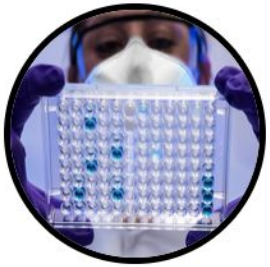


# 6PM

**11PM in London (GMT), 8AM in Tokyo (GMT+9)**

## Plant Intelligence

**Moderator:** Katy Börner, *Indiana University*

**Presenter:**

- Roger P. Hangarter, *Indiana University*

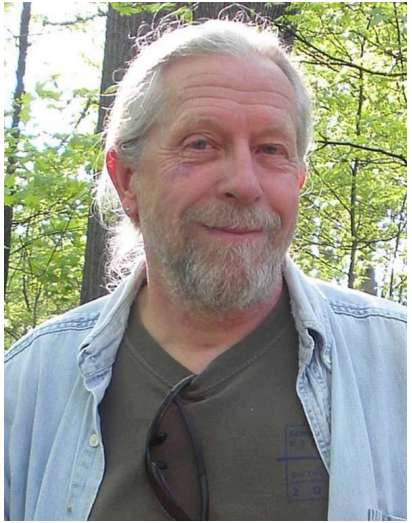
ENVISIONING INTELLIGENCES

Aurora Mititelu

# Roger P. Hangarter

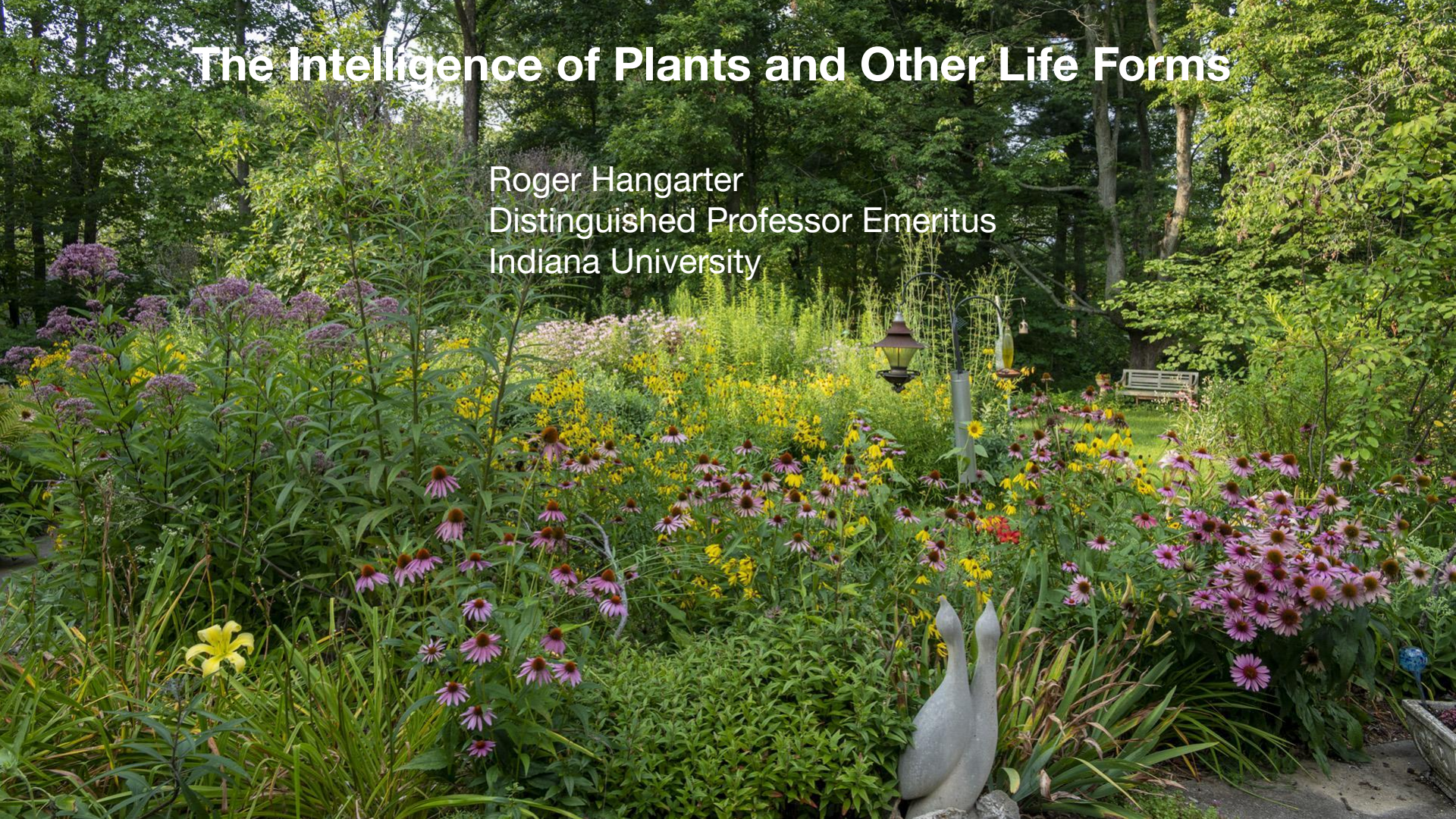
Roger Hangarter is a Distinguished Professor and Chancellor's Professor of Biology at Indiana University. He received his Ph.D. from Michigan State University and conducted postdoctoral research at the University of Illinois, Urbana. Prior to joining Indiana University, he was Associate Professor of Botany at The Ohio State University. He has served as a Program Officer for grant programs at the National Science Foundation, USDA, and DOE, and has held numerous leadership roles in the American Society of Plant Biologists, including serving as its President. He is a Fellow of the American Association for the Advancement of Science (AAAS) and the American Society of Plant Biologists (ASPB).

