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From the desk of Editor .....

The ninth volume of the Journal assumes a special significance for all of us – who are either directly or indirectly associated with it, particularly because this is for the first time that the Journal has been accorded an ISSN and its name has been changed to 'Indian Journal of Biological Sciences' with due approval. The initial hesitation with which we – the four Departments of Zoology, Botany, Physiology and Anthropology, had ventured upon combining our efforts to put forth a united projection of diverse fields of biological interest, has now turned into a firm conviction in our ability to pursue such an approach. It still remains as one of the challenges as we are on the threshold of completing a decade of our collective existence. We are, however, more than willing to meet that challenge, which we consider to be an opportunity for us to prove ourselves. After all, the idea of formulating a task expended in acting out a programme of considerable importance is worth carrying on.

Editor-in-Chief

INBREEDING AND ITS CONSEQUENCES IN HUMAN POPULATIONS

D.P. Mukherjee [1]

ABSTRACT

The paper based on an extension lecture examines the bio-genetic and social consequenas of inbreeding .It also highlights the importance of inbreeding effects in population studies.

Inbreeding and kinship :

THE term inbreeding' is used, for human beings, in two senses. In a loose social sense, it denotes mating within a social group resulting from endogamy or in-group marriage (Roberts, 1967). But, as a biological term, it can be defined as the result of mating between ***consanguineous relatives***, so that the ***offspring*** are homozygous for genes 'identical by descent' (autozygous). ***Inbreeding can be defined as the process by which alleles which are identical by descent are transmitted to individuals through both parents.***

Mating means sexual union resulting in the production of offspring. Marriage gives the social approval for mating in most populations. Random mating is a necessary condition for a population to remain in the Hardy-Weinberg equilibrium. Inbreeding is generally regarded, as a type of non-random mating. In a large population, the chance of mating between descendants of common ancestors is indeed low. When such matings or marriages are significantly greater than expected by chance, they must have been preferred. An endogamous population may not necessarily be biologically highly inbred. However, random mating within a very small population may lead to inbreeding.

Individuals belonging to a society are related. Two types of relationships are recognized: (1) ***kinship,*** the relationship included in the **genealogy** (Family tree), (2) social relationships of other kinds, such as friendship or socio-economic relationships like network relationships. Kinship can, again, be of two kinds: (1) ***consanguineous,***

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when the relationship can be traced through one or more common ancestors, and (2) ***affinal,*** when the relationship can be traced through marriage between the relatives themselves or between their consanguineous relatives.

In anthropological literature, consanguineous relationship is defined in different ways. For social anthropologists (e.g. Morgan, 1871; Van Gennep, 1906; Malinowski, 1913), consanguinity need not be actual biological relationship traced through a common biological ancestor, but is its social acceptance, e.g. through adoption.

In human biology, consanguineous relationship has to be traced in the **pedigrees,** which are bilateral genealogies (displaying both paternal and maternal fines of descent) considering all biologically related individuals (e.g. including illegitimate children and excluding socially adopted ones). Two consanguineously related individuals must both have inherited same genes from one or more common ancestors. In the literature of Human Population Genetics, the terms relationship and kinship have been freely used to mean consanguineous relationship.

Theoretically, all individuals belonging to the human species or subspecies *Homo sapiens sapiens* can be thought of as descendants of common ancestors, however remotely. In some societies, very distant consanguinity may have social significance. But as direct genetical significance of consanguineous marriages is that they lead to inbreeding, spouses who have remote ancestors in common is not so meaningful (Cavalli-Sforza and Bodmer, 1971). More closely related spouses share a larger proportion of common ancestral alleles than less closely related ones. The offspring of near relatives are expected to be homozygous for a relatively larger number (or proportion) of homozygous ancestral alleles, and larger probability of autozygosity of particular alleles than those of distant relatives. The offspring of very remotely consanguineously related parents are expected to be homozygous for only negligible proportions of genes identical by descent. Furthermore, the probability of autozygosity in them is likely to be even smaller due to increased probability of mutation in ancestral genes (Li, 1955).

Thus, consanguineous marriages are events that can be counted, but inbreeding resulting from them is a process by which more and more homozygosity of ancestral alleles are transmitted to the offspring of more and more closely consanguineous parents. Attempts at measuring the intensity of inbreeding from the beginning of 20th century (Pearl,

1913; Dahlberg, 1929) has culminated in the formulation of the inbreeding coefficient, F, which is defined as (a) Correlation between uniting gametes (Wright, 1921; Whalund, 1928), (b) the probability of two homologous genes or alleles of an individual being identical by descent (Haldane and Moshinsky, 1939; Cotterman, 1940; Malecot, 1940), and (c) expected proportion of autozygous loci in individuals or their groups (Mukherjee et al., 1974, Mukherjee, 1984).

There are several ways, other than consanguineous marriages, identifiable in pedigrees, that inbreeding may occur in human populations: (a) local endogamy or small marriage distance, (2) small size of the interbreeding population or its subdivision into isolates or demes, (c) positive assortative mating for phenotypic characters, and so on, that should not be ignored in studies of genetical effects of inbreeding. The levels of inbreeding in the offspring of apparently nonconsanguineous marriages differ between populations, the inbreeding levels or intensities studied in the offspring of identified consanguineous marriages are population specific.

Again, inbreeding intensity increases not only with the closeness of consanguinity between parents themselves, but also with the degree of consanguinity in the common ancestors of consanguineous parents. This is incorporated in the formula used for deriving inbreeding coefficient.

The extent of parental consanguinity can be assessed by the mean coefficient of kinship between the parents. The coefficient of kinship is defined as the probability of a gene taken at random from one parent at a locus being identical by descent to a gene taken at random from the other parent at the same focus. If there were no mutation, this coefficient of kinship between the parents would be equivalent to the mean F of their offspring (Cavalli-Sforza and Bodmer, 1971; Immaizumi, 1988).

Estimating the degree of relationship and Inbreeding :

In human biology and biological anthropology, and genetics, both the degree of consanguineous kinship and inbreeding can be measured in the following ways, presented in the order of their development.

A. Coefficient of relatedness:

Wright (1922) introduced the **coefficient of relatedness** and formulated it by using the coefficient of inbreeding, F, as follows:

$$R_{ij} = -\frac{2F_{ij}}{\sqrt{(1+F_i)(1+F_j)}},$$ [where Fi and Fj are F,s of two individuals and Fij = Fi X Fj]

The ***coefficient of relatedness, R, between two individuals,*** i and j, can be easily obtained by adopting the following steps of calculation:

(Step 1) assigning the value of ½ (the proportion of common genes or chromosomes) to the relationship between a parent and an offspring and the value of ½ to the relationship between two sibs (two brothers, two sisters or a brother and a sister), i.e. to each first degree consanguineous relationship;

(Step 2) counting the number of such relationships (n) (called paths) that connect two related individuals, i and j between whom coefficient of relationship is to be obtained; and finally,

(Step 3) using the formula: Rij = $(½)^n$ **[where n is the number of paths.]**

= (½)1 X (½)2 X (½)3 ..... X (½)n.

The average coefficient of relationship for a population can be derived from this.

B. Coefficient of inbreeding:

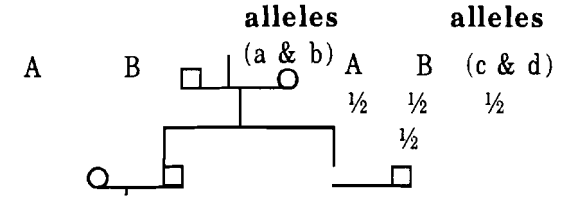
For autosomal genes

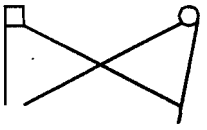
(i) The value of the coefficient of relatedness, R, between two consanguineous parents, none of whom are inbred should be twice the value of the inbreeding coefficient, F, (Wright, 1921) of any of their offspring for autosomal loci. So, **(½ X R) of the parents can be used as a rough measure of F for an individual.**

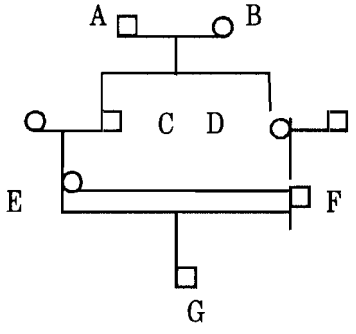
The F is one half of the R. The R between a parent and offspring is ½ and the F of an offspring of father: daughter mating would be ½ X ½ = ¼. The R between an uncle/aunt and nephew/niece is ¼ and the F of the offspring of a maternal uncle and niece marriage is 1/8 (=¼ X ½). The R between first cousins is 1/8, and the F in the offspring of first cousins is 1/16. The R between step brother/sister is ¼ and R between their offspring is 1/8, and so on.

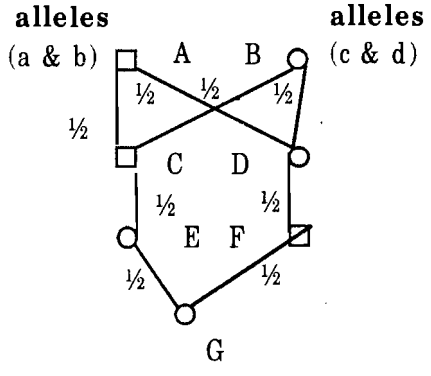
(ii) Another approach is to trace the probability of an individual receiving each of the four alleles (a, b, c, d) of two common ancestors through both parents and then sum these probabilities.

The probability of G receiving 'a' allele from great grand father, A, through the mother's father, C, and mother, E, is ½ X ½ X ½ = 1/8. The p of G receiving the same allele 'a' from A, through G's father F is also 1/8.









Pedigree

Path diagram

Thus, the total probability of G receiving allele 'a' from A through both parents is 1/8 X 1/8 or 1/64. [The two probabilities (p) of G's receiving 'a'. from A through his father and through his mother are independent events. One does not influence the other.]

Similarly, the p of G being autozygous for allele 'b' of A is 1/64, p of his being autozytgous for 'c' of B, and that for 'd' of B is 1/64 in each case.

As G cannot be autozygous for more than one of the four alleles at a locus at the same time, the p's of G being autozygous for a, b, c, and d are mutually exclusive. Therefore, the overall p of G (an offspring of 1st cousin marriage) being homozygous for an allele (identical by descent) at a focus is 1/16 (= 4 X 1/64) = 0.0625.

We can also say that an offspring of 1st cousins is autozygous for 1/16th of an autosomal locus.

That of an offspring of 1st cousins once removed is 1/32 = 0.03125

2nd cousins 1/64 = 0.015625

2nd cousins once removed 1/128 = 0.0078125

3rd cousins 1/256 = 0.00390625

3rdcousins once removed 1/512 = 0.001953125

and, so on.

Reduction of oOne degree of kinship between the consanguineous parents halves the value of F in their offspring.

iii) Wright's method of **using path coefficients:**

The foregoing method of calculating F is not only time consuming but also complicated when there are multiple relationships between the same pair of parents. For example, a pair of parents may not only be related as second cousins, but may be also second or third cousins through other lines of descent. It would be convenient to use Wright's method of path coefficients to avoid complications. The steps for that method are as follows:

(Step 1) Identifying all common ancestors. e.g. A and B in the given pedigree.

(Step 2) Counting the number of individuals in the paths in the chain connecting the parents of the inbred offspring through each common ancestor separately. In the former pedigree of first cousin mating, there are 6 paths connecting the parents, E and F, of G, through each common ancestor, A and B. The probability of transmission of the ancestral allele in each path is ½ so that the final probability of inheritance of the same ancestral allele is (½)k, where k m the number of such individuals.

(Step 3) Multiplying the value of [1 +F A] to the value of each common ancestor

(Step 4) Summing up the values of $(½)^{n-1}(1+F_a)$ or $(½)^k$ $(1+F_A)$ for different common ancestors.

This is expressed in the formula $F = \sum\sum^{n-1}$, where n is the number of paths (connecting parent: offspring pairs) that link the parents of the inbred offspring through a particular common ancestor. The symbol $\sum$ denotes summation of the chains connecting the individual through each common ancestor. The operation can be further simplified by using the equivalent formula: $F = \sum (½)^k$, in which k is the number of relatives connecting the two parents through a common ancestor. k is equal to (n-1). For example, the offspring of a 1st cousin marriage are connected to each of the two great grandparents through 5 relatives. So $F = \sum (½)^5 + (½)^5 = 1/32 + 1/32 = 1/16$.

If a common ancestor, himself or herself is also inbred, the formula for F should be $F = \sum (½)^k (1 + F_A)$, where F_A is the inbreeding coefficient of the common ancestor in question. There is no harm in making this the general formula for F.

Isonymy :

Crow and Mange (1965) suggested an interesting approach to the computation of the mean kinship coefficient in a population that makes use of the frequency of identical surnames or isonymy. The method is approximate. It depends on assumptions that are not always easily tested. Disadvantages are to some extent outweighed by the simplicity of the approach and the opportunity it provides to prove for remote consangunity to a greater degree than by any other pedigree method.

One quarter of the consanguineous first cousin marriages, with frequency c, on the average, have identical surnames, because of the inheritance of their grandfather's surname through two sibs, three quarters have different surnames. The contribution of first cousin marriages to the average inbreeding coefficient is their frequency times their F-value, which is 1/16 c.

If we want to estimate the contribution to F of all first cousin marriages, on the basis of the frequency (c/4) of first cousins who have the same surnames, we must multiply by four, then by the F value (1/16); or equivalently multiply directly the frequency of marriages of first cousins with the same surnames by ¼. Second cousins have same surnames 1/16 of the time, and their F value is 1/64. Thus taking the frequency of second cousin marriages with same surnames and multiplying it by ¼, we again obtain the contribution of all second cousin marriages to F. In general, probability that relatives of any degree (odd or even) have same surnames, because of inheritance from a common mate ancestor in patrilineal societies or from a common female ancestor in matrilineal societies, is always four times the inbreeding coefficient of the particular type of mating. This neglects some pedigrees that are rare.

The frequencies of isonymous pairs of individuals divided by four gives F value of the population. We can determine the frequency of isonymous pairs at random from the population, or we can determine it from actually mated pairs. It is likely that, in most cases, the discrepancy between frequencies obtained by these two methods will be small or insignificant. If the difference is significant, we may partition the total observed kinship coefficient f (obtained from isonymous mates) into a fraction due to random mating, f_r,

and a fraction due to nonrandom mating, f_n. The latter may be positive or negative depending on whether there is a tendency of positive or negative assortative mating with respect to surnames (for relationships). The value of f_n will differ from zero if people mate preferentially or avoid mating with others of the same or related surnames. The relation between total inbreeding coefficient f and its parts fr and fn is always in the form $(1- f) = (1- f_r)(1 - f_n)$. It should be noted that the method is not applicable in certain situations where surnames may not indicate relationship.

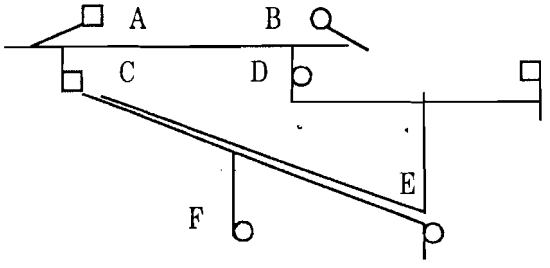
For X-linked genes

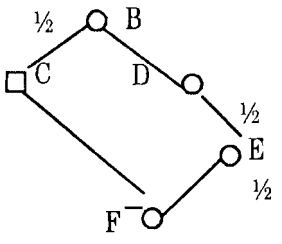
Inbreeding (homozygosity of ancestral genes) for X-linked genes only occur in female individuals and not in normal male individuals. A man cannot transmit his X-chromosome to his sons and must do so to his daughters. Therefore, ***inbreeding coefficient for an X-linked gene (F_x) of a female individual has to be calculated by counting only the number of female individuals in any path (in a pedigree) connecting the individual her common ancestors through both parents. Then sum up the values of å(1/2)^f, for each common ancestor; where f is the number of females in the chain of paths, after multiplying it with ($1+F_{AX}$), in which F_{AX} is the inbreeding coefficient of the common ancestor***. The formula to be used is $F_X = å(1/2)^f (1+F_{AX})$.

The values of the inbreeding coefficient (F_X) for any path connecting a father with a son must be zero and the total chain of paths involving such a path should also be zero. The F_X of a path joining a father with a daughter is 1. Therefore, the chain of paths involving a common ancestor including a father : son path should be avoided in such calculations.

A few examples will clearly illustrate the calculation of Fx of female individuals in pedigrees.

Example 1: Maternal uncle and niece mating





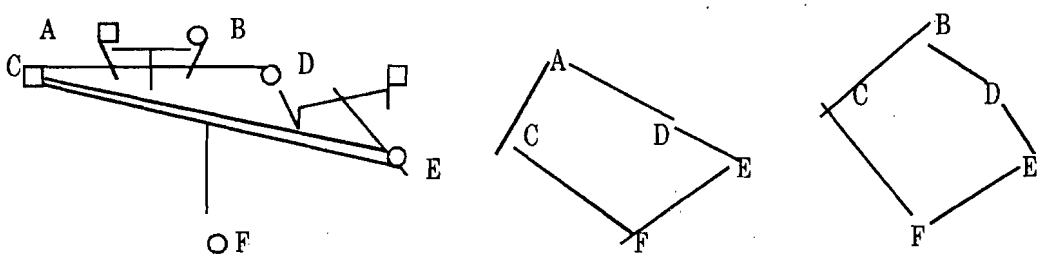
$F_a = \sum(1/2)^k(1+F_A)$ $\quad FX = \sum(1/2)^f(1+F_{AX})$

$= CADEF + CBDEF$ $\quad = \sum(1/2)^3(1)$

$= (1/2)^4(1+F_A)+(1/2)^4(1+F_A)$ $\quad = 0.125$

$= 0.125$

Example 2 : *Paternal uncle and niece mating*

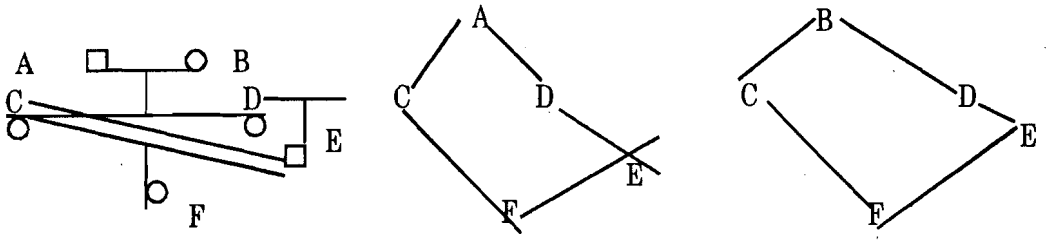


$F_a = CADEF + CBDEF = (1/2)^4(1+F_A)+(1/2)^4(1+F_A)$

$= 0.125$

$Fx = CBDEF = (1/2)^2(1+f_{AX}) = 0.250$

Example 3:Marriage between mother's sister and niece



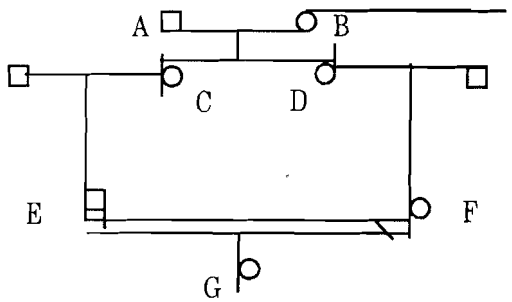
$F_x = (1/2)^2(1+F_{AX})+(1/2)^3(1+F_{AX})$

$= 1/4 + 1/8$

$= 3/8 = 0.375$

$F_a = (1/2)^4(1+F_A) + (1/2)^4(1+F_A) = 0.125$

Example 4 : Mother's sister's son X mother's sister's daughter mating



F_A = ECADFG + ECBDFG

$= (1/2)^5(1+F_A)+(1/2)^5(1+F_A)$

$= 0.0625$

Fx = ECADF + ECBDF

$= (1/2)^3 + (1/2)^4$

$= 1/8 + 1/16 = 3/16$

$= 0.1875$

Obtaining the arithmetic mean of individual coefficients, F, of all individuals in the group or the population, can indicate the mean inbreed1ngcoefficient, F_g of a group or a population. Often F_g is derived from the frequencies of marriages with different kinship coefficients between spouses (e.g. Morton, 1958; Neel and Schull, 1962;Srinivasan and Mukherjee,1976) on the assumption of equal number of offspring of those marriages. However, it is more accurate if the average number of offspring of each type of marriage is multiplied with the F for each type of marriage (Mukherjee et al., 1971). The standard deviation, s, of F works out to be

$s = \sqrt{\Sigma F^2/N - (Fg)^2}$ and standard error,

s.e. = $s/\sqrt{N}$

Genetically consequences of inbreeding :

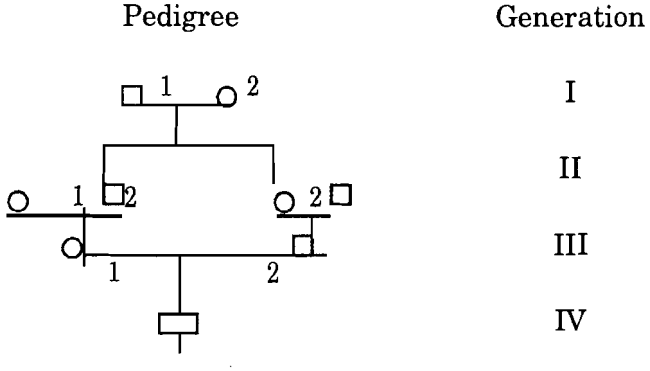
Inbreeding essentially causes homozygosity of genes identical by descent. Often homozygous genotype of recessive or additive genes would show an abnormality or disorder in the phenotype. This is shown in the following example.

