

Escaping the Poop Cocoon: Are There Behavioral Adaptations of Toad Tapeworms for Transmission?



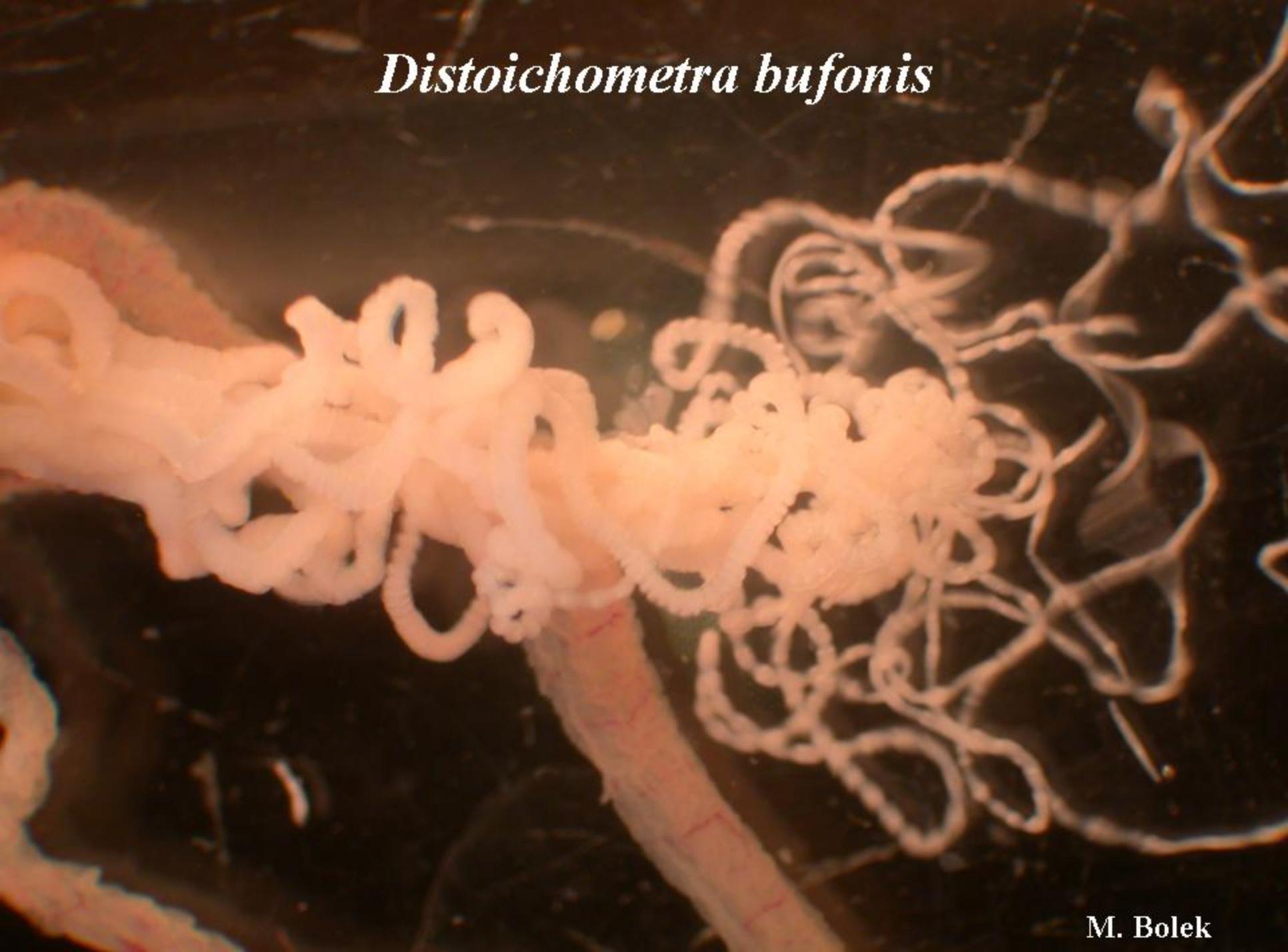
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School of Biological Sciences, University of Nebraska—Lincoln



**Natural History of the Invertebrates, CPBS 2006,
Otter Creek!**

M. Bolek

Distoichometra bufonis



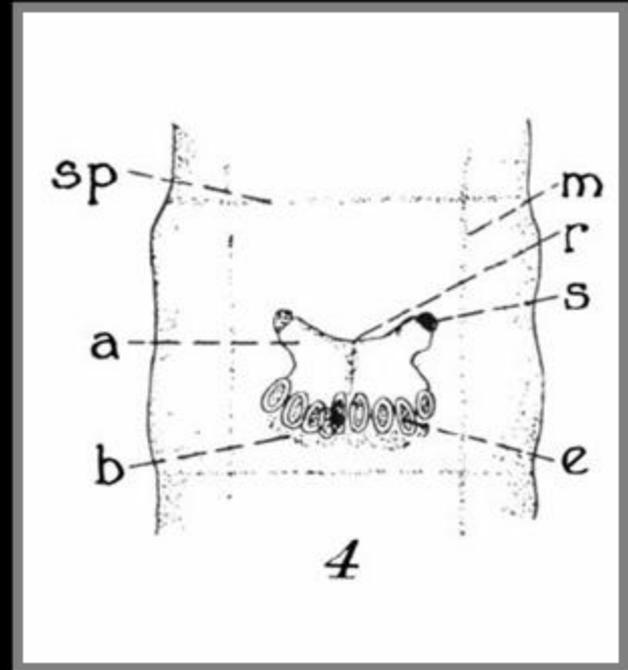
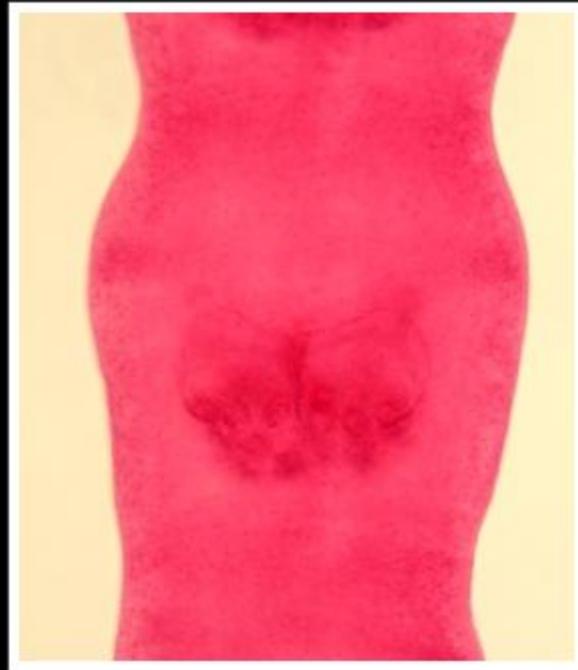


Bufo woodhousii



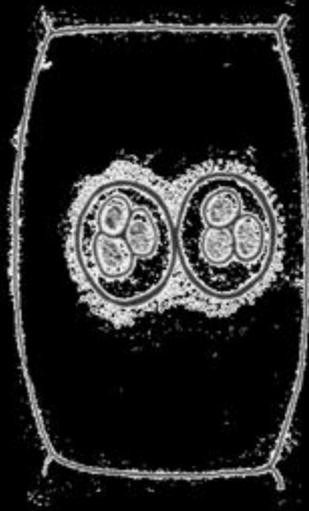
Spea bombifrons

Cyclophyllidae: Nematotaeniidae

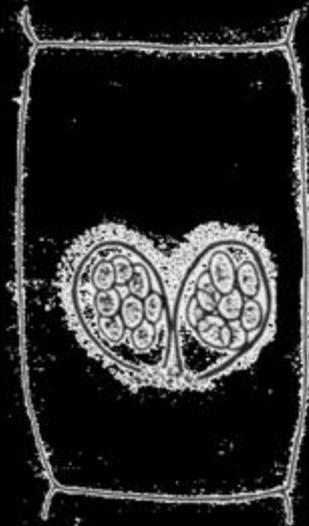


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Dickey 1921



Cylindrotaenia



Bitegmen



Distoichometra



Nematotaenia

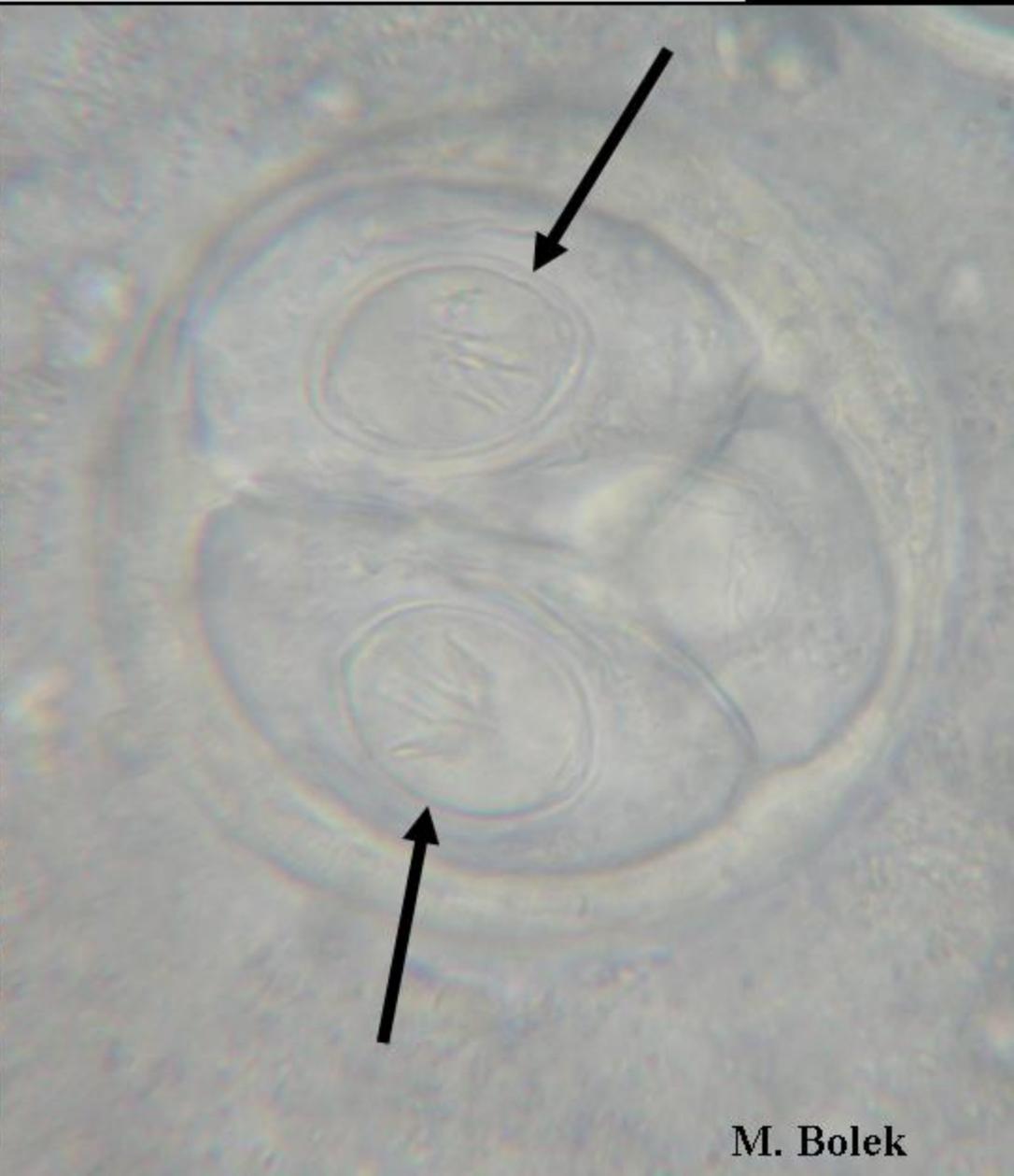


Four genera and 18 recognized spp.



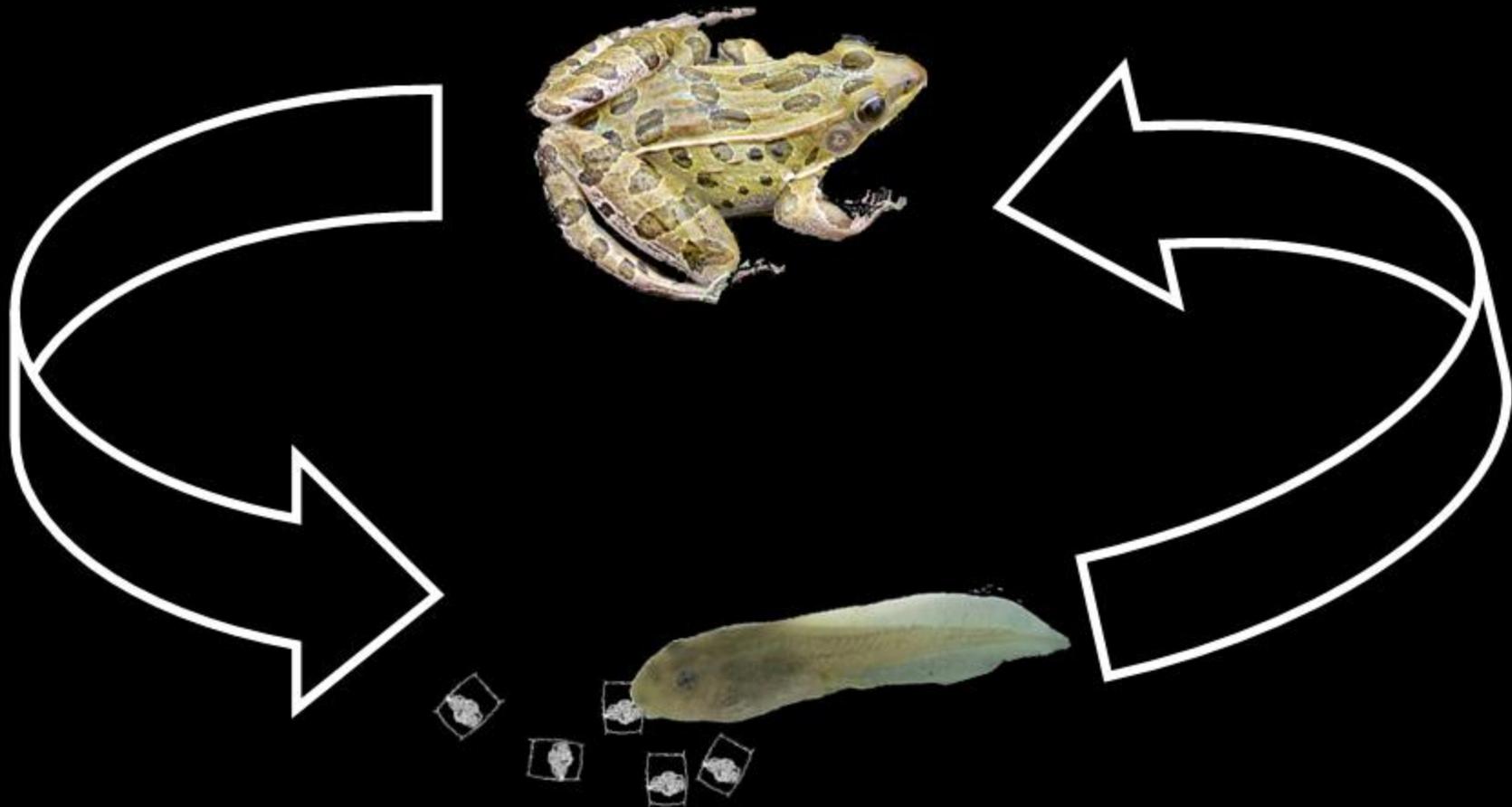
Gravid Proglottids

Eggs in Parauterine Capsules



Joyeux (1924)

