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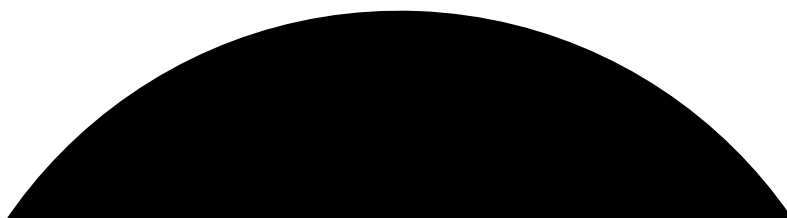
Can Plants Really “See”?

Words by Martin Bourdev

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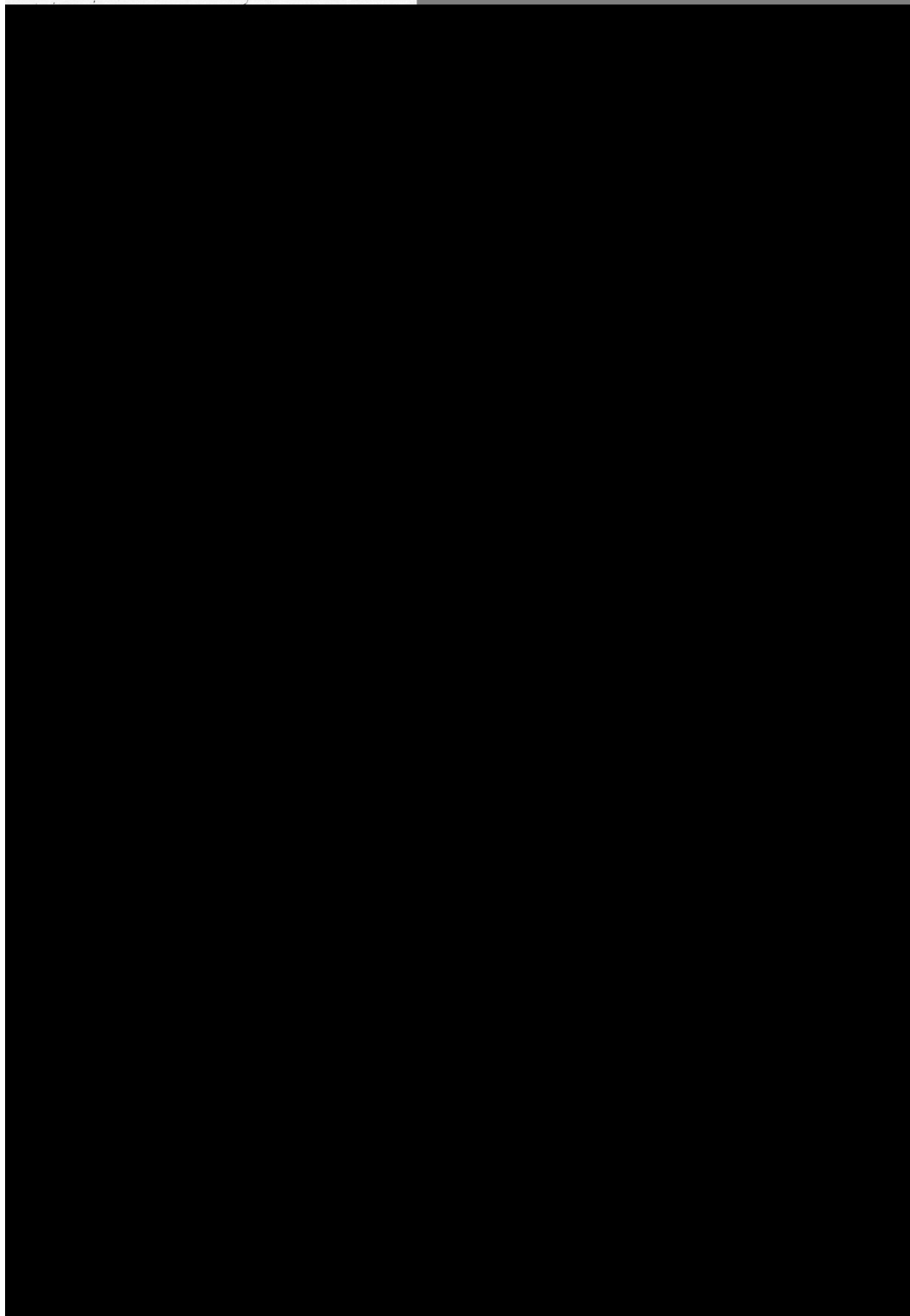


In the early 2010s, Chilean plant ecologists Ernesto Gianoli and Fernando Carrasco-Urra spotted what looked like a peculiar tree stem in the rainforest. On closer inspection, they realized it was a vine, *Boquila trifoliolata*, imitating a nearby tree’s leaves — closely matching their size, shape, and vein patterns. After further study, Gianoli and Carrasco-Urra discovered that this aptly named “Chameleon Vine” could mimic all sorts of plants, or even multiple *different* plants at once by changing the shapes of leaves growing at various heights along the vine.