Q. The pedigree shows marriage of a man, III_2, who carries a gene for b-thatassaemia, 'T', with his mother's brother's daughter, III_1. He has married his matrilateral cross cousin. What is the probability that his son/ daughter (offspring) win be affected with b-thalassaemia (who is homozygous for the 'T' gene).

A. Since the gene T for b-thalassaemia is uncommon, the man, III_2, has inherited the T gene from either his mother or father, each with the probability of 1/2. The probability of the mother, II_2, inheriting the gene from her father, I_1, is 1/2. The probability of I_1 transmitting the gene T to II_1 is 1/2 and that of II_1 transmitting the gene T to III_1 is also 1/2. Thus, the probability of III_1 receiving the T gene from the common ancestor, I_1,is (1/2 X 1/2 X

1/2 X 1/2) = 1/16. Similarly, the probability of III_1 receiving the gene T from the common ancestor, I_2 is 1/16.

The total probability of III_1 gene T from either I_1 or I_2 is 1/16 + 1/16 = 2/16 = 1/8. Again, the probability of two heterozygotes producing recessive homozygote is 1/4. Therefore, the probability of the offspring, X, being homozygous for the gene T is 1/4 X 1/8 = 1/32 = 0.03125.



Offspring of first cousins:

If we were certain that both III_1 and III_2 are first cousins and III_1 is maternal uncle's daughter of III_2, then the probability of their offspring being affected is only 1/4.

In case of the total genome, a quarter of the total number of total would be autozygous in the offspring, X.

Another problem:

Q. What is the probability of having an affected offspring if a hetrozygous carrier of a rare gene, marries unaffected person ?

A. The probability of an affected offspring is 1/4 X 2pq, in which p and q are frequencies of the rare and the common alleles in order, because 2pq is the chance of an unaffected person in the population carrying the gene, and 1/4 is the chance of a recessive genotype in the offspring of two hetrozygotes.

Population studies:

Long before population genetics has emerged, plant and animal breeders have known that inbreeding causes a deterioration of viability, vitality and health of the offspring (Pirchner, 1969). Bemiss (1858) has drawn attention to harmful effects of consanguineous marriages in human beings. Several studies have referred to gifted offspring of consanguineous marriages, while others showed defects in the inbred offspring (Huth,

1875; Westermerck, 1903; East and Jones, 1919).

Morbity and mortality:

Recessive inheritance of rare segregating traits — alkaptonuria, oculocutaneous albinism, phenylketonuria, retinitis pigmentosa, ichthiosis congenita, deaf-mutism-has been detected by studying parental consanguinrity of affected individuals or examining the offspring of consanguineous marriages (Bateson, 1902: Etderton, 1911; Sjogran, 1931; Sanders, 1938; Sutter and Tabah, 1953; Book, 1957; Schull, 1958; Dronamraju and Meera Khan, 1960; Freire-Maia, 1963; McKushik et al, 1964: Kumar et al., 1967; Krieger, 1969; Jacob and Jayabal, 1971; Roberts and Bonne, 1973; Mukherjee et al , 1974; Rao and Mukherjee, 1975; Devi et al., 1981; Afzal and Sinha, 1984; and others), However, most of the congenital malformations and prenatal and postnatal mortality may be the result of autozygosity of several loci at the same time. X-linked recessive genes for diseases like haemophilia are confirmed by their high incidence in the offspring, especially in female offspring, of closely consanguineous marriage (Muir, 1928).

Inbreeding has been suggested to be advantageous for a population in the long run, due to selective elimination of harmful recessive genes by increased mortality through generations (Hatdane.1924; Gates, 1946; Hayman and Mather, 1952; Reeve, 1955; and others. Sanghvi (1966) mathematically inferred a progressive decline of deleterious alleles as a result of inbreeding through hundreds of generations as in Andhra Pradesh in India. A few authors studying large samples of regional populations e.g. people of North Arcot in Tamil Nadu (Rao and Inbaraj, 1979) and patients of Karnatak (Devi et al, 1981), which are heterozygous in gene pools, and types of consanguineous marriage etc. have suggested slight increase of morbidity and mortality. But the inbreeding effects can hardly be denied in view of consistent results.

Quantitative traits:

The most useful study of inbreeding effects on quantitative traits is comparing **the *frequency distribution*** of characters in individuals with different degrees of inbreeding, as observed in Indian populations (Mukherjee, 1984). For most of the characters, an antimode is found in the distribution in highly inbred groups of individuals. The position of the antimode varies among characters, For stature, body weight, But it is shifted towards the lower end of the distribution in the case of total finger ridge count, for instance. The antimode usually represents the heterozygotes, which are reduced in frequency in

inbreeding. This is accompanied by high frequencies of both high and low values of the trait that represent the homozygotes. This is an indication of additive effects of genes. If the increase of frequencies in one side is markedly greater than that of the other consistently, we can suspect some amount of recessive effects of genes for the side which show relatively greater frequency (Mukherjee, 1984, 1992, 1996; Mukherjee et al, 1980. 1991; and others).

When there is no clear bimodality or absence of antimode, a shift of the mode to one side in the inbred group would suggest a dominant-recessive effect of the concerned genes, as in the case of palm print patterns. The shift of the mean is in the direction of recessive traits.

The mean

Usually, authors have studied the effect of inbreeding in the depression of the mean value of the trait, such as stature, being guided by the idea of 'inbreeding depression'. In population genetics, we generally look for the change of mean, according to the following formulation of Mather (1949):

Population mean for a trait determined by alleles at a single locus

Genotype	Value	Frequency	Frequency X Value
AA	+a	p^2	p^2a
Aa	d	2pq	2pqd
Aa	-a	q^2	$-q^2a$

Mean = $a(p-q) + 2dpq = M_0$

Mean of a population, trait determined by multiple loci, with the inbreeding coefficient F

Genotype	Value	Frequency	Frequency X Value
AA	+a	$\sum p^2 + \sum pqF$	$\sum p^2a + \sum pqaF$
Aa	d	$2\sum pq - 2\sum pqF$	$2\sum pqd - 2\sum pqdF$
Aa	-a	$\sum q^2 + \sum pqF$	$-\sum q^2a - \sum pqaF$

Mean = $\sum a(p - q) + 2\sum dpq - 2\sum dpqF = M_0 - 2\sum dpqF = M_F$.

Thus, the mean for inbreeding at the level of F will change in the direction opposite to the dominant phenotype, d, by the amount $2\sum dpqF$. In the absence of dominance, d=0, there will be no change of the mean, that is, $M_0 = M_F$.

However, it has been consistently observed (Mukherjee, '1984, '1992) that the mean does not change with the increase of f in a linear fashion in most of the traits that are subject to selection. Initially, there is an increase of mean in low inbreeding due to selection against the recessive traits with low values. in high inbreeding, however, there is a decrease in the mean due to the overewhelming effect of homozygosity,although the effect of selection still continues.

The variance

The variability of the measurable character generally increases with inbreeding. Theoretically, the variance due to additive genes within lines is $2Spqa^2(1 - F)$, where F is the coefficient of inbreeding, and that between lines is $2Spqa^2 X 2F$. Thus, the total variance due to additive genes in a population with inbreeding coefficient, F, is $2Spqa^2(1+F)$. The total additive variance increases in a degree of inbreeding, F, by an amount equal to F (Wright, 1921; Li, 1955) independently of gene frequencies, The increase of variance will be detectable with inbreeding in practice only if a substantial part of the genetical variance were due to recessive genes at low frequencies. The extent to which the theoretical changes of variance can be observed in practice depends on how much environmental variance is present. The estimates of variance require a large number of observations and the estimate obtained are usually subject to rather large deviations due to the chances of sampling. 1t has been observed that while variance increases with inbreeding, it decreases consistently in low inbreeding as a result of selection against the recessive phenotypes (Mukherjee, 1984).

The variance is usually examined in terms of the square of the 'Coefficient of variation' (s/ Mean2) as the mean may often differ between different levels of inbreeding.

Genetic load

The concept of genetic load refers to the reduction of fitness of a population due to the occurrence of suboptimal genotypes (Crow, 1958). Such a reduction may be due to the appearance of mutant phenotypes (mutation load) or due to individuals being homozygous when heterozygotes are optimal (segregation load). The inbreeding effects on still birth, infant and child mortality, and congenital malformations are often examined through an exponential model (Morton et al., 1956) as follows.

$P_s = 1 - \exp [- (a + b F]$., where P_s is the expected proportion of survivors and F is the inbreeding coefficient. In other words, they have fitted a linear regression to the negative logarithm of the surviving proportion of the inbred offspring on F. '-log Ps=

A+BF' to derive lethal equivalents between B and A + B. Modifications of these estimates are suggested (Sanghvi, 1963; Smith, 1967).

The estimates of a (A) and b (B) are obtained by using weighted least-square technique (Smith, 1967). However, Levins (1959) has questioned the linearity of effects of inbreeding on mortality and morbidity. There is, thus, a limitation of estimating genetic segregation load from inbreeding effects.

Some recent findings:

Recently it has been observed that increments due to growth of stature and other body measurements do not show any change of mean with inbreeding but there is an increase of variance with inbreeding in both Qureshi muslims of Aligarh (Badaruddoza, 1992) and Telaga population of Kharagpur (Das, 2000). Such a result of inbreeding effect would suggest the additive effects of genes on growth. There is, again, a consistent decrease of variance between left and right sides in a number of dermatogryphic traits in the closefy inbred group of individuals. This would suggest a reduced developmental variance in homozygotes compared to heterozygotes (A. Mukherjee, 1990).

We usually observe an excess of whorls on fingers among males in most of the populations. But occasionally, in a few small populations females appear to show an excess of whorls on fingers over the proportion in males. This requires an explanation. It has been observed that there is an increase of both whorls and arches in the inbred group of individuals. But the increase of whorls in females is often more than that in males. While males are inbred only for autosomal genes, females are inbred for autosomal as well as X-linked genes.It is found that females with X-linked inbreeding have particularly excess of whorls over that in males. This would, of course, suggest the influence of X-linked gene or genes on the finger print patterns. This problem is now being further investigated in this way. There have been controversial reports about inbreeding effects on sex ratio. It has been possible to clarify that the effect of high and low inbreeding differ subject to the effect of selection (Mukherjee et at., 1996). Inbreeding effects may clarify a number of genetic problems in human society, apart from searching for new deleterious genes in a population.

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REFERENCES

Afzaf, M. and S.P:Sinha.1984. Effects of consanguinity on fertility and mortality among Ansari Muslims of Bhagalpur.*Bat.Acad. Sci Letters.* **7**: 383—386.

Bateson, M. 1902. *Report on the evolution committee of the Royal society* (london) **1**:133

Bemiss, S.M. 1858.Report of influence of marriage of consanguinity upon offspring. *Trans. Ame, Med. Assen.* **11**: 319-425.(Cited in Schull and Neel, 1965)

Badaruddoza, 1992. *Inbreeding and Genetic Studies on Certain Quantitative Traits in 8 Population from Uttar Pradesh (India).* Ph. D. thesis, Atijarh Muslim University.

Cavatti-Sforzs, L.L. and W.F. Bodmer. 1971. *The Genetics of Human Populations.* W.H. Freeman and Co., San Francisco

Cotterman, C.W. 1940. *A Calculus for Statisticat Genetics.* Ph.D. dissertation, Ohio State University, Ohio.

Crow, J.F. and A.P. Mange, 1965. Measurement of inbreeding from the frequency of marriages between persons of the same surname. *Eugen. Quart.* **12**: 199-203.

Dahlberg , G. 1929. Inbreeding in man. *Genetics.* **14**: 421- 454.

Das, B. K. 2000. *Types and Trends of Consanguinity and Inbreeding among Tetugu Speaking Populations of Kharagpur; West Bengal and Some Biological Consequences.* Ph. D. thesis, Vidyasagar University, Midnapore

Devi, A.P.R., N.A. Rao and A.H. Bittles. 1981. Consanguinity, fecundity and postnatal mortality on Kamatak, South India. *Ann.Ham.Genet.* **8**: 469-472

Dronamraju, KR. and P:Meera Khan. 1960. Inbreeding in Andhra Pradesh. J. *Heredity.* **13**: 21-29.

East, E.M. and D.F. Jones, 1919. *Inbreeding and Outbreeding.* J.B. Lippincot. Co. Philadelphia

Elderton, E. M. 1911. *On the Marriages of First Cousins,* tondon. (Cited in Gates, 1946)

Freire-Maia, N. 1963. The load of tethar mutations in the Whites and Negro Brazilian populations. II. Second survey. *Acta Genet,* Basel. **13**:199-225.

Gates, RR. 1946. *Human Genetics.* **Vol.1 and 2.** Macmittan Co., Newyork.

Hardane, J.B.S. 1924. A mathematical theory of natural and artificial selection. *Trans. Camb.Phil. Soc.* **23** :19-41.

Haldane, J..B.S., and A.G. Moshinsky, 1939. Inbreeding in Mendelian population with special reference to human cousin marriage. *Ann.Eugen.* **9** : 321-340.

Hayman, B.L. and K. Mather. 1952. The progress of inbreeding when homozygotes are at a disadvantage. *Heredity.***7** : 165-183.

Huth, A.M. 1875. *The Marriage of Near Kin.* longmans Green, London

Imaizumi, . 1988, Familial aggregation of consanguineous marriages in Japan. *J.Biosoc. Sciences.* **20** : 99-109

Jacob, J.T.and P.Jayabal. 1971. Foetat and child loss in relation to consanguinity insouthem India, *Indian J. Med. Res.* **59** : 53

Kumar, S., RA.Pai and M.S. Swamlnathan. 1967. Consanguineous marriages and the genetic load due to lethal genes in Karala. *Ann.Mum.Genet.* **31**: 45-51.

Levins, R. 1959 Discussion. *Eugen. Quart.* **6** : 109 - 111.

Li, C.C. 1955. *Population Genetics.* University of Chicago Press, Chicago.

Malecot, S. 1940. *Les Mathematiques de Heredite.* Masson et Cic., Paris.

Malinowski, B. 1913. *The Family Among the Australian Aborigines.* Hodder, london

Mather, K. 1949. *Biometrical Genetics.* Methuen and Co. ltd., London.

McKushik, V.A., J.A.Hostetler, J,A,Egeland and R. Eldridge. 1964. The distribution of certaln genes in the old order Amish. *Cold Spring Harbor Symposium Quant Biol.* **29** : 98-114.

Morgan, L.H. 1871. Systems of consanguinity and affinity of the human family. *Smithsonian Contributions to Knowledge.* **17** : 1-590.

Morton, N.E. 1958. Empiricat risks in consanguineous marriages. *Amer. J. Hum Genet.* **10** : 344-349.

Morton, N.E., J.F.Crow and H.J. Muller. 1956. An estimate of the mutational change in man from data on consanguineous marriages. *Proc.Nat.Acad.Sci.* **42** : 855-863.

Mukherjee, A. 1990. Inbreeding effects on bilateral asymmetry of dermatoglyphic patterns. *Amer. J. Phys, Anthropol.* **81** : 77-89

Mukherjee, D.P. 1984. Inbreeding and genetics of quantitative traits in man. In : *Human Genetics and Adaptation, Vol 1. K. C. Malhotra and A. Basu, (eds.)* Pp. 533-561. Indian Statistical Institute, Calcutta

Mukherjee, D. P 1992. Consanguineous marriages and their genetical consequences in some Indian populations. In : *Isolation, Migration and Health.* D.F.Roberts, N. Fujiki and K.Torizuka (eds.).pp.83-74. Cambridge University Press, Cambridge.

Mukherjee,D.P. 1996. Anthropotogical genetics of quantitatrive variation. J.indian

Anthrop. Soc. 31.: 217-224

Mukherjee, D.P., S. Bhaskar. and M. Lakshmanudu. 1974 Studies on inbreeding and its effect in some endogamous populations in Chitoor district, Andhra Pradesh. *Proc. First Ann. Conf., Indian Soc. Hum. Genet.* p.17. and *Bull. Anthrop. Survey India.* **26** : 10-22. (1977).

Mukherjee, D.P., P.C. Reddy and M. Lakshmanudu.1980. Dermatogtyphlc effects of inbreeding. *J. Indian Anthrop. Soc* **16** : 67-79.

Mukherjee, D.P., Lily Kundu and A.Mukherjee.1987. Inheritance of finger triradii : Reappraisal with new data on famity and twin correlation and inbreeding effects. In : *Contemporary Studies in Hunan Genetics.* A. K. Chowdhuri, S. B. Roy and B. N. Sarkar (eds.).pp. 183-207.IBRAD, Kolkata.

Mukherjee, D.P., B. K. Das and A. Guha. 1995. Nonlinear inbreeding effects on secondary sex ratio in relation to birth order and parental age. *J.Biol. Sci V.U.* **1** : 32-41.

Muir, J. 1928. Heredity in hemophilia in South Africa. *J.Med.Assn.S.Africa.* **2** : 599-606.

Pearl, R. 1913. A cobtribution towards an analysis of the problem of inbreeding. *American Naturalist.* **47** : 577- 614.

Pirchner, F. 1969. *Population Genetics in Animal Breeding.* W.H.Freeman and Co., San Francisco.

Rao. P.S. S. and S. C. fnbaraj.1979. Trends in human reproductive wastage in relation to long term practice of inbreeding. *Ann.Hum.Genet;* **42** : 401-413.

Reeve. E.C.R. 1955. Inbreeding and homozygotes at a disadvantage. *Ann. Hum. Genet.* **19** : 332-346.

Roberts, D.F. 1967. The development of inbreeding in an island population. *Ciencia e Cultura.* **19** : 18 — 84.

Roberts. D.E and B. Bonne. 1913. Reproduction and inbreeding among the Samaritans. *Soc.Biol.* **20** : 64-70.

Sanders, 1938. Die heridiat die albinism. *Genetics.* **20** : 97-120

Sanghvi, L.D. 1966. Inbreeding in India. *Eugen. Quart.* **13** : 291-301.

Schull. W.J. 1958. Empirical risks In consanguimeos marriages: sex ratio, malformations and viability. *Amer. J.Hum. Genet.* **10** : 294-343.

Sjogran, T, 1931. Die Juvenile amaurotic idioyie. *Hereditas.* **14** : 83.

Smith, C.A.B. 1967. Note on the Paper 'Consanguineous marriages and genetic load due to lethal genes in Kerats.' *Ann. Hum. Genet,* **31** : 146-141.

Srinivasan, S. and D.P. Mukherjee. 1976. Inbreeding among some Brahman populations of Tamil Nadu. Hum. *Heredity.* 26 : 131-136.

Sutter, J. and L. Tabah. 1953 Effects des marriages consanguineous surla descendence. *Population.* **6** : 59-82.

Van Gennep, 1906. *Mythes at Lagendas d Australie, Paris.*

Wahlund. V.S. 1928. Zussammensetzung der vererbungsfehre aus betrachtet. *Hereditas.,* **11** : 65-106.

Westemerck.. E.A. 1903. *The History of Human Marriage.* 3rd edition. Macmillan and Co. London

Wright, S. 1921. Systems of mating. II. The effects of inbreeiding on the genetic composition of a population. *Genetics.* **6** : 124-143.

Wright, S. 1922 CoeffiCient oflnbreeding and relationship. *American Naturalist.* **56** :330-338.

AN ESTIMATION OF UNDETECTED MALARIA IN AN ENDEMIC AREA IN KOLKATA

A.K.Hati [1], B.Mondal [2], H.Mukherjee [3], P.Chaudhuri [4], S.Purakayastha [4] and S.Roy [5]

ABSTRACT

In an endemic area in central Kolkata in a laboratory malaria cases were recorded longitudinally from 1997 to 2003 through examination of blood slides of suspected cases. Out of 227916 suspected patients, 97617 (42.8%) were suffering from malaria. Another 83669 blood slides of persons of the same area, not at all suspected to be suffering from malaria, were also examined and 319 of them were found to have malaria (167 had vivax malaria and 152 had falciparum malaria), without any sign and symptom. Of those 319 persons, 139 (female 49, male 90) and 64 (F25, M39) were carrying gametocytes of *P. vivax* and *P.falciparum* respectively, acting as silent carriers. Gametocytaemia was highest in the age group of 40-50 and 21-30 years in *P.falciparum* cases and *P.vivax* cases respectively. It was estimated that in this endemic area 38/10,000 population had undetected or hidden malaria, 19.95/10,000 had vivax malaria and 18.16/10,000 had falciparum malaria, out of which 16.61/10,000 and 7.64/10,000 were carrying gametocytes of *P.vivax* and *P.falciparum* respectively.

INTRODUCTION

In an area in central Kolkata, malaria is endemic. In a laboratory situated in this area (Gautam Laboratories, 9A Kalikrishana Tagore Street, Kolkata 700007) patients suspected to be suffering from malaria come to examine their blood for detection of malaria parasites. Cases detected daily are being recorded since 1997.The laboratory remains closed only for two days/year during holi festival. In this laboratory blood slides of people, who are not suspected to be suffering from malaria, are also examined. These

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slides are also daily searched for detection of malaria parasites. This study has been conducted with a definite purpose, to evaluate whether malaria is present in any undetected form in the community. Passively recorded causes may show the tip of the iceberg only. Estimation of undetected cases may show the real magnitude of the problem. Hence this study has been designed.

