Health of *Nomia* Bee Beds– *Pathogen screening in managed alkali bee populations*

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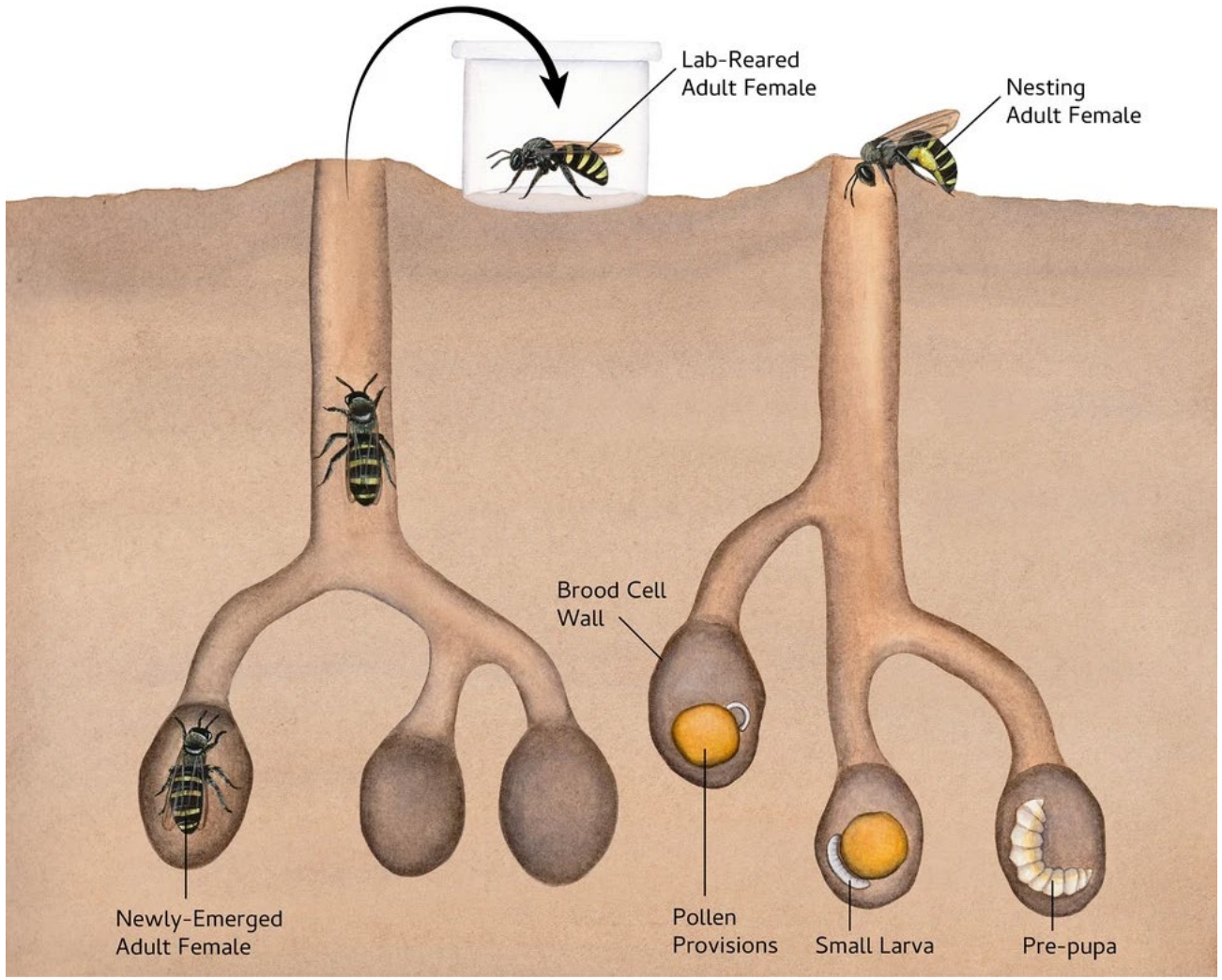
Beds with Good Nesting

July 20, 2022

Why are the bees no longer thriving in the poor beds?

Beds with very Poor Nesting



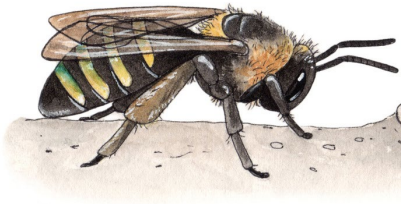
Kapheim, K.M., Johnson, M.M. & Jolley, M. Composition and acquisition of the microbiome in solitary, ground-nesting alkali bees. *Sci Rep* **11**, 2993 (2021). https://doi.org/10.1038/s41598-021-82573-x

New pollen, egg

Old pollen,
egg/larva failed

Prepupa (healthy)

