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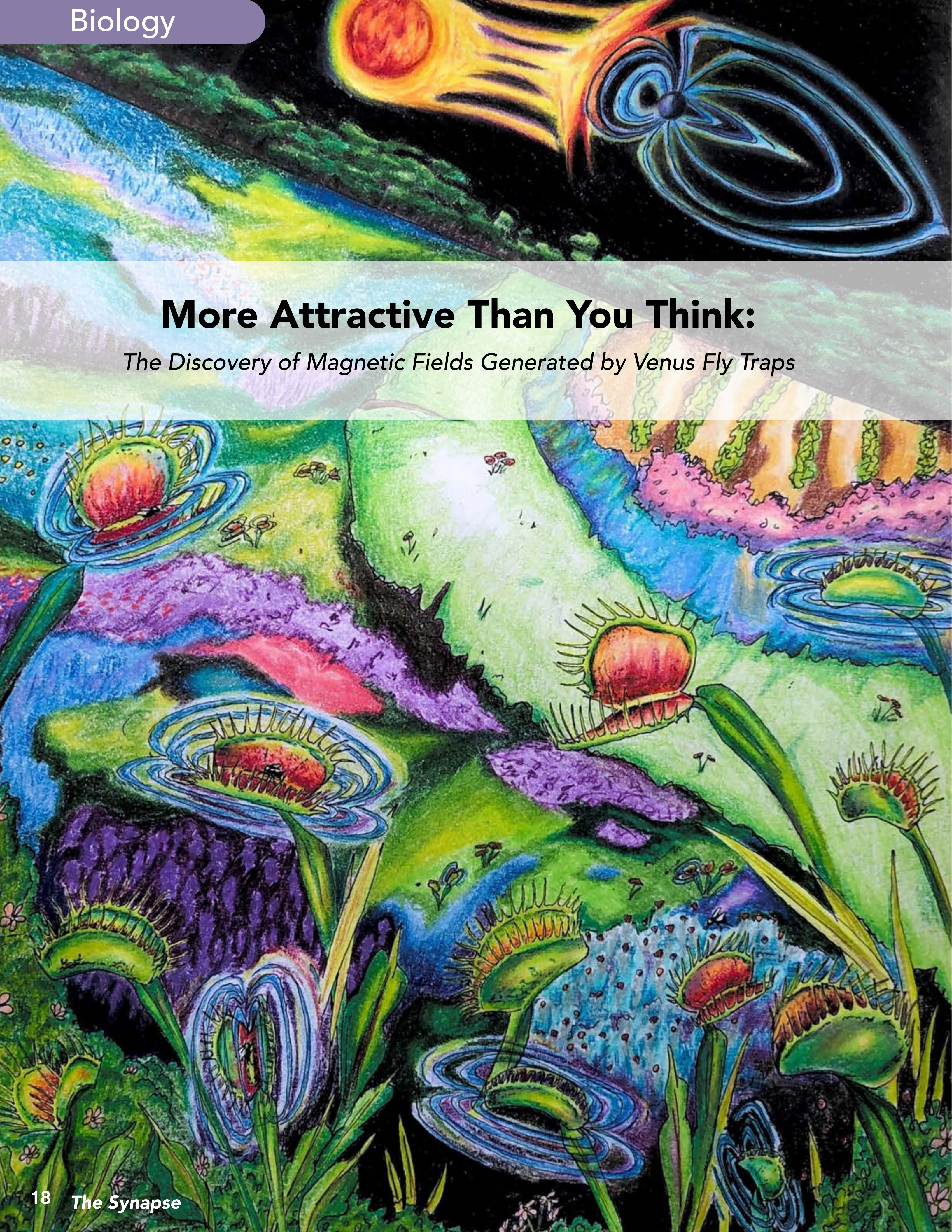

More Attractive Than You Think:

The Discovery of Magnetic Fields Generated by Venus Fly Traps

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Venus flytraps have captivated children, fans of science fiction, and plant enthusiasts for decades. These tropical plants subvert our ideas about vegetative characteristics with their carnivorous diets and movable "jaws." In January 2021, researchers at Johannes Gutenberg University Mainz in Berlin discovered that Venus flytraps produce a detectable magnetic field. The generation of a magnetic field by electrical signals, also called biomagnetism, has been studied widely in humans and animals but, until now, had only been identified in two other plants. Anne Fabricant, the lead researcher, explains that "wherever there is electrical activity, there should also be magnetic activity." However, Fabricant reports "that the magnetic signals in plants are very weak, which explains why it was extremely difficult to measure them with the help of older technologies." So, while the discovery of the magnetic field itself was relatively expected, actually being able to measure the field was momentous.

