The Use of *Drosophila Melanogaster* in High School Genetics

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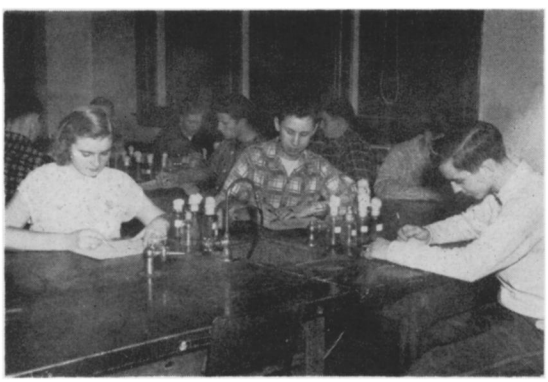
Certain genetic principles can be taught at the high school level more effectively if the class discussions are accompanied by laboratory work. In teaching a unit in genetics the instructor has the problem of selecting the type of plant or animal to use in the laboratory. Controlled crossing of plants is not practical because of seasonal aspects. Even if the high school has greenhouse facilities, the time element again makes the crossing of plants inadvisable. Hamsters, rabbits, and white mice are good for breeding experiments, but the period of gestation, the available space, and the time consumed in keeping the animals clean makes the use of such animals impractical for high school use.

The fruit fly is ideally suited for high school laboratory crossing experiments because of the small amount of space needed,



Students working with fruit flies in the laboratory.

the short life cycle, and cleanliness. The 14-day life cycle allows a class to make several crosses within six to eight weeks. The transmitted characters, illustrating certain genetic principles, may be discerned by examining the flies with the naked eye.

Materials Used in the Experiments

Three strains of fruit flies are used by the writer for the experiments in the laboratory. The first type used is referred to as the wild-type strain. The visible characteristics of this strain are red eye color, long wings, and gray body color. All three of the above-mentioned characteristics exhibit complete dominance. The second strain has vestigial wings, and the third strain has ebony body color.

Pure strains of fruit flies may be obtained from most biological supply houses at reasonable prices. Many strains are available and may be used with equal success. The flies should be used within two weeks after receiving them from the supply house. Only one bottle of each pure strain need be ordered. Culturing of the pure strain by the students will produce more than enough flies to complete the unit.

The following materials are needed in preparing the culture medium:

1. Three pure strains of *Drosophila melanogaster*
2. Agar-agar
3. Corn meal (yellow corn meal may be used)
4. Bre'r Rabbit molasses
5. Karo corn syrup
6. Water
7. Pan for boiling the medium
8. Bottles–250 cc. (The bottles must be able to withstand heat; each group of two students will require eight bottles.)
9. Paper toweling cut into strips $2'' \times 5''$
10. Cotton batting
11. Pressure cooker (or stove oven)
12. One cake of yeast
13. Ether
14. Small camel hair brush
15. Gummed labels

Preparing the Medium

The culture preparations available are many and varied. The writer has used a medium recommended by Dr. C. B. Bridges, California Institute of Technology, in Turtox Service Leaflet No. 15, General Biological Supply House, Chicago, Illinois. This medium is easy to prepare and the results obtained are favorable. The formula is:

40 grams agar-agar
200 grams corn meal (yellow corn meal may be used)

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140 cc.	Bre'r Rabbit molasses
140 cc.	Karo corn syrup
2000 cc.	Water

The agar-agar is added to the water and brought to a boil. The corn meal is added slowly, stirring continuously. When well mixed, the Bre'r Rabbit molasses and the Karo corn syrup are added and the mixture is allowed to boil slowly for ten minutes. Enough of the warm cooked medium is poured into the bottles to fill them to a depth of one inch. A strip of paper toweling is placed in each bottle while the medium is still warm. The paper serves as a place for the larvae to pupate. The bottles containing the medium and paper are stoppered with cotton batting.