MATERIALS

An area in central Kolkata has been selected for the study.

Thick and thin blood films are drawn from suspected cases of malaria and stained with Giemsa and Leishman respectively and examined under oil emersion lens for detection of malaria parasite throughout the year from 1997 to 2003.

Peripheral blood slides of another group of people have been examined for presence of malaria parasites, if any, who are not suspected to be suffering from malaria from August 1997 to September 2003.

RESULTS

Table 1 shows prevalence of malaria in the endemic area. Altogether 227871 patients were asked to examine the peripheral blood for detection of malaria parasites of whom 97617 (42.3%) were positive for malaria, 57553 (58.98%) of them were suffering from vivax malaria and 40529(41-51%) from falciparum malaria.

Percentage of falciparum malaria per year varied from 26.25 (2003) to 50.73 (1998).

Peripheral blood samples of another 83669 persons, not suspected to be suffering from malaria, were examined for detection of malaria parasites. A total of 319 of them showed malaria parasites in their peripheral blood 167 (52.55%) had vivax malaria and 152 (47.64%) had falciparum malaria. Out of 167 vivax malaria cases 139 (83.22%-females 49, males 90) were harbouring gametocytes in their blood. Out of 152 people having falciparum malaria, 64 (42.10%-female 25, male 39) had gametocytaemia (Table 2).

Age gradation of 50 persons carrying *P.vivax* gametocytes and 64 persons having *P.falciparum* gametocytes, is shown in Table 3.

Among 64 persons carrying *P.falciparum* gametocytes, 25 (39.1%) were females and 39 (60.9%) were males. Among 139 *P.vivax* gametocyte carriers, 49 (37.2%) were females and 90 (64.7%) were males.

Table 4 depicts monthwise distribution of number of *P.vivax* and *P.falciparum* cases along with number of gametocyte carriers.

DISCUSSION

In an endemic area some malaria patients always remain undetected. There are various reasons. Some patients remain undetected even if signs and symptoms are present. Some patients may harbour the parasite during the late treatment failure phase. Here the so called initial recovery takes place, in which case this duration may be almost 1 month after treatment with a resistant drug. Besides, premunition (1) may occur, that means a balance is reached between the parasite and host, as a result of which disease manifestations may not be present in some persons, though they carry parasites. Though they do not always suffer from signs/symptoms of malaria, they may act as excellent carriers, transmitting the disease silently in the society.

Estimation of existence of undetected malaria in an area, though of paramount importance, specially for control measures, has never been attempted. A small scale field trial has been conducted in Purulia (2), where 14.2% undetected malaria cases have been obtained (47 out of 329). This is a sort of sample survey and its purpose is not to estimate the prevalence or incidence of undetected malaria cases.

In this study we have tried to estimate the prevalence and incidence of undetected malaria in a selected endemic urban area, where 42% of cases asked for examination had malaria. In this area, we detected 97617 malaria cases during 1997-2003, 40529(41.70/0) of whom had falciparum malaria. Falciparum malaria cases ranged from 26.25 (2003) to 50.73 (1998) (Table 1).

Our data reveal that in the study period in this endemic area 38/10,000 people had undetected malaria, 19.95/10,000 harboured vivax malaria and 18.16/10,000 harboured falciparum malaria, 16.61/10,000 and 7.64/10,000 carried P.vivax and P.falciparum gametocytes respectively (Table 2).

Undetected malaria cases/10,000 population varied from 20:39 in 2003 to 56.05 in 2001 (Table 2). Maximum number of vivax cases occurred in the age group of 41-50 years, though in all age groups starting from 1-10yrs to 61-70yrs., both vivax and falciparum cases were found. Maximum number of vivax (41) and falciparum (35) cases were obtained in the month of August and December respectively (Table 4). 60.9% of males and 39.1% of females with undetected malaria carry gametocytes. This figure for vivax malaria is 64.7% and 35.2% in males and females respectively.

This study has estimated undetected malaria in an urban area, which may serve as a model for all such future references.

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REFERENCES

Cook, G. (1996). *Manson's Tropical Diseases* chapter 61; Malaria, XX Edn. Ed. N.J. White (ELBS with W.B. Saunders, London): I I I 10

Mukhopadhyay, A.K., Hati, A.K. and Dey, P. 2000. Malariogenic situations amounting to premunition in areas of Ayodhya Hills of District Purulia, West Bengal. *J. common Dis.,* 32, 231-233.

Table 1

Prevalence of malaria in an endemic area in central Kolkata

Year	Cases asked for detection of malaria parasites	Malaria Parasite positive	Plasmodium Vivax	Plasmodium falciparum	% of Plasmodium falciparum
1997	23730	8272	5207	3072	37.11
1998	38411	17395	8816	8825	50.73
1999	41045	19296	9801	9541	29.4
2000	31845	13355	8779	4613	34.54
2001	38127	16391	8629	7825	47.73
2002	28828	12108	8323	3818	31.53
2003	25885	10800	7998	2835	26.25
	227871	97617	57553	40529	41.51
		42.83%			

Table 2

Undetected or hidden malaria cases in an endemic area in central Kolkata

Year slides	Plasmodium Undetected Vivax		Plasmodium falciparum				Total examined	Total Malaria/ 10,000
	PVTG/PVG		PVT	PFR	PFRG	PFG		
1998 (Aug-Dec)	14	2	3	-	1	20	4965	40.28
1998	16	II	8	7	5	47	13608	34.53
1999	22	7	23	9	7	68	13050	52.10
2000	27	3	11	11	2	54	142\5	37.98
2001	27	3	36	9	4	79	14094	56.05
2002	16	2	7	5	1	31	13933	22.14
2003	17	0	0	1	2	20	9804	20.39
	139	28	88	42	22	319	83669	

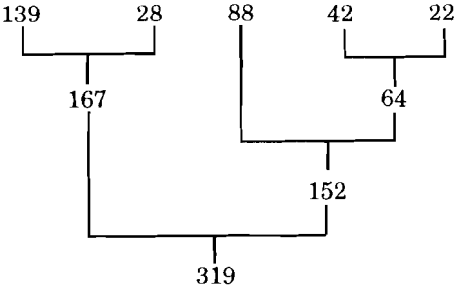

Table 3

Age gradation of 50 persons carrying P. uivax gametocytes and 64 persons having P.falciparum gametocytaemia.

Age gametocytes	Age gradation of 50 persons having P.vivax gametocytes in the peripheral Blood	Age gradation of 64 persons having P.falciparum in the peripherals blood
1-10	5	2
11-20	4	9
21-30	14	9
31-40	9	7
41-50	7	17
51-60	4	12
61-70	4	9
70>	3	-
	50	64

Table 4

Monthwise number of P.uivax and P.falciparum cases. Number of gametocyte carriers of P. uivax and P.falciparum/ month has also been shown

	Total no. of viv Cases	Cases harbourin P. 'ivax gametocvtes	Total no. of falciparum	Cases harbouring of falciparum itametocytes
Jan.	5	4	14	12
Feb.	1	1	7	3
March	10	10	4	2
April	8	7	1	1
May	9	8	4	3
June	15	]2	6	4
July	22	17	2	-
August	41	39	13	5
Sept.	19	18	19	6
Oct.	19	8	23	6
Nov.	17	14	24	9
Dec.	1	1	35	13
Total	167	139	152	64

THE INFLUENCE OF LOBULES IX & X OF CEREBELLAR VERMISON ON THE HEAD-UP TILTING RESPONSE IN CATS

Tusharkanti Ghosh [1]

ABSTRACT

The blood pressure of anesthetized (alpha chloralose) cats after head-up tilting at an angle of 45°showed two distinct phases: 1) initial fall of arterial blood pressure (uncompensated phase), 2) an early compensated phase. After injection of procaine into lobules IX and X (modulo-uvular area) of cerebellar vernis, the uncompensated phase was elevated and the early compensated phase was delayed. Similar results were observed in chronic nodulo-uvular ablated cats compared to intact control animals. These results suggest that the orthostatic reflex probably needs the integrity of the lobules IX & X of cerebellar vermis for regulation of blood pressure during change of posture. Considering the close neural coordination between vestibular recepters and nodulo-uvular area, a modulatory role of this area of vernis on the vestibulo-sympathetic reflex has been suggested.

INTRODUCTION

The circulatory effects of up right posture in animals include a fall in systemic arterial pressure, followed by a rapid compensatory phase (17). Head-up tilting in cats produces similar circulatory effects (11, 15). Circulatory regulating during head-up tilting is mainly effected through neural orthostatic reflex, though some humoral mechanisms have also been indicated (11). Three neural components participate in orthostatic reflex : baroreceptors (7), cardiopul-monary afferents (16) and cerebellar fastigial projections to medallery vasomotor area (5, 11). Cerebellar fastigial nucleus (FN) is important for the adjustment of circulatory system during tilting and vestibular apparatus is probably sending the afferent information to FN for

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circulatory adjustment (4, 5). There is evidence that information from vestibular apparatus is conveyed to FN (2, 19). The rapid and accurate cardiovascular adjustments to changes in posture are diminished in peripheral vestibular lesioned animals (22).

Lobules IX and X of cerebellar vernish (uvula and nodule) receive vestibular information through vestibular nucleus and also through primary vestibular projection to these areas (3, 6). On the other hand, Purkinjee cell action of lobules IX and X influence directly the vestibular nucleus (6), though fastigio-vestibular pathway may mediate the nodula-uvular influence on vestibular nucleus. Keeping in view of such close neural connections between vestibular apparatus and lobues IX and X, the present study was undertaken to investigate the role of these cerebellar lobules in the regulatory mechanism of circulatory system during tilting.

Materials and Methods

Experiments were performed in 14 cats of either sex having body weight between 2-4 kg. The cats were divided into three groups: GroupA : Normal intact animals in which procaine HCI was injected in lobules IX and X through microcannula; Group B : Intact control animals; Group C : Chronic nodulo-uvular lesioned (lobules IX and X) animals. In all these animals femoral arterial blood pressure and respiration were recorded either in kymograph or polygraph in anesthetized condition (alpha chloralose 30-35 mg/kg body weight). The blood pressure was measured from femoral artery by mercury manometer or pressure transducer (Statham P23 DC). In polygraphic study, the mean arterial blood pressure was derived from the formula (Ps + 2 Pd) /3 where Ps was systolic pressure and Pd was diastolic pressure. The pressure transducer (in polygraphic study) or the manometer (in kymographic study) were kept at heart level of cat during tilting. The rectal temperature was maintained at 37°C by a regulated thermal pad covering the animal. Head-up tilting response was measured before and after procaine injection in Group A animals and also in Group B and Group C animals with the help of a tilt table.

Procedure of Procaine Injection: A stainless steel cannula with guide (26 gauze) was inserted at an angle of 90 at 15 mm below the occipita proturence, 0.2 to 0.5 mm laterally from midline, 10-12mm deep into cerebellar cortex with the help of a stereotaxic apparatus following the method described by Ghosh and Maiti (9). 10ml of procaine solution (pH 2-3) containing 10 mg of procaine HCL (Abbott Laboratories) was injected by a Hamilton syringe. After termination of experiment the active

area where the procaine solution was injected was demarked by injecting 0.01 ml. saline containing India ink. Histological preparation of cerebellum with pons and medulla was prepared as described by Ghosh and Maity (9).

Procedure of Lobules IX-and X ablation: Cats were anesthetized with pentothal (35-40 mg/kg body weight i.p.). A 2 mm bur hole was made on a point of occipital bone having the stereotaxic co-ordinates P20, L0, H -3. One polythene tube connected to an aspirator was used for ablation following the method described by Ghosh (8). The suction hole after ablation was blocked by bone wax and the cut ends of skin and muscles were sutured separately. Proper animal care was taken on subsequent days. 14-16 days after operation cats were anesthetized (alpha chloralose 30-35 mg/kg body weight) and were prepared for recording blood pressures.

After termination of experiment the brain was perfused with saline and formol and cerebellum with pons and medulla was collected for histological preparation. The lesioned areas are identified from the stained section of cerebellum.

Tilting: A tilt table was made where the head of the cat can be fixed in supine position. This tilt table could be moved to elevate the head of the cat to an angle of 45^0 from the horizontal level. Such change of position of the head might be accomplished within 2 seconds. The position of head was maintained for 50 sec to 90 sec. Only the cats which showed an immediate fall of blood pressure followed by rapid regaining of steady state level were used in the experiment.

Analysis : The significance of change of blood pressure responses was calculated by student 't' text, $P < 0.05$ being considered significant.

Results

In the intact anesthetized cats before injection of procaine, blood pressure response to head up tilting at an angle of 45^0 showed a brief fall followed by rapid recovery. The maximum fall of mean arterial pressure from 114.8 mm Hg to 99.2 mm Hg occurred within 5-20 seconds of tilting. This initial response was followed by a rapid over-compensation. Later the blood pressure returned to the pre-tilt level or slightly elevated (Fig. 1A). But the steady state pressure fluctuated with the increased and decreased depth of respiration in most of the animals. A brief increase of blood pressure was also noticeable after the tilting table was taken to initial position. So the orthostatic reflex to head-up tilt could be classified into two distinct phases: (1) an initial fall of arterial pressure (uncompensated phase) - the maximum fall in mean arterial

pressure within 20 sec after tilt, (2) an early compensated phase - the difference between maximum fall and blood pressure level after 30 sec. of tilting. In some animals a late compensated phase was observed which may be considered as the difference between maximum fall of blood pressure after 50 seconds of tilting.

Fifteen minutes after the injection of procaine when blood pressure returned to the normal level, the blood pressure response to head-up tilting at an angle of 45^0 was measured. In all the animals the initial fall in uncompensated phase was higher after injection of procaine (Fig. 1B). In the procainized state the initial fall of mean arterial blood pressure was 37 mm Hg. The early compensated phase was also delayed after injection of procaine in nodule and the blood pressure did not regain the pre-tilt value even after 50 sec of tilting (Fig. 1 B).

Similar type of result was observed in chronic nodule-uvular ablated animals. In these animals the early compensated phase was 48.4 mm Hg after tilting of the head at an angle of 45^0. This fall of mean arterial pressure was greater than that of the control animals (Table-1). In the intact control animals the maximum fall of 16.75 mm Hg was observed from the mean arterial blood pressure of 116 mm Hg. The early compensated phase in chronic nodule-uvular lesioned animals was delayed compared to that of the intact control animals. The initial fall of blood pressure was not compensated in chronic nodulo-uvular lesioned animals after 54 sec of tilting and the arterial pressure was regaining the normal value, very slowly. In these animals blood pressure came back to pre-tilt level after the animal regained its initial position.

Discussion

The present study has demonstrated that lesion of nodulo-uvular area or pharmacological depression of this part can impair the orthostatic reflex adjustment in anesthetized cats. The abnormality is found in the enhancement of the initial fall in the blood pressure at the moment of tilting and in the failure of the blood pressure to restore to the control level when tilt is maintained. A lower level of blood pressure after 30° up from a position 30^0 down in conscious rabbits was found after bilaterial destruction of lateral nodulus-uvula in the cerebellum (14). Therefore, it appears that lobules-IX and X are important for modulation of cerdiovascular responses during orthostatic adjustment. It has been reported that some cardiovascular reflexes like bilaterial carotid occlusion response was decreased in chronically prepared nodulo-uvular lesioned cats (9) and observed baroreceptor

induced bradycardia was increased in rabbits following uvula removal (12).

The electrical stimulation of rostral part of FN not only produced a pressor response with tachycardia but also a cardiodynamic pattern simulating the cardiovascular changes during head-up tilting (1, 4, 13). These changes consist of vasoconstriction of arterioles in limbs, kidney and abdominal viscera. The impairment of orthostatic reflexes was reported after lesion of bilaterial rostral fastigial nucleus (5, 11). As the lesion of vestibular nerve also produced similar impairment of orthostatis reflex and further lesion of FN could not produce a summated effect. This contention is in agreement with the observation of Doba and Reis (5), who concluded that fastigial and vestibular projections involved in the orthostatic reflex to share a common neuronal mechanism. These workers opined that vestibular apparatus might trigger the rostral fastigial nucleus which then participated in the initiation and possibly the maintenance of orthostatic reflexes. It may be mentioned here that besides head-up tilting, caloric or rotaroy stimulation of vestibular apparatus produced a drop in the blood pressure (18). But the present study indicates lobules IX and X of cerebellum which are closely connected with vestibular apparatus neuronallay, also participate in the distribution of blood in body so to maintain a stable blood pressure. It has been reported that impairment of orthostatic reflexes due to lesion of rostral FN recovers within a week (10). However, in the present experiment impairment of orthostatic reflexes were recorded 14-16 days after nodulo-uvular lesion. As the orthostatic reflexes have not been measured at different time intervals, the approximate time of recovery of this reflex after cerebellectomy can not be ascertained.

Information arising from the vestibular apparatus may be an important source during tilting, especially when the head is not moved on the neck. In the present experiment, as the animals were not paralysed, so the role of proprioceptive information from the muscles can not be excluded. But the reasons for the vestibular controlling of the cardiovascular, regulation are not so certain. It has however been reported by Yates (20) that the medial and inferior vestibular nucleus just caudal to Deiters' nucleus mediate the vestibular influence on circulation. Indeed, vestibular signals are transmitted to preganglionic neuron of spinal cord which in turn regulate cardiovascular system by sympathetic outflow. When vestibular receptors are stimulated, natural execution of the influence of the neck receptor and baroreceptor happens through

experimental manipulation. This causes increased outflow of splachnic nerve discharge in nose up rotation and decreased splachnic discharge in nose down rotation (21). However, Nisimaru et al (14) found an inhibition of renal sympathetic nerve activity in conscious rabbits following tilting of head at 30^0 up position. Immediately after the inhibition, a transient increase of renal nerve activity was noted by these workers. Therefore, a vestibulo-sympathetic reflex becomes active during tilting. These results calculated from the present study indicate that vestibulo-sympathetic reflex seems to be under the modulatory influence of lobules - IX and X of cerebellum. This contention may be supported by the observations that include the recovery of orthostatic tolerance over time after vestibular lesion in animals which undergo impairment after ablation of posterior cerebellar vermis (22).

References

1. Achari, N.K. and Downman, C.B.B. (1970) : Autonomic effector responses to stimulation of nucleus fastigius. J. Physiol., **210,** 637-650.

2. Brodal, A. (1972) : Vestibulocerebellar input in the Cat: Anatomy, Prog. Brain Res., **37,** 315-327.

3. Brodal, A. and Torvik A. (1957) : Uber den Ursprung der sekundaren vestibulocerebellaren Fasern de Katze. Eine experimentellanamische Studie. Arch. Psychiat. Neven Kr., **195,** 550-567.

4. Doba, N. and Reis, D.J. (1972) Changes in regional blood flow and cardiodynamics evoked by electrical stimulation of the fastigial nucleus in the cat and their similarity to orthostatic reflexes. J. Physiol, **227,** 729-747.

5. Doba, N. and Reis, D.J. (1974) : Role of the cerebellum and vestibular apparatus in regulation of orthostatic reflexes in the cat, Circulation Res., **34,** 9-18.

6. Dow, R.S. (1936) : The fibre connection of the posterior parts of the cerebellum in the cat and rat. J. Compo Neurol., **63,** 527-548.

7. Gauer, O.H. and Thorn, H.L. (1965) : Postural changes in circulation. In Hand Book of Physiology, Sec 2 Vol.3, Circulation, P. 2409 - 2439, Editors, W.F. Hamilton and P. Dow, Washington D.C., Physiol Society.

8. Ghosh, T.K. (1984) : Cerebellar modulation of cardiovascular reflexes. Ph.D Thesis, Univ. of Calcutta, P.58-59.

9. Ghosh, T.K. and Maiti A.K. (1981) : Cardiovascular and respiratory responses resulting from procainizatlon of cerebellar nodule in cats, Ind. J. Physiol, & Allied Sci., **35**(2), 45-63.

10. Huang T.F., Carpenter, M.B. and Wang S.C. (1977) : Fastigial nucleus and orthostatic reflex in cat and monkey. Am. J. Physiol. **232,** H 676 - 681.

11. Koyama, S., Ammons, W.S. and Manning, J.W. (1981) : Visceral afferents and the fastigial nucleus in vascular and plasma renin adjustments to head-up tilting. J. Auton. Nerv. Syst., **4**(4), 381-392.

12. La Noce A., Bradley, D.J., Goring, M.A., and Spyer, K.M. (1991) : The influence of lobule IX of cerebellar posterior vermis on the baroreceptor reflex in the decerebrate rabbit. J. Auton. Nerv. Syst., **32**(1), 31-36.

13. Lisander, B., and Martner, J. (1971) : Interaction between the fastigial pressor response and the baroreceptor reflex. Acta Physiol. Scand., **83,** 505-514.

14. Nisimaru, J., Okahara, K. and Yanai, S. (1998) : Cerebellar control. of the cardiovascular responeses during postural changes in conscious rabbits. Neurosci. - Res., **32**(3), 267-271.

15. Oberg, B. and White, S. (1970) : The role of vegal cardiac nerves and arterial

barroreceptors in the circulatory adjustments to hemorrhage in the cat. Acta Physiol. Scand., **80,** 395-403.

