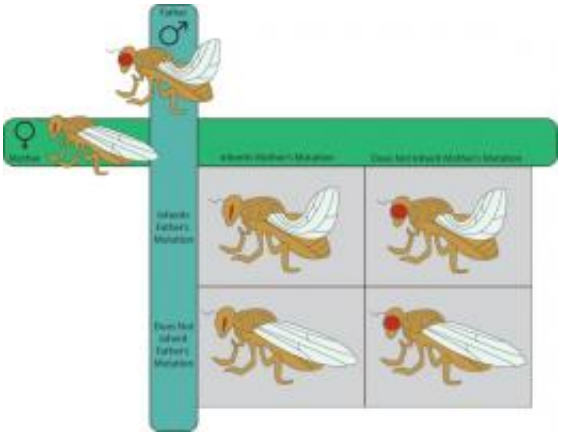
UCLA biologists reveal potential 'fatal flaw' in iconic sexual selection study

June 26 2012, By Kim DeRose



A new sexual selection study replicates an iconic 1948 study and finds it flawed. The graphic shows that children of fruit fly parents with different mutations have an equal chance of inheriting just the mother's mutation, just the father's mutation, both mutations or neither mutation. (Credit: Kim DeRose)

(Phys.org) -- A classic study from more than 60 years ago suggesting that males are more promiscuous and females more choosy in selecting mates may, in fact, be wrong, say life scientists who are the first to repeat the historic experiment using the same methods as the original.

In 1948, English geneticist Angus John Bateman published a study showing that male fruit flies gain an evolutionary advantage from having multiple mates, while their female counterparts do not. Bateman's conclusions have informed and influenced an entire sub-field of

evolutionary biology for decades.

"Bateman's 1948 study is the most-cited experimental paper in sexual selection today because of its conclusions about how the number of mates influences fitness in males and females," said Patricia Adair Gowaty, a distinguished professor of ecology and evolutionary biology at UCLA. "Yet despite its important status, the experiment has never been repeated with the methods that Bateman himself originally used, until now.

"Our team repeated Bateman's experiment and found that what some accepted as bedrock may actually be quicksand. It is possible that Bateman's paper should never have been published."

Gowaty's study was published June 11 in the online edition of *Proceedings of the National Academy of Sciences* and is scheduled for publication in an upcoming print edition.

The original experiment on Drosophila melanogaster, also known as the common fruit fly, was performed by creating multiple, isolated populations with either five males and five females or three of each gender in a jar. The insects mated freely in the experimental populations, and Bateman examined the children that made it to adulthood. To count the number of adult offspring engendered by each of his original insect subjects, Bateman needed a reliable way to match parents with children.

Nowadays, modern geneticists would use molecular evidence to determine the genetic parentage of each child, but DNA analysis was not available in the 1940s. Instead, Bateman chose his initial specimens carefully, selecting D. melanogaster flies that each had a unique, visible mutation that could be transferred from parent to child, Gowaty said.

The mutations were extreme. Some of the flies had curly wings, others

thick bristles, and still others had eyes reduced in size to narrow slits. The outward differences in each breeding subject allowed Bateman to work backward to determine the parentage of some of the fly progeny and to document each mating pair among the original insects. A child with curly wings and thick bristles, for example, could only have come from one possible pairing.

Yet Bateman's method, which was cutting-edge for its time, had a "fatal flaw," according to Gowaty.

Imagine the child of a curly-winged mother and an eyeless father. The child has an equal chance of having both mutations, only the father's mutation, only the mother's mutation or no mutation at all. In order to know who mated with whom, Bateman used only the children with two mutations, because these were the only ones for which he could specifically identify both the mother and father. But by counting only the children with two mutations, Bateman probably got a skewed sample, Gowaty said. In repeating Bateman's experiment, she and her colleagues found that the flies with two severe mutations are less likely to survive into adulthood.

Flies use their wings not only to hover but also to sing during courtship, which is why curly wings present a huge disadvantage. Specimens with deformed eyes might have an even tougher time surviving. The 25 percent of children born with both mutations were even more likely to die before being counted by Bateman or Gowaty.