The sterilization of the bottles and medium often poses a problem for the high school laboratory which may not have an autoclave. The writer successfully substitutes a pressure cooker for an autoclave. The cooker is filled to a depth of one inch of tap water and the bottles are placed upright in the cooker. The cooker is heated and maintained at 15 pounds pressure for 20 minutes. If a pressure cooker is not available, favorable sterilization may be obtained by placing the bottles containing the medium in a kitchen oven for two hours at 150° F.

The prepared medium usually begins to sour within two or three weeks. When this occurs the medium should be discarded. If sourness occurs during an experiment, the flies must be transferred to a bottle containing fresh medium.

Characters for Separating the Males and the Females

The adult male and female flies can be distinguished from each other by several differences. The tip of the abdomen of the female is pointed, whereas the abdomen of the male is rounded. The tip of the abdomen of the male is solid black in color, whereas the abdomen of the female is striped (Figs. 1 and 2).

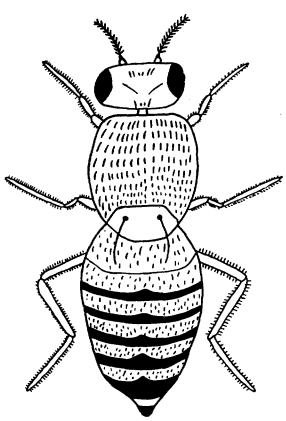

FIG. 1. Female *Drosophila* minus wings.

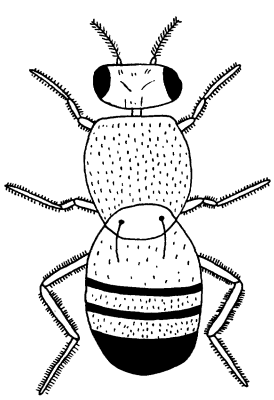

FIG. 2. Male *Drosophila* minus wings.

Preparing the Medium for Crossing

One-quarter cake of yeast is dissolved in 250 cc. of tap water. One drop of this solution is added to each sterilized bottle within 24 hours or less before the flies are introduced.

Method of Handling Adult Flies

About ten or 12 adult flies are transferred from the pure strain bottle (as received from the supply house) to a clean bottle. In transferring the flies, merely invert the mouth of the pure strain bottle over the clean bottle and tap the pure strain bottle until the flies move into the clean bottle. When the transfer is completed, put two or three drops of ether on cotton and place it into the clean bottle. When the flies appear incapacitated, place them on a piece of white paper. The flies will remain immobile for about five minutes. Never expose the flies to the ether for more than one minute. A small camel hair brush, moistened by dipping it into a glass of water, makes the handling of adult flies easy.

Selecting Virgin Females for the First Experiment

Virgin long-winged females are needed for the crossings. Virgin long-winged females are obtained by carefully removing ten or twelve pupae with a pair of forceps from the wild-type pure strain bottle. The pupae are deposited immediately into a fresh culture bottle. The bottle should be labeled properly with the type of strain and the date the larvae were placed in the bottle. Check the bottle each morning. Flies that have emerged during the night are released. During the day examine the bottle every four hours. The flies that emerge during the four-hour period are the ones used for selecting virgin females. These virgin females are used in making the monohybrid cross discussed later.

First Experiment (Monohybrid Crosses)

Each group of two students is given a labeled culture bottle containing one long-winged virgin female and one vestigial-winged male as selected above. The students write their names on the label and place the culture

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bottles containing the flies on a shelf or table in the laboratory. A week after the cross has been made, the parent flies are removed from the bottle to prevent breeding of the parents and the offspring.

Within the next four days emergence of the adult flies begins. These adult flies are the F_1 generation of a cross between a virgin long-winged female and a vestigial-winged male. The students transfer the flies from the culture bottle to the etherizing bottle. The etherized F_1 flies are placed on a piece of white paper and examined for the wing character. All of the flies examined should exhibit the long-winged character of the female parent.

It is not necessary to culture virgin females for the F_2 cross. Each group of students selects one etherized female and one male and places them into a newly prepared culture bottle. Within ten days after the F_2 cross is made the parent flies are removed and treated in the same manner as described above.