Cylindrotaenia americana



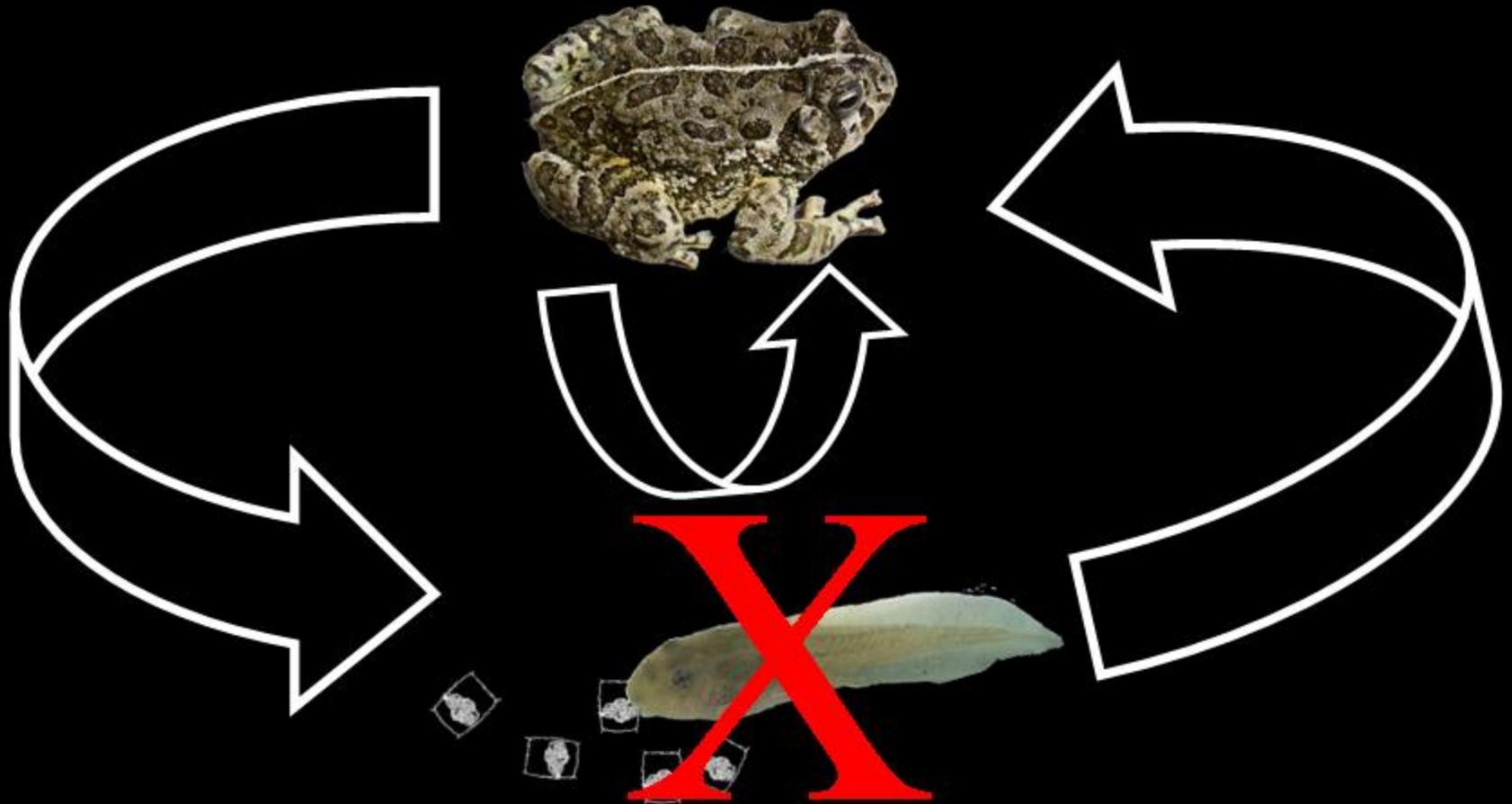
Joyeux (1924)

Cylindrotaenia americana ??

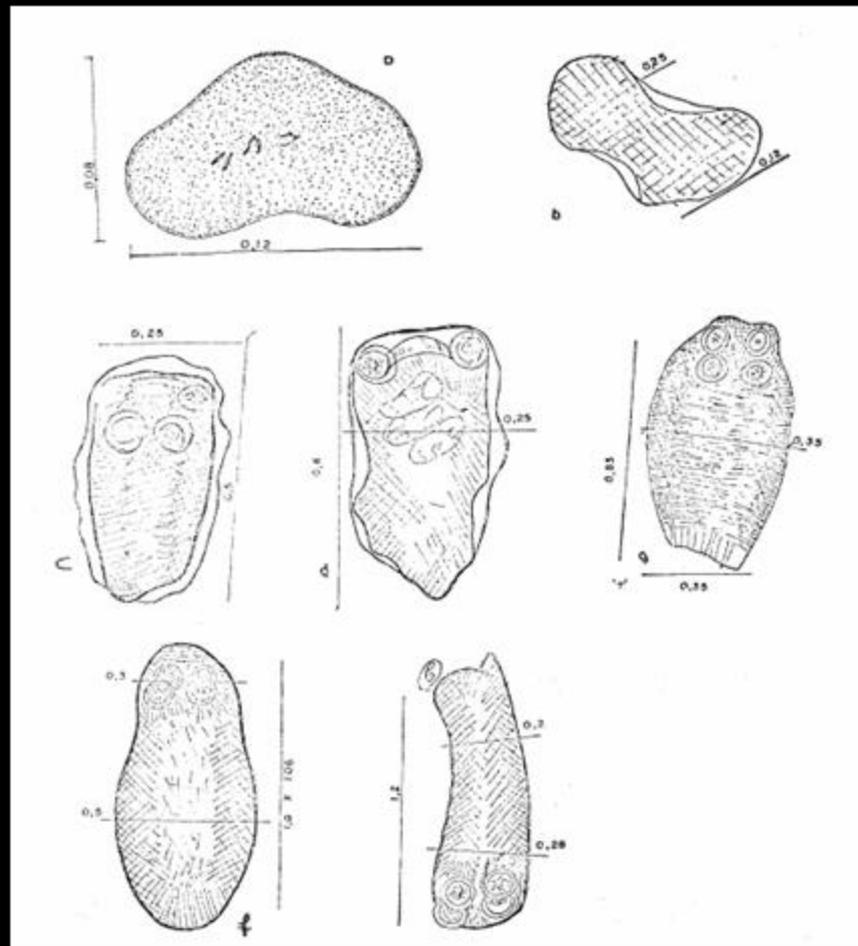


Stumpf (1981/1982)

Cylindrotaenia americana ??



3 of 55 toads contained Tetrathyridia in the Gut.



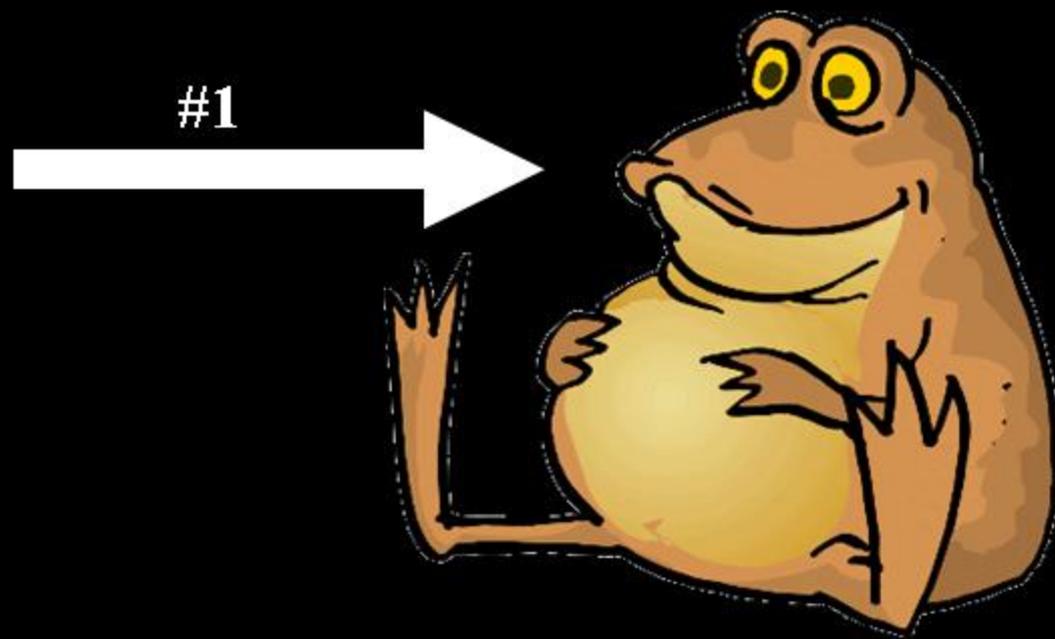
Life Cycle of *Distoichometra bufonis*



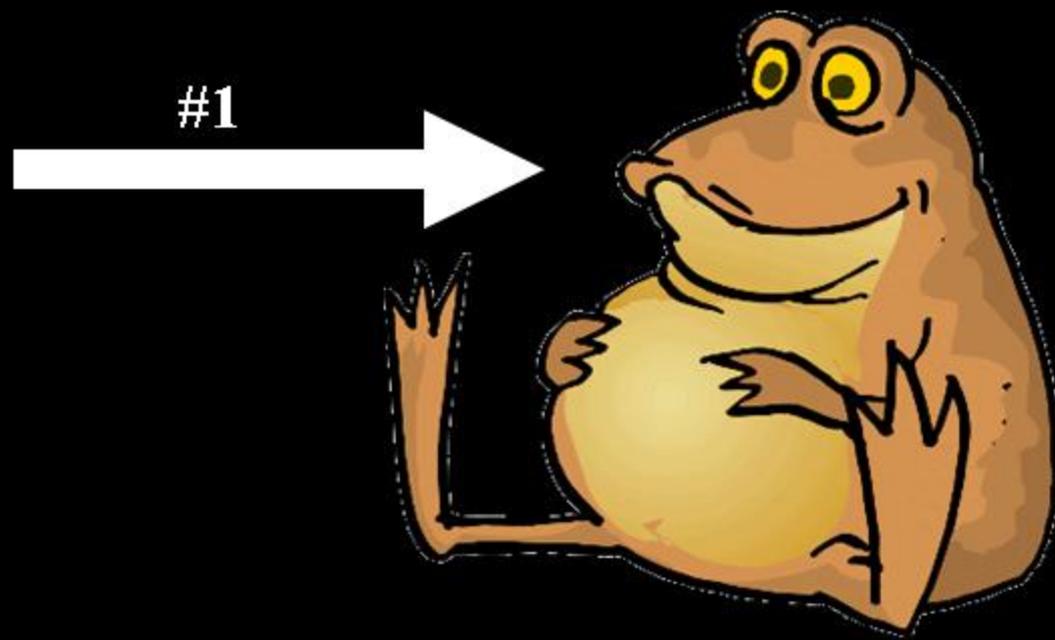
A 25 mm *Bufo woodhousii*!



What comes in must come out!

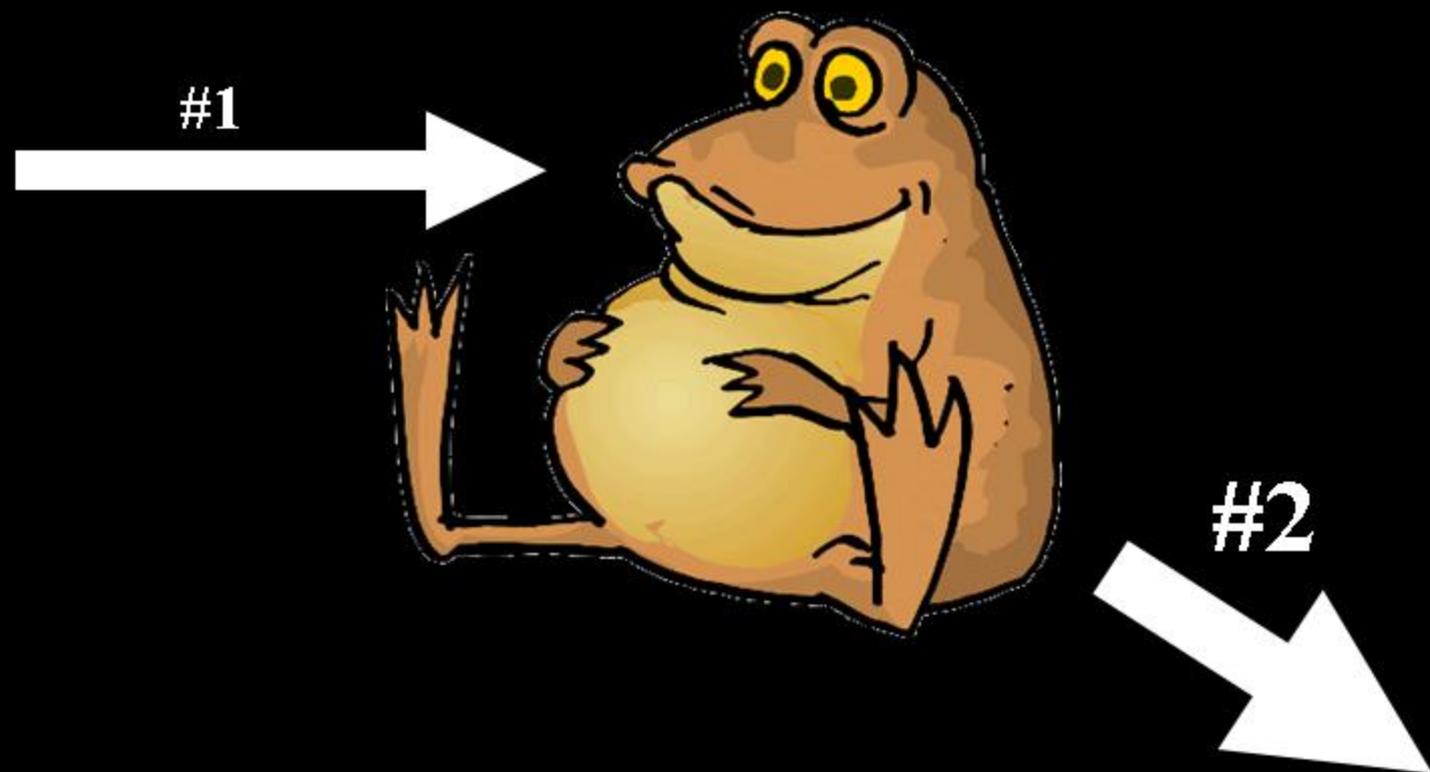


What comes in must come out!

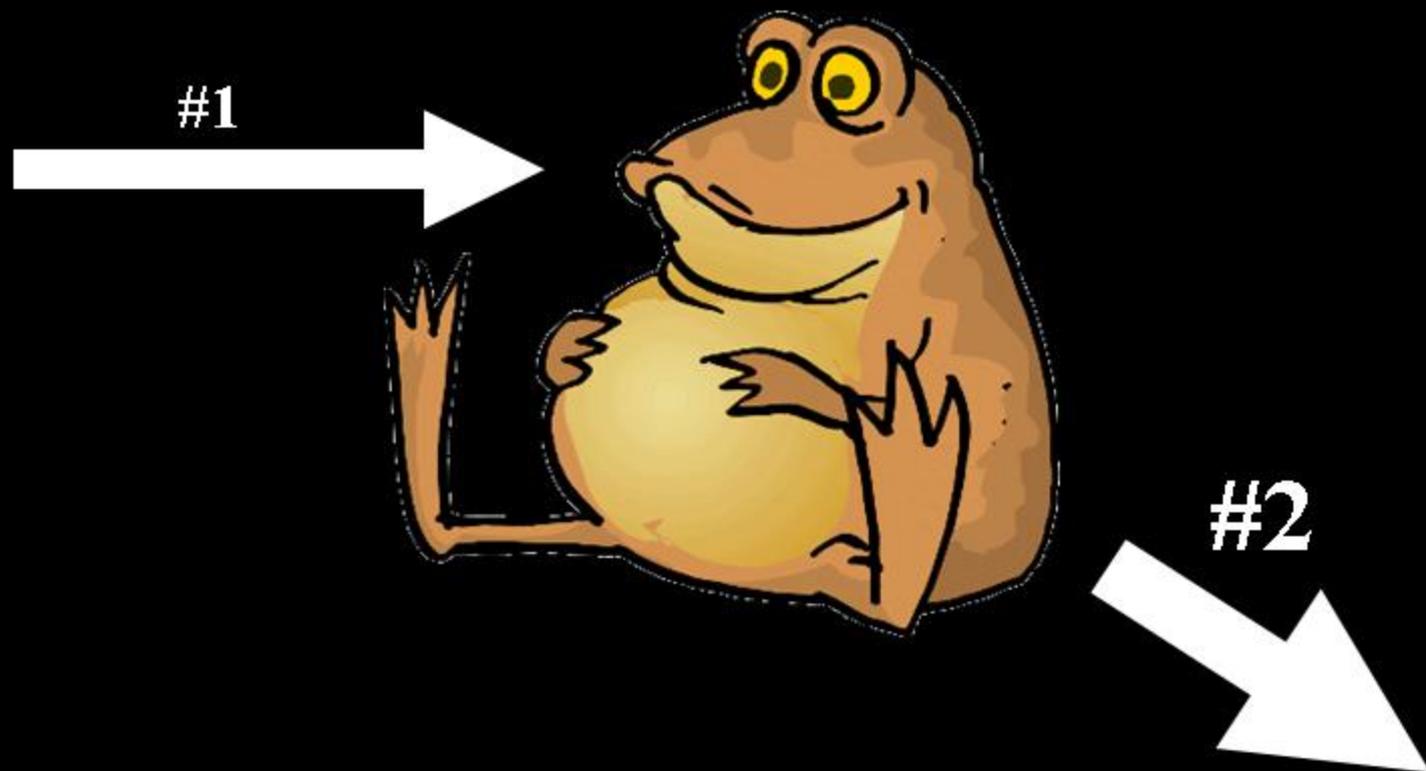


**BUSINESS
END**

What comes in must come out!



