New microsporidian species infecting invasive and native stink bugs

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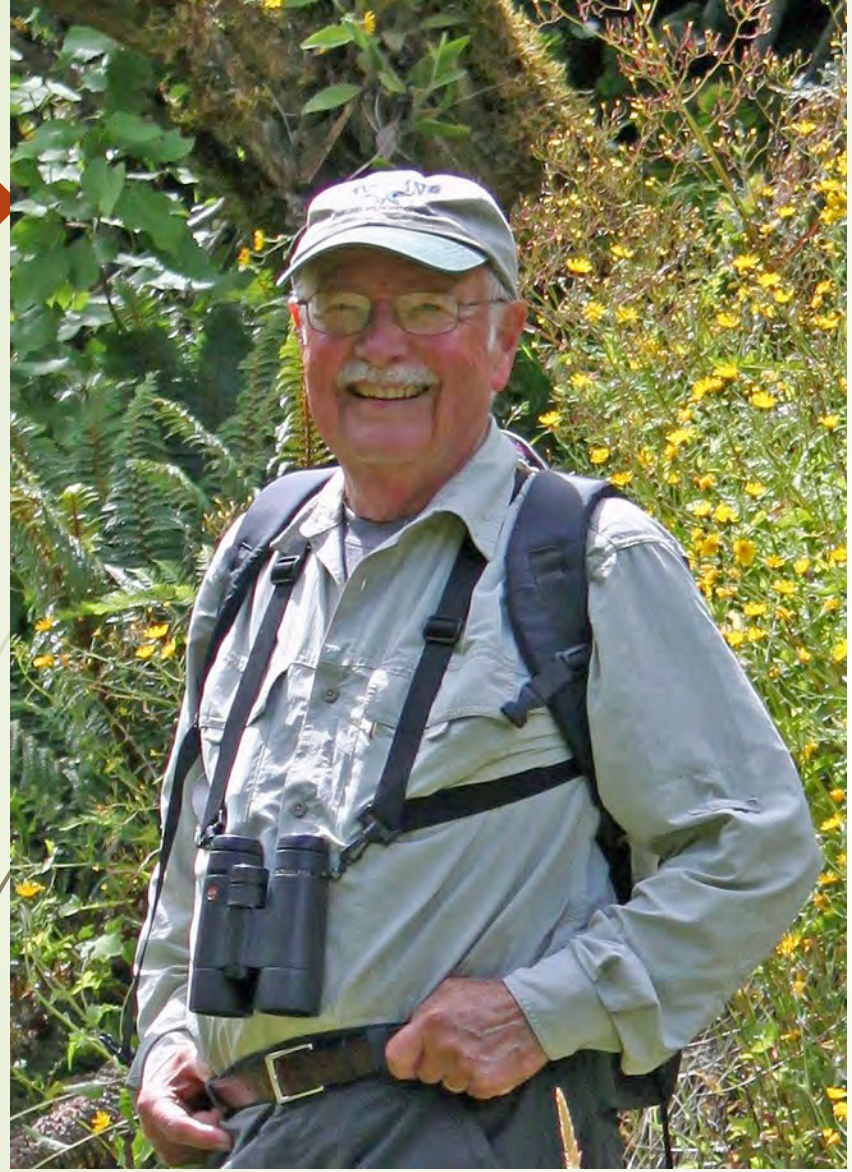
Relatively few Hemiptera are hosts of Microsporidia

	Families	# species
Aquatic	Geridae	1
	Corisidae	1
	Notonectidae	1
	Veliidae	1
	Omaniidae	1
Terrestrial	Aphididae	1
	Lygaeidae	1
	Pentatomidae	3
	Cimicidae	1
	Pyrrhocoridae	1
	Cicadellidae	1
	Miridae	1
	Rhopalidae	1
	Plataspidae	1

