Quantitative Variation of Chromosomal Polymorphism in Natural Populations of *Drosophila ananassae*

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Although the major morphological polymorphism is rare in the genus *Drosophila*, the chromosomal polymorphism is very common. The chromosomal variability is mainly due to inverted sections in the chromosomes. The degree of chromosomal variability differs in different species of *Drosophila* and within the species in different populations. It has been shown by several authors that inversion polymorphism is adaptive (for review see da Cunha 1960).

Dobzhansky *et al.* (1950) and da Cunha *et al.* (1950) studied the natural populations of *Drosophila willistoni* in Brazil and reported that the mean number of heterozygous inversions per individual varies in different populations. To account for such findings they advanced the working hypothesis that the populations which exploit a greater variety of ecological niches in the territory which they inhabit, are more polymorphic than the populations restricted to a narrow range of ecological opportunities. This hypothesis has been tested further by several workers and the results obtained tend to support it (da Cunha *et al.* 1953, da Cunha and Dobzhansky 1954, Carson 1955, Salzano 1955, da Cunha *et al.* 1959).

There are, however, a number of exceptions to the above ecological niche hypothesis. A prominent exception is the presence of a very low degree of chromosomal polymorphism in most of the cosmopolitan species of the genus *Drosophila* (Carson 1955). *Drosophila ananassae*, although a cosmopolitan and domestic species, shows a high degree of chromosomal polymorphism (Kaufmann 1936, Kikkawa 1938, Dobzhansky and Dreyfus 1943, Shirai and Moriwaki 1952, Freire-Maia 1955, 1961, Seecof 1957, Futch 1966, Ray-Chaudhuri and Jha 1966).

The purpose of this paper is to report an investigation of inversion frequencies at various localities in India including Andaman and Nicobar Islands.

Materials and methods

The flies of *D. ananassae* for the present study were collected from five different localities viz., Jamsoti, Lowari, Ukhara, Port Blair and Kamorta. Jamsoti and Lowari, two small villages consisting of about thirty huts each, are situated in the Chakia forest, Varanasi U. P. Ukhara, a small town, is situated near Durgapur, West Bengal. Port Blair and Kamorta are located in Andaman and Nicobar Islands. The climate of these islands is tropical and humid.

Table 1. Observed and expected frequencies of different genotypes in natural populations of *Drosophila ananassae*

Locality		Genotypes									
		AL ⁺ /AL ⁺	AL ⁺ /AL	AL/AL	χ^2	DE ⁺ /DE ⁺	DE ⁺ /DE	DE/DE	ET ⁺ /ET ⁺	ET ⁺ /ET	χ^2
Jamsoti	Ob. Ex.	30	0	0	—	17 18.4	13 10.2	0 1.4	30	0	—
Lowari	Ob. Ex.	21	0	0	—	12 12.9	9 7.1	0 0.9	19 19.04	2 1.91	0 0.05
Ukhara	Ob. Ex.	3 2.8	7 7.4	5 4.8	0.04	5 5.4	8 7.2	2 2.4	9 8.06	4 5.87	2 1.07
Port Blair	Ob. Ex.	4 5.5	29 25.6	28 29.9	0.97	13 11.5	27 30.0	21 19.5	27 28.9	30 26.2	4 5.9
Kamorta	Ob. Ex.	2 1.5	5 5.9	6 5.6	0.37	2 2.3	7 6.4	4 4.3	5 4.9	6 6.2	2 1.9

Table 2. Frequencies (in per cent) of various gene arrangements in natural populations of *D. ananassae*

Locality	2L		3L		3R	
	AL ⁺	AL	DE ⁺	DE	ET ⁺	ET
Jamsoti	100	0	78.3	21.7	100	0
Lowari	100	0	78.6	21.4	95.2	4.8
Ukhara	43.3	56.7	60.0	40.0	73.3	26.7
Port Blair	30.3	69.7	43.4	56.6	68.8	31.2
Kamorta	34.6	65.4	42.3	57.7	61.5	38.5

Table 3. Frequencies (in per cent) of various inversions found in heterozygous condition, and the mean numbers of heterozygous inversions per individual in natural populations of *D. ananassae*

Locality	Flies tested	Heterozygous inversions			Mean per individual
		AL ⁺ /AL	DE ⁺ /DE	ET ⁺ /ET	
Jamsoti	30	—	43.3	0	0.43
Lowari	21	—	42.8	9.5	0.52
Ukhara	15	46.6	53.3	26.6	1.26
Port Blair	61	47.5	44.2	49.1	1.40
Kamorta	13	38.4	53.8	46.1	1.38

The collections of flies were made by exposing fermenting banana supplemented with baker's yeast in small milk bottles and ice cream cups. All flies were collected in domestic habits. The flies were brought to the laboratory and the females of *D. ananassae* sorted out. Each female was placed in a separate glass vial with sufficient yeast added to the regular culture medium. Preparations by the usual acetocarmine method have been used. Quantitative data were obtained through the analysis of only one F₁ larva from each female captured in nature.

Results

Altogether only three inversions are detected from the populations studied. They were detected earlier from Indian populations by Ray-Chaudhuri and Jha (1966) and termed by them as alpha in II L, delta in III L and eta in III R. These inversions correspond to subterminal (II L), terminal (III L) and basal (III R) inversions described by Kaufmann (1936). Due to the occurrence of alpha inversion in II L three genotypes, the standard homozygote AL⁺/AL⁺, the heterozygote AL⁺/AL and the inversion homozygote AL/AL are possible. The same is true for both delta in III L and eta in III R viz., DE⁺/DE⁺, DE⁺/DE, DE/DE and ET⁺/ET⁺, ET⁺/ET and ET/ET respectively. These nine genotypes are scored separately for all the populations studied.

