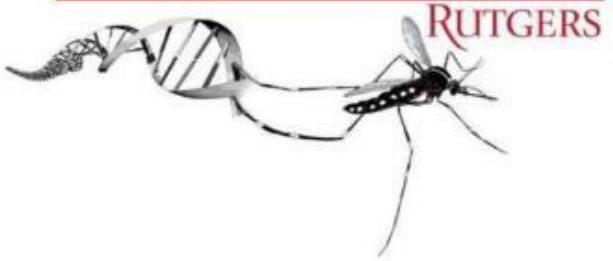
A Brief Tour of Vector-borne Diseases: Past, Present and (possibly) Future

James L. Occi MA, MS, PhD

Microbiologist
NJ Department of Health
Molecular Virology
james.occi@doh.nj.gov
and
Post-PhD Vagrant
Center for Vector Biology
Rutgers University
James.occi@rutgers.edu

NJ Health
New Jersey Department of Health

Center for
VECTOR BIOLOGY
RUTGERS



Tick Biology 101

Arachnids (8 legs)

~900+ species in three families
- Ixodidae-hard (742 spp)
- Argasidae-soft (193 spp)
- Nuttalliellidae (1 sp)

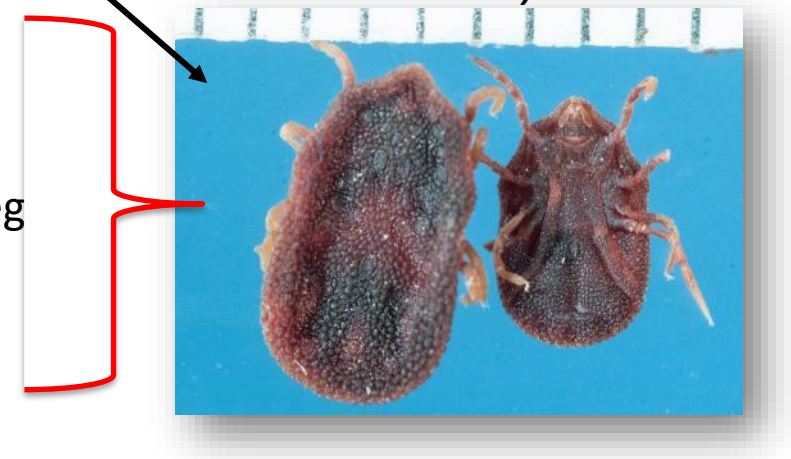
Obligate blood-feeding ectoparasites

Fast feeders (minutes, < 2 hr)
Multiple feeds per stage
Lay multiple small batches of eg
Live for years (some decades)

Vectors of pathogenic microbes

Dermacentor variabilis

Carios kelleyi

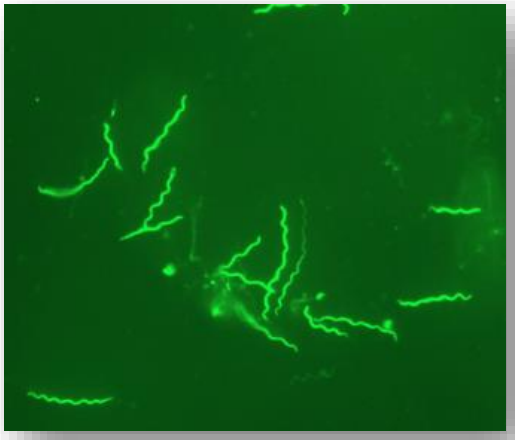


Vector-borne Disease-The Basics

1. Pathogen: bacterium, virus, protozoan etc.
2. Vector: flea, mosquito, louse, tick, mite etc.
3. Reservoir: rodent, human etc.
4. Proper biotic and abiotic factors.