Dead Prepupa

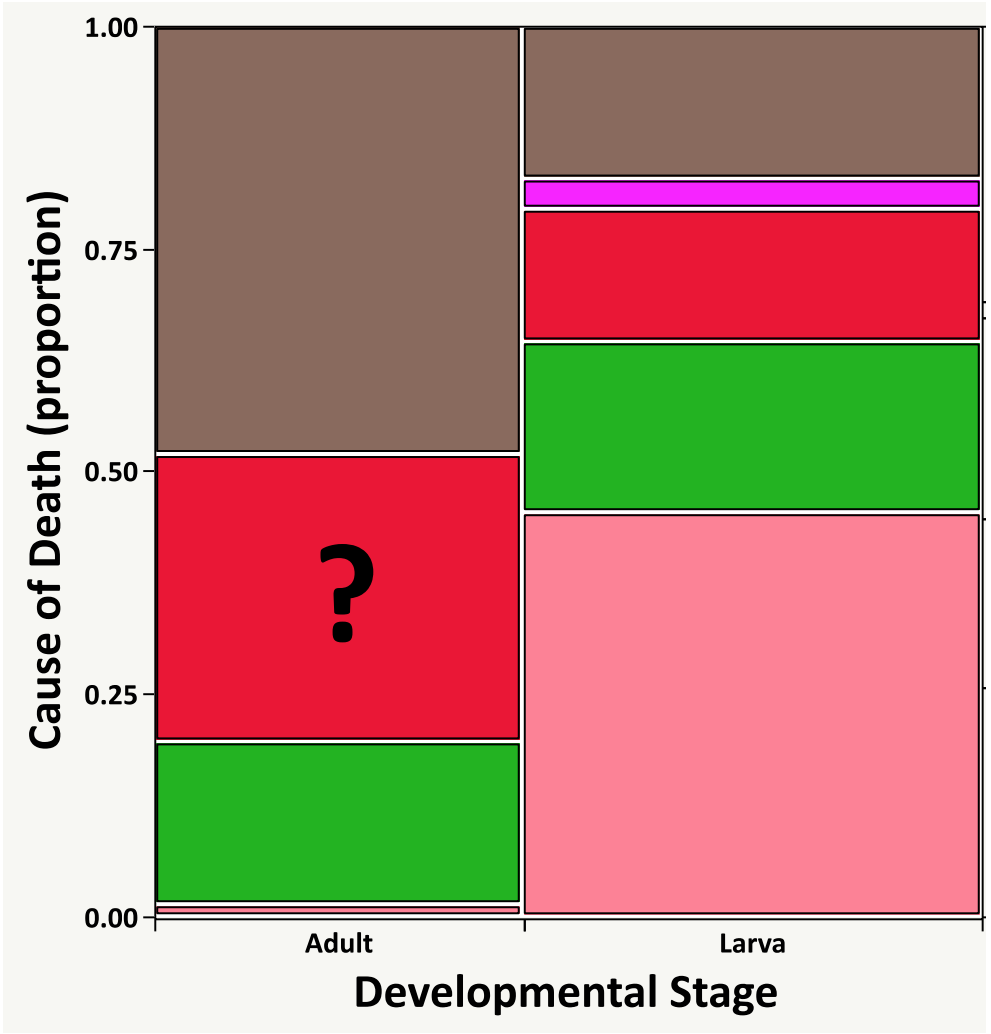


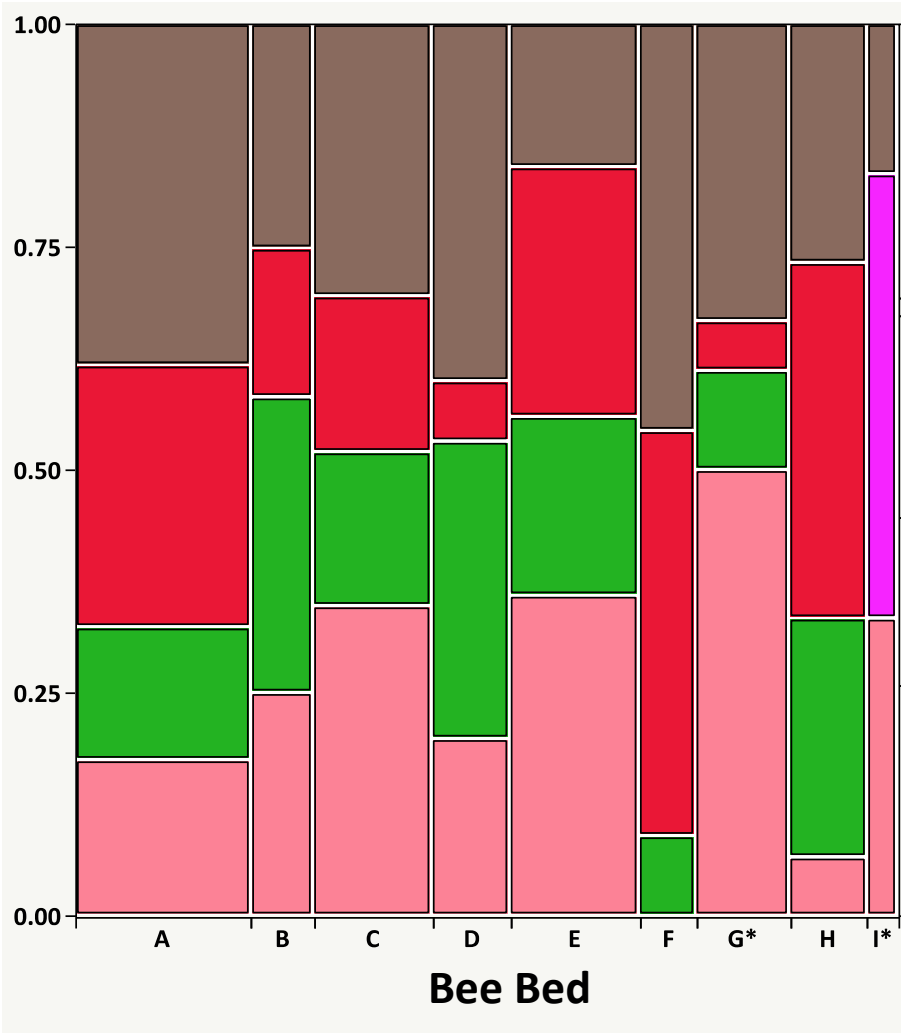
Healthy Adult

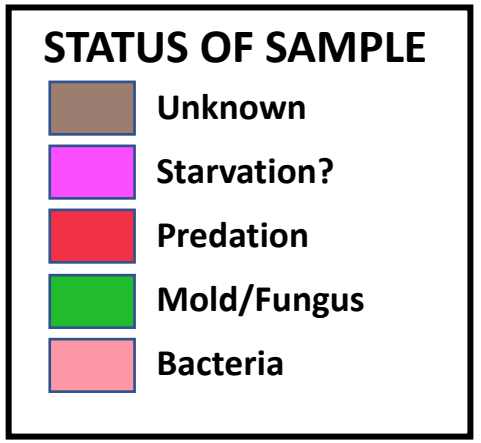
Dead Adult

?? Unknown
contents??