Table 1 shows the observed and expected frequencies of different genotypes in natural populations of *D. ananassae*. The expected values are calculated on the basis of Hardy Weinberg Law. The χ^2 test shows no significant discrepancy between observed and expected frequencies. It does not necessarily follow, however, that the populations are in equilibrium, since we have no information about frequencies at different stages of the life cycle or in successive generations (See Wallace 1958).

Table 2 shows the frequencies (in per cent) of standard (AL⁺) and alpha (AL) gene arrangements in II L, standard (DE⁺) and delta (DE) in III L and standard (ET⁺) and eta (ET) in III R. In the Jamsoti and Lowari populations the alpha gene sequence is totally absent. The delta sequence occurs in low frequency. The eta inversion could be detected only from two individuals in

heterozygous condition out of twenty one examined from Lowari. The Port Blair and Kamorta samples, on the other hand, show the presence of all the three inversions at fairly high frequencies, whereas the Ukhara population is intermediate in this respect.

The frequencies (in per cent) of heterozygous inversions and the mean numbers of heterozygous inversions per individual in all the five localities are presented in Table 3. The heterozygotes for the delta inversion are fairly frequent in Jamsoti and Lowari whereas the other two kinds are either rare or absent. The sample from Ukhara shows a peculiarity in having the eta heterozygotes in very low frequency but for the other two types it is more or less similar to Port Blair or Kamorta. The mean number of heterozygous inversions per individual is highest for the Port Blair population and the lowest for Jamsoti population.

Discussion

The three inversions, alpha (subterminal) in II L, delta (terminal) in III L and eta (basal) in III R with which we are dealing in this paper are perhaps coextensive with the species. They have been reported earlier from Alabama (Kaufmann 1936), Formosa, China, Japan (Kikkawa 1938), Brazil (Dobzhansky and Dreyfus 1943), Hawai Islands, Central and North America (Shirai and Moriwaki 1952, Futch 1966), Marshall Islands (Seecof 1957), Cuba (Futch 1966), Africa (Shirai and Moriwaki 1952) and India (Ray-Chaudhuri and Jha 1966, Singh 1970). Such wide spread occurrence of specific inversions is a feature of *D. ananassae*.

Dobzhansky and Dreyfus (1943) reported the occurrence of these inversions in all Brazilian localities from which the samples of *D. ananassae* were derived. According to these authors, about one half of individuals are heterozygous for subterminal (II L), forty per cent of individuals heterozygous for terminal (III L), and thirty per cent of individuals heterozygous for basal (III R) inversions in all localities. The quantitative data on these inversions presented in this paper and that of Shirai and Moriwaki (1952) do not seem to support the generalization made by Dobzhansky and Dreyfus (1943). In the populations of Brazilian localities the mean number of heterozygous inversions per individual oscillate around the total mean 1.31, between the narrow limits 1.17–1.60 (Freire-Maia 1952). The present data, on the other hand, show that the mean number of heterozygous inversions per individual ranges from 0.43 to 1.40. Thus it is apparent that there are quantitative variations of inversion polymorphism in the natural populations of *D. ananassae*. In the populations of Jamsoti and Lowari which are situated in the vicinity of the Chakia forest, the standard gene orders in all chromosomes occur in high frequency. But in the populations of Port Blair, Ukhara and Kamorta the inversion sequences are very frequent. The alpha gene arrangement in all the three localities is dominating over the standard. The delta gene sequence also shows the same trend although eta is below fifty per cent in all the populations studied. The present data stand in contrast to those of Krivshenko (1963) in *D. busckii*, another cosmopolitan species. He finds that the 'standard' gene orders for all chromosomes in *D. busckii* appear every where in very high frequency.

It is apparent from the existing data that the Jamsoti and Port Blair populations differ with respect to the frequency of chromosomal types and also the level of heterozygosity. It is difficult to point out the ecological differences between these two populations because not much is known about the breeding sites or food habits of the species. The only apparent difference is that the former sample comes from a typical forested area with a few huts inhabited by cultivators and the latter from areas inhabited much more thickly by human beings. The difference in the degree of chromosomal variability in these populations may be due to the differences in ecological conditions which the populations encounter.

On the basis of the results presented in this paper it can be suggested that *D. ananassae* perhaps stands out distinct from other cosmopolitan species and we feel that more extensive data are required to bring out clearly the peculiarities if any regarding population dynamics of inversion polymorphism of the species specially with regard to the wide spread inversions.

Summary

The samples of *Drosophila ananassae* have been collected from Jamsoti and Lowari, two small villages of the Chakia forest, U. P., Ukhara a small town near Durgapur, West Bengal, Port Blair and Kamorta situated in Andaman and Nicobar Islands. The samples from these widely separated localities have shown that the three inversions viz., alpha (subterminal) in II L, delta (terminal) in III L and eta (basal) in III R are widely distributed. The natural populations show marked differentiation in distribution of the chromosomal types. The mean number of heterozygous inversions per individual varies in different populations. The highest value is 1.40 for the Port Blair (Andaman) population and the lowest 0.43 for the Jamsoti (Chakia forest) population.

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