Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231– 6345 (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jls.htm
2016 Vol. 6 (3) July-September, pp. 1-7/Vidya et al.
Research Article

POPULATION STRUCTURE OF INDIGENOUS BADAGAS OF THE NILGIRIS, TAMIL NADU BASED ON POLYMORPHIC BLOOD GROUP ALLELES

C. Vidya[1], R. Radha[1], B. Sivaraj[1], N. Sumithra[1], M. Jyothi[2] & *R. Sanil[1]
[1]*Molecular Biodiversity Research Lab, Department of Zoology & Wildlife Biology, Government Arts College, Udhagamandalam-643002, the Nilgiris, Tamil Nadu.* [2]*Providence College for Women, Coonoor-643103, The Nilgiris. *Author for Correspondence*

ABSTRACT
Badagas are indigenous group of people restricted to the hill district of the Nilgiris in Tamil Nadu state of Southern India. They have a multifarious community composition with sub caste and sexual seclusion between groups within the community. The district of the Nilgiris (the home land of Badagas) is alienated into four residential zones by them. The residential zones (*seemai)* are classified as the Thodanad *Seemai*, the Mekkunad *Seemai*, the Porangadu *Seemai* and the Kundha *Seemai.* To understand the divergence in population genetic configuration in various *Seemai*, a study was undertaken based on the ABO alleles. Analysis of the results shows that the Thodanad and Mekkunadu belong to a common cluster, while Kunda and Poragadu form another separate stalk with common ancestry. The interpolation of sampling sites data on geographical information system (GIS) map specifies, Thodanad and Mekkunadu set together, with southern part of Mekkunadu flanked by Kunda and Porangadu. It can be concluded that the concept that Badagas altogether migrated to the hill from northern Mysore plains and flourished in the hill district is a delusion. Instead, it is optional that the exodus takes place in different period of time and initial immigration happened from the southern Mettupalayam plains followed by a more recent migration from northern side. In total Badagas are not a clan or clique, instead they are an admixture of numerous nomadic people immigrated to hills during various period of time forms a complex community structure.

***Keywords*:** *Badagas, ABO Allele, Genetic Distance*

INTRODUCTION
The earliest account of the subsistence of Badagas in the Nilgiris was by a Jesuit Priest Jacome Ferraira in 1603 (Francis, 1908), who came to the hills in search of Christians who were said to settled in this hills long back. The Nilgiris is the homeland of Badagas and the hill district is divided into four zones or divisions (*Seemai* in Badaga language) named Thodanad, Mekkunad, Porangadu and Kundha. Breeks (1873) identified eighteen sexually secluded subsets or sub caste among Badagas. Indian anthropologists (Sastri and Mahalinga, 1892; Parthasarathy, 2008) after the exhaustive study recognized only six sexually separated, socially graded subsets or sub caste in the community. A good number of anthropologists considered Badagas as the 'migrators' from the Karnataka plains and suggested that the term 'Badaga' means Northerner, signifying the course of migration (Rivers, 1906, Hockings 1980, 1999; Parthasarathy, 2008). As a substantiation of migration, it is suggested that the language spoken by the Badagas is somewhat similar to 12th century Kannada. They concluded that the reason for migration to hills may be due to political turmoil or famine in the Mysore plains (Emeneau, 1939; Francis, 1908; Hockings, 1979; Parthasarathy, 2008).

The residential division (*Seemai*) is based on the four hills of the Nilgiris, referred as the *Nakkubetta* (the four hills in Badaga language). In each *Seemai* there are a group of villages which are supposed to be closely related based on the origin. Thothanadu residential division owes its boundaries up to Sholur and fall in the Udhagamandalam taluk and is also refered by Badagas as *Rajabathagiri Seemai.* The Porangadu residential division also referred as *Heliabalia Seemai*, has its boundaries up to Hoopathali to Haliverae which falls mainly in the Kotagiri taluk. The Mekkunadu residential division extents its boundary from Kethi to Keeyour included in the Coonoor taluk, also referred as *Asalavisalagiri Seemai.* The Kundanadu *Seemai* or *Aragilia Seemai* has its boundary from Edakadu to Thuneri included in the

