Natural selection in a population group of Andaman and Nicobar Islands

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Abstract

Background: Natural selection is a continuous process that operates in populations to weed out deleterious genes and preserve the genes that increase the chances of survival, procreation, and multiplication. The fitness of a population group is measured in terms of its differential fertility and mortality. These are the most fundamental events through which natural selection is operative. Selection intensity, which is a measure of the fitness of a population, is expressed in terms of differential fertility, and differential mortality, assuming that the heritability of fitness is complete and that the birth and death rates are all selective. These indices are influenced by a number of socio-cultural conditions, religious, ethnic, and environmental factors which have been studied by different researchers in different parts of the world, including India. Objective: In this paper, an attempt was made to study the index of total selection, index of selection due to mortality, and index of selection due to fertility among the Andaman Indians, an island population of Andaman and Nicobar Islands and we highlight the variability of selection intensity in different ecological zones of India, namely the island, coastal, plains and plateau, Himalayan region, and the desert ecologies. Materials and Methods: Data were collected on pre-designed questionnaire, from women aged 40 + years, on various demographic parameters. Results: The value of the Index of Total Selection was found to be 1.263, the component due to fertility was 1.020, and that of mortality was found to be 0.120

Key words: Ecological zones, natural selection, population, tribal

INTRODUCTION

India is home to more than 5300 communities that include the Caste groups, Scheduled Tribes, Scheduled Castes, Particularly Vulnerable Tribal Groups (PTGs), religious groups, minority groups, and ethnic groups, and these various groups have well adapted to the different ecological zones of the country. The Great Himalayas and the seas mark off the country from the rest of Asia giving it a distinct geography, varied socio-biological diversity, and different ecological climates. The fertility and mortality rates of any population group reflect its successful adaptation to the environment which the group inhabits. For example, a higher mortality rate may be indicative of poor environmental conditions besides other factors. These in turn are maintained by the process of natural selection. Natural selection is a continuous process that operates in populations to weed out deleterious genes and preserve the genes that increase the chances of survival, procreation, and multiplication. The fitness of a population group is measured in terms of its differential fertility and mortality. These are the most fundamental events through which natural selection is operative. Selection intensity is a measure of the fitness of a population, expressed in terms of differential fertility, and differential mortality, assuming that the heritability of fitness is complete, and that both, the birth and the death rates, are selective. To measure the change in the fitness of a population group, Crow devised a method known as the Index of opportunity for Total Selection. This was an indirect method that did not take into account the pre-reproductive mortality and fertility, thus providing an upper limit for the same. Johnston and Kensing later incorporated the component of prenatal mortality thus, extending Crow’s original approach. They further
separated the mortality component into a component due to variance in prenatal loss and another due to postnatal mortality. In the absence of genetic variation and differential selection, a value of zero is obtained.\[6\]

It has been observed that the above indices are affected by the changing socio-economic, cultural, religious, and environmental factors, and various studies in different parts of the world have demonstrated the same. The influence of the extra-somatic factors has been supported by studies from India as well. These studies have been conducted on Indian castes and tribal populations. The latter are characterized by poor nutrition, large family size, unhygienic living conditions, and higher incidence of diseases. A change in the value of selection intensity with the changing socio-economic status was also proved\[7\] based on the values obtained between rural and urban areas in India. On the basis of 24 Himalayan populations, it was also found that the value of component due to mortality, fertility, and the index of total selection decreases gradually from the high altitude to low altitude and observed that the same decreases from the lower social category (Shilpkar) to the higher social category (Brahmans), thus indicating an inverse relationship between various indices and social status.\[4\] A differential pattern of fertility and mortality among the Himalayan populations further suggested that they were passing through a stage of transition. The study also showed that the progress of the groups which inhabited high altitudes and were socio-economically deprived was lower when compared to the groups of the other regions.

Many studies have explored and revealed the relationship between the socio-economic and the index of total selection, but these studies have not considered the geo-climatic dimensions.\[8\]-\[10\] India is a land of diverse geography and varied environments. Different population groups inhabiting these environments have adapted successfully to the harsh conditions. Ranging from the high altitudes to the plains, coastal, desert, and island ecology, India has a range of ecological niches inhabited by different population groups. In this paper, an attempt has been made to measure the opportunity for natural selection among the Andaman Indians, a heterogenous group, inhabiting the Andaman and Nicobar Islands and further analyze how varied geo-climatic conditions affect the process of natural selection in India. The data have also been obtained from already published studies.\[11\]-\[22\]

