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Changes in Inversion Frequency by Inbreeding in *Drosophila melanogaster*

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ABSTRACT

Drosophila melanogaster flies were collected in different regions of Jhansi (U.P) and the inbreeding was allowed to occur under controlled conditions in BOD.The effects of inbreeding were seen and also its correlation with different inversions was worked out. The main finding was on egg viability which seems to decrease with inbreeding. Further the inbreeding results in depression of vigor because it increases homozygosity of a locus and thus brings together the deleterious recessive alleles.

Key words: Correlations, egg viability, inbreeding depression, homozygosity, recessive alleles

INTRODUCTION

Inversions are the structural changes in the chromosomes which involve the orientation of a segment of chromosomes in the reverse direction and hence the order of genes in this region is exactly the reverse of that found in the homologue (non-inverted). The inversion result from the breaking of a chromosome at two sites so that three segments are formed and that the middle one is rotated through 180^0 i.e. joined in reverse direction. The inversions were first observed by Strutevant (1926) by the genetic map preparation of *Drosophila melanogaster*. The detection of inversions is relatively easy in Drosophila due to polytene chromosomes.

In *Drosophila* the traits that have been associated with inversion polymorphism include viability, development time, longevity, mating success, fecundity, bristle number, resistance to thermal stress and body size. These traits can be a good proxy in the study of inbreeding.(Chapko, 1979). Singh (1989) study showed a good variation of frequency of different gene arrangements in 24 Indian populations of *D. Ananassae*. The inbreeding has a great effect on crossing over and recombination is greatly suppressed in the regions of inversions (Ramel, 1962).

According to the dominance hypothesis, inbreeding depression is caused by expression of deleterious recessive alleles in homozygous individuals. In the present work the frequency and egg to larva viability were taken into consideration to study the effect of inbreeding in *Drosophila melanogaster*.

MATERIAL AND METHODS

For the study of inversion frequency and inbreeding depression in *Drosophila melanogaster*, the flies were collected in different regions of Jhansi (U.P) like Shivaji Nagar and the local Sabzi Mandi of Jhansi.The flies were trapped by means of aspirators, nets and plastic funnels into empty bottles. The flies were then transferred into food bottles in the laboratory. The food had following composition:

CONTENT	QUANTITY
Agar Agar	13 gm
Maize powder	160 gm
Crude sugar	170 gm
Active yeast powder	60 gm
Nipazine	8 gm
Acid mix	20 ml
Water	2400 ml

All the cultures were incubated at 25±1^{0}C and maintained under continuous lighting in BOD. The tests considered were for egg viability in *D. melanogaster* and its correlation with inversion frequency. The various steps in the experiment were:

(i) Random selection of 15 female and 10 male flies was done. These were called parents (P1). They were allowed to cross and lay eggs for 19 hours. Then after they were transferred into food vial fitted at the bottom of a plastic bottle. They were obtained by etherizing and were starved for 2 hours in empty bottle.

(ii) In the second step 10 male flies of P1 were crossed with 15 females of F1 (after allowing the virgin females to mature in food bottle). Egg counting was done after 19 hours.

(iii) In the third step, 10 male flies and 15 females of F1 were crossed and egg counting was done as usual after 19 hrs.

(iv) Subsequent squashing of the larvae using Lacto-0resien method was done. The inversions were observed in both parental and F1 larvae.

RESULTS

All the four kinds of common cosmopolitian inversions were observed in the laboratory stock of *D. melanogaster*. None of them was pericentric and all of them were autosomal.Among the inversion 2LT inversions were more frequent i.e. maximum number of inversions were in the 2 L arm. In case of F1 generation 2L arm had 4 inversions out of total 6 inversions seen. The frequency of different inversions is given in Table 1.

Table 1. Frequency of different gene arrangements in *D. melanogaster*

		2 LT	2 RNS	3LP	3RP
Parents	p	0.86	0.95	0.95	0.98
	q	0.14	0.05	0.05	0.02
F1	p	0.75	0.95	1	0.95
	n	0.25	0.05	0	0.05

Calculation of observed and expected number (i.e. Hardy and Weinberg proportions) of different karyotypes of the various inversions is given in the Tables 2 and 3 for parents and F1 respectively.

Table 2. Observed and expected values of different gene arrangement in *Drosophila melanogaster* (parents)

S. No.	Inversion	+/+	+/-	-/-
1	2 LT			
1.a	Observed expected	37	12	01
1.b	χ^2	36.98	12.04	0.98
1.c		0.0000108	0.0001329	0.0004082
2	2RNS			
2.a	Observed expected	45	05	0
2.b	χ^2	45.12	4.75	0125
2.c		0.0003191	0.0131579	0.125
3	3LP			
3.a	Observed expected	45	05	0
3.b	χ^2	45.12	4.75	0125
3.c		0.0003191	0.0131579	0.125
4	3RP			
4.a	Observed expected	48	02	0
4.b	χ^2	48.02	1.96	0.02
4.c		0.0000083	0.0008163	0.02

df*=1;p>0.05

Table 3. Observed and expected values of different gene arrangements in *Dmelanogaster* (F1)

S. No.	Inversion	+/+	+/-	-/-
1	2 LT			
1.a	Observed expected	6	3	1
1.b	χ^2	2.85	3.7500	0.625
1.c		3.5683628	0.15	
2	2RNS			
2.a	Observed expected	9	1	0
2.b	χ^2	9.025	0.95	0.025
2.c		0.0000693	0.0026316	0.025
3	3LP			
3.a	Observed expected	10	0	0
3.b	χ^2	10	0	0
3.c		0.0	0.0	0.0
4	3RP			
4.a	Observed expected	9	1	0
4.b	χ^2	9.025	0.95	0
4.c		0.0027701	0.0026316	0.0

$df^{*}=1; p>0.05$

It is evident from the data that there is no significant deviation in both the cases. However, because of selection of lesser number of flies the observed $\chi 2$ value at one place (3.5683628) in 2LT came near to the tabular value (3.84), i.e. near to the significant level. This shows that the egg laying and 2LT inversions have some correlation. Table 4 shows the correlation among the eggs laid and the different inversion frequencies.

