

Galls

What are they and
why should you care?

Gaston del Pino

What are galls?

- Galls are any benign growth on external tissue of plants
 - The closest analogue for humans would be a benign tumor or wart
- Many things can cause gall formation
 - Viruses and bacteria
 - Aphids, psyllids and other hemipterans
 - Gall midges and some fruit flies
 - Cecidomyiidae
 - Gall wasps (Cynipidae)



THE MURDER HORNET



BECAUSE 2020 WASN'T FUN ENOUGH YET!

Wasps kill more people than snakes, spiders and scorpions yet are only arrested 5% of the time.



Bees vs. Wasps

	Bees	Wasps
Pollinate Flowers	✓	✗
Create amazing Structures	✓	✗
Have a hive mind	✓	✗
Don't fuck with you if you stand still	✓	✗
Make sweet, sweet honey	✓	✗
Number of Stings	1	∞

BEE OR WASP?

HOW TO TELL THE DIFFERENCE:



BEE

1. Pollinates Flowers
2. Makes Honey
3. Improves The Environment
4. Reluctant To Sting



WASP

1. Just An Asshole

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And Sherwood Forestry, With A Grant From The TCC MN CO-OP Extension

DO NOTHING TO HARM OR
UPSET IT



STINGS YOU ANYWAYS



The Cynipidae

- About 1300 species worldwide, about 800 species in the US
 - We'll talk about that number in more depth
- Galls made by cynipids are most common on oaks, but can also be found on members of the Rosaceae, Asteraceae and Salicaceae
- Galls formed by cynipids have an internal structure or chamber inside of the gall, which most other gall-forming insects lack
 - A single gall may contain a single chamber (e.g. *Disholcaspis cinerosa*) or multiple chambers (e.g. *Callirhytis batatoides*)