16. Pelletier, C.L. and Shepherd, J. T. (1973) : Circulatory reflexes from mechanoreceptors in the cardio-aotic area. Circulation Res., 33, 131-138.

17. Pollock, A.A. and Wood, E.H. (1948-49) : Venous pressure in the saphenous vein at the ankle in man during exercise and changes in posture. J. Appl. Physiol., 1, 649.

18. Spiegel, E.A., and Demetriades, Th.D. (1924) : Beitragezum Studium des vegetativen Nerven systems. VII. Der Zentrale Mechanismus der vestibularen Blutdrucksenkung und ihre Beduntung fur die Entstehung des Labyrinthschwindels. Pflugers Arch ges. Physiol., 205, 328 - 337.

19. Wilson, V.J. (1972) : Physiological pathways through the vestibular nuclei. Int. Rev. Neurobiol., 15, 27-81.

20. Yates, B.J. (1996) : Vestibular influences on the autonomic nervous system. Ann. N.Y. Acad. Sci, 781, 458-473.

21. Yates, B.J. and Miller, A.D. (1994) : Properties of Sympathetic reflexes elicited by natural vestibular stimulation: implications for cardiovascular control. J. Neurophysio. 71 (6), 2087 - 2092.

22. Yates, B.J., Holmes, M.J. and Jian, B.J. (2000) : Adaptive plasticity in vestibular influences on cardiovascular control. Brain Res. Bull., 53(1), 3-9.

TABLE - 1

Head-up-tilt response in different experimental conditions

Animal Group	Condition (No. of animals)	Uncompensated phase (mm Hg.)	Earlycompensated phase (mm Hg.)
Gr-A	Before procaine injection in nodulo-uvular area (5)	15.6 + 1.72	27.8 + 2.50
	After procaine injection in nodulo-uvular area (5)	37.0+ 1.64*	25.0 + 1.95
Gr-B	Intact control animals (4)	16.75 + 1.60	25 + 1.31
Gr-C	Chronic nodulo-uvular lessioned animals (5)	48.4 + 2.06*	17.0 + 1.06

Mean Values + S E, * P < 9-.001

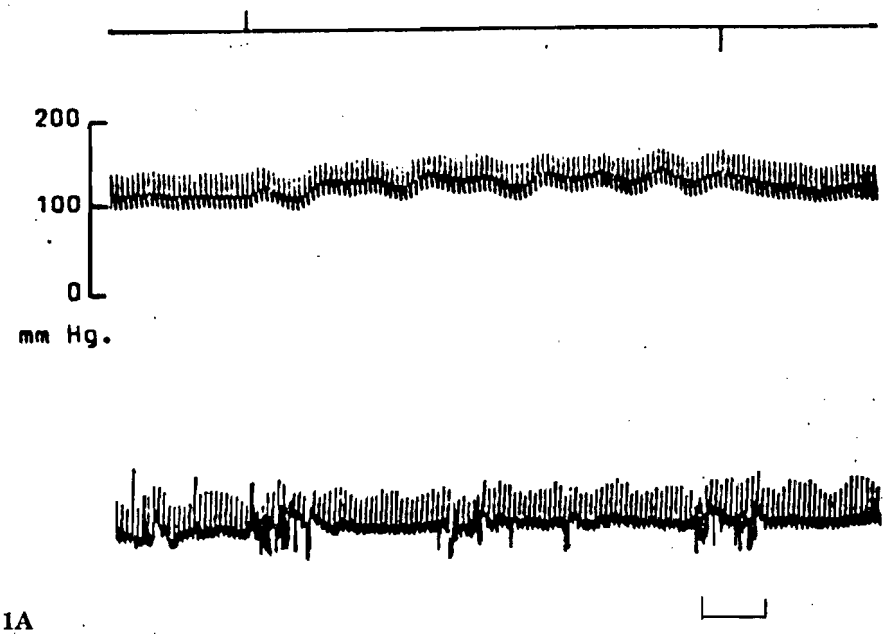

Fig. - 1A

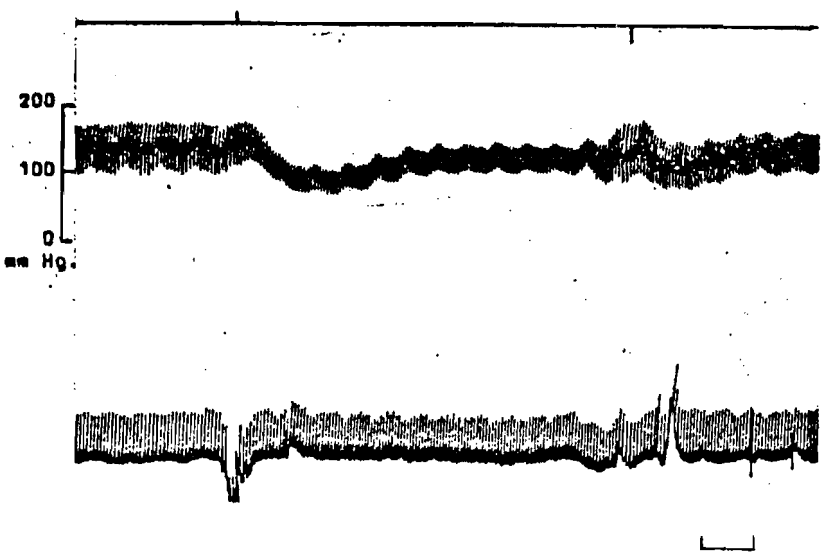

Fig. - 1A

Fig. - 1. Effect of head-up tilt to 45^0 on blood pressure in chloralose andesthetized cat. A: Before. injecttion of procaine, B: After injection of procaine. Polygraphic tracings are from top to bottom: signal of tilting, femoral arterial pressure and electrocardiogram. In the top tracing the upward mark indicates the time of head-up tilt while downward mark denotes regaining of normal position of head. Length of the horizontal line=4 seconds.

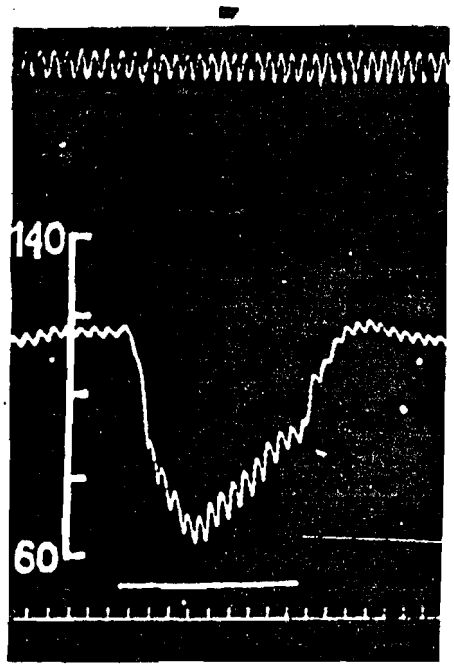

Fig. 2. Effect of head-up-tilt to 45° on blood pressure in chronic nodulo-uvuler lesioned cat. Reading downward: respiration, femoral arterial pressure, time marking. Vertical scale at the left side: blood pressure in maHg. Horizontal line below the blood pressure tracing denotes the duration of up-tilt. Time scale: t 6 seconds interval.

AN ERGONOMIC STUDY ON THE DEVELOPMENT OF MUSCULOSKELETAL DISORDERS AMONG THE FIXED LOAD AND VARIABLE LOAD HANDLING WORKERS OF KOLKATA

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ABSTRACT

Manual material handling (MMH) is a very common and predominant mode of work both in the organized as well as in the unorganized sectors. MMH, being a strenuous work involving lifting of heavy load manually, carrying that load for a considerable distance most often create serious pressure on the musculoskeletal system. Musculo Skeletal Disorders (MSDs) are the leading causes of disability of the people during the working years.

In the present investigation a comparative study was conducted among 25 randomly selected male fixed load handling workers and 25 randomly selected male variable load handling workers of the central market area of Kolkata. The methodology, which was undertaken to carry out this study, was the questionnaire analysis, assessment of physiological parameters and statistical analysis.

From the results, it was evident that the fixed load lifted from the platform was much less than the variable load lifted from the ground. However, the frequency of fixed load lifting was much greater than that of the variable load lifting. It was found that an alarming proportion of the MMH workers suffer from work-related pain mostly affecting the leg, neck and low back regions. Their rigorous work schedule clearly exemplifies the high incidence of musculoskeletal disorders among the MMH workers.

Key words: MSD, MMH, fixed load, variable load.

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INTRODUCTION

MANUAL Material Handling (MMH) is the commonest concern in our daily life. We lift, carry, push, pull while moving, packing or storing various sorts of objects. The objects may be bulky or small, smooth or with sharp edges, of varied shapes. Handling of these materials occurs occasionally or repeatedly during leisure activities or as a part of occupational work. According to the reports of Sen et al (1975)1, Modi (1986)2, Kogi & Sen (1987)[3], one may find more than 70% of the total population of India engaged directly in MMH.

There are a number of variations in the way a load is being handled. The lifting of load may be from floor or from higher or lower level than the floor. Besides, the lifting may be symmetrical. Not all the process of handling materials of various shapes and sizes have equal effect on human body, while some methods of load handling turns out to be less strenuous and physiologically economical than others.

Forces produced during various process of material handling e.g. pulling, pushing, lifting etc. are normally sensed by a person and maintained within the safe mechanical limits of the tissues involved. But in certain condition, these forces produced may be much above the normal tolerance level of the person. This may be either due to improper handling or due to too much heaviness of the load. Whatever may be the reason, improper material handling results in Musculo-skeletal Disorder. According to Levy (2000)[4], occupationally caused or aggravated MSDs rank first among the health problems in the frequency with which they affect the quality of life.

The purpose of the study is to evaluate the prevalence of MSDs among the MMH workers engaged in lifting variable load and fixed load.

METHODS

25 male workers involved in handling variable load manually and another 25 male workers involved in handling fixed load manually at the central market area of Kolkata were randomly selected for this study. The ages of the subjects of both the groups vary within a wide range of 15-55 years. All the subjects of both the groups had a minimum working experience of at least 1 year.

The methodology, which was

undertaken to carry out this study, was questionnaire analysis, assessment of physiological parameters and proper statistical analysis.

QUESTIONNAIRE METHOD

Modified Nordic Questionnaire was used for this study (5). The questionnaire constitutes a series of objective questions with multiple-choice responses. The questions were grouped into the following major sections dealing with:

- Physical parameters of the workers;
- Occupational backgrounds;
- Subjective symptoms from the musculoskeletal system OR detailed questions on work-related pain.

Each subject was approached by the experimenter for explaining the aim of study in a layman's term. Only on acceptance from the subject, the interview started on the basis of the questionnaire.

ASSESSMENT OF PHYSICAL PARAMETERS

The heights and weights of the subjects who participated in the study were recorded with the help of an anthropometer, a measuring tape and a weighing machine respectively.

The filled-up questionnaires were then put to critical analysis. From the data collected, the following parameters were calculated:

a) Body Mass Index (6)

b) Body Surface Area (7)

OCCUPATIONAL BACKGROUNDS

This portion of the questionnaire dealt with the questions on the number of years associated with the investigating occupation, the period of work performed everyday and number of working days in a week.

DETAILED QUESTIONNAIRE ON WORK RELATED PAIN

In this part of the questionnaire, the participants were interviewed about any kind of discomfort felt in the body such as hands, wrist, shoulder, neck, low back, leg etc. while lifting heavy loads (during work) and also during rest. They were also asked whether they experienced pain or any other kind of discomfort.

ASSESSMENT OF PHYSIOLOGICAL PARAMETERS

a) A stopwatch was used to measure the heart rate just after work by 10 beats method.

b) The blood pressure was measured by the help of sphygmomanometer and a stethoscope just after work.

STATISTICAL ANALYSIS

Student "t" test was performed among the fixed load handling workers and variable load handling workers to find out whether there is any significant difference in between the physical parameters as well as in between the physiological parameters at $p < 0.05$ (8).

RESULTS

From the questionnaire, it was found that:

i) Average duration of work is 12 hours per day.

ii) All the subjects work throughout the week (all 7 days).

When asked about the "work-rest cycle", no clear answer was given except that, they took rest only between two working periods. But it is certain that there is no specific work-schedule maintained by the subjects.

The physical characteristics of the workers of both groups were shown in Table-I. No significant difference in physical characteristics was observed in between the two groups.

Table-II represented the heart rate and blood pressure of the workers of both groups, where significant difference was found in between the physiological parameters of both the groups.

The frequency of lifting per day & the quantity of load raised per lift from the platform and from the ground were shown in Table-III. In both the cases a highly significant result was observed.

The discomfort feeling involving different body parts of the workers was shown in Table-IV.

The relationship between the number of years in the present occupation and the prevalence of musculoskeletal disorder (MSD) of the workers was shown in Table-V.

Table-VI represented the relationship between the age of the workers and the prevalence of musculoskeletal disorder (MSD).

DISCUSSION

From the analysis of results it was revealed that there was no significant difference in between the physical characteristics of both the groups. This clearly indicates that the groups belong to identical socio-economic condition (Table-I).

From Table-II it was observed that there existed a significant difference between the heart rate and blood pressure measured just after work among the workers. The probable reason behind this result is that the variable load handling workers lift enormous load at a time (100.4 kg/ lift) compared to the load (50 kg/lift) lifted by the fixed load handling

workers. For this purpose, the variable load handling workers require a much greater effort resulting in enhanced heart rate and blood pressure.

From Table-III it was evident that the frequency of fixed load lifting (243.8 times/day) from the platform was significantly higher than the frequency of variable load lifting (97.4 times/day) from the ground. On the contrary, it was also observed that the fixed load lifted from the platform (50 kg/lift) was significantly lesser than the variable load lifted from the ground (100.4 kg/lift). This clearly suggests that as the fixed load lifting worker lifts lesser load from the platform, he can perform the lifting act a much greater number of times throughout the day and vice versa. Thus it can be assumed that the work-related stress developed in both the groups is somewhat identical.

The questionnaire analysis revealed that an alarming proportion of the variable load handling workers suffered from work-related pain or discomfort mostly affecting the neck (88%), low back (84%) and leg (72%). It was also noted that the fixed load handling workers felt discomfort mostly at the shoulder (48%) and low back regions (48%). This clearly indicates that the mode of load carrying exerts tremendous effect on the development of MSD. The worker lifts the variable load from the ground, carries it overhead and to balance it, an enormous pressure is exerted on the neck, the low back and the leg regions resulting in severe discomfort in these regions. On the other hand, the worker lifts the fixed load from the platform and maintains a constant forward bending posture with the load on his back resulting in severe discomfort at the shoulder and low back region (Table-IV).

From Table-V it was observed that with the increase in the years of experience of the workers, there is also a progressive enhancement in the percentage of the workers getting affected with MSD.

It was revealed from Table-VI that as the age of the workers increase, there is a gradual enhancement in the percentage of workers getting affected with MSD.

It can be concluded from the present study that although there exists an identical work related stress in both the variable and fixed load handling workers, a considerable difference in their mode of lifting and load carrying may lead to the development of MSD at different body parts of the workers.

REFERENCES

1. Sen, R.N. & Nag, P.K. (1975) : Work organisation of heavy load handling in India. Journal of Human Ergology (Japan) **4** : 103-113.

2. Modi, H. (1986) : Materials handling equipment. Purchase Magazine, Ross D'ess, Bombay, **9** : 10-22.

3. Kogi, K. & Sen, R.N. (1987) : Third World Ergonomics, International Reviews of Ergonomics (UK.), **1** : 77-118.

4. Levy, B.S. & Wegman, D.H. (2000) . Occupational Health – Recognising and Preventing Work-Related Disease and Injury (4th ed.) : 3-6.

5. Kuorinka, I. Johnson; Kilborn B.; Vinterberg A; Biering, M.; Sorenson, F.; Anderson, G. & Jorgenson, K. (1987): Standardized Nordic Questionnaire for the analysis of musculoskeletal symptoms: Applied Ergonomics : **18** : 233-237

6. Gangopadhyay. S, Ghoshal. G, Das. T. (2002): An Ergonomic Study on MSD and Working Postures of Manual Material Handling Workers in The Central Market Area of West Bengal. : Indian Journal of Occupational and Environmental Medicine : **6** : 225 - 229.

7. Banerjee. S, Sen. RN. (1957): A nomogram for calculating the surface area of the body of Indians. Ind. J. Med. Res.: **45**(1): 33-34.

8. Das, Debojyoti & Das, Arati (1993) : Statistics in Biology & Psychology, Academic Publishers, edition-2nd: 87-102.

TABLE-I

Physical Characteristics of Variable Load Handling Workers (A) and Fixed Load Handling Workers (B)

	AGE (years)			HEIGHT (cm)			WEIGHT (kg)			BMI (kg/m2)			BSA (m2)		
	A	B	Remarks	A	B	Remarks	A	B	Remarks	A	B	Remarks	A	B	Remarks
MEAN	34.8	36.8	NS	167	167	NS	58.5	59.6	NS	21.1	21.4	NS	11.73	1.7	NS
SD	±10.5	±9.2		±5.33	±6.96		±6.57	±11		±2.4	±3.91		±0.12	±0.16	

TABLE-II

Heart Rate and Blood Pressure of Variable Load Handling Workers (A) and Fixed Load Handling Workers (B) just after work

	HEART RATE (beats/min)			SYSTOLIC PRESSURE (mmH g)			DIASTOLIC PRESSURE (mmHg)		
	A	B	REMARKS	A	B	REMARKS	A	B	REMARKS
MEAN	115.7	98.4	S $P < 0.001$	121	118	S $P < 0.001$	80.6	78.2	S $P < 0.05$
SD	7.67	7.61		5.53	6.24		4.16	3.5	

TABLE-III

Frequency of Lifting per day and load raised Per Lift of Variable Load Handling Workers (A) and Fixed Load Handling Workers (B)

	FREQUENCY OF LIFTING (per day)			LOAD LIFTED (kg/lift)		
	A	B	REMARKS	A	B	REMARKS
MEAN	97.4	243.8	S ($P < 0.001$)	100.4	50	S ($P < 0.001$)
SD	±14.4	±10.1		±13.7	0	

TABLE-IV

Discomfort Feeling at Different Body Parts of Variable Load Handling Workers (A) and Fixed Load Handling Workers (B)

BODY PARTS	NUMBER OF SUBJECTS AFFECTED		PERCENTAGES (%) OF SUBJECTS AFFECTED	
	A	B	A	B
NECK	22	18	88	27
SHOULDER	7	12	28	48
HAND & WRIST	3	4	12	16
LOW BACK	21	12	84	48
LEG	18	9	72	36

TABLE-V

Relationship Between Years of Experience and Prevalence of Musculo Skeletal Disorders among the Variable Load Handling Workers (A) and Fixed Load Handling Workers (B)

YEAR OF EXPERIENCE (years)	NUMBER OF SUBJECTS		NUMBER OF SUBJECTS AFFECTED		PERCENTAGES (%) OF SUBJECTS AFFECTED	
	A	B	A	B	A	B
BELOW 5	4	1	1	0	25	0
5 -15	11	10	6	4	54.5	40
16 - 25	8	12	6	8	75	66.7
26 - 35	2	2	2	2	100	100

TABLE-VI

Relationship Between the Age and Prevalence of Musculo Skeletal Disorders among the Variable Load Handling Workers (A) and Fixed Load Handling Workers (B)

AGE GROUP	NUMBER OF SUBJECTS		NUMBER OF SUBJECTS AFFECTED		PERCENTAGES (%) OF SUBJECTS AFFECTED	
	A	B	A	B	A	B
15 - 24	4	3	2	0	50	0
25 -34	8	4	5	2	62.5	50
35 - 44	6	12	4	7	66.7	58.3
45 - 54	7	6	6	5	85.7	83.3

DIVERSITY OF ORNAMENTAL FISHES IN INDIA: PROSPECTS AND POTENTIALITIES IN EARNING FOREIGN EXCHANGE

Partha Bandyopadhyay [1], and Bidhan C. Patra [1]*

ABSTRACT

Aquarium fish forms an important component of fisheries; provides aesthetic requirements and upkeeps the environment. The world trade of ornamental fish has been estimated to the tune of US$ 6 billion and striding further, with an annual growth rate of about 10% per year. Indian water possesses a rich diversity of ornamental fish, with over hundred varieties of indigenous species in addition to a similar number of exotics. Though the country possesses vast resources in terms of natural water bodies and species diversity we have a great potential to increase the level of export of about US $ 30 million. The export from India is mainly confined to freshwater indigenous varieties and is limited to the fishes from the North Eastern states (85%) and a few breed varieties of exotic species (15%). In spite of the availability of rich ichthyofauna in and around coral reef areas of Lakshadweep, Andaman and Nicobar islands and Mandapam, the country could not make any headway in export of marine ornamental fishes so far. It is again important' to adopt a rational exploitation strategy from natural freshwater resources where the indigenous varieties are available. Considering the high potentials of ornamental fishes in India, it is imperative to provide a great R & D support for booning the sector.

Key words: Ornamental fish, diversity, indigenous species, export potential

INTRODUCTION

ORNAMENTAL fish farming and trade are gaining greater attention in recent years, as the world turnover in this industry has exceeded more than 10,000 crores annually. Our neighboring countries like Singapore and Sri Lanka are known to produce and export ornamental fishes worth of 2,100 crores rupees annually. However,

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India's contribution to the international export market is alarmingly very poor and is only about one crore rupees per annum (Jamson and Santhanam, 1999). Our fertile and pollution free aquatic habitats harbour a variety of ornamental fishes though; their collection, farming and trade have not hitherto been intensified. This could possibly be due to the lack of awareness in ornamental fish farming technologies, although in many cities and towns, aquarium keeping has emerged as a valuable hobby from time immemorial (Mills and Vevers, 1982).