Hangarter's research and outreach focus on plant biology, visualization, and education. He developed the sLowlife and Plant Dance exhibits and the Plants-In-Motion website to bring plant science to broad audiences. His photography and time-lapse movies have been exhibited in museums and galleries worldwide, including the US Botanic Garden, Washington DC; the Chicago Botanic Gardens; the Grunwald Gallery of Art at Indiana University; the Science Museum of Minnesota; Clifford C. Hach Gallery, Philadelphia; the David Weinberg Collection, Chicago; Field Museum, Chicago; Museum of Science and Technology, Santiago, Chile; Montshire Science Museum, Vermont; and SPACE 151, Levi Art + Architecture, San Francisco, CA. He has received numerous awards, including Teaching Awards from the ASPB and Botanical Society of America, the MERLOT Award for Exemplary Online Learning Resources, the NSF and AAAS Science & Engineering Visualization Challenge Award, and an Emmy Award for Photography (Great Lakes Region).



# The Intelligence of Plants and Other Life Forms

Roger Hangarter
Distinguished Professor Emeritus
Indiana University



# Plants are living organisms

Plants grow and reproduce

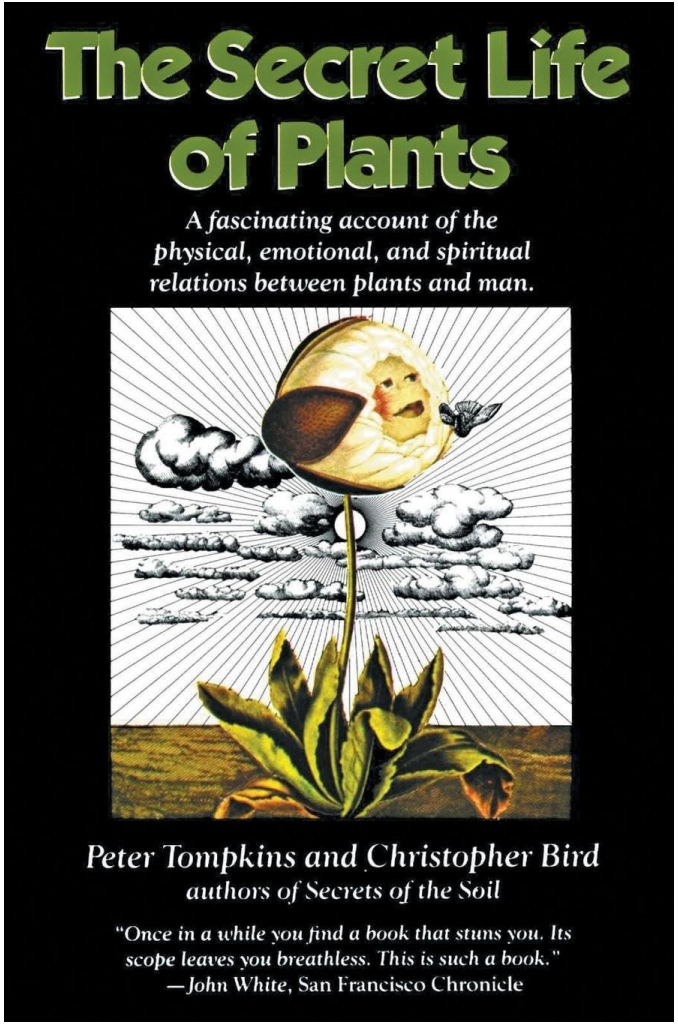
Plants search for nutrients and light (energy)

Plants perceive and respond to external and internal stimuli

Plants communicate with each other

Plants communicate with other creatures

Plants alter their local environment




Published in 1973

HOME SEARCH

SCIENCE

## Sorry, Vegans: Brussels Sprouts L

HOME SEARCH

SCIENCE | SPECIAL ISSUE

## No Face, but Plants Lik

By CAROL KAESUK YOON MARCH 14, 2011

The Opinion Pages

**Opinionator**

THE STONE

## If Peas Can Talk, Should We

By MICHAEL MARDER APRIL 28, 2012 3:30 PM 37

The Stone is a forum for contemporary philosophers and other thinkers on issues both timely and timeless.

Imagine a being capable
information — a being w
inhabiting a world of its
us will think of a human
animal, and virtually no

Since Nov. 2, however, c
sativum, a species colloq
day, a team of scientists
Research at Ben-Gurion
its peer-reviewed researc
drought conditions com
with which it shared its
relayed to its neighbors
drought, prompting ther
similar predicament.





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# Do Plants Have Brains?