Local tribes had long used *Boquila's* fibers for weaving baskets and ropes, and its juice for treating sore eyes. Still, despite the genus first being documented in 1839, the broader scientific community had been unaware of its capacity for mimicry.

Gianoli and Carrasco-Urra sought to explain the mechanism by which *Boquila* senses another plant's leaves and then tailors its own to match. In a 2017 study, the duo offered two possible explanations: Either *Boquila* had evolved a heightened ability to detect volatile chemicals emitted by nearby vegetation, or it was somehow borrowing genetic information from nearby microbes to camouflage itself.

A third, more recent hypothesis, however, has received far more attention: *Boquila* vines mimic nearby plants via a primitive form of vision.



A drawing of *Boquila trifoliolata* by French botanist, Pierre Jean François Turpin (ca. 1820).

While outlandish at first blush, this idea is based upon a centuries-old notion suggested by Gottlieb Haberlandt and Harold Wager, respected botanists working at the turn of the 20th century. Haberlandt and Wager argued that certain lens-shaped leaf cells without chloroplasts — so-called “ocelli” — could function like tiny eyes. These specialized cells can bend incoming light onto the

leaf's interior, creating a bright central spot that shifts with the leaf's angle. This bright spot then triggers a molecular cascade that leads to adjustments in leaf orientation, allowing the plant to position its leaves to absorb more photons for photosynthesis. (Here is a [time-lapse video](#) of a plant moving in response to the changing sunlight.)

In 2016, researchers František Baluška and Stefano Mancuso suggested that ocelli could also explain *Boquila's* uncanny shape-shifting ability, positing that these "tiny eyes" may *actually be capable of sight*. Inspired by this line of thinking, molecular botanists Jacob White and Felipe Yamashita performed the first and only controlled study focused specifically on the plant-vision hypothesis in 2021. Their study has been viewed more than 180,000 times online, garnering the duo a 2024 Ig Nobel Prize in Botany for "finding evidence that some real plants imitate the shapes of neighboring artificial plants." (These awards are often more humorous than serious, but they do lead to lots of press attention!)

Alas, numerous inconsistencies in White and Yamashita's methods and interpretations undermine the paper's central claims. As the Internet becomes rife with speculation about "seeing plants," remember that extraordinary claims require extraordinary evidence.

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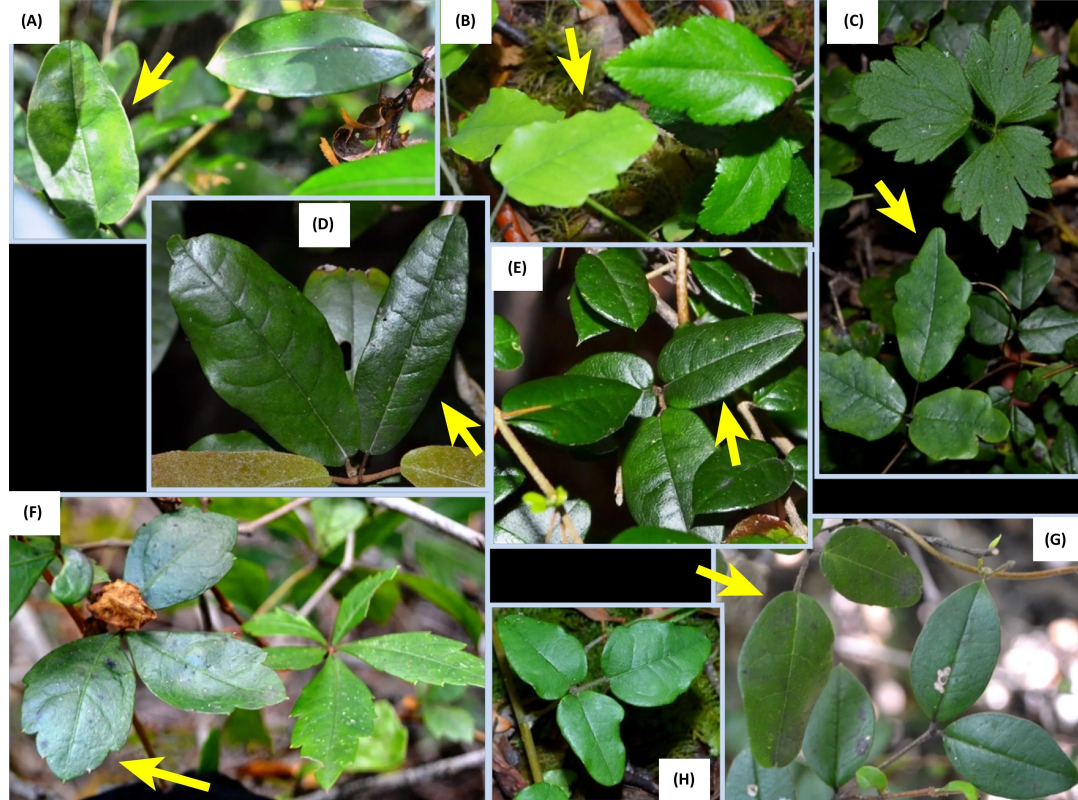
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Consider the Evidence