Lyme Disease:

Borrelia burgdorferi

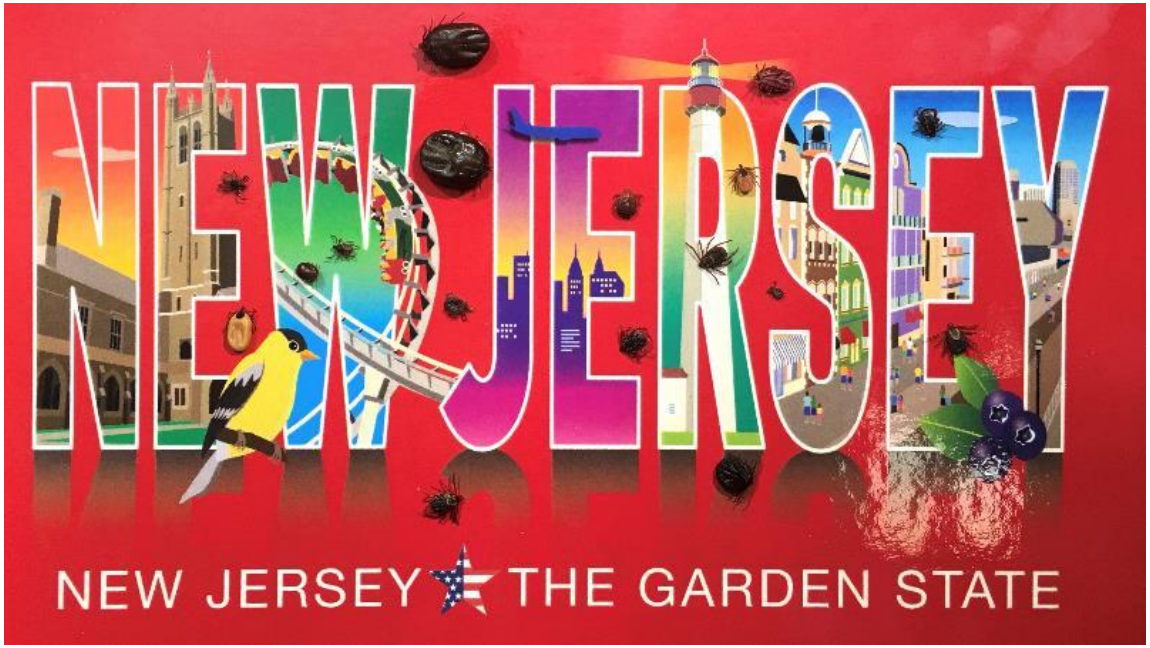


Ixodes scapularis (nymph)

Peromyscus leucopus

2019 Tick-borne Diseases in the US and NJ

Disease	US Cases	New Jersey
Lyme Disease	34,945	3,587
Anaplasma/Ehrlichiosis	7,967	284
Spotted Fever Rickettsiosis	5,544	208
Babesiosis	2160	236
Powassan virus	21	4
Total	50,637	4,319



https://www.cdc.gov/ticks/data-summary/index.html

https://www.nj.gov/health/cd/statistics/arboviral-stats/

New Jersey's Burden of Five Tick-borne Diseases 2016-2019 (NJDOH)

