

Naturally selected *Varroa*-resistance behaviors in unmanaged survivor bees living in the Arnot Forest, NY, USA



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Apis mellifera →



← *Varroa destructor*

Many mite-resistance breeding
programs have sought to
maximize a perfect



“silver bullet”
mite-resistance trait
in their bees

Survivor bees



Figure 1. The global distribution of naturally occurring *Varroa* mite-surviving *A. mellifera* populations.

Arnot Forest



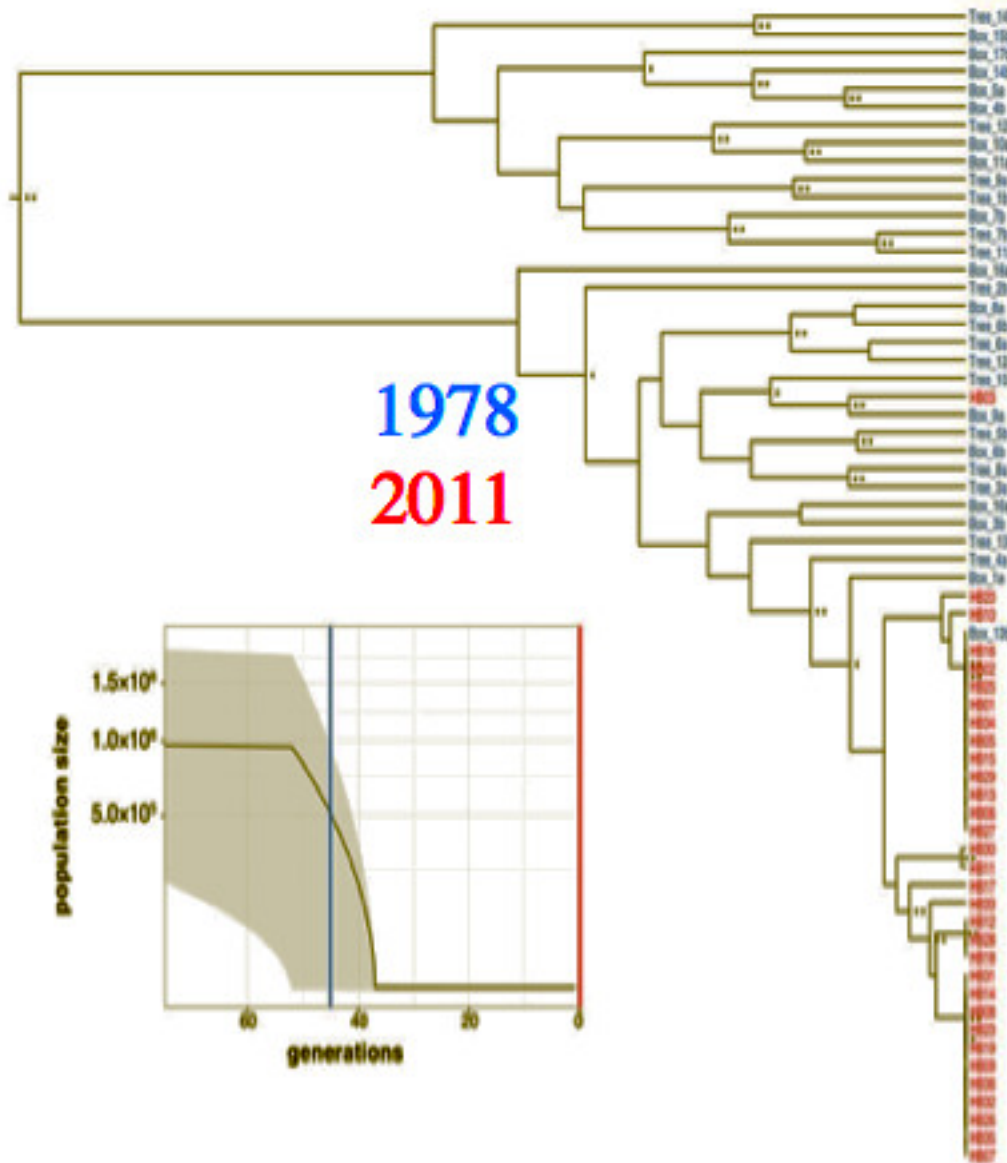


Arnot Forest Bees



- 1978, mapped bee trees in forest
- 1995, *Varroa* found in Cornell apiaries
- 2002, check the forest to confirm no bees...
...and finds bees!?
- 2002, same density of colonies in forest