In their 2021 study, White and Yamashita tested whether *Boquila* could copy plastic leaves, an approach intended to rule out Gianoli's ideas involving airborne chemicals and transferred genes. Plastic leaves do not emit organic signals and contain no DNA, so any mimicry could *imply* some kind of primitive vision.

To begin, White and Yamashita placed *Boquila* vines beside plastic houseplants and then partitioned each vine's stem into an upper, middle, and lower section separated by opaque shelves. The plastic leaves sat on the middle shelf, about 28 centimeters above the vine's roots. Because these shelves blocked the vine's lower section from "seeing" the plastic houseplants, the researchers labeled the top leaves (with a line of sight to the plastic plant) as "mimic" and the bottom leaves (with no line of sight) as "non-mimic."



All of these images are of the same plant, *B. trifoliolata*. Credit: Ernesto Gianoli, *Trends in Plant Science*

As the vines grew, the scientists measured various parts of the leaves, such as their lengths, widths, and number of free-ending veinlets — the tiny veins ending before the leaf's edge. They also calculated the aspect ratios (length divided by width), circularity (how similar a shape is to a perfect circle), rectangularity (similarity to a rectangle), and form factor (width divided by length) of the leaves. Over time, the top leaves grew narrower and longer, with fewer free-ending veinlets — a bit closer to the shape of plastic leaves.

At first glance, this study appears to support the plant-vision hypothesis. But the findings are far from conclusive.

For starters, the “mimic” leaves and “non-mimic” leaves didn't have identical growing conditions. The opaque shelves created two different microenvironments, blocking some sunlight from reaching the bottom shelves. A stronger experimental design would have compared entire vines exposed to plastic plants with entire vines grown without them, or rotated which shelf served as the control group to account for the blocked sunlight.

The second problem is seasonal variation — and this is where things get weird. “During the winter,” the researchers write in their study, “the plants grew quickly though the leaves showed poor mimicry of the artificial plant's leaves. The original plant that we had did not show good evidence of mimicry until the spring and summer. We decided to continue the experiment and see if there were better results in the warmer months.”

In other words, the first experiment failed, so the authors repeated it until they got significant results. This observation also suggests that *Boquila* may change its leaves seasonally; the observed shape shifts could just be a result of normal environmental triggers — such as day length, temperature, or humidity — and not any special optical abilities. (These plants, after all, are native to warm, humid rainforests.)

White and Yamashita's experimental design. Two opaque shelves split each vine into three vertical regions. Only the parts of the vines located above shelf #1 and shelf #2 are exposed to the plastic leaves. Credit: [White & Yamashita \(2021\)](#).

And even if we overlook these nitpicky caveats, the data still don't decisively prove that *Boquila* is somehow “seeing” the plastic leaves and mimicking their shapes.

If the vine is truly copying the plastic plant, then one would expect the dimensions of the mimic leaves to approach the dimensions of the plastic leaves. This is certainly true of aspect ratio (length divided by diameter), where a larger value indicates a skinnier form. The slender plastic leaves have an aspect ratio of nearly 3, so they are three times as long as they are wide. *Boquila* leaves “observing” the decoys grow to around 2, while non-mimic leaves hover between 1.0 and 1.5. This trend lies at the core of the authors' argument for plant vision.