2022--Causes of Death- Variation between stages and beds

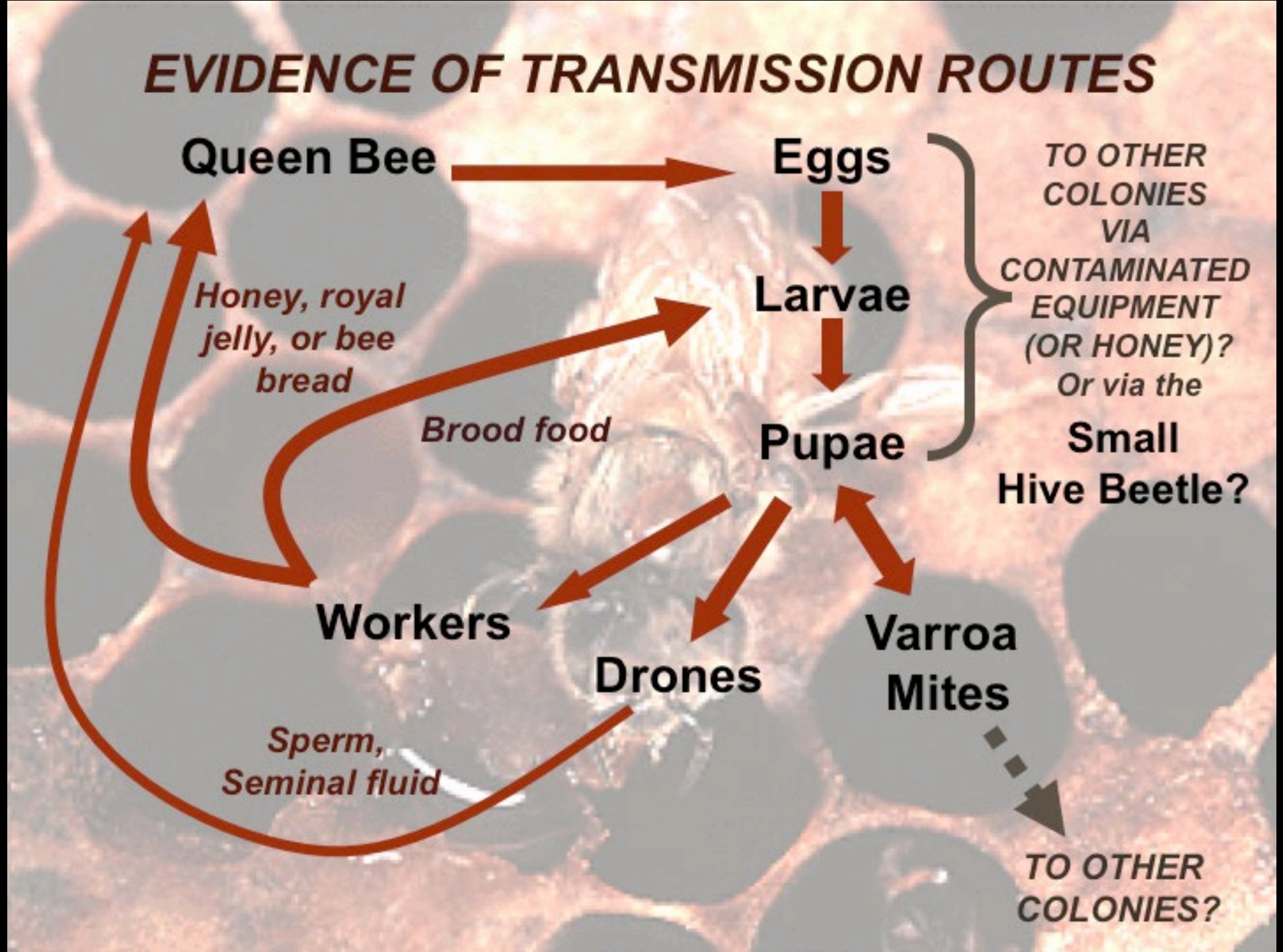




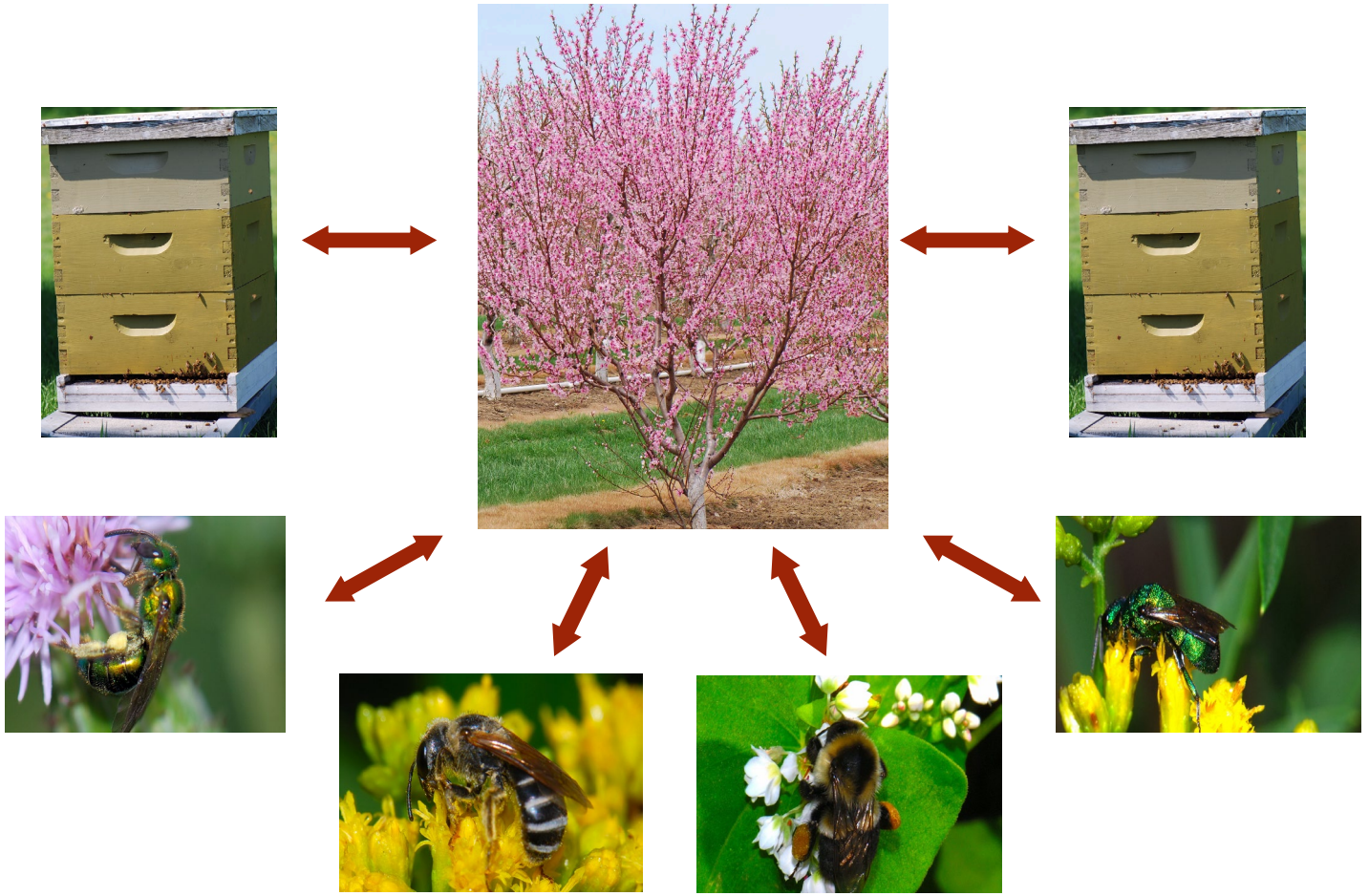


Viruses

- Over 40 different viruses described in bees
- A few DNA viruses; majority ssRNA viruses
- Most discovered from isolated cases of colony losses
- Described symptoms vary greatly among the viruses, even among closely related viruses.
- Many viruses in bees not well understood.

