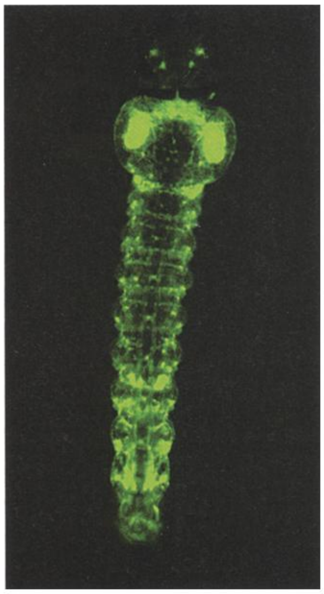
in 1998, boosted by new genetic engineering techniques (*Science*, 20 October 2000, p. 440). As they reported in the 23 May issue of *Nature*, Marcelo Jacobs-Lorena of Case Western Reserve University in Cleveland and his colleagues recently inserted an extra gene into *Anopheles stephensi*, a mosquito that transmits malaria in India, that made the insects resistant to mouse malaria. Others are tweaking the genes of *Aedes aegypti*, the mosquito that transmits dengue.

But the ultimate target is *Anopheles gambiae*, the main vector of the deadliest malaria parasite, *Plasmodium falciparum*, in Africa. Researchers hope to make resistance genes spread through natural mosquito populations by hitching them to a selfish piece of DNA called a transposon or to a strange bacterium called *Wolbachia* that sweeps through insect populations by manipulating its host's sex life. If this works, they will have created golden bugs that could save millions of lives—at least in theory.



Still a stretch. Making transgenic mosquitoes has become relatively easy—this larva carries the green fluorescent protein gene—but ecologists say this strategy is a long way from driving down malaria.

CREDIT: JOHN R. CLAYTON/CDC

At the meeting, ecologists came up with a discouraging list of hurdles that could easily sink the plan. For example, will the new mosquitoes be able to compete for partners with their natural counterparts? (Past studies have shown that spending a few generations in the lab diminishes their sexual attractiveness.) How long would it take for a new resistance gene to penetrate the population, and would it be 100% effective in mosquitoes that carry it? (If not, the transgenic bug would barely make a dent in malaria incidence, suggests a model by Christophe Boëte and Jacob Koella of the Pierre and Marie Curie University in Paris.) In areas with multiple malaria vectors, would all the species need to be "treated"? And would *P. falciparum* develop resistance to the new genes, as it has to many drugs? Or could this be prevented if multiple antiparasite genes were used?

Studying many of these issues is problematic. Most researchers agreed that after cage experiments, some sort of pilot trial would be needed. But where? It must be a place from which mosquitoes can't escape. São Tomé, one of a handful of islands that form a republic off the east coast of Africa, has been suggested, and one meeting participant floated the idea of creating artificial "oases" in the Sahara desert. Even more vexing are some of the ethical and regulatory issues. Although it's unclear who would set the rules, a field test would have to meet safety standards as strict as those for vaccine trials, said entomologist Yeya Touré, malaria coordinator at WHO's Special Programme for Research and Training in Tropical Diseases—or perhaps even stricter, as it would expose people who had not agreed to participate.

Feeling "a bit like a ham sandwich on Passover," the only molecular biologist at the workshop, David O'Brochta of the University of Maryland, College Park, admitted that he and his colleagues have given little thought to these issues. But that reflects a lack of expertise rather than concern, he said, urging ecologists to join the work.

In the past, said meeting host Willem Takken of Wageningen University, granting agencies have not been impressed by old-style fieldwork such as counting mosquitoes or studying their feeding behavior. But at least NIAID is now convinced that the ecologists' input is urgently needed, says Kate Aultman, program manager for vector biology. Some at the meeting said that they were uncomfortable allying themselves too closely with a research program that faces such major problems. But most still preferred joining it to trying to beat it—if only because the research might be valuable regardless of whether transgenic mosquitoes ever take wing.

–MARTIN ENSERINK

FISHERIES RESEARCH

Mixed Schools a Must for Fish?

Fish markets teem with neatly iced schools of similarly sized fish. The marked uniformity is often the result of two forces: customer demand for pan-sized portions and fishing regulations that limit harvests to older fish to preserve populations. But some biologists fear such selective culls could permanently alter the genetic makeup of wild fish stocks.

Now, two scientists have gone fishing in their laboratory to test that idea. And on page 94, they say they've netted data suggesting that fisheries managers should rethink their rules if they want to prevent

ScienceScope

Scientific Gold Mine? U.S. researchers are getting ready to dig even deeper into the possible uses of an underground science laboratory. The National Science Foundation (NSF) said last week that it will hold a 3-day workshop on subterranean science in September in Washington, D.C. And although the notice doesn't mention it by name, a controversial proposal to convert the shuttered Homestake Gold Mine in South Dakota into the world's deepest lab will be the invisible elephant in the room (*Science*, 15 February, p. 1213).

NSF is already mulling a nearly $300 million request from physicists to build the Homestake lab, which they say would be the perfect place to build giant detectors for studying neutrinos. But the project has become ensnarled in political, environmental, and cost concerns, and NSF reviewers have so far given little hint on how they view the bid.

Earlier this year, the White House asked the National Academy of Sciences to take a global look at proposed facilities for neutrino physics and underground science in general, with an eye toward avoiding duplication. Organizers say the conference, which they expect to be "75% about physics and astrophysics and 25% about other fields," including geoscience and the environmental sciences, will feed into the academy report. It is expected to shape attitudes toward the Homestake lab.