What comes in must come out!



#3 ?????

**How does *D. bufonis* escape its definitive
toad host?**

OR

**What is going on at the BUSINESS END
of the toad?**



Toads are Fossorial

M. Bolek

Adult Toads are Nocturnal!



Toads Relieve Themselves Once Every 24 Hours.





INCHES

1

2

3

CAT. NO. 73035 STUDENTS RULE



METRIC 1

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7



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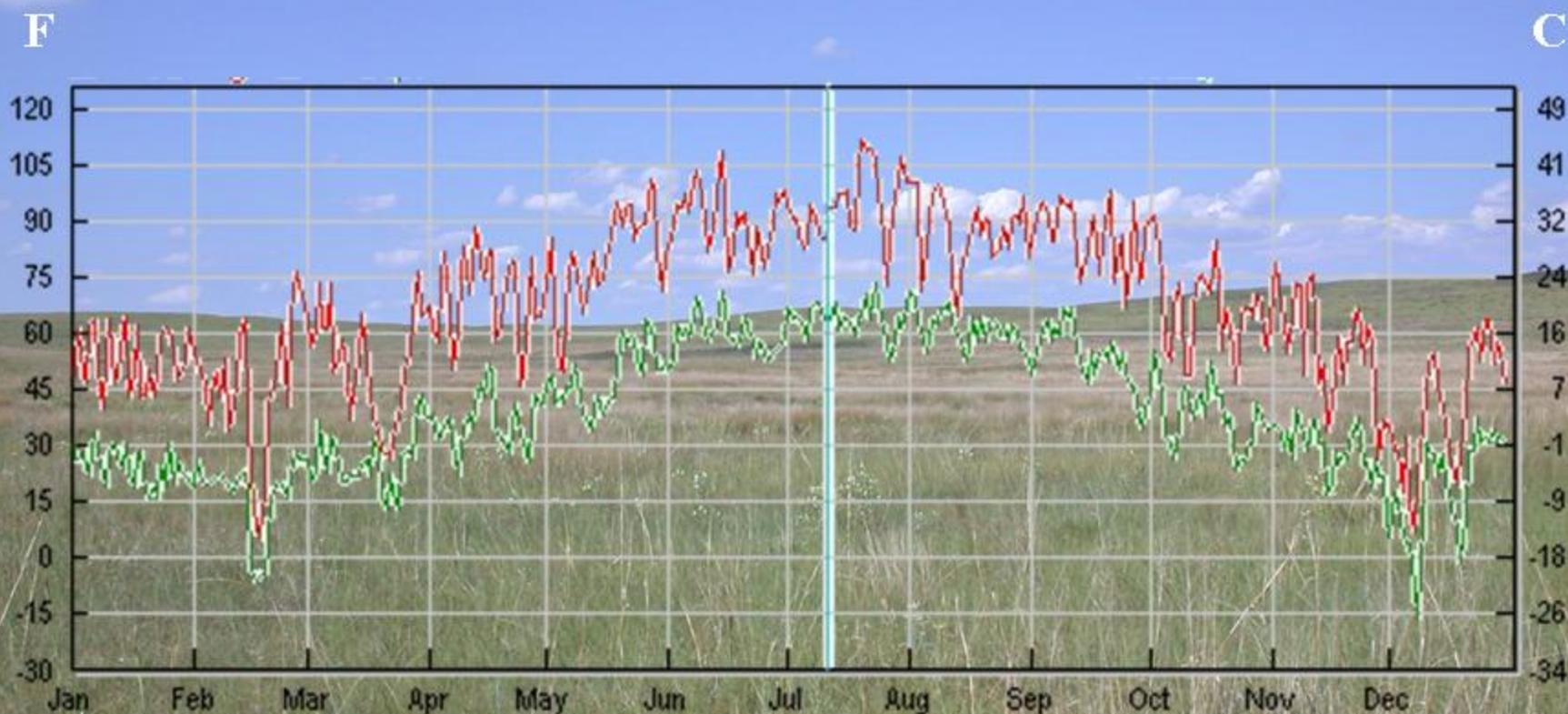
Adult Toad Poop Size

- **Average Length 40.00 mm (range 21 mm-80 mm).**
- **Average width 10.22 mm (range of 8 mm-16 mm).**

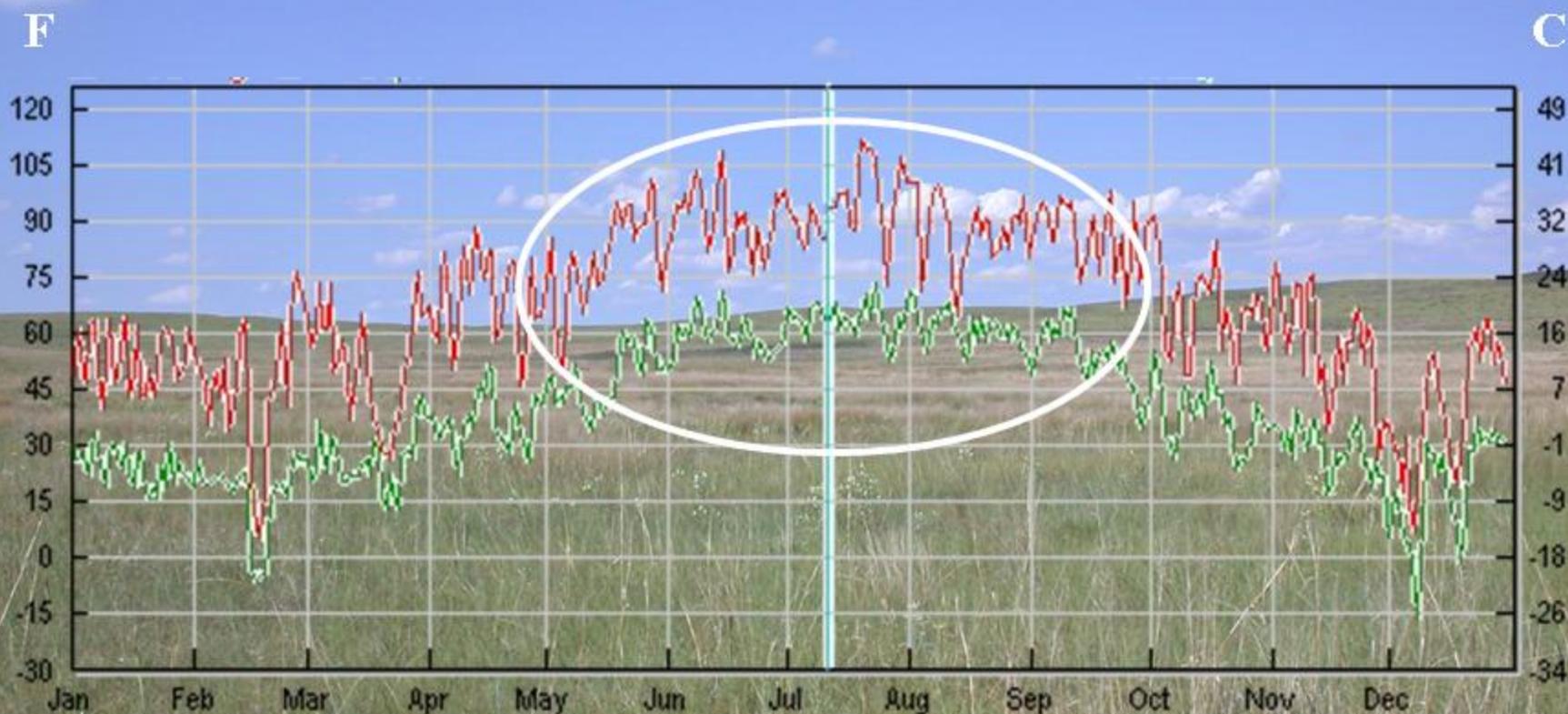


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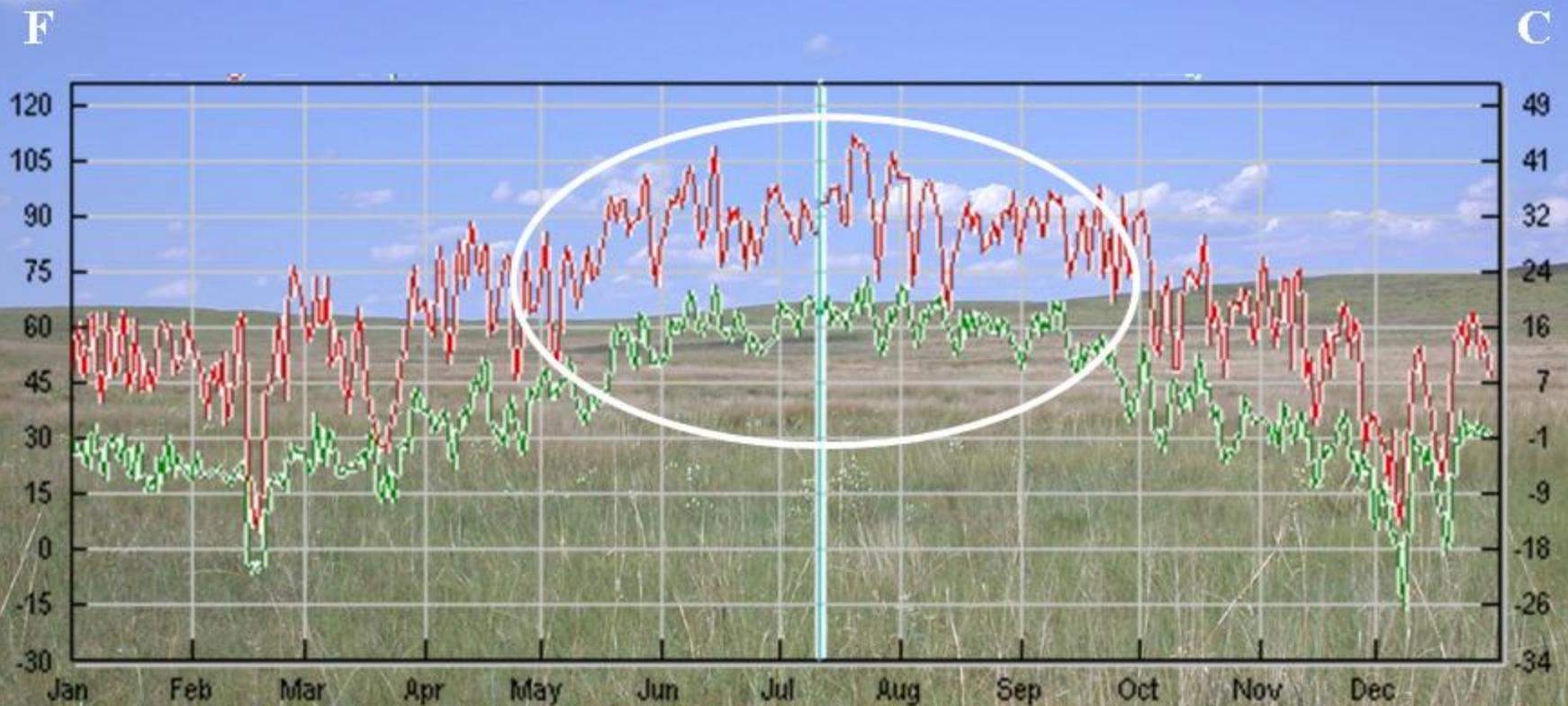
Average High and Low Monthly Temperatures in Keith Co. Nebraska



