

Still, money remains a key issue. The budget increase to €24 billion—which would be even higher if Goulard can deliver on a commitment, made during the debate, to correct for inflation—will help pay for 3000 new jobs. “The hemorrhage has stopped; that’s positive,” says SLR co-founder and spokesperson Alain Trautmann. But Trautmann and other critics say the bill falls far short of what’s needed to revamp anemic government labs. Roughly one-third of the new money comes in the form of tax deductions for industry, which, Brézin notes, does little for basic research. To his critics’ surprise, Goulard also made a turnaround and promised to try to raise Ph.D. students’ salaries to 1.5 times the minimum wage. But it’s a commitment that could easily be forgotten if there’s no money or if Goulard is replaced, Trautmann says.

The law authorizes new “Regional Centers for Science and Education” to bring scientists from government institutes and universities together, but the plan doesn’t go far enough to provide the

needed relief for university research, says Bach. Researchers are also “nervous” about the bill’s vagueness, he says; for example, it’s not clear whether a new High Council for Science and Technology—which researchers had lobbied hard for—will be truly independent or merely decorative. Goulard sees a major advance: “Never, and I mean never, has so much been done for French science,” he said last week.

Opinions are divided, meanwhile, about the new grants agency ANR, which started operating last year with temporary authority. Bach believes it will create a new way to support talented young people, provided it stays free of political interference. But SLR and the trade unions oppose the new agency, which they worry will not improve flexibility as much as it will reduce certainty for the average researcher. Indeed, one reason SLR lost steam, Meunier says, is that it had become increasingly aligned with the trade unions, which argue for more money but have opposed substantive change. Despite the banners, the balloons,

and the whistles, the research unions tend to be conservative, protecting the interests of those inside the system with good jobs at the expense of younger people, he says.

Trautmann acknowledges that there has been a “convergence” between SLR and the unions and that it has caused some early members to turn their backs on the movement. He says he isn’t happy with this himself, as SLR was started primarily to address the plight of young scientists. “We don’t want to be a new union,” he says. Now that the landmark reform bill has passed, SLR will decide on its fate at a general meeting on 11 March. Although Trautmann says he wants to continue “analyzing and communicating” about science policy in some way, he says the group could decide to dissolve.

For now, most scientists are hoping for better times. If the left comes to power in the 2007 elections, the research budget will get a 10% annual increase, Socialist Party leader François Hollande promised last week. —MARTIN ENSERINK

EVOLUTIONARY BIOLOGY

Speciation Standing In Place

Surprising some evolutionary biologists, studies of birds, fish, trees, and insects show that it doesn’t take a mountain chain, island, or other geographic quirks to create a species



It’s not often that one witnesses speciation in action, but some birdwatchers in Africa may be having that privilege. Michael Sorenson, an evolutionary ecologist at Boston University, and Robert Payne of the University of Michigan, Ann Arbor, have monitored African indigobirds at a field site in Cameroon for the past decade. The opportunistic birds lay their eggs in the nests of different species of finches. The newborn indigobirds then look and act as if they belong there, and as adults, incorporate the twills and whistles of their foster parents into their own mating calls.

Recently, the researchers observed one species, called the blue indigobird, lay eggs in the nests of both the African firefinch and the

Black-bellied firefinch. The resulting indigobirds learned the songs of their respective finches and now seem to have developed into two “races.” Although all the blue indigobirds can still mate with one another—which means the races are not yet distinct species—females prefer suitors who know the same finch song they do. And they pass their preferences on: Female indigobirds that grow up in an African firefinch nest, for example, tend to lay eggs in the same kind of nest rather than in one belonging to a Black-bellied firefinch. “We have a nice example of early stages of speciation in this group,” concludes Sorenson.

This bird tale, described in an upcoming *Behavioral Ecology* paper, is one of several recent

Nesting behavior. By sneaking into nests of two kinds of finches, the blue indigobird is on its way to splitting into two species.

volleys in the continuing debate over how speciation occurs. For the past 50 years or so, many influential evolutionary biologists, notably the late Ernst Mayr, have held that physical separation among members of a species, such as that caused by the emergence of a mountain chain, typically drives the splitting of one species into two. Populations separated by geographic barriers can’t interbreed and eventually evolve into distinct species. Examples of this speciation process, called allopatry, abound.

Charles Darwin recognized allopatry as a driving force of speciation. But he also thought populations could diverge into separate species in the absence of physical barriers, an idea now called sympatric speciation, or simply sympatry. However, his successors were at a loss to explain how this could happen, and they could find few examples. By 1907, textbooks dismissed sympatric speciation, and 35 years later, Mayr virtually tossed the idea out of modern evolutionary thinking with his strong antisympatry rhetoric. Since then, few researchers have taken sympatry seriously.

