ANIMAL ECOLOGY

Global Tracking of Small Animals Gains Momentum

If Martin Wikelski has his way, the International Space Station will one day keep a close eye on thousands of our planet's bats, songbirds, dragonflies, rodents, and other small creatures.

A specialist in animal movements, the ecologist at the Max Planck Institute for Ornithology in Radolfzell, Germany, has for a decade pursued what a collaborator once dubbed a "ridiculous idea": a new space-based system to track animals too small to be monitored globally with current instruments. Next month, however, Wikelski and his colleagues will begin testing whether a new animal tag can eventually communicate with the International Space Station. Wikelski has also been promised $2.3 million to start to set up an antenna on the space station for ICARUS, as the project is called. If all goes well, he says, by the end of 2014, the antenna will be tracking about 1000 small animals, with the potential to follow thousands more, enabling him and collaborators to assess how the creatures spend their lives and where they die.

Keeping tabs. A proposed space station antenna would help researchers figure out where these African fruit bats go after breeding.

Wikelski's fellow biologists are eager to see ICARUS succeed. "I would see that as a major leap forward," says John Wingfield, an environmental endocrinologist now heading the biology directorate at the National Science Foundation. "It expands the capability to monitor and follow animals from space."

A well-established space-based animal-tracking system called ARGOS already exists, using a constellation of satellites to observe tagged creatures. A mainstay of migration studies for decades, ARGOS has, for example, enabled researchers in the Census of Marine Life to follow 23 marine species, including albatrosses and whales, for weeks or even years. "When the ARGOS satellites became available, [they] completely revolutionized the way people looked at migratory movements," says Chris Guglielmo of the University of Western Ontario in London, Canada, who studies bird migration.

Yet for the most part, transmitters needed to communicate with the ARGOS network are relatively large, limiting what can be tagged. "We miss the vast majority of the small animals on the planet," Guglielmo says.

Wikelski came up with the idea behind ICARUS almost a decade ago, after he and Roland Kays, a mammalogist at New York State Museum in Albany, successfully tracked some 374 members of 38 mostly small species, ranging from mammals to insects, in a Panamanian forest. They could use smaller tags than those for ARGOS because the devices only needed to connect with a series of antennas arranged among the trees. Wikelski wondered whether similar antennas, placed into space, could follow small species that roamed more widely.

Kays scoffed at Wikelski's idea, as did NASA when he sought support in 2003. But Wikelski was inspired and encouraged by George Swenson Jr., a radio astronomer at the University of Illinois, Urbana-Champaign, who helped devise the Very Large Array, a series of ground-based antennas that use sophisticated signal processing to detect faint radio waves from distant galaxies. In 2005, Wikelski and Swenson's Illinois colleague William Cochran proposed a sort of reverse radio astronomy, a low Earth-orbiting antenna that would pick signals from tagged small animals out of the myriad of other louder radio signals coming from Earth. To test out the concept, Wikelski and his colleagues put small radio tags on dragonflies and chased them for 12 days by car, motorcycle, and plane (*Science*, 11 August 2006, p. 780).

Wikelski originally envisioned a system of new low Earth-orbit satellites, but he concluded that would be too expensive and time-consuming, among other problems. The space station seemed to offer a good alternative. It passes over all points between 70° north and 70° south three times a day, which would enable one antenna to monitor tagged animals on most of the planet. Wikelski's persistence paid off this year when the German Air and Space Agency told Wikelski it hoped to commit $2.3 million toward outfitting the space station for ICARUS by 2014.

Wikelski must still work with a company to develop lighter radio transmitters powerful enough to be detected in space. Some existing tracking tags weigh as little as 5 grams, but generally they are heavier because of the power needed to send signals to the ARGOS satellites, which are 850 kilometers above Earth. Often tags will have a global positioning system (GPS) for more accurate position information, but that adds even more weight. (Tags that calculate location based on day length are much smaller but are accurate only to within 100 to 200 kilometers.)

Because the space station is only 320 kilometers away, the ICARUS system will demand much less energy than ARGOS to send data, reducing battery requirements. As currently designed, most tags for ICARUS will contain a GPS that regularly takes stock of the wearer's location, storing those data for many months if needed. To be most energy efficient, the ICARUS tag will be preprogrammed to turn on only when the space station will pass overhead and will deliver its data only when triggered by the space station. The first tags, with GPS, will be 5 grams, and Wikelski thinks they will get lighter. But, Guglielmo cautions, "if it were that easy, other companies would have done it."

Still, Guglielmo is hopeful ICARUS will fly. For most migrating species, researchers don't know where animals go once they leave their breeding grounds—knowledge critical for setting up conservation plans. "I think people will line up to try out the system," says Guglielmo, who would like to use this technology to follow birds that migrate through Canada.

–ELIZABETH PENNISI

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