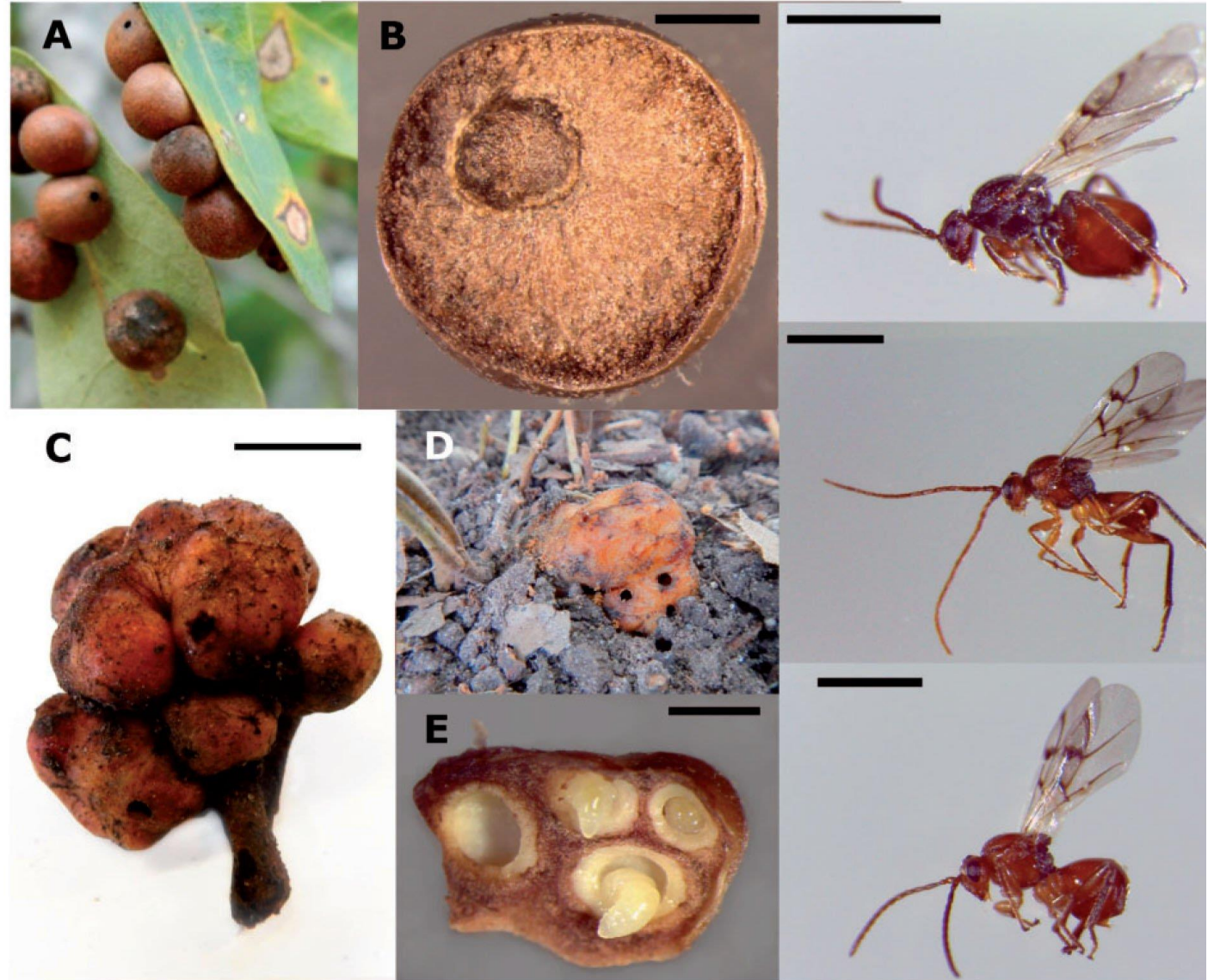
Gall Formation

- Cynipids can form on almost any plant tissue
 - Most visible on leaves and stems, but can be formed on roots, catkins and buds
- The exact mechanism for gall production is not known, but probably involves some input from the ovipositing female to modulate the plant's phytochemistry and some influence from larval feeding
- Gall tissue is not merely modified tissue, but the development of a novel plant "organ"
 - Gall wasps can significantly modify almost a third of the oak genome compared to the tissue from which it is derived

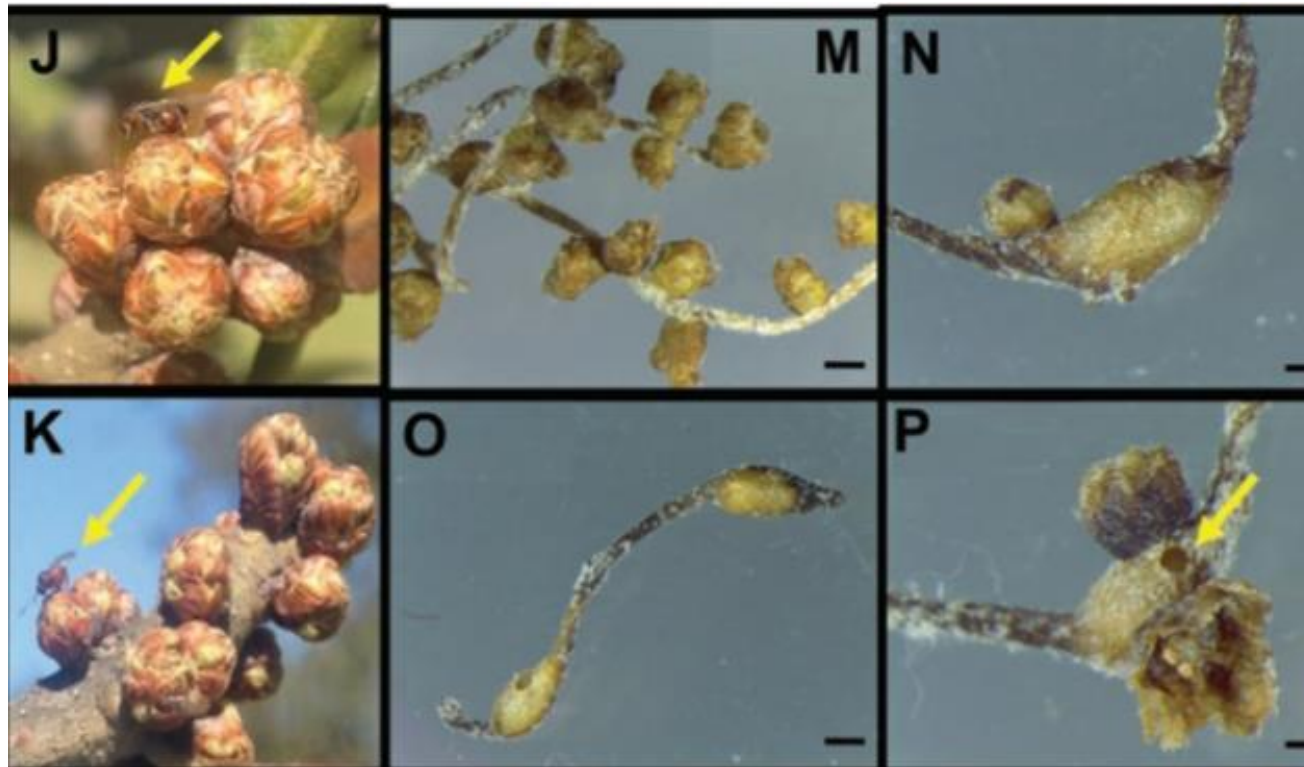


Cynipid Life History

- Many cynipids have a cyclically parthenogenic life cycle
 - That means that males and females mate to produce a generation of only females, which themselves lay the following gametic generation
 - Some gall wasps have seemingly lost the sexual generation and only produce agamic females
- Gametic and agamic generations do not necessarily (nor often) generate galls on the same plant tissue
- For example: *B. treatae* forms single-chambered galls on leaves in the agamic generation and multi-chambered root galls in the gametic



What happens when we find a new gall?