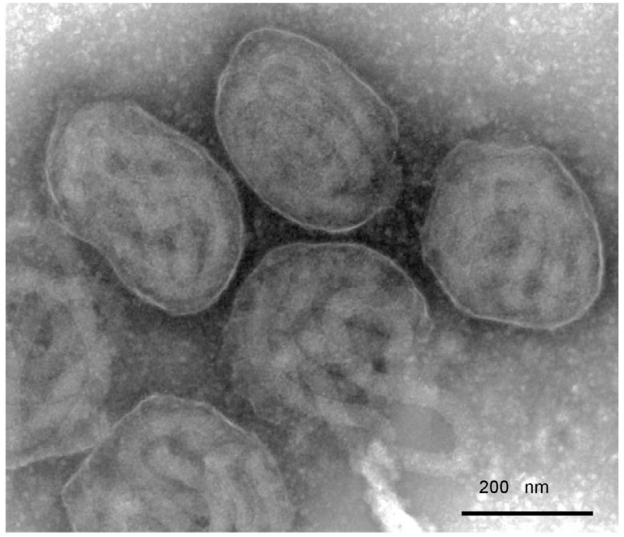

EVIDENCE OF TRANSMISSION ROUTES
Queen Bee
Eggs
Larvae
Pupae
Workers
Drones
Varroa Mites
Honey, royal jelly, or bee bread
Brood food
Sperm, Seminal fluid
TO OTHER COLONIES VIA CONTAMINATED EQUIPMENT (OR HONEY)? Or via the
Small Hive Beetle?
TO OTHER COLONIES?

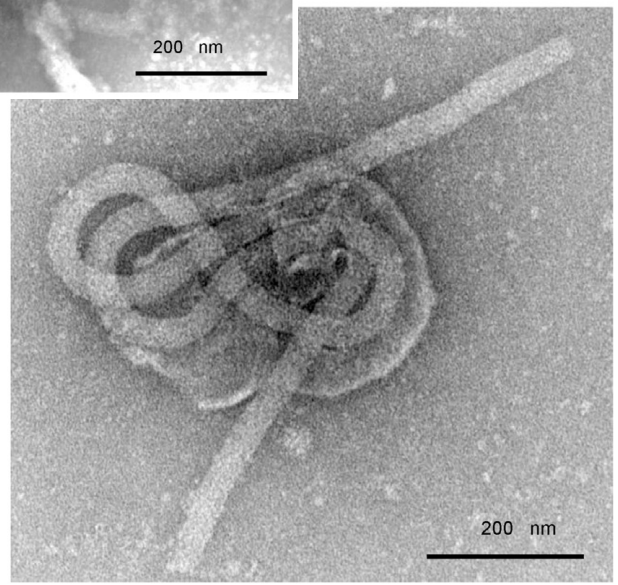
Transmission of Viruses via Pollen

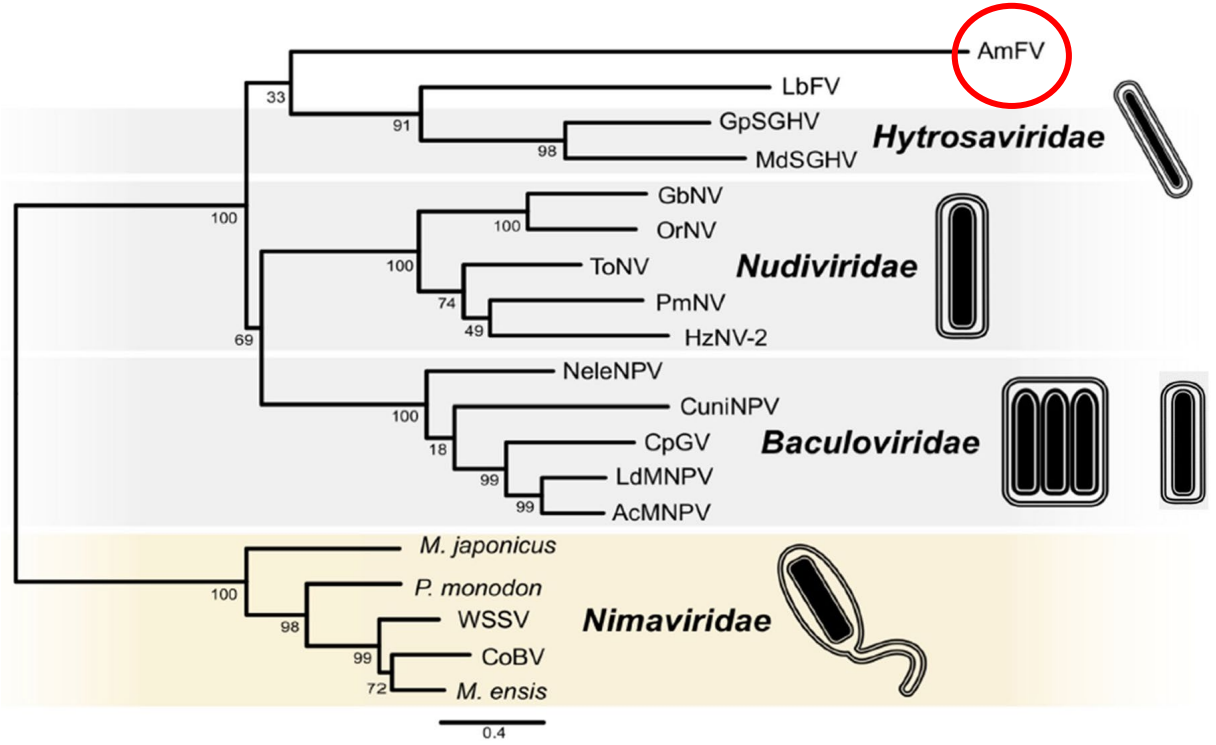


Singh R, Levitt AL, Rajotte EG, Holmes EC, Ostiguy N, Vanengelsdorp D, Lipkin WI, Depamphilis CW, Toth AL, Cox-Foster DL. RNA viruses in hymenopteran pollinators: evidence of inter-Taxa virus transmission via pollen and potential impact on non-Apis hymenopteran species. PLoS One. 2010 Dec 22;5(12):e14357.

