

Monarchs Check Clock to Chart Migration Route

People who need to consult maps, radio traffic reports, or the Global Positioning System to navigate from one city to another should stand in awe of monarch butterflies. They migrate thousands of kilometers to a small

winter retreat in Mexico. These intrepid travelers use the sun as a guide, but exactly how has been a mystery. Now researchers demonstrate that monarchs depend on an internal clock to determine their course.



Fly away home. Monarch butterflies use the sun as a guide and an internal clock to keep them on course as they migrate to Mexico.

Studies of birds 50 years ago indicated that long-distance migrants “need an accurate internal timepiece” to use the sun as a compass, says Steven Reppert, a neurobiologist at the University of Massachusetts Medical School in Worcester. Without a clock, the sun would prove an unreliable landmark as it moves across the horizon; a clock allows animals to compensate for this apparent motion and maintain a direct course.

By combining genetic and behavioral studies, as reported on page

1303, Reppert and his colleagues established that monarchs use their internal timepiece, apparently set by genes that are important to circadian rhythms, to fly in the right direction. The work “shows provocative links between the circadian machinery and the compass mechanism required for seasonal migration,” says Gene Robinson, a neurobiologist at the University of Illinois, Urbana-Champaign.

To demonstrate that monarchs have internal clocks and that these clocks are set by daylight, Reppert’s collaborator Oren Froy tested monarchs’ emergence from their chrysalises. They normally emerge in the morning, but exposure to constant light instead of daily light-dark regimens caused the butterflies to emerge throughout the day, indicating that their clocks had been disrupted.

Next, Anthony Gotter, also part of Reppert’s team, looked at flight patterns during lab simulations of a normal day-night cycle, one in which light was advanced 6 hours, and one in which night never came. Once the butterflies were accustomed to these light regimens, Gotter tested their behavior outside using a flight simulator, a 150-liter barrel in which the butterfly flies while tethered to a tungsten wire connected to a computer. The monarchs could track the sun’s path as it moved over the top of the simulator, which was open to the sky. Butterflies whose lab light cycle corresponded to local daytime headed southwest. They had been collected in Massachusetts at the beginning of the study, and “that seems to be the genetically programmed direction that they need to go to get to Mexico,” Reppert says.

Next the researchers looked at monarchs whose exposure to light was advanced by 6 hours, so the “day” in the lab lasted from 1 a.m. to 1 p.m. Outside, these would-be migrants shifted their orientation by 115° and headed southeast. Like birds whose circadian rhythms have been fooled, the time-shifted insects failed to interpret the sun’s position correctly. During the morning, they acted as though the sun were in the west rather than the east. Butterflies that had been in constant light indoors simply headed straight for the sun no matter where it was in the sky.

To see whether gene expression corresponded to light-induced changes in behavior, Reppert and his colleagues measured RNA from a gene called *period* (*per*). Fruit fly researchers had identified *per* as a key gene for setting the internal clock, and Reppert’s group isolated the gene in monarchs. The *per* gene’s activity was high during dark periods and low during light times. Butter- ▶

SARS

Researcher Told to Stay Home After China Trip

NEW YORK CITY—Ian Lipkin is working hard to improve diagnostic tests for severe acute respiratory syndrome (SARS). And now he knows firsthand how important they are: An accurate test might have prevented health officials from slapping Lipkin, a researcher at Columbia University in New York City, with an isolation order last week, when he developed fever and a cough after returning from China.

Lipkin flew back to New York City on 7 May after spending 3 days with top SARS researchers in Beijing at the invitation of the Chinese government. Six days later, he developed symptoms that included fever and a cough, making him a suspected SARS case.

Lipkin is convinced he doesn’t have the disease; his first symptoms were a runny nose, sneezing, and congestion, whereas SARS usually starts with a fever and an unproductive cough. What’s more, four nasal and two oral swabs tested at his lab using the polymerase chain reaction all came back “stone-cold negative,” Lipkin says, “and I think I’m running the best assay on the planet.”

Nonetheless, Lipkin decided to stay away from a SARS meeting at the New York Academy of Sciences last Saturday that he had helped organize; instead, he followed the talks and asked questions through a speakerphone, occasionally startling partici-

pants with frightful coughs. Also at the meeting were Marcelle Layton and Donald Weiss, two top communicable-disease officials at the city’s Department of Health. Before the day was over, Lipkin received a call from the department, telling him to stay home until 25 May.

New York City Department of Health spokesperson Andrew Tucker says the agency doesn’t discuss individual cases, but he confirmed that a “50-year-old male with a travel history” became New York City’s 22nd suspected SARS case this weekend. Allan Rosenfield, dean of Columbia’s Mailman School of Public Health, says “everybody here is 99% sure [Lipkin] just had a bad cold.” But he says he respects the city’s decision.

Lipkin, who had to cancel a talk at the American Society for Microbiology’s general meeting on Tuesday, says his temporary imprisonment drives home the need to develop a validated test as soon as possible—the next flu and cold season could be “absolutely crippling to the health system” without one, he says. In the meantime, he’s trying to work from home; and in case he gets bored, he says, “Marci Layton has said she’ll rent me some videos.”