Commercial ornamental fish culture only generates revenue and foreign exchange but also create employment opportunities for both urban and rural folks (Bandyopadhyay and Patra, 2002). Technical advances in the commercial ornamental fish production have taken place during the past 40 years. Suitable technologies for the mass production of egg – laying and live – bearing fishes have also been developed recently. For proper water quality maintenance, flow through systems has also been developed. Due to these, the world ornamental fish industry has steadily grown over the years. Gradually, more and more entrepreneurs are showing interest in this area.

Ornamental fishery is an important trade, which, despite the potential to provide a considerable amount of foreign exchange, it has been underutilized in India. Indian seas and freshwater bodies have vast resources of ornamental fishes, and their commercial value is also large (Swain and Bandyopadhyay, 2002). The country's ornamental fish trade is only rupees 2.3 crores against the world trade of US$ 650 billion (Swain et al., 2001). Today ornamental fishery is recognized as a viable economic activity. It gives a lot of employment and plays a vital role in the socio-economic development of the country. Recently, ornamental fishery has become an alternative means of employment. In the last four to five years, it has grown tremendously. If given the required importance, the industry has the potential to become one of the major industries in the future.

INDIAN ORNAMENTAL FISHES, WIDE VARIETIES, UNIQUE FEATURES FOR FOREIGN EXCHANGE

Indian ornamental fishes with their brilliant colours and unique features need no introduction to the world market. The freshwater and brackish water bodies and the seas around the Indian subcontinent abound in attractive varieties which are dearer to the hobbyists the world over. India exports over 300 varieties of fresh water ornamental fishes today. The tropical ornamental fishes from North Eastern and Southern

provinces of India are in great demand in the hobbyists market. Export of marine ornamental fishes is yet to take off from India (Swain et al., 2001). Prominent among the freshwater Indian ornamental fishes are loaches, eels, berbs, catfishes, gobys, etc.

India also exports tank-raised varieties of fishes such as gold fish, mollys, guppys, platys, sword tails, tetras, angles, gouramis, African cichlids and fighters. Different colours with various patterns of fishes are the essence of these varieties. A few varieties of Indian ornamental fishes that are being exported are given in Table 1.

FRESH WATER ORNAMENTAL FISHES FROM INDIA AND THEIR EXPORT POTENTIAL

Freshwater ornamental fishes have far better demand in the world market than sea ornamentals, which continue to be marginal importance despite the greater interest in their breeding (Butcher, 1992). Indian water possesses a rich diversity of freshwater ornamental fish and they can breed in captivity. Further, the vastness of the country's natural resources in comparison to those of potential countries like Indonesia, Malaysia, Sri Lanka, Singapore and many African countries offers great scope for exploitation as also possibilities for commercial production. The areas around seven sister-states in North-East of India also possess innumerable varieties of freshwater ornamental fishes (Ponniah and Sarker, 2000).

A wide range of freshwater ornamental fishes, ranging from cheap guppies to costly neon tetras is being breed by aquaculturists in India. Berbs are the most important group and most species of the group are known to have originated from India. Rosy barb (Puntius conchonius), tiger barb (Puntius tetrazona), striped barb (Puntius aequipinnatus), zebra danio (Branchydanio aebalineatus) are the typical example of ornamental fish species of Indian origin, which are bred and reared easily (Jameson et al., 1995). The species, *Betta splendens,* commonly called as Siamese fighting fish, occurs in varied colours like green, red, blue, albino and sometimes with a combination of two or three shades which are widely available throughout India and has a greater export value. Live bearers, though originated in Central America, are widely distributed in India. Breeding of most of the live bearers is relatively easy (Swain and Bandyopadhyay, 2002) and their export demand is very high.

MARINE ORNAMENTAL FISHES AND THEIR EXPORT POTENTIAL IN INDIA

Our coastal waters form a rich abode

of an extremely varied ichthyofauna. Coral reefs and lagoons of islands abound in most fascinating species. Vizhinjam, the seas around Lakshadweep and Minicoy islands on the western side and Andaman and Nicobar islands on the eastern side team up with innumerable varieties of colourful marine ornamental fishes like clown fishes, marine angles, squirrels fishes, surgeon fishes, trigger fishes, damsel fishes, butterfly fishes, parrot fishes, rabbit fishes, pipe fishes etc. The Central Marine Fisheries Research Institute (CMFRI) reports that India is a sleeping giant considering the vast untapped potential for marine ornamental fish exports. These fish varieties are distributed in the coral islands of the Andaman and Nicobar Islands, as well as Lakshadweep. Marine ornamental fishes are highly priced and much sought after and it is estimated that the trade in this field can grow to be about US $ 50 millions a month to facilitate and foster the export of ornamental fishes from India. The Vizhinjam center of CMFRI has launched extensive research programmes involving 60 species of marine ornamental fishes. The development of a technology to hatchery breed clown fishes is a breakthrough considering the great demand for tropical marine fish species the world over. The achievement of Sri Lanka in this regard was noteworthy and India should learn a lesson from this island country (Anon, 1999). With this objective in mind, Indian Council of Agricultural Research (ICAR) is making a detailed survey of marine ornamental fishes available in India, investigating the suitability of different species for aquaculture, and is making active research on hatchery production of important species for enhancing foreign exchange. In order to expand its operations in the ornamental marine fish breeding programme, CMFRI plans to extend such studies to other areas of including Kozhikode and Mandapam (Anon, 1999), which have existing facilities.

WORLD TRADE OF ORNAMENTAL FISHES

The world trade of ornamental fish has been estimated to the tune of US$ 4.5 billion in 1995 (Swain et al., 2001) and striding further, with an annual growth rate of about 10 percent per year. It is estimated that 8% (7.2 million houses) of the estimated 90 million houses in USA keep fish in the houses.

European Union is the second largest market with over 3.2 million houses possessing aquaria. Keeping aquarium is most popular in Netherlands, which is the largest market of the European Union countries and 20 % of the Dutch houses keep aquaria in their houses. Japan is the third largest market constituting around 10 % (1.2 million

houses) of her population of 120 million. At present, more than 65 % of the total export trade of aquarium fishes is from Asian countries. The countries with maximum contribution to world market during 1994 were Singapore (30.0 %), Hong Kong (7.6 %), Thailand (7.0 %), Indonesia (6.9 %), Philippines (5.1 %), Malaysia (3.3 %) and Japan (2.5 %). It is reported that only Singapore is earning Rupees 2000 crore from this trade. Even our neighboring countries like Sri Lanka is earning about 100 crore annually. India's earning is less than 1 crore rupees per year. If India utilizes this large diversity and huge potentiality of ornamental fishes, we may top the five countries in the next four to five years.

FUTURE PROSPECTS OF ORNAMENTAL FISH TRADE FROM INDIA TO WORLD MARKET

Because India possesses vast resources in terms of natural water bodies and species diversity and having a congenial environmental condition of tropical and subtropical climate in the country favouring the growth and general upkeep of fish health, we have a great potential to increase the level of export of about US $ 30 million (about 110 crore) every year (Swain et al., 2001; Swain and Bandyopadhyay, 2002). Further systematic studies on the biology of the most of the varieties of ornamental fish are yet to be made. It is again important to adopt a rational exploitation strategy from natural freshwater resources where the indigenous varieties are available. The strategy should be made on propagation of some of the colourful varieties of ornamental fishes in captivity after knowing their exact feeding habit, biology. Further, it is necessary to create infrastructure along with the associated requirements which is stated below:

- Technical experts are necessary to be set up for mass production of ornamental fishes
- Small-scale production capacities need to be provided with necessary support facilities for enhancing output.
- Ornamental fish culture needs to be treated at per with agriculture sector with similar facilities, and concessions must be available to them.
- Health centers for quarantine certification at key locations to meet the desired standards need to be set up.
- Training programmes on different aspects of ornamental fishes by resourceful organizations for long and short duration

depending on the clientele groups and importers should be arranged.

Information on export potential and possibilities, transporting, packaging, climatic condition of importing countries and their needs must be available to the farmers.

Presently, the private entrepreneurs and village backyard units as commercial enterprises are coming up for ornamental fish production (Swain and Bandyopadhyay, 2002). With the growing interest of the farmers and the entrepreneurs especially among unemployed youth for establishment of small scale units of ornamental fish, this activity will soon occupy a significant position in the fisheries sector, booning their livelihood and also enhancing economic development of the country. Marine Products Export Development Authority has introduced a package on development assistance for the promotion of export of ornamental fish from the country.

CONCLUSION

As far as India is concerned, rapid development in ornamental fish farm would be a boon to the national economy. Ornamental fish farms including hatcheries have now been put up by some selected business houses to diversify their activities. This may continue and more ornamental fish farms may be set up on specific regions selectively for marine, brackish water and also freshwater ornamental fishes. This approach would help us to identify many more useful ornamental fishes for our natural environments and multiply them suitably, so that India can come up and compete internationally in this trade.

ACKNOWLEDGEMENTS

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REFERENCES

Anon. (1999). Knowhow for hatchery production of Clown fish. *The Business Line,* December 3, 1999, 16 p.

Bandyopadhyay, P., Patra, B. C. (2002). . Life bearing ornamental fish breeding can improve the livelihood of poor rural people in India: a new approach for rural socio-economic development. To be published in Abstract in 35th Annual Conference of the Indian Anthropological Society entitled "Rural Development: Biological and Social Indicators" during 19-21 September, 2002 at Vidyasagar University, Midnapore, West Bengal. Pp 19

Butcher, L. (1992). Manual of ornamental fish. *British Small Animal Veterinary Association Publication,* Gloucestershire, 200 p.

Jameson, J. D., Srinivasar, A. and Venkataramanujam, K. (1995). Ornamental fish culture technology, *Tanuvas Publication,* Chennai, 103 p

Mills, B. and Vevers, G. (1982). Tropical aquarium fishes. *Salamender Books Limited,* London, 208 p

Ponniah, A. G. and Sarker, V. K. (2000). Fish biodiversity of North-East India. *National Bureau of Fish Genetics Resources,* Lucknow, 228 p

Swain, S. K. and Bandyopadhyay, P. (2002). Commercial live bearing ornamental fish breeding: a beginners delight. *Fishing Chimes,* 22 (3): 56 - 60.

Swain, S. K., Jena, 1. K. and Ayyappan, S. (2001). Major commercial ornamental fish, their trade and market potential. In. *Compedium of Lectures Ornamental Fish Breeding and Culture,* CIFA, Bhubaneswar, 1- 6 P

Table 1. Few species of export potential Indian ornamental fishes

Acauthocobitis botia
Acanthophtbalmus kuhlii
Amblyceps mangois
Amblypharyngodon mala
Anabas teuudinens
Anguilia benoensis
Aorichthys aor
Aplocheilus panchax
Aplocheilus blocki
Aplocheilus lineatw
Badis badis
Barbus schberii
Barilius bakeri
Barilius hama
Barilius canarensis
Barilius gatensis
Bardius shacra
Batasio travancoria
Botia acanthocobitis
Botia lobachata
Botia rostrata
Botia striata
Botio Dario
Brachirris sp
Brachydanio albolineatus
Brachydanio rerio
Cassocheduslatius
Chaca chaca
Channa amphibia
Chnnna barca
Channableheri
Channa gachua
Channa marulius
Channa orientaus
Channa punetatw
Channa stewartii
Channa striatus
Chanda baculis
Chanda nama
Chanda ranga
Chanda wolfi
Chichlasoma meeki
CLuius batrachus
Colisa chuna
Colisa fasciata
Colisa labiosw
Colisalalius
Colisa sofa
Ctenops nobilis
Oanio devario
Oanio malabaricus
Oanio neaglierriensis
Oatniodes quadrifasciatus
Elcotris marmoratus
Etroplus maculatus
Etroplus surantensis
Esomus danricus
Gagata cenia
Garra bughl
Goblus sandanundio
Gonoproctoptems - curmuca
Gyptothorax cavia
Hara horai
Horabagrus nigricollaris
Harabagarus brachysoma
Labeo boga
Labeo boggut
Labeo calbasu
Labeo dyocheilus
Labeo robita
Laguvia shawl
Laubuca dadibur Jori
Laubuca laubuca
Lepidocephalus guntea
Lycodontis tile
Macrognathus aculeatus
Macropodus cupuanus dayi
Mastacembelus aculeata
Mastacembelus armatus
Mastacembelus pancalus
Monoterus cuchia
Monotetrus travancorieus
Mystus gulio
Mystus montanus
Mystus tengara
Mystus vittatus
Nandus nandus
Nangra itchkeea
Noemacheilus botia
Noemacheilus carica
Ncomacheilus savona
Neomacheilus beavani
Neoma cheilusscaturigina
Notopterus notopterus
Puntius sophore
Puntius stigma
Puntius tambrapamel
Puntius vittatus
Rashora danicomus
Rasbora maculata
Rhinomugil corsula
Rita fila
Rohtee alfrediana
Schismatorhynchus nukta
Scisor rhapdophorus
Sctaophagus argus
Sctophagus rubrifrons
Sillaginopsis panijus
Stigmatogobius sadanundio
T etradon cutcutia
Tetradon steindachneri
Tor khudree
Tor mussullah
Toxotes aculator
Trichogaster leeri
Wallago attu
Xenentodon cancilla

ENVIRONMENT AND DEVELOPMENT: A THEORETICAL PERSPECTIVE

Abhijit Guha

ABSTRACT

The paper makes an attempt to examine the three models of development, which have a bearing on environment. The whole question of development needs to be seen from an ecological perspective. A balanced and sustainable course of development requires a holistic approach. The paper suggests a policy guideline for environment and development.

INTRODUCING THE PROBLEM

THE issue of environment and development is an old one, at least as old as the devastations caused by periodic draughts and floods to human societies in many parts of the globe. Human beings viewed nature both as ultimate source of sustenance to all living organisms as well as an all-powerful agency capable of destroying any human made structure. The industrial society started to visualise nature or environment as an unlimited reservoir of material wealth that can satisfy growing human needs with appropriate technological innovations. The result of this vision was, of course, rampant exploitation of the environment in Europe and its colonies in Asia, Africa and Latin America. The reaction to industrialism also developed within the very heart of the industrial countries - Great Britain, France, Germany and United States of America through the writings of poets, novelists, philosophers, politicians and not the least, scientists (Guha 2000). The anti-industrial and pro-environmentalist thinking which had a long history and tradition in the non-western world flourished in the form of anti-colonial freedom struggles in the third world countries. The independent countries of the third world, however, took up the path of industrialisation in the name of modernisation arod rapid economic growth. The growing population figures triggered by a decline in mortality rates received greater attention from the planners and policymakers of the newly independent countries rather than the devastations caused to the

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environment through the adoption of macroeconomic growth model. For example, in India the economic planners emphasised more on big dams, application of chemical fertilizers and other industrially produced technological means for higher agricultural production. The question of land and water pollution as well as declining agricultural production within the success zone of Green Revolution came to the notice of our planners through an informed press and the brilliant works done by some environmental NGOs. The issue of environment and development has now justifiably become environment versus development (Nagarik Mancha 1997). This is the wider context of our discussion on environment and development. In the following section we would discuss about the various meanings and models of development propounded by the different schools of thought in human history.

THE THREE MODELS OF DEVELOPMENT

In the biological sciences the word 'development' is often linked with 'growth'. In this sense, development means certain characteristic changes in body and/or mind of an individual leading to a particular stage in the life-cycle of a living organism That is why, a biologist talks of 'adolescent development' or a psychologist discusses about 'sexual development'. But a biologist also talks about 'evolutionary development' which means a kind of linear movement from simple to complex. Within the life-cycle of an individual organism, while 'growth' simply means a physical increment in length or size, 'development' implies a higher level of complexity in terms of division of labour among organs and their coordination.

PRODUCTION MODEL

The nineteenth century social evolutionists took up the biological analogy and placed human societies on an evolutionary scale where "simple" societies were "less developed" and "complex societies" were "more developed". There was also an idea of progress cherished by the nineteenth century scholars. According to them, Euro-American societies stood at the pinnacle of technological, social and moral progress because they were most developed. And the key to this development was superior technology which helped them to exploit nature to satisfy ever-increasing human needs. This was the philosophy behind industrialism. It viewed nature or environment either as a passive entity or an infinite reservoir of raw materials to be exploited and given shape to finished goods sold in the market. To put the matter in a simplistic manner, the nineteenth century growth-oriented model of progress placed all its emphasis on production and technology. Neither

social arrangements nor environment had any place in this scheme of development (See Fig. 1).

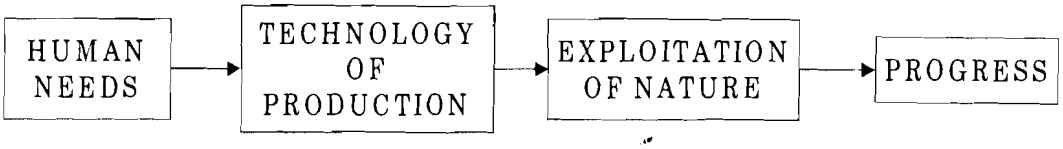


Fig. 1. PRODUCTION MODEL OF DEVELOPMENT

grew through the writings of the socialist thinkers, particularly Karl Marx and Friedrich Engels. In this model the major emphasis was given on relations of production rather than only on production. According to Marx, it is the social arrangements which indicate the level of development of a particular type of social formation. In this model, progress does not mean more growth with higher level of technology but a better distribution of wealth across the different groups of people living in the same society. It was believed that a more equitable distribution of wealth and resource would result in a harmonious relation with nature. (See Fig. 2)

DISTRIBUTION MODEL

The second model of development

The distribution model like the production one also paid a major emphasis on technology of

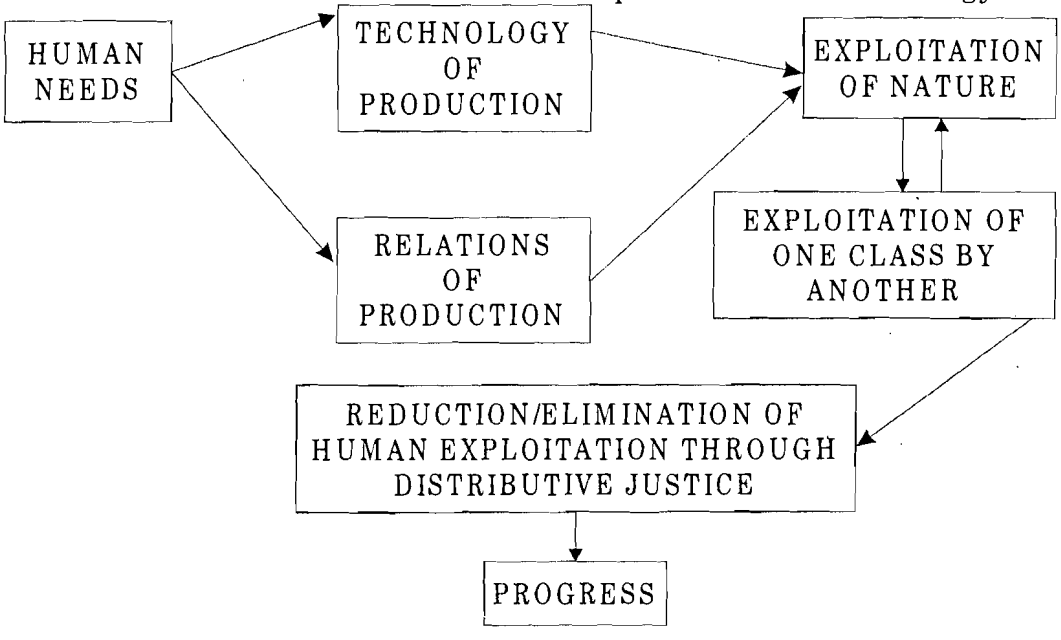


Fig. 2. DISTRIBUTION MODEL OF DEVELOPMENT

production. Environment in this model too was given a backseat.

CONSUMPTION MODEL

The third model of development arose as a reaction to the production model of the capitalist system. This model rejected the production view of development. According to this model, there are two major ways to affluence. One was to meet the ever-increasing needs of human societies with more and more goods and services. The other way to affluence was to cut down the needs and level of consumption to achieve plain living. One can still remain affluent without being rich. Mahatma Gandhi believed in this model of development. His philosophy of non-violence and panchayati raj is closely related with the curtailment of material comforts in human life. In the third model, equitable distribution of wealth, participatory and local level democracy and living in harmony with nature through non-violence are intimately interrelated in a holistic framework (see Fig. 3).