Average High and Low Monthly Temperatures in Keith Co. Nebraska

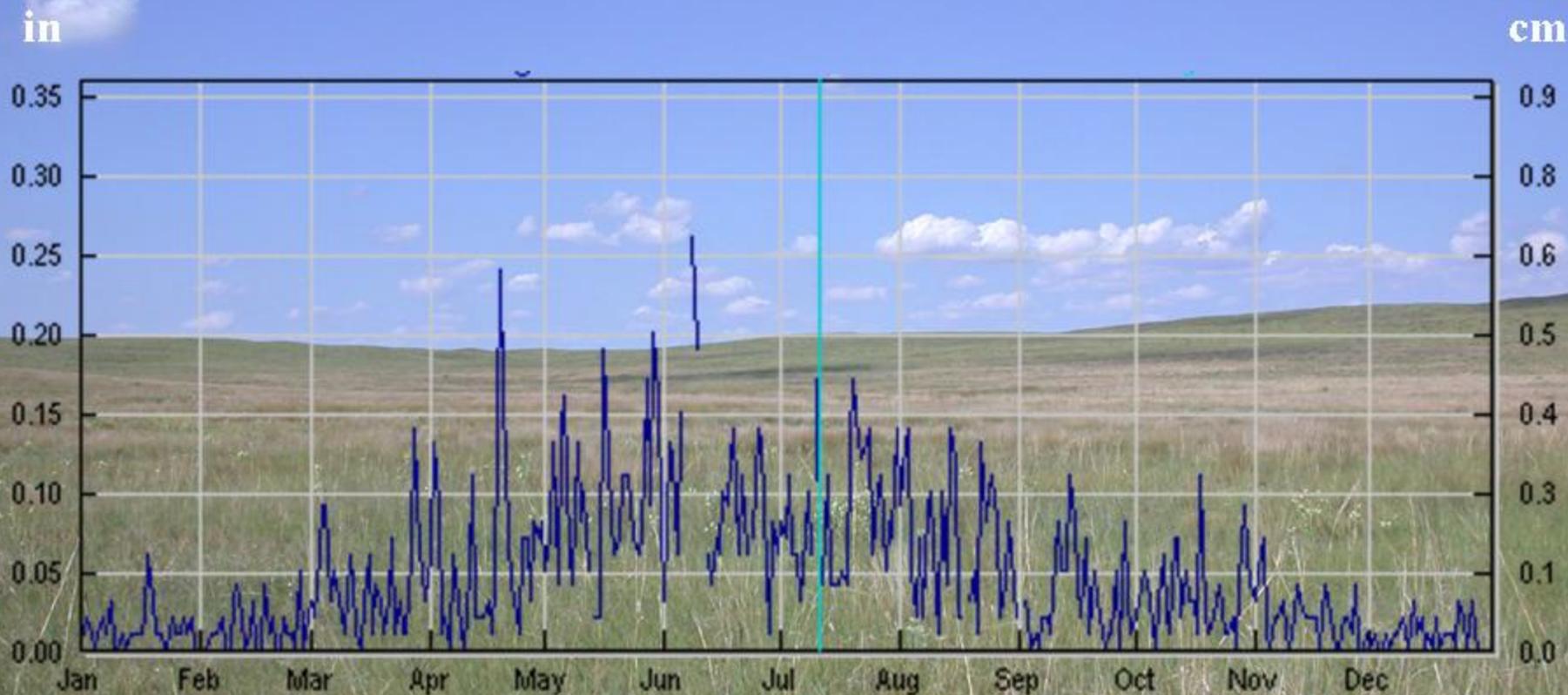


Average High and Low Monthly Temperatures in Keith Co. Nebraska

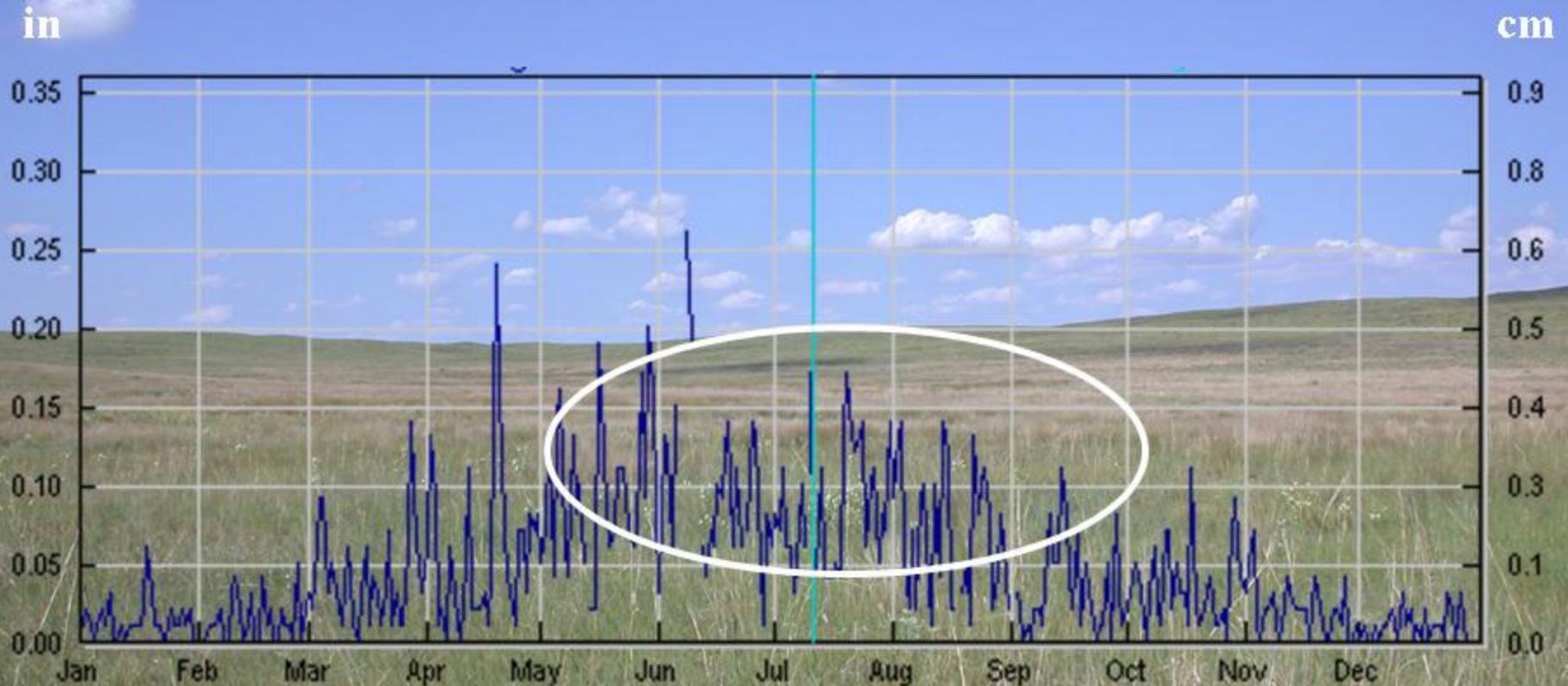


It is Hot!

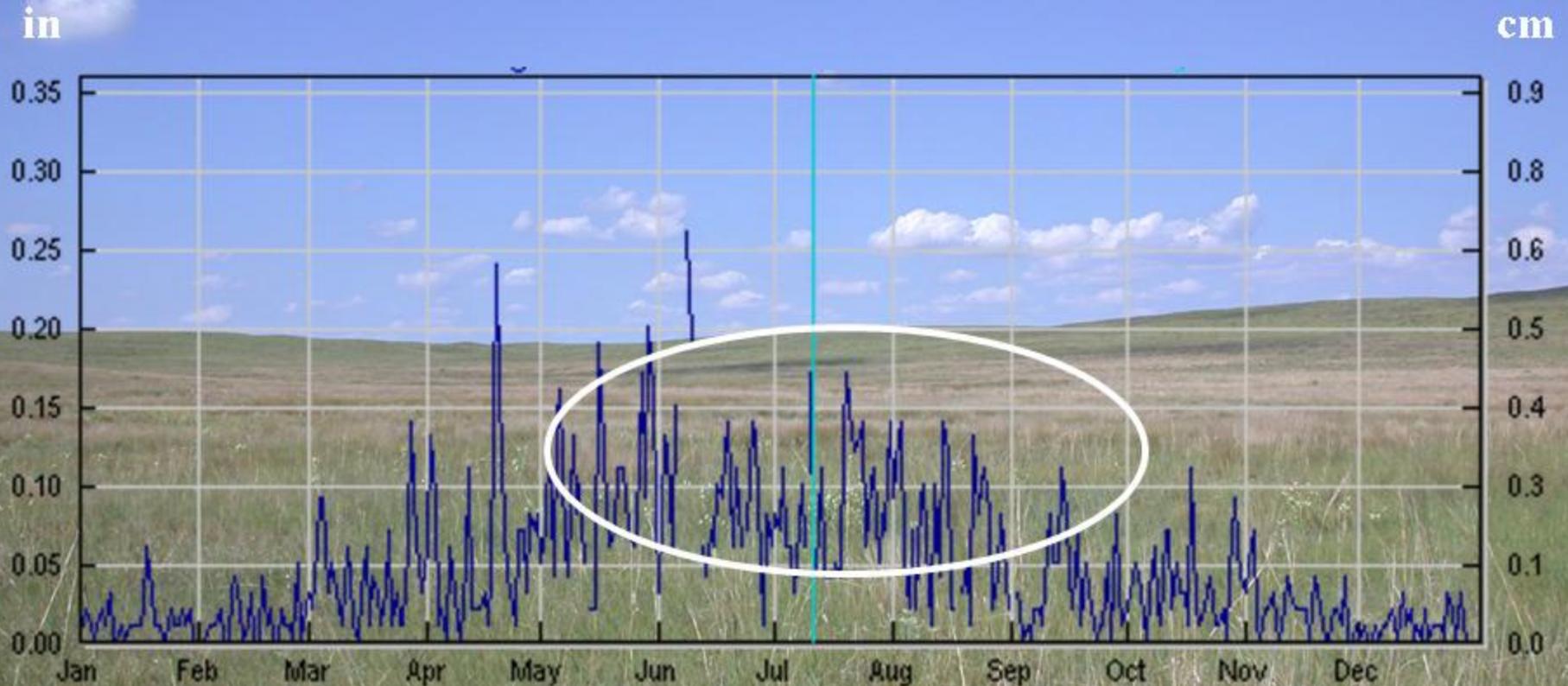
Average Rainfall for Keith Co. Nebraska



Average Rainfall for Keith Co. Nebraska



Average Rainfall for Keith Co. Nebraska



It is Dry!

How Hot Does Toad Poop Get?

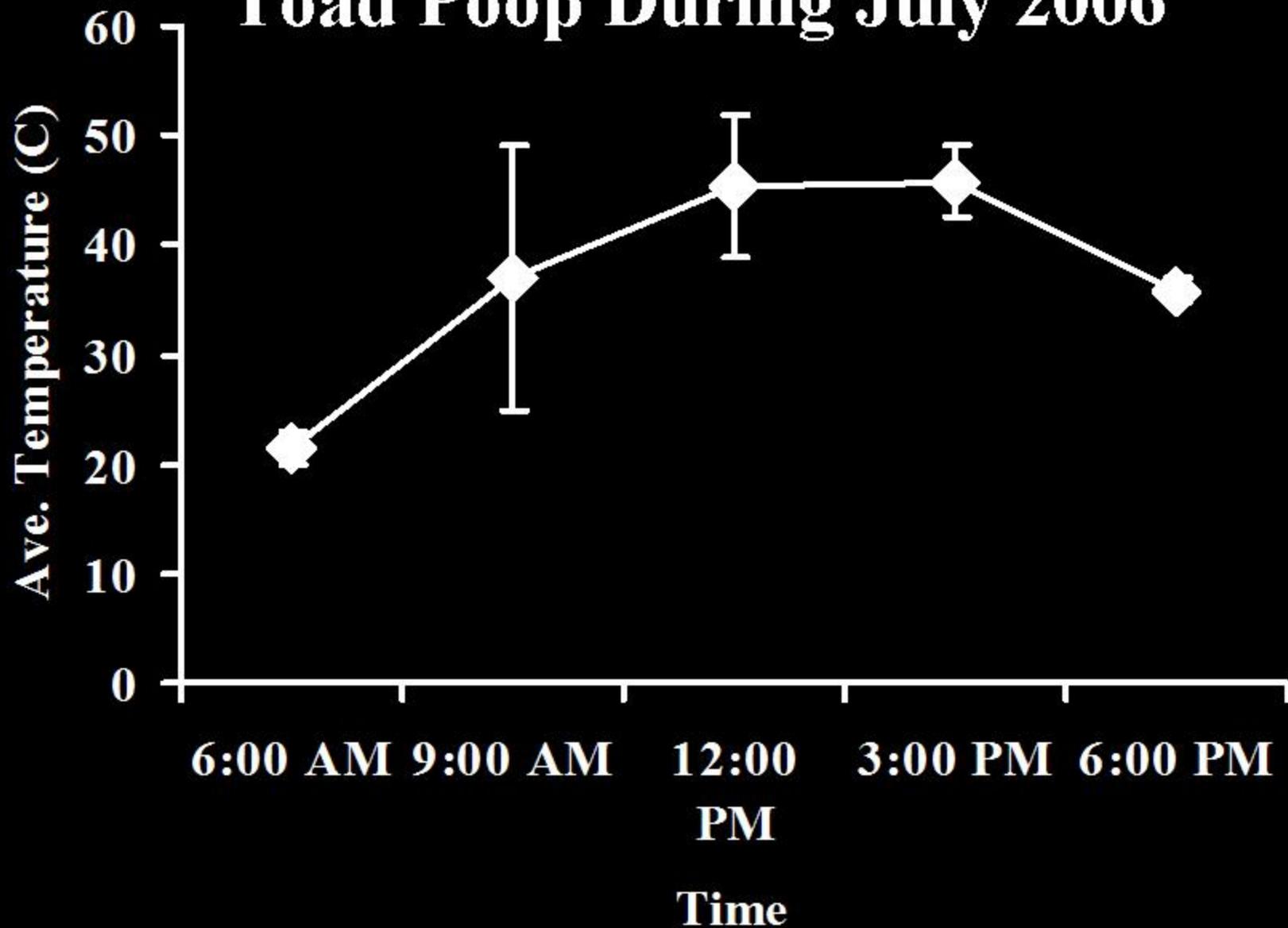


Ms. Kristina Hubbard and Ms. Mackenzie Waltke. The Charlie's Angels Toad Poop Assistants.

