INTRODUCTION
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Analysis of genetic variation in natural populations of various species is the major thrust of experimental population genetics (Ayala, 1976). The genotypic approach is useful for analysis of association between chromosomal and/or allozyme polymorphism and environmental heterogeneity. The phenotypic approach involves direct study of quantitative eco-behavioural traits. The ecological and behavioural genetics of Drosophila has been analysed by two approaches i.e. the study of flies caught in natural environments in order to correlate species genotypes with the environment; and study of populations under laboratory environmental conditions in order to assess the factors of ecological importance. The later approach has been preferred because of ease of breeding large number of *Drosophila species* in the laboratory for behavioural experiments.

Environmental alcohol in *Drosophila melanogaster* has received much attention because alcohol metabolism is dependent on alcohol dehydrogenase which is polymorphic in most populations. *Drosophila melanogaster* contains two widespread alleles, F and S but with very different frequencies often varying according to latitude (Oakeshott et al., 1981; David, 1982). More active *Adh^f* allele is more abundant in temperate populations while less active *Adh^s* allele predominates in the tropical populations. These two alleles have different biochemical properties and capacities to use alcohols as substrates (Vigue and Johnson, 1973; Day et al., 1974; Alahiotis, 1982).

Many species of family drosophilidae feed on diverse type of fermenting fruits, vegetables, plant types (such as cacti) and even household decaying organic food materials (Carsons, 1971; Atkinson and Shorrocks, 1977). The range of primary and secondary alcohols as by-product of fermentation produced in the environment depends on the type of microflora (Yeasts and other microbes) involved and the types of organic matter undergoing decomposition (Parsons, 1983). *Drosophila* ADH uses several primary or secondary alcohols as substrates (Vigue and Johnson 1973, Day et
al., 1974; Chambers et al., 1978). It is generally found that primary and secondary alcohols are transformed into aldehydes and ketones respectively. Aldehyde is further metabolised into acetate and used in kreb's cycle (Clarke, 1975; David et al., 1976; David 1977; Deltombe Lietaert et al., 1979). On the other hand ketones do not seem to be further metabolised (Papel et al., 1979; Van Herrewege et al., 1980) although some contrary results have been published (Oakeshott, 1977). Moreover, ketones are usually more toxic than the corresponding alcohols. Thus it is quite interesting to predict the utilization of diverse type of alcohols at intra and interspecific level in *Drosophila* species populations collected along north-south axis of Indian subcontinent.

In the wild, alcoholic fermentation is always followed by a bacteria mediated acetic acid fermentation, so that resources became acidic (Parsons 1982; David et al., 1983; Eid-Dib et al., 1993). Ethanol and acetic acid are produced simultaneously and detoxification of these two products seems to occur along the same metabolic pathway leading to acetyl Co-A production although ADH is not involved in acetic acid tolerance. Ethanol adaptation in laboratory has been analysed, while acetic acid adaptation has remained so far neglected (Hageman et al., 1990). So an attempt has been made to analyse acetic acid and alcohol utilization/tolerance levels in different geographical populations of various drosophilids from Indian subcontinent.

Contrary to the earlier views of random mating populations of various drosophilids in a region, some cases of sub-divided or metapopulations under ecological or behavioural conditions have been documented (Spiess, 1989). Comparative studies of natural populations originating from wineries (Where ethanol occurs at high concentration) than surrounding areas (where ethanol concentrations are lower) have revealed higher alcohol tolerance together with higher *AdhF* allele frequency in winery populations of Spanish wine cellar (Briscoe et al., 1975). On the other hand, increased ethanol tolerance was not found to be invariably associated with higher *AdhF* allele frequency in winery populations (Gibson et al., 1981). Thus ethanol appears to be a major selective force in *D. melanogaster*. Micro-differentiation over remarkably short distances
has been observed in *D. melanogaster* due to differential fitness resulting from environmental alcoholic stress. But such studies were lacking in other drosophilids from the Indian subcontinent. Thus, in the present study an attempt has been made to check microspatial differentiation in *D. immigrans* populations within short range distance of about 5km apart.