However, this trend falls apart for other measurements, like length and width. The plastic leaves are 7 cm long. If the plant could really see, then the mimic leaves would grow close to that length,

while non-mimic leaves diverge. Instead, mimic leaves only grow to about 2.5 cm, while non-mimic leaves grow to about 3 cm, closer to the plastic plant than the mimics. This trend holds for width, too. The plastic leaves are about 2.4 cm wide, which non-mimic leaves achieve, while mimic leaves don't even reach 1.5 cm. The authors simply ignore the tendency of non-mimic leaves to match the length and width of the plastic leaves more closely. Although the authors use aspect ratio to persuade the scientific community of plant vision, comparing the lengths and widths argues the opposite of their claim.

Various measurements reported in White and Yamashita's paper. Black bars correspond to so-called non-mimic, or control, leaves. Mimic leaves were exposed to plastic leaves. Bars are divided into ages (young, middle, old), with old leaves corresponding to those at the top of the vine, nearest to the sun. Charts adapted from White & Yasmashita (2021).

The researchers also note fewer free-ending veinlets and thinner vascular networks in mimic leaves, interpreting this as evidence of active mimicry. Such vascular differences are governed by auxin, a plant hormone that regulates leaf venation and shape. White and Yamashita argue that differences in auxin levels between mimic and non-mimic plants "can be interpreted as an attempt to modify their leaf shape, trying to mimic the plastic leafs [sic]." But the authors never measure auxin levels *in either plant at any stage of their experiment* to support this claim. Nor do they explain how a *Boquila* plant would "see" a nearby leaf and then alter its hormone levels to mimic it, making this assertion yet another example of the logical leaps that pervade their paper.

Extraordinary Claims

Still, one flawed paper does not entirely invalidate the potential for plant vision. Botanists know that plants sense light direction and intensity. Simple organisms, including certain algae, also use

lenslike structures to focus light and have primitive forms of image detection. In single-celled or colonial algae, refractive imaging can help direct movement toward or away from sunlight, so the concept of a plant possessing rudimentary vision is not outlandish. The question is whether *Boquila* can process complex images well enough to copy an artificial leaf.

Some algae have “eyespots” that help guide them toward or away from sunlight. The eyespot detects the light’s direction and intensity, then triggers signaling mechanisms that control flagellar beating. Credit: [Yamashita & Baluška](#) (2023).

For that to be true, *Boquila* would need more than lens-shaped cells. It would need a way to translate incoming light into signals that reorder its leaf structure, from shape and color to the number of veins. Although some scientists speculate about bioelectric networks or hormone distributions, nobody has shown exactly how a vine, which lacks a brain or central nervous system, could create an “image” and convert it into leaf-mimicking growth.

Meanwhile, Gianoli’s two alternate theories — chemical signaling and horizontal gene transfer — have their own shortcomings. If *Boquila* somehow detects airborne molecules from host leaves, how does it then turn that chemical chatter into precise leaf shapes? If it borrows genetic material from bacteria, how does it select only the genes that influence morphology? Nobody yet knows.

Still, scientists have documented both volatile [chemical communication](#) and [bacterial gene-swapping](#) in plants before, so these ideas at least have some basis in observed phenomena. A parasitic plant called *Cuscuta pentagona*, found throughout the U.S. and Canada, follows chemical cues to grow towards tomato plants, preferring them over wheat. The same plant also has 108 active genes that originated from horizontal gene transfer.

None of these ideas are easy to test conclusively, but more rigorous experiments could at least narrow the possibilities. Researchers might spray a *Boquila* vine with chemical extracts from other plants to see if it changes shape even in the absence of a visible host. Conversely, they might sterilize a vine's surface to remove potential bacteria or manipulate horizontal gene transfer pathways, then see whether it still mimics.

To test the vision idea directly, scientists could either add more controls to White and Yamashita's original study, or else physically "break" the ocelli — disabling lenslike cells or blocking the hypothetical signal cascade — to see if that interrupts mimicry.

Boquila trifoliolata's mimicry is compelling precisely *because* none of the explanations for it are simple. Delineating any of them would increase our understanding of the way plants can absorb and act on complex information from their environment. We should encourage more rigorous experimentation with *Boquila* and keep an open mind. But until we gather evidence justifying the extraordinary claim of plant vision, we must treat it for what it is: a remarkable, but unproven, idea.

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