## Some biologists argue that "neurobiology" has been too narrowly defined

By Rob DeSalle and Ian Tattersall

*Adapted with permission from* The Brain: Big Bangs, Behaviors, and Beliefs, *by Rob DeSalle and Ian Tattersall, published by Yale University Press. Copyright © 2012 by Rob DeSalle and Ian Tattersall*

*Mimosa pudica*, also called sensitive plant or touch-me-not, folds its leaves rapidly when mechanically disturbed. Few plants exhibit such quick movements, although many—such as those that open and close their blooms according to the time of day—respond with slower movements to environmental stimuli.

*Martin Shields/Photo Researchers, Inc*

**Some people think that plants respond to talking**, the playing of music, and other forms of human attention. And although plants more than likely do not process human language, they are nonetheless highly aware of their surroundings and are very capable of communication among their cells. Furthermore, some scientists think that a plant's internal communication system is very close to what we could legitimately call a nervous system. After all, some mimosas are famous for retracting rapidly after being disturbed, and Venus flytraps react swiftly to the presence of insects in their capture devices. Charles Darwin made comparable observations and proposed similar ideas about plants. In one of his less well known works, *The Power of Movement in Plants* (1880), he wrote about



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resented a
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xperiments of a
expert named
1966, on a whim,

*Plants have electrical and chemical signalling systems, may possess memory, and exhibit brainy behavior in the absence of brains.*

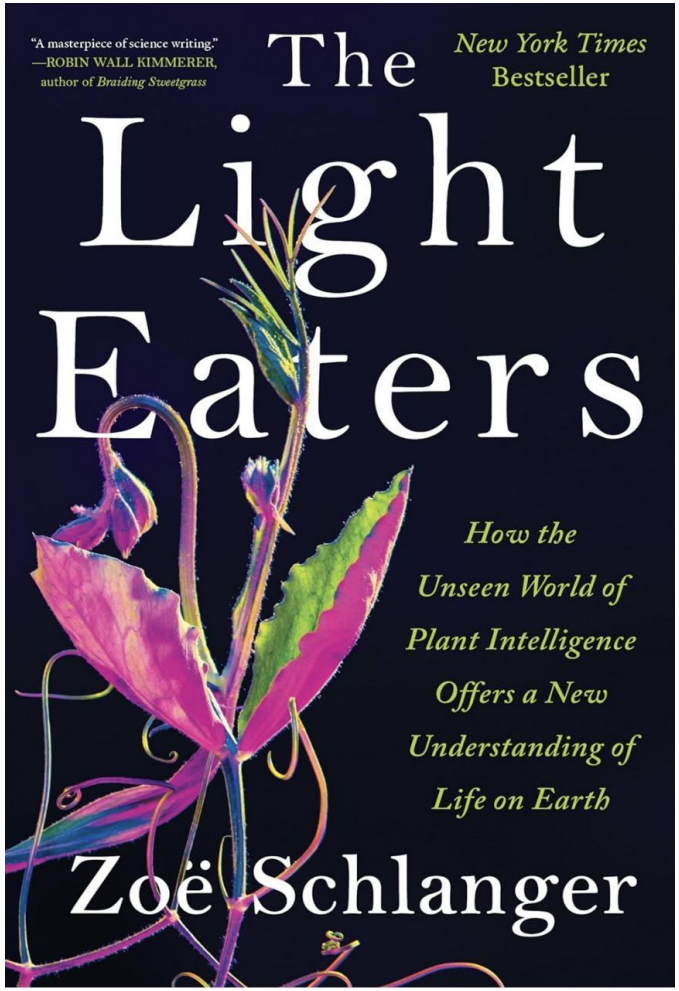
CONSTRUCTION BY STEPHEN DOYLE / PHOTOGRAPH BY GRANT CORNETT

Scientific American

ink?

*of plants that see, feel, smell—and*

51




Published in 2024

# Darwin had the patience to see what plants are capable of doing

**POWER OF MOVEMENT**

**IN**

**PLANTS**

CHARLES DARWIN, LL.D., F.R.S.

ASSISTED BY

FRANCIS DARWIN

WITH ILLUSTRATIONS.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1880



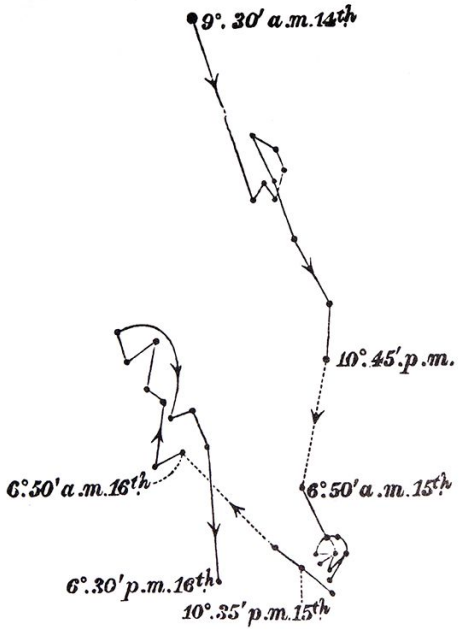
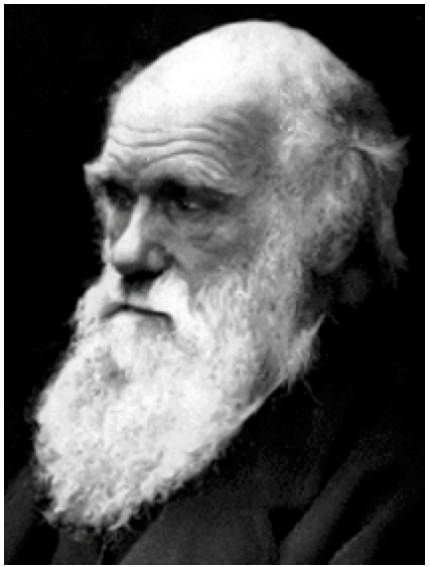