Now the situation is changing fast. The indigobird study, combined with recently published reports of sympatric speciation among cichlid fish and palm trees, have offered compelling new support for the concept. Although some researchers are not yet convinced, sympatric events can now be detected with unprecedented certainty, says evolutionary biologist Axel Meyer of the University of Konstanz, Germany, who led the new cichlid fish study. Even supposedly airtight examples of allopatry

have sprouted leaks; a new study questions whether certain mammalian groups arose through allopatry, as researchers have long thought.

Instead of asking if sympatry occurs at all, “the question has now become ‘How frequently does sympatry underlie the genesis of new taxa?’” says Jeffrey Feder, an evolutionary biologist at the University of Notre Dame, Indiana.

The case for sympatry

Sympatry has been slow to catch on in part because it is hard to envision why members of one group in a population would predominantly mate only with each other. “There has to be some sort of assortative mating, or you don’t get [species-defining] genetic differences creeping in,” says Kenneth Petren, an evolutionary ecologist at the University of Cincinnati, Ohio. With allopatry, it’s simple: Geographic barriers leave individuals little to no opportunity to breed with their peers. But with sympatry, “ecological” barriers—genetic, morphological, or behavioral quirks that lead to changes in food preferences, courtship colors, breeding season, and so forth—cause group members to prefer or have contact with a specific type of mate.

Sympatry is hard to spot. To find it in a world seemingly dominated by allopatry, evolutionary biologists must identify a place where it is highly unlikely that physical barriers have separated members of a species. They must identify closely related, but nonetheless different, species and measure the amount of “gene flow” between the two species. In sympatry, where some interbreeding occurs throughout the speciation processes, gene flow is rampant, especially at first. As a result, the two species look similar—genetically speaking—except for the particular genes underlying the changes in behavior, morphology, etc., that make the two species different. In contrast, in allopatry, physical barriers essentially cut off gene flow, freeing entire genomes to evolve in different directions. Thus, the pattern of genetic differences provides a key clue about the method of speciation.

One of the oft cited cases of sympatry is a 1994 report by Ulrich Schliewen, an ichthyologist at the Zoological State Collection

New territory. Fruit flies that originally lived off hawthorne trees have now colonized apple trees and evolved a dislike for hawthorne fruit, which may ultimately create a new fly species.



in Munich, Germany, and his colleagues. They concluded, based on mitochondrial DNA studies, that 11 cichlid species living in a small lake in Cameroon arose sympatrically from a common ancestor trapped in the



Backdoor speciation. In a Cameroonian lake, the slender Konia cichlid (*top*) hybridized with another species and gave rise to the fatter, sponge-eating Pungu cichlid (*bottom*).

2.5-kilometer-wide space. Schliewen attributed this burst of sympatry to the original species evolving in ways that, for example, helped the fish thrive at different depths. Schliewen’s work has been widely heralded as one of the best examples of sympatric speciation, in part because it’s unlikely that this isolated lake would have been colonized enough times by outside species to create the current diversity, says Feder.

In 2004, Schliewen described a new twist on the evolution of this tightly knit group of fish. With more extensive genetic testing, he found that at least one of the 11 species arose as a hybrid of two other species, suggesting yet another avenue of speciation among sympatric species.

Schliewen had few molecular techniques at his disposal when he did his initial work in the early 1990s, which left some people skeptical of the sympatry claim at the time. But in the 8 February issue of *Nature*, a team led by Meyer and one led by Vincent Savolainen and William Baker of the Royal Botanic Gardens, Kew, in Richmond, U.K., apply new genetic analyses to come up with two additional compelling examples of sympatry.

Meyer and his colleagues examined two fish species, the arrow and Midas cichlids, that live in an isolated 5-kilometer-wide volcanic lake in Nicaragua. By comparing the species’ mitochondrial genes, variable DNA sequences called microsatellites, and other genetic landmarks, the researchers demonstrated that the arrow cichlid evolved from the Midas cichlid fewer than 10,000 years ago. They argue that the lake is too small for this to have resulted from physical separation. Instead, they believe that competition for food may have pushed members of the ancestral species to go in different ways. The Midas cichlid is an algae-eating bottom feeder with a deep body, whereas the arrow cichlid, whose slender shape is built for swimming, often dines on winged insects. Other researchers have shown that the two prefer to mate with their own kind and that when forced to interbreed, they fail to produce young.

Savolainen and Baker also picked a remote spot to search for sympatry: Lord Howe Island, a 12-square-kilometer speck of volcanic rock 580 kilometers east of Australia. There they studied two indigenous palm tree species, the kentia palm, which is used throughout the world as a houseplant, and the much shorter curly palm. A DNA-based family tree of all the island’s palm species indicated that the curly palm descended from the kentia palm about 1 million to 2 million years ago. Although the two species coexist in 20% of the island sites surveyed, the timing of their flowering now keeps them separate, say Savolainen and Baker.

