Good and bad news for migrating monarchs

Each winter the Oyamel forests of central Mexico blaze orange with hundreds of millions of monarch butterflies that come to escape colder areas. Their stunning wings carry natural chemical tags that are enabling scientists to trace the insects to their birthplaces across eastern North America, giving clues about where monarch conservation is most needed.

Leonard I. Wassenaar and Keith A. Hobson of Environment Canada in Saskatoon, Saskatchewan, have used natural chemical tags to study songbird migration (SN: 12/5/98, p. 356). Their report in the Dec. 22, 1998 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES marks the first time the technique has been applied to migrating insects.

"It will allow us to definitively answer questions that we have been just nibbling at for decades," says monarch specialist Sandra M. Perez of the University of Arizona in Tucson.

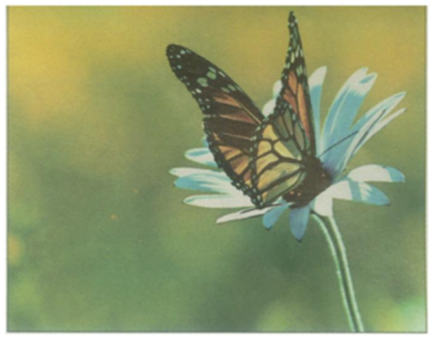
Until now, researchers' primary method for tracking monarch migration has been to paste tiny adhesive tags on the butterflies' wings while the insects are up north and hope to find the same insects later. This technique revealed the monarchs' general migration pattern, but only 125 out of hundreds of thousands of tagged butterflies have turned up in Mexico since 1975, when the winter colonies were discovered.

"With the [new] technique, every monarch butterfly you see has a 'tag,'" Perez says. The chemical tags reflect different concentrations of hydrogen isotopes in rainwater across the continent.

The isotope called deuterium clutches an extra neutron in its nucleus and so is heavier than ordinary hydrogen. As a result, water molecules containing deuterium tend to fall out of clouds before those bearing hydrogen. For example, storm systems that begin over the Gulf of Mexico and work their way inland drop more deuterium along the coast than in midcontinent regions.

The tag is passed along as the water moves from soil to milkweed plants, the monarch caterpillar's main food. "You are what you eat, isotopically," Wassenaar says. The isotope ratio is constant from the plant to the caterpillar and, finally, to the adult butterfly.

Wassenaar and Hobson matched the isotope tags of 100 monarchs from each of the 13 winter colonies with those of butterflies captured at the breeding grounds the previous summer. The summer origins that the researchers identified revealed that each winter colony draws butterflies



Half of the monarchs that winter in Mexico come from the U.S. Midwest.

from all across the breeding range, "which is good news for the monarch," Wassenaar says. Logging threatens most of the Mexican forest colonies, and researchers had feared that loss of a single winter site could strike a fatal blow to an entire breeding population.

The bad news is that Mexico is not the only country with a monarch-conservation problem, says Orley R. Taylor of the University of Kansas in Lawrence. At least half of the winter migration stems from the U.S. agricultural heartland, between eastern Nebraska and western Pennsylvania. Open fields of corn and soybeans are popular spots for milkweed, but the plant may soon be wiped out as crops are bioengineered to survive pesticides designed to kill all weeds, says Taylor. Loss of the milkweed would threaten the monarch's survival. *—S. Simpson*

Math discoveries catch kids unawares

Many educators and scientists assume that conscious knowledge is the engine that drives learning. A new study suggests instead that, at least among grade-schoolers, unconscious problem-solving insights often set the stage for academic advances.

Second-graders who practice solving inversion problems—such as 8 + 10 – 10 = 8—start out by computing the answers but frequently turn to a more efficient strategy unconsciously. Without realizing they are doing it, they learn to ignore the number that is both added and subtracted, report psychologists Robert S. Siegler of Carnegie Mellon University in Pittsburgh and Elsbeth Stern of the Max Planck Institute for Psychological Research in Berlin.

Children more quickly attain this insight, and become aware of it sooner, when practice sessions include only inversion problems, rather than mix them with other math problems, such as 9 + 10 – 3.

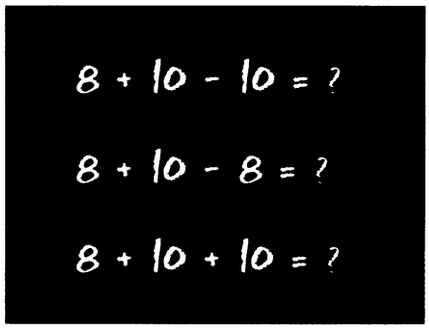
However, after becoming aware of the shortcut, kids employ it only part of the time, returning at other times to more time-consuming calculations. In the long run, the child's nurturing of an array of problem-solving tactics allows for adjustments in tougher math challenges, Siegler and Stern propose.

"We find that a strategy can be used to solve a problem without people knowing that they used it," Siegler says. "We need to see if children and adults generate unconscious discoveries on other tasks."

Siegler and Stern studied 31 children, 8 or 9 years old, who attended an afterschool center in Munich. In pretests, children said that they solved inversion problems by using computation (such as adding 10 and then subtracting it from 8) or negation (adding 10 to 8, then realizing that 10 – 10 = 0 and skipping to the result)—strategies taking at least 8 seconds per problem.

Children then completed six weekly practice sessions. Each session featured 20 problems, all inversions for some kids and a mix for others.

Nearly all children in both conditions discovered the shortcut strategy for solving inversion problems without realizing it, the scientists report in the December 1998 JOURNAL OF EXPERIMENTAL PSYCHOLOGY: GENERAL. Kids exhibited sudden, sharp drops in solution times, to 4 seconds or less, that are typically achieved by using the shortcut. Nonetheless, they



continued to tell researchers that they used calculation or negation to reach correct answers.

Children who solved only inversion problems reported using the shortcut after having employed it unconsciously five or fewer times. Those exposed to a mix of problems took longer to become aware of using the shortcut and often cited a transitional strategy, such as saying "8 + 10 . . . 9, 10, 11 [counting on fingers] . . . oh, it's 8!"

Kids given only inversion problems proved more likely to apply the shortcut both to appropriate (8 + 10 – 8) and inappropriate (8 + 10 + 10) variations.

"This study shows that conceptual insights emerge unconsciously during practice," remarks psychologist David C. Geary of the University of Missouri in Columbia. "Learning may often be outside conscious control." *—B. Bower*