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Precocenes and Synthetic JH

Most discussions of development are limited to within the developing organism's body. However, as we saw in Chapter 18 and in more detail in Chapter 21, an organism's development can sometimes be regulated by environmental factors outside the body. There are several types of developmental phenomena where chemicals produced by one organism (often of another species) induce changes in the development of another organism.

Given the voracity of insect larvae, it's amazing that any plant exists at all. However, despite their calm outward appearances, plants are vicious. Most of our poisons come from plants, and this is largely due to the plants' having to deal with animal predators throughout their evolutionary history. One of the most fascinating levels of control by which plants can get rid of animal pests occurs at the level of juvenile hormone. Some plants poison predators with extra amounts of it, while other plants destroy the ability of their predators to make it themselves.

I. Plant juvenile hormones

When Karel Sláma came from Czechoslovakia to work in Carroll Williams's laboratory at Harvard, he brought with him his chief experimental animal, the European plant bug *Pyrrhocoris apterus*. To the consternation of the entire laboratory, these bugs failed to undergo metamorphosis at the end of the fifth instar. Rather, they became large sixth-instar larvae&emdash;something never before observed in nature or in the laboratory&emdash;and ultimately died before becoming adults. After many variables were tested, the paper towels lining the dishes were tested for their effect on the larvae. The results were as conclusive as they were surprising: larvae reared on European paper (including pages of the journal *Nature*) underwent metamorphosis as usual, while larvae reared on American paper (such as shredded copies of the journal *Science*) did not undergo metamorphosis. It was eventually determined that the source of the American paper was the balsam fir, a tree indigenous to the northern United States and Canada. This tree synthesizes a compound that closely resembles juvenile hormone (Bowers et al., 1966; Sláma and Williams, 1966; Williams, 1970), and it probably employs this juvenile hormone analogue to get rid of certain insect predators.

II. Preventing JH activity

Some other plants have compounds that produce the same effect&emdash;the death of insect predators&emdash;but do so by eliciting metamorphosis too early. Two compounds that have been isolated from composite herbs have been found to cause the premature metamorphosis of certain insect larvae into sterile adults (Bowers et al., 1976). These compounds are called precocenes. When the larvae or nymphs of these insects are dusted with either of these compounds, they undergo one more molt and then metamorphose into the adult form. Precocenes accomplish this by causing the selective death of the corpus allatum cells in the immature insect (Schooneveld, 1979; Pratt et al., 1980). These cells are responsible for synthesizing juvenile hormone. Without juvenile hormone, the larva commences its metamorphic and imaginal molts. Moreover, juvenile hormone is also responsible for the maturation of the insect egg. Without this hormone, females are sterile. So the precocenes are able to protect the plant by causing the premature metamorphosis of certain insect larvae into sterile adults.

Plants have several ways of defending themselves against larval predators. Another, and extremely interesting one, involves recruiting animal allies against larval foragers. This type of defense is used by several plants against the beet armyworm.

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