Kunda taluk. A residential division or *Seemai* is formed of many hamlets or villages commonly referred as Hatti, a synonym of Halli meaning village in Kananada. Each of these divisions differs in their rituals, custom, way of worship and even there are marriage hindrances within and between the divisions. There also exists social gradation or racial differentiation and sexual seclusion within the community and *Seemai*. This makes it difficult to analyze and understand the complex communal structure of Badagas. As it is hard to understand the communal setup, a pilot study was undertaken to understand the genetic structure of the population in different *Seemai* based on the ABO allelic variations.

MATERIALS AND METHODS

Methodology

Study was conducted in the Badaga villages belong to all the four divisions named Thothanadu, Porangadu, Mekkunadu and Kunda. It is estimated that there are eighty three settlements (*Hatti* in Badaga language) in Thothanadu, 112 settlements in Porangadu, seventeen nine settlements in Mekkunadu and twenty eight settlements in Kunda. In total there are 302 settlements and estimated households is around 23, 000 and the population is roughly 1,40,000 (Parathasarathy, 2008). Institutional Human ethical committee concurrence was obtained for the study and the collection of blood was done strictly according to the Indian Council for Medical and Research (ICMR) guidelines. Since it is not practical to study the entire village, systematic stratified sampling techniques is used to collect the blood samples. The Badugas follows a system of marrying from specified villages only. Thereby, inter marrying villages with in a *Seemai* (division) was considered as a deme or Mendelian population. Those villages which have frequent marriages with a village of other *Seemai* are ignored from the sampling. Strata's for sampling were created with these concepts and samplings were done accordingly as per methodology described by Yates & Grundy (1953). For analysis, 750 samples from Thodanadu *Seemai*, 590 samples from Meekunadu *Seemai*, 140 samples from Porangadu *Seemai* and 260 samples were collected from Kundha *Seemai*.

Blood samples were collected by pricking the finger tip with a sterilized lancet. The finger tip was cleaned before pricking with surgical spirit. The first drop of blood was wiped out and the succeeding drops were used for grouping, The ABO blood group was estimated by the slide method using the commercially available antiserum. The doubtful slides were observed under the microscope and rechecked with tube method using washed erythrocytes to confirm the doubtful results. The allelic frequency of the ABO allele was calculated according to the formula given by Bhasin and Chatwal, (1996). Homozygosity in the population and the heterozygosity were described using the formula described by Nei (1978). As 'A, B and O' are multiple alleles in a locus, genetic distance matrix between various *Seemai* was estimated using Euclidean method (Gower and Legendre, 1986), Cavalli-Sforze and Edward (1967) chord method and Nei (1972-73) method. Dendrograms for Nei's D were created using the Unweighted Pair Group Mean Analysis (UPGMA) was done by the using D-UPGMA online software (Garcia-Vallve *et al.*, 1999). GIS maps were created based on the GPS (Global Positioning System) readings of the sample sites using the Q-GIS software version 180.

RESULTS AND DISCUSSION

Results

The proportion of the ABO blood group among Badagas in various *Seemai* of the Nilgiris is given in table 1. Results indicate that O group is the major blood group among Badagas of the Nilgiris. When considering the A group blood, this is found to be more in Porangadu followed by Thodanadu, Mekkunadu and Kundha. The comparative high level of B group blood makes Kunda and Porangadu a cluster and the other two into a group. The chi-square analysis shows that the population is in Hardy Weinberg equilibrium. The allelic frequency (table 2) of ABO antigen among the various *Seemai* of the Nilgiris shows O allele is very prevalent in all *Seemai*. This allele occupies more than 70% share in the locus followed by 'B and A' in minor equal proportion. The existence of homozygosity and the heterozygosity is in almost equal ratio indicating allelic stability in the population.