- Swarms caught in the forest were infested with *Varroa*
- 2011, same density of colonies in forest

Genetic Continuity



Queen lineages
dropped from 23 to 3

No loss of genetic
diversity
(weakened colonies
still produced drones)

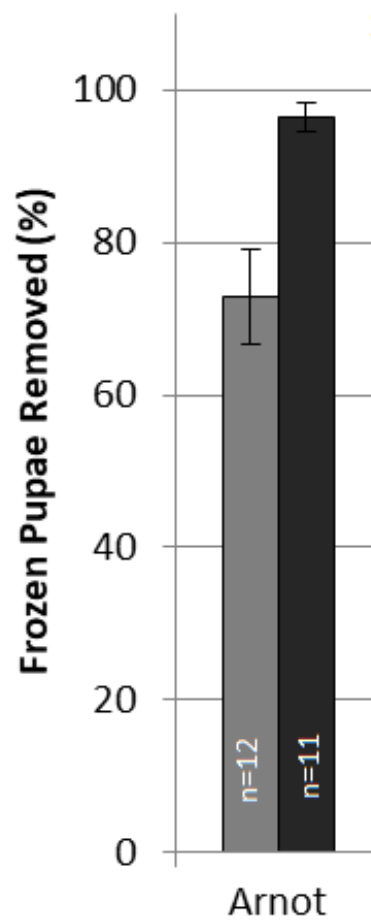


Studying the Arnot Bees



Hygienic Behavior: #1





Source Location: Arnot (NY)
Year Assayed: 2014-2016

■ 24hr ■ 48hr

Grooming Behavior: #2

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												

EXPERIMENT: _____ USDA-ARS BEE RESEARCH LAB (301) 354-8574
COMPOUND: _____ APIARY: _____ BEEKEEPER: _____
TREATMENT #: _____ HIVE #: _____ APPLICATOR: _____
FORMULATION: _____ DATE IN: _____ DATE OUT: _____
APP. RATE: _____ TIME IN: _____ TIME OUT: _____
TOTAL NUMBER OF MITES: _____

