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An Assessment of Inheritance Patterns in Two Mutant Eye-color Traits of Drosophila melanogaster

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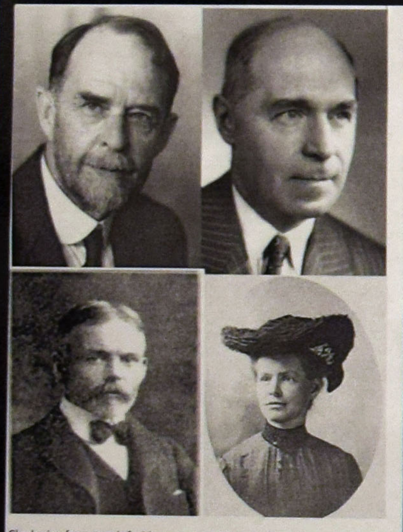
I: ABSTRACT

This experiment was a two generation test cross (from F0 to F1 and F1 to F2) to check the patterns of inheritance and their chi-square significance. Wild-type males and females were paired with the opposite sex of the two mutant groups- Sepia eyes and White eyes. The pairings thus resulted in 4 tube conditions. Generations were counted, and identified by sex and phenotype- Wild-type or Mutant. The next generation was seeded with approximately 6-8 individuals from each sex and released once the next generation reached their pupal phase. Fresh tubes were seeded between F1 and F2.

Identifying these patterns give us a tried and true method of determining future phenotypes and specific genetic patterns like recessive, dominant, and sex-linked traits. This basic experiment also serves as a baseline experiment to help others in the class with their Drosophila experiments and the data will be shared including several diagrams of inheritance patterns and gene expression.



Clockwise from top left: Thomas Hunt Morgan, Herman Joseph Muller, Nettie Maria Stevens, and Edmund Beecher Wilson. (Photos: Encyclopedia Britannica, Nobel Prize Website, and Wikipedia.)

II: INTRODUCTION

Fruit-flies make excellent specimens for genetic tests. They possess a small genome and a quick life-cycle; around 2 weeks per generation. Also, characteristics such as eye-color and wing-length are easily assessed under a microscope while the flies are sedated. This project utilized the former trait to build a basic Punnett square and test that hypothesis with Chi-square statistical analysis. Historically several breakthrough discoveries and Nobel Prizes in science have been awarded due to work with fruit flies. Thomas Hunt Morgan founded this practice and earned a Nobel Prize. His student Hermann Joseph Muller also earned a Nobel Prize for irradiating specimens to produce mutations. Both Nettie Maria Stevens and Edmund Beecher Wilson simultaneously discovered the presence of sex-linked traits. All of them used fruit flies.

III: Materials and Methods

Parkland College's pure-breeding populations were utilized as the parental generations. +/+ Wild-type (WT) fruit flies were paired with the opposite sex of two different true-breeding recessive (-/-) eye colors: sepia and white. This yielded four colony conditions.

Condition 1: Wild-type females with white-eyed males
Condition 2: Wild-type females with sepia-eyed males
Condition 3: Wild-type males with white-eyed females
Condition 4: Wild-type males with sepia-eyed females

The colonies consisted of labeled plastic cylinders (10 cm long and of 3.5 cm diameter) with a 1:1 volumetric ratio of water to Ward's Drosophila Medium Blue dry food flakes [see figure 3]. After the mixture settled into a gel in an upright container, the containers were laid on their side and 6-8 females and 6-8 males were placed in the tubes in the conditions previously described. These flies were anesthetized using an alembic gas-supply shown in figure 4. They were then correctly sexed by the morphological features shown in figure 2.

These were allowed to breed for a period lasting one week (Sept. 30 to Oct 7) the parental generation was then anesthetized and discarded and their pupal offspring allowed to colonize the container. After maturing for another 9 days (Oct 16), these offspring were then sorted by phenotype and sex and counted. 6-8 individuals from each available phenotype and sex were selected (at this point only two options) for each conditional group and put into fresh, labeled colonies.

This whole process was allowed to repeat to obtain the F2 generation and their counts on the 8th and 9th of November with a discard of the F1 parents taking place October 30, 2018.

IV. RESULTS

The Chi-squared equation was used to assess expected percentage values of the total population corresponding to established inheritance patterns against observed values from the actual counts performed on October 16th and November 8th and 9th.

Because these values included 4 possible phenotypes we counted those as degrees of freedom to give us the critical value of 7.81. None of our measurement exceeded this value so we accept the hypothesis that sepia eyes are autosomal recessive and white eyes are X chromosome sex-linked recessive.

