



Fig. 1. Photomicrograph of synapsed polytene X-chromosome of a *D. ananassae* female larva heterozygous for *ln* (1) LA in the left arm (XL) and *ln* (1) RA in the right arm (XR).

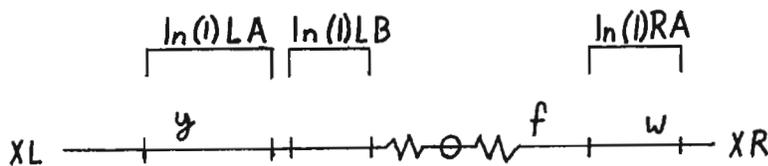


Fig. 2. Diagram of *ananassae-pallidosa* X-chromosome showing approximate locations of break points of three inversions and genes *y*, *f* and *w*.

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Galus, H.M., I.B. Perelle and L. Ehrman.
SUNY College at Purchase, Purchase, New York. The heritability of egg length in *D. paulistorum*.

employed hatchability as the criterion of fitness and found that hatchability was higher from intermediate-sized eggs. Studies of artificial selection for egg length have also been undertaken utilizing this same species (Bell, Moore and Warren 1955; Parsons 1964). In these instances artificial selection for egg length resulted in the culling of both large- and small-sized lines diverging from unselected control lines. Maximum divergence occurred by the tenth generation of selection after which regression toward the unselected mean appeared to take place.

Research published by Perelle, Daniels and Ehrman (1980) indicates that egg length heritability is low in the Mesitas strain of *D. paulistorum*. A bimodal distribution resulted when

4 where the crossover frequency between *f* and *w* is 34.6% compared to 22.3% in Experiment No. 3, a highly significant difference ($\chi^2 = 73.12$, $p < .001$). A similar interchromosomal effect resulting in the enhancement of crossing over between *f* and *w* was found when Experiments 1 and 2 were compared ($\chi^2 = 30.18$, $p < .001$). The possibility of an interbrachial effect in the X-chromosome was also investigated but with no clear-cut results. The difference in crossing over between *y* and *f* in Experiments 4 and 5 ($\chi^2 = 4.30$, $p < .05$) is quite possibly due only to additional autosomal inversions while that between *f* and *w* in Experiments 5 and 6 ($\chi^2 = 3.92$, $p < .05$) could be interbrachial caused by the addition of *ln* (1) LB.

Fig. 2 presents a schematic representation of the X-chromosomes of *ananassae* and *pallidosa* showing the suggested locations of the three genes, *y*, *f* and *w*, and the three inversions, *ln* (1) LA, *ln* (1) LB, and *ln* (1) RA. The hybrid X-chromosome that it represents has been of considerable value to me since it has allowed me to examine aspects of chromosome behavior in two very closely related species using essentially the same chromosome in each species.

References: Futch, D.G. 1966, Univ. Texas Publ. 6615: 79-120; Hinton, C.W. and J.E. Downs 1975, *J. Heredity* 66: 353-361; Moriwaki, D. and Y.N. Tobar 1975, *Handbook of Gene-*

Research done by Curtsinger (1976a,b) indicates that egg length in the Oregon-R *D. melanogaster* strain is influenced by stabilizing selection. This is a type of natural selection in which intermediate phenotypes are favored. Curtsinger

a graph was constructed of measured egg lengths versus frequency or number of eggs deposited. The midpoint of depressed frequency of eggs was found at approximately the mean length of the eggs. Hatchability of all measured eggs was then derived. Upon comparison among egg lengths, frequencies and hatchability, it was discovered that eggs of the mean length--that of depressed frequency--had a higher hatchability than any other egg length measured. From these results it was concluded that heritability of egg length must be low in this strain. If egg length was indeed substantially heritable then the point of highest hatchability--in this case the mean--would represent the modal egg length. Initially one would suspect a larger number of assorted lengths would be produced, but a significantly higher percentage of mean-lengthed eggs would hatch. The resulting adults would then be likely to produce more eggs of approximately the same mean lengths, and this mean would have eventually become the most common, modal egg length. Therefore when the graph of eggs deposited versus egg lengths was constructed, a unimodal distribution would have resulted with its point of highest frequency at the modal length, rather than the bimodal distribution which was actually found.

A more direct approach to heritability estimates was taken in our present study. This was done by measuring and comparing eggs from which larvae eclosed to produce P_1 and F_1 generations, i.e., over a three generation level. Once more the *D. paulistorum* strain used originated in Mesitas, Colombia and belonged to the Andean-Brazilian semi-species.

Eggs were chosen at random from cultures of this strain, measured, and then "bottled" according to their individual egg lengths. Measurements were taken on microscope slides aided by a 12 x 10 cm microscope screen (Hudson Photographic Ind. Inc., Irvington-on-Hudson, NY 10533, model #325), which was attached to a compound microscope. A 20X objective lens was used and magnification contributed by the screen was adjusted to give a total magnification of 100X. The image of eggs were then measured with a metric ruler on this screen; once measured, they were divided into groups of 0.005 mm egg length intervals. Then, each group was gently placed into half-pint culture bottles which held cardboard spoons containing fresh medium (Carolina Biological Supply, Burlington, NC 27215, Formula 4-24) seeded with yeast. To this substrate a 0.01 percent solution of crystal violet was added to impede bacterial growth and provide background pigment.