Table 3 shows the genetic distance matrixes. The table shows the Euclidean distance, Chord distance and Nei's distance. Euclidean distance matrix is a measure of geometric distance. The evolutionary matrixes are shown in the other two matrices. Among this Chord distance is a measure mainly depending on Genetic drift and Nei's distance is the measure of both drift and mutation. Figure 1 shows the Unweighted Pair Group Mean Analysis (UPGMA) analysis of the Nei's data. The analysis shows that there are three clusters among the Badagas. The Thodanadu and the Mekkunadu together forms a cluster and the Kunda and Porangadu are different clusters originated from a common stalk. Figure 3 shows the Geographical information system (GIS) map of the area and suggests that Mekkunadu and Thodanadu are also geographically related.

Table 1: Proportion of the Blood Group in Various Seemai

Residential Area	Blood Group Proportion				χ^2	HWE (0.05)
	A	B	O	AB		
Mekkunadu	0.187	0.215	0.550	0.048	2.72	NS
Thothanadu	0.196	0.232	0.529	0.043	0.30	NS
Porangadu	0.207	0.324	0.438	0.030	3.54	NS
Kundha	0.160	0.337	0.474	0.029	0.89	NS

Table 2: Allelic Frequency of ABO Antigen in Various Seemai

	A	B	O	He	Hs
Mekkunadu	0.1249	0.1407	0.7344	0.43	0.57
Thothanadu	0.1272	0.1484	0.7244	0.44	0.56
Porangadu	0.1277	0.1980	0.6742	0.49	0.51
Kundha	0.0996	0.2044	0.6959	0.46	0.54

Table 3: Genetic Distance Matrix in Various Seemai

Residential Division		Mekkunadu	Thothanadu	Porangadu
Thothanadu	Eucleidean	0.0128		
	Chord	0.0077		
	Nei	0.0001		
Porangadu	Eucleidean	0.6767	0.7261	
	Chord	0.7578	0.7542	
	Nei	0.7068	0.7011	
Kundha	Eucleidean	0.6993	0.7271	0.6966
	Chord	0.7607	0.7607	0.7461
	Nei	0.7189	0.7133	0.6860

Discussion

The Badagas are unique community endemic to the Nilgiris District of Tamil Nadu state in Southern India. There are a lot of legends regarding the origin of Badugas and are reported by many cultural anthropologists, (Manoharan, 2009; Parthasarathy, 2008). Anthropologists like, Parthasarathy (2008), Hockings (1965, 68, 79, 80, 99) Sasthri and Mahalinga (1892) are of the opinion that Badagas are migratory people from Karnataka plains. They also suggested that the migration may happen during many periods owing to political turmoil or famine. But, Manoharan (2009) strongly disagree and suggested that the Badagas have relation to the Tamilnadu plains.