Lyme Disease	**13,461**
Babesiosis	**852**
Anaplasmosis	**523**

Blacklegged tick

Ehrlichiosis	**440**

Lone star tick

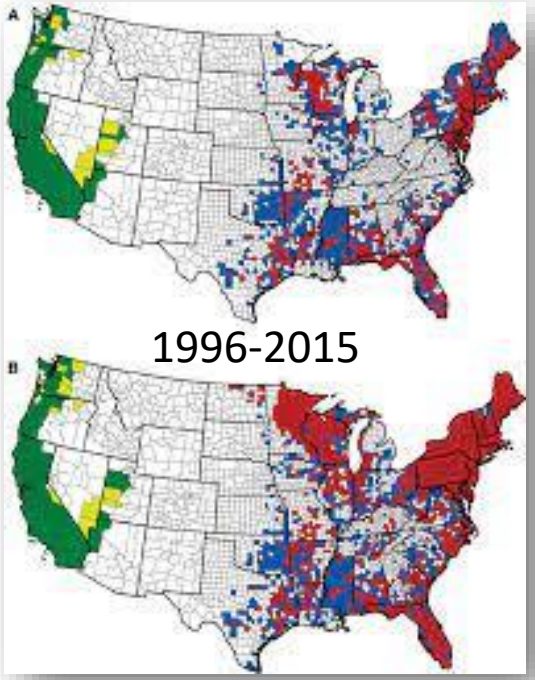
SFR ("RMSF")	**557**

American dog tick

Reasons for Increases

(1) Geographical expansion of indigenous ticks and their pathogens

Ixodes scapularis



Gulf coast tick
Amblyomma maculatum

(2) Introduction of invasive tick species

Asian longhorned tick, *Haemaphysalis longicornis*
2017

Reasons cont…

(3) Changes in land use

Native forests→ farms→ suburb/forest regrowth

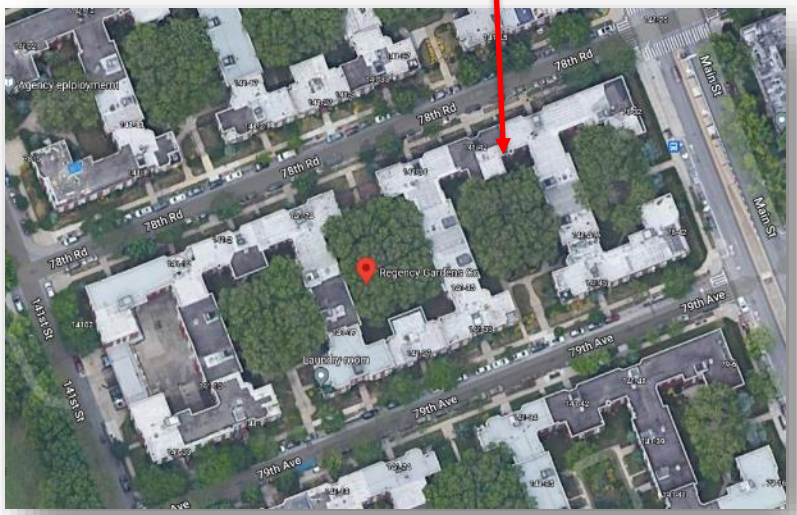
(deer) (no deer) (more deer than ever)

(4) Climate change ?

(5) Sometimes we have no clue ?

1946: Kew Gardens, Queens, Regency Park Apts

Unit 141-12 78th Ave



Residents of housing complex (no age, sex disparity).

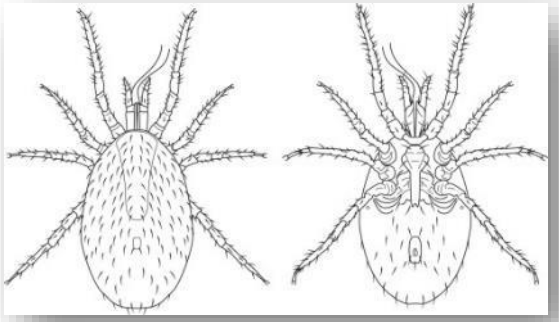
Chief complaints: fever, rash and eschar.

Described as “atypical chickenpox”

When?: 124 cases - January thru October.

Epidemiological Studies

- Entomological surveys: mosquitoes
- A few dogs with fleas
- A few American dog ticks
- All affected households - mice (*Mus musculus*).
- Mites in the immediate areas crawling up the walls-some engorged



-a rickettsial agent was recovered from blood one patient
-this agent reacted with sera from this and other patients.

Rickettsialpox

aka Kew Gardens Fever

(Greenberg et al 1947 AmJPubH 37:860)

House (Hugh Laurie) puts his life in danger to treat a patient (guest star Aaron Refyem) in the "A Pox on Our House" episode of HOUSE airing Monday, Nov. 15 (8:00-9:00 PM ET/PT) on FOX.

Credit: Patrick Wymore/FOX

- Pathogen: *Rickettsia akari.*
- Vector: house mouse mite, *Liponyssoides sanguineus.*
- *Reservoir: house mouse, Mus musculus.*

Proper Conditions:

- Budget cutbacks precluded daily use of the incinerators.
- Kitchen scraps etc. accumulated, affording food source for mice.

