about half a billion dollars per shuttle flight. "It's costly as hell," says Simon Ostrach, a materials scientist at Cleveland's Case Western Reserve University who has flown experiments on Spacelab. "I'm not sure any scientist would say it's worth the cost of shuttle flights." Still, he adds, costs are relative. "Physicists, for example, use some pretty expensive facilities, too." Robert Park, a physicist at the American Physical Society, notes that Spacelab-related research is probably the costliest in history. "Some of the science is probably worth doing, but there is a lot of science we don't do because it costs too much."

Figuring out the value of the science done on Spacelab is not a simple matter, however. "On a cost-per-science basis, it's a pretty pricey program," says NASA adviser Norine Noonan, a former White House official and now dean of the graduate school at the Florida Institute of Technology in Melbourne. "But if you want to encourage a community, you have to provide flight opportunities."

Such efforts are needed, says Noonan, to help the life and microgravity sciences overcome their second-class status at an agency focused on astronomy and astrophysics. "They've always been the stepchild—the Cinderella without the glass slippers," she says. The agency's relationship with the outside scientific community has not been much better. "To this point, NASA's interaction with the biomedical community has been negative," says Osborn.

But missions like Neurolab are altering that perception, say some non-NASA researchers. Andrew Monjan, chief of aging neurobiology at NIH, says he's seeing a marked improvement in NASA's attitude. For example, NIH assembled a panel to review each of Neurolab's 26 experiments—the first time such a review has been conducted for a Spacelab mission, say NASA officials, and a measure of the agency's quest for scientific quality. Planned experiments during the 16-day flight range from three-dimensional rat mazes to examining synaptic connections in crickets.

Although Neurolab researchers say the data will be critical for understanding the brain, some outsiders disagree. "I'm not very impressed with the experiments I'm familiar with," says Charles Stevens, a Salk Institute neurobiologist. "The money would be much better spent on Earth." Adds another neuroscientist: "The science they're doing is unbelievably boring."

To date, NASA lacks metrics on Spacelab's accomplishments. Life and microgravity scientists will meet this fall to examine the impact of their work over the past 15 years. Although Seibert estimates that several hundred students have received graduate degrees based on work from Spacelab and that the experiments have produced more than 1000 scientific papers, even the program's supporters acknowledge that there have been no major breakthroughs. "The amount of really good science done is limited," says Osborn.

One reason, says Ostrach, is the lack of flight opportunities. "There is precious little time in space for experiments," says Ostrach, who waited for more than a decade to fly an experiment and whose son now has one on Neurolab. "We've had the total experimental time of one master's thesis." He says it is also hard to repeat and alter experiments and to publish papers based on only one data set.

NASA managers will decide shortly whether to approve a second Neurolab flight in September, a mission that would definitely be the swan song for Spacelab. With the space station not scheduled for completion until 2003, that mission looms as the start of hard times for researchers trying to hitch a ride into orbit.

–Andrew Lawler

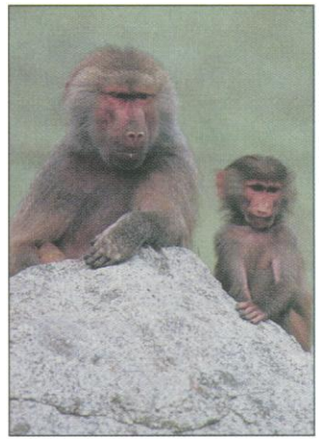
SOCIOBIOLOGY

A Blow to the 'Grandmother Theory'

When anthropologists announced a new evolutionary explanation for menopause last February, papers from the *Sydney Morning Herald* in Australia to *La Vanguardia* in Spain spread the news. The idea that it's advantageous for human females to live long after menopause so they can help feed their grandchildren—a notion taken from studies of African hunter-gatherers—captured public attention (*Science*, 25 April 1997, p. 536). But now a study of old female lions and baboons, published in this week's issue of *Nature*, challenges this "grandmother hypothesis."

Co-author Craig Packer, a biologist at the University of Minnesota, St. Paul, found that in these species, grandmothers did help feed and protect their grandchildren—but their investment had no impact on the youngsters' survival when compared to those lacking grandmothers. And loss of fertility did not boost the amount of care older lions or baboons gave to their grandchildren—in fact, only lions who were still nursing their own cubs were also able to nurse grand-cubs. In Packer's view, "menopause isn't adaptive. It has no function." Rather, it's simply a consequence of the aging of female reproductive systems.

However, the timing of menopause, Packer says, is influenced by how long mothers need to stay alive to ensure the survival of their own offspring. He and co-authors Marc Tatar of Brown University in Providence, Rhode Island, and Antony Collins of the Gombe Stream Research Centre in Kigoma, Tanzania, found that the few female baboons who survive to old age begin to lose their fertility at about age 21, then live another 5 years or so. Lions lucky enough to live until the beginning of menopause at age 14 die by age 18. The length of the interval between menopause and death, Packer says, appears to be determined by how long infants depend on their mothers: Lion cubs are vulnerable for only 1 year, so their mothers don't need to live much longer. But baboons orphaned at age 2 usually die, so a baboon mother's life-span is 5 years beyond her last pregnancy—somewhat longer than the time in which she has a dependent infant.



G. LACZ / ANIMALS, ANIMALS

Quality care? Young olive baboons may enjoy the company of grandmothers, but such care doesn't help them survive.

In humans, most children are dependent on their mothers for about 10 years and fertility begins to decline at 40. Scaling that to the numbers seen in lions and baboons, the expected life-span for women who survive into old age would be 58 to 65 years—perhaps the life-span for hunter-gatherers before modern medical care, although actual numbers are unknown. "There's no reason to stay alive to look after your grandchildren," says Packer. "Postmenopausal life expectancy is for looking after your own children."

But one of the authors of the grandmother hypothesis, anthropologist Kristen Hawkes of the University of Utah in Salt Lake City, isn't ready to concede defeat. She notes that only a few adult female lions and baboons survive past menopause—only 3.4% of lions and only 7% of baboons. By comparison, more than 80% of women hunter-gatherers live that long—and they often survive into their 70s, well beyond the decade needed to ensure their own offspring's survival. "I'm going to use these data [to strengthen my argument], because it shows we're really odd in that we live so long after menopause," says Hawkes. She says that human grandmothers, with their provisioning of weaned grandchildren, are doing "a very special kind of thing."

–Ann Gibbons