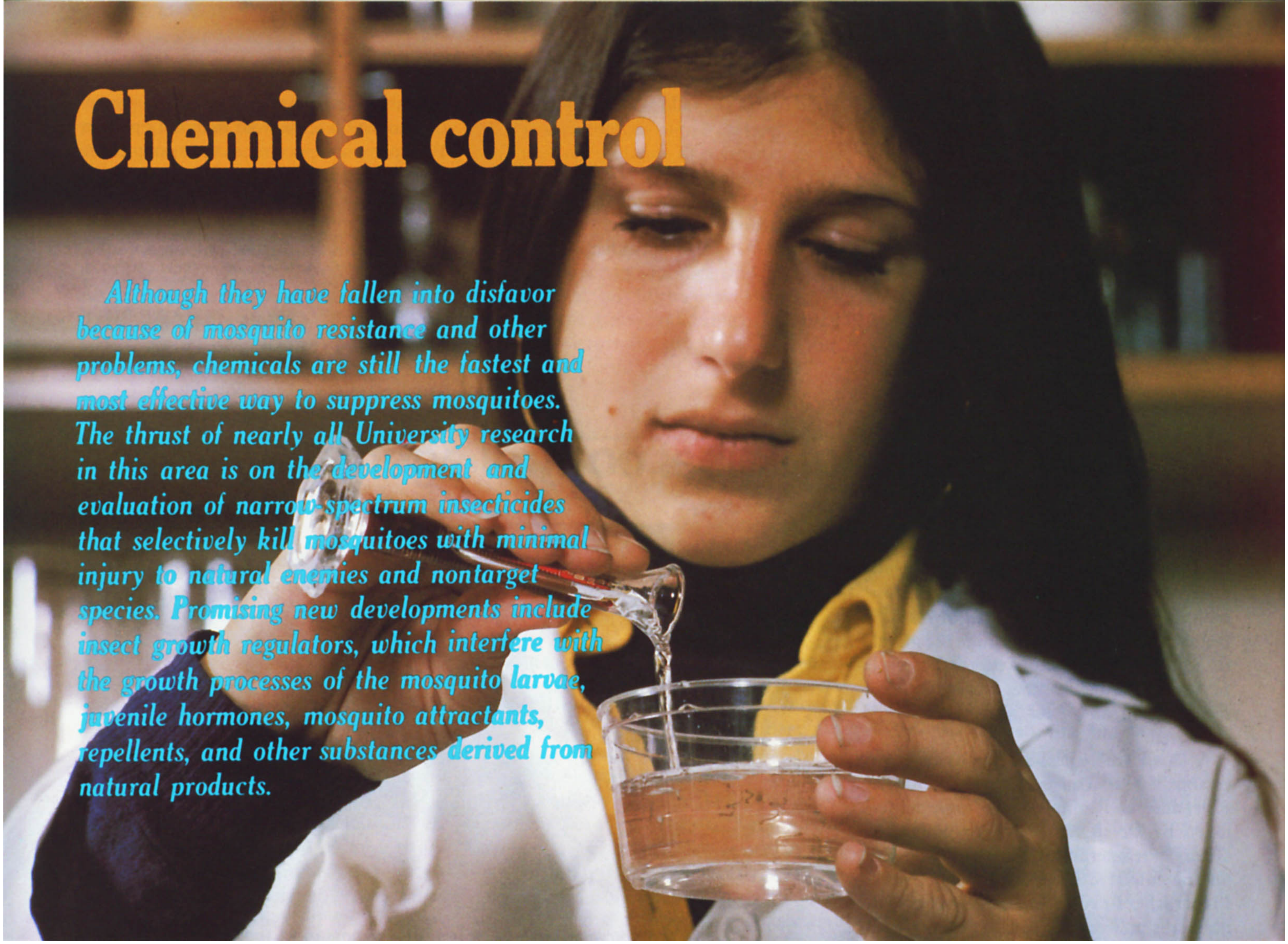

Conventional and nonconventional chemicals for mosquito control

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University researchers are systematically seeking and developing specific and less hazardous chemical tools for large-scale mosquito control programs. Following are some examples of research on the newer mosquito control agents.