The report is due early next year. For meeting details, see www.physics.umd.edu/ness02.

Bailed Out After nearly a week in jail, two biology postdocs accused by the FBI of stealing commercial secrets from a Harvard lab (*Science*, 28 June, p. 2310) were released last week from a San Diego prison on $250,000 bail each.

Jiang Yu Zhu and his wife, Kayoko Kimbara, are expected to travel to Boston for an initial hearing on 17 July before a federal district court. In the meantime, they face an 8 p.m. curfew. Zhu, now at the University of California, San Diego, and Kimbara, now at Scripps Research Institute in La Jolla, California, could face 25 years in prison and $750,000 in fines if found guilty of conspiring to steal Harvard secrets and shipping Harvard property across state lines. A formal criminal indictment is likely to come later this month.

Contributors: Stephen S. Hall, Pallava Bagla, David Malakoff, Andrew Lawler

A matter of scale. Selective catches of Atlantic silversides (above) left genetic legacies.

some stocks from swimming down dangerous evolutionary paths. "Managers haven't focused enough on the long-term, Darwinian consequences of selective harvest," says one author, ecologist David Conover of the State University of New York, Stony Brook. Some biologists, however, say the lab-based results lend little to the current debate over how best to protect teetering populations.

Scientists have already suggested that some fish populations are evolving rapidly in response to heavy fishing. Several cod and salmon stocks, for instance, appear to have shifted to smaller, earlier maturing fish as fishers systematically removed larger and older specimens. But wild populations can be difficult to study, so fishing's genetic impacts have remained in dispute.

To get a clearer view, Conover and graduate student Stephan Munch moved to the more manageable confines of the lab. Four years ago, using eggs collected from wild stocks, they hatched six captive populations of Atlantic silversides. Then they went fishing. From each school of 1000, they removed 90%. In two of the tanks, they took the largest fish; in two others, the smallest; and in the remaining control tanks, the harvest was random. After allowing each school to rebound to its original size, they repeated the process for four generations, charting how the size, weight, and growth rates of the populations changed over time.

The results were dramatic. Population characteristics in the random-catch tanks, as expected, stayed relatively even. But the balance disappeared with other methods. Taking the bigger fish produced a catch that was initially heavier than in controls. The average weight of individual fish soon shrank, however, and by the fourth generation, the catch was substantially smaller than in controls. In contrast, taking the smaller fish produced a catch that was lighter at first, but the hauls and the individuals grew heavier over time.

The rapid shifts in the selectively culled populations were due to inherited genetic changes, the authors say. The same thing is happening in the wild, they speculate, although on a much slower timetable, due to the greater size and age diversity of natural stocks. As a result, "management practices meant to maintain [robust catches] may be having the opposite effect over the long run," says Conover. The pair recommend establishing more reserves that are off-limits to anglers and regulations that protect larger fish as well as smaller ones.

Several fisheries scientists, including Felicia Coleman of Florida State University in Tallahassee, say the findings suggest that those ideas are on target. But others, including Carl Walters of the University of British Columbia in Vancouver and Ray Hilborn of the University of Washington, Seattle, say the experiment is far too limited to support major management changes. "All they have done is show that growth rates are heritable; what they haven't done is see what the impact of this would be on a realistic fishery," says Hilborn. **–DAVID MALAKOFF**

COMPUTER SCIENCE

Collective Effort Makes The Good Times Roll

Two wrongs don't make a right, but two dozen of them might. A pair of physicists has found that groups of imprecise clocks can collaborate to tell time with remarkable accuracy. Their findings might one day help computers tackle tough problems as a team.

Scientists and engineers know the difficulty of extracting accurate information from a collection of imperfect devices, such as a clutch of clocks. Every clock gives a slightly different reading, and the problem is how to combine those readings to get the best estimate of the time. The most obvious solution is to average readings from all the clocks—a strategy once employed by sailors at sea—but the inaccuracy decreases only slowly as the number of clocks increases. For example, to get an estimate 10 times more accurate than that of a single clock, a timekeeper would need about 100 clocks.

On time. Working together, imprecise clocks can keep good time.

A far better way is to read only some of the clocks, report physicists Damien Challet and Neil Johnson of Oxford University. In a computer study, the researchers simulated collections of clocks with readings distributed around the correct value according to a bell curve. They then took the reading of each clock individually, the average reading for each possible pair of clocks, the average reading for each group of three, and so on. By trying every subset, Challet and Johnson found that they could usually identify a combination containing roughly half the clocks whose average reading was far closer to the correct time than the simple average of all the clocks, as they report in the 8 July issue of *Physical Review Letters*. For example, starting with 20 clocks, they typically found a subset of about 10 whose inaccuracies compensated for one another almost perfectly, so that their average was 100,000 times more accurate than was the average of all the clocks.

Moreover, Challet and Johnson proved mathematically that in certain cases, it is relatively easy to compute the best combination, given the amount by which each clock is fast or slow. That implies that a technologist should be able to figure out how to cobble together a nearly perfect machine from a basket of faulty parts after simply checking the inaccuracy of each part.

The work is an important step in the study of "collectives," groups of autonomous agents that conspire to achieve a common goal, says David Wolpert, an expert in complex systems at NASA's Ames Research Center in Moffett Field, California: "Things become really interesting when the agents aren't little clocks but computer chips." Such studies will be crucial, Wolpert adds, as computers evolve from machines that perform specific tasks, by following strict rules, to more adaptable entities that can work together and find their own ways to solve larger problems.

–ADRIAN CHO

Adrian Cho is a freelance writer in Boone, North Carolina.