- Spring 2013, the lab noticed that a gall wasp (*A. quercuslanigera*) was seemingly ovipositing on catkin tissue of oaks on Rice's campus
 - This gall was previously only known from its asexual form: a fuzz covered group of single gall chambers
 - Catkins were collected for emerging wasps, for morphological assessment and DNA
- The following spring, asexual females found on catkins were collected and brought into the lab for preference testing and then kept for morphology/DNA

What happens when we find a new gall? (cont.)

- DNA analysis showed that collected catkin-emerged and agamic *A. q.lanigera* wasps a single clade when compared to other *Andricus* species
- The emergence timing for the agamic and gamic generations also aligned
- These findings showed that there are still a lot of unknowns within cynipids
 - How many ephemeral/non-descript galls have been unnoticed by the scientific community?
 - How many cynipids known by only the agamic generation are tied to an unknown gall of the gamic generation?

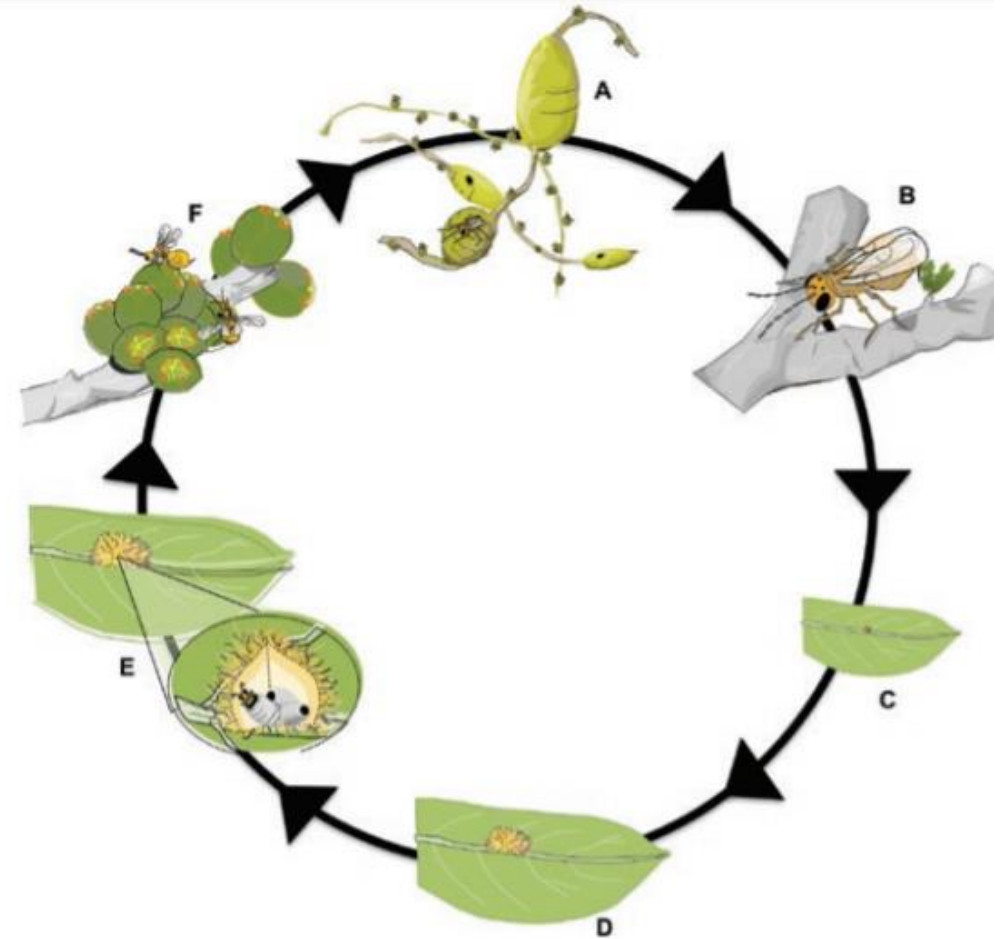
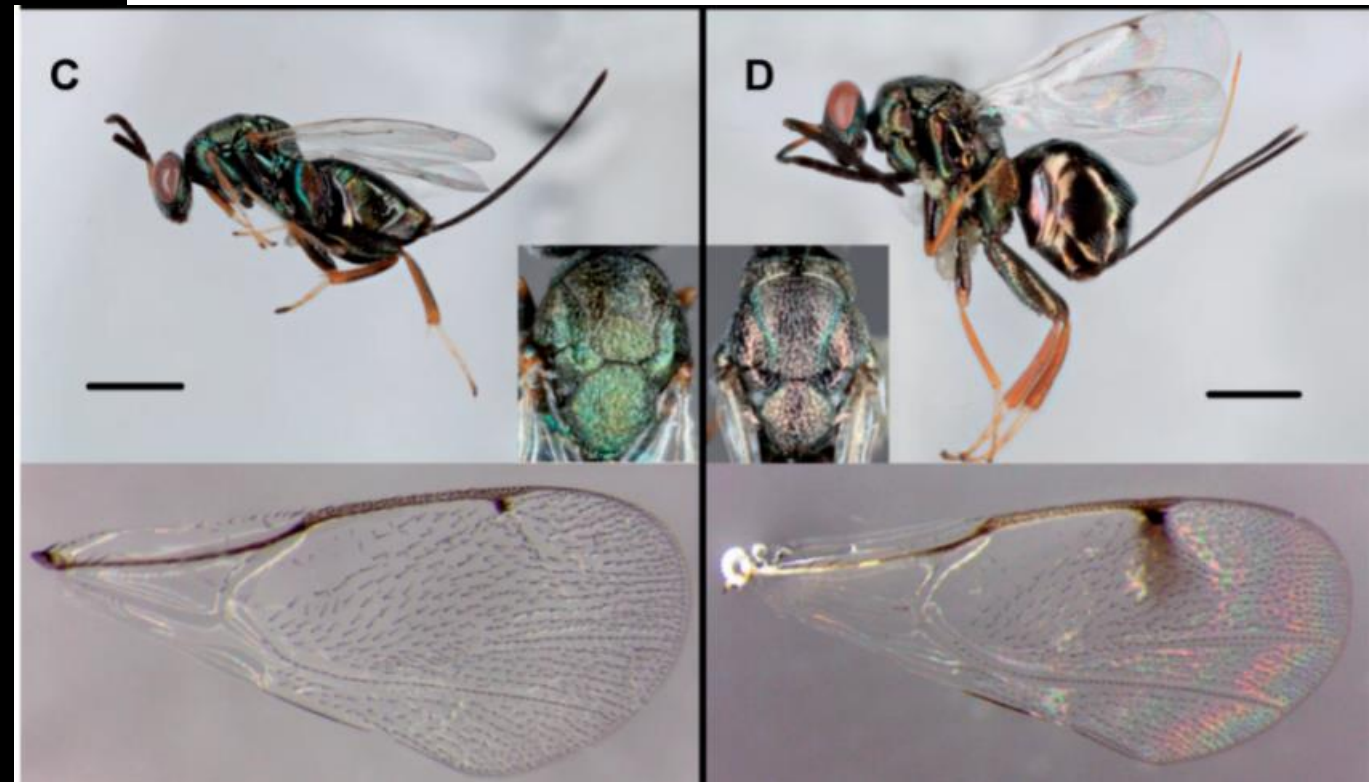
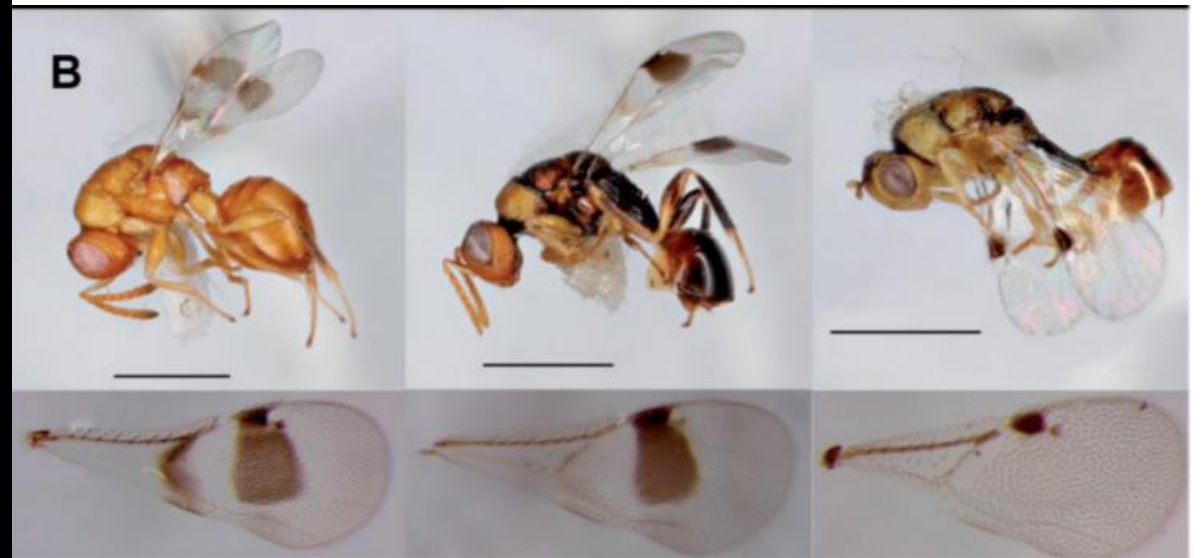