**THE POPULATION**

The Andaman Indians is a population group comprising of the descendants of convicts that were brought to the Port Blair jail by British during the colonial period from different parts of India. Later, those who were administratively (based on health status) freed were given land, along with other facilities. They came up with villages in South Andaman and took up agriculture as their main occupation. The population of Andaman and Nicobar Islands in 1951 (Census of India) was 31,000 and as per the 2001, Census of India, now it is 356,256. The ancestors of the Andaman Indians had different geographical, traditional, linguistic, castes, and religious background. Gradually, they started mixing, leading to a creation of a homogenous group which is known as Andaman Indians.\[23,24\]

**MATERIALS AND METHODS**

The data for the island populations [Figure 1], i.e. Andaman Indians, were collected during an extensive fieldwork carried out in different phases, from October 1999 to June 2000 in Port Blair, capital of Andaman and Nicobar Islands. During the fieldwork, the data were collected on fertility and mortality. Pre-designed questionnaires and genealogies were used for collecting data. A total of 161 women aged 40+ years were interviewed collecting information on variables such as the number of children surviving, number of abortions, etc.

Further in this study, 95 populations from different ecological zones of India that includes the coastal populations (56), island populations (2), plains and plateau/peninsular region (6), Himalayan region (25), and desert ecology (6) have been taken from the published literature.\[4,9,11,12,16-18,25-42\] The available data from already published were subjected to analysis and the mean and
standard deviation values of the index of total selection \((I)\), component due to mortality \((I_m)\) and fertility \((I_f)\), the variance in live births, were calculated using SPSS 16.0. Due to the incompleteness of the data, the index of selection potential given by Basu et al\(^{[11]}\) which incorporated the childhood mortality component could not be calculated and hence incorporated into this study. The values presented here in the paper are based on the index proposed by Crow\(^{[8]}\) and Johnston and Kensinger.\(^{[4]}\)

**RESULTS**

The results of the analysis of the data from 161 women aged 40+ years are shown in Tables 1 and 2. It is apparent from Table 1 that out of the total 161 women, who bore 512 pregnancies, 475 resulted in live births, the variables used in calculating the selection potential among the Andaman Indians. Table 1 shows that the average number of live births among Andaman Indians was 2.9 and the variance of live births was found to be 8.7. The proportion surviving to reproductive age was found to be 0.892, and the proportion surviving to birth 0.927. The proportion of children surviving from birth to 5 years of age was reported to be 0.922, while those surviving (from 5 years) to reproductive age was 0.968. The component due to fertility exceeds the component due to mortality. The value of \(I_m\) was found to be 0.120, while that of \(I_f\) was found to be 1.020. The total index of selection following Crow’s method (1958) was found to be 1.263. The value of the same was found to be highest (1.439) using the method proposed by Basu et al.\(^{[11]}\) probably as it incorporates the embryonic mortality as well. However, the value of \(I_f\) was found to be 1.439.

Table 3 shows the pooled results of the selection intensity among populations from different environmental regions of India. The highest mean value of index of total selection is found to be among the island population (1.136), followed by the populations of the plains and plateaus (0.711). The value for the coastal populations was found to be 0.703, for the Himalayan region was 0.674, and the lowest was reported for the desert populations, with a value of 0.492. The mean value of the index of selection due to mortality \((I_m)\) ranged from a highest of 0.398 among the coastal populations to a lowest of 0.169 among the island populations. The mean value of the same for Plains and Plateau population was found to be 0.335; among the Himalayan region it was 0.281, and still lower at 0.231 for the desert populations. Similarly, the mean value of index of selection due to fertility was found to be highest among the Island populations (0.835), followed by the populations from the Himalayan region (0.390), the Plains and Plateau (0.287), and the Coastal populations (0.219). The lowest
value for the index of selection due to fertility was found to be among the population groups from desert ecology (0.214). The mean value of the mean live births ranged from a highest of 5.3 among the populations from the Plains and Plateaus and the Himalayan region, to the lowest of 4.0 among the populations from islands. A value of 5.2 and 4.9 was reported among the coastal and desert population groups, respectively.

**DISCUSSION**

In this study, the data have been collected from Andaman and Nicobar Islands, from 161 women aged 40+ years. The group is a mixed ethnic group, with agriculture and business as the mode of economy. However, a few are also engaged in jobs, while handful works as contractors.