Rocky Mountain Spotted Fever

Late 1800s Bitterroot Valley

Vector: American dog tick, *Dermacentor variabilis*

Pathogen: *Rickettsia rickettsii* (most virulent of the ~20 SFGR)

Reservoir(s) *Dermacentor variabilis* and rodents?

The Disease:

Currently 5-10% fatality rate…unless misidentified/misdiagnosed (40-80% depending on study)

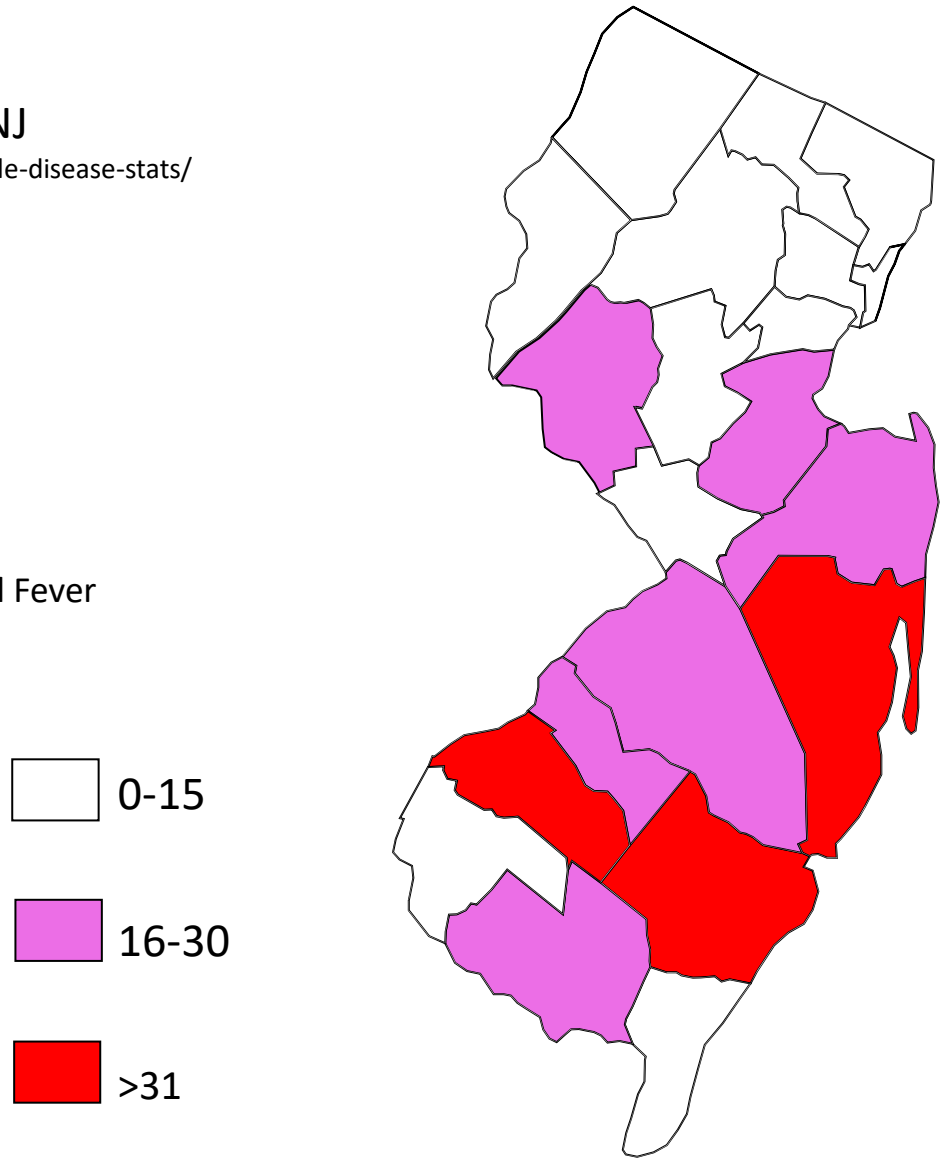
Rocky Mountain Spotted Fever in NJ?