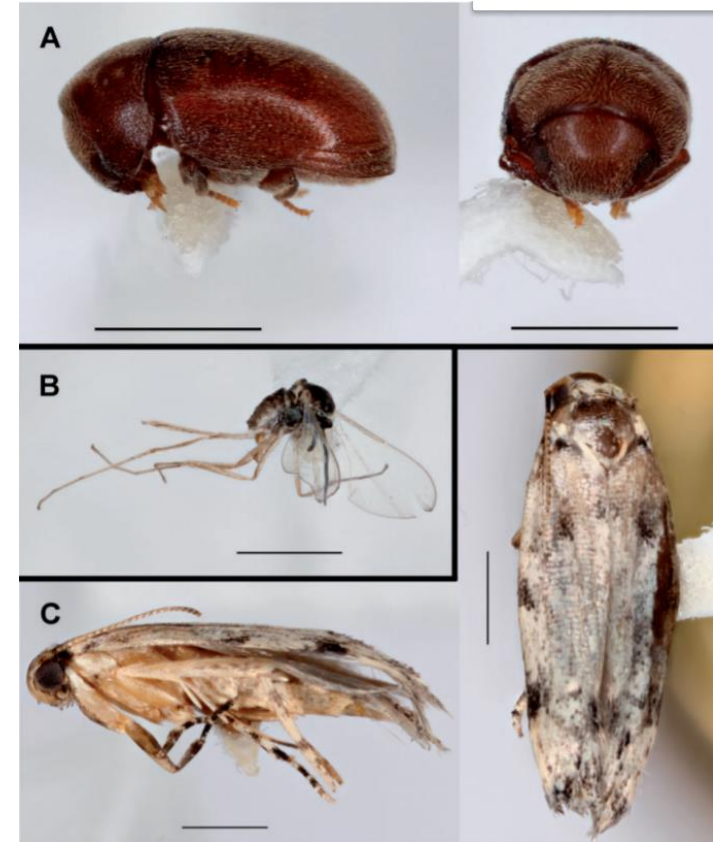
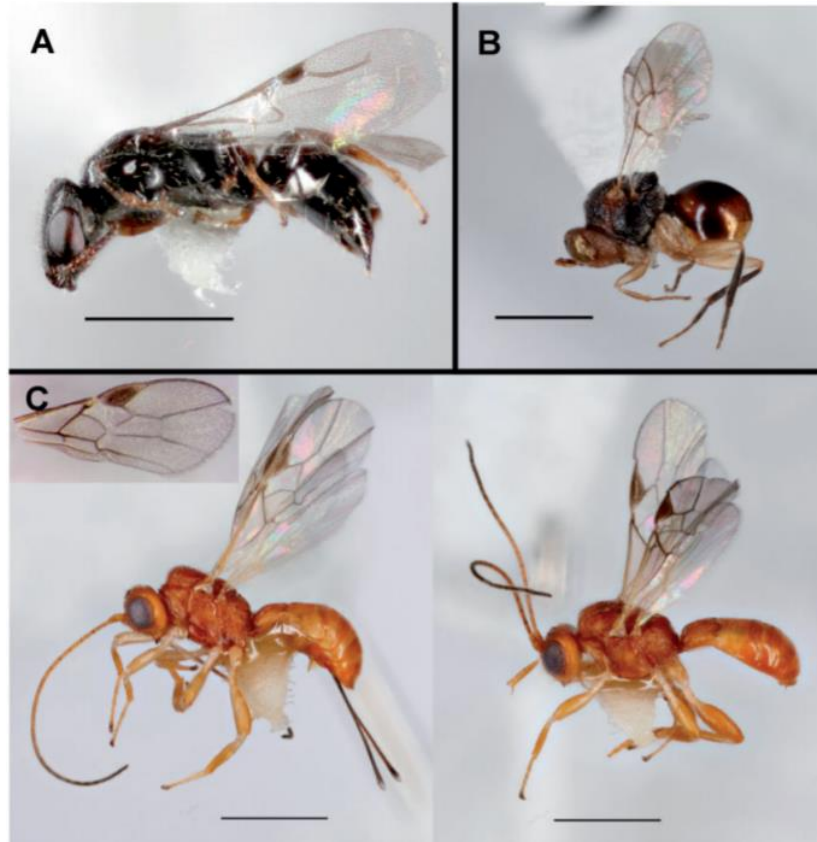
Fig. 4. The life cycle of the cyclically parthenogenic gall wasp, *Andricus quercuslanigera*, on its host plant, *Quercus virginiana*, in southeastern Texas. See text in *Description Life History Timing and of Sexual Generation Gall* section for a detailed description of the life cycle.