Apis mellifera filamentous virus (AmFV)



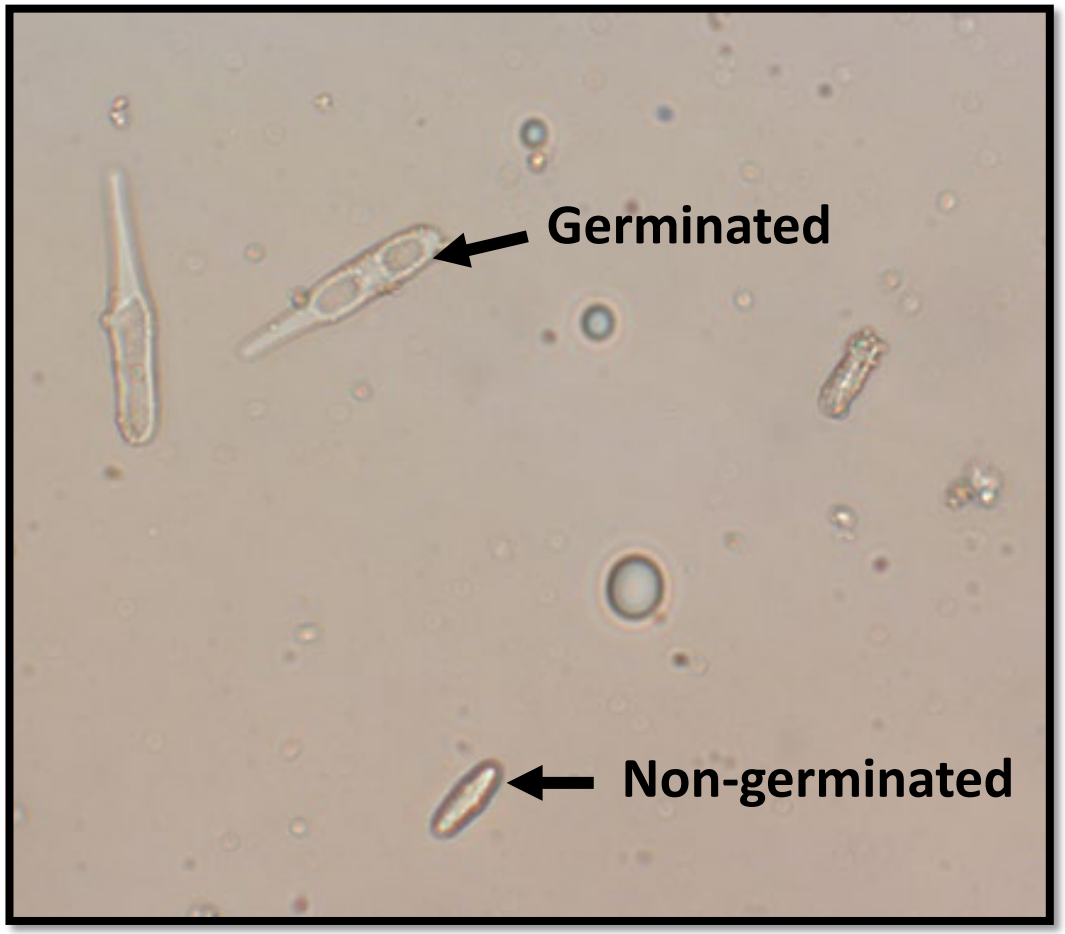




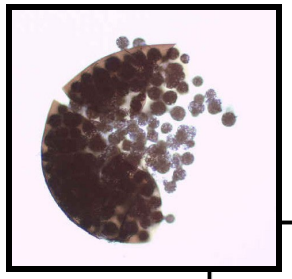
Yang D, Wang J, Wang X, Deng F, Diao Q, Wang M, Hu Z, Hou C. Genomics and proteomics of Apis mellifera filamentous virus isolated from honeybees in China. Virol Sin. 2022 Aug;37(4):483-490. doi: 10.1016/j.virs.2022.02.007.

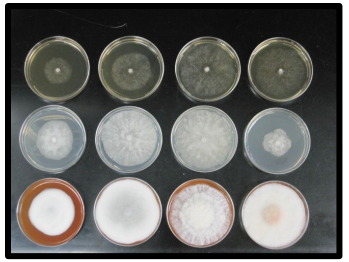
van Oers, M.M., Herniou, E.A., Jehle, J.A. *et al.* Developments in the classification and nomenclature of arthropod-infecting large DNA viruses that contain *pif* genes. *Arch Virol* **168**, 182 (2023). https://doi.org/10.1007/s00705-023-05793-8