Availability of resources is variable among localities and seasons whereas the demography principally depends on two parameters i.e. resources and favourable temperature (David et al., 1983, 1984). Water is the most important factor of environment for any terrestrial animal and numerous structural, functional and behavioural adaptations have been described (Edney, 1977). Water balance is maintained by water ingestion and to a lesser degree by metabolic water production. Water loss in nature is usually reduced by a behavioural preference for humid environments. (Perttumen and Salini, 1956, Parsons, 1980). Temperature is also linked to the water balance problem. Starvation tolerance, which depends on the amount of available reserves and especially of lipids (David et al., 1975) could also be related to a lower metabolic rate and to the experimental stress (Hoffmann and Parsons, 1989a). However, starvation tolerance has been mainly investigated for its physiological significance (David et al., 1975, Da Lage et al., 1989) and for comparing artificially selected lines (Service et al., 1985; Service, 1987; Hoffmann and Parsons, 1989 b) while natural populations are poorly documented. Thus, it was considered pertinent to check desiccation and starvation tolerance in natural populations of some Indian drosophilids.

In insects, dispersal is a common phenomenon and many species of *Drosophila* were utilized to study dispersal from the stand point of population ecology as well as population genetics (Dobzhansky et al., 1973). In *Drosophila*, not many studies have been carried out either in wild or in laboratory populations (Parsons and McKenzie, 1972; Parsons, 1983). The complexity of phototactic behaviour was analysed on the basis of response of *Drosophila pseudoobscura* to light (Pettendrigh 1954). Crumpacker and Williams (1973) suggested that dispersal rates of flies might be correlated with habitat differences and genetic
differences in the populations. Light sensitivity also varies according to latitude. Medoni (1958) described an increase in positive phototaxis from tropical Africa to Europe. Some laboratory experiments have been carried out using migration tube system with *D. melanogaster* from which it can be concluded that different strains have differing powers of dispersion (McDonald and Parsons, 1973). Thus, it has been attempted to see rate of dispersion, if any, in different geographical populations of *D. melanogaster* from India.

Genetic analysis of morphological traits, although well documented from many selection experiments, has been rather neglected during the recent years. This seems to be due both to practical and theoretical difficulties. Such traits are often difficult to evaluate with good accuracy and moreover they show continuous variability so that genetic differences are to be described in terms of heritability and polygenes. Morphological differences, in a broad sense, are however the best criteria used by taxonomists for identifying species. From such observations, we can conclude that morphology is always a privileged target for the genetic changes occurring during speciation. Morphological evolution and structural gene evolution can proceed at independent rates (King and Wilson, 1975; Cherry et al., 1978). Temperature and nutrition are the two main factors of environment that influence population differentiation. Resistance to high temperature in *Drosophila* is associated with important traits as fertility and body size (Powell, 1974; Cavicchi et al., 1984). Nutritional effects i.e. poorly fed or crowded larvae produce smaller flies (Bakker, 1961; Robertson, 1963; David et al., 1980). It is also known that flies from European strains are larger in body size than those from tropical strains and that a latitudinal cline is found between Europe and tropical Africa (David and Bocquet, 1975). The adaptivity of the organism to varied environmental factors can be assessed by the common characters which directly influence the physiology of that particular organism and vice versa. Since certain morphological characters like body weight, thorax length, wing length etc. can give us direct information about the physiological and behavioural adaptation of the organism, it is pertinent to check the variation in such morphological traits in relation to environmental factors like temperature,
humidity etc. from Indian subcontinent as different populations of *Drosophila* face heterogeneous environments which can give us direct information about the physiological and behavioural adaptations of different *Drosophila* species.

Genetic control of behaviour is an important variable in the dynamics of natural populations. Genetic response to selection for behavioural traits in *Drosophila* has, however, been demonstrated by Carson, 1971 (Phototaxis); Sokolowski, 1980 (Larval locomotion and feeding); Lee Ehrman, 1981 (Olfaction and sexual selection). Reproductive isolation develops by the gradual accumulation of genetic differences between populations as a by-product of other adaptive or neutral genetic changes in allopatry. Sexual or ethological isolation which is a premating barrier to gene exchange in which opposite sexes of different populations fail to mate due to behavioural incompatibility constitutes the most important class among the different means of reproductive isolation in animal species. It plays an important role in evolution as during the process of speciation the isolated populations diverge genetically because they interact with quite different environments. Some species as *D. pseudoobscura* and *D. melanogaster* do not show significant deviations from random mating among natural populations on the contrary the phenomenon of sexual isolation is widespread in the genus *Drosophila* and has been extensively studied between different populations of certain species such as *D. virilis*, *D. serrata* and *D. paulistorum*. Strong sexual selection but no reproductive isolation was observed in experimental matings between French and Afrotropical populations of *Drosophila melanogaster* (Cohet and David, 1980). During the present studies intraspecific sexual isolation was examined among Indian geographical populations of *D. immigrans*, *D. nasuta-nasuta*, *D. kikkawai*, *D. ananassae* and *D. melanogaster* since information on these species is not available.

