containing RGCs link to the SCN.

Meanwhile, those studying melanopsin will soon have another tool: mutant mice that lack the pigment. "I think there is a high probability they are going to see some defect" in those mice, says Northwestern's Takahashi. A defect would be further evidence that melanopsin has a light-sensing role.

But it may be too much to expect the clocks in the mutant mice to be totally unresponsive to light. The circadian clock is too important for survival to rely on just one photopigment, Takahashi says. Although melanopsin may be the clock's main light detector, most researchers expect that there are other sources of light information—perhaps from the rods and cones, or from cryptochrome-containing cells—that may fill in if melanopsin is knocked out.

"It is very satisfying that everything has come together this way," says clock researcher Greg Cahill of the University of Houston about the recent progress. After years of learning which cells and molecules are not the circadian photoreceptors, he says, "now, we have really nice information about what they might be." **–MARCIA BARINAGA**

MEETING PRIMATOLOGY

Homeland Defense In the Wild

INUYAMA, JAPAN—The 100 participants in "Research on Long-Lived Animals" held here 15 to 18 January discussed the driving force behind male territoriality in chimpanzees, the behavior of gibbons toward long-lost relatives in need, and a successful effort to protect muriquis in Brazil. But they also explored the sociability of primates, with both welcoming and farewell parties and a trip to a traditional Japanese pub.

Territorial Motives

Are male chimpanzees after food or sexual favors when they seek to expand their territory? An analysis of 25 years of data from the Kasakela chimpanzee community at Gombe National Park in Tanzania suggests that both reasons apply, with nutrition taking the lead in this long-running debate among primatologists.

The Kasakela community may be the best studied group of primates on Earth thanks to the pioneering work of primatologist Jane Goodall in the early 1960s. Although Goodall is still involved, most of her efforts now go into conservation. Local workers have continued tracking individual animals from nest to nest, recording their movements, diet, weight, companions, and interactions, with both group members and neighboring communities. But their notebooks were accumulating dust in Goodall's house in Dar es Salaam until 1990, when Anne Pusey and colleagues at the department of ecology, evolution, and behavior at the University of Minnesota, Twin Cities, shipped them to the university's Jane Goodall Institute.

Using computers to tease out a number of subtle changes over time, Pusey presented evidence here that male territoriality is aimed at gaining access to food rather than attracting mates, as many believed. At the same time, a copious food supply has the added benefit of enticing more females. "This is really something of a merger of the two theories," says Pusey. A report on a portion of these results is in press at *Animal Behavior*.

Chimpanzee communities consist of roughly equal numbers of adult males and females and their offspring. Males stay with the natal group for life. Interactions with male chimps from neighboring groups are always hostile, usually fiercely so. Juvenile females typically migrate to a different group. Once they become adults, however, females usually remain with a community and tend to stay near the center of the community's territory.

CREDIT: A. PUSEY

Banana bait. A treat lures Gombe chimps onto scales to be weighed.

Pusey's analysis refines that observation by showing that adult females modified their roaming pattern in accordance with changes in the community's boundaries, which varied over time from 5.5 to 13 square kilometers. When the group's territory grew, the core area covered by adult females also expanded. When the group's territory shrank, adult females restricted their movements to a smaller core to avoid being at the edges of the territory.

When the Kasakela group expanded its territory, males were not rewarded with more females, Pusey says, presumably because females in the neighboring community also restricted their movements to a smaller core area as their group's territory shrank. Indeed, when adult females did occasionally wander into the fringes of Kasakela territory, Kasakela males drove them away. "So we don't think access to females is the prime motivating factor in defending territory," Pusey concludes.

Instead, the analysis supports the hypothesis that males defend a feeding range for themselves, resident females, and their offspring. Signs of better nutrition followed an increase in the group's territory: Average body weight climbed, resident females were more likely to show the swelling of the rump indicating fertility, and their babies were born closer together.

Even so, an expanding empire may eventually pay off in the mating game. Pusey's team also found that juvenile females were more likely to join the Kasakela community when its territory was at its maximum. Perhaps they recognized that the group commanded a good food supply, Pusey speculates, or were attracted to heavier, better fed males. "One of the benefits of long-term studies is that you can answer questions you might not even have thought of when you started the study," says Jan van Hooff, a primatologist at the University of Utrecht, the Netherlands. "And these results from Gombe are a good example."

Why the size of a community's territory waxes and wanes so much remains a puzzle, however. Pusey says recent studies of chimp groups adjacent to the Kasakela community suggest that groups expand their range when they outnumber their neighbors. But more long-term data are needed to understand what triggers these growths and declines in population, data that might yet be found in the Gombe notebooks.

Set Out Another Plate, Ma

A crisis often brings families closer together. That adage is as true for gibbons as for humans, according to new work by Teruki Oka, a primatologist at the Forestry

Fireproof friendships. Gibbons in East Kalimantan reestablished familial ties after being uprooted by forest fires.

and Forest Products Research Institute in Morioka, Japan.

