Scientists discover cause of weakness in marine animal hybrids

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A female Tigriopus californicus copepod with an egg sac containing 30 to 40 offspring was obtained for the new study from a population just south of San Diego's Ocean Beach. Credit: Scripps Institution of Oceanography, University of California - San Diego

Scientists at Scripps Institution of Oceanography at UC San Diego have shown for the first time that a genetic malfunction found in marine crustaceans called copepods likely explains why populations of animals that diverge and eventually reconnect produce weak "hybrid" offspring.

Hybrid animals result when populations of a given species separate from one another, undergoing genetic mutations while apart and eventually reestablish ties and interbreed. Hybrids often suffer from lower fertility levels, slower development and higher rates of mortality due to environmental causes.

The new research described by Christopher Ellison and Ronald Burton of Scripps Oceanography is published in this week's online edition of the *Proceedings of the National Academy of Sciences*.

"In addition to informing us about evolutionary processes, this research has important implications for a variety of biomedical and agricultural practices, such as stem cell production and cloning of domestic animals," said Burton, a professor in the Marine Biology Research Division at Scripps.

For the past several years, Ellison and Burton have been studying copepods of the species *Tigriopus californicus*, animals about one millimeter in length that live in coastal intertidal habitats. The researchers produced hybrid specimens in the laboratory by mating animals from San Diego, Los Angeles and Santa Cruz, Calif. At their home between high and low tides, these copepods experience rapid changes in their environment, such as when rainwater dilutes tide pools and the animals are forced to "up-regulate," or activate, specific genes to produce the energy required to manage the stress caused by the rapid change in salinity levels.

Ellison and Burton found that hybrids were incapable of turning on the required genes, and traced this "gene regulation" malfunction to mitochondria, the location inside cells where energy is generated. They further pinned the problem area to a single enzyme, called "RNA polymerase," for the failed trigger.

"In hybrids we found that these genes don't turn on in response to stress, which means the animals don't have enough energy, and that leads to low survivorship," said Burton.

Burton said the study demonstrates how evolution continually molds the interactions of genes in animal populations.

"When populations are hybridized, genes that normally work well within populations are forced to interact with genes from other populations, sometimes leading to dramatic incompatibilities," said Burton. "When the incompatibility affects something as central as cellular energy production, as in *Tigriopus*, it is not surprising that hybrids show slower growth and reduced reproduction and survivorship."

Burton added that the results of the new study hold implications for stem cell research and animal cloning, as those efforts involve taking components of one cell and placing them into another, situations that test gene compatibility and interaction. The findings also may be applicable to agriculture where many crop plants are of hybrid origin.

Ongoing and future studies in Burton's laboratory involve examinations of hybrids with close geographical ties, such as those that live in close proximity in Southern California, to probe the genetic breakdowns more closely. His group also is attempting to replicate the mechanisms in a test tube, experimenting with various DNA and enzyme combinations that might exhibit the problem.

Ellison, who contributed to the research while a graduate student at Scripps and is now a postdoctoral researcher at Cornell University, earned the 2007 Edward A. Frieman Prize from Scripps for research that paved the way to the new study.

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Source: University of California - San Diego