A comparison of the three models of development reveals their

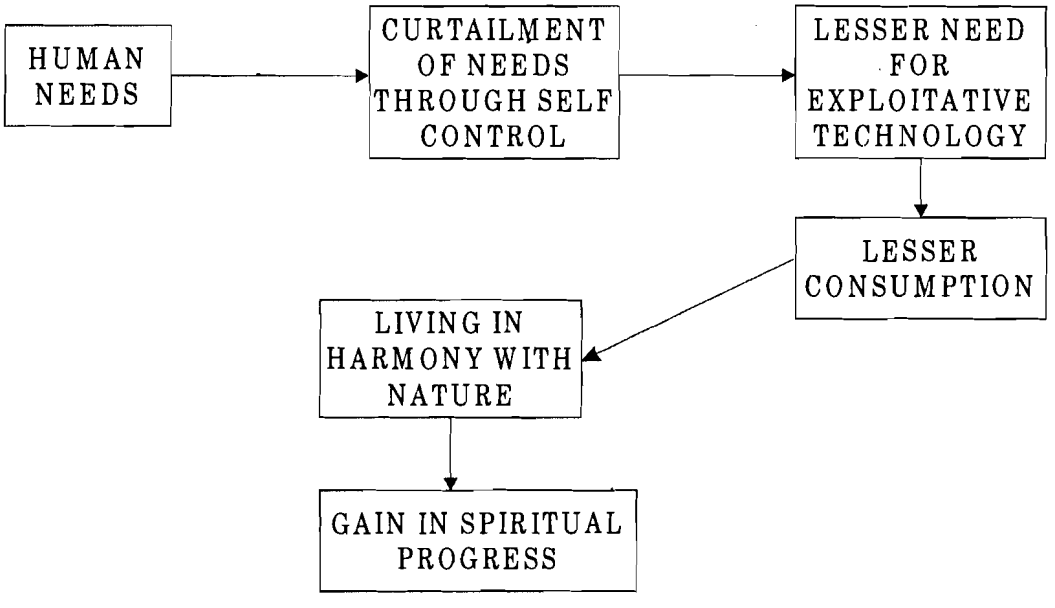


Fig. 3. CONSUMPTION MODEL OF DEVELOPMENT

contradictory as well as conciliatory elements. Among the three, the third model placed a major importance to the relationship between human beings and nature while the first two models gave most of their emphasis

on production. Quite interestingly, in post-Independent India all the three models of development have made their complex interplay at the level of policymaking and implementation. In the next section, we would make an attempt to sketch the relationship between the basic features of environment and the three models of development.

THE BASIC FEATURES OF ENVIRONMENT AND THE THREE MODELS OF DEVELOPMENT

Environment in ecology is defined in relation to living organisms. Within the realm of ecological science nature is incomplete without plants, animals and micro-organisms. Anthropological ecology has brought humans at the centre of any ecosystem analysis. The very definition of environment is therefore holistic. Environment is everything that surrounds living organisms. Theoretically speaking, environment has no boundary. But for all practical purposes boundaries are drawn around ecosystems, although in reality they are open systems having interconnections with other such systems. Viewed from this angle, forests, tribal peoples and forest policy of a country are interacting elements of the same ecosystem whose dynamics depend upon the interplay among trees, people and the government. The second important feature of environment relates to the maintenance of equilibrium at least for some period of time. Ecosystems are characterised by stability and this has immense policy implications. Any developmental input is bound to alter the nature of inter-dependence of the parts of the ecosystem. If ecosystems are perturbed beyond their limits it causes strains and may ultimately damage the whole system.

The third feature of environment is just the opposite of the second one. Environments also change and lose their equilibrium (See Fig. 4).

This, of course, does not mean that new equilibrium can never be

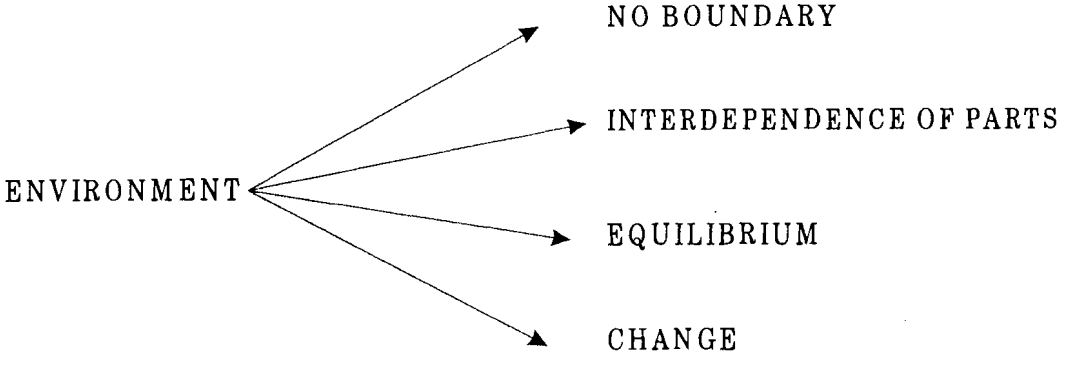


Fig. 4. *FEATURES OF ENVIRONMENT*

reached. Very often, one ecosystem changes into another. How much of it is beneficial to the living organisms and human beings is basically an empirical problem which has to be observed in each case. The complexities of this problem is multiplied in case of human societies since human groups vary tremendously in terms of their access to nature, value systems, class positions, technological level and so on. What is advantageous for one group of human beings may be disastrous to others (Gadgil and Guha 1995). When the entry of nomadic Gujars and their cattles were prohibited in the Rajaji National Reserve Forest it was a success for the Government Forest Department but not for the Gujars. Similarly, when fertile agricultural lands were acquired in Medinipur district by the State Government for the establishment of heavy industries it was a boon for the industrialists, but it had also brought about a series of environmental, economic and political crises for the small peasants and sharecroppers who have been displaced from their main source of livelihood. Examples may be multiplied but the lesson we learn from the relationship between development models and the basic features of environment is clear enough. So, for the production as well as the distribution, models of development did not pay much regard to the balancing and harmonious features of environment. For these two models, environment had to be disturbed in order to achieve development, while the consumption model emphasised the inner controlling mechanisms of the human mind as the key solution to environmental degradation. (See Fig.5).

All the models have shown their difficulties in terms of application.

DEVELOPMENT MODELS	→ GIVE EMPHASIS TO →	FEATURES OF ENVIRONMENT
PRODUCTION MODEL		1. INFINITENESS 2. CHANGE
DISTRIBUTION MODEL		1. INTERDEPENDENCE OF PARTS 2. CHANGE
CONSUMPTION MODEL		1. INTERDEPENDENCE OF PARTS 2. EQUILIBRIUM

Fig. 5. RELATION BETWEEN DEVELOPMENT PARADIGMS VIS-A-VIS THE FEATURES OF ENVIRONMENT.

The capitalist and the socialist countries have not yet been able to solve their own problems of environment and development. The consumption model has not yet been able to make inroads much into the human psyche. Human beings most often are short-sighted. They run after immediate gains and profit. Sustainable development is still the catchword for many, but has not yet become a practising ethic either for the policymakers or for the citizens of a globalised world. In the following section we would discuss about the relationship between environment and development with the help of some specific examples.

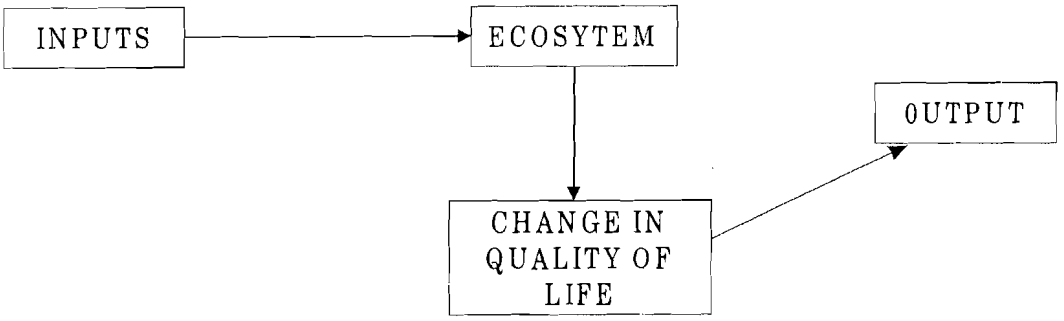
ENVIRONMENT, DEVELOPMENT & POLICY

Basically, development involves giving inputs to a system (a series of interrelated parts) for bringing about a change in the quality of life of the people. *For the anthropologists as well as environmentally oriented planners environment and development without a concern for the different categories of people having differential access to environmental settings has no meaning for a fruitful study of human adaptation to different ecosystem.*

The inputs for development in any human society can be of four basic types which are: (i) resource input, (ii) technological input, (iii) population input and finally, (iv) sociocultural input. This can again be illustrated with the help of the example of agriculture. Agricultural development in any region requires integration of all the above four kinds of developmental inputs in order to run in a balanced and sustainable path instead of a growth oriented trajectory alone. The problem with our policy makers is that they rarely look into agricultural development from this holistic point of view (see Fig. 6).

Development Involves Inputs :
Inputs work upon the ecosystem to bring about change in *quality of life.* The interrelatedness of the components involved is shown below :

Inputs are of 4 basic kinds:
i) Resource Input, ii) Technological



input, iii) Population Input, iv) Social-Cultural Input

Our policy making process should be in this line and it should have also the information backup to achieve its goal.

The case of *common property resources* (CPR) in India can be cited

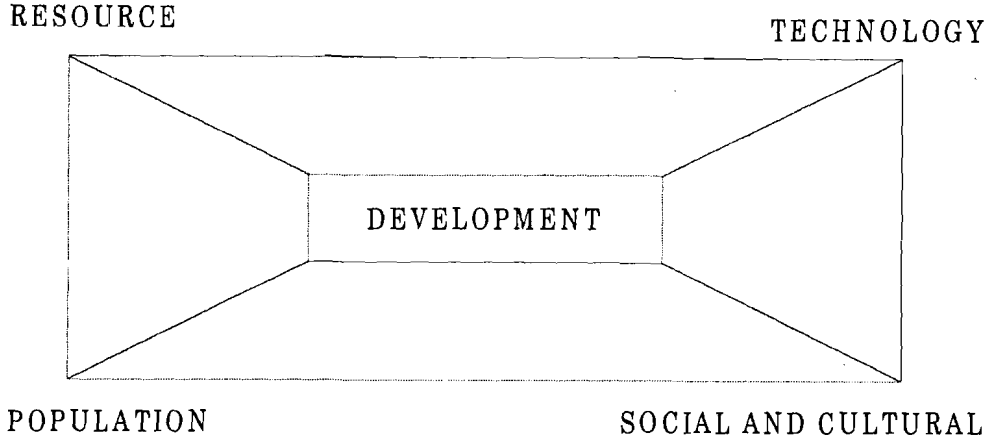


Fig. 6. *A POLICY GUIDELINE FOR ENVIRONMENT AND DEVELOPMENT (A SIMPLIFIED INPUT-OUTPUT MODEL)*

as an example of unsound policymaking by the planners of our country (Guha 1998). It is a fact that over one-fourth of the country's land is common property with open access which anyone from the village or more often from surrounding villages can use About 20 to 30 million people, depend on this land to meet 80 to 90 percent of their fuel, fodder and food needs. And who are these people? They are the poor and the marginalised people of our nation – tribes, lower castes, landless labourers and poor women and children. These natural resources have been subject to maximum degradation owing to the absence of any policy of our government. As a result, the area under common property resource regimes has decreased from 74 million hectares in 1900 to 69 million hectares in 1980. Case studies conducted by the students and teachers of the Department of Anthropology at Vidyasagar University demonstrated that in Medinipur district there are interesting examples of management of common property resources by the villagers themselves. In a village in the Nayagram police station in Jhargram subdivision, villagers over time have been able to enforce some unwritten rules for cultivation in a *char* land (a piece of newly emerged

land in Subarnarekha river). The rule was simple. Farmers were allowed to reclaim arable land on the *char* (which was transferred from an open access natural resource base to a common property resource) only by employing family members. This resulted in an egalitarian distribution of arable land among the villagers inhabited by the families of different caste groups.

Codified Law Versus Unwritten Rules: The Case Of Management Of The Commons By The People Of Dahi At Nayagram

Dahi is not a fictitious name of a village like other classical village names frequently found in the anthropological literature. It is a multi-caste village situated on the bank of the Subarnarekha river bordering the Gopiballavpur block of Jhargram subdivision. After the devastating flood of 1978 in West Bengal, which also affected the Nayagram block, a huge piece of land emerged in the Subamarekha river near Dahi. In Bengali language this type of land is called 'Char'. *Char* land has many interesting socio-political, legal as well as cultural connotations. Firstly, according to law the Land and Land Reforms Department of the Govt. of West Bengal can neither record nor distribute char land before a certain period of time, which is twenty years and even after that period it may take many years for the Department to put this type of land under record. Secondly, it is a matter of common experience that the people living in the vicinity of *chars* begin to use them in a variety of ways ranging from the collection of fuel and fodder to regular cultivation of crops and building of houses. Thirdly, since the rights over *char* land is not being codified in law for a long period of time intense disputes over its use by the individual families and social groups are found to take place quite frequently. These disputes also lead to violent conflicts and char lands can become a perennial source of law and order problem to the local administration. Now both the nature of use and the conflict over the *char* depend upon geographical, socioeconomic as well as political factors. For the local people in general *char* is a new kind of natural resource, which always contain a built-in element of risk and uncertainty. It is a pity that the anthropologists who have done their field researches in West Bengal have not yet paid any attention to the socio-cultural dynamics of *char* land reclamation. Incidentally, unlike the Social Anthropologists, the great novelist Tarasankar Bandopadhaya wrote wonderful accounts of village level family feuds centering round char land in his novels on Bengal villages.

The char, which arose near Dahi, was a semi lunar piece of alluvial land of about forty acres having a slim natural land bridge with the village.

Within a year, a local variety of tall grass started to grow on this land. The villagers, particularly the members of the poorer families began to collect those grasses for the thatching of their huts. There was no dispute or conflict over the collection of this natural resource, which grew abundantly on the *char*. After a few years, some enterprising peasant families started to reclaim portions of the char land by clearing the grass and began to sow paddy seeds and some rabi crops. The yield of the crops was not unsatisfactory and gradually the number of families who undertook *char* reclamation increased. Side by side, smaller disputes and minor conflicts over the establishment of the rights of cultivation on *char* land through reclamation also began to take place. In course of time, this piece of land became a good source of economic support for many families in the different villages of the locality. But this transformation of a *char* land from a natural resource base for the collection of grass to regular cultivation of food and cash crops was not a very peaceful transition. Violent conflicts started to occur and the local panchayat and the political leaders entered into the arena of resource utilisation. Series of meetings at various levels cutting across caste, community and village boundaries were organised and there evolved a set of unwritten rules regarding the use of the *char*. The rules were not only interesting but notably enough, those have also been found to be followed by the local people till the time of the entry of one of our students in Dahi. It would be better if mention the rules and their implications in the following order.

1. Only the people of Dahi were permitted to enjoy the usufructory rights of cultivation on *char* land since it had a physical connection only with this village.
2. The families of Dahi who had lost their arable land in the *char* 1978 were not allowed to reclaim land on the *char* on the apprehension that if permitted, these families might appeal to the court to receive legal entitlements on reclaimed land. The local political leadership at that moment did not want to invite legal dispute on the use of *char* land.
3. No family was permitted to reclaim land on the *char* through the employment of wage labour although during different stages of agriculture one was allowed to do it. (Guha, 1997).

The common element of all these three rules can be phrased by the single word "exclusion" which served two purposes, viz., (i) minimization of conflict and legal disputes and (ii) imposition of a constraint upon relatively wealthy families while they reclaim land on the *char* for cultivation. We studied the impact of these unwritten rules in 1988 by collecting data on the pattern of landholding of the families who

cultivated on the *char* land. Our survey revealed that out of sixty households, 95 per cent could reclaim only 0.5-1.00 acres of land. The pattern of recorded landholding of all the households of Dahi showed a far greater range containing 36 per cent households owning 2.6-4.1 acres of arable land. The rules of exclusion had protected the poor and the less powerful families on the *char*, which was transformed from an open access resource to common property resource by the villagers themselves who rescued it from the "tragedy of the commons".

REFERENCES

Guha, R.	2000	*Environmentalism: A Global History*. Oxford University Press
Gadgil, M. and R Guha,	1993	*This Fissured Land: An Ecological History of India*. pp. 1-68. Oxford University Press.
Gadgil, M and R. Guha	1995	*Ecology and Equity: The use and abuse of nature in contemporay India*. pp.9-33. Penguin Books.
Guha, A.	1997	Society, Culture and Natural Resource: Case studies on Tribal and Caste Villages of Medinipur, West Bengal. In *Environment and Society*. Edited by P. Basu. Reliance Publishing House: New Delhi
Guha, A.	1998	Common Property Resources. *Frontier*. Vol. 31. No. 13, October 25-31.
Nagarik Mancha	1997	*Bipanna Paribesh Nagarik Mancha, Kolkata*.

OBESITY AMONG PUNJABIS OF KHARAGPUR TOWN : SEX DIFFERENCES

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ABSTRACT

A cross-sectional study of 445 adult (> 20 years) migrant Punjabi (191 males; 254 females) resident, in Kharagpur town, West Bengal, was undertaken to investigate sexual dimorphism in anthropometric characteristics and levels of overall and central obesity. The mean age of both sexes were similar (males = 38.3 years, s.d. = 11.7; females = 36.5 years, s.d. = 11.4). Results revealed that there existed significant sex differences in all anthropometric characteristics except calf (CC) and hip (HC) circumferences. Males had significantly greater mean height, weight, sitting height (SH), sub ischial leg length (SLL), mid upper arm (MUAC), waist (WC) and thigh (TC) circumferences, and waist-hip ratio (WHR). However, females had significantly greater ($t = 2.77$; $p < 0.01$) mean overall adiposity (body mass index, BMI) compared to males. While the frequency of undernutrition (BMI < 18.5) was similar in both sexes (males = 15, 7.9%; females = 20, 7.9%), there were significantly ($c2 = 11.1$, $p < 0.025$) more women (n = 55, 21.7%) who were obese (BMI ³ 30) when compared with men (n = 22, 11.5%). Moreover, significantly ($c2 = 111.6$; $p < 0.0001$) more women (n = 179, 70.5%) were centrally obese compared to men (n = 38, 19.9%).

This study could provide evidence that there existed significant sexual dimorphism in several anthropometric characteristics. In addition, significantly more women were found to be obese, both overall as well as centrally, compared to men.

INTRODUCTION

OBESITY is becoming a worldwide phenomenon affecting all levels of society and is being described as an epidemic (World Health Organization, 1998; Kopelman, 2000). The prevalence of obesity has increased over the last decade in both developed and developing countries (Delpeuch and Maire, 1997; Flegal et al., 1998). In the former, the decline in physical activity and the excessive

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consumption of high-fat diets are thought to be major contributors (James and Ralph, 1999). In the latter, the same causes are possibly operating due to urbanization, ageing of the population, improvement in socioeconomic standards and Westernization in terms of food processing, dietary habits and lifestyles (Ghebremenskel and Crawford, 1994; Popkin, 1998, Doll et al., 2002).

Body mass index (BMI = weight (kg) / height (m)2), a weight-for-height index, has been widely used to measure obesity in adults worldwide (Bray et al., 1998; WHO, 1995; 1998). BMI is a proxy measure for total body fat (Doll et al., 2002). In adults, BMI cut-off points of 25 and 30 are widely used to define overweight and obesity (WHO, 1998; Wang and Wang, 2002). In addition, the ratio of waist to hip circumference or waist-hip ratio (WHR) is frequently used as an index for abdominal adiposity (Bose and Mascie-Taylor, 1998; Bose and Das Chaudhuri, 2001; Ghosh et al., 2001, 2003; Doll et al., 2002).

Extensive studies have been carried worldwide to record the prevalence of obesity among different ethnic groups (WHO, 1998; Gutierrez-Fiscal et al., 2000; Liese et al., 2001; Lasky et al., 2002). There are several recent studies on adults (Dudeja et al., 2001; Khongsdier, 2001; Shukla et al., 2002; Reddy et al., 2002; Lubree et al., 2002; Venkataramana and Reddy, 2002) which have investigated the levels of overall (BMI) and central obesity (WHR) among various ethnic groups of India. However, such investigations in West Bengal are limited to the Benaglee ethnic group (Ghosh et al., 2000, 2001; Bose and Das Chaudhuri, 2001). Information on the frequency of obesity based on both total as well as central fat, among different ethnic populations resident in urban West Bengal, is lacking (Ghosh et al., 2003). The present study has attempted to study sex differentials in anthropometric characteristics and obesity status of ethnic Punjabis of Kharagpur town, West Bengal.

Specifically, the present study on Punjabis in Khargapur had two objectives:

1) To investigate sexual dimorphism in anthropometric characteristics,

2) To evaluate sex differentials in the frequency of obesity.

MATERIAL AND METHODS:

Subjects:

The sample size consisted of 445 adult (> 20 years) migrant Punjabis (191 males; 254 females) resident in Kharagpur town. The subjects were selected by random sampling method. Information on their age and ethnicity were obtained from specific questions included in the

questionnaire. All subjects were required to complete a signed consent form and questionnaire. The mean ages of both sexes were similar (males = 38.3 years, s.d. = 11.7; females = 36.5 years, s.d. = 11.4).

Anthropometric measurements:

All anthropometric measurements were made by trained investigators (NY and SR) using standard techniques recommended by Lohman et al (1998). Measurements included height, weight, sitting height (SH), and mid upper arm (MUAC), waist (WC), hip (HC), calf (CC) and thigh (TC) circumferences.

The following derived variables were also studied:

1) Body mass index (BMI, kg/m2) = Weight (kg) / Height2 (m2).
2) Waist - hip ratio (WHR) = WC / HC.
3) Sub-ischial leg length (SLL, cm) = Height (cm) - Sitting height (cm).