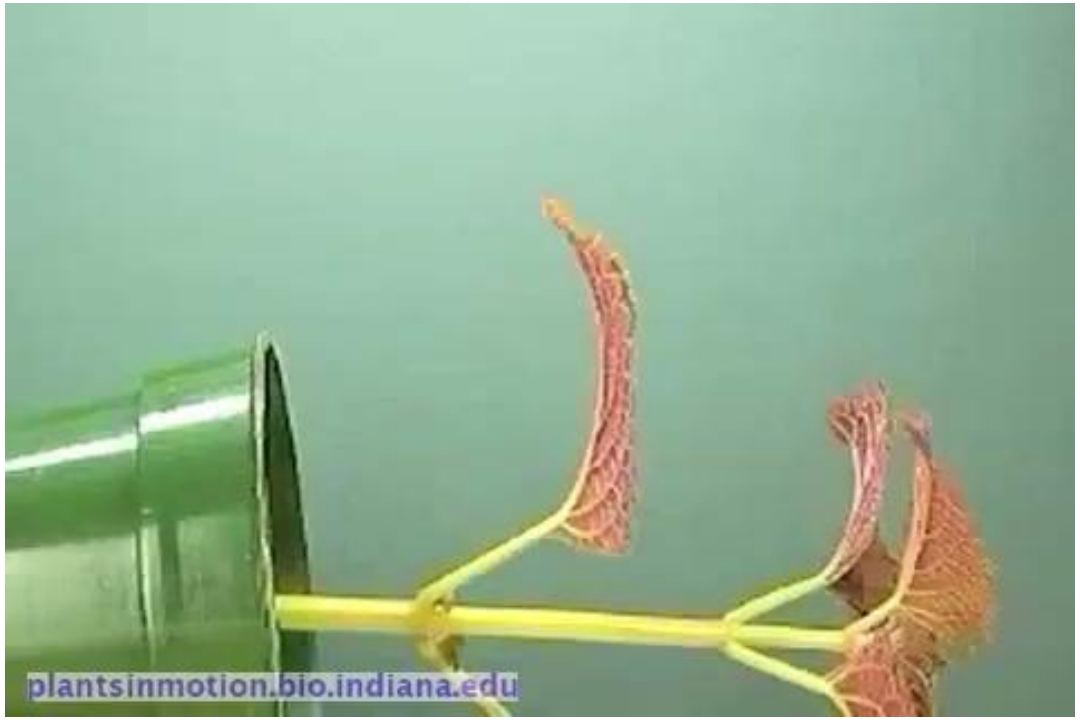

Fig. 98 *Pelargonium zonale*



# Plants sense and respond to the direction of light

Sunflower seedling
(*Helianthus annuus*)

# Plants sense and respond to the direction of gravity




Coleus

# Plants coordinate their responses to the direction of light and gravity

Corn seedlings
(*Zea maize*)

# Plants keep track of time of day

Sunflower
(*Helianthus annuus*)

# Plants search their surroundings

Morning Glory
(*Ipomoea purpurea*)

# Plants respond to mechanical stimulation

Venus Fly Trap
(*Dionaea muscipula*)

Sensitive Plant (*Mimosa pudica*)

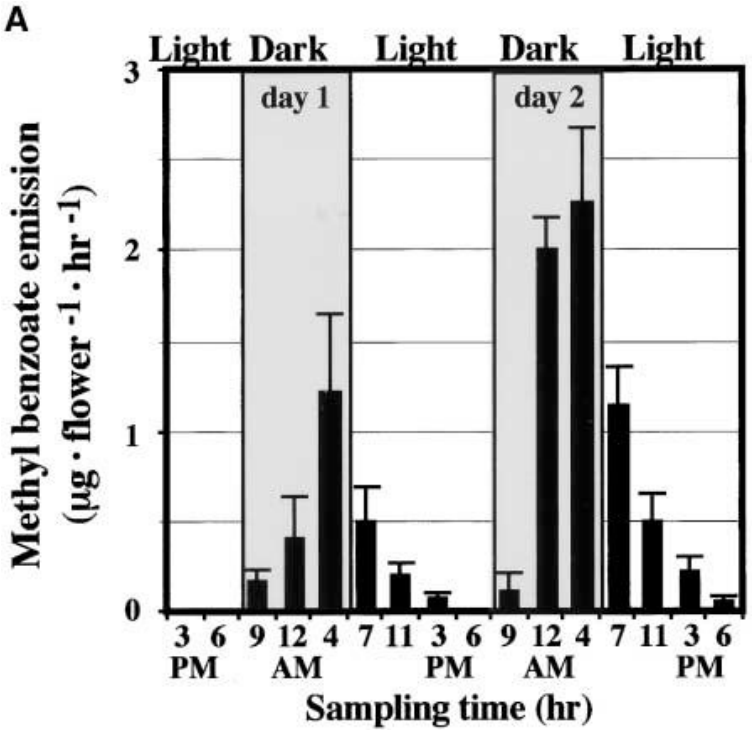
*It is impossible not to be struck with the resemblance between the…movements of plants and many of the actions performed unconsciously by the lower animals.*

