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Morphometric Traits in Drosophila Popualtions: Analysis of Variation in Reciprocal Cross Progeny

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Abstract: Reciprocal cross effects (i.e., differences between reciprocal hybrids that are developed by reversing the strains from which the dam and the sire are taken) are commonly used as a measure of sex-linkage or maternal effects. Morphometric traits were studied in a cross between two geographic populations of Drosophila kikkawai, i.e. a northern and southern. Average values in the F_1 was similar and close to the midparent value. A clear maternal genotype effect was, however, observed for all traits between reciprocal F_1s.

Keywords: Drosophila kikkawai, reciprocal cross, parents, offsprings etc.

INTRODUCTION

A reciprocal cross is one of a pair of matings in which two opposite sexes are coupled with each of two different genotypes and mated in opposite combinations. For example, a female of a certain genotype A is first crossed with a male of genotype B. Then, in the reciprocal cross, a female of genotype B is crossed with a male of genotype A. Reciprocal crosses are used to determine whether maternal or paternal factors influence the **inheritance** of the characteristic. They are used to detect sex-linkage, **maternal inheritance**, or **cytoplasmic inheritance**. Further investigations demonstrated that, the large difference between the parental strains was entirely due to differences in their genetic properties of traits concerned.

These observations led us to investigate the genetic bases of quantitative traits (Thomas, R.H. and Barker, J.S.F. 1993) in crosses between northern and southern populations of D. kikkawai. The most interesting observation is a maternal effect, observed between reciprocal F_1s and intermediate between parents. Moreover, strains that are well adapted to local climatic conditions of natural populations. Significant differences were found between flies according to their geographic origins.

MATERIAL AND METHODS

Two geographic populations were compared. A northern population was collected from Shimla. The other population was collected from Chennai. Both populations were kept as mass culture in laboratory bottles. More than 100 adults were transferred at each generation in order to avoid inbreeding and prevent laboratory drift. These mass populations were used in the toxicity tests.

Simultaneously, isofemale lines were established by isolating wild collected females in single vials. Quantitative traits were measured Five morphometrical traits were measured; fresh body weight (BW), measured in two days old flies (expressed in mg x 100); wing length (WL), measured from the point of attachment with thorax upto the tip of the third longitudinal vein (expressed in mm x 100); thorax length (TL), measured from anterior margin of the thorax to the tip of postscutellum (expressed in mm x 100) and W/T ratio. Adults were grown at full thermal range in bottles on a killed yeast food.(Van’t Land, J.P., Van Putten, B., Zwaan, A., Kamping and Van Delden, W. 1999) Upon emergence they were lightly etherized and distributed in groups of 20 males or 20 females. After a recovery of 3-4 h on the same food, they were transferred to airtight plastic vials.

RESULTS AND DISCUSSION

Quantitative traits were measured on mass cultures from Shimla and Chennai populations. Reciprocal F_1 cultures were investigated. The differences between sexes were highly significant. This sex difference became significant when all the data (parents, F_1) were considered simultaneously. F_1 flies exhibited intermediate values which was not statistically different from the mid-parent value. The reciprocal F_1s were, however, significantly different (Table 1-3). In such a case, male and female progeny must be analysed separately, since females are genetically identical while males of the reciprocal F_{1S} are clearly different, and the direction of the difference agreed with the mother's characteristics. A similar observation was also valid for females. The difference was a little smaller than in males, but not significantly so. All these observations demonstrated that the difference between the reciprocal F1s was mostly due to a maternal genotype influence which persisted until the adult stage.

A broad variability was evidenced between lines, and this may be due to the high inbreeding. The phenomenon was relatively more pronounced among the southern lines, with coefficients of variation around 35%. On the other hand, there was no overlap of the values between and the differences according to geographic origins were highly significant. A final observation was that the mean values were somewhat superior to those of the parental lines, but the differences were not significant. Two main conclusions may be drawn from this work. First the large difference exist between the northern and southern populations of D .kikkawai. A second and novel, conclusion was the magnitude of a maternal effect which discriminated the reciprocal F1s and also the fact that this effect concerned both starvation and desiccation tolerances. Various processes may explain maternal influences, including the transmission of cytoplasmic organelles (Vaiserman AM et.al, 2013) or symbionts, a perturbation of the mother's physiology by environmental effects (David, 1975) or the asymmetric contribution of paternal and maternal genotypes to the formation of the embryo. Our observation are probably explained by this last type i.e. maternal genotype effect. The most striking observation was that physiological differences between reciprocal F1s, which were initiated in the embryo, persisted until the adult stage. By contrast, maternal effects, described by Olive W. Driver, 2013. disappeared much earlier in the larval stages. We do not know which metabolic pathway could be involved in the maternal influence observed in crosses between northern and southern populations (Van Noordwijk, A.J. Van Balen, J.H., and Scharloo, W. 1998.)