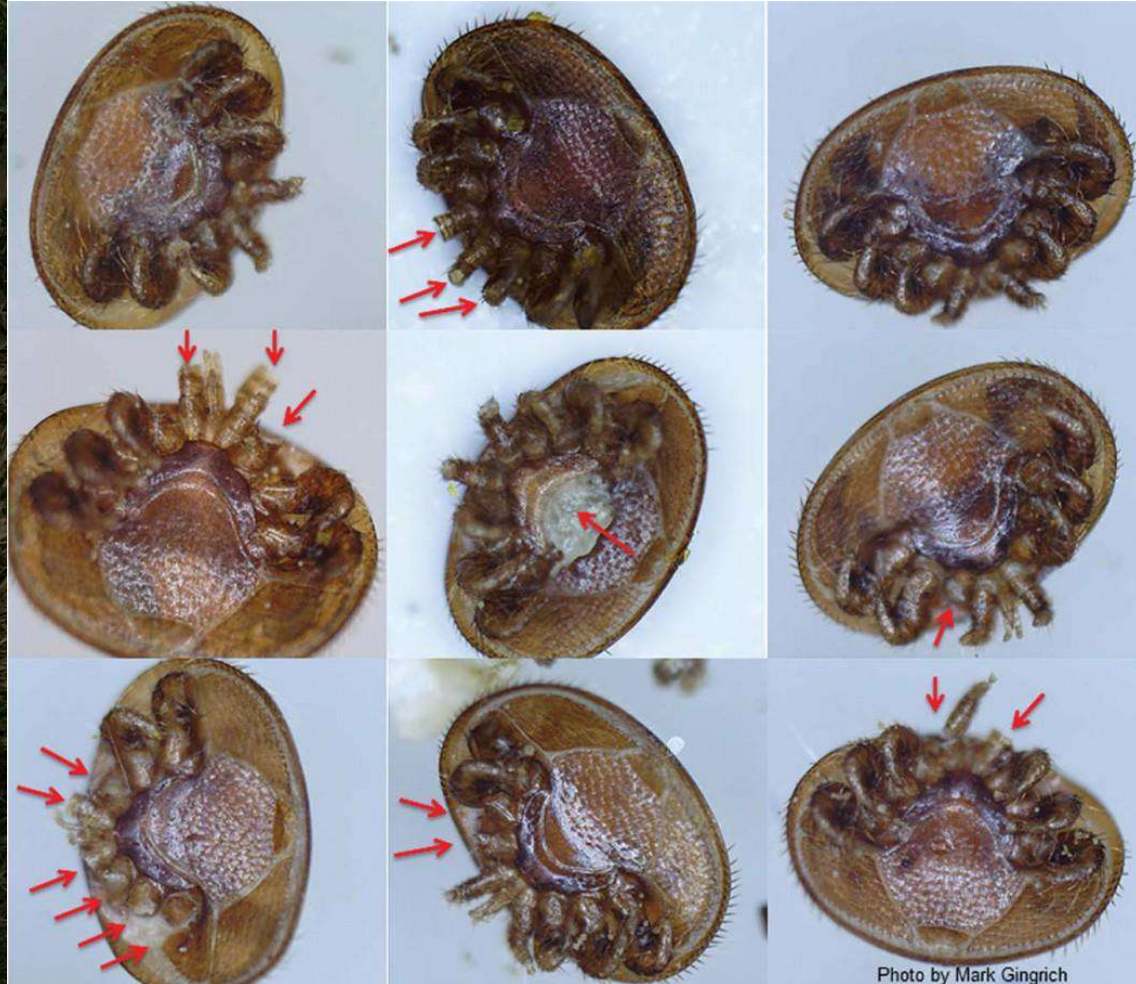
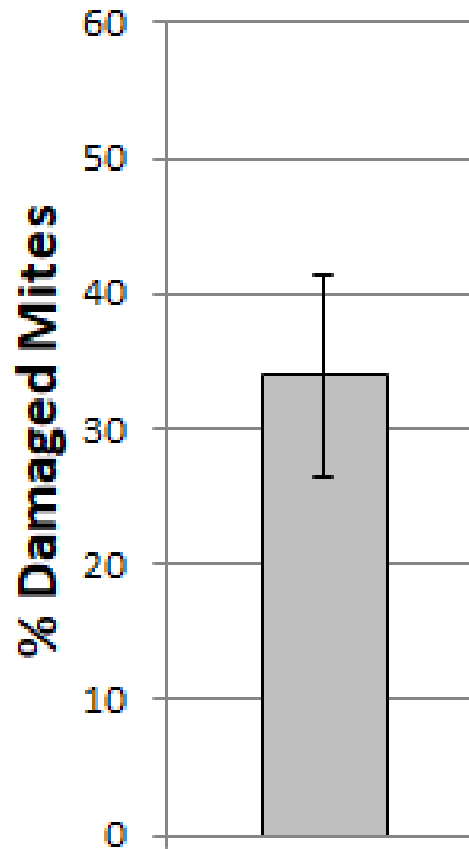