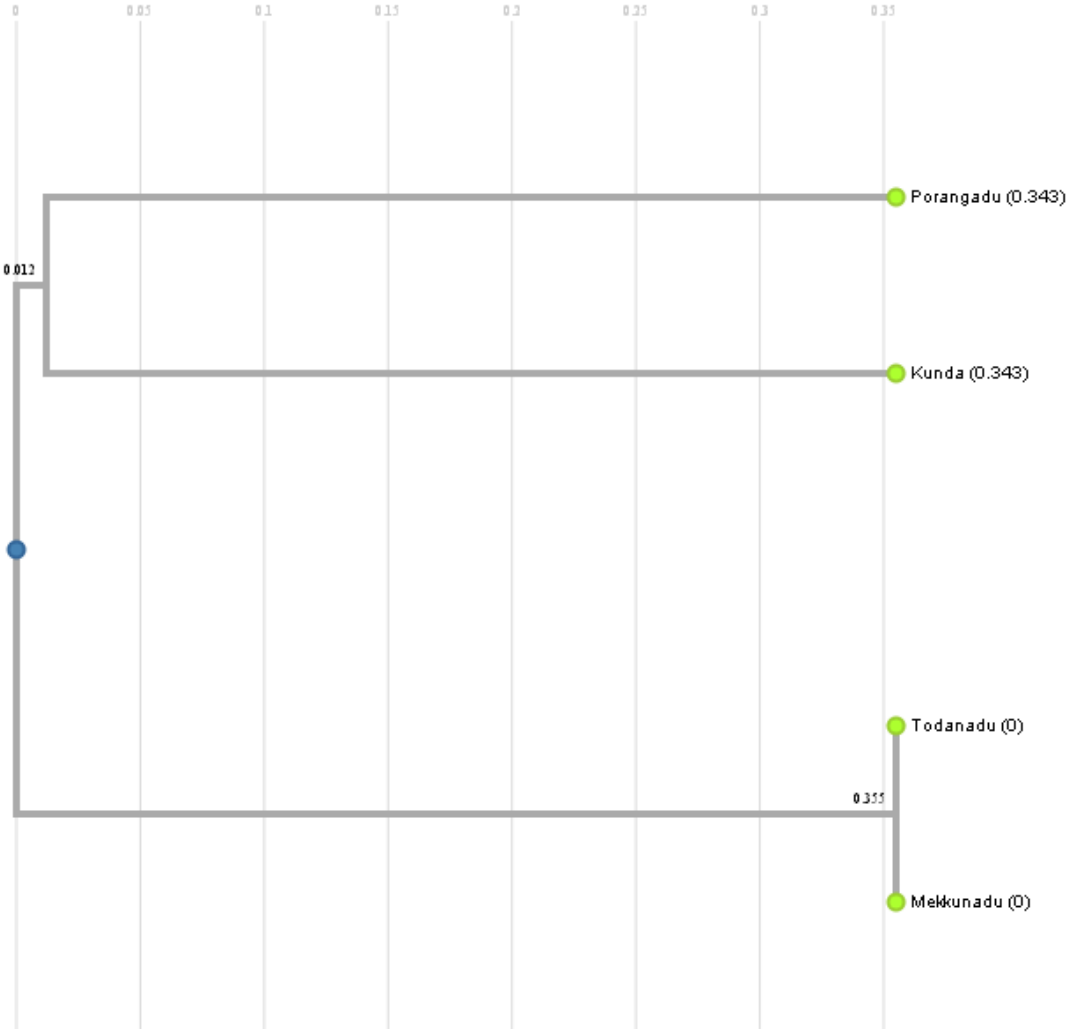

Figure 1: Dendrogram (UPGMA) Showing Genetic Distance

As in a south Indian population, there are many sub sects within Badagas and graded according to their position in the society. In the present scenario, even though the gradation is not so prominent to be identified, still the marriage hindrances exist within the populace. Such type of racial sexual isolation can be observed only in population and not in a clan or in an anthropological tribe. In all the four divisions of the hill district there exists cultural differences between the *Seemai*. Even today, there is prohibition of marriages, between villages making separate inbreeding groups (can be called as races) by sexual isolation within the community. None of the cultural anthropologists paid attention to this, though they had explained the existence of sub sects (Breeks, 1873; Sathri and Mahalinga, 1892; Parthasarathy, 2008) among the population. The present study based on ABO allele shows that the Todanadu and the Mekkunadu forms a common cluster or ancestral stock (Figure 1). While Kunda and the Porangadu forms a separate stalk, among this Kunda is undoubtedly a separate stalk. This discrepancy with the Porangadu, may because of its geographical position (Figure 2). The cultural system also shows that the porangadu is different from other *Seemai* in its worship methods.

Badagas in general have comparatively high proportion of O group than the other blood group, with very high frequency of O allele. Kundha and Porangadu have comparatively high frequency of B allele than the other two groups. Comparing A allele, Kundah has least frequency while other three share almost same frequency. The variation in frequency of allele can be caused by migration of peoples or groups that

have high or lower frequency for one of the alleles at the time of migration (Lewontin and Krakauer, 1973). The same shift in allelic frequency can also result from random genetic drift or as result of mutation creates O by inactivating glycosyltransferase (Cserti and Dzik, 2007; Anstee, 2010). There are more than 180 variations (polymorphisms) for the ABO gene and is used to identify ethnic groups that formed after humans migration (Chester and Olsson, 2001; Yip, 2002; Calafell *et al.*, 2008).