The pair suggests that soil differences on Howe Island created the ecological barrier that drove this sympatric speciation. Today, kentia palms thrive on the island's basic soil, whereas curly palms stick to acidic soils. Savolainen and Baker suggest that as the kentia palm spread onto different soils, its flowering time was delayed, possibly because the genes needed to adapt to the

slow egg development, such that their eggs hatch at peak apple season. Feder and his colleagues' recent work also shows that the two kinds of maggots remain separate in part because they are attracted to the odor of their particular fruit and are repulsed by other fruits.

Other insects seem to be following a similar path to a sympatric split. Last year, Thibaut

tough call since we were not there at the time of speciation," says Feder.

Coyne also worries that the genetic evidence of close kinships may be misleading. In the case of the Lord Howe Island palms, for example, the second palm species may have arisen elsewhere. If wind blew some of that palm's pollen to Lord Howe and hybrids resulted, then the intermingling of the genomes of the two species would make them seem more closely related than they really are. "It's a judgment call," Coyne says. "There are other alternatives that have to be taken seriously."

Richard Glor, an evolutionary biologist at the University of California (UC), Davis, has found such an alternative explanation for the diversity of anole lizards on Cuba. Cuba is a relatively small island with 60 species of Anole lizards, and some researchers have proposed that sympatric speciation underlies much of the lizards' diversity. In 2004, Glor and his colleagues analyzed genetic differences among three green canopy-dwelling lizards to determine when the species separated. They concluded that the speciations occurred more than 5 million years ago, at a point when a rise in sea level had broken Cuba into multiple islands. Thus, physical separation, not sympatry, gave rise to the three species, which are reunited on a single island today, says Glor.

Still, that ambiguity cuts both ways. Some cases of mammalian speciation attributed to allopatry have recently been called into question. UC Davis evolutionary biologist Michael Turelli admits that he had hoped to quiet sympatry sympathizers with a new study, appearing in the March issue of *Evolution*. He and his former student Benjamin Fitzpatrick gathered data on the ranges of 14 groups of mammals—"where no one thinks that sympatric speciation is going on," says Turelli.

The study's rationale was simple: If two closely related mammals arose through geographic isolation as allopatry demands, then they should have ranges that were disconnected, at least early in their evolutionary history. (Over time, these species might expand their ranges such that the two would intersect somewhat.) With sympatric speciation, the opposite should be true, Turelli explains. By definition, sympatric species start off in the same place and only over time do their ranges diverge.

The analysis firmly established allopatry for gophers but not for two-thirds of the other mammals. "We saw clade after clade where there was no clear signal," says Turelli. "The punch line is it's less obvious that it's all allopatry all the time."

Indeed, even the most fervent fans of allopatric speciation are becoming more open-minded. Just as Mayr did later in his career, Coyne is softening his stance, for example. At least, says Giacomo Bernardi, an evolutionary biologist at UC Santa Cruz, "evolutionary biologists are at last essentially agreeing that sympatric speciation is possible."

—ELIZABETH PENNISI



Castaway. Cuban lizards became diverse after the island was partially submerged and divided into isolated islets.

altered pH affected the transmission of those involved in flowering. The new flowering schedule jump-started the speciation process.

The studies are "a good beginning" to demonstrating sympatry, says Jerry Coyne, an evolutionary biologist at the University of Chicago, Illinois, who has in the past been skeptical of proposed cases of sympatric speciation.

Sympatry on the fly

Some apparent cases of speciation in action, such as that of the indigobirds, are also bolstering the case for sympatry. Back in the 1860s, local farmers noticed that some fruit maggots had switched their mating and breeding grounds from hawthorns, which are native to America, to apples, a domesticated fruit species. A century later, Guy Bush of Michigan State University in East Lansing proposed that this type of ecological separation might be a common mechanism by which fructivore insects diverge into new species. Although not yet genetically distinct enough to be separate species, the apple and hawthorn maggots are proving a strong example of incipient sympatry, says Feder. The two types of maggots have begun to develop some subtle genetic differences. For example, apple maggots are much more likely to have genetic variants that

Malausa, at the Université Paul-Sabatier in Toulouse, France, and his colleagues found very little intermating in the wild between European corn-borers that prefer corn and ones that prefer hop or mugwort, even though all belong to the same species. Further enforcing this reproductive isolation, says Malausa, is that corn-feeding caterpillars of the species emerge as moths later than caterpillars with a hop-mugwort diet do (*Science*, 8 April 2005, p. 258).

Judgment calls

Fans of sympatric speciation are still working to win over many evolutionary biologists. For every researcher who sees a solid example of sympatry, there's a skeptic ready to poke holes in the case. "It's hard to rule out some sort of geographic separation, even if it's micro-separation," notes Petren. Hop versus corn, or apples versus hawthorn, could easily be interpreted as geographic isolation on a small scale, for example. And seemingly sympatric species isolated on islands or in lakes may have divided their territories enough to enforce reproductive isolation, Petren points out. The arrow and Midas cichlids divided their lake by depth; the kentia and curly palms stick to particular soil types. "It's always a