Protozoan machinery grinds parental genes

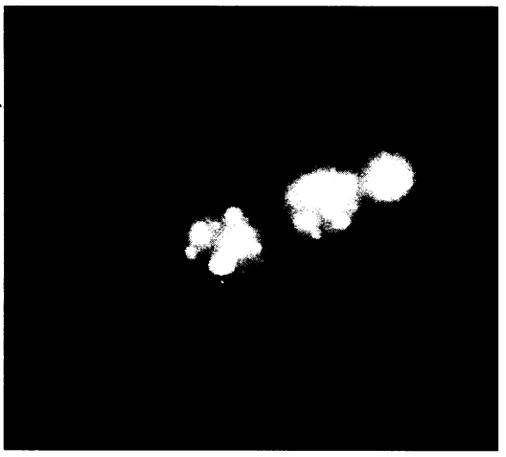
Teenagers often wonder how they can circumvent the outdated commandments handed down by their parents. Lacking a conscience, one tiny protozoan resolves the issue forcefully, dissolving many of its parents' genes as it charts its own course, according to new research.

"We've found the protein machinery a protozoan uses to turn off, and get rid of, unwanted genes," says C. David Allis of the University of Rochester (N.Y.). He and his colleagues at Rochester and at the Fred Hutchinson Cancer Research Center in Seattle report in the Oct. 4 CELL their studies of tetrahymena, a relative of the paramecium that stars in high school biology classes.

Most single-celled creatures have one nucleus that contains all their genetic information, but tetrahymena has two. A micronucleus holds the creature's full set of genes, while a macronucleus has a restricted set that carries only essential living instructions.

When food is plentiful, tetrahymena operates under the command of the macronucleus and splits repeatedly into identical copies of itself. If stressed by lack of food, however, the micronucleus takes over and the protozoan starts hunting for a sex partner. Each individual wants to exchange genes to improve its chances of survival, says Allis.

When two famished tetrahymena encounter each other, their cell walls dissolve and the pair joins. Their micronuclei break apart and fuse into a larger nucleus. There, some genes exchange places, moving from a chromosome of one parent to a chromosome of the other. Finally, the nucleus splits into eight parts, four of which become macronuclei and four micronuclei. The nuclei are parceled out in such a way that the four offspring have identical genes.



James F. Smothers/University of Rochester

Circular bands of destruction: Proteins dissolve parental genes in a tetrahymena cell.

Researchers knew that during this division, some unknown actor strips the new macronuclei of all genes related to sexual reproduction and simultaneously destroys the parental macronuclei. The new micronuclei emerge unscathed. To ferret out the culprit, Allis and his colleagues labeled the doomed genes with a fluorescent molecule.

"We looked for anything hanging around in the nuclei at this time," says Allis. What they found was a suspicious protein that attached to the tagged genes in the new cells and to all of the genes inside the parental macronuclei. The researchers suspect that the protein harbors another molecule, an enzyme that chews up DNA. It kills the old macronuclei and leaves the new macronuclei with only basic living instructions.

"The protein serves as master control switch, making regions of chromosomes inactive," says biologist Robert B. Dickson of Georgetown University Medical Center in Washington, D.C. "It's an important discovery for basic biology."

Tetrahymena belongs to a family of protozoans called ciliates, and biologists wonder if other members share this ruthless ability to dispose of parental genes.

Allis describes the newly discovered protein as a permanent cellular organ and calls it a "dumposome." That term isn't mentioned in the study, however, and his coauthors downplay the idea of a new organelle. In their view, the young cells shoot out the protein to clean up their new homes only briefly, during sexual reproduction.

The researchers are now creating a version of tetrahymena that is incapable of expressing the gene-wrecking protein and plan to see what happens to new generations that lack it. They think the mechanism of gene disposal might be related to control of cell death in higher animals. — *D. Vergano*

New evidence of early cosmic architecture

Forming a cosmic web, galaxies in relatively nearby parts of the universe arrange themselves as spidery filaments or as giant walls separated by huge voids. That's what telescope surveys began to reveal in the 1980s, when astronomers charted the cosmos a few hundred million light-years from Earth.

A team of astronomers reported last May that they had seen hints of the same large galactic structures in a patch of sky 20 to 30 times more distant (SN: 4/27/96, p. 260). Although researchers cautioned that the pattern of galaxies in this single region of the sky might not be representative of the cosmos as a whole, the observations suggested that the smooth, primordial universe developed lumps—networks of galaxies—earlier than some theorists have asserted.

Now, the same team has examined the distribution of distant galaxies in a different patch of sky and found indications of a similar structural pattern. Study coauthor Judith G. Cohen of the California Institute of Technology in Pasadena emphasizes that neither sky survey is large enough to do more than suggest the existence of galactic walls and filaments at large distances. Nonetheless, the new work validates the earlier findings, she says.

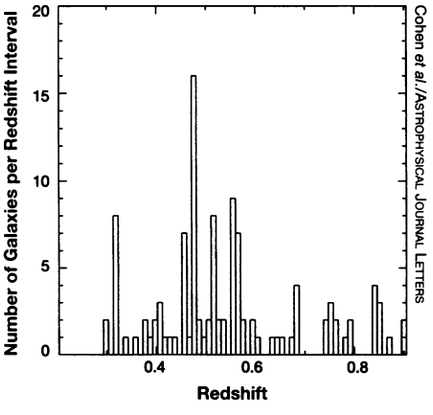
"We were worried that [our earlier findings] could be a statistical fluke," she says. "It's nice to know that they have been confirmed."

As in their previous study, Cohen and her collaborators used the 10-meter W.M. Keck Telescope atop Hawaii's Mauna Kea to measure the redshifts, or recession velocities, of a group of galaxies first identified by the Hubble Space Telescope. Cosmic expansion makes distant galaxies recede faster than nearby ones and shifts the light they emit to correspondingly redder wavelengths. Thus, redshift indicates a galaxy's distance from Earth.

In the Nov. 1 ASTROPHYSICAL JOURNAL LETTERS, Cohen and her colleagues report that slightly more than half of the 140 galaxies in their survey, some of which lie halfway to the edge of the visible universe, aren't distributed evenly. Instead, they cluster together in six main groupings. In a separate study, other astronomers have reported evidence of clustering among 18 galaxies that lie at far greater distances (SN: 9/7/96, p. 149).

The new observations suggest that the universe may have evolved more rapidly than standard cosmological theories would allow, Cohen says.

Theorist Simon D.M. White of the Max Planck Institute for Astrophysics in Garching, Germany, disagrees, noting that observers haven't compiled enough data for a showdown with any theory. He adds, however, that the studies "hint that a confrontation may be coming." — *R. Cowen*



Redshifts of distant galaxies show clustering.