When it comes to mating, fruit flies can make rational choices

January 17 2017

The female fruit flies under a black light, marked so the researchers can tell them apart. Credit: Devin Arbuthnott

Humans make rational choices—though perhaps not all the time. But does the ability for rational decision-making extend to other members of the animal kingdom? If so, how far are they from the human lineage?

The answer, according to researchers from the University of Washington, is pretty far.

In a paper published Jan. 17 in the journal *Nature Communications*, they report that fruit flies—perhaps the most widely studied insect in history—show signs of rational decision-making when choosing a mate. Through a complex series of behavioral experiments, the team shows that male fruit flies, when presented with a pair of females as potential mating partners, display a key component of rational choice: transitivity.

"Transitivity is a hallmark of rational decision-making," said senior author Daniel Promislow, a UW professor of pathology and biology. "Essentially, it is the process of establishing a rank order of preference, and then making behavioral decisions based on that hierarchy."

Transitivity has been shown in other animals, such as some bird species, while searching for food. But Promislow's team, led by first author and postdoctoral researcher Devin Arbuthnott, is among the first to see if rationality extends to mate choice.

The researchers showed that individual male fruit flies from one wild-derived strain, called Canton-S, displayed transitivity when presented with potential female mates from 10 different laboratory strains of fruit flies. In these tests, a researcher would place one Canton-S male in an arena with a pair of females, each from a different strain, and note if the male mated with either female.

"Before each test, we would mark each female with a yellow or red fluorescent powder," said Arbuthnott, who is now a postdoctoral

researcher at the University of British Columbia. "If the male attempted to mate with either female, we could determine the female's identity based on her color."

To account for all possible pairings of females from the 10 strains, they tested Canton-S males against 45 pairs of females. No fly, male or female, was tested more than once. After repeating these tests 10 to 20 times for each combination, the researchers discovered that Canton-S males displayed a consistent, ranked preference regarding which female to mate with.

"This is the pattern we would expect to see if males are making transitive decisions—a sign of rational choice," said Arbuthnott.

Using the same assays, they showed that males from a second strain, Oregon-R, also display transitivity with females from the 10 laboratory strains. There were only a few small differences between the hierarchies displayed by Oregon-R males and Canton-S males, said Arbuthnott.

Fruit fly mating assay tubes in the laboratory. Credit: Devin Arbuthnott

Though the researchers only tested mate choice in male flies, the decision to mate in this species is definitely a two-way street. But Arbuthnott focused on male mate choice in these experiments to help dispel a misconception about mating in many animal species.

"There is a classic theory that females are the 'choosy' sex and males aren't choosy," said Arbuthnott. "We wanted to show that males are definitely making choices too when interacting with the females."

The males are likely responding to a combination of visual, chemical and behavioral cues from the females. The team conducted more experiments to learn about the "information" the males picked up from females. Blind males still displayed transitivity when choosing between females, as did mutant males who had no sense of taste and smell. But blind males with no sense of smell or taste did not display transitivity.

"The results from these sensory deprivation experiments indicate that there is some redundancy in the information provided by the female visual and chemical cues," said Promislow.

They also analyzed one particular signal, a complex secretion of chemicals known as cuticular hydrocarbons, or CHCs.

"CHCs are essentially 'contact pheromones,'" said Arbuthnott. "When they're in close proximity, fruit flies can taste one another's secretions and—we believe—learn information about a potential mate."

By gas chromatography, which separates and identifies individual CHC molecules, they discovered that females from lines less likely to be chosen for mating secreted higher levels of two particular CHCs, which may act as "repellant" signals.

In addition, the researchers counted the number of offspring produced by females from each line, and discovered that males were more likely to mate with females with a greater capacity to produce the next generation.

Their results indicate that male fruit flies construct a hierarchy—a sign of transitivity and rational choice—and may be doing so by integrating diverse visual and chemical cues from females.

"They're able to process the information they're receiving in the most

advantageous way," said Arbuthnott. "Their decisions are transitive, which is indicative of rational choice."

More information: *Nature Communications*, DOI: 10.1038/NCOMMS13953

Provided by University of Washington