Opportunity for natural selection among three endogamous subpopulations of Andhra Pradesh

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The Crow's index of opportunity for natural selection has been calculated for three endogamous subpopulations namely Arya Vysya, Thrivarnika and Kalinga Vysya of North Coastal Andhra Pradesh. The total index is in the order Arya Vysya > Thrivarnika > Kalinga Vysya. However, the mortality component is more in Kalinga Vysya, reflecting the poor medical facilities available to them due to their low socio- economic profile compared to other two populations. The results of the present study are compared with those among the other caste populations of Andhra Pradesh.

Key Words: Fertility, mortality, Arya Vysya, Thrivarnika and Kalinga Vysya populations, Andhra Pradesh

Introduction

Selection is one of the important evolutionary factors, which brings about a change in the gene pool of a population. This change is brought about by differential fertility and differential mortality. Differential fertility and mortality are due to difference in genetic fitness of individuals which can be determined in terms of viable offspring produced by the individual.

Crow (1958)[1] devised the index of total selection which can be computed using the reproductive success of a population. The index assumes that the reproductive differentials are due to genotypic differences and fitness is completely heritable. In reality the effect of genetic component in differential fertility and mortality is rather small and reproductive outcome of an individual or population is the result of the interaction of a variety of sociocultural factors (Crow, 1966).[2] Therefore, the index sets an upper limit for the potential action of natural selection and is renamed as opportunity for natural selection. It has two components, due to differential fertility and differential mortality (Crow, 1972).[3] These two components determine the relative fitness of the populations. Later Johnston and Kensinger (1971) extended its scope to include prenatal mortality as the Crow's method takes into consideration only postnatal mortality.

The object of the present work is to study the extent of variation provided for the natural selection to operate through differential mortality and also to find out the factors responsible for the variation.

Materials and Methods

The three populations, Arya Vysya, Thrivarnika and Kalinga Vysya are endogamous and according to Sherring (1881)[5] supposed to belong to one common stock. Arya Vysyas are distributed throughout Andhra Pradesh. Kalinga Vysyas are mostly spread in Srikakulam and Vijayanagaram districts whereas Thrivarnikas are small in number and spread in small pockets of Vijayanagaram, Visakhapatnam, East Godavari and Warangal districts. Arya Vysyas are vegetarians whereas the other two populations are non-vegetarians. A detailed description of the three populations is given elsewhere (Lakshmi et al, 2002).[6]

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Demographic information was collected from 846 married women (301 from Arya Vysya, 258 from Thrivarnika and 287 from Kalinga Vysya). Out of these women, 183 Arya Vysya, 165 Thrivarnika and192 Kalinga Vysya women were found to have completed their reproductive life either by menopause or hysterectomy or permanent family planning measure such as tubectomy of the wife or vasectomy of the husband. A detailed schedule was used to collect the demographic data. Personal interview of both wife and husband of household were carried out. The women were requested to recollect the information about abortions and still births if any. They were assured that the information will not be revealed to anyone and not to conceal the information because of its significance in the present work. The information was cross checked with the husband and elders also in the case of joint families.

The indices of opportunity for natural selection are calculated after Crow (1958)[1] and Johnston and Kensigner (1971)[4] following the equations given below.

$I = I_m + I_f / P_s$ (Crow, 1958)[1]

$I_m = P_d / P_s$

$I_f = V / X^2$

where I is index of opportunity for total selection, I_m is mortality component, P_d is proportion of deaths below 15 years of age, P_s is proportion of children surviving from birth to reproductive age, I_f is fertility component, V is variance in offspring number in completed sib-ship and X is mean number of live births per women who completed fertility.

$I = I_{me} + I_{mc} / P_b + I_f / P_b x P_s$ (Johnston and Kensinger, 1971)[4]

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

$I_{mc} = P_d / P_s$

$I_f = V / X^2$

Where I_{me} is the index of selection due to prenatal mortality, P_{ed} is the probability to die before birth and P_b is the probability to survive till birth. I_{mc} is the index of selection due to postnatal mortality, P_d is proportion of deaths below 15 years of age, P_s is proportion of children surviving from birth to reproductive age. I_f is the index of selection due to fertility component, V is variance due to fertility and X is mean number of live births per women who completed fertility.

Results and Discussion

Table 1 presents the parameters used in calculating the total selection intensity in the study populations. The mean number of live births is more in the case of Kalinga Vysya followed by Arya Vysya and Thrivarnika. The proportion of prenatal deaths is highest in Arya Vysya and least in Kalinga Vysya. The proportion of pre reproductive deaths is highest in Kalinga Vysya and least in Arya Vysya.

Both Crow's and Johnston and Kensinger's indices of selection intensity are presented in Table 2. Crow's and Johnston and Kensinger's indices in the present study populations and other caste populations of Andhra Pradesh are given in Tables 3 and 4 respectively for comparative study. When Crow's index is considered the contribution of fertility component is more in all the three study populations and highest contribution is observed in Arya Vysya. The mortality component is highest in Kalinga Vysyas. It is well known that better medical facilities reduce the mortality component. There is considerable improvement of medical facilities in India in the last two decades. The Arya Vysya and Thrivarnika are fairly rich communities, which are conscious of health care. They can also afford medical and healthcare expenditure. These factors might have led to low mortality component among these populations. Most of the Kalinga Vysya are poor and hence a relatively higher mortality component.