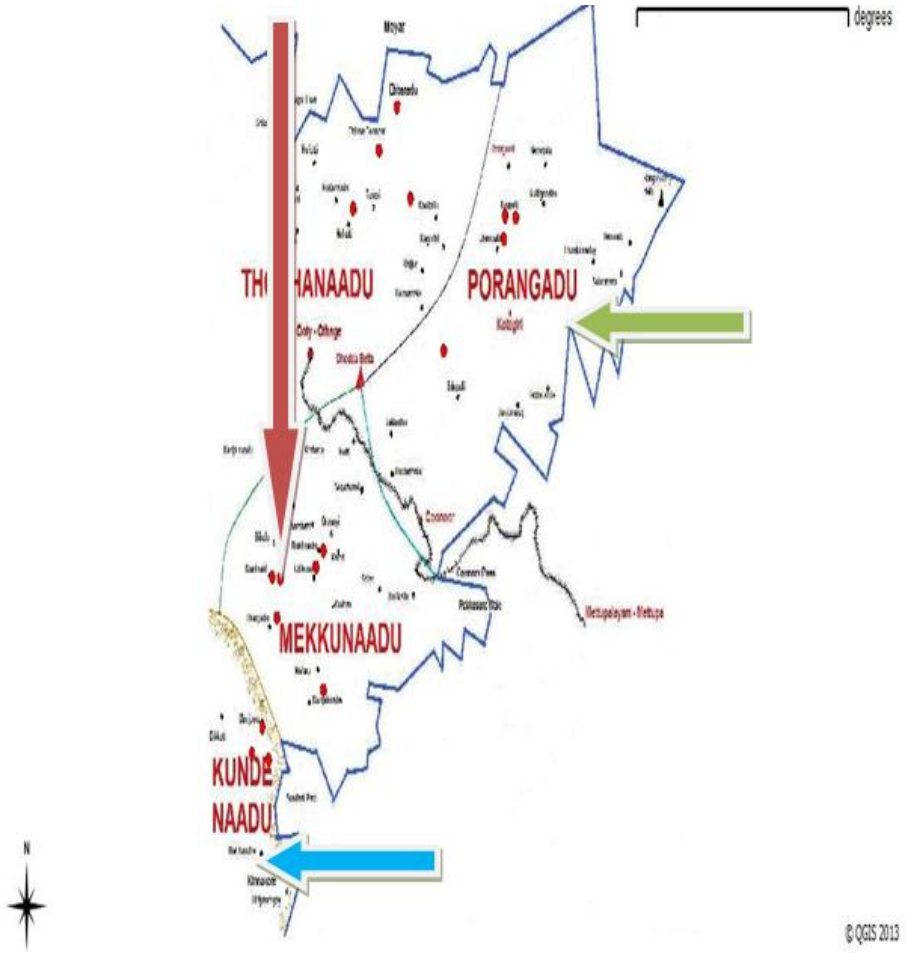

Figure 2: Periodical Migration of Badagas

Blue arrow: Indicates the earlier migration from Mettupalayam;
Forest green arrow: Indicates the later migration from Mettupalayam;
Brown arrow: Indicates the last migration from Karnataka plains

In order to assess the possibilities of mutation and genetic drift three genetic distances where assessed. Euclidean distance is a measure of the geometric distance between populations based on alleles (Edwards, 1971). Chord distance measures the genetic drift (Cavalli-Sforza and Edwards, 1967), while and Nei (1972 -73) distance is a measure of drift and mutation respectively. All the distances are pointing to the common fact that the Kunda is a separate stalk and Mekkunadu and the Thodanadu belongs to very close common origin. It is Porangadu which show differences and show more similarity to the Kunda stalk. When analyzing the spatial data using GIS technique, it can be observed that Kunda and the Porangadu is in the Tamil Nadu slope of the Hill and are separated from each other by a portion of Mekkunadu (Figure 2).

