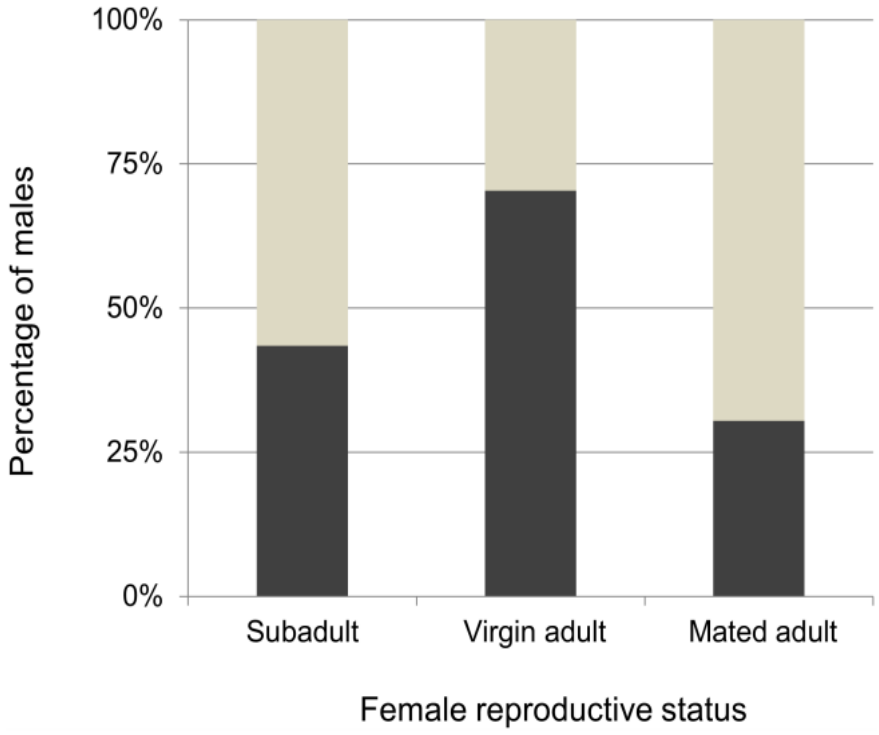
HOW TO USE THIS RESOURCE

Show the following figure and caption to your students. The accompanying Student Handout provides space below the image caption for Observations, Notes, and Questions and space next to the "Background Information" for Big Ideas, Notes, and Questions. The "Interpreting the Graph" and "Discussion Questions" sections provide additional information and suggested questions that you can use to prompt student thinking, increase engagement, or guide a class discussion about the characteristics of the graph and what it shows.



Caption: The figure shows the percentage of male spiders that remained in an empty, female-built web for four days after being placed there by researchers (dark bars) and the percentage of male spiders that left the web (light bars). The webs were built by females that differed by reproductive status: subadult, virgin adult, or mated adult.

BACKGROUND INFORMATION

Physical and behavioral adaptations increase an animal's reproductive success. An animal has higher reproductive success when it produces more offspring that survive to reproduce. Because males can produce many more sperm than females can produce eggs, males and females usually evolve different strategies for increasing reproductive success. Some of these strategies involve mate choice, or choosing certain types of individuals to mate with. In many species, males can produce many sperm without using too much energy. As a result, these males are often "un-choosy." They try to mate with many females in order to produce many offspring. Females, on the other hand, are often limited by the energy required for egg production. These females are often "choosy." They try to mate with males that are healthier or better providers in order to produce more successful offspring.

Although un-choosy males and choosy females are found in many animals, this trend can be altered by the behaviors of certain species. One such species is *Cyrtophora citricola*, a web-building spider that can live in colonies of thousands. The female spiders usually eat the males during or immediately after mating. This behavior is called sexual cannibalism. Due to sexual cannibalism, most males never get a chance to mate more than once. In addition, as females cannibalize males, the number of females for every male increases in the population.

Scientists hypothesized that these factors would make male *C. citricola* spiders choosier about their mates. In one experiment, the scientists placed male spiders into empty webs built by different female spiders. The females were categorized into three groups based on reproductive status:

1. subadults, younger females that were not yet ready to mate
2. virgin adults, which were ready to mate for the first time
3. recently mated adults, which were likely to use the sperm of previous mates to produce offspring.

Males can detect the reproductive status of females by sensing chemicals in the females' webs. By observing whether the males stayed in the webs, the scientists determined the males' preferences for different types of females.

INTERPRETING THE GRAPH

The graph shows that the reproductive status of a female spider influenced whether males stayed in that female's web. Males were most likely to stay in the webs of virgin females, indicating that the males preferred the females with which they had the best chance of producing offspring. Males were less likely to stay in the webs of females that were not ready to mate (subadults) or that had recently mated. The males would be less likely to produce offspring with females from either of these two groups.

The figure provides evidence of males using a choosy strategy that is likely to increase their reproductive success. This observation is the opposite of the pattern in most animal species, in which females are choosier than males. The scientists propose that this rare example of male choosiness evolved due to *C. citricola*'s unique combination of sexual cannibalism and colony living. Although sexual cannibalism gives females an easy meal, it prevents males from mating multiple times. Male spiders may have thus evolved choosiness to compensate for limited reproductive opportunities. The evolution of male choosiness was likely facilitated by *C. citricola*'s colonial community structure. Living in large colonies gives males the opportunity to encounter a variety of nearby females. If females are more spread out and harder to find, males cannot afford to be as choosy about their mates.

Teacher Tip: Prompt your students to explain the parts of the graph as applicable:

- Graph type: Stacked bar graph
- *Y*-axis: Percentage of males that either stayed in (dark bars) or left (light bars) female webs after four days
- *X*-axis: Three reproductive status categories for female spiders. Subadults are not yet ready to mate. Virgin females are ready to mate for the first time. Mated adults have recently mated with another male and are likely to use the previous male's sperm to father offspring.

DISCUSSION QUESTIONS

- Describe the three categories of females listed in the figure. Which category do males prefer? Provide evidence from the figure.
- What features would make females of a particular reproductive status more or less appealing to males?
- What are the relative ages of the three female reproductive statuses? Why might males have different preferences for females of different ages?

- Do you think younger or older males would be choosier about their mates? Use the concept of reproductive success to explain your answer.
- Why does this figure use a stacked bar graph instead of a double bar graph that shows the light and dark bars side-by-side?
- How do you think sexual cannibalism affects female and male reproductive success?
- Scientists hypothesize that both sexual cannibalism and colonial living contributed to the evolution of male choosiness in *C. citricola*. Describe how both factors might contribute to the evolution of this behavioral strategy.
- Can you think of other factors that could cause male choosiness to evolve? Use the concept of reproductive success to support your answers.

KEY TERMS

cannibalism, female reproductive status, mate, mate choice, natural selection, reproductive success, sexual selection

SOURCE

Figure 2 from:
Yip, Eric C., Na'ama Berner-Aharon, Deborah R. Smith, and Yael Lubin. "Coy Males and Seductive Females in the Sexually Cannibalistic Colonial Spider, *Cyrtophora citricola*." *PLoS ONE* 11, 6 (2016): e0155433. https://doi.org/10.1371/journal.pone.0155433.

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