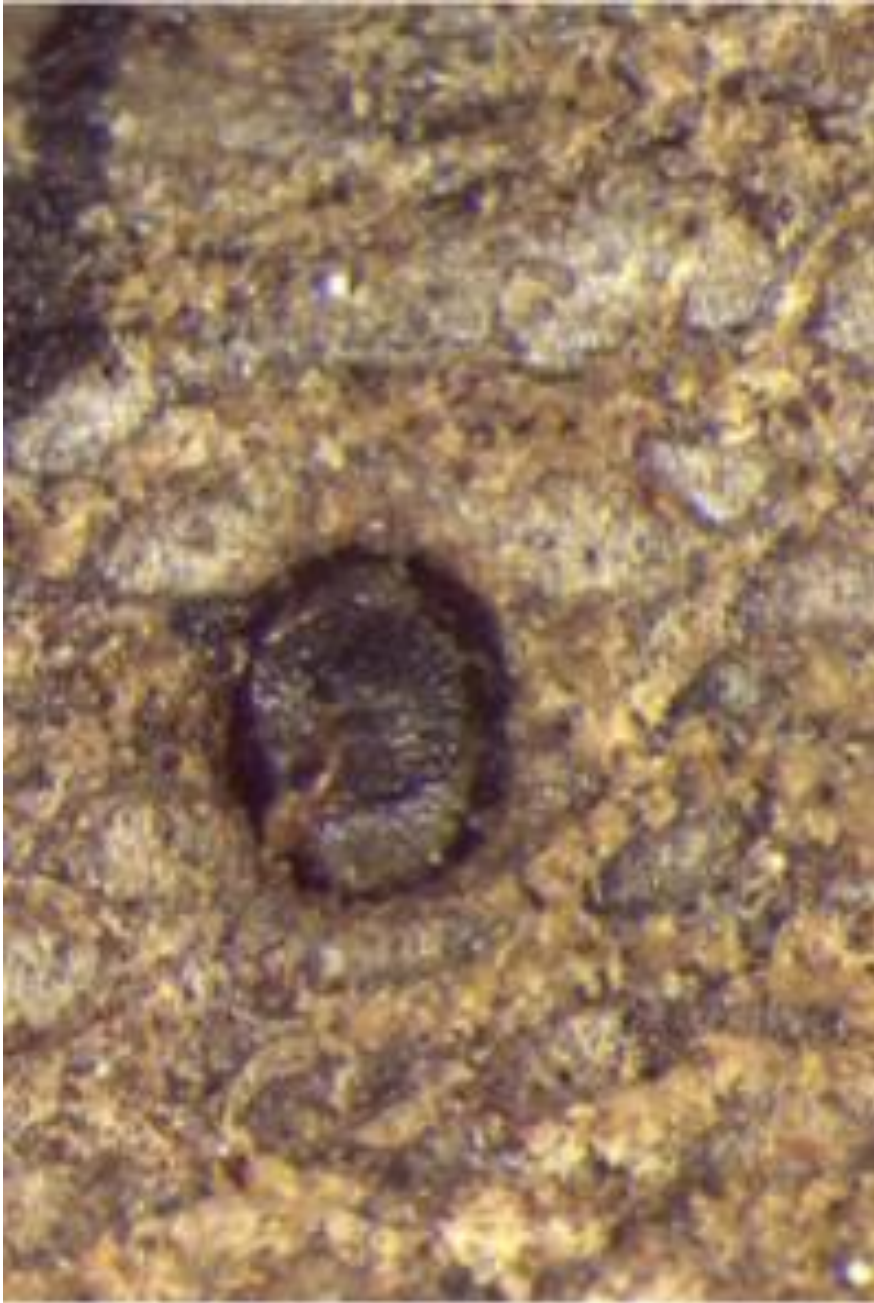
Galls: the B&B of plants

- Galls wasps may make the galls, but they aren't the only ones to use them
 - Inquilines: Insects that may lay their eggs or live in the gall without killing the developing gall wasp
 - Parasitoids: Insects that lay their eggs on the gall wasp eggs, larvae or pupae as food source
 - Earlier parasitizing species usually have shorter ovipositors
 - Hyperparasitoids: Parasitoids of parasitoids



Galls: the B&B of plants





Invasion of the Body
Snatchers

Invasion of the Body Snatchers

- Starting in 2014, the lab noticed a significant number of failed emergences in galls formed by *Bassettia pallida*
 - The gall in an inconspicuous stem gall similar to *C. q.batatoides*
- Dissection of galls saw that fully formed wasps were still completely within the galls and evidence of a possible parasitoid





