Hormonal Control of Insect Growth and Development

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In recent years scientists have shown there are two hormones that control growth and development in insects. The two hormones are ecdysone and neotenin, the juvenile hormone. Ecdysone stimulates the growth of certain structures, primarily new cuticle (from which grows new skeleton) and initiates molting. Neotenin prevents growth to maturity. When the hormones are balanced, the larva molts to a further stage of maturity. If there is a greater amount of neotenin, further metamorphosis will be hampered. (See bibliography)

A student in an advanced biology class grew interested in the interrelation of the two hormones and after reading as much as he could he planned some simple experiments concerning the imbalance of neotenin; that is, there was to be more neotenin than ecdysone. A number of compounds have been found to have various degrees of juvenile hormone activity. These compounds are commercially available farnesol, all trans-farnesol and farnesol-diethylamine. Due to its availability, farnesol was selected in place of a neotenin extract.

Materials Needed:

1. Pupae of *Tenebrio molitor* (common mealworms)
2. Corn oil
3. 2-4 dram vials
4. Fine dissecting needles
5. Gauze and rubber bands
6. 1-ml hypodermic syringes
7. Farnesol

Experimental Procedure:

Tenebrio molitor may be obtained from a pet shop. They will be in the larval stage. Place them in a temperature control box at 25-30 C° (77-86 F°) and allow the larvae to pupate.

Dilute the farnesol with corn oil according to the following ratios of farnesol to oil: 1:0, 1:1, 1:2, 1:4, 1:8, 1:16 and 1:32. Dilutions are made with a 1 ml hypodermic syringe on a drop basis (one drop of farnesol to one drop of corn oil). This type of dilution will make it possible to plot the effectiveness on graphs.

Isolate recently molted pupae of *Tenebrio* (about 12 hours after molting). Place a minute drop of one of the diluted compounds on each of three pupae along the right dorsal side. Also, place a drop of pure corn oil on several pupae in the same location. These will be used as the control. Puncture the integument through each of the droplets with a fine dissecting needle. Use a separate needle for each of the punctures. The pure corn oil will be one of the controls used.

Place each pupae, prepared as above, in a small vial. The end of the vial is to be covered with gauze and held in place with a rubber band. Label each vial as to the compound concentration. These vials should be kept under the same conditions as the *Tenebrio* stock cultures.

When the treated *Tenebrio molitos* pupae molt to adults (6-8 days at 77-86 F°) spots of pupal cuticle remain if sufficient compound is used. These patches show up against the normal dark brown integument of the adult. The Wigglesworth (1958) method of scoring is used to express the effectiveness of the treatments. The scores are as follows:

1. large white area=4 points
2. intermediate sized white area=3 points

3. small white area=2 points
4. brown scar within extremely white point in it =1 point
5. entire brown scar=0 points

The controls should receive a score of zero. Each patch is scored separately and the three are averaged for each concentration.

Problems in the Investigation:

1. Some of the *Tenebrio* larvae would not pupate. Be very careful not to chill the larvae. Chilling lengthens the life cycle considerably.
2. After injection some of the pupae died. Use a fine gauge needle (approximately a 25-27) so less damage is done to the insect.
3. Inject slowly. If you inject rapidly the powerful spray may damage tissues excessively.
4. Use sufficient numbers of experimental insects to make valid conclusions. In some of the early work only six insects were used and four died at various stages making it almost impossible to make valid conclusions. In later experiments it was noted that we got nearly 30% recovery or completion of the experiment. (Nearly 70% died before reaching adulthood.

Results of the Investigation:

Of the 30% of insects recovered it was found that adults treated with 1:0, 1:1, 1:2, 1:4 and 1:8 farnesol to corn oil concentrations received scores of 4. Insects treated with concentrations of 1:16, 1:32 and 0:1 received scores of 1 and had brown scars. To interpret these results, the farnesol apparently does act as the juvenile hormone, neotenin. It retards normal metamorphosis of tissue and thus leaves white scars. If normal metamorphosis goes on brown scars show at the points of injection injury.

The adults that received a score of 4 had large sections of pupal cuticle and the wings were deformed. The *Tenebrio* treated with 1:0 concentration of farnesol had wings that were only about half the length of the abdomen.

The controls (treated with pure oil) had brown scars and had no visible pupal cuticle.

This type of investigation has opened up many questions such as why is the hatching rate so low? Is it humidity, temperature, light or what? Could farnesol be applied on the surface and get results without breaking the epidermis? Was there some product in the vials retarding metamorphosis such as found by Dr. Carroll Williams at Harvard? He found some paper contains a natural juvenile hormone which apparently was an evolutionary feature to protect certain trees from injury by insects.

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FLEA BEETLES

Some 2,000 Argentine flea beetles have joined the Army Corps of Engineers' battle against the channel-choking alligator weed. The tiny insects feed entirely on the noxious aquatic weed, which is a serious impediment to navigation and stream flow in 3,000 miles of inland waterway in eight southeastern states from North Carolina around to Texas. The beetles were released on an experimental basis and with the consent of the states concerned and the U. S. Fish and Wildlife Service, in the Savannah National Wildlife Refuge near the South Carolina-Georgia border. The move followed four years of research in cooperation with the Agricultural Experiment Service of the U. S. Department of Agriculture to make sure the introduction of the beetles would have no adverse repercussions on other aquatic growth.

MOUTH PROTECTORS

The football player who wears a mouthguard inside his mouth may be helping to protect himself from a brain concussion.

Mouth protectors aid in reducing skull deformation and compression between the brain. Such injuries are common in contact sports and often result from blows to the head. If the injuries are severe, brain damage may occur.

Dentists have felt for some time that mouth protectors may do much more than prevent injury to the oral tissues.

FISH REST REGULARLY

Fish seldom appear to be sleeping because they do not have eyelids, but observations reveal that they do rest regularly.