EVALUATION OF OBESITY STATUS:

Obesity status of the subjects was evaluated using standard BMI and WHR cut-off points. The following cut-off points were used:

A) Using BMI (WHO, 1998):

Category	BMI (Kg/m2)
Undernutrition	< 18.5
Normal	18.5 - 24.9
Overweight	25 - 29.9
Obese	³ 30

B) Using WHR (Wildman and Medeiros, 2000):

Category	Males	Females
Normal	£ 0.95	£ 0.80
Centrally obese	> 0.95	> 0.80

STATISTICAL ANALYSES

Sexual dimorphism in anthropometric characteristics were evaluated using Students' t Test. Significant sex differences in the frequency of obesity were determined utilising the chi-square test. Statistical significance was set at $p < 0.05$. All statistical analyses were performed using the Statistical Package for Social Science (SPSS-PC).

RESULTS

The means and standard deviations of the anthropometric characteristics of the subjects are presented in **Table 1**. Results revealed that there existed significant sex differences in all anthropometric characteristics except CC and HC. Males had significantly greater mean height ($p < 0.001$), weight ($p < 0.001$), SH ($p < 0.001$), SLL ($p < 0.001$), MUAC ($p < 0.005$), WC ($p < 0.001$), TC ($p < 0.005$) and WHR ($p < 0.001$). However, females (25.6 kg/m2) had significantly greater ($t = 2.77$; $p < 0.01$) mean total body fat (BMI) compared with males (24.3 kg/m2).

Table 2 presents the nutritional status of the subjects based on their BMI values. While the frequency of undernutrition (BMI < 18.5) was similar in both sexes (males = 15, 7.9%; females = 20, 7.9%), there was significantly more women (n = 55, 21.7%) who were obese (BMI ³ 30), when compared with men (n = 22, 11.5%). The number of individuals who were overweight (men = 26.7%; women = 29.9%) was similar in both sexes. The sex difference in frequency of obesity was statistically ($c2 = 11.08141$; $p < 0.025$) highly significant.

Evaluation of central obesity status among the subjects revealed significant ($c2 = 111.6198082$, $p < 0.0001$) sexual dimorphism **(Table 3).** Significantly more women (n = 179, 70.5%) were centrally obese compared to men (n = 38, 19.9%).

DISCUSSION

This study showed that there existed significant sexual dimorphism in several anthropometric characteristics among adults Punjabis of Kharagpur. Similar sex differences have been reported among adult Bengalees (Ghosh et al., 2001). Although there are several reasons, this dimorphism is primarily due to differences in levels of hormones, particularly sex hormones, present in the two sexes. Further investigations are needed to fully understand the mechanism and dynamics of sexual dimorphism. These studies should aim at investigating the relationship between adiposity and hormones.

The extent of obesity (measured by BMI) observed in this population was significantly higher among women. There could be many probable

reasons for this, the most prominent being the lack of physical activity as well as increased dietary fat intake among women. Recent studies from other developing countries (WHO, 1998; Doll et al., 2002; Lasky et al., 2002) have also reported that women had significantly higher rates of obesity than men. However, such trends are not always observed in developed countries where some studies (Gutierrez-Fisac, et al., 2000; Doll et al., 2002) have reported higher rates of prevalence of obesity among men.

Using WHR as a measure of central adiposity, this study demonstrated that there existed significant sexual dimorphism in the frequency of central obesity, with significantly more women being centrally obese. The extent of central obesity (increased WHR) was much higher than overall obesity (increased BMI), in both sexes, implying that although many individuals did not have excess total body fat, they had exaggerated fat deposition in the abdominal region of the body. This finding is similar to that of Doll et al. (2002). This finding is also consistent with the observation (Singh et al., 1996; Bose, 1997; Bose and Mascie-Taylor, 1997) that Indians (in native India as well as migrant Indians elsewhere), in general, do not have excess total body fat, but have enhanced fat accumulation in the abdominal region.

Studies similar to the present one should be undertaken among other ethnic populations resident in rural as well as urban West Bengal. These investigations should give new insight into the prevalence of obesity among these populations. It is now well documented (Valdez et al., 1993; WHO, 1998, Kopelman, 2000) that obesity, especially abdominal obesity, is associated with increased risk for coronary heart disease (CHD), non-insulin dependent diabetes mellitus (NIDDM) and other chronic diseases. Effective health promotion programmes can be formulated to reduce the prevalence and incidence of obesity and associated diseases based on the findings of these studies. Such programmes would be beneficial in controlling the menace of chronic diseases like CHD and NIDDM. India is a country with vast ethnic heterogeneity and studies on different ethnic groups (Venkataramana and Reddy, 2002; Bose and Das Chaudhuri, 2001; Ghosh et al., 2000; 2003) have found different, though not always contradictory, results regarding the health risks of overall and abdominal obesity. Therefore, care should be taken to conduct "ethnic-specific" studies since the causes of high prevalence of obesity are multifactorial.

In summary, the main conclusions of this study were that there existed:

1) Significant sexual dimorphism

in several anthropometric characteristics,

2) No sexual dimorphism in the level of undernutrition,

3) Significantly more women were in the obese, category as indicated by BMI as well as WHR, and

4) The presence of a much higher central obesity than that of excess total body fat in both sexes, particularly among women.

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REFERENCES

Bose, K. (1997). Coronary Heart Disease Among Migrant South Asians in Britain: An Overview. *J. Ind. Anthropol. Soc.*, **32:** 269-275.

Bose, K. and Das Chaudhuri, A.B. (2001). A comparative study of adiposity and central fat distribution of normotensive and hypertensive older Bengalee Hindu women of Calcutta, India. *Coll. Antropol.* **25:** 521-527.

Bose, K. and Mascie-Taylor, C.G.N. (1997). Interrelationships of Age and the Body Mass Index with Risk Factors of Non-Insulin Dependent Diabetes in European and Migrant Asian Males. *Am. J. Hum. Biol.*, **9:** 291-296.

Bose, K. and Mascie-Taylor, C.G.N. (1998). Conicity index and waist-hip ratio and their relationship with total cholesterol and blood pressure in middle-aged European and migrant Pakistani men. *Ann. Hum. Biol.*, **25:** 11-16.

Bray, G.A., Bouchard, C. and James, W.P.T. (1998). *Handbook of Obesity.* New York: Marcel Dekker.

Delpeuch, F. and Maire, B. (1997). Obesity and developing countries of the south. *Med. Trop.*, **57:** 380-388.

Doll, S., Paccaud, F., Bovet, P., Burnier, M. And Wietlisbach, V. (2002). Body mass index, abdominal adiposity and blood pressure: consistency of their association across developing and developed countries. *Int. J. Obes.*, **26:** 48-57.

Dudeja, V., Misra, A., Pandey, R.M., Devina, G., Kumar, G. And Vikram, N.K. (2001). BMI does not accurately predict overweight in Asian Indians in northern India. *Br. J. Nutr.*, **86:** 195-112.

Flegal, K.M., Carroll, M.D., Kuczmarski, R.J. and Johnson, C.L. (1998). Overweight and obesity in the United States. *Int. J. Obes. Relat. Metab. Disord.*, **22:** 39-47.

Ghebremeskke, K. and Crwaford, M.A. (1994). Nutrition and health in relation to food production and processing. *Nutr. Health*, **9:** 237-253.

Ghosh, A., Bose, K. and Das Chaudhuri, A.B. (2000). Comparison of anthropometric characteristics between normotensive and hypertensive individuals among a population of Bengalee Hindu elderly men in Calcutta, India. *J. R. Soc. Health,* **120:** 100-106.

Ghosh, A., Bose, K. and Das Chaudhuri, A.B. (2001). Age and sex variations in adiposity central fat distribution among elderly Bengalee Hindus of Calcutta, India. *Ann. Hum. Biol.*, **28:** 616-623.

Ghosh, A., Bose, K. and Das Chaudhuri, A.B. (2003). Association of food patterns, central obesity measures and metabolic risk factors for coronary heart disease in middle aged Bengalee Hindu men, Calcutta, India. *Asia Pac. J. Clin. Nutr.*, **12:** 166-171.

Gutierrez-Fisac, J.L., Banegas, J.R., Artalejo, F.R. and Regidor, E. (2000). Incrreasing prevalence

of overweight and obesity among Spanish adults, 1987-1997. *Int. J. Obes. Rel. Metab. Disord.*, **24:** 1677-1682.

James, W.P. and Ralph, A. (1999). New understanding in obesity research. *Proc. Nutr. Soc.* **58:** 385-393.

Khongsdier, R. (2001). Body mass index of adult males in 12 populations of Northeast India. *Ann. Hum. Biol.*, **28:** 374-383.

Kopelman, P.G. (2000). Obesity as a medical problem. *Nature,* **404**: 635-643.

Lohman, T.G., Roche, A.F. and Martorell, R. (1988). *Anthropometric Standardization Reference Manual.* Chicago: Human Kinetics Books.

Lasky, D., Becerra, E., Boto, W., Otim, M. and Ntambi, J. (2002). Obesity and gender differences in the risk of type 2 diabetes mellitus in Uganda. Nutrition, 18: 417-421.

Liese, A.D., Doring, A., Hense, H.W. and Keil, U. (2001). Five year changes in waist circumference, body mass index and obesity in Augsburg, Germany. Eur. J. Nutr., 40: 282-288.

Lubree, H.G., Rege, S.S., Bhat, D.S., Raut, K.N., Panchnadikar, A., Joglekar, C.V., Yajnik, C.S., Shetty, P. And Yudkin, J. (2002). Body fat and cardiovascular risk factors in Indian men in three geographical locations. *Food Nutr. Bull.* **23:** 146-149.

Popkin, B.M. (1998). The nutrition transition and its health implications in lower-income countries. *Pub. Health Nutr.* **1:** 5-21.

Reddy, K.S., Prabhakaran, D., Shah, P. And Shah, B. (2002). Differences in body mass index and waist hip ratio in North Indian rural and urban population. *Obes. Rev.* **3:** 197-202.

Shukla, H.C., Gupta, P.C., Mehta, H.C. and Herbert, J.R. (2002). Descriptive epidemiology of 880.

Singh, R.B., Mori, H., Chen, J., Mendis, S., Moshiri, M., Zhu, S., Kim, S.H., Sy, R.G. and Faruqui, A.M. (1996). Recommendations for the prevention of coronary artery disease in Asians: a scientific statement of the International College of Nutrition. *J. Cardiovasc. Risk,* **3:** 489-494.

Valdez, R., Siedell, J.C., Ahn, Y.I. and Weiss, K.M. (1993). A new index of abdominal adiposity as an indicator of risk for cardiovascular disease: A cross-population study. *Int. J. Obes.*, **17:** 77-82.

Wang, Y. and Wang, J.Q. (2002). A comparison of international references for the assessment of child and adolescent overweight and obesity in different populations. *Eur. J .Clin. Nutr.,* **56:** 973-982.

Wildman, R.E.C. and Medeiros, D.M. (2000). *Advanced Human Nutrition.* Boca Raton: CRC Press.

World Health Organization (1995). *Physical Status, the use and interpretation of anthropometry.* WHO Technical Report Series No. 854. Geneva: WHO.

World Health Organization (1998). *Obesity: preventing and managing the global epidemic.* Report of a WHO Consultation on Obesity. Geneva: WHO.

Table 1: Sexual dimorphism in Anthropometric characteristics among migrant Punjabis of Kharagpur Town.

Variable	Males (n = 191)	Females (n = 254)	t	p <
Height (cm)	169.2 (6.3)	153.8 (6.4)	25.3	0.001
Weight (kg)	69.6 (13.7)	60.4 (12.3)	7.47	0.001
Body mass index (kg/m2)	24.3 (4.4)	25.6 (5.2)	- 2.77	0.01
Sitting height (cm)	86.2 (6.0)	79.4 (3.8)	13.72	0.001
Sub ischial leg length (cm)	82.9 (5.9)	74.4 (4.6)	16.67	0.001
Mid upper arm circumference (cm)	27.1 (3.7)	25.9 (3.6)	3.29	0.005
Waist circumference (cm)	89.3 (11.7)	82.8 (13.1)	5.44	0.001
Hip circumference (cm)	98.9 (10.5)	98.7 (11.9)	0.22	n.s.
Calf circumference (cm)	32.3 (3.8)	31.7 (3.9)	0.76	n.s
Thigh circumference (cm)	44.7 (6.6)	42.9 (5.7)	2.91	0.005
WHR	0.90 (0.05)	0.84 (0.06)	12.19	0.001

n.s. = not significant.

Table 2: Sex differences in Nutritional Status using BMI categories

Sex	Undernutrition (BMI < 18.5)	Normal (18.5-24.9)	Overweight (25-29.9)	Obese (BMI ³ 30)
Male (n = 191)	15 (7.9)	103 (53.9)	51 (26.7)	22 (11.5)
Women (n = 254)	20 (7.9)	103 (40.6)	76 (29.9)	55 (21.7)

Percentages are presented in parentheses.

Sex Difference:
c (3) = 11.08141; p < 0.025.

Table 3: Presence of Central Obesity among the Subjects

Sex	Normal	Centrally Obese
Males (n = 191)	153 (80.1)	38 (19.9)
Females (n = 254)	75 (29.5)	179 (70.5)

Percentages are presented in parentheses.

Sex Difference:

c (1) = 111.6198082; p < 0.0001.

RELATIONSHIP BETWEEN ABO AND Rh (D) BLOOD GROUPS AND FERTILITY AMONG THE BENGALEE POPULATION

Ashish Mukhopadhyay [1]
and
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ABSTRACT

This study investigates the effects of ABO and Rh (D) incompatibility on fertility among 86 families belonging to Bengalee Hindu Caste Population of the Madhyamgram area, North 24-Parganps, West Bengal, India. Analysis of data shows differences in human fertility between compatible and incompatible matings in the ABO and Rh (D) systems and a selective loss of pregnancy wastage in certain type of matings although the difference is not significant. The ratios of pregnancy wastage per living children for ABO and Rh (D) compatible and incompatible mating groups vary markedly. The frequency of different forms of reproductive wastage viz. miscarriages, spontaneous abortions and still births are analyzed with respect to blood group compatibility and incompatibility.

INTRODUCTION

AMONG the various blood group polymorphisms known in humans, the ABO and Rh (D) systems bear great significance. Landsteiner (1900; 1901) recognised the existence of A, B and O blood groups in humans. Later on a fourth blood group, the AB blood group discovered by DeCastello and Sturli (1902). Dungern and Hirszfeld (1910) showed their pattern of inheritance to be Mendelian. Forty years after the discovery of the ABO blood group system, the Rh blood group was discovered by Landsteiner and Weiner (1940). The existence of differences in the allele frequencies of the ABO blood group system opened up new horizons of research in anthropology. The distribution of blood groups among various populations have been extensively studied.

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Later on, the nature of selection and polymorphism in the ABO and Rh (D) blood group systems also gained in importance when their involvement in incompatibility selection was established. This selection helps in maintaining the polymorphism and also influences fertility. It has also been established that the mating type of the couple plays a great role in assessing the effects of compatibility and incompatibility selection. Studies on fertility include those of Matsunaga and Itoh (1958), Hiraizumi (1964) and Clegg (1979). In India, blood groups and fertility differential have been extensively studied (Chakravartti and Chakravartti 1978; Satyanarayana et al. 1978; Jindal and Basu 1981).

The present study is an attempt to examine the effects of ABO and Rh (D) compatibility and incompatibility selection on fertility in order to understand the effects of selection operating at the prenatal stage of the Bengalee Hindu Caste Population (BHCP) of Madhyamgram area of North 24 Parganas, West Bengal.

Material and Methods

The data in the present study consist of 86 families (397 individuals – 196 males and 201 females) belonging to the BHCP residing at the Madhyamgram area, North 24-Parganas, West Bengal, India. Though very few families with one child were included in the study, those with multiple children were selected at random. The field study was carried out during the period of May - October 1998. Requisite information on fetal loss (miscarriage, induced and spontaneous abortion, and still birth) and postnatal death including neonatal death were collected through personal interviews. Fetal deaths occurring after 7 months of gestation were classified as stillbirths while those occurring between 6 weeks and 7 months of gestation were termed as miscarriages. Deaths occurring within 1 week after birth were called neonatal deaths while those after 1 week were called postnatal deaths.

The ABO and Rh (D) blood groups were determined by the standard method of Boorman and Dodd (1957). Blood was collected by finger prick method using sterilized needles in vials containing anti-coagulant (EDTA) and transported to the laboratory. The blood groups determined were A, B, O and AB in the ABO system and D in the Rh system for parents and offspring. During collection of blood, data on reproductive performance and other associated biosocial parameters of the couples were noted.

The sample was divided into 2 broad categories according to compatibility and incompatibility. These were further subdivided into 4 groups, i.e., CC [compatible for both ABO and Rh (D) blood groups], IC [incompatible

for ABO, compatible for Rh (D) blood groups], CI [compatible for ABO, incompatible for Rh (D) blood groups] and II [incompatible for both ABO and Rh (O) blood groups]. Necessary statistical tests were performed as per requirements. Statistical significant level was considered as $p < 0.05$.

Results

A summary of the reproductive performance of the families in each mating type from ABO compatible and incompatible matings is shown in the Table I. There were a total of 39 compatible matings with 80 living children and 47 incompatible matings with 129 living children. The numbers of prenatal deaths recorded in compatible matings were less than half than those recorded in incompatible matings. The total prenatal and postnatal loss was 53 in incompatible matings (65.43%) and 28 in compatible matings (34.57%).

Reproductive performance and pregnancy wastage by mating status of the couple is presented in Table II. The total number of pregnancies for ABO compatible and incompatible matings was 108 and 182 respectively. The same was 277 and 13 respectively for the Rh (O) blood group. The ratio of pregnancy wastage per living children was greater for both ABO (0.41) and Rh (D) (0.62) incompatible matings groups. The mating types were further classified into CC, IC, CI and II types and the data on reproductive performance and pregnancy wastage presented in Table III. The total pregnancy wastage in CC and IC mating types were almost similar (26.92% and 27.75% respectively). However, in the II mating type, the total pregnancy wastage was considerably quite higher (55.56%). No pregnancy wastage was recorded under the CI mating type for the present sample.

An outline of reproductive wastage in each mating type under compatible and incompatible matings for both the ABO and the Rh (D) systems are shown in Table IV. The total number of fetal wastage recorded were 57. of which 28 (49.12%) were miscarriages, 21 (36.84%) were spontaneous abortions, 1 (1.75%) was categorized under induced abortion and 7 (12.28%) were still births. When the interactions between the ABO blood group and the Rh (D) blood group was considered, the cases of fetal wastage were 18 (31.58%), 34 (59.65) and 5 (8.77%) under CC, IC and II matings types respectively.

The mean distribution of pregnancies and children in ABO mating types is presented in Table V. The mean number of pregnancies in case of compatible matings was lower than that in case of incompatible matings (2.11 and 4.50). This difference was statistically significant ($t = 3.340$, d.f.

84; $P < 0.05$). The mean number of children in case of compatible matings was also lower at 1.59, while in case of incompatible matings, it was higher at 3.20. In this case, the differences were statistically significant ($t = 3.007$, d.f. 84; $P < 0.05$).

Discussion

Family studies in India and other countries have reported contradictory results, some showing effects of blood group incompatibility through differential fertility while others showing no such effect (Matsunaga and Itoh 1958; Hiraizumi 1973; Chakravartti and Chakravartti 1978). The occurrence of reproductive wastage in ABO and Rh (D) incompatibility have been supported by Cohen (1970), Takano and Miller (1972), Lauritsen et al. (1975), Satyanarayana et al. (1978), Clegg (1979) and Banerjee (1989), all of whom showed significantly higher incidence of reproductive failure in the incompatible mating group.

The present study shows differences in pregnancy wastage in different mating types (Table I). The incidence of prenatal death was higher (68.42%) in case of incompatible matings than in compatible matings (31.58%). A larger share of pregnancy wastage was recorded in case of incompatible matings (65.43%) as compared with compatible matings (34.57%). A selective pressure operating through materno-fetal incompatibility has thus been observed in the present sample.

The present study provides some additional information for the occurrence of materno-fetal incompatibility involving ABO and Rh (D) blood groups (Table II). The incidence of pregnancy wastage for both ABO and Rh (D) mating types were greater in case of incompatible matings than compatible matings. But the difference was not statistically significant in both the cases [chi square value (d.f. = 1) = 0.345, $p > 0.05$ and chi square value (d.f. = 1) = 0.751, $p > 0.05$ respectively]. The incidence of ABO incompatibility, however, was found to be much higher among couples compared to the findings of Nag and Banerjee (1976).

The frequency of loss of living children has been calculated by taking the difference in the ratio of pregnancy wastage per living children (Table II). The ratios of pregnancy wastage per living children for ABO incompatible and compatible matings were 0.41 and 0.35 respectively. The former was greater than the latter by a value of 6 per 100 living children. For the Rh (D) system, the ratio of pregnancy wastage per living children were 0.62 and 0.38 for incompatible and compatible matings respectively. In this case, the former was greater than the latter by a value of 24 per 100 living children. It reveals that the

operation of selection in human reproductive performance and pregnancy wastage was more effective for Rh (D) blood group than for ABO blood group. The number of pregnancies were higher for both ABO and Rh (D) blood groups in case of incompatible matings (Table III). This table also reveals that the number of matings, living children, prenatal deaths and postnatal deaths were higher in case of incompatible matings for both ABO and Rh (D) blood groups.

