sketchier data from bigger closures—"make a compelling argument that reserves will work across a wide spectrum of scales, in many geographical locations, and for many different fisheries."

One researcher, however, cautions that reserves are just one tool available to fisheries managers. "The question is, 'What role should [reserves] play in the mix of regulatory options?' " says Ray Hilborn, a fisheries biologist at the University of Washington, Seattle. Hilborn argues that less severe moves—from closed seasons to size limits—could produce equally significant fisheries improvements. He also questions whether reserves can work wonders for some fisheries that are already highly regulated, such as those in the United States.

Some sport and commercial fishing groups have challenged the California effort and asked the Bush Administration to reconsider a major reserve in the Hawaiian Islands (*Science*, 8 December 2000, p. 1873). In August, the American Sportfishing Association (ASfA) and other groups also convinced Senators John Breaux (D–LA) and Kay Bailey Hutchison (R–TX) to introduce the Freedom to Fish Act (S. 1314), which would require government planners to make reserves as small as possible. "Blanket closures and no-fishing zones should not be the first solution, but rather the last," says an ASfA statement.

Roberts agrees that reserves should be tailored to specific ecosystems and public goals. But "fishers have nothing to fear from reserves," he says. The real danger "is a future without them." **–DAVID MALAKOFF**

GENETICS

Fragile X's Missing Partners Identified

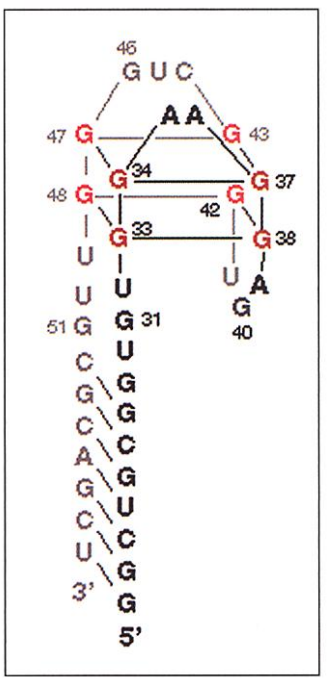
Three research teams have begun to decipher the molecular signals that lead to fragile X syndrome, one of the most common causes of mental retardation. People with this syndrome carry a mutated version of a gene on the X chromosome, and since 1991 researchers have known that this mutation blocks the production of a certain protein. But how that deficit causes the syndrome remains mysterious. Two new reports finger a set of messenger RNA (mRNA) molecules in the brain as crucial targets of the missing protein—findings that suggest these mRNAs play key roles in helping neurons communicate with each other. The third team reports that disabling a gene for one of these mRNAs eliminates symptoms of the mutation in a fruit fly model of fragile X, suggesting that eventually it may be possible to treat the syndrome.

Together, the studies could help explain the role certain fragile X–related proteins play in the brain. "This is a major step toward understanding the biology of fragile X and understanding the biology of higher cognitive functions," says geneticist Harry Orr of the University of Minnesota, Twin Cities.

The genetic mutation in fragile X syndrome gives the chromosome a distinctive look: One arm appears to be hanging on by a thread. The mutation prevents the gene from producing the so-called fragile X mental retardation protein (FMRP). In addition to mental retardation, people with the disorder often have elongated faces, autism, and attention deficit disorder, among other symptoms. On the microscopic level, people with the syndrome have misshapen dendrites, neural projections that receive signals from other neurons.

Scientists have struggled to find a link between the missing protein and these symptoms. In normal brain cells, FMRP binds to strands of mRNA, molecules that transmit blueprints for protein production. But with millions of differently shaped RNA molecules floating around in the cell, researchers have had trouble figuring out which are controlled by FMRP.

To crack this problem, a group led by neuroscientist Robert Darnell at Rockefeller University in New York City manufactured trillions of different versions of mRNA. By seeing which stuck to FMRP and washing away the rest, the team narrowed its search down to a family of RNAs called G quartets, which are shaped like cubes on a stick—imagine square Popsicle flavored ices. The team then searched databases of the human genome to find sequences that produce similarly shaped mRNAs, suspecting that these mRNAs are targets of FMRP in the brain.



Syndrome subjects. Some mRNAs with this G quartet shape are misregulated in fragile X syndrome.

Working independently, geneticist Stephen Warren of Emory University in Atlanta and his colleagues ground up mouse brains and mixed them with antibodies that specifically grab FMRP out of the mush. The team counted more than 400 mRNAs that came along with FMRP for the ride. When the two teams compared results, they identified a dozen mRNAs that have both a G quartet structure and cling to FMRP.

Warren's group then looked in the brains of people with fragile X syndrome and found that eight of those mRNAs were either overexpressed or underexpressed. "These are the first eight mRNAs ever identified that are really different in fragile X patients," Darnell says. Both teams report their results in the 16 November issue of *Cell*. Figuring out what these mRNAs do is the next step, but Darnell speculates that they build proteins that help brain cells communicate with each other.

Knowing which mRNAs FMRP interacts with could potentially lead to treatments for the disease, suggests a third study. *Drosophila* have a gene similar to the FMRP-producing gene, and scientists can disable it to induce a version of fragile X syndrome. Neurogeneticist Kendal Broadie of the University of Utah in Salt Lake City and colleagues made fragile X fly mutants and noticed an increase in concentrations of the fly version of map1b—a protein built by one of the mRNAs Warren's team found to be overexpressed in people with fragile X syndrome. When the team increased the levels of map1b in normal flies, fragile X symptoms appeared—a sign that map1b is behind the fly syndrome. But the clincher came when the team simultaneously disabled the fragile X gene and, to compensate, hobbled the gene that makes map1b. The researchers ended up with normal flies, they report in the 30 November issue of *Cell*.

"This was completely startling," Broadie says. "There were no defects left over whatsoever." That suggests, he says, that a single mRNA target might be the key to explaining what causes fragile X syndrome, at least in *Drosophila*. If the same proves true in humans, "that takes us to the point where we might be able to treat and cure" fragile X syndrome.

Other experts are more circumspect about treatment possibilities. "At this time," says Orr, "it is a bit simplistic to think that the whole story of fragile X syndrome is controlled by the ability of this protein to regulate a single mRNA," especially considering the hundreds of potential targets found by Warren's group. Still, Orr agrees with other experts that the recent convergence of fragile X research is a major step toward understanding what causes the disorder.

–EMILY SOHN

Emily Sohn is a writer in Minneapolis, Minnesota.

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