

Did Insects Skim Before They Flew?

A fly fisherman, James Marden spent many hours watching insects flit about the water's surface, little knowing that his casual observations would someday provide new insight into how insects evolved wings. Then, one chilly day, a stone fly skimming along an icy stream made Marden wonder whether the first flying insects took off from water, not land.

Now, this evolutionary biologist at Pennsylvania State University in University Park and a student, Melissa G. Kramer, have created a possible scenario for the evolution of wings in these six-legged creatures.

As with the origin of flight in vertebrates (SN: 2/6/93, p.87), the origin of insect flight has proved hard to pin down. Insect fossils from almost 400 million years ago have fully developed wings. Yet older fossils show no signs of wings at all, Marden says.

Some evolutionary biologists suggest that wings began as courtship ornaments, to make an individual more attractive to its mate (SN: 2/6/93, p.84). A few male crickets, for example, flap nonfunctional wings to lure females, and those with bigger wings mate more often than those with smaller ones, Marden says.

Others think wings first served as solar panels, to help insects warm up and keep active more hours of the day. Support for this idea comes from demonstrations that small "wings" indeed collect heat. However, wings large enough for gliding do not really help the insect keep warm.

On the basis of his close examination of wingless insect fossils, paleontologist Jarmila Kukalova-Peck of Carleton University in Ottawa, Ontario, proposes instead that wings originated as gills used for either swimming or gas exchange.

Marden didn't buy the first two theories, because such early "wings" don't require the muscles that insects had to evolve to power flight. And until he saw

the stone flies skimming along the water, he couldn't quite figure out how gilled creatures made the transition to an airborne existence. "The models all assumed that flying came from glid-

Tiny hairs keep wings dry (top) as a stone fly skims across water (bottom).

ing," he explains.

Entomologists consider stone flies and another aquatic insect, the mayfly, to be primitive relics that, like horseshoe crabs, have changed very little over millions of years. During the early stages of their life cycles, these insects live underwater. When they transform into winged adults, they climb onto a rock, then skim to shore. There they find food and mates, says Marden.

To skim, these insects flap their wings as if to fly, but they never lift off. Thus, stone flies have acquired not only the wings, but also the muscles, patterns of movement, and articulations needed for flight, Marden notes. "[They provide] a way for showing how all the flight components could have come about," he adds.

Marden and Kramer clipped the wings of some stone flies of the species *Taeniopteryx burksi*, videotaping individuals before and after clipping to assess skimming speed relative to wing size and to the ratio of flight-muscle mass to body size. They also changed the ambient temperature: Cooling reduced muscle output, simulating the effect of less muscle power.

The larger the wings, the greater the relative muscle size, and the warmer the environment, the faster the insects skimmed, Marden and Kramer report in the Oct. 21 SCIENCE. Moreover, stone flies could still skim in 1.5 °C air and with their wings clipped to about 25 percent of normal length.

The researchers also noticed that in the warm laboratory, 31 stone flies tried to fly. Six gained altitude, while 9 maintained sustained flight and 16 could not, Marden and Kramer report. Those with bigger muscles flew best and skimmed most rapidly. "[These tests] allowed us to show that skimming improved right up to the point that they were big and strong enough to fly," Marden points out.

Moreover, tiny curved hairs cover the wing surface of adult stone flies and subadult mayflies. These hairs keep the wing dry and afloat. Stone flies also have hair on the ends of their legs. These hairs provide a new feature for paleontologists and evolutionary biologists to look for as they puzzle over whether insects first had to swim, then skim before they could fly, Marden adds.

— E. Pennisi

Atomic age spawned experiments on humans

Throughout the first 3 decades of the nuclear age, radiation experiments involving humans were both common and widely debated — at least within federal decision-making circles — the 6-month-old Advisory Committee on Human Radiation Experiments reported late last week.

President Clinton chartered the 14-member committee to investigate the research value and ethical underpinnings of 13 specific human radiation experiments — and those of any others it could track down.

So far, the group has identified about 400 such experiments between 1944 and 1974. However, data suggest that the final tally will reach several thousand, notes committee head Ruth R. Faden, an ethicist at Johns Hopkins University in Baltimore.

Documents turned over to the panel by federal agencies now indicate that during the late 1940s and early 1950s, policy makers debated whether to involve humans in radiation experiments and, if so, whether they should restrict those studies to people who gave some kind of informed consent.

The conventional wisdom has been "that there was very little such active discussion at the government level," Faden points out.

In fact, however, such discussions led

the Secretary of Defense in 1953 to issue a "top secret" policy directive stating that the Nuremberg Code's ethical guidelines for experiments must "govern the use of human volunteers by the Department of Defense (DOD) in experimental research in the fields of atomic, biological, and/or chemical warfare." But, Faden notes, "we have reason to believe, at least in some instances, that [such] policies were not followed."

Moreover, she says, "we are clearly concerned about the possibility that there may have been injustices in the selection of subjects. . . whether there was consent or not."

In this regard, the report points to studies in which researchers exposed people to plutonium and other radioactive materials "with no clear therapeutic or diagnostic potential," in which researchers irradiated the testicles of prisoners, and in which pregnant women received radioactive iron as part of a study on uptake of the metal by the fetus.

The report also makes passing reference to more than 300 tests that intentionally released radiation outdoors — usually at national laboratories or military centers — to investigate the effects of nuclear warfare or nuclear rocket and aircraft technologies.

— J. Raloff



Marden, Kramer/Science