RESULTS TABLE

F1

Condition 1	Phenotypes			
	red-eyed ♂	red-eyed ♀	white-eyed ♂	white-eyed ♀
OBS	21	35	0	0
EXP	28	28	0	0
(OBS-EXP)^2/EXP	1.75	1.75	0	0
Sum= 3.5				

Condition 2	Phenotypes			
	red-eyed ♂	red-eyed ♀	sepia-eyed ♂	sepia-eyed ♀
OBS	17	23	0	0
EXP	28.5	28.5	0	0
(OBS-EXP)^2/EXP	4.64	1.06	0	0
Sum= 5.7				

Condition 3	Phenotypes			
	red-eyed ♂	red-eyed ♀	white-eyed ♂	white-eyed ♀
OBS	0	40	26	0
EXP	0	33	33	0
(OBS-EXP)^2/EXP	0	1.48	1.48	0
Sum= 2.96				

Condition 4	Phenotypes			
	red-eyed ♂	red-eyed ♀	sepia-eyed ♂	sepia-eyed ♀
OBS	37	33	0	0
EXP	35	35	0	0
(OBS-EXP)^2/EXP	0.11	0.11	0	0
Sum= 0.22				

F2

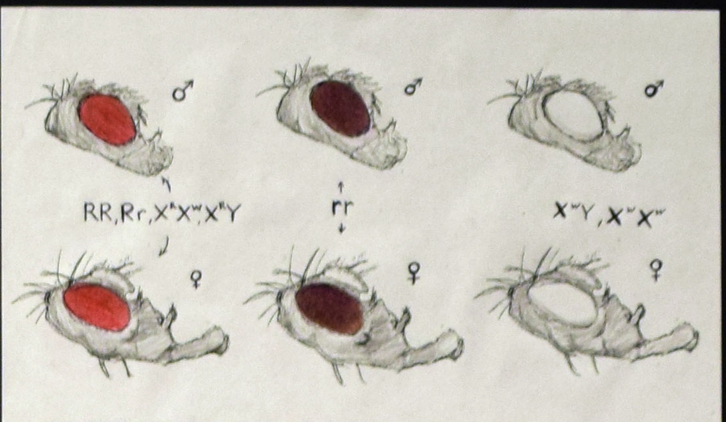
Condition 1	Phenotypes			
	red-eyed ♂	red-eyed ♀	white-eyed ♂	white-eyed ♀
OBS	12	47	15	0
EXP	18.5	37	18.5	0
(OBS-EXP)^2/EXP	2.28	2.7	0.66	0
Sum= 5.64				

Condition 2	Phenotypes			
	red-eyed ♂	red-eyed ♀	sepia-eyed ♂	sepia-eyed ♀
OBS	25	35	12	11
EXP	31.125	31.125	10.375	10.375
(OBS-EXP)^2/EXP	1.2	0.48	0.25	0.03
Sum= 1.96				

Condition 3	Phenotypes			
	red-eyed ♂	red-eyed ♀	white-eyed ♂	white-eyed ♀
OBS	28	28	22	17
EXP	23.75	23.75	23.75	23.75
(OBS-EXP)^2/EXP	0.76	0.76	0.13	1.92
Sum= 3.57				

Condition 4	Phenotypes			
	red-eyed ♂	red-eyed ♀	sepia-eyed ♂	sepia-eyed ♀
OBS	13	15	7	4
EXP	14.625	14.625	4.875	4.875
(OBS-EXP)^2/EXP	0.18	0	0.93	0.16
Sum= 1.27				

$$X^2 = \sum \frac{(\text{observed - expected})^2}{\text{expected}}$$



EYE COLOR & MORPHOLOGICAL HEAD DIFFERENCE
drawing by Seth Yates
Fig 1

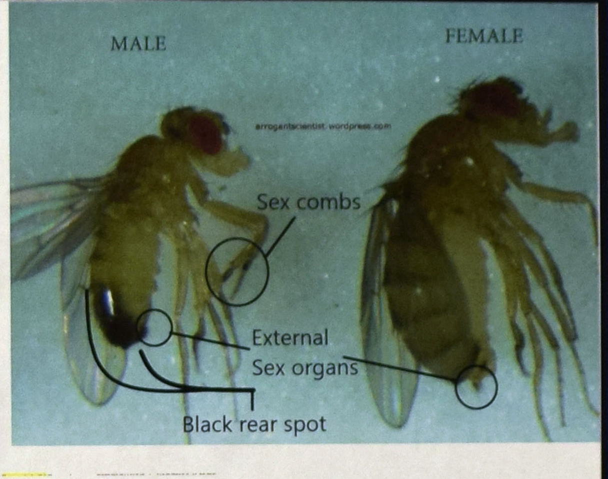


FIGURE 2
(Photo: http://arrogantscientist.files.wordpress.com)