Chalkbrood– fungal pathogen of bees



Ascosphaera fungi

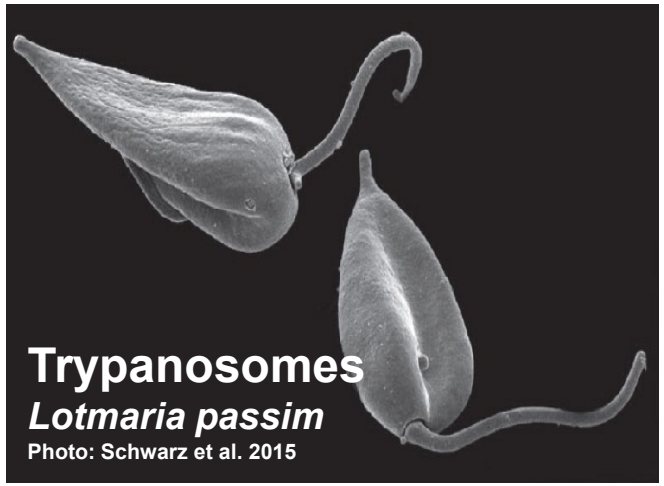




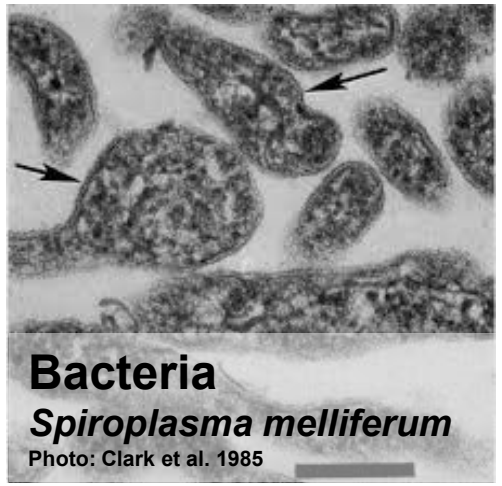
- 30 Species
- All associated with bees
- Some are pathogens
- Disease called chalkbrood

Other possible pathogens

***Trypanosomes*, and other unicellular pathogens**

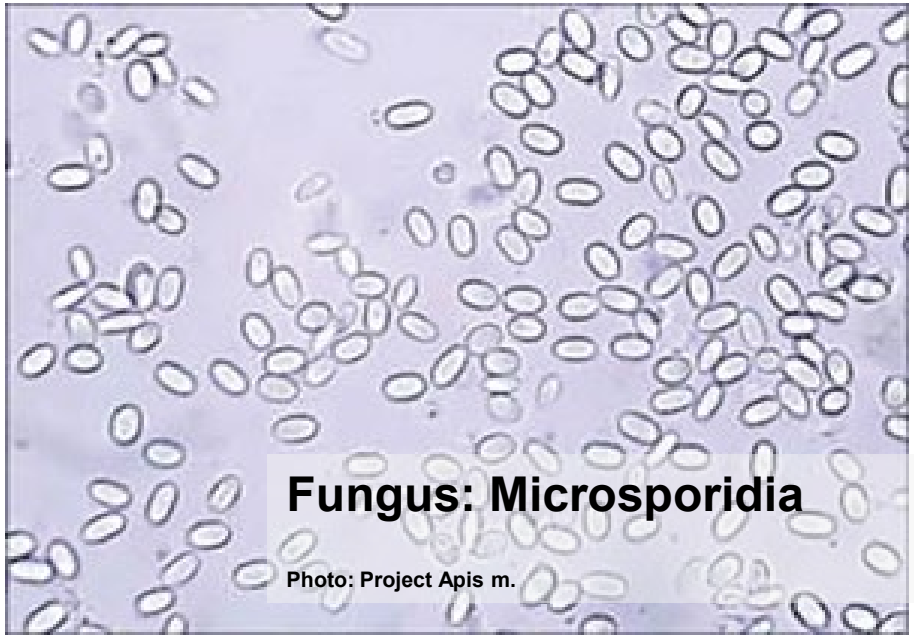


Spiroplasma



***Microsporidia*– distant relative of fungi. Unicellular with vegetative form and spores.**

Many species are known to attack only specific hosts



What do we know about Alkali bees?

Infection of ssRNA viruses in Alkali Bees and Alfalfa Leafcutting Bees in **2010**

(R. Singh in collaboration with R. James)

	Virus Prevalence (% bees)			
Bee species	DWV	IAPV	BQCV	SBV
ALCB	17.5 ± 13.2*	12.5 ± 15.5	5.0 ± 7.1	0
Alkali bee	34.3**	17.1	2.9	2.9
Honey bee	87.1 ± 17.0*	62.9 ± 33.8	89.9 ± 10.9	20.0 ± 40.1

ALCB: alfalfa leafcutting bee; DWV: deformed wing virus; IAPV: Israeli acute paralysis virus. BQCV: black queen cell virus; SBV: sacbrood virus.

None of the samples were positive for Kashmir bee virus (KBV), acute bee paralysis virus (ABPV) and chronic bee paralysis virus (CBPV).

* Mean ± SD; adults only; 20 ALCB adults per field from 4 separately owned farms; 20 honey bee workers per hive, 3 hives per apiary, and 4 apiaries.