It has been widely demonstrated that sexual behaviour of *Drosophila* is under genetic control (Spiess, 1970; Parsons, 1973; Spieth and Ringo, 1983). Although several mutations have been found to affect mating activity in different species of *Drosophila*, the significant variation in mating propensity of wild strains and inversion karyotypes of some species, as well as significant
response to artificial selection for sexual activity, provide evidence for polygenic control of this phenomenon. Selection experiments have been carried out for mating propensity and mating speed in different species of *Drosophila* and significant responses have often been obtained (Manning, 1961, 1963; Mac Bean and Parsons, 1967; Kessler, 1968, 1989). Male activity and female receptivity are the main factors responsible for successful matings in *Drosophila*. The males which inseminate more females in a limited time will contribute more progeny (Fulker, 1966). Thus male mating propensity is an important component of fitness. In some species positive correlation was observed between mating activity and fertility (Fulker, 1966). Parsons (1964) detected significant variation between strains, hybrid vigour and reciprocal effects while studying mating speed in wild laboratory strains of *D. melanogaster*. During the present investigation an attempt has been made to check the correlation between mating activity and fertility in *D. melanogaster* and *D. ananassae* collected along north-south transect of Indian subcontinent.

Studies on biogeography and evolutionary history, ecological, behavioural and quantitative traits were made in Afrotropical and European populations of *D. melanogaster*. Except some data on *D. melanogaster* and *D. ananassae*, there is complete lack of data on ecological and behavioural studies on some drosophilids as *D. ananassae*, *D. bipectinata*, *D. malerkotliana*, *D. melanogaster*, *D. immigrans*, *D. nasuta-nasuta*, *D. kikkawai*, *D. takahashii*, *D. busckii* from the Indian subcontinent. Climatic factors as temperature, humidity, rainfall vary according to latitude/altitude along north-south transect of Indian subcontinent. So geographical populations of *Drosophila species* from latitudinal/altitudinal origin constitute the suitable material for exploring the effect of evolutionary forces on the genetic variability occurring in them. The objectives of the proposed studies are to analyse the nature and magnitude of genetic variability in altitudinal and latitudinal populations of *Drosophila species*. These are summed up as under -
A) **Ananassae Species Subgroup**
1. Latitudinal differentiation of starvation and desiccation tolerance in Indian populations of *Drosophila ananassae*.
2. Intraspecific sexual isolation among natural populations of *Drosophila ananassae*.
3. Latitudinal variation in mating propensity and fertility in different populations of *D. ananassae*.
4. Utilization of diverse dietary alcohols in geographical populations of *Drosophila ananassae*.
5. Morphological, behavioural and physiological adaptations in latitudinal populations of *D. bipectinata*.
6. Ethanol and acetic acid tolerance in different geographical populations of *D. malerkotliana*.

B) **Melanogaster Species Subgroup**
1. Genetic divergence in ADH Polymorphism and utilization of alcoholic resources in Indian geographical populations of *D. melanogaster*.
2. Primary and secondary alcohol utilization in some species of *melanogaster* species subgroup.
3. Analysis of dispersal behaviour in eight populations of *Drosophila melanogaster*.
4. Intraspecific sexual isolation, variation in mating propensity and fertility in latitudinal populations of *D. melanogaster*.

C) **Immigrans Species Subgroup**
1. Alcohol utilization, microspatial differentiation and behavioural divergence analysis in geographical populations of *D. immigrans*.
2. Study of intraspecific sexual isolation in different geographical populations of *D. nasuta-nasuta*. 
D) Other *Drosophila* Species

1. Study of sexual isolation in latitudinal populations of *Drosophila kikkawai*.

2. Geographical divergence for ethanol utilization in *Drosophila takahashii* populations.

3. Larval ethanol utilization in various *Drosophila* species.

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