Microsporidia from pentatomids

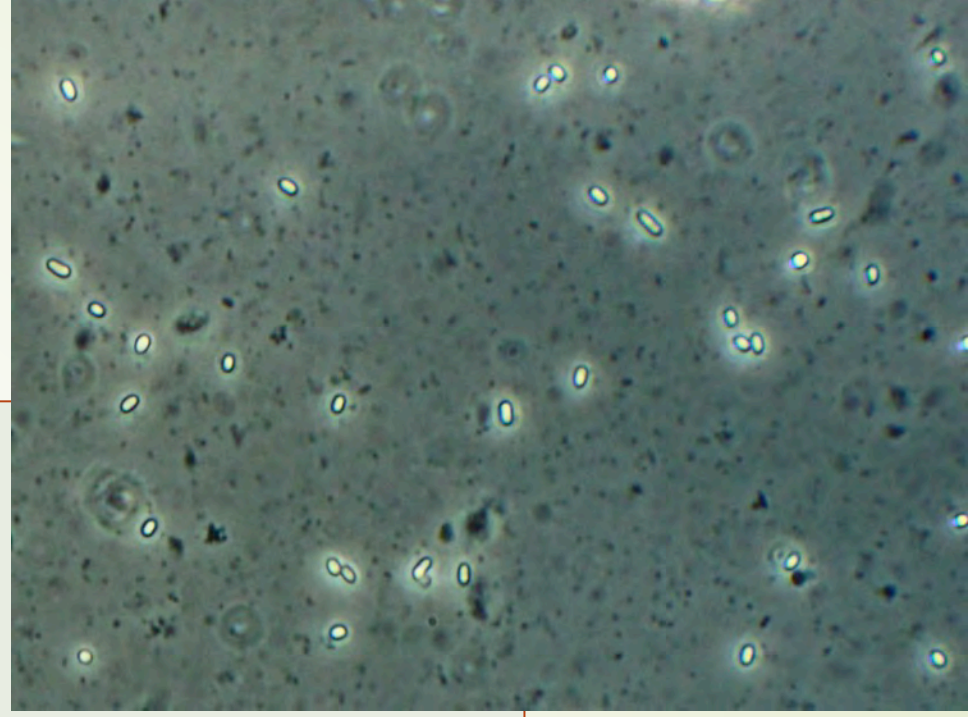
- 1 = European species (*Graphosoma lineatum)*
- 1 = North American species (green stink bug)
- 1 = transcriptome of BMSB collected in Allentown PA



Joe Maddox
Illinois Natural History Survey

1968-1972
Microsporidia reported from native **green stinkbugs** in **Illinois** (reported at conference in1978; no formal publication)

Chinavia hilaris



Early finds of BMSB microsporidia:

BMSB lab colonies crashing
*in a USDA Florida quarantine (2012)
[colony originating from **Delaware**]
*__University of Maryland__ (2015)

Bryan Petty and Anne Nielsen found microsporidia in BMSB in **New Jersey** (2014)

- We found microsporidia in:

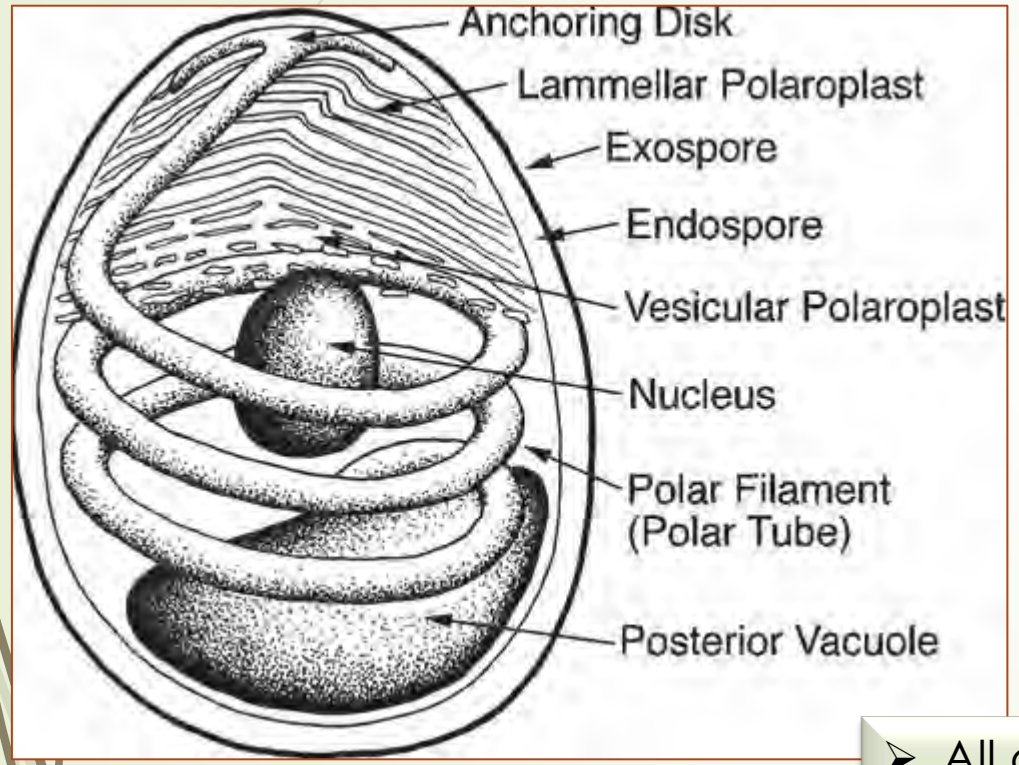
1. **North America**
    1. **BMSB (PA)**
    2. **Green stink bugs, *Chinavia hilaris* (IL and PA)**
    3. **Dusky stink bugs, *Euschistus tristigmus* (PA)**
    4. **Brown stink bugs, *Euschistus servus* (PA)**