Spotted Fever Rickettsiosis in NJ

https://www.nj.gov/health/cd/statistics/reportable-disease-stats/

Year	Cases
2020	35
2019	209
2018	147
2017	137
2016*	64

*STILL CALLED Rocky Mountain Spotted Fever



Transmission of *Rickettsia rickettsii* primarily by two species of tick in the US…

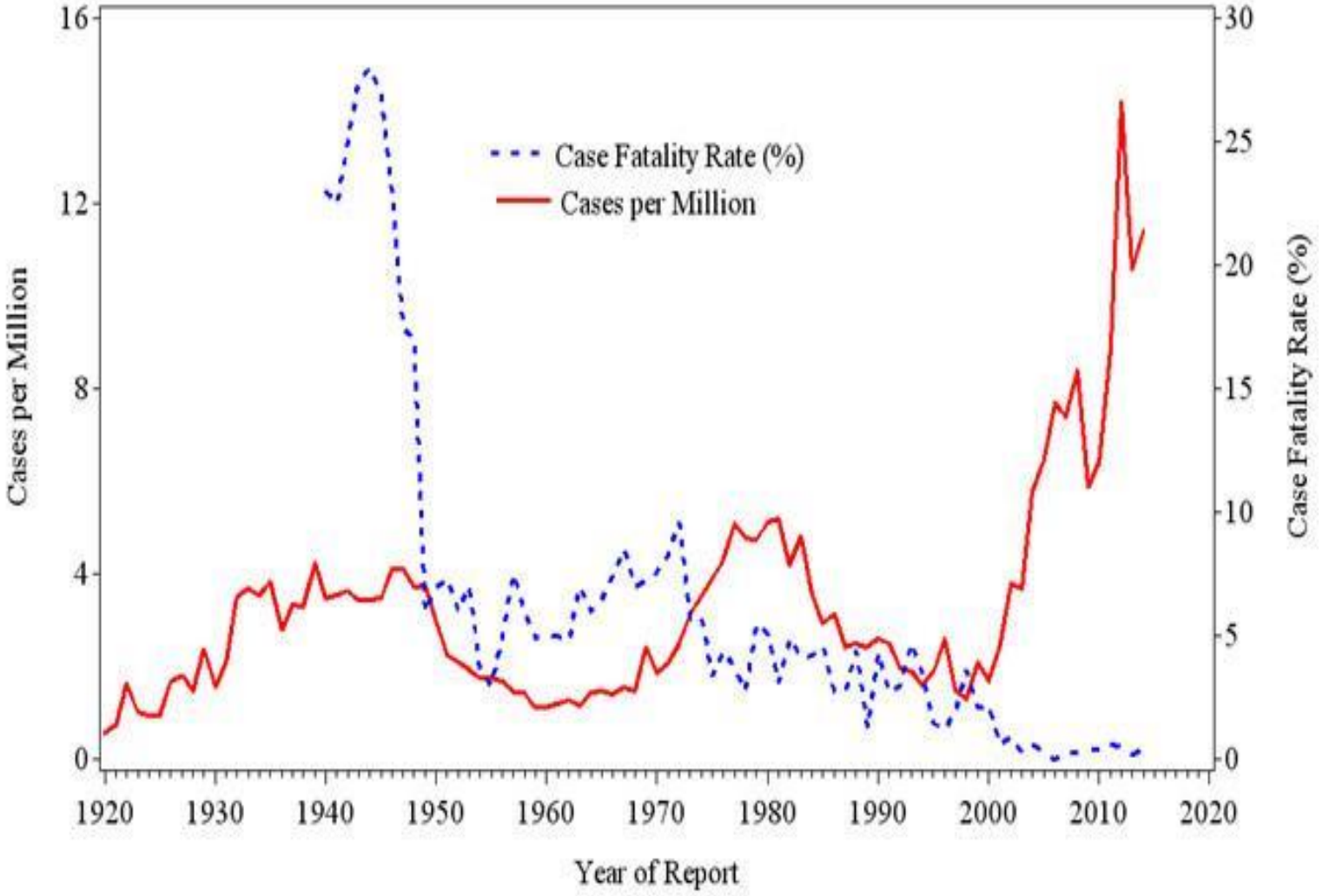

American dog tick, *Dermacentor variabilis*


Brown dog tick, *Rhipicephalus sanguineus*

…and sometimes by species of *Amblyomma*


Amblyomma americanum

Changing Epidemiology of RMSF



www.cdc.gov/rmsf

Studies on spotted fever *Rickettsia* in *Dermacentor variabilis*

(east of the Mississippi since 2004)