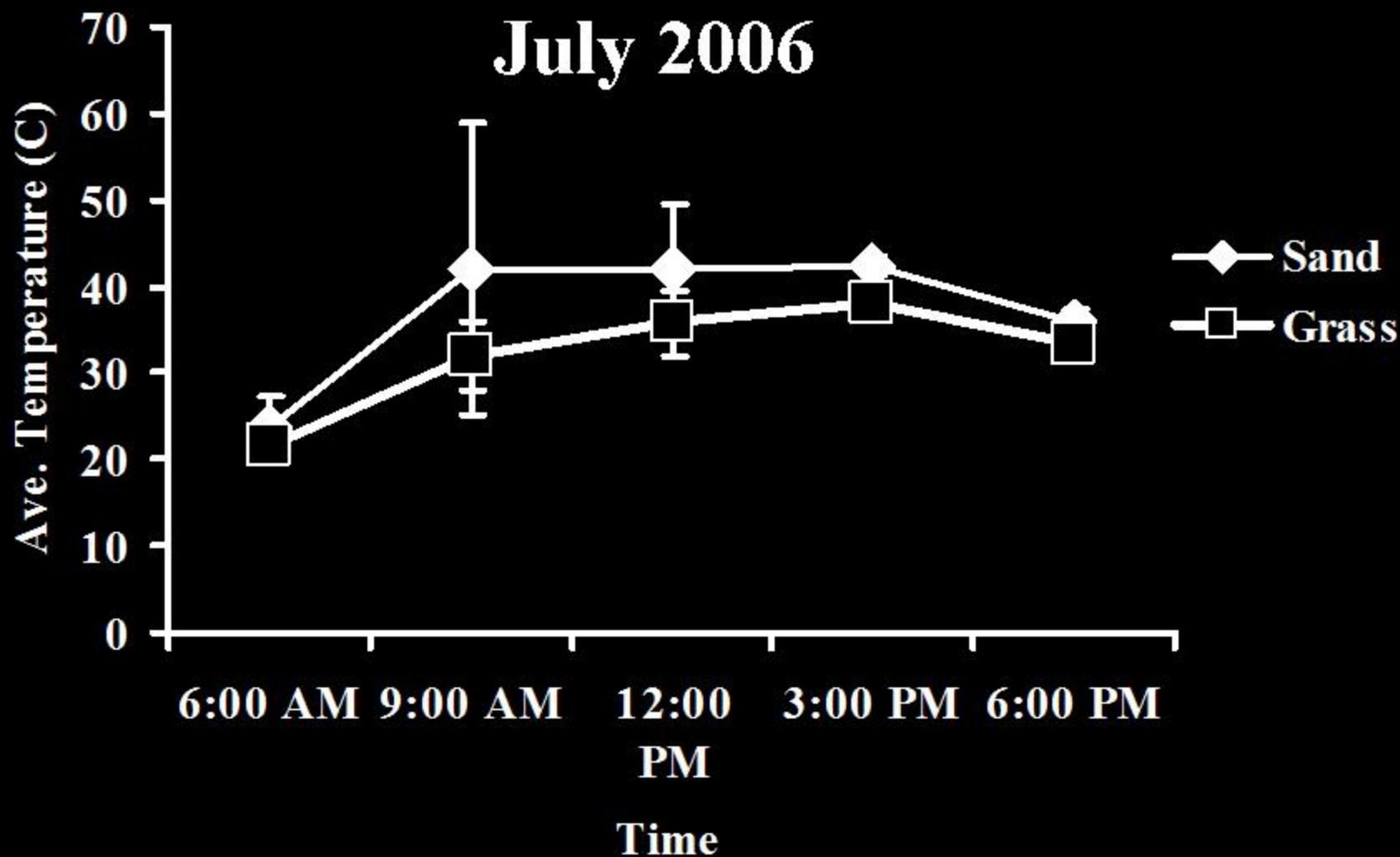
Measured Toad Poop Temperature



Daily Temperature of 24 Samples of Toad Poop During July 2006



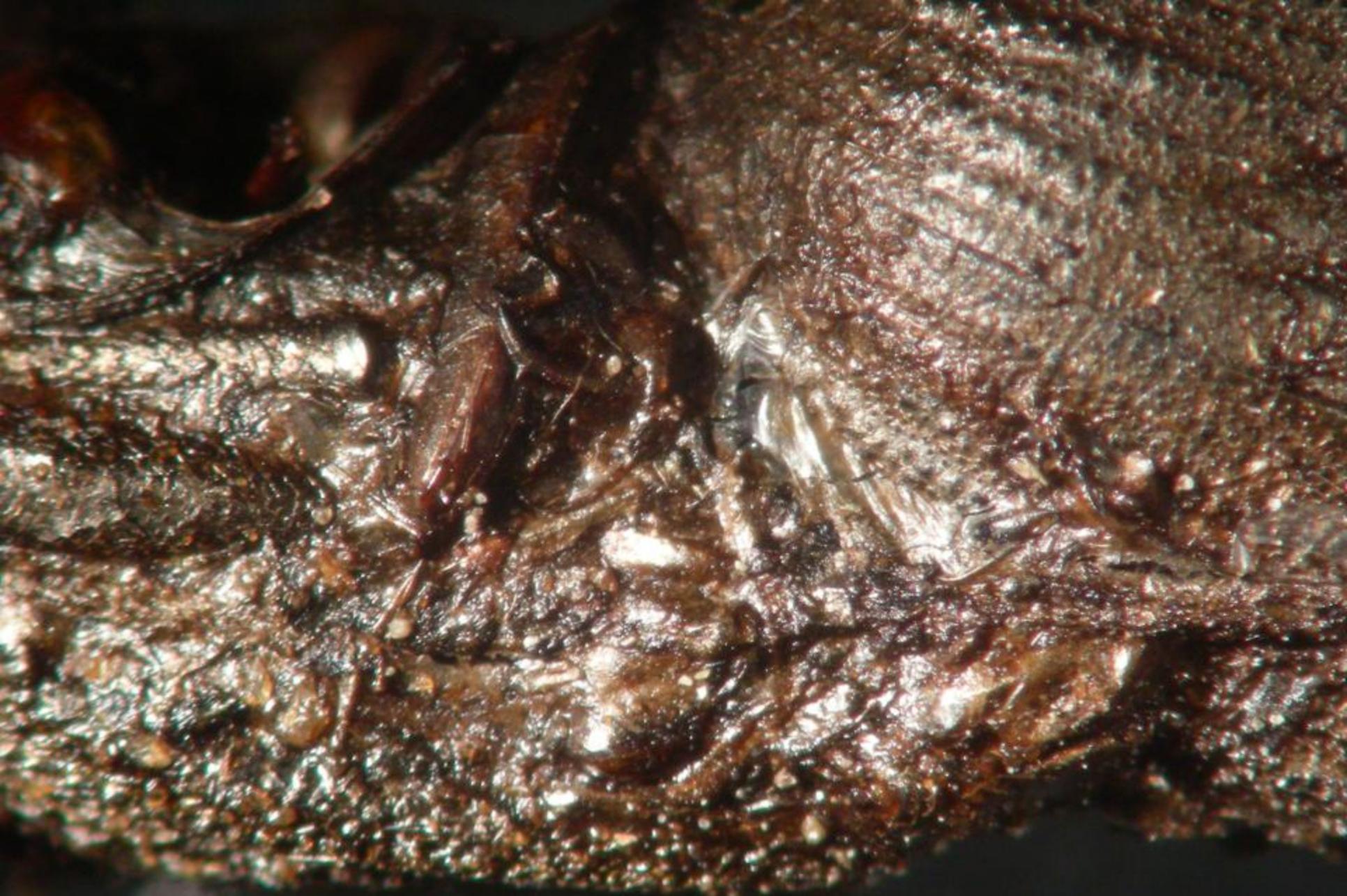
Daily Temperature of Toad Poop in Sandy and Shaded Environments During July 2006



Maximum Toad Poop Temperature

- The maximum surface temperature of toad feces reached was $73.8\text{ }^{\circ}\text{C}$, that is $164.12\text{ }^{\circ}\text{F}$!







The question became: How does the tapeworm release its eggs from this solid poop cocoon?

Other Tapeworms

- Segments of *Echinococcus granulosus* migrate a considerable distance and even climbed vertically on plants.

Other Tapeworms

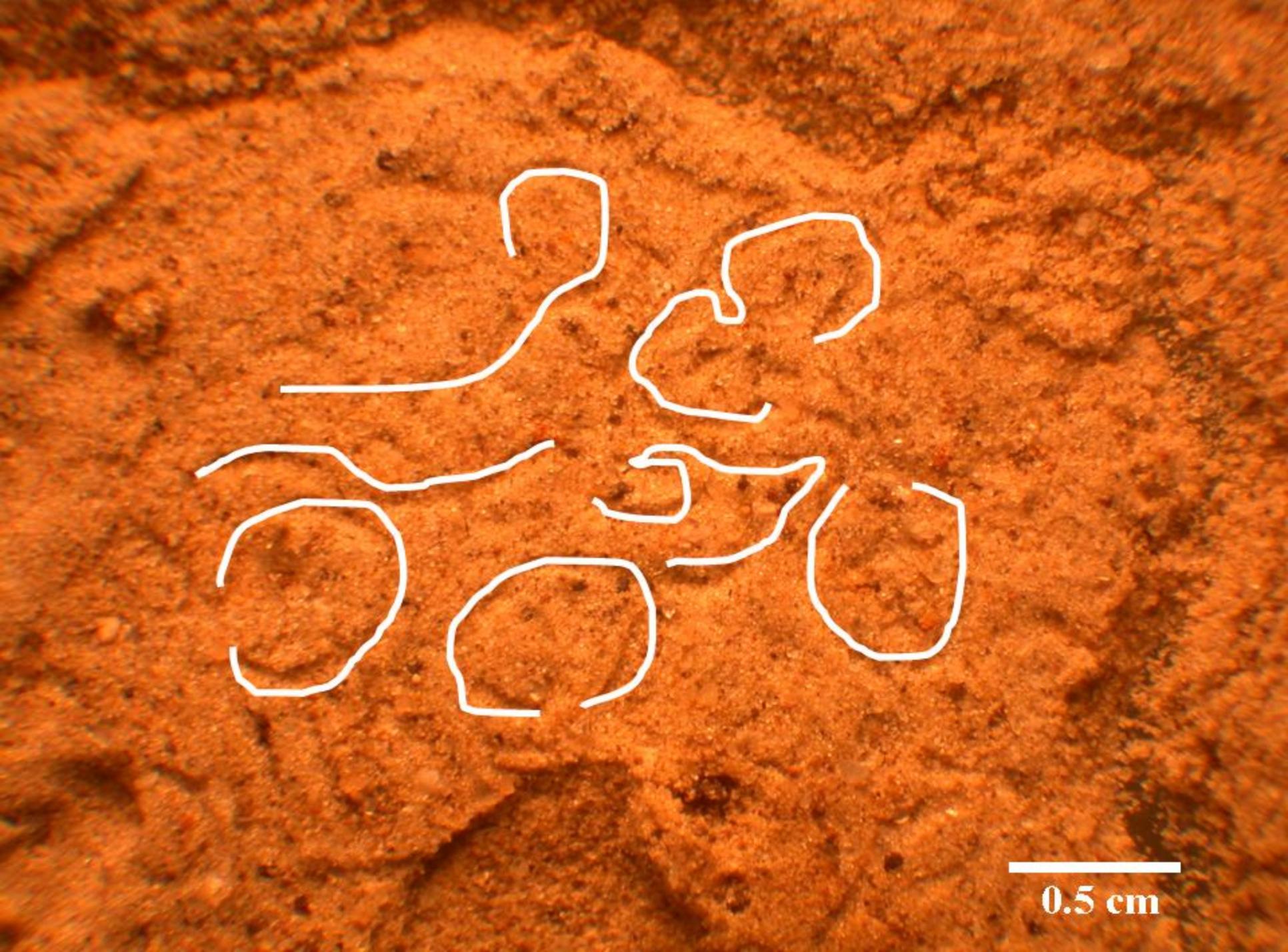
- Segments of *Echinococcus granulosus* migrate a considerable distance and even climbed vertically on plants.
- *Taenia hydatigena* gravid proglottids migrated 90 cm horizontally away from feces.