The progeny of the F_2 generation exhibit a ratio of approximately three long-winged flies to one vestigial-winged fly. This is obtained by the students counting and recording the number of long-winged flies present. These findings are coordinated with the class discussion.

The monohybrid cross can be repeated, using a long-winged male and a vestigial-winged female. The F_2 progeny of this cross demonstrate that the sex of the flies has no marked effect upon the results of the matings. The 3:1 ratio also can be demonstrated by mating a gray-body-colored male with an ebony-body-colored virgin female.

Second Experiment (Dihybrid Crosses)

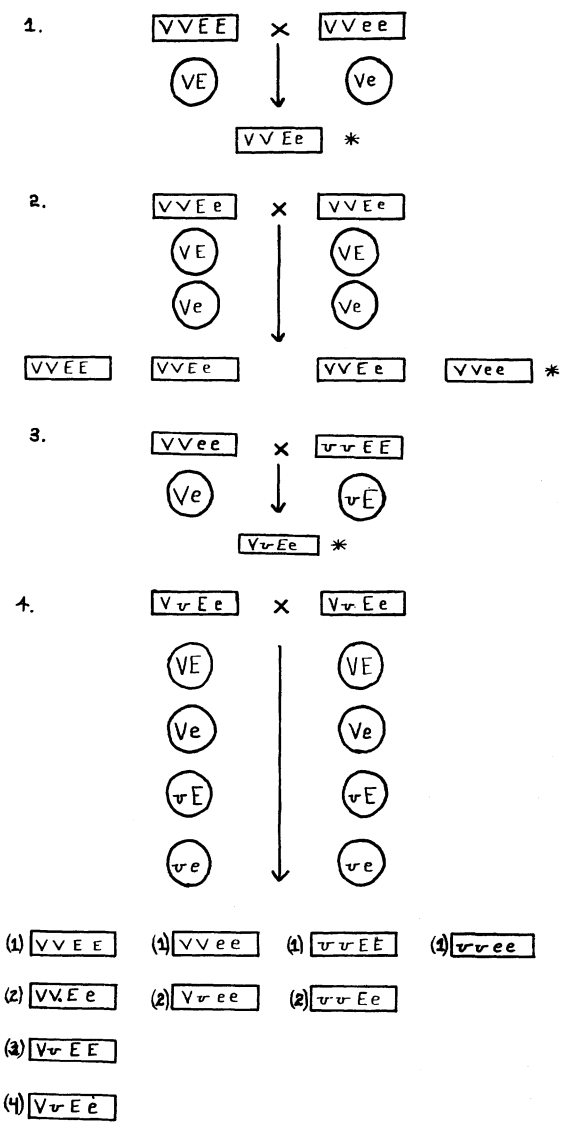
The general procedure of crossing and handling the flies in the first experiment is used in the second experiment. Each group of two students prepares a culture bottle containing a long-winged, gray-body-colored virgin female and a long-winged, ebony-body-colored male. The culture bottle is labeled and set aside as described above. A week after the cross has been made the parent flies are removed from the bottle and within another four days the emergence of the adult flies begins.

The progeny of the cross between the long-winged, gray-body-colored virgin female and long-winged, ebony-body-colored male are transferred to a clean bottle and etherized. All flies examined should exhibit the long-winged, gray-body-color characters of the female parent.

DIHYBRID CROSS

V = Long Wings **E = Gray Body Color**
v = Vestigial Wings **e = Ebony Body Color**

Note: The individuals to be used in the succeeding cross are marked with asterisks (*).



Each group selects one etherized female and one male and places them into a newly prepared culture bottle. Within ten days after the second cross is made the parent flies are removed and the culture bottles are watched for the emergence of the adult flies. The adult flies are transferred to a clean bottle, etherized, sorted, and counted. Approximately three-fourths of the progeny of

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the second cross will exhibit long-winged, gray-body-color and one fourth will exhibit long-winged, ebony-body-color.

