johnston, F.E. and Kensinger, K.M. 1971. Fertility and mortality differentials and their implications for microevolutionary change among the Cashinahua. *Human Biology*, 43:356–64.

Jorde,L.B. and Durbize, P. 1986. Opportunity for natural selection in Utah Mormons. *Human Biology*, 58:97-114.

Kapoor, A.K. and Kaur, J. 2012. Natural Selection in a population group of Andaman and Nicobar Islands. *Journal of Natural Science, Biology and Medicine*, 3(1):71-77.

Livingstone, F.B. and Spuhler, J.N. 1965. Cultural determinants of natural selection. *International Social Science Journal*, 17:118–20.

Murty,J.S. and Ramesh,A.1978. Selection intensity among the tribal populations of Adilabad District, Andhra Pradesh, India. *Social Biology*, 25:302-305.

Padmanabham, P.B. and Jaswal, I.J.S. 1982. A demographic study of Apatanis, presented at the seminar on *Biological and Cultural Variation of the People of North-East India*, organised by Anthropology Department, Gauhati University, 1982.

Rao,V.V. and Murty, J.S. 1984. Selection intensities and inbreeding among some caste

groups of Andhra Pradesh, India. *Social Biology*, 31:114-119.

Reddy, B.M. and Chopra, V.P. 1990. Opportunity for natural selection among the Indian populations. *American Journal of Physical Anthropology*, 83:281–96.

Sarkar, N.C., Barua, S. and Varte, R.T. 1994. Opportunity of selection in the Khampti of Lakhimpur district, Assam, India. *Journal of Human Ecology*, 5:217–20.

Sarkar, N.C. 1997. Opportunity for natural selection among the Muklom of Arunachal Pradesh. *Current Anthropology*, 38:140–3.

Sarma, M. 2013. Measuring opportunity for natural selection: Adaptation among two linguistically cognate tribes inhabiting two eco-systems of North-East India. *Indian Journal of Human Genetics*, 19(2):159-164.

Sengupta, S. and Kalita, M. 1996. Selection intensity among the Sonowals of Assam', In: S.Sengupta (ed.), *Peoples of North East India,* New Delhi: Gyan Publishing House: 73-80.

Sengupta, S. 2004. Opportunity for natural selection in North East Indian Populations. *Bulletin of Department of Anthropology, Dibrugarh University*, 32:43–56.

Tripp-Reimer, T.1980. Genetic demography of an urban Greek immigrant community. *Human Biology*, 52:255-267.

Vasulu,T.1987. Population structure among the Yanadi. *Bulletin of Indian Society and Human Genetics*,12:14.

Wright, S.1943. Isolation in distance. *Genetics,* 28:114-138.