Photo by Mark Gingrich

Grooming



Arnot

n=8

Date assayed: 2016

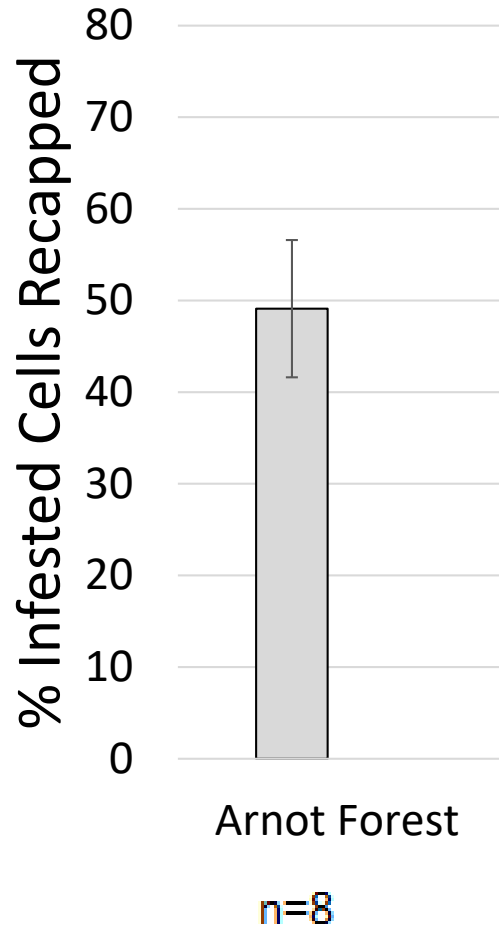
(Historical and present data
from Hunt et al. 2016)

Peck & Seeley, in prep

Uncapping/Recapping: #3



Uncapping/Recapping: #3



(Additional data from Oddie & Buchler et al. 2018)

Additional resistance traits exist!

- Small colony sizes and frequent swarming
 - We know the Arnot Forest bees are doing this
 - But I can't give away Tom's *entire* keynote talk
- Slightly reduced development time (?)

Summary Observations

Arnot Forest bees express multiple resistance traits

Arnot traits >> hypothesized ancestors

Arnot traits << breeding efforts can achieve

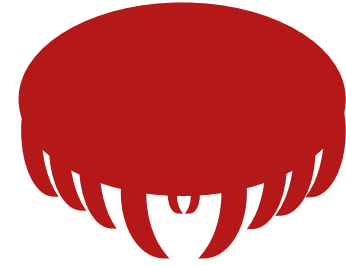
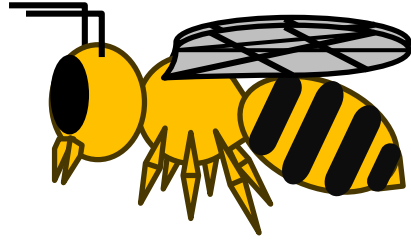
Why invest in multiple traits?

Why not just maximize “the best” trait?

Costs of expressing maximal resistance trait levels

Examples:

- Excessively hygienic bees may remove both diseased and healthy brood (Vandame et al. 2002)
- Grooming bees may invest excessive time and energy into vigorous grooming
- Too much uncapping and recapping may disrupt brood development, and occupies the time of the workers



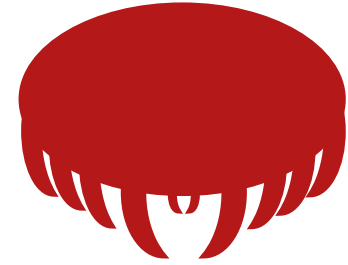
Just like with miticide resistance, mites that evolve to counter a single resistance trait will knock the bees back to square one

Varroa IPM calls for using multiple miticides to keep the mites on their “toes”

Bees seem to be using multiple resistance traits



Conclusions



- Arnot Forest bees survive with *Varroa* by expressing multiple resistance phenotypes at intermediate-high levels
- Bee breeding efforts should be cautious about seeking a single “silver bullet” resistance trait



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- The *Varroa* mite