"It's not surprising that the kids died like flies when they got one dramatic mutation from mom and another dramatic mutation from dad," she said.

Gowaty found that the fraction of double-mutant offspring was significantly below the expected 25 percent, which means Bateman

would have been unable to accurately quantify the number of mates for each adult subject. Further, his methodology resulted in more offspring being assigned to fathers than mothers, something that is impossible when each child must have both a father and a mother, Gowaty said.

Bateman concluded that male fruit flies produce many more viable offspring when they have multiple mates but that females produce the same number of adult children whether they have one mate or many. But Gowaty and her colleagues, by performing the same experiment, found that the data were decidedly inconclusive.

In their repetition — and possibly in Bateman's original study — the data failed to match a fundamental assumption of genetic parentage assignments. Specifically, the markers used to identify individual subjects were influencing the parameters being measured (the number of mates and the number of offspring). When offspring die from inherited marker mutations, the results become biased, indicating that the method is unable to reliably address the relationship between the number of mates and the number of offspring, said Gowaty. Nonetheless, Bateman's figures are featured in numerous biology textbooks, and the paper has been cited in nearly 2,000 other scientific studies.

"Here was a classic paper that has been read by legions of graduate students, any one of whom is competent enough to see this error," Gowaty said. "Bateman's results were believed so wholeheartedly that the paper characterized what is and isn't worth investigating in the biology of female behavior."

Repeating key studies is a tenet of science, which is why Bateman's methodology should have been retried as soon as it became important in the 1970s, she said. Those who blindly accept that females are choosy while males are promiscuous might be missing a big piece of the puzzle.

"Our worldviews constrain our imaginations," Gowaty said. "For some people, Bateman's result was so comforting that it wasn't worth challenging. I think people just accepted it."

Shaking the foundation

Biologists studying sexual selection examine mating habits of organisms ranging from fruit flies to gorillas, both in the lab and in the wild, in order to better understand how certain traits or behaviors confer evolutionary advantages.

Sexual selection began as a discipline following Charles Darwin's publication of "The Descent of Man, and Selection in Relation to Sex," considered Darwin's defense against critics of his theory of evolution through natural selection. He argued that while the unwieldy, colorful tails of peacocks hindered flight and made males easy targets for hungry tigers, the flamboyant plumage served a vital role in attracting potential mates. The overdressed birds had an unexpected evolutionary advantage that did not help when it came to escaping predators but did help when it came to producing offspring through sexual selection, said Gowaty.

Darwin, and later Bateman, cleaved to the notion that females of a species tended to be discriminating and passive, while the far more promiscuous males competed for their attentions. In the last few decades, however, evolutionary biologists have shown that the story is far more complicated. Gowaty, who has been interested in female mating habits in insects and birds since the beginning of her career, spent 30 years in the field studying Eastern bluebirds. She published the first molecular genetics study showing that females in a socially monogamous species mated outside their traditional pairs regularly.

Gowaty describes the benefits of multiple mates as an answer to the never-ending evolutionary struggle against what may be the world's

greatest predator: disease.

"Our pathogens have much shorter generation times than we do as the hosts, and they evolve offenses much more rapidly than we can evolve defenses," she said. "One of the rules of nature is that our pathogens are going to get us."

In this illness-driven arms race, organisms that produce offspring from multiple mates are more likely to produce some children with the right antibodies to survive the next generation of viruses, bacteria and parasites. Fruit fly males are likely to give females the additional variation in the genome that they need to build strong immune systems in their kids, Gowaty said.

For Gowaty, there are many open questions remaining when it comes to female mating habits, whether in fruit flies or other organisms. Yet shaking the bedrock of the Bateman paradigm may help the field examine new perspectives.

"Paradigms are like glue, they constrain what you can see," she said. "It's like being stuck in sludge — it's hard to lift your foot out and take a step in a new direction."

This study was federally funded by the National Science Foundation. Other co-authors included Wyatt Anderson, a professor of genetics at the University of Georgia and a member of the National Academy of Sciences, and Yong-Kyu Kim, a research scientist at Emory University.

Provided by University of California, Los Angeles

fatal.html