*It is hardly an exaggeration to say that the tip of the radicle…having the power of directing the movements of the adjoining parts, acts like the brain of one of the lower animals…*

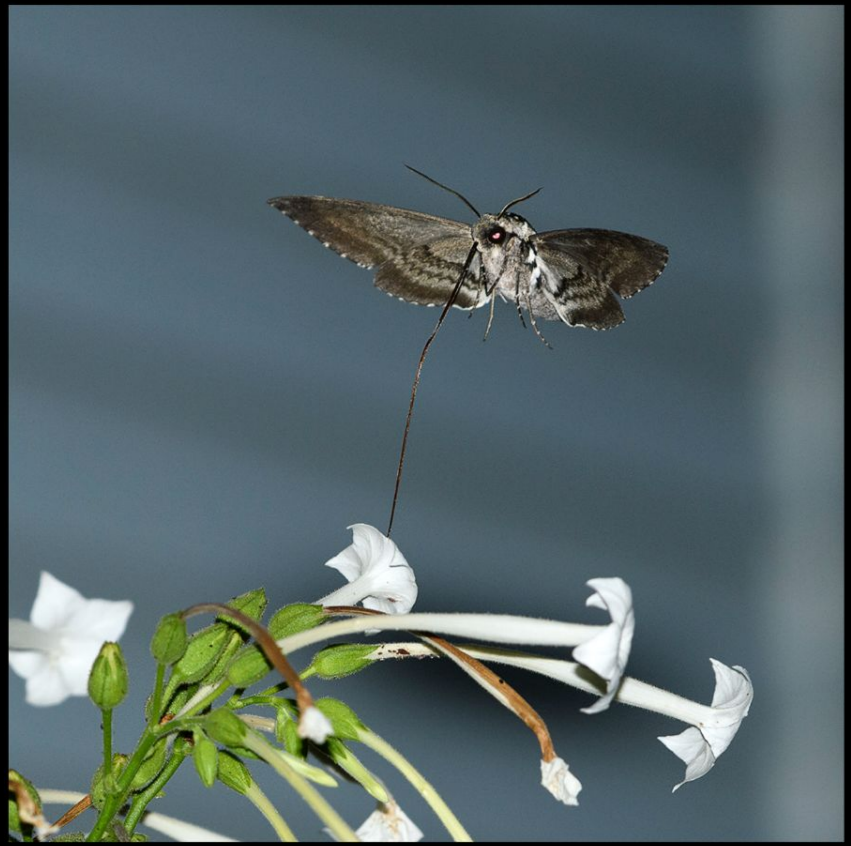
– Charles Darwin
*The Power of Movement in Plants*, 1880


Interspecies communication

# Night pollinated flowers emit volatile signals at night




*Nicotiana suaveolens*



*Carolina Sphinx Moth, Tobacco Hornworm (Manduca sexta)*


Parasitic wasp

The plant attracts a pollinator (sphinx moth)

If it’s a female moth, it may deposit an egg

The egg hatches and caterpillar starts to eat the plant

The plant emits chemical signals to attract a parasitic wasp

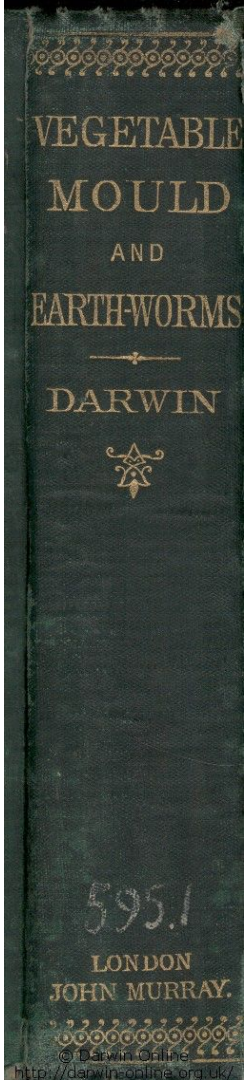
The wasp larva secret a viral protein that blocks caterpillars immune response

The plant also emits chemical signals that activate defense responses in nearby plants

# What about other living things?

Darwin studied plant movements (behaviors) to test his ideas about the evolution of complex human behaviors. He reasoned that if he could determine the materialistic basis for behavior in a “simple lower organism” he could explain how natural selection could act upon it to evolve more complex behaviors.

# Earthworms





Earthworms do not have eyes but are sensitive to light.