The percentage of the population engaged in business was 12.8, while only 18.6% worked as waged laborers, and 63.8% of the population took agriculture/horticulture as their main occupation. A mere 4.8% of the population was in government service. However, of the total population of the Andaman and Nicobar Islands, 15.8% were cultivators, while only 3.8% was agricultural laborers. Moreover, 5.2% of the population engaged in household industries, and a majority of people (75.3%) were involved in other work (Census of India, 2001). Till now, there has been a dearth of studies focusing on coastal or island ecology. Among the island populations it is observed that the fertility component exceeds the mortality component, which is also true in the case of population groups inhabiting the Himalayan region. The mean value of the index of total selection among the Andaman Indians (1.263) obtained in this study was found to be closer to the coastal population of Jalari (1.078).

During the fieldwork, it was found that there are two groups of people residing in Port Blair. One of the group that has settled down in Andaman and Nicobar groups of islands comprises of various castes from different parts of India, while the second group constitutes a group of laborers who migrated from the Indian states of West Bengal, Andhra Pradesh, Tamil Nadu, and Kerala. The first group, i.e. the Andaman Indians, has been the beneficiaries of the various developmental schemes of the Government of India (2009–2010).

According to the report of the Planning Commission (Government of India) on Andaman and Nicobar Islands,[6] there has been an improvement in the economic status of the people leading to demographic and social developments in the state. Though there has been an improvement in the health indicators over the past few decades, but still there is a need for improvement. Despite the Government of India's best efforts in launching and implementing various health policies for the development of tribal/backward class in the area, there is a wide gap in the perceived and achieved targets. Thus, for the Andaman Indians, the variable values of the selection intensities are indicative of the fact that the populations of the island ecology are undergoing a transition phase. The observed values of mortality can be improved by providing better health care facilities, effective policy implementation, and employment plans for the unemployed.

On comparing the pooled results of the values of the selection intensities of population groups from five environmental regions of India, it is apparent that the mean value of the index of total selection varies abruptly, as we move from islands (1.136) to the coastal region (0.703). There is not much variation in the values of the same as we move further into the plains and plateaus (0.711). However, the values changes greatly, as the ecology changes from Plains to the Himalayan region and to the desert. The population groups from the desert report the lowest value of the index of total selection (0.492), which does not differ significantly from the mean value of the coastal population. It thus becomes apparent that there is a gradient in the mean value of the index of total selection as we move from the lower to the upper part of the country. This may be attributed to the varying contribution of the fertility and the mortality

### Table 3: Selection intensity and other variables among selected population groups from different ecological zones of India

| Environmental regions of India | Populations (N) | $I_m$ Mean | $I_m$ SD | $I_i$ Mean | $I_i$ SD | $I_t$ Mean | $I_t$ SD | LB Mean | LB SD |
|-------------------------------|----------------|-----------|---------|-----------|---------|-----------|---------|---------|-------|
| Coastal                       | 9              | 0.398     | 0.223   | 0.219     | 0.099   | 0.703     | 0.295   | 5.2     | 2.0   |
| Plain and plateau             | 53             | 0.335     | 0.200   | 0.287     | 0.203   | 0.711     | 0.362   | 5.3     | 1.2   |
| Island                        | 2              | 0.169     | 0.069   | 0.835     | 0.261   | 1.136     | 0.178   | 4.0     | 1.6   |
| Himalayan region              | 25             | 0.281     | 0.193   | 0.390     | 0.507   | 0.674     | 0.469   | 5.3     | 1.6   |
| Desert                        | 6              | 0.231     | 0.114   | 0.214     | 0.092   | 0.492     | 0.134   | 4.9     | 0.6   |
| Total                         | 95             | 0.316     | 0.197   | 0.314     | 0.316   | 0.695     | 0.380   | 5.3     | 1.4   |

$I_m$: Index of selection due to mortality, $I_i$: Index of selection due to fertility; $I_t$: Total index of selection; LB: Live Births

[6] Planning Commission (Government of India) on Andaman and Nicobar Islands.
indices. It is also observed that the fertility component exceeds the mortality component among the population groups inhabiting the Islands, and the Himalayan region. Given the extreme climatic conditions, it is interesting to note the observed trend. The mean value of the index of selection due to fertility gradually declines from Coastal to the Desert ecology. The mean value of the index of selection due to mortality was found to be highest among the population groups from the coastal ecology, followed by (though not significant) but a marginal difference in the populations from Plains and Plateaus. The value is lowest among the population from the Islands, and nearly the same for the Himalayan region and the Desert. The results of the analysis indicate nonsignificant difference in the values compared across different ecologies [Table 4]. Further, there is a paucity of data on Island populations that makes the comparisons challenging.