State/Region	# *D. variabilis*	% *R. montanensis*	% *R. rickettsii*
Maryland	***392***	***4%***	***0***
Mid-Atlantic states	**1,400**	***3.8%***	***0.7%***
Virginia	***2,396***	***0.85%***	***0***
Tennessee	***2,515***	***1.2%****	***0***
North Carolina	**532**	**53%**	**0.9%**

*mostly = at very low prevalence, *R. parkeri*, *R. amblyommatis* were identified.

Ammerman et al 2004, Stromdahl et al 2011, Henning et al 2014, Trout-Fryxell et al 2017, Kakumanu et al 2018

Do New Jersey's Ticks Carry SFGR?

Dermacentor variabilis

No. Tested = 954

R. montanensis 1.3%
and no *R. rickettsii*

Amblyomma americanum

No. Tested = 245

R. amblyommatis 20%
and no *R. rickettsii***

** Egizi et al found 1 out of 1,858 *A. americanum* pos for *R. rickettsii*

Getting to the cause(s) of SFR

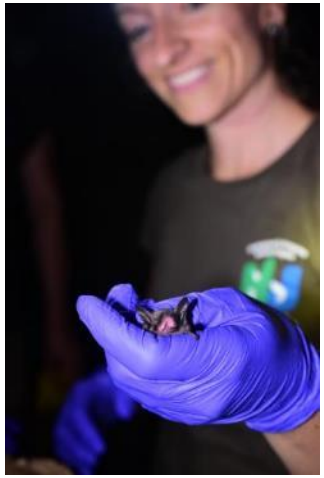
Blood work: PCR and sequencing (not serology) from active cases

Ticks feeding from suspected cases of SFR

Tick surveillance

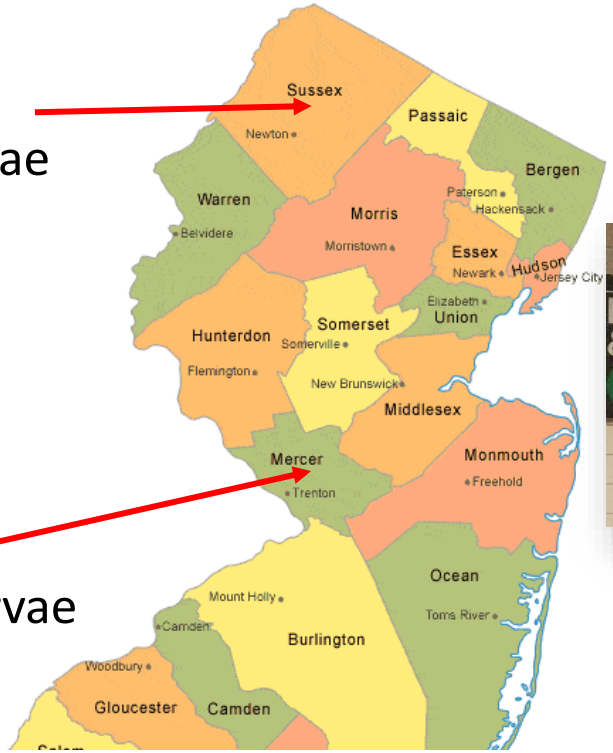
Animal surveillance !!!

Do we have *Carios kelleyi* in New Jersey?



3 *C. kelleyi* larvae

12 *C. kelleyi* larvae



Summary

1. We confirmed the first *Carios kelleyi* in New Jersey bats.
2. We submitted vouchers specimens to the Yale Peabody Museum
3. And the first *C. kelleyi cox1* sequences to GenBank.