—MARTIN ENSERINK

Smithsonian Seeks to Boost Fellowship at Natural History

Curators at the Smithsonian National Museum of Natural History consider visiting doctoral and postdoctoral fellows the lifeblood of their institution. Over the past decade, however, shrinking budgets have squeezed the flow, reducing visiting fellows to about a half-dozen. But museum director Cristián Samper hopes to restore it with a \$20 million initiative included in his 2005 budget request, which the Smithsonian is just beginning to assemble.

The fellowships initiative is just one of several ideas for invigorating Smithsonian science. Another calls for spending \$15 million on a program to develop molecular fingerprints for existing and newly discovered species. And the museum would like \$20 million to create a molecular genetics inventory of tropical forests and their pollinators and herbivores. That work will involve the Smithsonian's Tropical Research Institute in Panama. The Smithsonian Environmental Research Center in Maryland, meanwhile, hopes to develop a new focus on invasive marine species.

Samper emphasizes that the efforts are still in the planning stage. (The White House won't approve the 2005 budget request until late this year.) Still, Smithsonian scientists say they like the ideas; museum paleontologist Kay Behrensmeyer is particularly pleased "that the fellowships came out on top."

—ELIZABETH PENNISI

Update: Stranded Chinese Physicist Gets Visa

After an 8-month wait for a visa, a Chinese physicist is finally returning to her research at the University of Utah in Salt Lake City.

Last fall, fifth-year doctoral student Xiaomei Jiang returned to China after her parents died, for what she expected to be a brief visit (*Science*, 20 December 2002, p. 2305). But post-9/11 security reviews stalled her return visa and those for thousands of other foreign students and researchers. The National Academies protested the delays, saying that they were having "serious, unintended consequences for American science."

Bush Administration officials have been working to clear the backlog, and Jiang reported this week that she had received her visa. She hoped to fly back to Salt Lake City within days and restart a life that had been put on an unexpected hold.

—DAVID MALAKOFF

flies exposed to constant light for several days showed no swings in *per* activity.

Taken together, the experiments demonstrate that the internal clock, perhaps timed by *per* activity, tells monarchs how to calibrate their movements against the sun. "It's the first molecular entrée" into the clock-assisted migration, says Charalambos Kyriacou, a behavioral geneticist at the University of Leicester, U.K.

But it's no slam dunk. Orley Taylor, an entomologist at the University of Kansas, Lawrence, is not sure the work demonstrates that the clock guides navigation. "The data would be more conservatively interpreted as phototactic [light-based] orientation," he says.

In any case, many mysteries of monarch migration remain. For instance, monarchs from different parts of the eastern United States and Canada all end up in the same Mexican wintering grounds. They follow different bearings and start their journeys at different times, a feat that is hard to reconcile with a simple, species-wide clock, says Taylor. A further complication is that each year at least three generations of butterflies emerge before the last one flutters to Mexico in the fall. No one knows what triggers migration in that generation, says Reppert, but the circadian clock might help them recognize shortened day lengths and therefore the changing of the seasons.

—ELIZABETH PENNISI

ROYAL SOCIETY

Nine Women Make 2003 a Record Year

A record nine women are among the 42 new fellows elected by the U.K.'s Royal Society this year. Monday's bumper crop of female fellows comes just 3 weeks after the society's U.S. counterpart, the National Academy of Sciences (NAS), elected its highest-ever number of women—17—in its annual class of 72 fellows (*Science*, 9 May, p. 883). Women now make up 4.4% of the Royal Society's total fellowship of 1290, and 7.7% of NAS's 2015 members are female.

"The underrepresentation of women in science, engineering, and technology remains a major problem, but progress is being made," said Robert May, president of the society, in a press statement (www.royalsociety.org). He said that 11% of fellows elected in the past 5 years have been women, "which runs somewhat ahead of the percentage of women professors" in scientific disciplines at U.K. universities.

The 343-year-old scientific academy, which has never before elected more than four women in a year, came under fire from a British parliamentary committee in 2002 for having a low proportion of women and ethnic minorities. It has defended itself against charges of gender bias by pointing to the lack of women in U.K.'s scientific workforce. Julia Higgins, who was elected in 1995 and is now a vice president, says the society cannot be expected to elect a large share of women

when "the pool of women at senior levels in science in the U.K. is so small."

Among this year's fellows is Jocelyn Bell Burnell, a University of Bath astronomer whose doctoral work at Cambridge was a cornerstone in the discovery of pulsars in 1968. The discovery won a Nobel for her adviser, Antony Hewish, who shared the prize in 1974 with another British astronomer, Martin Ryle. A number of prominent scientists

maintain that Burnell deserved the prize as much as Hewish and Ryle.

"The perception back then was that science was done by senior men who had a fleet of minions to do their bosses' bidding," says Burnell. "When the Nobel was awarded, I wasn't in the frame because I was a junior and a woman." The increase in the percentage of women fellows, says Burnell, reflects a broader trend of many women

scientists, such as DNA crystallographer Rosalind Franklin, "getting written back into the history of their subject."

Other women joining the fellowship include Oxford molecular biologist Kay Davies, Harvard developmental geneticist Elizabeth Robertson, and Cambridge mechanical engineer Ann Dowling. Among the society's newly elected foreign members are two men from Germany, two from the United States, and one each from Mexico and Switzerland.

—YUDHIJIT BHATTACHARJEE



Better late than never. Astronomer Jocelyn Bell Burnell is one of nine women newly elected to the Royal Society.

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