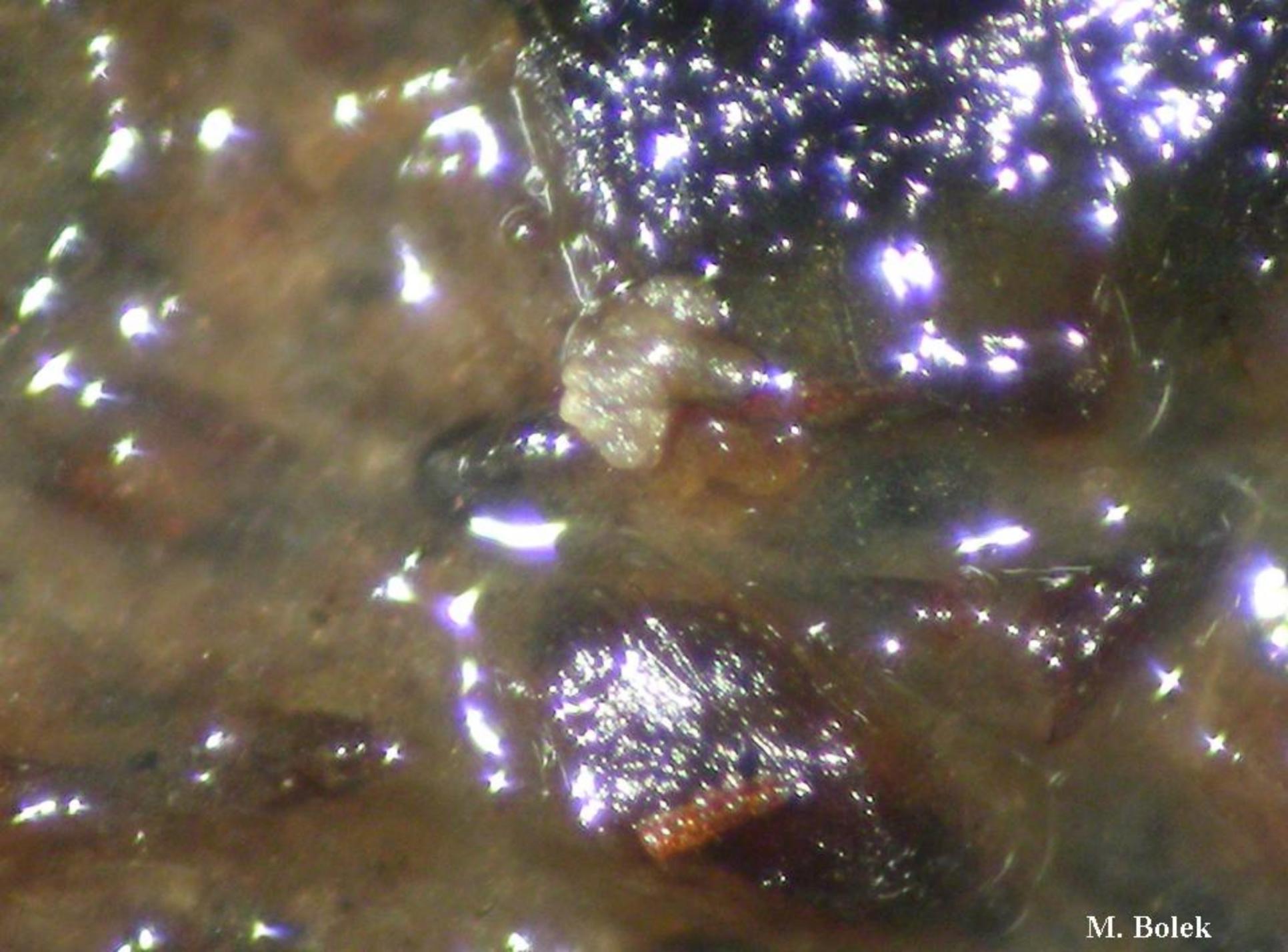


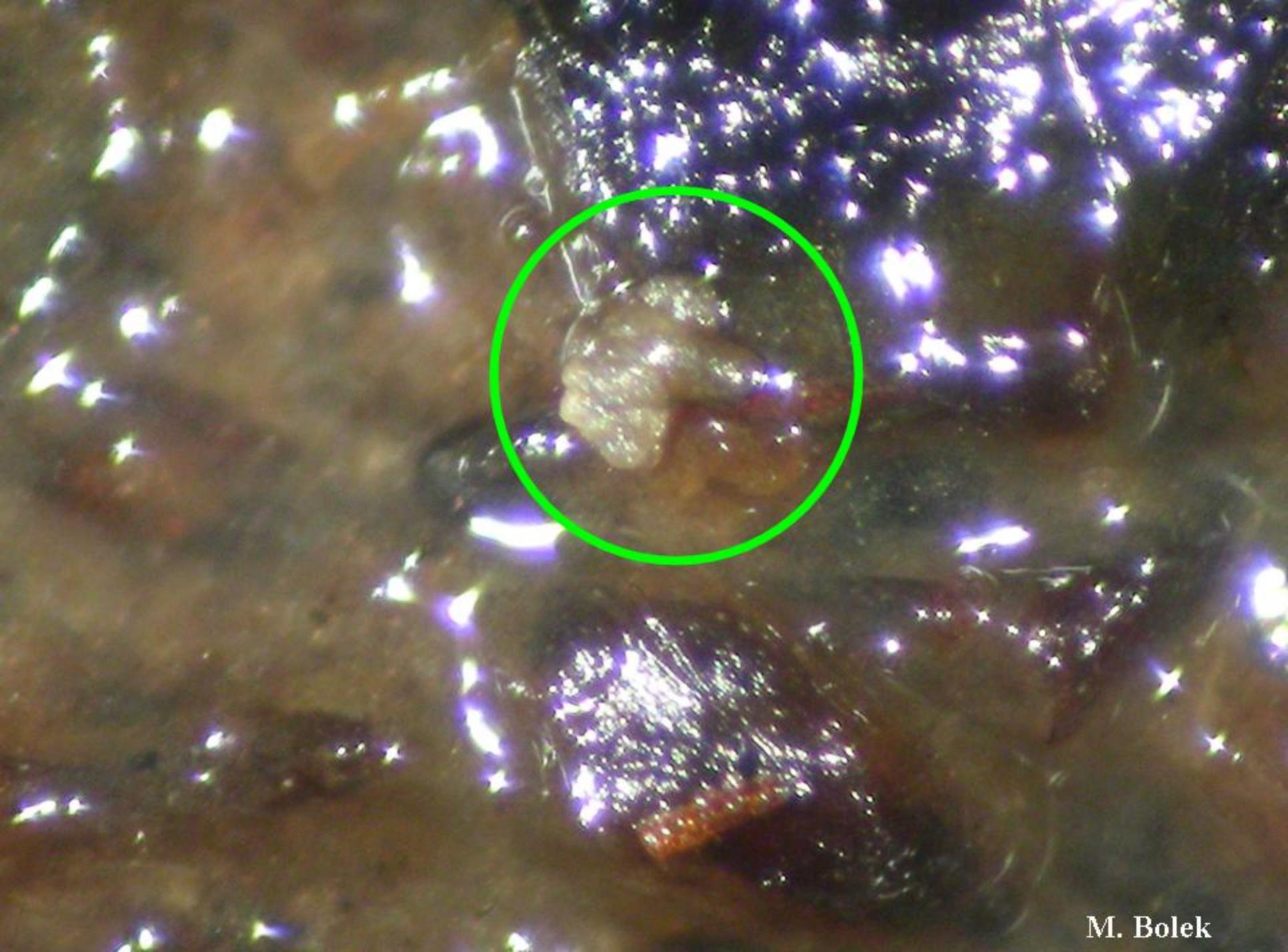




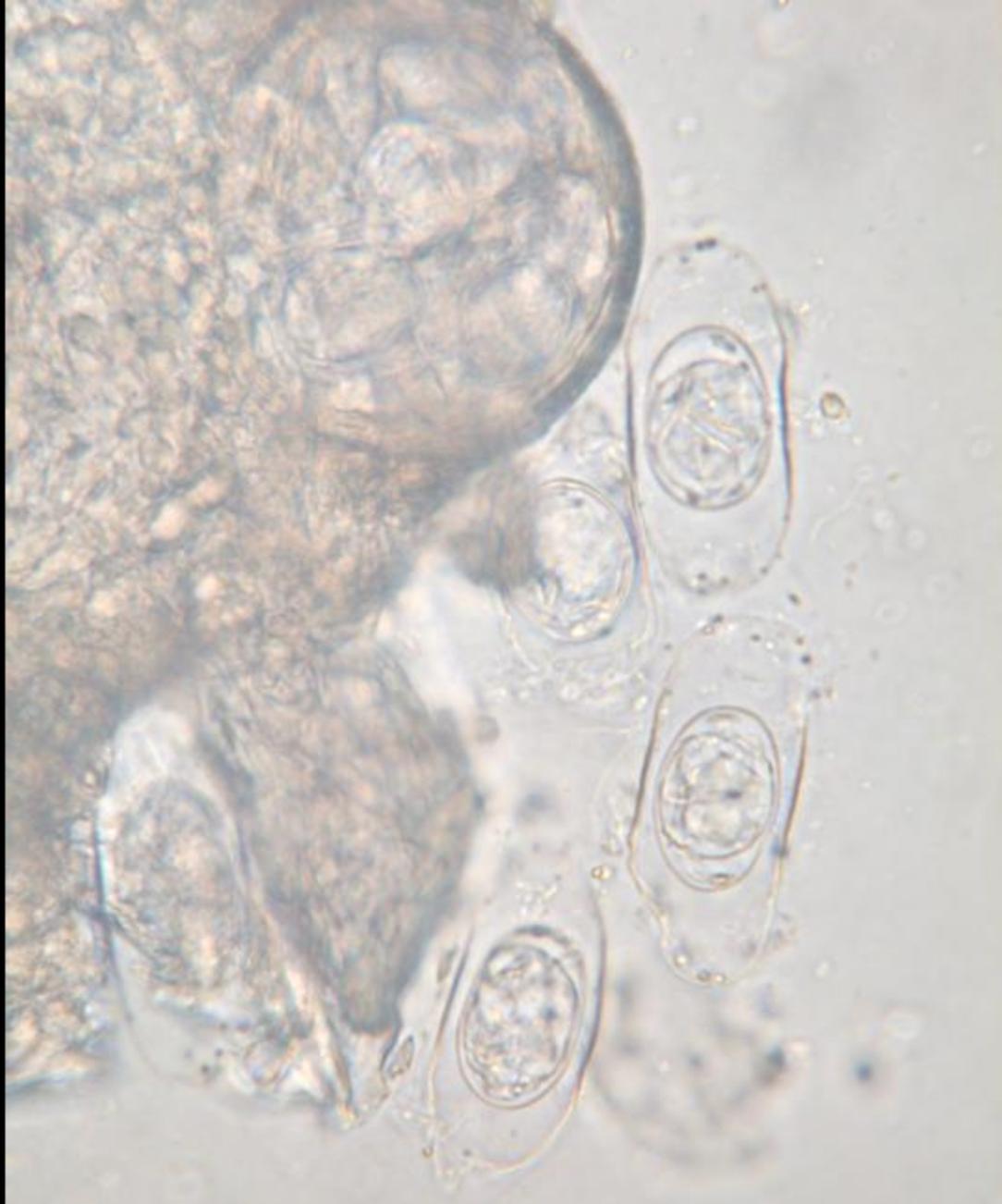
0.5 cm











Eggs with Oncospheres or Hexacanth

How do Proglottids Release Eggs?

Maturing Gravid and Gravid Proglottids



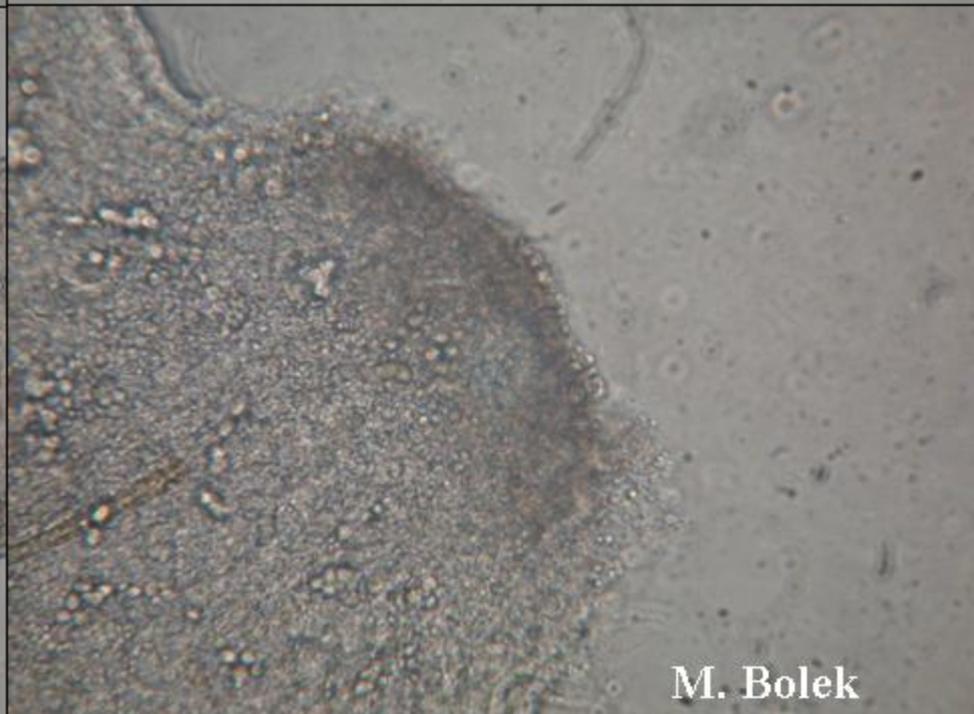




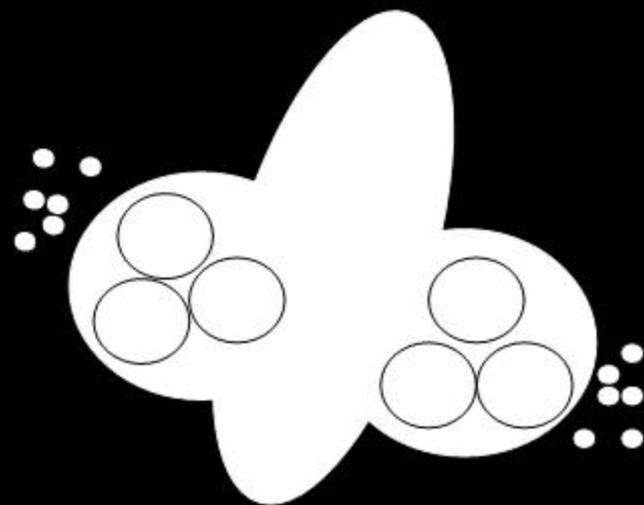
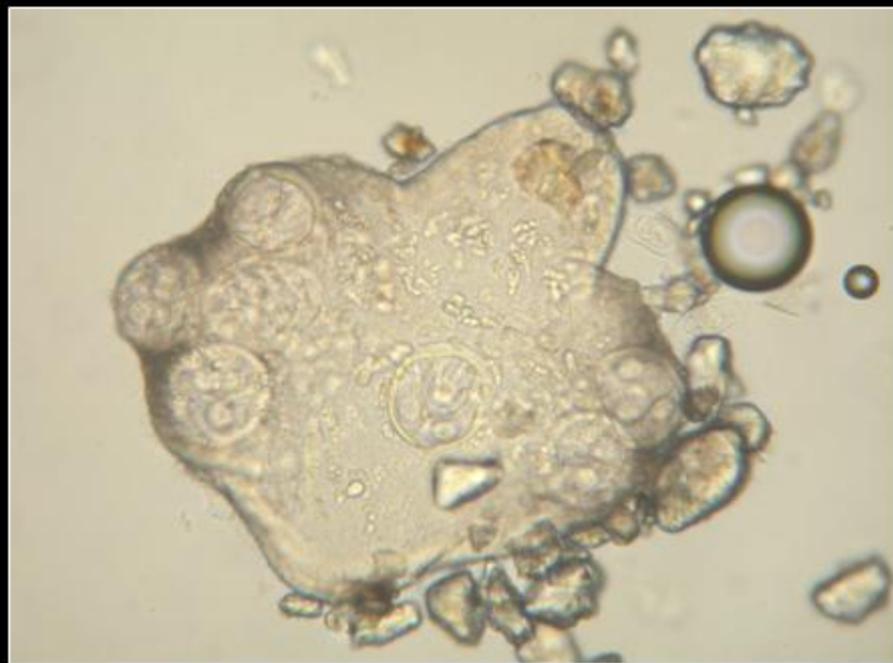
Maturing Gravid Proglottid



Gravid Proglottid



Under Laboratory Conditions Proglottids Move to the Surface of Toad Feces and Release Eggs



Collected Toad Poop to Examine the Proglottid Distribution on Toad Feces in Nature

METRIC

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The Magic of Cedar Point Biological Station!



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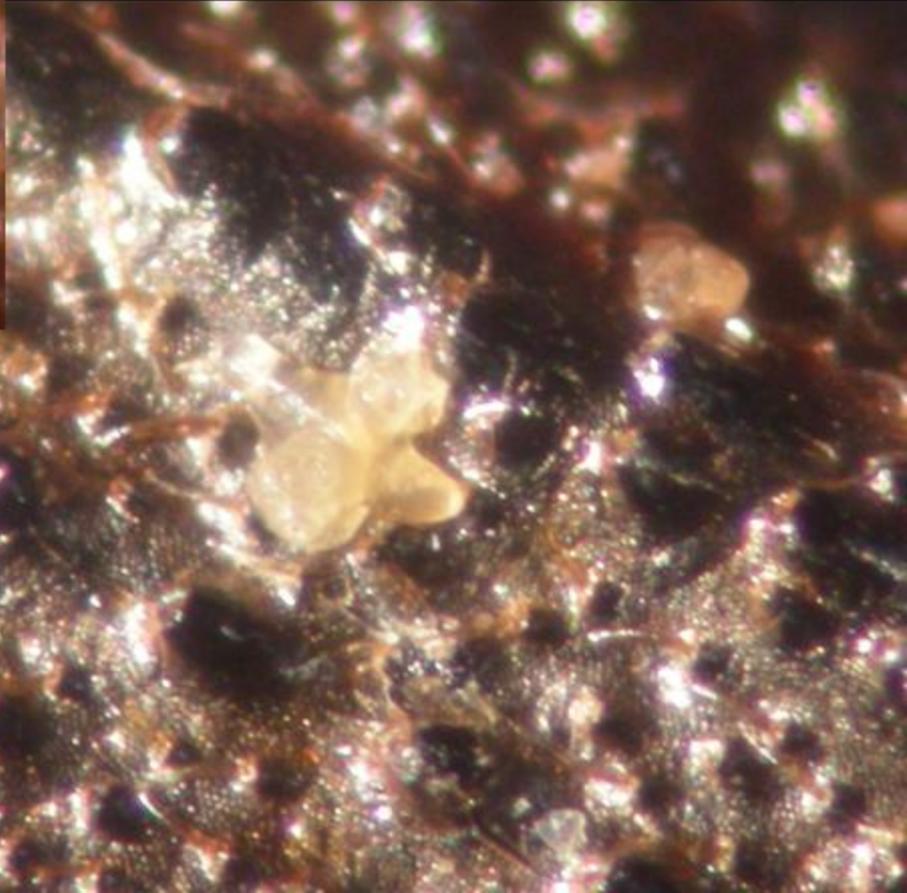
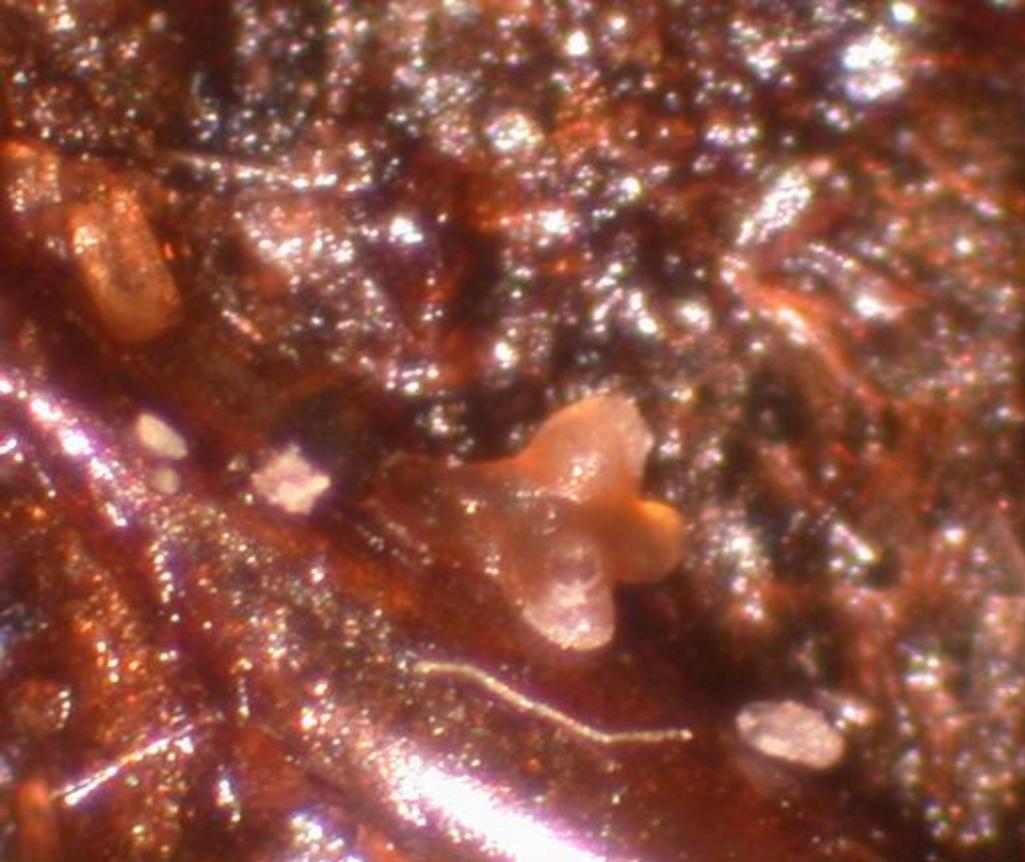