Invasion of the Body Snatchers

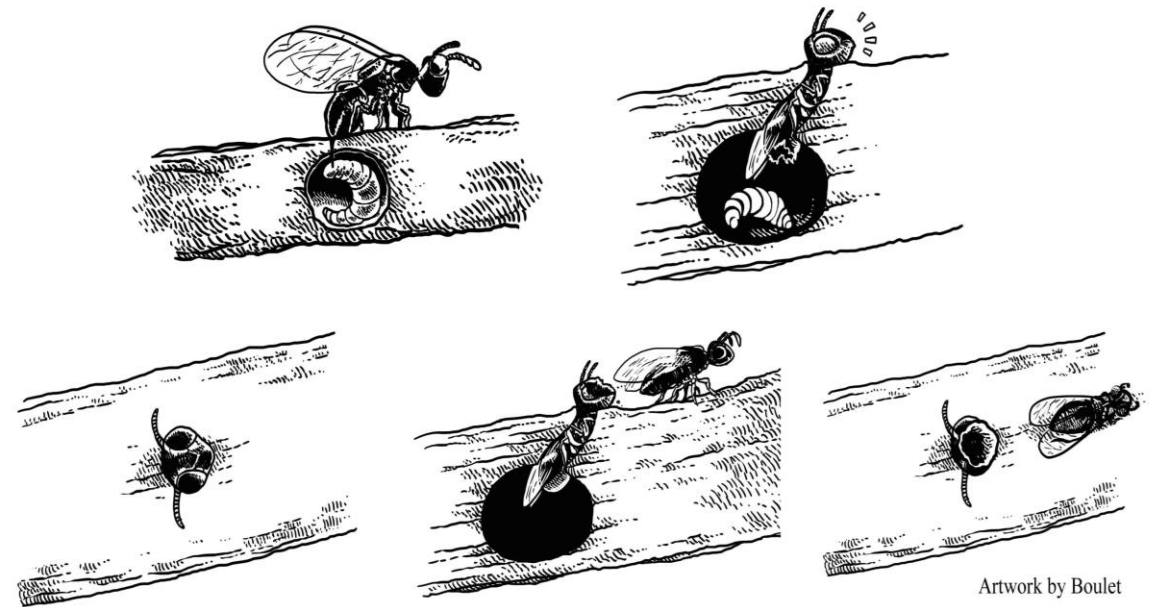
- Upon the emergence of the first parasitoid, it was noted that the head that was plugging the hole now had a hole in it!
- Further investigation showed that the holes chewed by healthy animals were significantly smaller than the plugged holes
 - Usually if an individual was healthy enough to chew out, it would be healthy enough to chew out completely
 - These plugged holes were also present earlier than any healthy *B. pallida* were emerging
- Eventually, we caught a live wasp emerging from the head of *B. pallida*

The crypt-keeper and its victim

A healthy gall wasp matures in a crypt formed in an oak tree and tunnels its way to freedom through the tree's bark.



Euderus set manipulates the gall wasp into making and plugging a tunnel. The parasite bursts out of the crypt through its head.



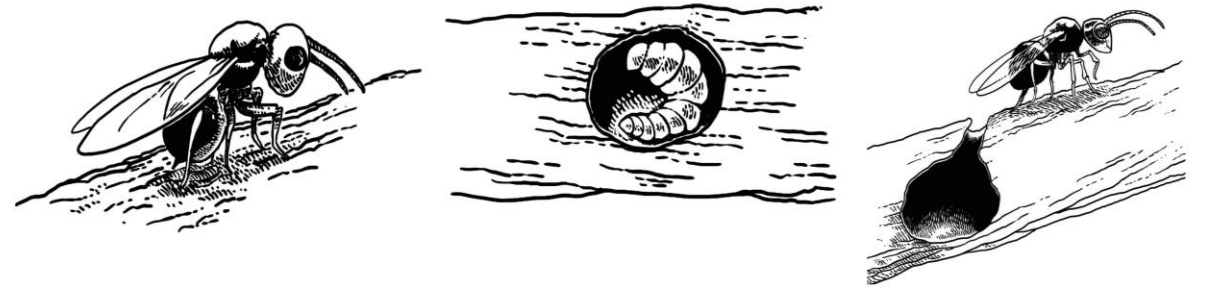
Artwork by Boulet

Invasion of the Body Snatchers

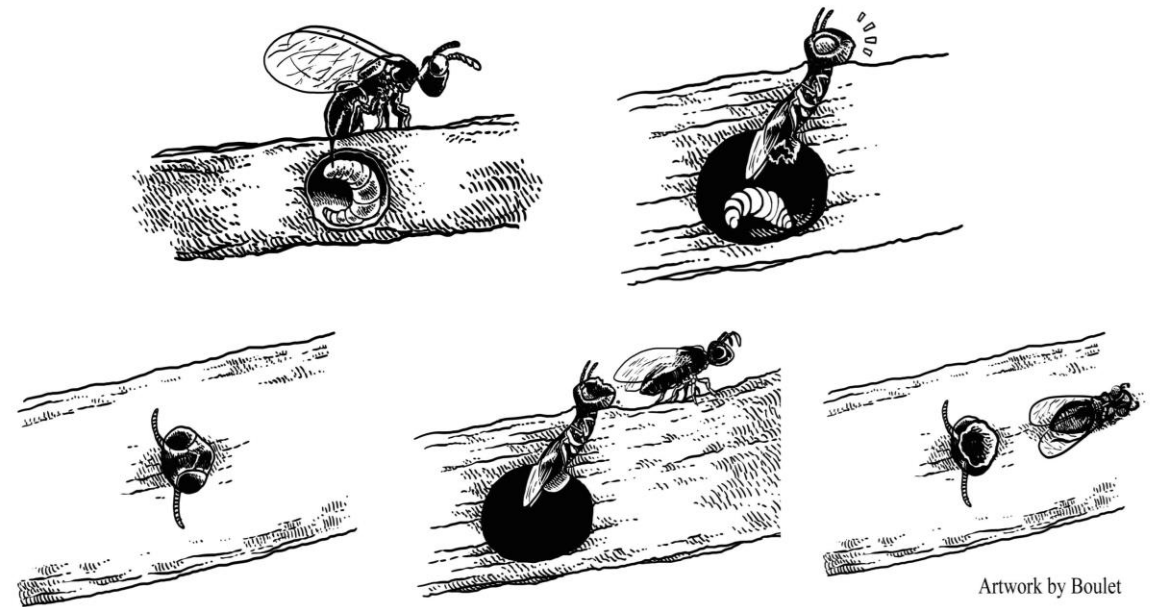
- Morphological, behavioral and genetic analysis led us to believe that this was a previously undescribed species
- The wasp was named *Euderus set*, after the Egyptian god of death
 - “common” name: crypt-keeper wasp, since *B. pallida* is known as an “oak crypt galler”
 - Set also killed the god Osiris and stuffed him in a crypt, so it works on both levels...

