Biologists Link Sexual Selection and Placenta Formation

UC Riverside research shows fish with placentas are smaller and less brightly colored than non-placental fish

By Iqbal Pittalwala on *July 9, 2014*

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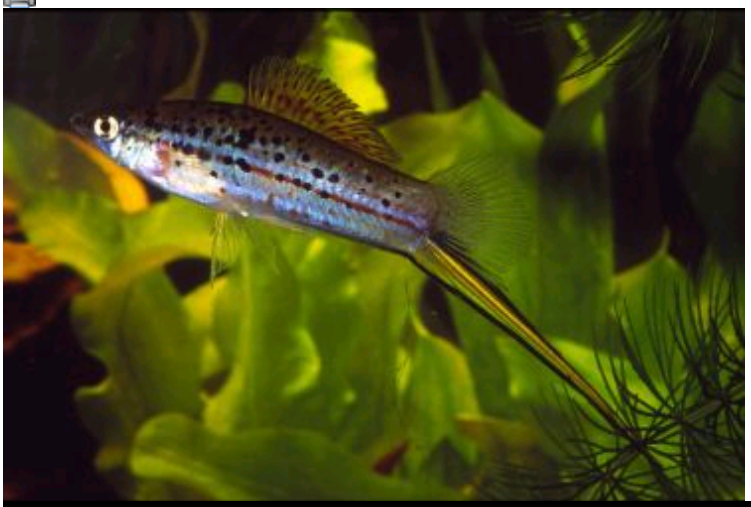

Non-placental species Xiphophorus hellerii. Note the beautiful ventral extension of the tail fin.**Photo credit: Juan Carlos Merino.**

RIVERSIDE, Calif. — Sexual selection refers to species' selection for traits that are attractive to the opposite sex. This special type of natural selection enhances opportunities to mate, the tail of male peacocks being an iconic example.

Biologists at the University of California, Riverside have now found that sexual selection and "placentation" — the formation of a placenta — are linked. Describing the life histories of more than 150 species of fish in the family

Poeciliidae, the researchers found that species with placentas tend to have males that do not have bright coloration, ornamentation or courtship displays. They tend to be much smaller than the males of species without placentas. They also tend to be very well endowed, enabling males to sneak up on females to mate with them without the formality of courtship.

“It impresses me as being a bit like science fiction to say that male morphology and mating behavior and female preferences will be in any way governed by the female’s mode of reproduction,” said David Reznick, a distinguished professor of biology, whose lab led the research. “I would have thought that what was going on in the inside of the animal would be largely independent of what is going on on the outside.”

Study results appear online July 9 in *Nature*.

All of 150 species Reznick’s team described give birth to live young, but some of these species have the equivalent of a mammalian placenta. The researchers discovered that the placenta has evolved multiple times and that species vary considerably in how well their placentas have developed.

“This diversity is enabling us to address questions about how and why the placenta evolved and to learn something about the consequences of having one,” said Bart J. A. Pollux, a former postdoctoral scholar in Reznick’s lab, a member of the research team and the lead author on the research paper.

Placental species Heterandria formosa. Note the lack of sexual dichromatism.**Photo credit: Chiara Sciarone.**

Complex organ

A mammalian organ that forms inside the mother’s uterus, the placenta plays a crucial role during pregnancy. It provides oxygen and nutrients to the unborn baby and removes waste products from the baby’s blood.

“Evolutionary biologists have been trying to answer how and why complex organs evolve,” Reznick said. “They have also been trying to answer how mating strategies and sexual selection evolve. These may seem like unrelated questions, but our research builds a bridge between them.”

Like the eye, the placenta is a complex organ. It is the product of a very large number of genes that must all be well integrated before the placenta can function properly, Reznick explained. “The seeming impossibility of this event is the basis of virtually all of the creation science/intelligent design arguments against evolution,” he said.

Conflict management

The new work adds to the growing abundance of evidence about how important parent-offspring conflict — the disagreement between parent and offspring over the nature of the parental investment in the offspring — is in shaping evolution. This conflict generally increases during parental care, with offspring employing all kinds of strategies to get more from their parents than is in the best interest of the parents to give to them.

“First conceived in 1974, conflict was the product of musings about the coefficient of relatedness between mothers, fathers and offspring,” Reznick said. “In the context of our paper, the evolution of the placenta is shaped by conflict,

but then its presence creates an ongoing conflict between mother and offspring that has a continuing role in shaping evolution."

Non-placental species Xiphophorus birchmani. Note the beautiful dorsal fin.**Photo credit: Leo van der Meer.**

An evolutionary theory put to the test

The new work presents for the first time the diversity of modes of reproduction in the Poeciliidae family. Further, it uses this diversity to perform a formal statistical test of an evolutionary theory called the "viviparity driven conflict hypothesis."

Reznick explained that a research paper in 2000 originally proposed this hypothesis, arguing that there must be a relationship between how animals reproduce and how important sexual selection is in choosing mates. Specifically, when animals evolve placentas, the paper's authors predicted a shift away from choosing who to mate with towards mating with multiple mates, then choosing which fertilized egg to nourish through to the end of development.

"The question is why this change?" Reznick said. "Females of non-placental species fully provision eggs before they are fertilized. If they are to choose a mate, then the choice must be made on the basis of the mate's appearance or behavior. Females of placental species make most of their investment in offspring after the egg is fertilized. This is also a time when the father's genome is active and contributing to the development of the baby. They thus have the ability to choose fathers on the basis of the performance of the developing baby."

All that glitters (in fish tanks) is non-placental

The Poeciliidae family includes guppies, platys, swordtails, and mollies that are frequently on sale in pet stores.

"The reason they are in pet stores is that all of these species are non-placental," Reznick said. "They have males with gaudy colors or elaborate display structures, like the tail of a swordtail or the enlarged fins of sailfin mollies. Gaudy males, it turns out, are more profitable."

Reznick noted that the work his lab is engaged in could not be done on mammals.

"All placental mammals inherited their placenta from a single common ancestor that lived more than 100 million years ago," he explained. "Whatever was happening then has long since been lost to history. These fish have evolved placentas around eight different times and some origins were quite recent. This diversity gives us the power to ask questions about how and why it happened and about what the consequences of the evolution of the placenta have been."

Reznick and Pollux were joined in the study by Robert W. Meredith and Mark S. Springer at UC Riverside. Pollux is now at Wageningen University, the Netherlands. Meredith, a former postdoctoral researcher in Springer's lab, is now at Montclair State University, NJ.

The research was supported by a grant to Reznick and Springer from the National Science Foundation.

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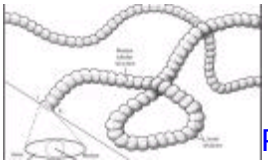
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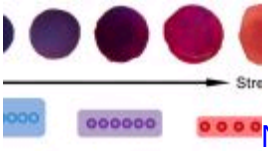
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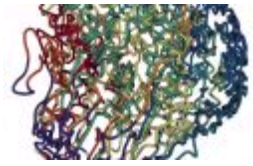
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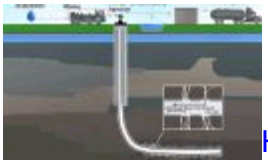
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