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Drosophila ananassae Stands Distinct from other Species of *Drosophila* in its Pattern of Chromosomal Polymorphism

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***Abstract: Drosophila*, a genus of family Drosophilidae (Class-Insecta; Order-Diptera) is characterized by rich species diversity containing more than 1500 species. It possesses polytene chromosomes which have been mostly studied from salivary glands and polytene chromosome maps have been prepared for a large number of species. It is known that about 100 species of *Drosophila* contain chromosomal aberrations and thus chromosomally polymorphic. There are different types of chromosomal aberrations but paracentric inversions are more common. There are intra and interspecific variations in the frequencies of inversions and the pattern of chromosomal polymorphism varies in different cases. To explain these findings of different cases different concepts/ hypothesis/ ideas have been proposed by different researchers: ecological niche hypothesis, flexible and rigid polymorphism, homoselection vs heteroselection, genetic coadaptation hypothesis, concepts of central and marginal populations, altitudinal and latitudinal variations, inversion clines, heterosis and balanced polymorphism, linkage disequilibrium, urban and rural population differentiation, suppression of crossing-over, inversion and frequency dependent selection, inversion and rare male mating advantage, inversions, behavior and mate recognition system etc. If these findings and their interpretations are compared among different species, *D. ananassae,* a cosmopolitan and domestic species, stands distinct from other species and has developed its own mechanism to adjust with its environment.**

***Index Terms:* Chromosomal polymorphism, different species, *Drosophila ananassae,* evolutionary significance.**

Species diversity in the genus *Drosophila* is well known. More than 1500 species have been reported so far and many more may be described if the research on taxonomy of *Drosophila* continues in future (Gupta, 2005; Brake & Bachli, 2008; Singh, 2015). For tracing ancestry chromosomal sequences have been used in Hawaiian species of *Drosophila* (Carson, 1987). Chromosomal polymorphism has been studied extensively in numerous species of *Drosophila* and extensive data have been reported on inversion frequencies in natural and laboratory populations of various species such as *D. pseudoobscura, D. persimilis, D. willistoni, D. robusta, D. rubida, D. subobscura, D. pavani* and others, (for references see the review by Singh, 2019). The data have been interpreted in different ways by suggesting different hypotheses/concepts/ideas by numerous investigators such as Dobzhansky, da Cunha, Carson, Levitan, Stalker, Brncic, Prevosti, Krimbas, Loukas, Sperlich and others. In India also, chromosomal polymorphism has been studied in *D. ananassae, D. melanogaster, D. nasuta* and *D. bipectinata* (Ranganath & Krishnamurthy, 1975, 1978; Shyamala & Ranganath, 1988; Kumar & Gupta, 1988, 1989, 1991; Singh, 1984, 1989, 1996, 1998; Banerjee & Singh, 1996; Singh & Singh, 2007a, 2008a; Das & Singh, 1991a, b; Singh & Das, 1992). *D. ananassae,* a cosmopolitan and domestic species possessing numerous genetic peculiarities (Singh, 2000, 2010, 2018a), presents unique features of its chromosomal polymorphism which are briefly described below:

1) A large number of chromosomal aberrations are reported in natural and laboratory populations of *D. ananassae* (Kaufman, 1936; Kikkawa, 1938; Dobzhansky & Dreyfus, 1943; Shirai & Moriwaki, 1952; Seecof, 1957; Freire-Maia, 1961; Futch, 1966; Ray-Chaudhuri & Jha, 1966; Sajjan & Krishnamurththy, 1972; Reddy & Krishnamurthy, 1972, 1974; Hinton & Downs, 1975; Singh, 1988a, 2019; Singh & Singh 2007b). There are 78 paracentric inversions, 21 pericentric inversions and 48 translocations. Thus it shows high degree of chromosomal polymorphism. The presence of highest number of pericentric inversions and translocations represents its specific feature. These

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aberrations are rare in other species of *Drosophila* and Freire-Maia (1961) suggested that it has developed some special mechanisms to retain such disadvantageous aberrations in its populations. It also reflects its unusual mutational property.