The high post natal mortality in Kalinga Vysya may be due to the poor medical facilities available to them due to their low socioeconomic condition. According to Singh (1974),[7] the incidence of child mortality greatly depends upon social status, the higher the social status, the lower the incidence of mortality. The same is observed by Bharati (1981),[8] Rajani Kumari et al (1985),[9] Babu et al (1995),[10] Sengupta and Begum (1998),[11] Kapoor and Patra (2002)[12] and Dharanipriya et al (2003)[13] suggesting the influence of socioeconomic conditions. Kapoor et al (2003)[14] also found an inverse relationship between various indices (I_m, I_f and I_T) and social categories in their study of selection potential for 24 different Himalayan populations.

When compared to the other neighbouring caste populations (by omitting the populations whose sample size is <50), highest value of Crow's index is observed in Kummari reported by Babu et al (1995).[10] Lowest

Table 1: Parameters used in calculating the total selection intensity in the present study populations

	Arya vysya	Kalinga vysya	Thrivarnika
Number of Women	183	192	165
Number of Pregnancies	722	842	554
Number of Live births	634**	770***	489**
Mean number of live births (X)	3.4645 $\pm$ 0.1493	4.0104 $\pm$ 0.1371	2.9636 $\pm$ 0.1176
Variance in number of live births (V)	4.0630	3.5623	2.2895
Proportion of prenatal deaths P_{ed}	0.1247	0.0891	0.1209
Proportion of survivors upto birth (P_b)	0.8753	0.9109	0.8791
Proportion of pre reproductive deaths (P_d)	0.0962	0.1299	0.1186
Proportion of surviving children (P_s)	0.9038	0.8701	0.8814

*indicates twin births

Table 2: Indices of selection intensity among the present study population

Population	According to Crow (1958)			According to Johnston and Kensinger (1971)			
	I_m	I_f	I	I_{me}	I_{mc}	I_f	I
Arya Vysya	0.1064	0.3385	0.4809	0.1425	0.1064	0.3385	0.6920
Kalinga Vysya	0.1493	0.2215	0.4039	0.0978	0.1493	0.2215	0.5412
Thrivarnika	0.1346	0.2607	0.4304	0.1375	0.1346	0.2607	0.6271

Table 3: Crow's index in select caste populations of Andhra Pradesh

Population	No. of women	I_m	I_f	I	Source
Arya Vysya	183	0.1064	0.3385	0.4809	Present Study
Kalinga Vysya	192	0.1493	0.2215	0.4039	Present Study
Thrivarnika	165	0.1346	0.2607	0.4304	Present Study
Vyshya	52	0.4220	0.1940	0.6980	Rao and Murty[15]
Bramhin I	450	0.1270	0.1800	0.3300	Rajani Kumari et al[9]
Brahmin II	196	0.0396	0.3484	0.3879	Sita Lakshmi[24]
Brahmin III	212	0.1823	0.2247	0.4384	Sree Krishna[25]
Kshatriya	355	0.0987	0.2982	0.4263	Dharani Priya et al[13]
Jalari	197	0.1880	0.1030	0.3100	Rajani Kumari et al[9]
Mala	325	0.2170	0.2940	0.5750	Reddy and Lakshmanudu[26]
Reddy I	87	0.4240	0.2270	0.7470	Rao and Murty[18]
Reddy II	250	0.1979	0.3859	0.6233	Chandrasekhar Reddy and Sudarsan Reddy[28]
Reddy Pedakanti	55	0.1650	0.2310	0.4340	Reddy and Reddy[29]
Vodde I	250	0.2340	0.1602	0.4318	Chandrasekhar Reddy and Sudarsan Reddy[28]
Vodde II	697	0.3460	0.2530	0.6870	Reddy et al[27]
Relli	132	0.2430	0.2820	0.5935	Ramesh[30]
		I_m	I_f/P_s	I	
Chakali	112	0.2013	0.4261	0.6274	Babu et al[10]
Kummari	69	0.3235	0.6337	0.9572	Babu et al[10]
Mangali	119	0.1972	0.4820	0.6792	Babu et al[10]
Madiga	105	0.2281	0.4676	0.6957	Babu et al[10]
Yadava	114	0.3326	0.2501	0.5827	Rajeswari et al[31]
Vadabalija	135	0.6095	0.2488	0.8583	Rajeswari et al[31]

value is observed in Jalari reported by Rajani Kumari et al (1985).[9] The genetic implications of these selective processes would be an increase in genetic load, especially inbreeding load and increase in fitness and genetic variation through fertility.