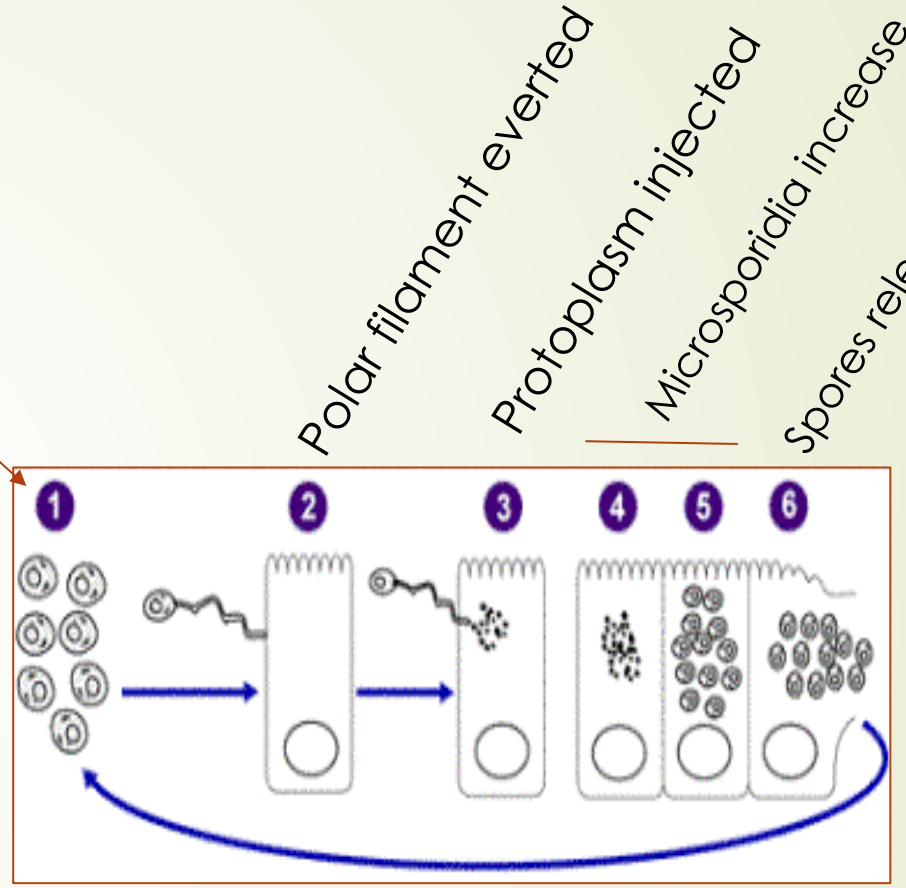
2. **South Korea and China**
    1. **BMSB**