TABLE 1 : Data on wing length (mm x 100) at six growth temperatures in parental and reciprocal F1, crosses between a Northern (Shimla) and a Southern (Chennai) populations of D. kikkawai.

	Sex	**12°C**	**14°C**	**17°C**	**21°C**	**25°C**	**28°C**
Parents							
Shimla	F	290.23±1.10	295.14±1.80	272.22±0.47	267.76±1.40	252.11±1.10	229.60±2.86
	M	269.95±1.40	274.04±2.10	248.55±1.10	240.32±1.00	221.04±1.30	213.18±1.40
Chennai	F	244.74±2.70	247.14±0.86	240.25±1.00	232.80±1.00	226.93±0.56	208.32±1.00
	M	219.78±2.40	223.03±0.78	213.31±1.70	211.35±1.00	200.03±0.39	187.40±0.79
t-value		**	**	**	**	**	**
F1							
Shimla(M) x Chennai (F)	F	265.80±1.30	270.06±1.10	266.40±0.69	242.52±1.40	239.52±0.83	227.70±0.69
	M	238.72±1.20	240.52±1.30	235.93±0.63	213.21±1.10	209.88±0.93	198.03±0.66
Shimla(F) x Chennai (M)	F	257.34±1.50	272.09±0.89	259.50±0.89	240.25±1.00	232.93±1.30	225.20±0.99
	M	234.76±1.10	247.01±0.96	233.69±0.63	215.48±0.86	208.85±1.20	197.10±0.99
t-value		**	**	**	**	**	**

All `t' values are significant.

TABLE 2 : Data on thorax length (mm x 100) at six growth temperatures in parental and reciprocal F1, crosses between a Northern (Shimla) and a Southern (Chennai) population of D. kikkawai.

	Sex	12°C	14°C	17°C	21°C	25°C	28°C
Parents							
Shimla	F	97.79±0.14	99.81±1.60	99.06±1.50	98.76±0.56	94.57±0.56	89.31±0.96
	M	86.69±0.53	89.43±0.76	88.59±0.48	87.74±0.49	83.61±0.56	83.05±0.63
Chennai	F	85.24±0.88	91.76±0.41	89.64±0.54	88.87±0.65	88.87±0.33	84.64±0.53
	M	79.92±0.41	81.24±0.81	79.28±0.86	80.78±0.63	79.18±0.36	77.52±0.43
t-value		**	**	**	**	**	**
F1							
Shimla(M) x Chennai (F)	F	88.67±0.63	96.13±0.59	98.56±0.33	93.00±0.56	94.73±0.53	89.31±0.29
	M	79.98±0.53	84.81±0.69	87.01±0.36	81.75±0.63	82.49±0.49	78.32±0..49
Shimla(F) x Chennai (M)	F	86.44±0.49	98.26±0.39	95.10±0.49	92.00±0.63	88.27±0.63	88.01±0..46
	M	78.78±0.46	86.01±0.36	85.44±0.29	82.08±0.39	80.95±0.56	77.48±0.56
t-value		**	**	**	**	**	**

All `t' values are significant.

TABLE 3 : Data on wing/thorax ratio (W/T) at six growth temperatures in parental and reciprocal F1, crosses between a Northern (Shimla) and a Southern (Chennai) population of D. kikkawai.

	Sex	12°C	14°C	17°C	21°C	25°C	28°C
Parents							
Shimla	F	3.02±0.01	2.94±0.03	2.77±0.01	2.71±0.03	2.66±0.01	2.60±0.01
	M	3.11±0.01	2.91±0.02	2.80±0.01	2.74±0.01	2.64±0.03	2.54±0.05
Chennai	F	2.87±0.02	2.72±0.06	2.64±0.12	2.55±0.01	2.51±0.01	2.46±0.01
	M	2.75±0.31	2.71±0.03	2.65±0.02	2.57±0.02	2.51±0.02	2.41±0.16
F1							
Shimla(M) x Chennai (F)	F	3.00±0.01	2.81±0.01	2.70±0.01	2.60±0.01	2.53±0.01	2.55±0.01
	M	2.98±0.01	2.83±0.02	2.71±0.01	2.61±0.01	2.55±0.01	2.54±0.01
Shimla(F) x Chennai (M)	F	2.97±0.01	2.77±0.03	2.73±0.01	2.60±0.01	2.63±0.01	2.56±0.01
	M	2.98±0.01	2.87±0.01	2.73±0.01	2.62±0.01	2.60±0.01	2.55±0.01

All `t' values are significant.

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