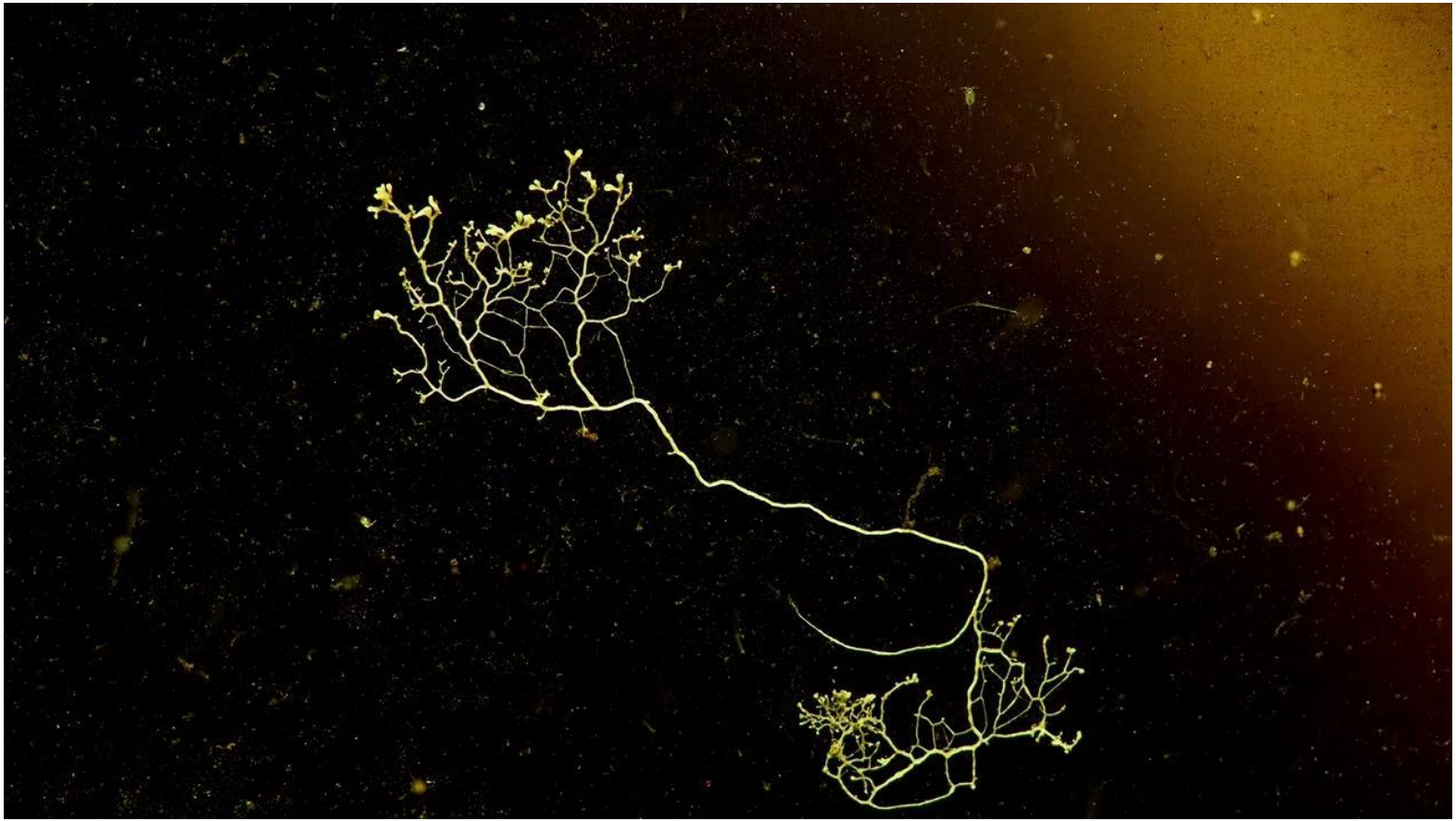
They do not possess any sense of hearing but are sensitive to vibrations transmitted in solid objects.

They have a sense of taste. "*Judging by their eagerness for certain kinds of food, they must enjoy the pleasure of eating*"

Intelligence is shown by worms in their manner of plugging and dragging food into their burrows.

*Mr. D. F. Simpson, who has a small walled garden where worms abound in Bayswater, informs me that on a calm damp evening he there heard so extraordinary a rustling noise from under a tree from which many leaves had fallen, that he went out with a light and discovered that the noise was caused by many worms dragging the dry leaves and squeezing them into the burrows.*