Reddy and Chopra (1990)[15] reviewed data on opportunity for natural selection (Crow's index) in 96 Indian populations and analyzed them according to regional, habitat and socioeconomic backgrounds. It has been seen that the total index varies from 0.258 among

Table 4: Johnston and Kensinger's index in select caste populations of Andhra Pradesh

Population	No. of women	I_{me}	I_{mc}	I_f	I	Source
Arya Vysya	183	0.1425	0.1064	0.3385	0.6920	Present Study
Kalinga Vysya	192	0.0978	0.1493	0.2215	0.5412	Present Study
Thrivarnika	165	0.1375	0.1346	0.2607	0.6271	Present Study
Brahmin I	450	0.1456	0.1270	0.1800	0.5886	Rajani Kumar et al[9]
Brahmin II	196	0.0553	0.0396	0.3484	1.4334	Sita Lakshmi[24]
Kshatriya	355	0.0890	0.0987	0.2982	0.5538	Dharani Priya et al[13]
Jalari	197	0.0428	0.1880	0.1030	0.3879	Rajani Kumari et al[9]
Mala	325	0.0230	0.2170	0.2940	0.6100	Reddy and Lakshmanudu[26]
Relli	132	0.0301	0.2430	0.2820	0.6415	Ramesh[30]
		I_{me}	I_{mc}/P_b	$I_f/P_b.P_s$	I	
Chakali	112	0.0238	0.2061	0.4362	0.6661	Babu et al[10]
Kummari	69	0.0721	0.3468	0.6794	1.0983	Babu et al[10]
Mangali	119	0.0351	0.2041	0.4990	0.7382	Babu et al[10]
Madiga	105	0.0226	0.2533	0.4782	0.7341	Babu et al[10]

a sub group of Yanadi tribe to 2.25 among the Kota. The I_t value of the present study populations are more towards the lower half of the range similar to the finding of Khongsdier (1994)[16] and Kapoor and Patra (1998).[17]

When the present Arya Vysya population is compared with the Vysyas reported by Rao and Murthy (1984)[18] there is a decline in the total index I (Crow's index), with a decline in the mortality and increase in fertility components. This is in agreement with Sphuler's review (1962, 1963, 1976)[19-21] of world wide data and studies at the National and State levels (Crow 1958,[1] 1972,[3] Jacquard and Ward, 1976,[22] Hed 1984[23] etc) which suggest that the effect of demographic transition on the opportunity for natural selection among the populations of industrialized nations are a marked reduction in the total index, a decline in selection due to pre reproductive mortality, an increase in the fertility index initially, followed by a gradual decline and increase in the relative contribution of fertility component to the total selection. It is interesting to observe the same trend in recently studied Brahmins (Sita Lakshmi, 2002)[24] when compared to earlier study on same population (Sree Krishna, 1989).[25]

Johnston and Kensinger index is also more due to fertility than the mortality components in Arya Vysya. But in Kalinga Vysya and Thrivarnika the contribution of mortality is more. As explained earlier, the high mortality component in Kalinga Vysya may be attributed to low education, poor medical facilities and poor economic status. The most interesting point is that the Thrivarnika have shown high mortality component despite good

education, better economic position and better medical facilities. We have details of consanguinity among these populations. The inbreeding coefficients for autosomal and sex linked alleles are 0.0183 and 0.0253 respectively, among the Arya Vysya, 0.0248 and 0.0373 respectively among the Thrivarnika and 0.0233 and 0.0292 respectively among the Kalinga Vysya. The Thrivarnika is numerically smaller than the other two populations. Therefore a high incidence of consanguinity and recessive lethal factors might have been responsible for higher mortality component of Johnston and Kensinger index among the Thrivarnika. It should be mentioned here that one should be cautious in interpreting the Johnston and Kensinger index which may be highly influenced due to under reporting of prenatal mortality, especially in countries like India where literacy rate is low.

Three endogamous Vysya populations Arya Vysya, Thrivarnika and Kalinga Vysya from Andhra Pradesh are studied for selective differences in mortality and fertility. Prenatal deaths are more in Arya Vysya while pre reproductive deaths are more in Kalinga Vysya. A low mortality component of Crow's Index in Arya Vysya and Thrivarnika and a relatively high component of mortality in Kalinga Vysya may be due to the relative differences in education, medical and healthcare and economic positions which are better in the Arya Vysya and Thrivarnika. The Thrivarnika are small in number and inbreeding coefficients are also high. Therefore recessive lethal factors may be responsible for a high component of prenatal mortality component of Johnston and

Kensinger index among the Thrivarnika.

The total I is a measure of increase in fitness. Therefore it is a measure of the rate of evolution of the population. It is influenced by the socioeconomic conditions which include medical facilities. Therefore increase in medical facilities leads to survival of individuals suffering from genetic diseases for example invention and availability of insulin has greatly increased the survival of diabetes. This will lead to increase of genetic load in the populations. At the same time the diseased persons survive, marry and reproduce. Thus their fitness- measured through fertility performance – increases.-

Study of the same population over different periods are of much use to observe this trend. The studies of Brahmins by Sitalakshmi (2002) and Sree Krishna (1989) and the present study Arya Vysyas and Vysyas studied by Rao and Murthy (1984) exhibit the same trend.

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