guarantee a mixed population.

Maternal effects can even influence the dynamics of entire populations—and thus may be a key to the spread of some insect pests. In studies of the gypsy moth, *Lymantria dispar*, a serious pest that is spreading across the United States defoliating forests each summer, MaryCarol Rossiter of the University of Georgia, Athens, has found that in good times, the female moth doesn't just produce more eggs; she produces larger ones as well. Her ever more healthy, faster growing young do likewise, and the population explodes. But eventually it gets so large, the moth "overshoots its resources," says Ginzburg. With food then in short supply, the undernourished females do not provision their eggs well and therefore create young that are not very capable reproducers themselves. The population crashes, setting the stage for the cycle to begin anew.

By incorporating such maternal effects into their model of population growth, Ginzburg and Dale Taneyhill of SUNY Stony Brook have been able to predict the cycling time for population increases and decreases in six moth species, including the gypsy moth. The model also seems to predict the growth and crashes of small mammal populations. While including information on the parents' quality when predicting population growth seems like common sense, most theoretical models have not done that, Ginzburg notes.

All these observations and predictions highlight that maternal effects do play an adaptive role. The next step will be understanding just how a mother's experiences are linked to the future of her progeny—and that means unraveling the molecular genetic mechanisms that mediate maternal effects, says Sinervo. Lots of developmental biologists study the role of maternal environments, but usually only in the context of the very early stages of an embryo. They examine, for example, how proteins contributed by a parent influence the timing of gene activation in the fertilized egg and, consequently, affect patterns of development. These, too, are maternal effects but are rarely considered in long-term ecological or evolutionary contexts. But Sinervo and others expect that to change as the importance of maternal effects in these other contexts sinks in. Says Fox: "[The field] is certainly not mainstream at the moment. But I think it will be."

–Elizabeth Pennisi

X-RAY CRYSTALLOGRAPHY

Structure of Gene-Tag Protein Solved

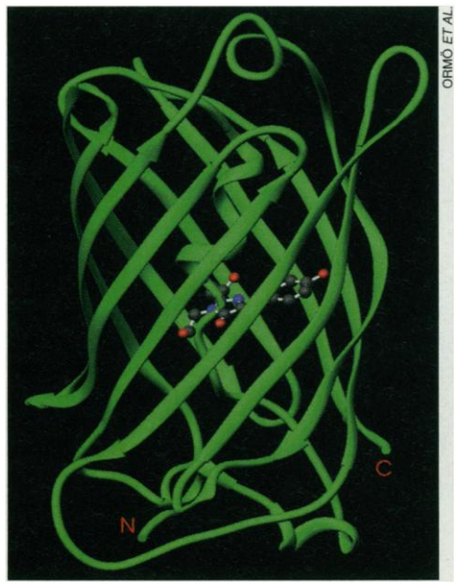
When the Roman natural philosopher Pliny the Elder wrote about a glowing marine creature nearly 2 millennia ago, he could never have imagined that future scientists would turn this marvel of nature into an everyday tool. But within the past several years, a green fluorescent protein (GFP) that lights up one sea creature, the Pacific Northwest jellyfish, has become a powerful marker for modern molecular and cell biologists. By linking the GFP gene to those encoding other proteins, they can track when and where the genes are expressed and also trace the workings of the protein products in living cells and tissues. Now GFP is poised to become even more useful. Instead of taking what nature provides, researchers may be able to tailor the protein for new purposes.

That is the prospect raised by scientists' first look at the three-dimensional (3D) structures of GFP molecules. On page 1392, a team led by S. James Remington of the University of Oregon, Eugene, reports the structure of a mutated form of the protein. And in work that will be published in the October issue of *Nature Biotechnology*, George Phillips and his colleagues at Rice University in Houston have determined the structure of the normal version of GFP.

Molecular geneticist Martin Chalfie, whose team at Columbia University pioneered GFP's application to cellular studies, has seen both structures and says they are very similar and "absolutely beautiful." They resemble a covered barrel with the glow-producing dye sealed inside. But the structures' beauty is a lot more than skin-deep. By helping to explain the properties of the fluorescent protein, the 3D map provides a guide to modifying it.

In particular, researchers hope to produce versions with new colors—say red or orange—that would allow them to track two or more proteins at the same time in the same cell. "We need two color labels to check whether proteins are near each other," says molecular biologist Roger Tsien of the University of California, San Diego, who co-authored the *Science* paper. "Most of molecular and protein biology involves proteins that are, in essence, kissing each other."

Remington says his team decided to work with the mutant protein because its properties are somewhat superior to those of the unmutated protein, and it has but a single amino acid change. In the normal protein, the green glow emanates from a ring formed by three amino acids—serine-65, tyrosine-66, and glycine-67. In the mutant the serine in this chromophore is replaced by a threonine. As a result of this structural change, the mutant protein glows more brightly and at a measurably—but not visibly—yellower color than normal GFP.



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Barrels of fun. The new GFP structures should help design more colorful gene tags.

Just tinkering with the three amino acids in the chromophore is unlikely to produce dramatic changes in the color of light it emits. But now that the protein's 3D structure is known, researchers can expand their range of options by changing other amino acids known to be in contact with the chromophore. Indeed, the Remington-Tsien team has already made a start at that. They replaced threonine-203, an amino acid that resides near the light-producing coil, with tyrosine, a larger amino acid. They expected that the replacement would distort the structure of the coil and thus alter the wavelength of light it emits. It did. The new mutant radiates an even yellower shade of green than the serine-to-threonine mutant does.

For his part, Phillips declines to comment on the details of the normal GFP structure before the results are published. He does say that it, too, resembles a barrel. He also says he plans to work with Remington's group. "Together they [mutant and normal GFP structures] may well explain the behavior that the mutant has," Phillips says. "And they may help us to generate more mutants."

Besides expanding GFP's color palette, the structures may allow investigators to apply the protein in new ways. Tsien suggests, for example, that finding out how mutations alter the GFP's color might help understand what mutations do to other color proteins, such as eye pigments. "Now that we know the structure, there is no end to what we can do," says Tsien. "The jellyfish has handed us a gift that keeps on glowing."

–Trisha Gura

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