Oka began studying gibbons in the Bukit Soeharto Education Forest of Mulawarman University in East Kalimantan, Indonesia, in 1995. He followed 21 individuals in six family groups as part of an effort to develop conservation plans for the region. His work took a surprise turn in the spring of 1998, however, when a forest fire swept through the study area. Although many larger trees were left standing, the loss of ground cover and smaller trees dramatically affected the animals' food supply and disrupted normal territorial patterns.

A number of sociological characteristics distinguish gibbons from other apes, Oka says. They form monogamous couples that defend a home territory for the exclusive use of themselves and their family. And both male and female offspring leave the group at sexual maturity, find mates, and stake out their own ranges. Although other adults are not welcome in a pair's territory, unrelated juveniles occasionally join family groups, apparently as part of the search for a mate.

Six of the 21 animals Oka had been tracking disappeared after the fire, presumably either killed or driven away. Seven more had moved from their home ranges, he found. One adult male who had lost his mate and home base moved to a neighboring territory with his male child and formed a new family group with the resident female, apparently chasing away the spouse, who was spotted roaming alone in another part of the forest.

Much to his surprise, Oka also found that two gibbon pairs displaced by the fire had joined family groups whose territories had not been so badly burned. Why would these gibbons suddenly tolerate competing adults in their ranges, he wondered. On a hunch, Oka analyzed the DNA of fecal samples to see if there might be a family connection. He was right.

The host couple were the parents of one member—male in one case, female in the other—of each intruding pair. In effect, at a time of crisis, the children and their mates were welcomed back home. "A family in need is a family indeed," Oka concludes. Minnesota's Pusey is intrigued by the findings: "It had always been thought that familial groups needed regular contact to continue to recognize kin." Toshisada Nishida of Kyoto University says that he's struck by the gibbons' ability to be flexible in an emergency.

But the welcome mat may not stay out forever. As the forest began to recover, Oka noticed that the parents grew less tolerant of sharing their fruit trees, sometimes to the point of chasing away a youngster. It was, he says, as if the parents were telling the younger couples that it was again time, now that the crisis had passed, to find their own piece of the forest.

A Conservation Success Story

Scientists have helped broker a deal between the Brazilian government and a local landowner that provides hope for the survival of a highly endangered New World monkey.

The northern muriqui of Brazil is one of the world's 25 most endangered species, with most of its woodland habitat having been cleared over the past century for farming. But last fall, the muriquis got a new lease on life when a 957-hectare patch of privately owned forest that hosts more than half of the 300 remaining monkeys was turned into a reserve. "Now we have the forest secure," says Karen Strier, a behavioral ecologist at the University of Wisconsin, Madison, whose studies of the muriquis focused attention on their plight and helped build a case for the reserve.

Muriquis had received scant attention before Strier began studying them in 1982. She found them to be a curious breed. Unlike many other primate species, there is virtually no aggression among the males of a troop, and females mate with as many males as possible. "These findings suggested a greater diversity in behavioral options for primates," Strier says.

But the century-long expansion of agricultural activity in Brazil's Atlantic Forest, which hosts muriquis and dozens of other species, threatened to foreclose further exploration of those options. Fewer than 10% of the forest remains, mostly as isolated fragments too small to sustain wildlife populations. One of the largest chunks is at Caratinga, about 560 kilometers north of Rio de Janeiro, where the Abdala family kept a sizable chunk of the forest intact to provide humidity for nearby coffee groves.

Studies by Strier and her colleagues in the 1990s concluded that the Caratinga muriquis are the only known population with sufficient numbers, genetic diversity, and habitat to be viable for the long term, and that enlarging the forest would allow more animals to survive. Armed with those data, researchers and conservationists added some 100 hectares to the forest by persuading some landowners to let surrounding pastures grow wild. But the biggest conservation victory came in September with a deal that will keep it in a natural state for perpetuity. Under the agreement, the Abdala family maintains title to the land and the Brazilian government agrees to watch over it.

The deal demonstrates the positive role that scientists can play in conservation efforts, according to Strier. "Long-term studies have so much to contribute, not only to understanding the biology and ecology of endangered primates," she says, "but also helping to tailor conservation efforts on their behalf."

Caratinga shows that "people with a long-term interest in conservation at a particular site can make a difference," says Marina Cords, a behavioral ecologist at Columbia University in New York City. But she cautions that not all conservation campaigns will be as easy to mount. Preserving the Caratinga forest was an obvious step to take, she says, because it is the only viable remaining habitat for a highly endangered species. "But someone trying to conserve a forest in Africa or Southeast Asia couldn't claim that it was nearly the only patch of forest left [for a certain species]."

Fast friends. Karen Strier's studies of muriquis helped build a case for preserving their Brazilian habitat.

–DENNIS NORMILE

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