Table 4. Correlation among eggs laid and the different inversion frequencies

	Eggs laid	2LT	2RNS	3RP	3LP
Eggs laid	+1				
2LT	-1	+1			
2RNS			+1		
3RP	+1	-1		+1	
3LP	-1	+1		-1	+1

*df=1

It is seen that there is negative correlation between 2LT inversions and eggs laid. This indicates that lesser the 2LT inversion frequency, the more the egg production and vice-versa. The following results were obtained during the crosses:

(i) The average number of eggs produced by two replicates of cross between P1 males and P1 females was 150. Among these 112 hatched out and 41 did not.

(ii) The average number of eggs produced by two replicates of cross between P1 males and F1 females was 206. Among these 99.5 hatched and 56.5 did not.

(iii) The average number of eggs produced by two replicates of cross between F1 males and F1 females was 103.5 among which 19.5 hatched and 84 did not.

Table 5. Number of eggs laid and their viability in different crosses of *D.melanogaster*

	parents			P1 males crossed with F1 females			F1 males crossed With F1 females		
	Total No. of eggs	No. of Unhatched eggs	No. of Hatched eggs	Total no. of Eggs	No. of unhatched eggs	No. Of hatched eggs	Total no. of eggs	No. of Unhatched Eggs	No. of Hatc-hed Eggs
A	140	46	94	217	61	156	97	74	23
B	166	36	130	195	52	143	110	94	16
Mean Of A & B	150	41	112	206	56.5	99.5	103.5	84	19.5

DISCUSSION

More than 326 inversions are known in *D. melanogaster* and most of them are paracentric (Lemunier *et al.*, 1986). On the basis of distribution and abundance, chromosome inversions in *D. melanogaster* have been divided into four types: (i) common cosmopolitian, (ii) rare cosmopolitian, (iii) recurrent endemic and (iv) unique endemic (Ashburner and Lemunier, 1976). All the four common cosmopolitian inversions occur in Indian natural populations of *D.melanogaster*. Most of the inversions detected during the present study occur at a low frequency as depicted in Table 1. This may be due to selection of lesser number of flies and environmental effect in Jhansi. It is interesting to note that very low frequency or complete absence of the common cosmopolitan inversions have been found in certain populations of *D. melanogaster* in Korea, Japan, Australia and USA (Mettler *et al.*, 1977).

No overlapping inversions were seen in the present study in *D.melanogaster*, a result which is in consonance with the previous works of Stralker (1976). Most inversions in *D. melanogaster* are paracentric.

In the present work inbreeding was allowed when the F1 males and females were allowed to cross and there was a marked difference in the eggs laid (i.e. egg count) and their viability in contrast to the P1 flies crossed (Table 1). Similar inbreeding depression results were recorded in *D. melanogaster* by other workers for example, Egg to adult viability showed I.D of 0.57 (Garcia *et al.*, 1994), wing length showed an I.D of 0.03

(Reeve, 1953). The association of body size and inversions in D.ananassae has been studied by Yadav and Singh (2003).

REFERENCES

Ashburner, M. and Lemunier, F. 1976. Inversion polymorphism in *Drosophila simulans. Proc. R. Soc London.B*., **193**: *137-15*

Chapco, W.1979. Correlation between chromosome segments and fitness in *D. melanogaster*. ii. The X chromosome and egg viability. *Genetics,* **92**:595-601.

Garcia, N.,Lopez-Fanjul,C.and Garcia-Dorado,A. 1994.The genetics of viability in *Drosophila melanogaster*; effects of inbreeding and artifical slection. *Evolution,* **48**: 1277-1285.

Lemunier, F., David, J.R. and Tsacas, L. 1986. The *melanogaster* species group. p. 147-256. In: *The Genetics and Biology of Drosophila. Academic Press, London.*

Mettler, L.E., Voelker, R.A. and Mukai, T. 1977. Inversion clines in *D. melanogaster. Genetics,* **87**; 169-176.

Ramel, C.1962. Inter-chromosomal effects of inversions in *D. melanogaster* crossing over.*Hereditas,* **48**:1-58.

Reeve, E.C.R. and Robertson, F.W. 1953. Analysis of strains of *D. melanogaster* selected for long wing. *J.Genet*., **51**: 276-316.

Singh, B.N. 1989. Inversion polymorphism in Indian populations of *D. ananassae. Heriditas,* **110**:133-138.

Stralker, H.D. 1976. Chromosone studies in wild populations of *D. melanogaster*. *Genetics,* **82**: 327-347.

Sturtevant, A.H.1926 Known and probable inverted sections of the autosomes of *D. melanogaster*. *Carnegie Inst. Washington Publ*., **421**: 1-27.

Yadav, J. and Singh, B.N. 2003. Inversion polymorphism and body size in Indian geographical populations. *J. Zool. Syst. Evol. Res*., **41**:217-226.