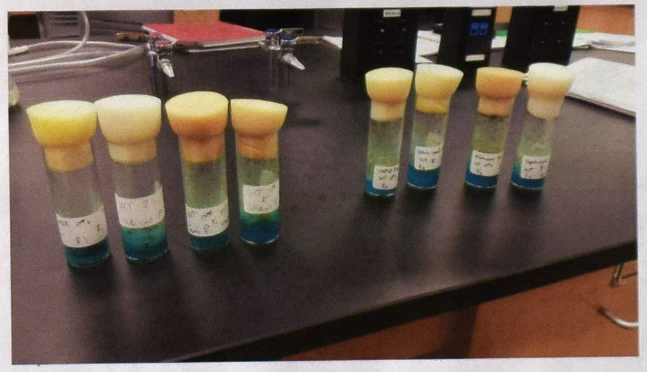


Photo by Seth Yates
Fig 3

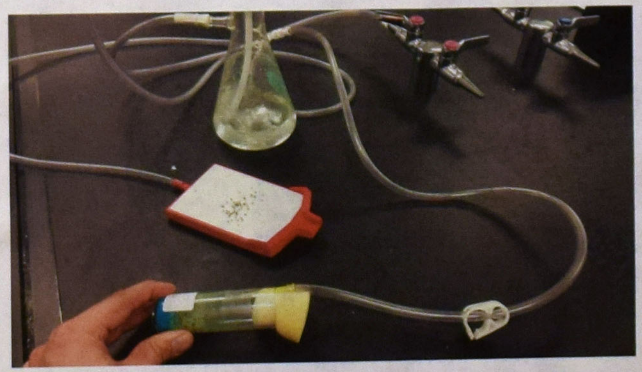


Photo by Seth Yates
Fig 4

X^R= Red, X^w= White

	X^w	Y
X^R	X^RX^w	X^RY
X^R	X^RX^w	X^RY

CONDITION 1 F1

X^R= Red, X^w= White

	X^R	Y
X^R	X^RX^R	X^RY
X^w	X^RX^w	X^wY

CONDITION 1 F2

X^R= Red, X^w= White

	X^R	Y
X^w	X^RX^w	X^wY
X^w	X^RX^w	X^wY

CONDITION 3 F1

X^R= Red, X^w= White

	X^w	Y
X^R	X^RX^R	X^RY
X^w	X^wX^w	X^wY

CONDITION 3 F2

R= red, r= sepia

	R	R
r	Rr	Rr
r	Rr	Rr

CONDITIONS 2 and 4 F1

R= red, r= sepia

	R	r
R	RR	Rr
r	Rr	rr

CONDITIONS 2 and 4 F2

V. CONCLUSION:

As our Punnett squares and data show we accept the null hypothesis that white eyes are X chromosome sex-linked recessive and sepia eyes are autosomal recessive. Sex-linked means that only one recessive X chromosome is necessary to be phenotypically present in males but two are needed to be present in females. Red eyes is completely dominant if the allele is present, in white-eyed males it is not. This held up to our data as no white-eyed females were present in the F1 generation of Conditions 1 and 3 but there were only white-eyed males in Condition 1. The Y chromosome which transmits male characteristics can only be inherited from a male forebear, this also means in males their X chromosome must come from their mother. Because the white-eyed allele is linked to the X chromosome the only group that can make white-eyed males in the next generation are white-eyed or heterozygous females. Males can only contribute their white-eyed allele to the next generation's females.

Sepia eyes are a simple autosomal recessive genetic condition. The F1 generation came out being all red-eyed, however the Punnett squares show that the F1 generation were all heterozygous regardless of gender. This occurs because the later deletion of a pigment protein PDA synthase refer to figure 5. This flow chart of eye pigment possibilities also shows that the white eyes occur because the entirety of pteridine pathway and the ommochrome pathway are shut off. The GTP second messenger system and tryptophan conversion that initiates them respectively are disabled leaving no pigment production.

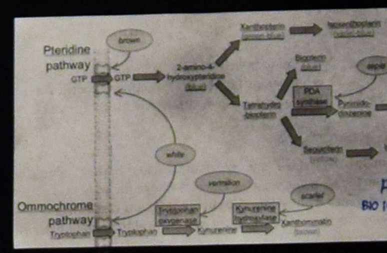


Fig 5
BIO 141 LAB MAN.
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SOURCES

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