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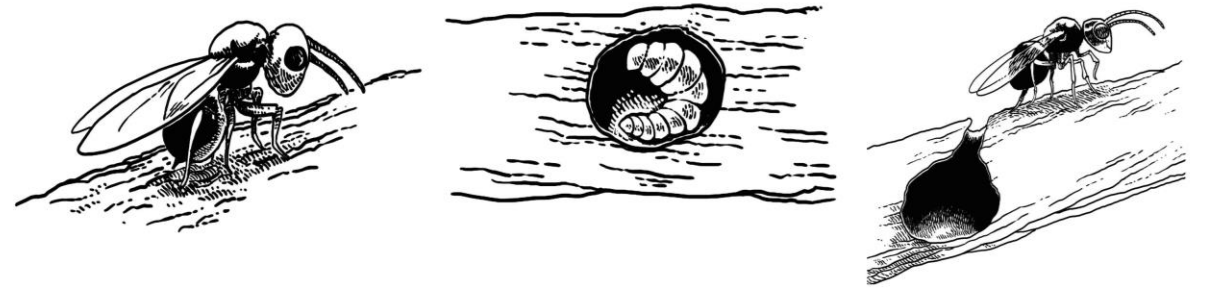


Invasion of the Body Snatchers

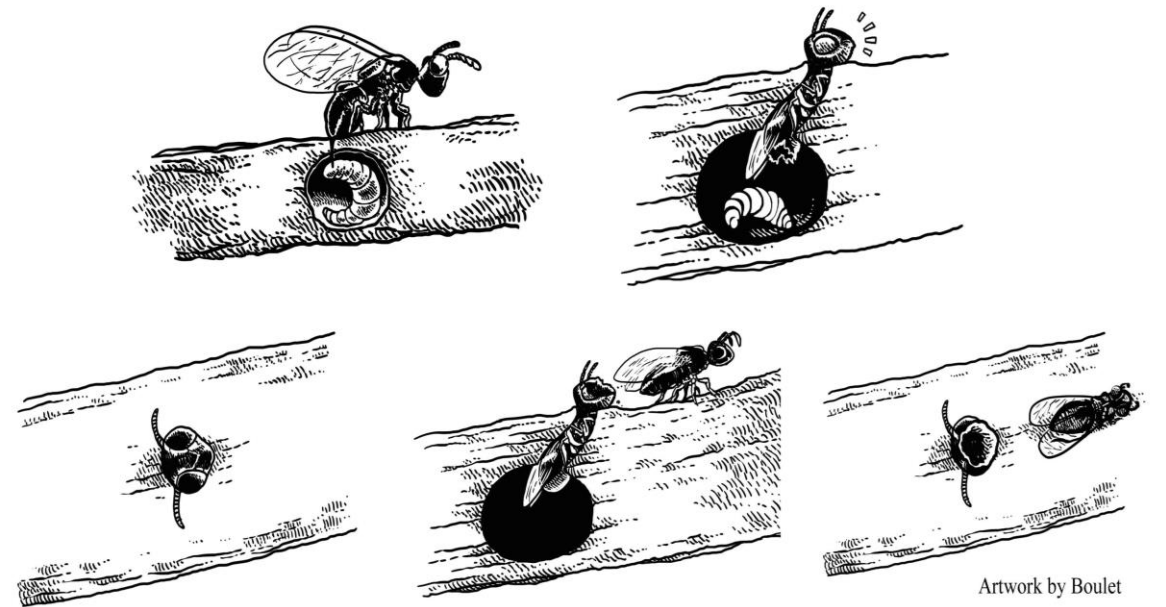
- It seemed that *E. set* was driving this head-plug phenomenon, but why?
 - The two main hypotheses were:
 - Create a seal to protect the parasitoid from abiotic factors
 - Make an easier escape route, a thin exoskeleton is easier than wood
 - When recovered by thin slips of bark, *E. set* was 3x less like to emerge than in control treatments
 - Breaching the plugged hole did not significantly reduce healthy *E. set* emergence
- *E. set* has been found in at least 6 other species, all of which show signs of this manipulation

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Artwork by Boulet

In Summary

- Not all wasps are scary!
- Gall wasps are basically tiny, flying teddy bears that help produce a lot of usually unnoticed diversity
- Research in gall wasps helps answer questions about speciation and interactions in the ecological community



References

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