

Grasshopper chemical factories

A Florida grasshopper adds a manmade chemical to its repellent arsenal

by Richard H. Gilluly

Recent years have seen an eruption of concern about the chemicals man puts into the environment. Scientists are gaining increasingly sophisticated information about the interaction of the chemicals with biological systems. What should have been obvious a long time ago is finally gaining general recognition: Man cannot add materials to the environment without altering ecosystems, sometimes detrimentally.

The complexity of chemical-ecosystems interactions, and the almost infinite range of possibilities for alterations, has been sharply pointed up by a report by Cornell University scientists of one of the oddest and most unexpected discoveries yet.

The scientists say a large, flightless grasshopper, that lives in Florida, *Romalea microptera*, probably takes the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D), metabolizes it, then uses it in a kind of chemical warfare to repulse predators.

There is no evidence *R. microptera's* use of the plant poison does any harm other than to the predators. They earlier had been repelled anyway, by chemicals the grasshoppers had apparently manufactured from indigenous materials and which are still part of their frothy spray. But Dr. Thomas Eisner, a lead investigator in the study, says the work in no way sanctions careless use of chemicals in the environment. Rather, the opposite: "The study illustrates the great unpredictability of chemicals in biosystems," he warns.

Dr. Eisner says there is no evidence the grasshoppers have made special evolutionary adaptations to use 2,4-D. "We're quite sure they are just able to do it," he says. "Such uses of man's chemicals are probably not all that exceptional in the insect world," he adds. "Lots of insects and other arthropods have similar repellents [of the kind manufactured from indigenous materials]." In other words, *R. microptera*, and perhaps other insects, may have highly sophisticated chemical factories in their bodies, and sometimes they may use materials of opportunity as well as materials they are accustomed to.

R. microptera emits the smelly brown froth from a pair

of respiratory outlets on either side of its thorax. The fluid, which is mixed with air to make the froth, is manufactured in glandular tissue associated with its trachea. The froth is repellent to ants and other predators.

The Cornell researchers milked several hundred grasshoppers of the fluid by gently squeezing the insects between their fingers and collecting it. Analysis with gas chromatography and mass spectroscopy turned up nine volatile chemicals. Quinones, phenols and terpenes had been identified in earlier studies of repellent manufacturing insects, so their presence was no surprise.

What was a surprise was the discovery of 2,5-dichlorophenol, a chlorinated aromatic. All indications point to 2,4-D as its source. The researchers speculate that the herbicide is metabolized to 2,5-dichlorophenol either in plants or in the grasshopper, or in both in a complex, multi-step process.

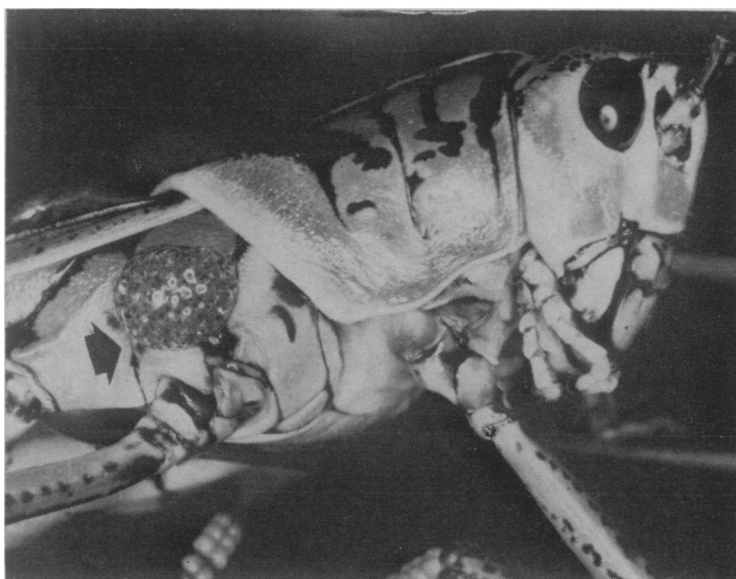
One strong piece of evidence for the herbicidal source (besides the obvious chemical one) is that there was no 2,5-

dichlorophenol in froth from grasshoppers taken on a biological station where no herbicides have been used. And the chemical is no useless addition to the froth; tests with ants showed that all by itself, it had strong repellent powers. Further, such chlorinated organic compounds are rare in nature.

Although there are many documented instances of insects using chemicals produced by other species, this, according to Dr. Eisner, is the first involving a manmade pesticide.

The Cornell researchers—Drs. Eisner, Jerrold Meinwald, Lawrence B. Hendry (now at Pennsylvania State University) and David B. Peakall—say their work should be interpreted as another reason for great caution in man's use of chemicals.

Yet presumably because there is no apparent ecosystem harm from *R. microptera's* unusual co-optation of man's technology, "Some people," says Dr. Eisner, "incredibly, have interpreted it in exactly the opposite way." □



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Romalea microptera with its repellent froth emerging.