In approximately 10-12 days, with the appearance of imagoes, crosses between parental flies were made. Such crosses were initiated both between imagoes hatched from eggs of the same lengths, and between imagoes hatched from eggs of different lengths. These parents were then placed in fresh half-pint culture bottles outfitted as described earlier, and allowed to breed. After approximately 2-3 days, eggs from these bottles were removed from the spoons and measured, using the same technique described above. The results from these crosses are listed in Table 1. Statistical analyses are provided in Tables 2 through 4.

t -tests were performed for each "within cross" to determine the relationship between the F_1 means (\bar{X}_2) and the P_1 means (\bar{X}_1). For crosses numbered 1, 3, 4, 6 and 9, \bar{X}_1 was found to be significantly different from \bar{X}_2 at $p < 0.01$. For crosses numbered 2 and 5, \bar{X}_1 was significantly different from \bar{X}_2 at $p < 0.05$. Only cross number 6 provided a nonsignificant t -value. t -values obtained for F_1 means with mothers' egg lengths and fathers' egg lengths showed essentially the same results (see Table 1). Comprehensively, these tests indicate that the P_1 and F_1 eggs within each cross do have significantly different egg length means.

The critical statistic for heritability is the regression line of F_1 values on parent values (Curtsinger 1980). Using standard regression techniques it was determined that the

Table 1. Results of crosses made between P_1 eggs of Mesitas *D. paulistorum*.

Cross no.	Mother's egg length (mm)	Father's egg length (mm)	Parents' mean egg length (mm)	Number F_1 eggs	F_1 's egg length means (mm)	Standard error
1	.445	.450	.447	19	.480	0.003
2	.470	.470	.470	14	.484	0.006
3	.480	.480	.480	23	.467	0.004
4	.485	.485	.485	12	.454	0.008
5	.455	.455	.455	12	.442	0.005
6	.500	.505	.502	17	.466	0.004
7	.460	.450	.455	7	.441	0.006
8	.435	.390	.412	22	.456	0.005
9	.505	.505	.505	9	.471	0.002

Table 2. t-tests: Mesitas D. paulistorum egg lengths.

cross no.	df	<u>t</u> values of F ₁ 's mean egg length with mother's egg length	<u>t</u> values of F ₁ 's mean egg length with father's egg length	<u>t</u> values of F ₁ 's mean egg length with parents' mean egg length
1	18	12.73	10.93	11.83
2	13	2.27	2.27	2.27
3	22	-3.35	-3.35	-3.35
4	11	-4.11	-4.11	-4.11
5	11	-2.61	-2.61	-2.61
6	16	-9.11	-10.46	-9.78
7	6	-3.23	-1.49	-2.36
8	21	3.96	12.30	8.13
9	8	-15.62	-15.62	-15.62

Table 3. One-way analysis of variance: Mesitas D. paulistorum egg lengths.

Source	df	Sum of squares	Mean squares	F ratio
between groups	8	23.064	2.883	7.74
within groups	126	46.949	.372	
total	134	70.013		

$F_{.01}(8,126 \text{ df}) = 2.65$

Table 4. Multiple range test--Scheffé procedure: Mesitas D. paulistorum egg lengths.

Subset 1		Subset 2	
Cross no.	F ₁ mean (mm)	Cross no.	F ₁ mean (mm)
7	.441	4	.454
5	.442	8	.456
4	.454	6	.466
8	.456	3	.467
6	.466	9	.471
3	.467	1	.480
9	.471	2	.484
1	.480		

regression of F₁ egg lengths on mothers' egg lengths is $.425 + 0.084m$; the regression of F₁ egg lengths on fathers' egg lengths is $.420 + 0.096f$. It is apparent that heritability is extremely low, 0.084 and 0.096 of mothers' and fathers' egg lengths, respectively. It must be noted that even though heritability was extremely low the apparent similarity of maternal and paternal effect is almost certainly due to the mating of flies artificially selected from identical or very similar length eggs ($r = 0.93$, $p < 0.001$).

A one-way analysis of variance was conducted on this data (Table 3). An F ratio of 7.74 was obtained, which is much higher than $F_{.01}(8, 126 \text{ df}) = 2.65$. This shows that a significant difference does exist between the mean F₁ egg lengths of the crosses. A multiple range test (Scheffé procedure) was calculated with these means and homogeneous subsets were derived (Table 4).

In conclusion, this study found low heritability existing in the Mesitas strain of D. paulistorum for egg length. This was shown most dramatically by the regression lines of F₁ egg lengths on mothers' and fathers' egg lengths and by the t-tests, which show significant differences existing between P₁ and F₁ egg lengths both within crosses and over all of the crosses.

References: Bell et al. 1955, Cold Spring Harbor Symp. Quant. Biol 20:197-212; Curtsinger 1976a, J. Hered. 67:59-60; _____ 1979b, J. Hered. 67:246-247; _____ 1980, pers. communication; Parsons 1964, Genetics 35:175-181; Perelle et al. 1980, Univ. Texas Publ., Studies in Genetics (in press).