# Slime Molds

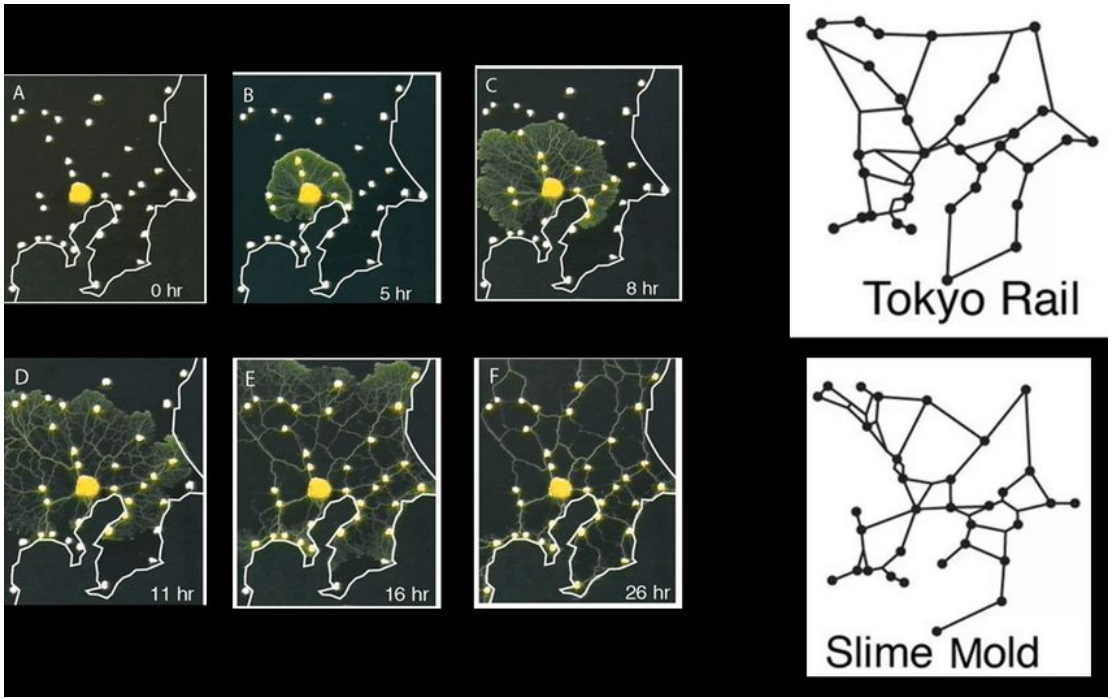


Slime molds can “smell” (sense) food

They can select the most nutritious foods

They can “remember” where they’ve been

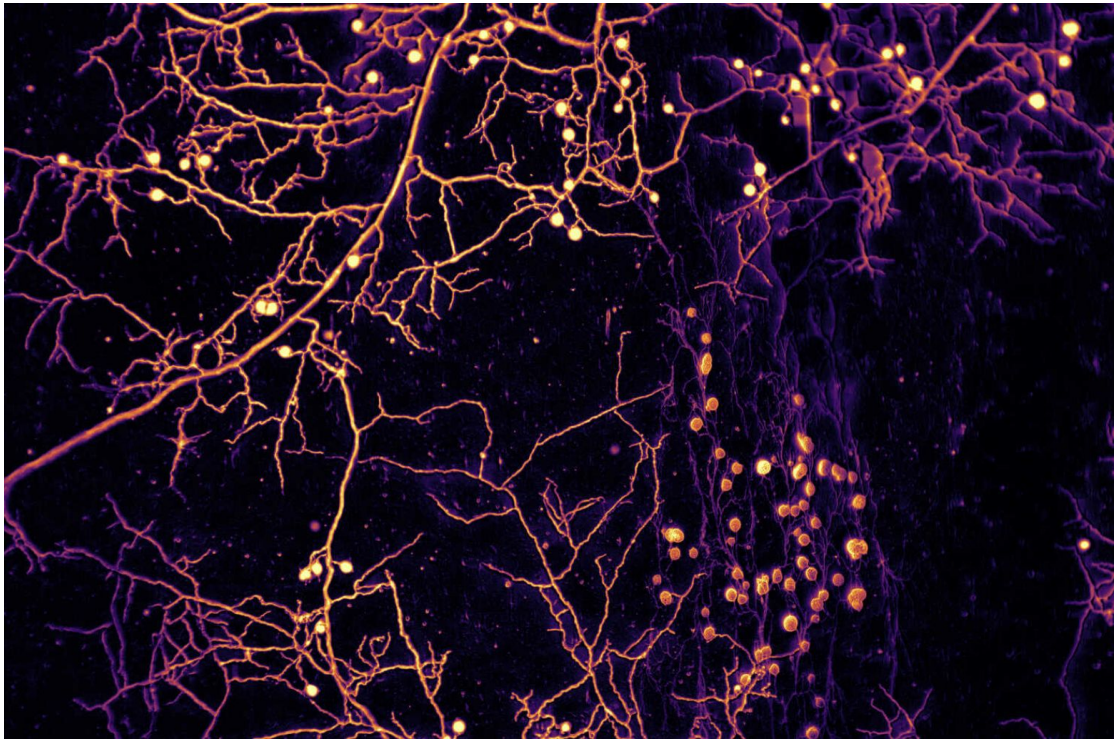
They can “devise” the best route to their meals




https://www.pbs.org/wgbh/nova/video/secret-mind-of-slime/

# In the “Wood-Wide Web”

Mycorrhizal fungi in the soil are thought to behave like slime molds, but in coordinated communication with plant roots.



# Sociomicrobiology

## A diversity of microbial behaviors are cooperative

Quorum-sensing (chemically sense population density)

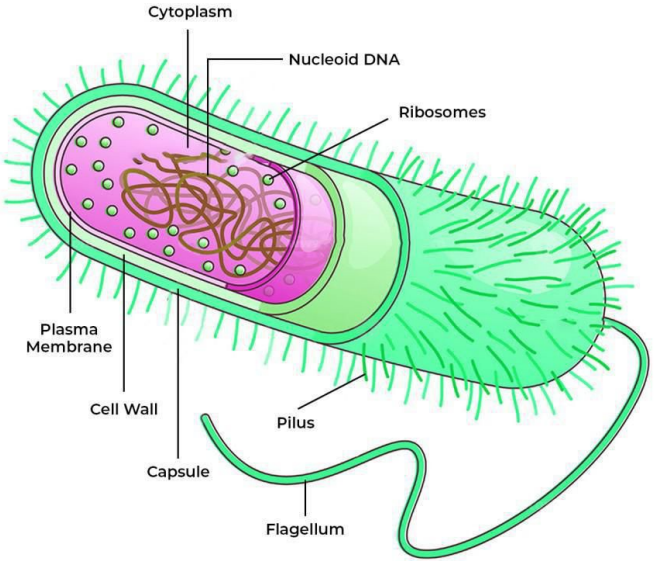
Cooperative forms of motility

Formation of biofilms (multicellular colonies with distributed jobs)

The production of microbial public goods such as iron-chelating molecules

Excrete enzymes that digest complex growth substrates

# Bacteria




Bacteria have many chemical receptors in their plasma membrane.