2) It is a feature of the pattern of chromosomal polymorphism in *D. ananassae* that out of so many paracentric inversions known in this species, only three (Subterminal-AL in 2L, Terminal DE in 3L, Basal-ET in 3R) could become cosmopolitan in distribution (Carson, 1965; Futch, 1966; Singh, 1970). It is suggested that these inversions originated once and spread to different populations and thus having monophyletic origin (Singh, 1970). These inversions captured heterotic gene complexes which provided adaptive superiority to their carriers. Thus they have become coextensive with the species (Singh, 1989).
3) When the stocks are maintained in the laboratory, these inversions persist showing heterotic buffering is associated with these inversions (Singh, 1982a).
4) Singh (1972, 1981, 1985, 2018b) tested the genetic coadaptation hypothesis of Dobzhansky (1950) but his results are not in agreement to those of Dozhansky in *D. pseudoobscura*. There was persistence of superiority of inversion heterozygotes in interstrain crosses in *D. ananassae* which clearly demonstrated that there is no coadaptation of chromosomes in natural populations of *D. ananassae*. In *D. ananassae*, genetic coadaptation was also tested using body size and interchromosomal associations. Interestingly, evidence for the absence of coadaptation in *D. ananassae* has also been provided by Yadav and Singh (2003), Singh (1982b) and Singh and Singh (2010a).
5) Extensive data on the frequencies of three cosmopolitan inversions in Indian natural populations of *D. ananassae* have been presented by Singh and his coworkers (Singh, 1984, 1989, 1996, 1998; Singh & Singh, 2007a). Their results demonstrated that Indian populations show evolutionary divergence and populations from south show more divergence when compared with those from the north. Further, south Indian populations show genetic similarity with those from Andaman and Nicobar Islands (Singh, 1986). Genetic drift may also cause changes in the frequencies of inversions in laboratory populations (Singh, 1987, 1988b; Singh & Singh, 2008b).
6) There is association between rare male mating advantage and AL inversion karyotype, inversion karyotype and mate recognition system and inversion karyotypes and mating propensity (Singh & Chattedrjee, 1986, 1988; Som & Singh, 2004; Nanda & Singh, 2011).
7) Linked inversions strongly suppress crossing over between them (Singh, 1973; Singh & Singh 1988; Singh & Mohanty, 1990). Tight linkage between inversions and founder effect cause linkage disequilibrium in isofemale lines of *D. ananassae* (Singh & Singh, 1990).
8) For the first time population substructuring at the level of inversion polymorphism in Indian populations has been reported (Singh & Singh, 2010b).
9) Interestingly, a new inversion within the subterminal (AL) in 2L was detected in a laboratory stock showing superiority of inversion heterozygotes (Singh, 1983).
10) In *Drosophila*, females show crossing-over but males do not show crossing-over. So the paracentric inversions do not affect the fertility of males. However, *D. ananassae* shows male crossing over as well as the presence of paracentric inversions (Singh, 2019, 2020).

In other species of *Drosophila*, the following conclusions are briefly described in respect of chromosomal polymorphism.

1) In *D. melanogaster*, more than 300 paracentric inversions have been reported (Das & Singh, 1991a; Lemeunier & Aulard, 1992). There is evidence for latitudinal clines in inversion frequencies in natural populations (Knibb, 1982; Das & Singh, 1991b; Singh & Das, 1992a). Inversions are often eliminated from laboratory populations (Singh & Das, 1992b).
2) In *D. pseudoobscura, D. willistoni, D. paulistorum, D. pavani*, and D. *bipectinata*, breakdown of heterosis in interracial hybridization experiments extends evidence for genetic coadaptation in natural populations of these species (Dobzhansy 1950, Dobzhansky & Pavlovasky, 1958; Brncic, 1961; Banerjee & Singh, 1998).
3) *D. pseudoobscura* shows seasonal variations in the frequencies of inversions in it natural poplations (Dozhansky, 1947).
4) In *D. robusta*, concept of heteroselection vs homoselection in central and marginal populations was suggested by Carson (1958). Central populations show heteroselection and high adaptedness in contrary to marginal populations showing homoselection and more adaptability which is correlated with rate of recombination. In the same species, Livitan (1954) reorted non- random associations of inversions in natural population for the first time.
5) Dobzhansky et al. (1950) proposed ecological niche hypothesis based on their work on *D. willistoni* and other species: “Inversion polymorphism is a device to cope with the diversity of environments”.
6) Inversion frequencies do not vary in natural populations of *D. bipectinata* extending evidence for rigid chromosomal polymorphism (Banerjee & Singh, 1996).
7) A large number of inversions are known in *D. subobscura* which show clines in their frequencies (Krimbas and Luokas, 1980).
8) *D. nasuta* shows high degree of chromosomal polymorphism in its natural populations. Evidence has been

presented for flexibility, heteroselection, linkage disequilibrium, and absence of genetic coadatation (Ranganath & Krishnamurthy, 1975, 1978; Shyamla & Ranganath, 1988; Kumar & Gupta, 1988, 1989, 1991).

Thus, the comparison of features of chromosomal polymorphism observed in *D ananassae* with other species clearly shows that it stands distinct from other species. Certainly, it has developed its own mechanism to adjust with its environment.

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