The Venus flytrap is able to sense the presence of its prey in its trap through mechanical receptors in the form of small hairs on the inside surfaces of their lobed leaves. These receptors are activated once touched by prey. While plants lack a nervous system, they can send signals from one part of the plant to the other. These signals travel in the form of an action potential, a rapid change

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in charge across a membrane, creating an electric shock that propagates from one cell to another. The change in charge occurs when positive ions accumulate on the outside of a membrane and quickly cross over through a protein channel, rapidly making the negative internal charge more positive. Through action potentials, plants and animals are able to rapidly send messages to other parts of the organism when a stimulus (either good or bad), has been detected. These electric shocks become a flow of electricity that moves throughout the organism, albeit a very small one. Like electric forces, magnetic forces are reliant on charged molecules interacting with one another with attractive and repelling forces. Due to this relationship, they are very interconnected. A magnet in motion can generate electricity, and conversely, an electrical flow can create a magnetic field. In animals and plants, their action potentials create small magnetic fields.

The researchers at Johannes Gutenberg University Mainz were able to trigger action potentials in the Venus flytraps with heat transmitted through surface-voltage electrodes. These electrodes were clamped to one of the flytraps' lobes, and the temperature was increased from 20° to 45°. As the electric action potential flowed through the Venus flytraps, the researchers were able to detect the magnetic field using glass sensors filled with a vapor of atoms whose electron energy levels are modified by magnetic fields. The development of these sensors, called atomic magnetometers, was historic. While magnetic fields have been detected in plants before, they were measured by superconducting-quantum-interference-device (SQUID) magnetometers, which are incredibly hard to use given that they are large and require extremely low temperatures. The atomic magnetometers are a lot more convenient than SQUID magnetometers because they are able to work at room temperature and can be miniaturized for easy portability. Additionally, the techniques developed by the Johannes Gutenberg University Mainz researchers are non-invasive and therefore can detect these changes in the plant without piercing the leaf and triggering other action potentials.

The researchers are currently focused on using their technique to measure smaller magnetic fields in other plants. However, their findings "give some hints about how electric currents are distributed in the trap" says Fabricant, and could be applied to discovering more about intercellular communication in plants. Without a central nervous system or "brain" headquarters, many aspects of these signals in plants remain a mystery. Tracking these signals with the help of atomic magnetometers can help start to answer some of these questions. Additionally, their findings can be used in non-scientific industries. We know that when plants sense a threat, they relay this information through signals that are picked up by cells, which generate a response. This knowledge that plants generate electromagnetic signals in times of stress can be used to track the health of crops. Measuring these fields and the changes in them in an easy and non-invasive fashion could be incredibly helpful in monitoring the crops' response to temperature changes, pests, or chemicals. In industrial agriculture, being able to detect that a section of your crops is being harmed through changes in its electromagnetic fields has the potential to save immense amounts of food and water waste.

Venus flytraps have defied our expectations for years with their simultaneous animal-like and plant-like characteristics. But their importance in connecting our knowledge of intercellular communication between the animal and plant kingdoms is even greater than we thought. The researchers from Johannes Gutenberg University Mainz developed a technique to accurately and easily measure the mechanical fields of plants in a non-invasive way. Investigating life at the cellular level not only contributes to the collective scientific knowledge, but also provides information that may alter policies to improve well-being on a larger scale. The detection of magnetic fields in Venus flytraps is only the first step towards learning more about the microscopic systems that regulate our everyday life, and is a springboard for that insight to inform our actions in the future. • • •