It is a controversy that does Badagas existed in the Hills before 18th Century? or do they have migrated from Mysore plains during the rule of Tippu Sulthan? Many social anthropologists suggested their

relation to Nanjagud temple in Mysore and suggested many stories regarding the migration of Badagas from Mysore (Hockings, 1979; Parthasarathy, 2008). The Jesuit priest who came to Nilgiris in his account written on 1603 wrote that he came to Manjakombai near Devarshola via the Kunda River and returned to Calicut through an easy route shown by kind Badagas (Rivers, 1908). This account is a confirmation that the Badagas exists in Kunda *Seemai* even before that time and have connections to Southern and eastern Plains of the Nilgiris (Mettupalayam-Mannarkkad). It is also to be considered that there exists Kannada speaking people (also called Kongu vellalar) in the foot hills of Tamil Nadu side of the Nilgiris. Manoharan (2009) suggested the link of Badagas with the Karamadai Temple in Mettupalayam plains in the foot hill. This link is mainly to the Porangadu village people living in the Mettupalayam slope of the hills. Based on all these, interpolating the genetic difference with the special separation data generated from GIS one can arrive on following hypothesis. Badagas are not a single clan or group instead they are a society with many complexities. Migration had happened to the Nilgiris hills many times during the last ten decades. People from the Mysore plains may migrate during 18th century forming the Todanadu *Seemai*. They further infiltrated into the eastern side of the hills establishing the Mekkunadu *Seemai*. This infiltration separated the already existing Kunda *Seemai* from the Poragadu *Seemai*. The migration of the people from the Metupalayam plains to the hill stations had happened before 16th century or a stalk of Badugas was existed in the hill even before ten decades.

This original stalk is referred as the Kunda *Seemai* stalk. Due to the easy accesses to the Metupalayam plains, migration to the Porangadu continues frequently diverging the population from Kunda. The migration of the People from the Todanadu, completely differentiated the Porangadu from the Kunda *Seemai*. The cultural exchange, interbreeding, co-operation and interaction among the different migration groups create such a complex cultural heritage and sub sects in the Hill district. The people from Porangadu related to Karamadai temple are the followers of Mother Goddess, a reason for the worship of Hethai (Mother Goddess worshipped by Porangadu *Seemai* and some parts of Todanadu and Mekkunadu *Seemai*). But, Badagas in general are general are Savaits who worship the "Hiruodayar" possibly Lord Siva (Parathasarathy, 2008).

So, to conclude, there is high level of genetic divergence within the Baduga population of the Nilgiris. Thodanadu and Mekkunadu people may be originated or migrated together from a common area (possibly Karnataka Plains due to the geographical position). Kunda is a separate stalk and is a very distinct, but shares a common stalk with Pornagadu area. This can be postulated that the Kunda *Seemai* people and the Porngadu people may migrated from the Mettupalyam plains (Tamil Nadu slope of Western Ghats). Peoples migrated from the Karnataka planes first occupy the Thodanadu (the land of Toda tribes) and then Mekkunadu (the western region). Porngadu people have shared genes with the Todanadu and Mekkunadu during their migration. The migration during different period and migration from different areas created a complex community structure, marriage hindrances and sub castes.

ACKNOWLEDGEMENTS

The authors deeply acknowledge Tamil Nadu State Council for Science and Technology (TNSCST), Chennai (for funding the project. Dr. Jakka Parthasarathy, Former Director, Tribal Research Centre, Ooty for valuable suggestions. Ms Jothi, Ms Anushya, Ms Kanaga and Ms. Durga for assistance in sample collection.

REFERENCES

Anstee DJ (2010). The relationship between blood groups and disease. *Blood* **115**(23) 4635-4643.

Bhasin MK and Chawal SMS (1996). *A Laboratory Manual for Human Blood Analysis,* (Kamala Raj Enterprises, New Delhi, India).

Breeks (1873). *Primitive Tribes and Monuments of the Nilgiris,* (Culture Publishing House, New Delhi, India).