Pili and flagella sense mechanical forces and can drive directional movement.

Bacterial cytoplasm contains many biochemical signal-transduction pathways.

## All living organisms:

Must be capable of acquiring suitable energy.

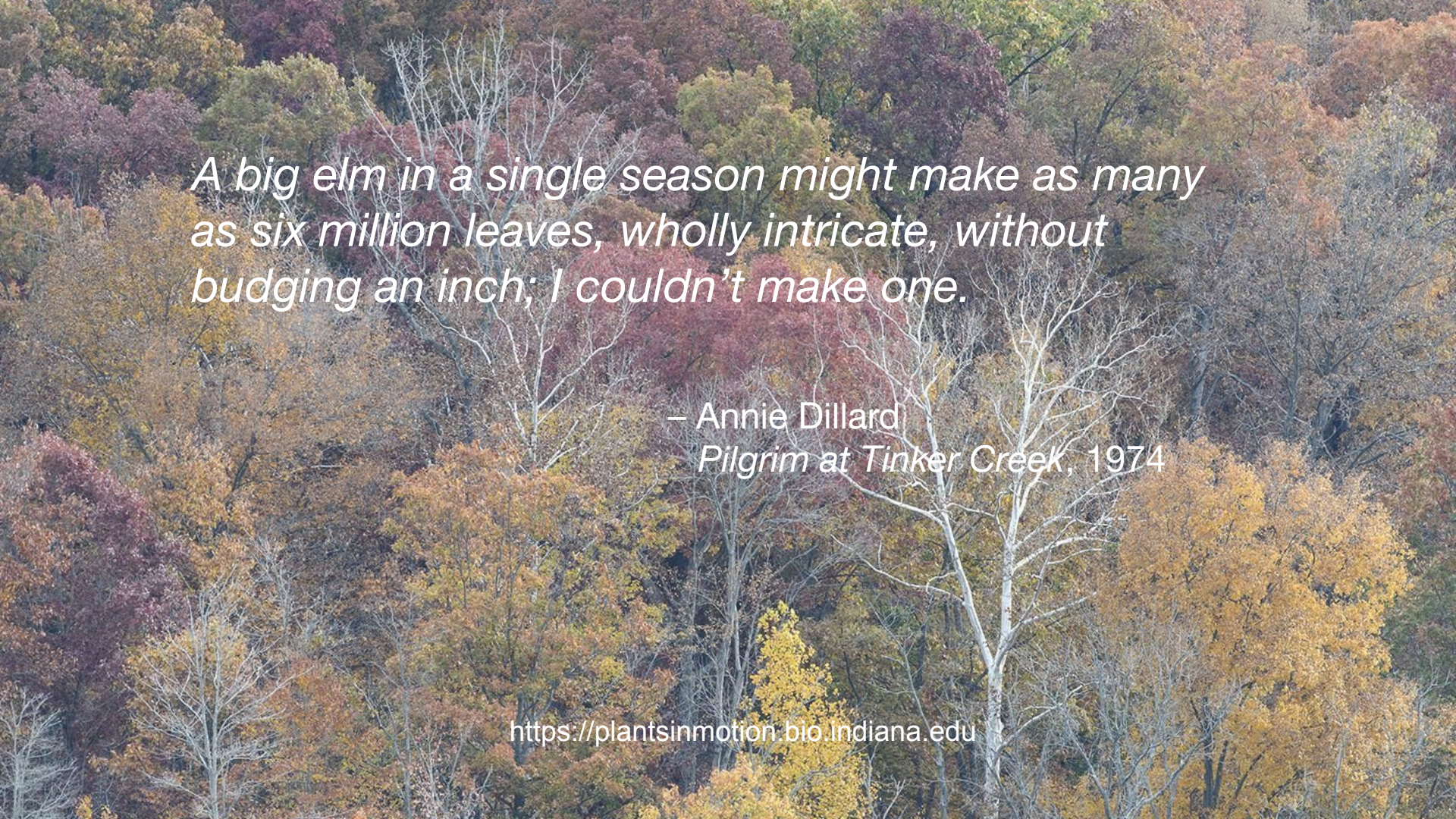
Must be capable of sensing and responding to their surroundings.

Must be capable of identifying abiotic (e.g., temp) and biotic (e.g., prey) threats.

Must be able to coordinate complex information about their surroundings.

Must be able to reproduce when conditions are appropriate.

All life forms,
from the smallest bacteria to most bigly-brained humans,
are inherently intelligent.


*A big elm in a single season might make as many as six million leaves, wholly intricate, without budging an inch; I couldn't make one.*

– Annie Dillard
*Pilgrim at Tinker Creek*, 1974

https://plantsinmotion.bio.indiana.edu

**24h Envisioning Intelligences**
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https://scimaps.org/call-for-submissions

ENVISIONING INTELLIGENCES

*Aurora Mititelu*