There was a higher incidence of prenatal deaths in incompatible than in compatible mating group in the present study (Table IV). The proportion of miscarriage was greater (49.12%) in the incompatible group followed by spontaneous abortion (36.84%). These are in agreement with the results reported by Mourant et al. (1976) and Banerjee (1989).

Regarding ABO mating types and fertility, there was a significant (t - value = 3.340, d.f. = 84; $P < 0.05$) difference in mean number of pregnancies between compatible and incompatible matings (Table V). This may be due to the fact that selection may occur even at the earliest period of pregnancy. There was also a significant (t - value = 3.007, d.f. = 84; $p < 0.05$) difference in mean number of living children between compatible and incompatible matings. This suggests a greater amount of pregnancy wastage in the incompatible group than in the compatible group.

In conclusion, the study shows higher incidence of reproductive wastage in the incompatible mating group although the difference is not significant. These results are, for the most part, in agreement with those reported by Matsunaga and Itoh (1958), Chakravartti and Chakravartti (1978) and Banerjee et al. (1998). However, they contradict the results of Lauritsen et al. (1975), Satyanarayana et al. (1978), and Clegg (1979). The various interpretations of the observed incompatibility have been discussed. It seems that more than one biological mechanism are involved in each incompatibility.

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REFERENCES

Banerjee, A. R. (1989). Selection and blood group polymorphisms. *Man in India*, **69** : 217-260.

Banerjee, A. R., S. C. Pal and J. Roy (1998). ABO mating and reproductive wastage. *Bulletin of the Department of Anthropology.* Dibrugarh University. **26** : 45-52.

Boorman, K. E. and B. E. Dodd (1957). *An introduction to blood group serology.* London: Churchill.

Boyd, W. C. and L. G. Boyd (1954). The blood groups in Pakistan. *Am. J. Phys. Anthrop.* **12** : 393.

Chakravartti, M. R. and R. Chakravartti (1978). ABO blood groups and fertility in an Indian population. *J. Hum. Genet.* **26** : 133-144.

Clegg, E. J. (1979). Blood groups and reproduction in Hebridean women. *Ann. Hum. Biol.* **6** : 111-127.

Cohen, B. H. (1970). ABO and Rh incompatibility: I. Fetal and neonatal mortality with ABO and Rh incompatibility: Some new interpretation. *Am. J. Hum.* Gent. **22** : 412-440.

DeCastelio A. V. and A Sturli (1902). Uber die Isoagglutinine in serum gesunder und Kranker Menschen. *Miinchen Med. Wchnschr.* (cit. Bhasin et al. 1994).

Dungern, E. von and L. Hirszfeld (1910). Uber Vererbung gruppen-spezifischer strukturen des Blutes. ILl. *Immunitatsforsch.* **6** : 284-292.

Hiraizumi, Y. (1964). Prezygotic selection as a factor in the maintenance of variability. *Quant. Biol.* **29** : 51-60.

Hiraizumi, Y. (1973). Frequency of prenatal deaths and its relationship to the ABO blood groups in man. *Am. J. Hum. Genet.* **25** : 362-371.

Jindal, A. and S. K. Basu (1981). ABO blood group incompatibility differentials in reproductive performance with respect to maternal age and parity among Dawoodi Bohrs of Udaipur, Rajasthan. *Ind. J. Med. Res.* **74** : 688-695.

Landsteiner, K. (1900). Zur Kenntnis der antifermentativen Iytischen and agglutinlerengen Wirkung des Blutserums und der Lymphe. *Zbl. Bakteriol.* **24** : 357-362.

Landsteiner, K. (1901). Uber Agglutinationserschinungen normalen menschlichen Blutes. *Wiener Klin. Wschr.* **14**: 1132-1134.

Landsteiner, K. and A. S. Weiner (1940). An agglutinable factor in human blood recognized by immune sera for rhesus blood. *Proc. Soc. Exper. Biol.* **43** : 223.

Lauritsen, J. G., L. Grunnet and O. M. Jensen (1975). Materno-fetal incompatibility as a cause of spontaneous abortion. *Clin. Genet.* **7** : 308-316.

Majumder, D.N. and C.R.Rao (1958). Bengal Anthropometric Survey 1945 : A Statistical Study. *Sankhya* **19** : 3-4.

Matsunaga, E. and S. Itoh (1958). Blood groups and fertility in Japanese population with special reference to intra-uterine selection due to maternal-fetal incompatibility. *Ann. Hum. Genet.* **22** : 111-131.

Mitra, S. and R. Dutta Chowdhury (1960). A study on the incidence of Rh factor in expectant Bengalee mother with a view to find out its effects on abortion, neonatal death, erythroblastosis foetalis and toxinea of pregnancy. *Ind. J. Med. Res.* **48** : 295-299.

Morton, N. E., H. Krieger and M. P. Mi (1966). Natural selection on polymorphisms in north eastern Brazil. *Am. J. Hum. Genet.* **18** : 153.

Mourant, A. E., A. C. Kopec and K. Domaniewska-Sobczak (1976). *The Distribution of the human blood groups and other polymorphisms.* London: Oxford University Press.

Nag, R. N. and A. R. Banerjee (1976). Unexplained infertility and ABa blood groups incompatibility. *J. Obstet. Gynec. India.* **26** : 285-290.

Roy, M. N., S. Ghosh, D. Mahasaya Roy and P. C. Mitra (1959). Rh-negative note and phenotypes in Bengalees. *J. Ind. Med. Assoc.* **32** : 10-13.

Satyanarayana, M., M. Vijayalakshmi, C. Sambasiva Rao and S. Mathew (1978). ABO Blood Groups and Fertility - with Special Reference to Intrauterine Selection due to Materno fetal Incompatibility. *Am. J. Phys. Anthrop.* **49** : 489-496.

Sen, N. N., C. L. Mukherjee and B. K. Aikot (1959). ABO and Rh (D) blood groups amongst Bengalees. *J. Ind. Med. Assoc.* **33** : 210-213.

Singh, K. S., V. Bhalla and V. Kaul (1994). *The Biological Variations in Indian Populations,* Peoples of India National series. Vol - X, Delhi, Oxford University Press.

Takano, K. and J. R. Miller (1972). ABO incompatibility as a cause of spontaneous abortion: Evidence from abortuses. *J. Med. Genet.* **9** : 144-150.

Valenzuela, C. Y. and Z. Harb (1982). A mother child segregation distortion for the Rh system. New evidence for another compatibility system associated with Rh. *Am. J. Hum. Genet.* **34** : 925.

Valenzuela, C.Y., C. Lyng, .L. Armanet, E. Islas, Z. Harb and M. P. Acuna (1984). Anomalias Segregacionales del Sistema Sanguineo ABO asociadas al Sistema Rh Interpretacion del efecto SAN. *Rev. Med. Chile.* **112** : 213-217.

Virdi, J., N. Mehta and H. Kaur (1994). ABO incompatibility and mother infant segregation distortions in Punjab, North India. *Man. In. India.* **74** : 233-239.

TABLE I: Summary of Reproductive Performances of Families in Each Mating Type from Compatible and Incompatible Matings

Mating types WxH		Total no. of matings	Total no. of living children	Pre-natal death	Post-natal death	Total pregnancy wastage	Total no. of pregnancies
Compatible matings							
O x O		1	1	-	-	-	1
A x O		6	7	1	-	1	8
AxA		-	-	-	-	-	-
B x O		8	15	7	-	7	22
B x B		12	25	5	3	8	33
AB x O		5	12	2	2	4	16
AB x A		3	9	2	1	3	12
AB x B		4	11	1	4	5	16
AB x AB		-	-	-	-	-	-
TOTAL	No.	39	80	18	10	28	108
	%	45.35	38.28	31.58	41.67	34.57	37.24
Incompatible matings							
O x A		9	27	2	5	7	34
O x B		18	50	12	6	18	68
O x AB		3	12	5	-	5	17
A x B		5	13	6	1	7	20
A x AB		2	9	4	-	4	13
B x A		9	14	9	2	11	25
B x AB		1	4	1	-	1	5
TOTAL	No.	47	129	39	14	53	182
	%	54.65	61.72	68.42	58.33	65.43	62.76

TABLE II: Reproductive Performance and Pregnancy Wastage by Mating Status of the Couple

Reproductive Performance and Pregnancy Wastage	Total	ABO		Rh (D)	
		Compatible	Incompatible	Compatible	Incompatible
No. of Matings	86	39	47	80	6
No. of Pregnancies	290	108	182	277	13
Pregnancies per Couple	3.37	2.77	3.87	3.46	2.17
Living Children	209	80*	129*	201 **	8**
%	72.07	74.07	70.88	72.56	61.54
Prenatal Death	57	18	39	52	5
%	19.66	16.67	21.43	18.77	38.46
Postnatal Death	24	10	14	24	-
%	8.28	9.26	7.69	8.66	-
Total Pregnancy wastage	81	28*	53*	76**	5**
%	27.93	25.93	29.12	27.44	38.46
Ratio of Pregnancy Wastage per living children	0.39	0.35	0.41	0.38	0.62

* chi square value (d.f. = 1) = 0.345, P > 0.05.

** chi square value (d.f. = 1) = 0.751, P > 0.05.

TABLE III: Reproductive Performance and Pregnancy Wastage by Mating Status of the Couple

Reproductive Performance and Pregnancy Wastage	**ABa & Rh(D) Compatible [CC]**	**ABO Incompatible & Rh (D) Compatible [IC]**	**ABO Compatible & Rh (D) Incompatible [CI]**	**ABa & Rh (D) Incompatible [II]**
No. of Matings	36	44	3	3
No. of Pregnancies	104	173	4	9
Pregnancies per Couple	2.89	3.93	1.33	3.00
Living Children	76	125	4	4
%	73.08	72.25	100.00	44.44
Prenatal Death	18	34	-	5
%	17.31	19.65	-	55.56
Postnatal Death	10	14	-	-
%	9.61	8.09	-	-
Total	28	48	-	5
Pregnancy Wastage %	26.92	27.75	-	55.56

TABLE IV: Summary of Repproductive Wastage in Each Mating Type from Compatible and Incompatible Matings

Reproductive Wastage	ABO & Rh (0) Compatible [CC]	ABO Incompatible & Rh (0) Compatible [IC]	ABO Compatible & Rh (0) Incompatible [CI]	ABO & Rh (D) Incompatible [II]	TOTAL
Miscarriage	9	16	-	3	28
%	15.79	28.07	-	5.26	49.12
Spontaneous Abortion	6	14	-	1	21
%	10.53	24.56	-	1.75	36.84
Induced Abortion	1	-	-	-	1
%	1.75	-	-	-	1.75
Still Birth	2	4	-	1	7
%	3.51	7.02	-	1.75	12.28
TOTAL	18	34	-	5	57
%	31.58	59.65	-	8.77	100.00

TABLE V : Mean Distribution of Pregnancies and Children

In ABC Mating Types

Mating Types WxH	**No. of matings**	**Total no. of pregnancies**	**Total no. of children**	**Mean No. of pregnancies**	**Mean no. of children**
Compatible Matings					
O x O	1	1	1	1.00	1.00
A x O	6	8	7	1.33	1.17
A x A	-	-	-	-	-
B x O	8	22	15	2.75	1.88
B x B	12	33	25	2.75	2.08
AB x O	5	16	12	3.20	2.40
AB x A	3	12	9	4.00	3.00
AB x B	4	16	11	4.00	2.75
AB x AB	-	-	-	-	-
TOTAL	39	108	80	2.11 @	1.59 #
Incompatible Matings					
O x A	9	34	27	3.78	3.00
O x B	18	68	50	3.78	2.78
O x AB	3	17	12	5.67	4.00
A x B	5	20	13	4.00	2.60
A x AB	2	13	9	6.50	4.50
B x A	9	25	14	2.78	1.56
B x AB	1	5	4	5.00	4.00
TOTAL	47	182	129	4.50 @	3.20 #

@ (t - value 3.340 ,d.t. 84 ; $P < 0.05$)

(t - value 3.007, d.f. 84 ; $P < 0.05$).

A PCR BASED DIAGNOSIS OF GENITAL TUBERCULOSIS FROM MENSTRUAL BLOOD OF INFERTILE WOMEN

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ABSTRACT

A very dependable and less expensive technique has been developed in our laboratory for the identification of *Mycobacterium tuberculosis* from the patients reported as infertile. A large number of people came to the centre for the detection of genetic problems. While studying these patients we noticed that many of them suffered from genital tuberculosis. This was detected through Polymerase Chain Reaction (PCR) technique by isolating DNA from menstrual blood as the sample instead of conventional invasive techniques. Most of the patients were cured after therapeutic intervention. Out of them, some women not only conceived normally after proper treatment, but even gave live births as well. We hope that this new, non-invasive technique will immensely benefit the society particularly the women who have been suffering from tuberculosis-related infertility.

Key Words: *Mycobacterium tuberculosis*, Genital Tuberculosis, IS 6110 Primer, Menstrual Blood, Infertility.

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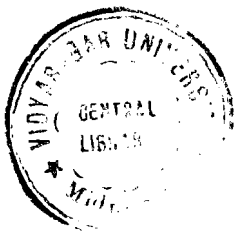

INTRODUCTION

TUBERCULOSIS is a common disease encountered in our country. The disease tuberculosis, which affected human population as early as about 4000 BC, still continues to be a global threat. The present study throws some light on cases of infertility related to Genito Urinary Tuberculosis (GUTB) Genital tract is a common site of extra pulmonary TB (15-20% of extra pulmonary cases), which requires a non- invasive way to detect it. The most common techniques known so far are endometrial biopsy, hysteroscopy, laparoscopy, which are invasive in nature. Instead of such invasive techniques we found menstrual blood to be a good material for detection of genital tuberculosis by first isolating DNA from the sample followed by PCR amplification of DNA with the help of a universally accepted primer (IS 6110) of 123 bp products, which is species specific to *M. tuberculosis*. To the best of our knowledge, the detection of genital tuberculosis from menstrual blood was not known eralier. The importance of this technique lies behind the fact that the true incidence and prevalence of GUTB are difficult to estimate, because a large number of patients remain asymptomatic with respect to genito-urinary tract and the disease is not looked for in asymptomatic patients. The infection usually stays as a silent disease for more than 20 yrs in the woman, who remains in apparently good health. Clinical features usually develop 10-15. yrs. after the primary infection. Only about a quarter of patients with GUTB have known history of tuberculosis, commonest symptom of which is primary infertility (sunmed.org).

Tuberculosis of female genital tract is common among people with pulmonary or other forms of extra genital tuberculosis and it is nearly always secondary to a focus elsewhere in the body. The disease involves kidney, ureter, bladder or genital organs. Genital tuberculosis in females is found in 0.75% to 1% of gynaecological disorders in India (Arora et.al., 1992) with considerable variation from place to place (Varma, 1991). It occurs mostly secondary to pulmonary tuberculosis, commonly

by haematogenous route in a manner similar to spread to other extra-pulmonary sites like urinary tract, bones, joints, etc. However, a few reports have indicated endometrium to be the most commonly involved site (Arora et al, 1992; Varma et al., 1991; Dawn et al., 1998; Weerekiet et al., 1999). The fallopian tubes are affected in almost all the cases, followed by the endometrium, ovaries, cervix, vagina and vulva (Dawn, 1998; Weerakiet et al., 1999; Giannacopoulos et al., 1998; Arora et al., 1994). Infertility, pelvic pain and menstrual disorders like scanty menstruation and amenorrhoea are the usual presentations (sumned.org). Infertility occurs due to pathology in endometrium and fallopian tubes resulting in blockage of ovum transport (Shaefer, 1972; Kumar et al., 1997). An intermittent chronic ache is also reported in lower abdomen. Direct inoculation of *Tubercle bacilli* can also take place over vulva or vagina during sexual intercourse with a partner suffering from tuberculous lesions of genitalia (Arora et al., 2003). An increase in the trend of the disease has been reported, which may be partly due to increase in the population along with overall rise in tuberculosis cases (Weerekiet et al., 1999).

MATERIALS AND METHODS

The infection was detected by Polymerase Chain Reaction (PCR) technique using bacterial DNA from menstrual blood (4-5ml approx.) as the sample. The patient was provided with a sterilized collection tube to collect menstrual blood by herself, preferably first day first discharge. Bacterial DNA was isolated with the help of QIA AMP Blood DNA Kit. Amplification of *M. tuberculosis* was done in a 20 µl reaction mixture that consisted of QIAgen Taq PCR Master Mix (containing Taq Polymerase, Magnesium Chloride (MgCl2), dNTPs and sterile H2O) and IS 6110 primer (Bangalore Genei, India). The insertion sequence of IS 6110 has an important role in diagnostic PCR (Kent et.al., 1996), since it is species specific and found only in *M. tuberculosis* complex group of mycobacterium. Amplification was done in a programmable thermal cycler by allowing an initial denaturation step of 95°C for 3 minutes followed by 30 cycles of: Denaturation at 94.5°C for 1 minute; Annealing at 66°C for 1 minute and Extension at 72°C for 2 minutes. After amplification, PCR products were separated by electrophoresis in 2% Agarose gel containing 0.5 µg/ml Ethidium bromide and visualized on an ultraviolet transilluminator at 302 nm wavelengths. Specific band were observed due to the amplification of 123 bp fragment of the repetitive element IS 6110, indicating the presence of *M. tuberculosis* DNA, whereas no band suggests the absence of *M. tuberculosis*.

RESULTS

Among the 321 cases studied so far over a period of one year, 240 (74.76%) were found to be positive for *M. tuberculosis* (Table I). It was also noticed that majority of the patients belonged to the age groups of 26-30 (26.79%) and 31-35 (26.17%) (Graph I). The patients were treated with AKT4 drug schedule for a span of four months, which is a combination of Rifampicin, Isoniazide Hydrazide (INH), Ethambutol and Pyrizinamide. Most of the patients were cured and till date 17 of them not only conceived normally but 11 women also gave live births after therapeutic intervention.

DISCUSSION

This PCR-based diagnosis of genital tuberculosis from menstrual blood is very sensitive, specific, rapid and highly advantageous due to its non-invasive nature and cost-effectiveness.

In various studies, data show PCR to be sensitive in >90% and specific in >95% compared to culture (37%), bladder biopsy (47%) and Intravenous Urogram (88%). PCR offers accurate clinical assessment, avoids delay in starting treatment (sumned.org) as it takes only about 6 hours. Tuberculosis should be suspected and excluded in every woman whose infertility or amenorrhea is not explained by other causes. Any virgin having signs and symptoms of chronic pelvic infection should be assumed to have tuberculosis until it is proved to be contrary. Pelvic tuberculosis will not disappear unless tuberculosis is completely eradicated and it may crop up at any time in full swing. Now-a-days, the ominous combination of human immunodeficiency virus, tuberculosis and pregnancy poses a new challenge (Tripathy et al., 2003). So all our efforts should be directed towards eradication of this deadly disease, for which, we hope that this new, non-invasive technique will be immensely helpful, especially to the women who are suffering from tuberculosis-related infertility.

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REFERENCES

Arora, V.K., Gupta R. and Arora, R. (2003) : Female genital tuberculosis - Need for more research, *Ind J Tub*. 50: 9-11.

Arora, V.K., Johri, A., Arora, R. and Rajarat, P (1994) : Tuberculosis of the vagina in an HIV seropositive case, *Tubercle Lung Dis*. 75: 239.

Arora, R., Rajaram, P. and Oumachigui, A. (1992) : Prospective analysis of short course chemotherapy in female genital tuberculosis, *Int J Gynaecol Obstet*. 38:

Dawn, C.S. (1998) : Textbook of Gynaecology and Contraception. 9th 311.ed., Calcutta, Arati Dawn, pp-321.

Giannacopoulos, K.C., Hatzidaki, E.G., Papanicolaou, N.C., Relakis, K.J., Kokori, H.G. and Giannacopoulos, C.C. (1998) : Genital Tuberculosis in a HIV infected woman: A case report, *Eur J Obstet Gynecol Reprod Biol*. 80:227.

Kent, L., Mc Hugh, T.D., Billington, O., Dale, J.W. and Gillespie, S.H. (1996) : Demonstration of homology between IS 6110 of Mycobacterium tuberculosis and DNAs of other Mycobacterium sp. *J Clin Microbiol*. 34(5) : 1348-1349.

Kumar, A. and Rattan, A. (1997) : Antigonadotrophic effect of Mycobacterium tuberculosis, *Horm Metab Res*. 29: 501.

Shaefer, G. (1972) : Female genital tuberculosis, *Clin Obstet Gynecol*. 19: 223.

Tripaty, S.N. and Tripathy, S.N. (2003) : Tuberculosis and pregnancy, *Int J Gynaecol Obstet*. 80(3): 247-253.

Varma, T.R. (1991) : Genital tuberculosis and subsequent fertility, *Int J Gynecol Obstet*. 35: 1.

Weerakiet, S., Rojanasakul, A. and Rochanawutanon, M. (1999) : Female genital tuberculosis: clinical features and trend, *J Med Assoc Thai*. 82: 227.

www.sunmed.org : Pelvic tuberculosis.

TABLE I : TOTAL NUMBER OF CASES DIAGNOSED OVER A PERIOD OF ONE YEAR

TOTAL CASES	TB POSITIVE	%	TB NEGATIVE	%	CONCEIVED AFTER TREATMENT	LIVE BIRTHS
321	240	74.77	81	25.23	17	11

GRAPH I : FREQUENCY OF AGE- GROUP WISE DISTRIBUTION AMONG INFERTILE PATIENTS