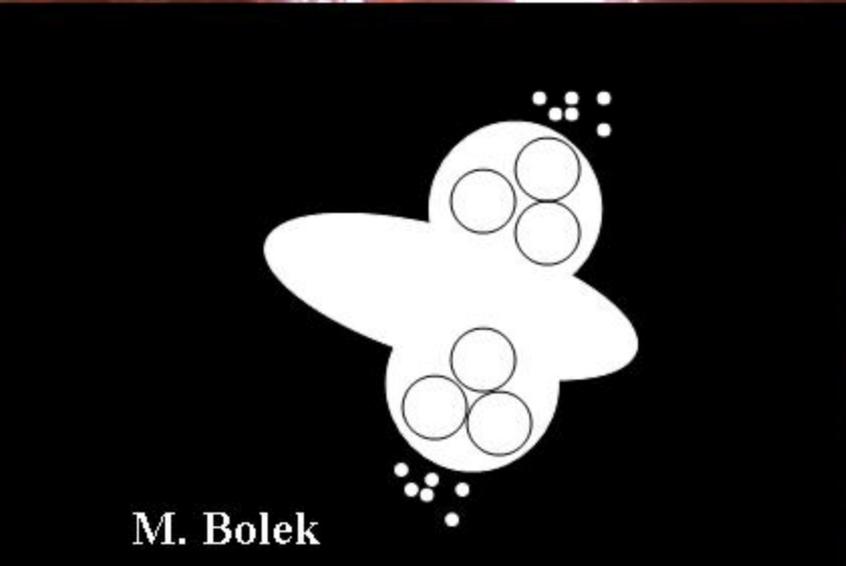
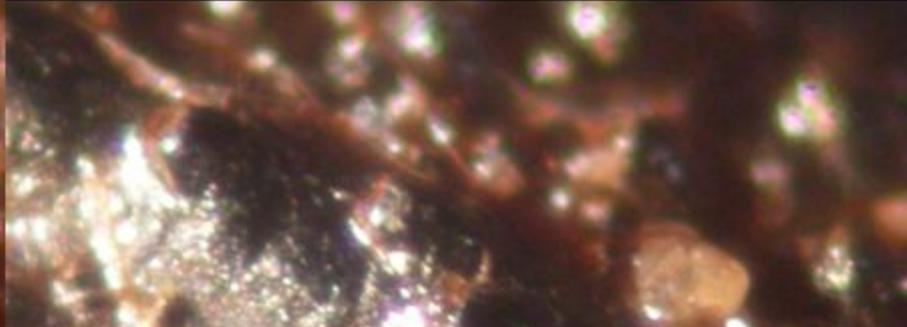
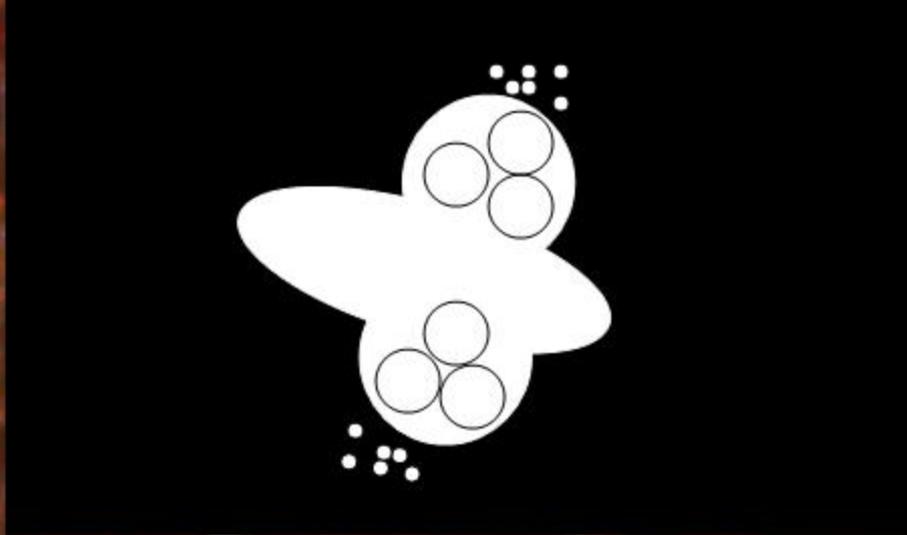
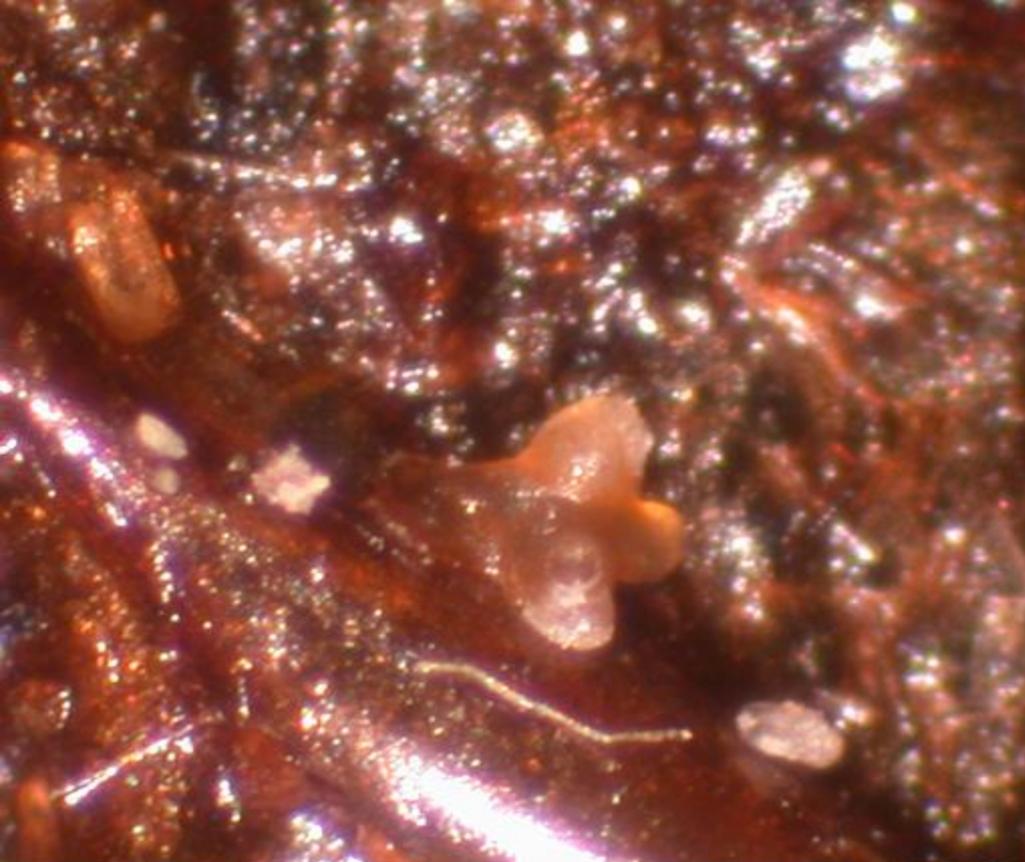




**We Collected Toad Feces from Sidewalks of
Cedar Point Biological Station and
Examined them for Proglottids.**





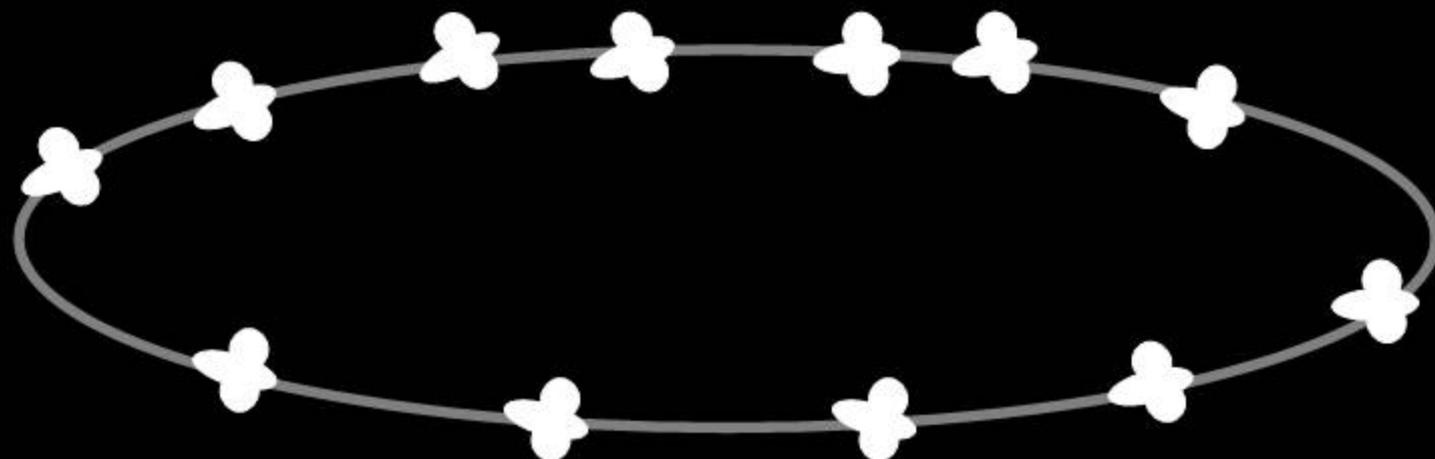


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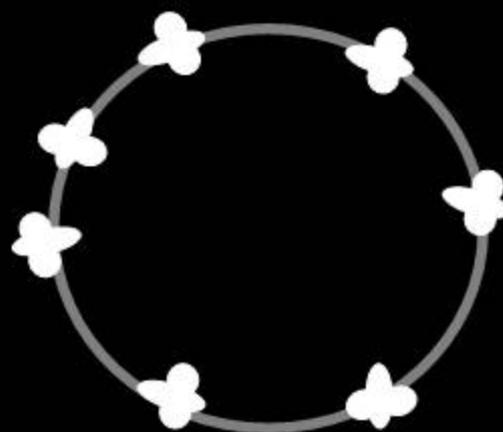
- **All dissected toads that were actively shedding proglottids, and all infected fecal pellets collected from nature contained proglottids on the surface of the fecal pellet.**

- **All dissected toads that were actively shedding proglottids, and all infected fecal pellets collected from nature contained proglottids on the surface of the fecal pellet.**
- **No proglottids were ever found inside any fecal pellets!**

Schematic of a toad fecal pellet and the distribution of gravid proglottids!

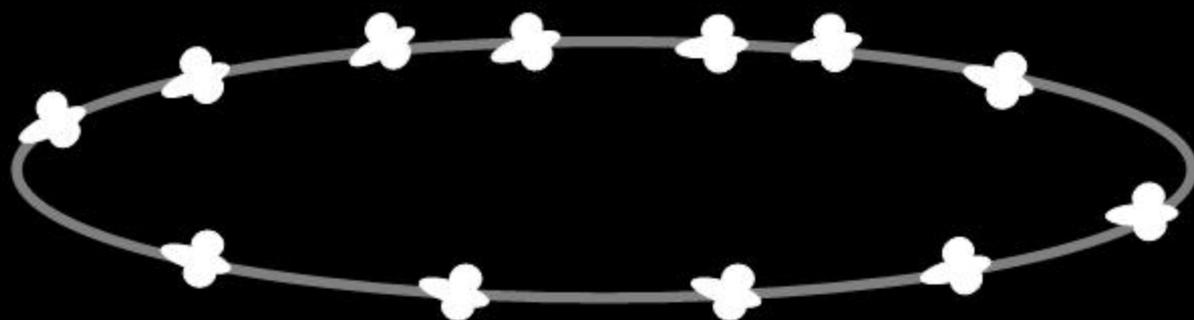


Sagittal View

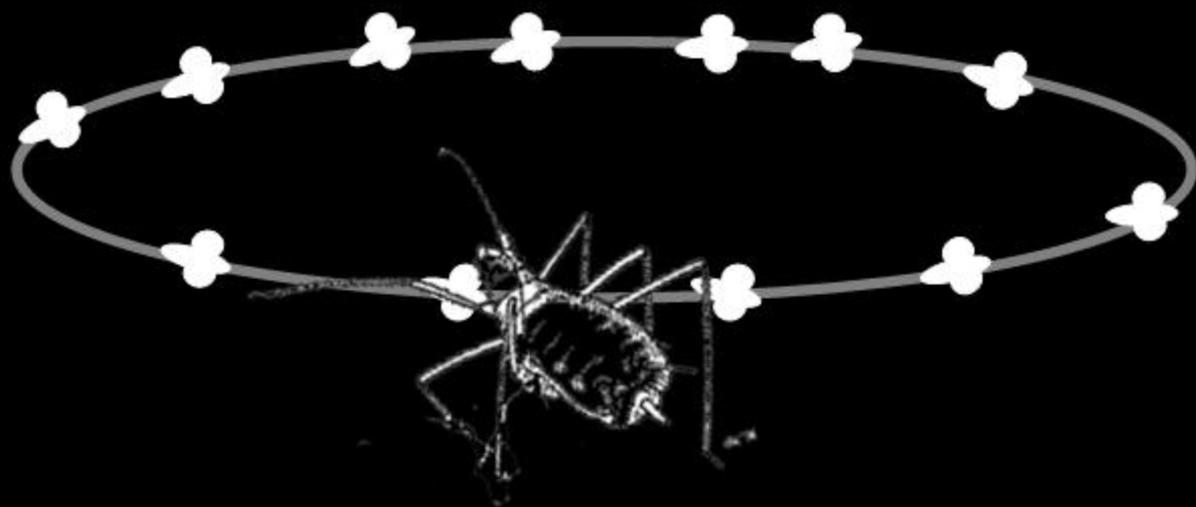


Transverse View

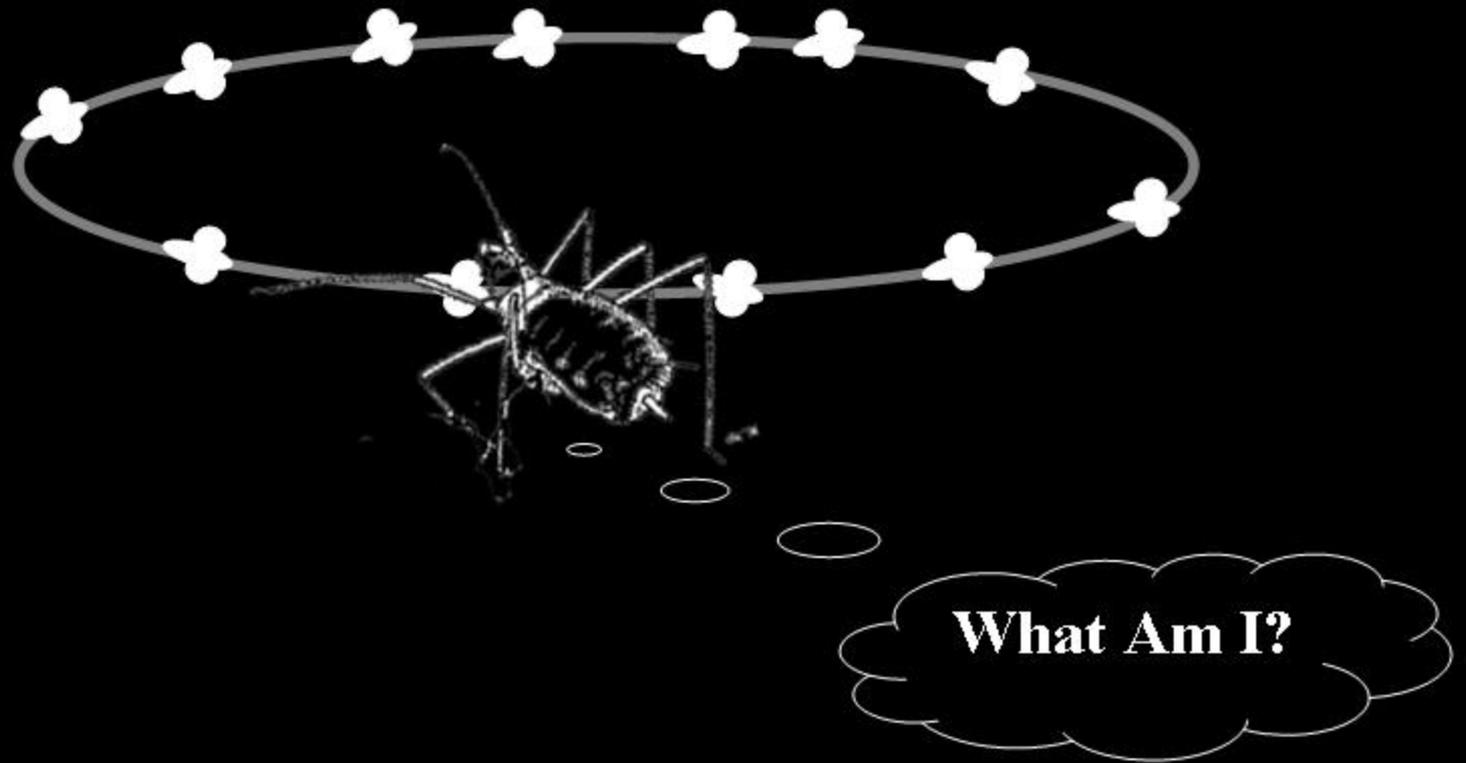
What purpose is there for a gravid proglottid to be on the surface of a dry fecal pellet?



Contact with an intermediate host?



Contact with an intermediate host?



So What Visits Toad Poop?



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M. Bolek









- **Of 19 different fecal pellets we observed, 9 were visited by ants; additionally ants were the only arthropods visiting toad fecal pellets!**

Ants Found in Toad Poop



Dolichoderinae
Dorymyrmex sp.



Myrmicinae
Pheidole sp.