** Alkali Bees-- Combined sample of adults & larvae (N=35).

2023– return to sample the bee beds in July

- Sample 10 bee beds
- Collect 140 larvae
  - 128 of the larvae appeared to be healthy
  - 12 were dead or dying
- Pathogen analysis on 30 of the healthy larvae from all the bee beds

Infection of ssRNA viruses in larval Alkali Bees in **2023**

	Virus Prevalence (% bees)			
Bee species	DWV	IAPV	BQCV	SBV
Alkali bee	0 %	0 %	0 %	0 %
Honey bee colonies in UT	80 %	80 %	100%	75.0%

Alkali Bees– 34 larval bees, from Henry, Heusby, Inman, Byerley, Andersen, Ponderosa, Maiden, Watson, Basement, Gardena Creek bee bed

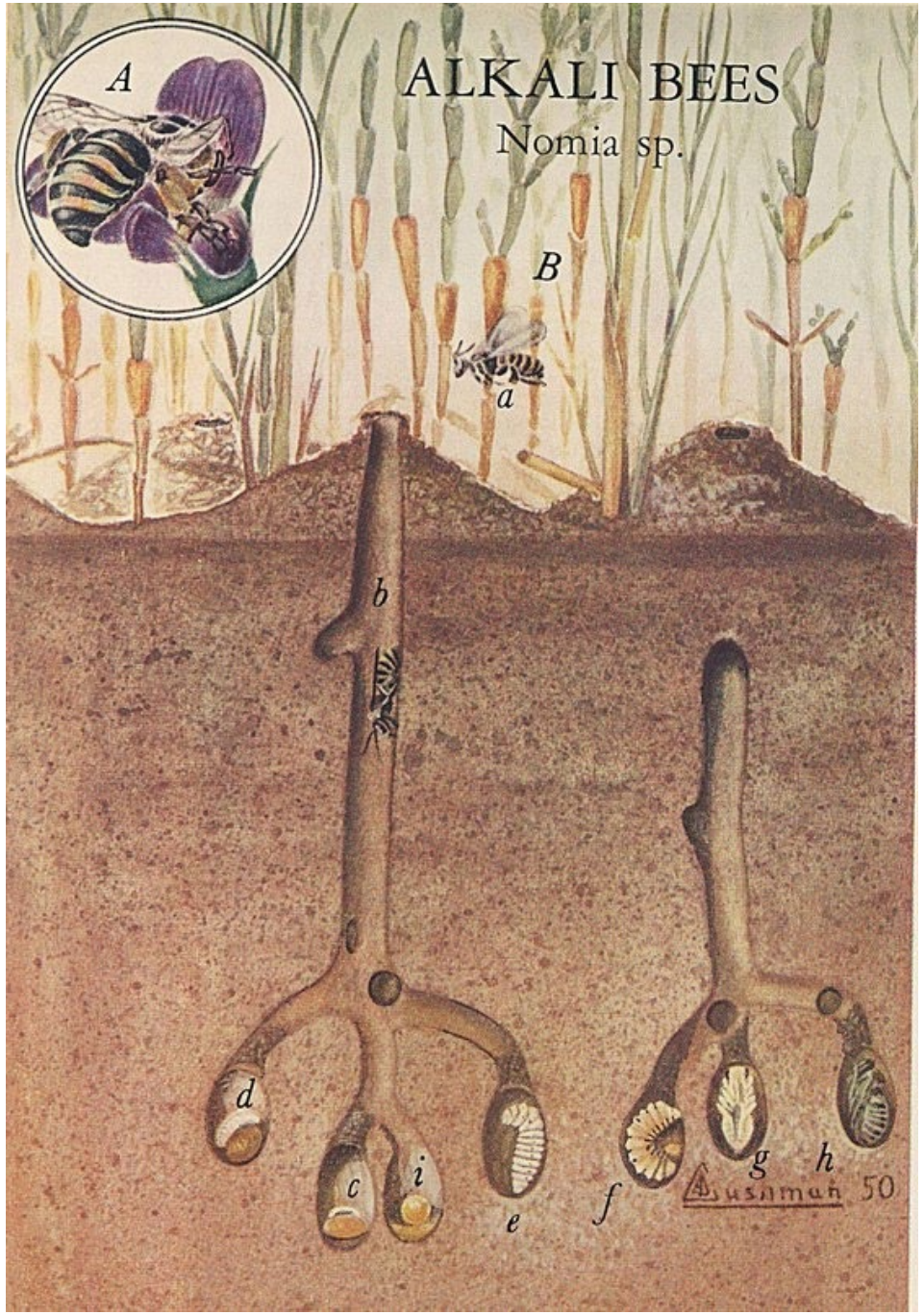
Other pathogens--

- AmFV– 4 out of 30 Nomia larvae
- Ascosphaera (chalkbrood fungus) – 4 out of 30 Nomia larvae
- **Microsporidia – 27 out of 30*** Nomia Larvae**

What is the significance of these results?

- AmFV– in other bee species, we have recently found that the AmFV virus is correlated with death of bumble bee colonies and larval death in Osmia lignaria
- In other bee species, data suggest that some species of microsporidia are linked with poor bee health
- Chalkbrood fungal infections can also kill bee larvae

- Infections of all of these pathogens may be worsened by sublethal impacts of pesticides and poor nutrition.
- *Future research--- analyze additional specimens and sequence the pathogens to determine how these in Nomia are related to other bee pathogens*



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