Calafell F, Roubinet F, Ramírez-Soriano A, Saitou N, Bertranpetit J and Blancher A (2008). Evolutionary dynamics of the human ABO gene. *Human Genetics* **124**(2) 123-135.

Cavalli-Sforza LL and Edwards AWF (1967). Phylogenetic analysis: models and estimation procedure. *American Journal of Human Genetics* **19** 233-257.
Chester MA and Olsson ML (2001). The ABO blood group gene: a locus of considerable genetic diversity. *Transfusion Medicine Reviews* **15**(3) 177-200.
Cserti CM and Dzik WH (2007). The ABO blood group system and Plasmodium falciparum malaria. *Blood* **110**(7) 2250-2258.
Edwards AWF (1971). Distances between populations on the basis of gene frequencies. *Biometrics* 873-881.
Emeneau MB (1939). The vowels of the Badaga Language. *Language* **15**(1) 43-47.
Francis W (1908). Madras District Gazetteers: The Nilgiris, (Government Press, Madras, India).
Garcia-Vallve S, Palau J and Romeu A (1999). Horizontal gene transfer in glycosyl hydrolases inferred from codon usage in Escherichia coli and Bacillus subtilis. *Molecular Biology and Evolution* **16**(9) 1125-1134.
Gower JC and Legendre P (1986). Metric and Euclidean properties of dissimilarity coefficients. *Journal of Classification* **3** 5-48.
Hockings P (1976). Paikara: An Iron-Age Burial in South India. *Asian Perspectives* **18** 26-50.
Hockings PE (1980). *Ancient Hindu Refugees: Badaga Social History 1550-1975*. (The Hague and New York: Mouton Publishers).
Hockings P (edition) (1992). *Encyclopedia of World Cultures, South Asia,* (USA, Boston: G. K. Hall) **3**.
Hockings P (1965). Cultural change among the Badagas, a community of Southern India, Ph.D., Thesis, Berkeley.
Hockings P (1968). Identity in Complex Societies: Are the Badagas Caste are Tribe Studies, Delhi. *Journal of African and Asian Studies* **2**(1) 29-35.
Hockings P (1979). *Ancient Hindu Refugees: Badaga Social History*, (Mouton Publishers, New York, USA) 1550-1975.
Hockings P (1980). *Sex and Disease in Mountain Community*, (Vikas Publishing House Pvt. Ltd, New Delhi, India).
Hockings P (1999). *Kindreds of the Earth: Badaga Household Structure and Demography*, (Sage Publications, New Delhi, India).
Hockings P (2001). *Mortuary Ritual of the Badagas of Southern Indian,* (Field Museum of Natural History, Chicago, USA).
Lewontin RC and Krakauer J (1973). Distribution of gene frequency as a test of the theory of the selective neutrality of polymorphisms. *Genetics* **74**(1) 175-195.
Manoharan (2009). *Baduga Inamakkalin Varalarum Kalacharamum* (Dhruv Publications, New Delhi, India).
Sastri N and Mahaliga S (1892). The Badagas of Nilgiri district. *Madras Christian College Magazine* **9**(10).
Nei M (1978). Estimation of average heterozygosity and genetic distance from a small number of individuals. *Genetics* **3** 583-590.
Nei M (1972). Genetic distance between populations. *American Naturalist* **106** 283-292.
Nei M (1973). The theory and estimation of genetic distance. In: N. E Morton (edition). *Genetic Structure in Populations*, (University Press of Hawaii, Honolulu, USA).
Parthasarathy J (2008). The Badagas the Nilgiris, TRC Report, HADP Publication, Udhagamandalam.
Rivers WHR (1906). *The Todas*, (Macmillan and Co., London, UK).
Yip SP (2002). Sequence variation at the human ABO locus. *Annals of Human Genetics* **66**(1) 1-27.
Yates F and Grundy PM (1953). Selection without replacement from within strata with probability proportional to size. *Journal of the Royal Statistical Society. Series B (Methodological),* 253-261