We compared morphology and ribosomal DNA

MICROSPORIDIA

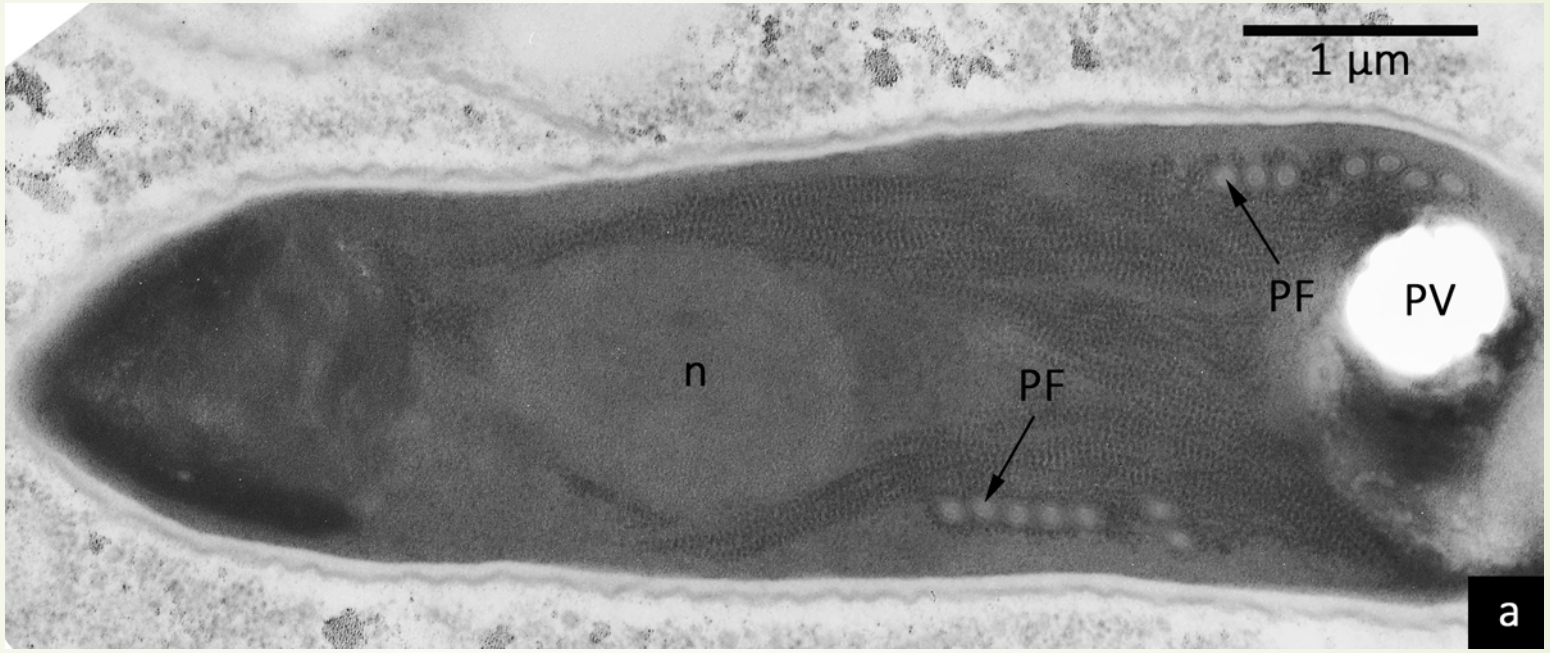
environmental spores





- All development is **intracellular**
- Infections usually **decrease fecundity and longevity**
- Range from only certain tissues to throughout host's body