Conventional insecticides

During the past seven years, the number of compounds submitted for testing from industrial and other research organizations has steadily declined. Organophosphorus-resistant (OP-R) strains of mosquitoes have cross-resistance to virtually all organophosphates received for testing. OP-resistance is widespread in field populations of *Aedes nigromaculis, Culex tarsalis, and Culex pipiens quinquefasciatus.* Propoxur, a carbamate, has now been used for more than a decade to control adults of OP-R strains; resistance to propoxur, however, has not yet been documented.

After treatment with a juvenile hormone, the mosquito dies either during the larval-pupal transformation (left) or while attempting to emerge as an adult from the cast skin (right).

Insect growth regulators (IGRs)

This broad term describes new types of chemical control agents that do not demonstrate classical toxicity but interfere with normal developmental processes, such as growth rate, molting, or metamorphosis. Research on IGRs during the past seven years has led to new chemical control agents, one of which is now being used by mosquito abatement agencies, and another expected to be approved soon for use.

Juvenile-hormone compounds

When the structure of a natural insect juvenile hormone became known in the late 1960s, a model was then available for synthesizing a new group of compounds. Many new compounds of this type were synthesized and screened, and the more active ones tested against mosquitoes. Their biological activity was found to differ greatly from that of conventional insecticides; the new compounds caused no direct toxicity except at very high doses. They caused mortality mostly in the pupal or adult stages or resulted in the formation of abnormal adults.

The new compound Altosid (methoprene) proved to be very active, especially against flood-water mosquitoes that have synchronous larval development. Intensive evaluations of methoprene side effects on nontarget organisms revealed a remarkable degree of safety, which is not the case for most conventional larvicides.

Hand-sprayer applications with an emulsifiable concentrate (EC) of methoprene showed that *Aedes nigromaculis* larvae could be controlled with as little as 1/80 pound active ingredient (a.i.) per acre but that timing was extremely critical; larvae had to be treated late in the fourth stage, because the active ingredient persisted only a few hours under field conditions. To overcome this problem, several hundred slow-release formulations were evaluated by the University of California.

The microencapsulated formulation, in which the active ingredient is contained in small particles (10u) was most effective when suspended in a water base to produce a 10 percent (a.i.) flowable concentrate. Because it provided several days of residual activity, this formulation proved to be economical for mosquito control programs. Research on the stability of methoprene in mosquito habitats led to its registration by EPA in 1974-75 as a mosquito control agent for use by mosquito abatement districts.

Methoprene is the only juvenile-hormone type of compound being sold commercially for insect control. Although other such compounds are being evaluated against mosquitoes, none is near registration.

Tertiary-butyl substituted phenols

When mosquito larvae are exposed to these compounds, they later die as unpigmented (albino) pupae. Field tests in California confirmed the potential activity of this group of compounds. They were effective against OP-R mosquito populations and showed no harmful effects on nontarget organisms and the environment. However, because they controlled only mosquitoes and were inactive against major agricultural insect pests, manufacturers concluded that their development was not commercially justified. Such economic considerations discourage those of us searching for new control agents for selective use against insecticide-resistant strains of mosquitoes.

Benzoyl-urea compounds

These compounds interfere with the mosquito molting process by inhibiting chitin formation. When mosquito larvae are exposed to benzoyl-urea compounds, they die at the time of the next molt, in the pupal stage, or as abnormal adults. One chemical agent of this type, Dimilin (diflubenzuron or TH-6040), has shown strong biological activity against all mosquito species in California. It is effective when applied by all standard methods at rates of 0.01 to 0.05 pound a.i. per acre. Treatments do suppress some nontarget organisms, especially cladocerans, but these populations usually recover, as do the target species.

When aqueous sprays containing diflubenzuron are applied over vegetation, persistent chemical residues result. However, granular formulations of this, as well as other control agents, penetrate the vegetation and release the active ingredient into the water without leaving much residue on vegetation. Persistence of this compound on soils is only short term at larvicidal rates. A petition for EPA registration of diflubenzuron as a mosquito control agent is pending.

Several other benzoyl-urea compounds are being evaluated for efficacy against mosquitoes, for nontarget effects, and for environmental persistence.

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