An etherized, long-winged, ebony-body-colored male is placed in a fresh culture bottle containing a vestigial-winged, gray-body-colored female. Within ten days after the third cross is made the parents are removed. When the adult flies emerge they are etherized and examined.

The progeny of this cross should exhibit long-wings and gray-body-color. One male and one female long-winged, gray-body-colored flies are placed in a fresh culture bottle. The parents are removed ten days after the cross is made. When the adult flies emerge, they are transferred to a clean bottle and etherized.

The progeny of this fourth cross exhibit a ratio of approximately nine-sixteenths long-winged, gray-body-colored flies; three-sixteenths long-winged, ebony-body-colored flies; three-sixteenths vestigial-winged, gray-body-colored flies; and one-sixteenth vestigial-winged, ebony-body-colored flies (Fig. 3). These findings are coordinated with the class discussion.

Discussion

The writer spends six to eight weeks on the unit, depending upon the speed of his class. The laboratory work is interspersed with class discussions. Usually five one-hour class periods are devoted to mitosis and meiosis, prior to beginning any of the laboratory work. After the virgin female culture is started, the writer begins class discussions of simple crosses, with particular emphasis on the cross being carried out in the laboratory.

While the dihybrid cross is developing, most of the class periods are spent discussing the broader aspects of genetics, such as hybrid corn, human genetics, and animal breeding. The writer believes that from such a unit on genetics the students obtain an invaluable knowledge of genetics in everyday life.

Suggested References

1. Demerec, M., and B. P. Kaufman. 1950. *Drosophila Guide.* Carnegie Inst. of Washington, 44 pp.
2. Sinnott, Edmund W., L. C. Dunn, and Th. Dobzhansky. 1950. *Principles of Genetics.* McGraw-Hill Book Company, 505 pp.
3. Turtox, General Biological Supply House. *The Culture of Drosophila Flies and Their Use in Demonstrating Mendel's Laws of Heredity.* Turtox Service Leaflet, No. 15, 4 pp.

Across The Editor's Desk

Discovery of a **potent new antibiotic,** called **tetracycline,** has been announced recently. The discovery fulfills a prediction that valuable new weapons against diseases could result from a determination of the chemical structure of terramycin, accomplished in 1952. Tetracycline has proven active against microorganisms linked with such diseases as bronchial pneumonia and "strep" sore throat, in laboratory tests, and appears to parallel the activity of terramycin against germs associated with typhoid fever, boils, and urinary tract infections.

Seeds of *Mimosa pudica,* the **"sensitive plant,"** obtainable from several supply houses or gathered from wild plants in some southern states, will germinate and grow in a warm room. These interesting plants can be used in the lecture room or laboratory to strikingly demonstrate responses by plants to heat and touch. My students also grow them at home as "conservation pieces," and for unique gifts.

Energetic and capable NABT member and former Managing Editor, **Irving C. Keene,** invites all of you to visit his new and modern suite of biology rooms at **Brookline High School** during NABT's Annual Convention in Boston, or any other time you are in that area. Irving's school is only seven miles from Boston; his article in this issue describes his unique and outstanding facilities, and includes an invitation to you.

Robert R. Finlay, Supervisor of Conservation Education, State Dept. of Education, Columbus 15, O., wants illustrated written descriptions of outstanding teaching techniques and practices in all phases of Conservation from Ohio teachers for the report of **NABT's National Conservation Project** in cooperation with The American Nature Ass'n. Contact Bob if you would like further information, or send him your material.

The number of Americans afflicted with cancer appears to be increasing yearly, and a majority of all having advanced stages of cancer die from it despite approved medical efforts. Many in the field of cancer research and control feel that we should give more attention to making young people aware of recognized and suspected **causes of cancer.** Reference materials for such class discussions, special reports, and projects appears in *A Methodology for Environmental and Occupational Cancer Surveys,* Pub. Health Tech. Monograph No. 1, U. S. Gov't Printing Office, Washington 25, D. C.; also in literature from Cancer Prevention, Inc.,

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