The Secret Life of Staghorn Ferns: Social Organization and Labor Division in a Eusocial Plant

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Have you ever struggled with multitasking? It turns out that many of Earth’s organisms have also faced this problem, and have evolved to solve the issue by dividing up social tasks among the community members. Until recently, it was believed that a separation of labor between individuals was limited to groups in the animal kingdom. However, in 2021, evolutionary biologist Dr. Kevin Burns and his colleagues found that this social organization also occurs in plants. The division of labor within a colony is called eusociality, meaning “truly social.” Eusociality is most commonly associated with insects like ants and bees. It consists of specialization of roles into reproductive and nonreproductive classes of individuals. As a result of specialization, individuals are focused on one task rather than trying to juggle between reproducing and acquiring nutrients; these types of colonies are often able to collect more resources for the colony. Burns and his fellow researchers traveled to Lord Howe Island, a small volcanic island in the Tasman Sea between Australia and New Zealand, to study the life cycles of ferns. On this island, they found that one fern, Platycerium bifurcatum, has developed eusocial behavior. Platycerium bifurcatum, also known as the staghorn fern, is native to tropical areas but is also commonly used as a household plant due to the peculiar antler shape of its fronds, its leaf-like structure, and its preference for warmer temperatures. Mature wild staghorn ferns always grow in colonies, in which individual ferns grow very close together and occupy the same niche. Staghorn ferns are also epiphytes, which means that they grow on other plants and trees and use the rain and dust in the air to get their nutrients. Another unusual thing about staghorn ferns is that each individual produces two types of leaves or fronds, called strap fronds and nest fronds. Nest fronds are wide, low to the ground, and infertile. They mostly absorb water and catch detritus that is floating in the air. On the other hand, strap fronds are reproductive and nonabsorbent. The waxy hydrophobic coating on the long, thin strap fronds directs the water downwards to the hydrophilic disk-shaped nest fronds. Burns believes that this limited environment spurred the staghorn ferns to evolve eusociality in order to more efficiently capture nourishment for themselves.

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To study this unique behavior in staghorn ferns, Burns and his colleagues set out to examine three things. To start, they examined the correlation between frond type and location in the colony. By graphing the number of reproductive fronds by height in the colony, the researchers found that more reproductive strap fronds were found in individuals at the top of the colony and that around 40 percent of all individuals in the colony were infertile. Next, they sought to determine if ferns in different locations in the colonies had different functions. They found that less water was absorbed by individuals that were at higher elevations in the colony, showing that ferns at the bottom of the colony were specialized for absorbing water. Lastly, the researchers considered the genetic relatedness of the individual ferns within the colony. They conducted DNA sequencing on four loci in individuals from 10 staghorn fern colonies. Ultimately, they found that the individuals within the colonies were genetically identical to each other in eight of the 10 colonies.

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Through their multifaceted investigation into the lives of Platycerium bifurcatum, the biologists found that these ferns have developed specialized nutritive and reproductive functions depending on where they are within the colony and that most of them share the same genetic information. This means that while certain individuals at the top of the colony are carrying out reproduction and passing on the colony’s genetic code, the other ferns are able to devote all of their biological energy to procuring nutrients for the colony. Furthermore, staghorn fern colonies also have developed a comprehensive system of roots that connects the individuals of the colony. Through this network, the non-reproductive ferns that collect the bulk of the water and nutrients are able to redistribute it to the reproductive ferns. In this way, not only have the ferns divided up their labor, but they have also developed an extensive communication network to go along with it.

The findings of Burns and his colleagues have massive implications for the field of evolutionary biology as they show a connection between social structures in plants and animals that were never seen before. Until now, scientists believed that brains were essential for developing complex and stratified social structures, but this study is disproving this proposed prerequisite. This study is just one of many recent experiments that have shown that plants are capable of much higher function and behavior than was previously thought. We are now in a time where we know that plants talk to each other, share food, and have social classes. However, only with further research will we be able to gain a better understanding of the evolutionary adaptations that started with ferns and led to the complex societies that humans operate in today.