The cultural diversity parallels geographic variation in India, thus contributing to the varying values of selection indices. The economic status, the literacy rates, health awareness level, social status, access to healthcare are some of the factors that can be held responsible for playing a pivotal role in natural selection. Another physical feature that may be regarded as a contributing factor to the observed values of selection indices is the nature of the topography. The successful implementation of the various health and family planning programs largely depends upon the easy accessibility of the targeted area. The difficult terrain of the mountainous region and the dense forest that covers the plains and plateau region makes it challenging to percolate the programs to the grass-root level. The unavailability of the drugs, family planning methods, medical facilities, and even the human resources (the health care staff) directs the course of these programs. For example, the high fertility rates among the Himalayan populations may be construed as a result of difficult availability of family planning methods in this area. On the other hand, the extensive health programs run by the Government of India for the tribal and the nontribal populations in the islands have lowered the mortality rates. Besides these, the numerous employment programs to uplift the economic status of the backward classes, awareness programs for the communities in general, and women in particular, housing facilities, adolescent health education programs, eradication of dreadful diseases, preventive programs have also been applauding factors that needs to be mentioned. In case the general population groups are given all the development programs, the awareness level among the people increases, their socio-economic status is increased, eventually leading to improvement in their health status and hence a decline in mortality. Thus, it is not only the genetic composition of a population group, but extra-somatic factors such as the social status (standard of living, religious affiliation, and habitat variation), awareness levels, economic status, the health status, availability and accessibility to various public health sources, nutritional status that can contribute to the fluctuating values of the selection indices.

Andaman Indians, and a migrant population’s awareness levels are low, and hence providing better health facility will enhance their socio-health status. These indices are a toll to calculate the natural selection operating at the population level. Our focus was to calculate the indices, and to see the operation of natural selection (through mother).

Coastal region means the populations who are living on the coastal line of Indian states; Island represents the Andaman and Nicobar Islands and Lakshadweep Islands; Plain area represents the area from the narrow alluvial belt parallel to the Himalayan axis to that between the mountains and the Southern Plateau; the Himalayan region ranging from Jammu and Kashmir to Arunachal Pradesh; and the desert focus on the Rajasthan and Gujarat states of India.

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### Table 4: t Test values for various ecological zones

| Ecological Zones       | t Value | Significance |
|------------------------|---------|--------------|
| Coastal-Plains         |         |              |
| Live births            | -0.244  | 0.813        |
| $I_m$                  | 0.799   | 0.443        |
| $I_f$                  | -1.552  | 0.135        |
| $I_t$                  | -0.061  | 0.951        |
| Coastal-Island         |         |              |
| Live births            | 0.832   | 0.504        |
| $I_m$                  | 2.571   | 0.039*       |
| $I_f$                  | -6.127  | 0.000*       |
| $I_t$                  | -2.701  | 0.091        |
| Coastal-Himalayan      |         |              |
| Live births            | -0.195  | 0.847        |
| $I_m$                  | 1.391   | 0.188        |
| $I_f$                  | -1.595  | 0.122        |
| $I_t$                  | 0.212   | 0.834        |
| Coastal-Desert         |         |              |
| Live births            | 0.341   | 0.740        |
| $I_m$                  | 1.895   | 0.082        |
| $I_f$                  | 0.117   | 0.909        |
| $I_t$                  | 0.022   | 0.127        |

Significant at *P < 0.05; $I_m$: Index of selection due to mortality; $I_f$: Index of selection due to fertility; $I_t$: Total index of selection
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APPENDIX

Demographic Study of the Andaman Indians
PI: Prof AK Kapoor
Sl No. Date: 
Name of the Village/Area: Area: Rural/Urban/Tribal
General Information
1. Name of the respondent/Ego:
2. Age:
3. Marital Status: Single/ Married/ Widowed/ Separated.
4. Age at marriage:
5. Total number of members in the family:
6. Family type: Joint/Nuclear/Extended
7. Occupation:
8. Family income (Rupees)/month: Less than 200/200–500/500–1000/1000–5000/5000–10,000/10,000 and above
9. Women's Information
   1. Age at menarche:
   2. Age at menopause:
   3. Total number of pregnancies:
   4. Number of children born:
   5. Number of children alive:
   6. Number of abortions:
   7. Number of still births:
   8. Number of infant deaths:
   9. Number of childhood deaths:
10. Number of adolescent deaths:

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