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Giardia's sex life revealed

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Scientists have found evidence that *Giardia*, an ancient protist long considered to be asexual, may have a sex life (*Curr Biol* 2005, **15:**186-191). The findings are reported in the January 26 issue of Current Biology.

"The origin and evolution of sex is one of the central unsolved puzzles for biology, and while we haven't solved it, these findings could bring us one step closer," co-author John Logsdon at the University of Iowa told *The Scientist*.

Giardia and other diplomonads are thought to be a roughly 2 billion year-old lineage, making them among the earliest diverging eukaryotes. Despite more than a century of study, they were not known to have sex, suggesting they might represent a premeiotic stage in eukaryotic evolution.

Logsdon and colleagues ran BLAST searches on the nearly complete Giardia lamblia genome project and then conducted phylogenetic analyses on the genes they found with a Bayesian likelihood method. They wanted to see if the protist possessed clear homologs of proteins that had crucial roles in meiosis in animals, fungi, and plants, many catalogued by Anne Villeneuve of Stanford University and Kenneth Hillers of California Polytechnic State University in 2001.

Homologs of five genes specific to meiosis in animals, fungi, and plants are present in *Giardia* - *Dmc1* promotes interhomolog recombination; *Spo11* creates DNA double-strand breaks; *Hop1* is part of the synaptonemal complex; and *Hop2* and *Mnd1* ensure accurate and efficient homology searching. The researchers say these meiosis-specific genes, in conjunction with the presence of known meiosis-related genes, provide strong evidence the protist has or very recently had the capacity for sexual reproduction.

While these genes might function in nonmeiotic processes, "as the authors point out, the more meiosis-specific genes they find, the harder it is to make a non-meiotic argument," said Miriam Zolanof Indiana University, who did not participate in this study.

"What I would like to know in further studies is if the presence of these genes indicates meiotic sex or premeiotic parasex, in which many of the same genes might be used," Zolan told *The Scientist*. "For me, the observation of a synaptonemal complex component protein indicates that it is probably meiotic sex."

"The conclusion by Logsdon's team that the origin of meiosis predates the divergence of *Giardia* in eukaryotic evolution is indisputable," Irina Arkhipova of Harvard University, who did not participate in this study, told *The Scientist*.

Future studies might involve attempts to find out whether Giardia is capable of genetic recombination, Arkhipova said. This would require creation of two genetically marked strains, which, upon co-infection, would produce recombinant progeny. "Not to mention the direct observation of *Giardia* sex, of course."

Giardia and many other diplomonad cells have two nuclei, raising the possibility they could essentially have sex with themselves. "It is certainly interesting, but may be a coincidence, that this group of organisms tends to have two nuclei," Logsdon said.

Of the meiotic genes surveyed by Logsdon and colleagues, *Giardia* does not appear to encode *Rad51,* nor *mutS* homologs *Msh4* and *Msh5*, which Villeneuve and Hillers suggested comprised core meiotic recombination machinery, along with *Dmc1*, *Spo11*, *Rad50/Mre11*, and *Mlh1*, which *Giardia*does possess.

"The more new organisms we get to look at, the more we can refine what is defined as the core machinery," Hillers, who did not participate in this study, told *The Scientist*.

In an initial survey for meiotic genes in other protist genome sequencing projects, Logsdon and colleagues found that Entamoeba and Encephalitozoon, neither of which are known to undergo meiosis, contain some meiotic-specific genes found in *Giardia*, suggesting hidden sex lives might be present in those species as well.

While *Giardia* may not be asexual, Logsdon holds out the possibility that an ancestrally ameiotic protist could still be discovered to shed light on the origin of sex and the split between eukaryotes and prokaryotes. "The genes and tools we used here will be critical for ascertaining the sexual status of such an organism," Logsdon said. "Still, we thought *Giardia* was the best candidate."

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