Nosema maddoxi

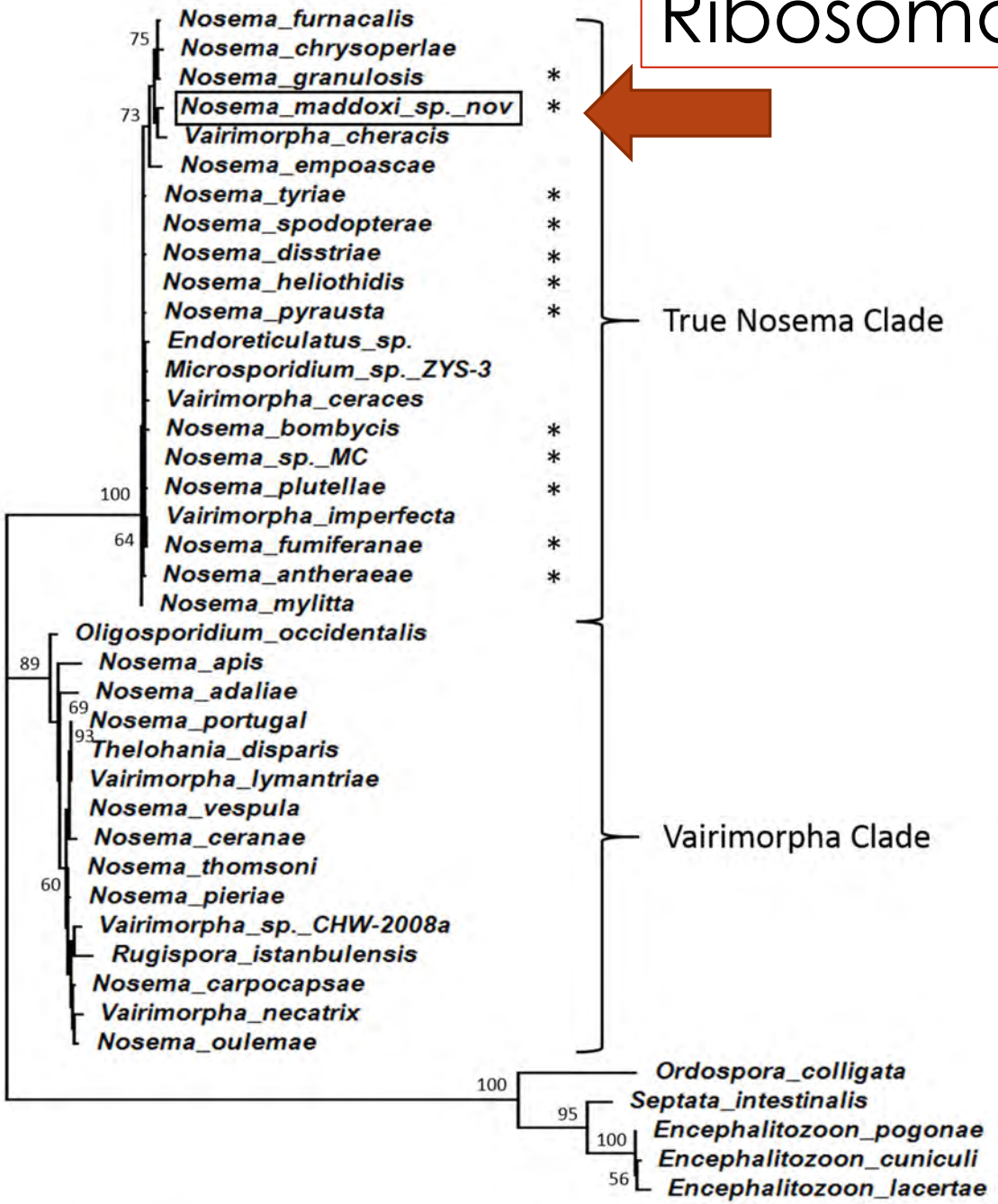


Uninucleate spores (4.7 x 2.2 µm)
Polar filaments with 7-9 turns
Systemic infections

There were still samples from infected green stink bugs from Illinois 1968 – before BMSB was in North America

Excellent rationalization for why not to throw out those old samples!

Ribosomal SSU



All the same microsporidian species

1. BMSB
    1. North America
    2. South Korea and China
2. Green (1968 and 2015), dusky and brown stink bugs
    1. North America

HOLARCTIC DISTRIBUTION!

FIELD PREVALENCE IN 2 HOSTS

Illinois	1970-1972	14.3-51.5%	GREEN
Northeast	2015-2016	0.0-28.3%	BMSB

Summary

- 1. SSU of microsporidia from brown marmorated, green, brown and dusky stink bugs are the same:
  - *Nosema maddoxi* (Journal of Eukaryotic Microbiology doi:10.1111/jeu.12475)
- 2. Also SSU of samples from South Korea and China were the same: *Nosema maddoxi*
- 3. *Nosema maddoxi* is considered Holarctic because it has been found in BMSB in Asia---and green stinkbugs in North America, before establishment of BMSBs.
- Molecular work shows that this species is *Nosema*, although spores are unikaryotic (atypical for this genus).
- Koch's postulates proved pathogenicity to BMSBs and prevalence was >50% in green stink bugs in Illinois in 1972 and almost 30% in Pennsylvania in 2016.

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