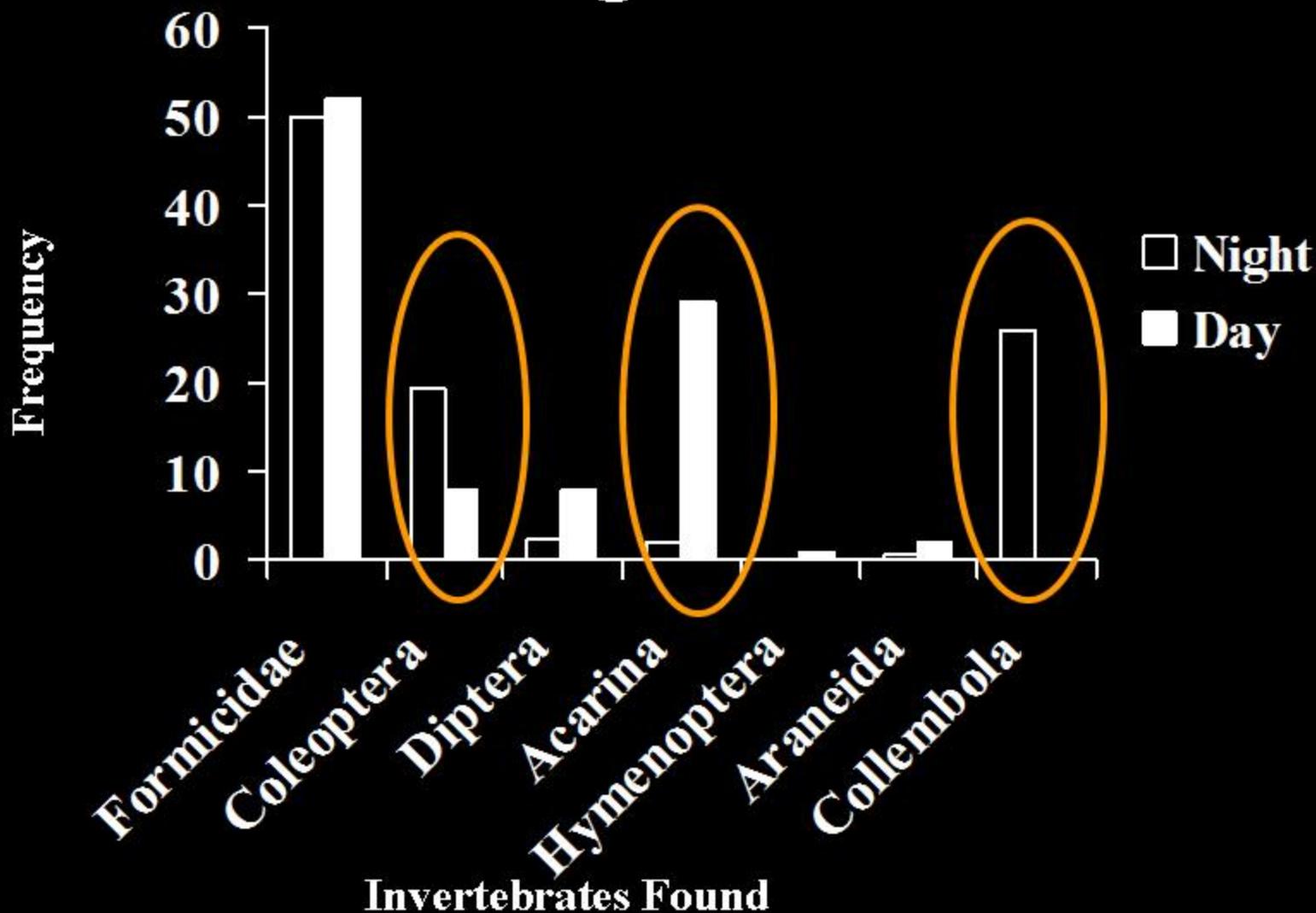


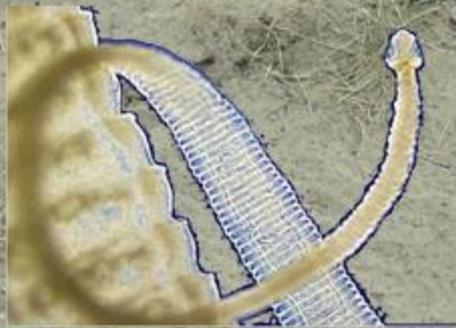


Toad Feces was Placed on Pitfall Traps

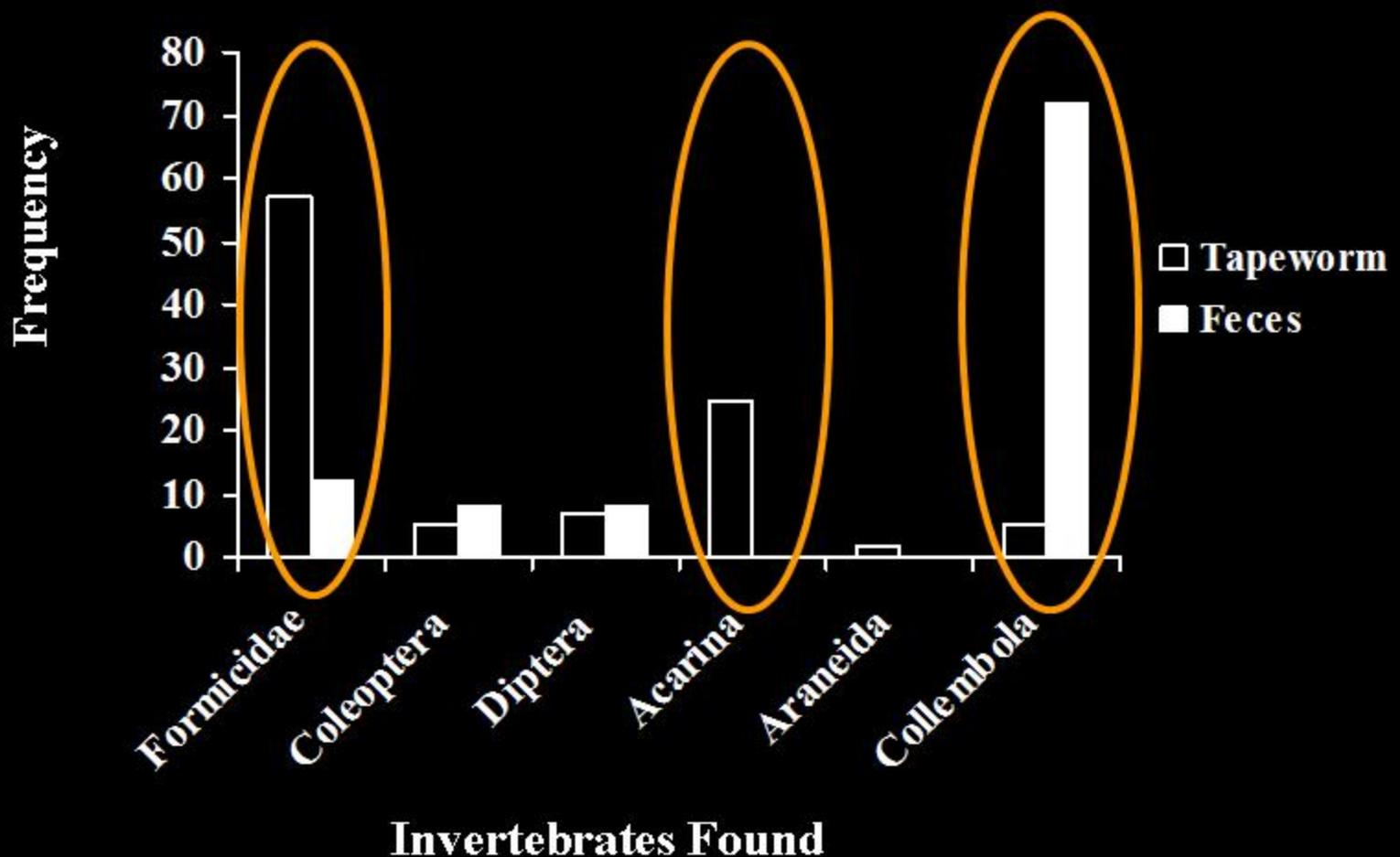


Results of Pitfall Traps Day and Night



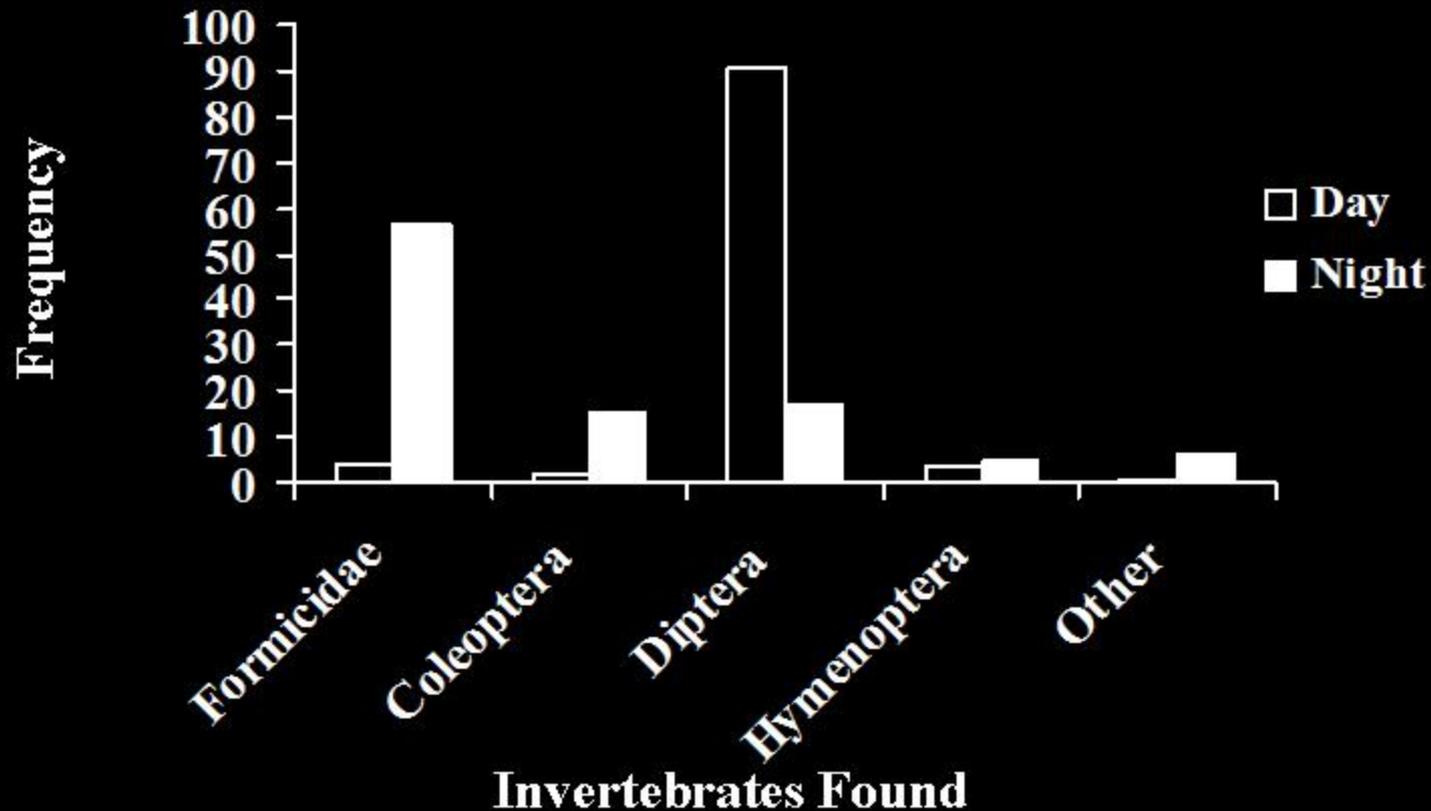


Results Pitfall Traps with Tapeworms or Toad Feces



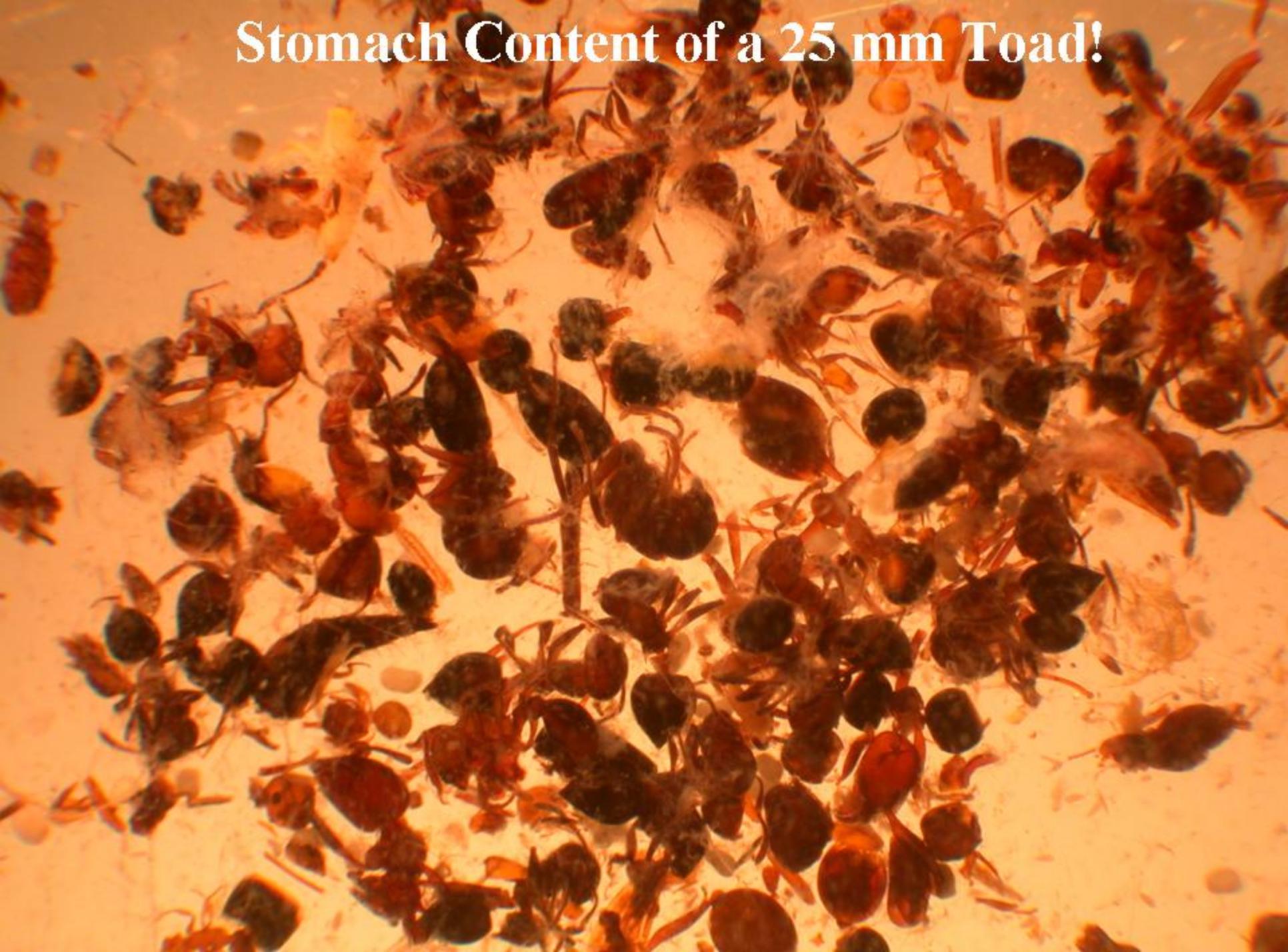
What do Toads Eat?

Results- Diurnal and Nocturnal Diets



Comparison of the percentage of invertebrates present in the stomach for diurnal and nocturnal toads.

Stomach Content of a 25 mm Toad!



Stomach Content of a 25 mm Toad!



Pheidole sp.

Do Ants Eat Proglottids?

Do Ants Eat Proglottids?

- **Gravid proglottids were placed on glass cover slips**
- **Half of the sample contained only dry proglottids, while the other half contained both dry proglottids and a drop of honey**



Do Ants Eat Proglottids?

- Gravid proglottids were placed on glass cover slips
- Half of the sample contained only dry proglottids, while the other half contained both dry proglottids and a drop of honey



- **85% of proglottids were taken from glass cover slides!**

- **We hypothesize that ants may serve as intermediate hosts for this tapeworm.**

**But are there Behavioral
Adaptations in the Proglottids?**

Common North American Nematotaeniidae



Cylindrotaenia americana



Distoichometra bufonis

DH



Semi-Aquatic;
Semi-Terrestrial



Terrestrial

Feces



Runny



Solid

Acknowledgments

- **Natural History of Invertebrates Students**
- **Dr. Agustin Jimenez**
- **Dr. Dennis Richardson**
- **Cedar Point Biological Station**
- **Dr. Jean Knops**
- **Gabe Langford, Alaine Knipes**



The "Toad Queen"

Questions?