First Record of *Carios kelleyi* (Acari: Ixodida: Argasidae) in New Jersey, United States and Implications for Public Health

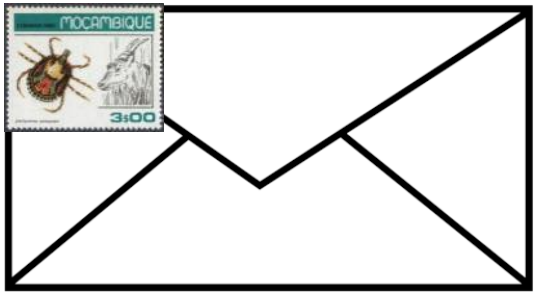
James L. Occi,[1,6] MacKenzie Hall,[2] Andrea M. Egizi,[1,3] Richard G. Robbins,[4,5] and Dina M. Fonseca[1]

We have bat ticks, now what?

Engorged *Carios kelleyi* larvae on back of hand with dime.

Methods:

1-send “tick kits” to bat researchers in northeastern US…



2-collected ticks from bat roosts

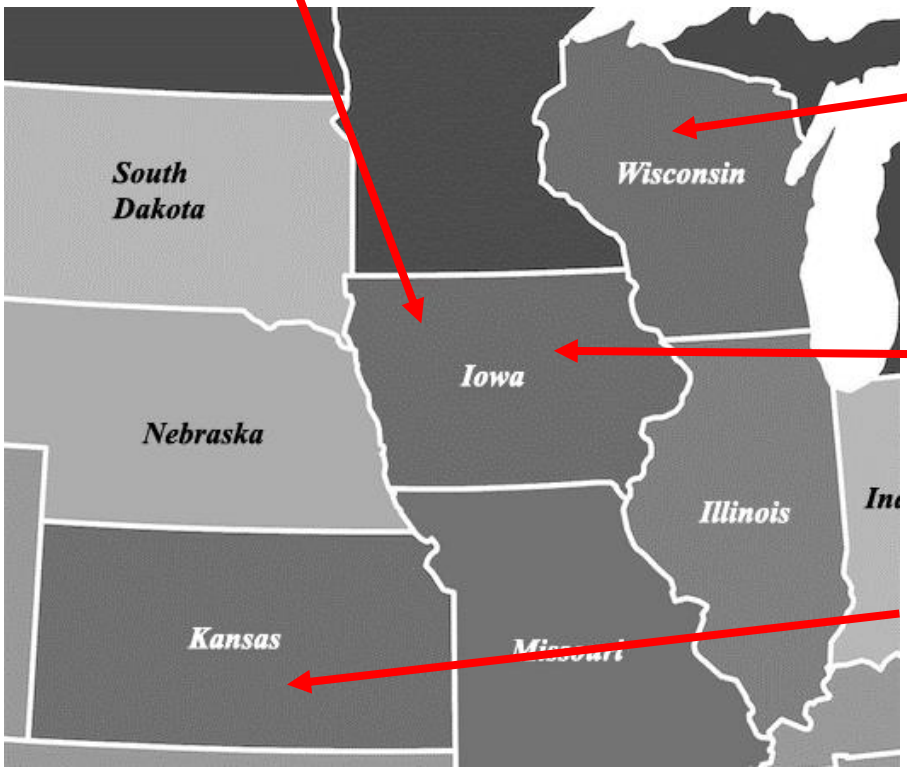
3-PCR ticks for spotted fever group *Rickettsia* (SFGR) and relapsing fever *Borrelia* (RFB)

4-DNA sequence of targets from a subset of positive ticks.

Public Health Issues: Soft ticks are known disease vectors. *Carios kelleyi*????

90% nymphs, adults (+) *Rickettsia* spp.

3.1% nymphs (+) *Borrelia johnsonii* (Loftis et al. 2005)



PCR screen of patients (~5000) with history of TBD, one Wisconsin resident PCR + *Borrelia johnsonii* (Kingry et al 2018).

45% nymphs (+) *B. johnsonii* (Gill et al 2008)

Kansas: - 66% nymphs, adults (+) *Rickettsia* spp. (Nadolny et al. 2021)

In the “field”…

A) MacKenzie Hall setting up CO_2 traps in bat guano.

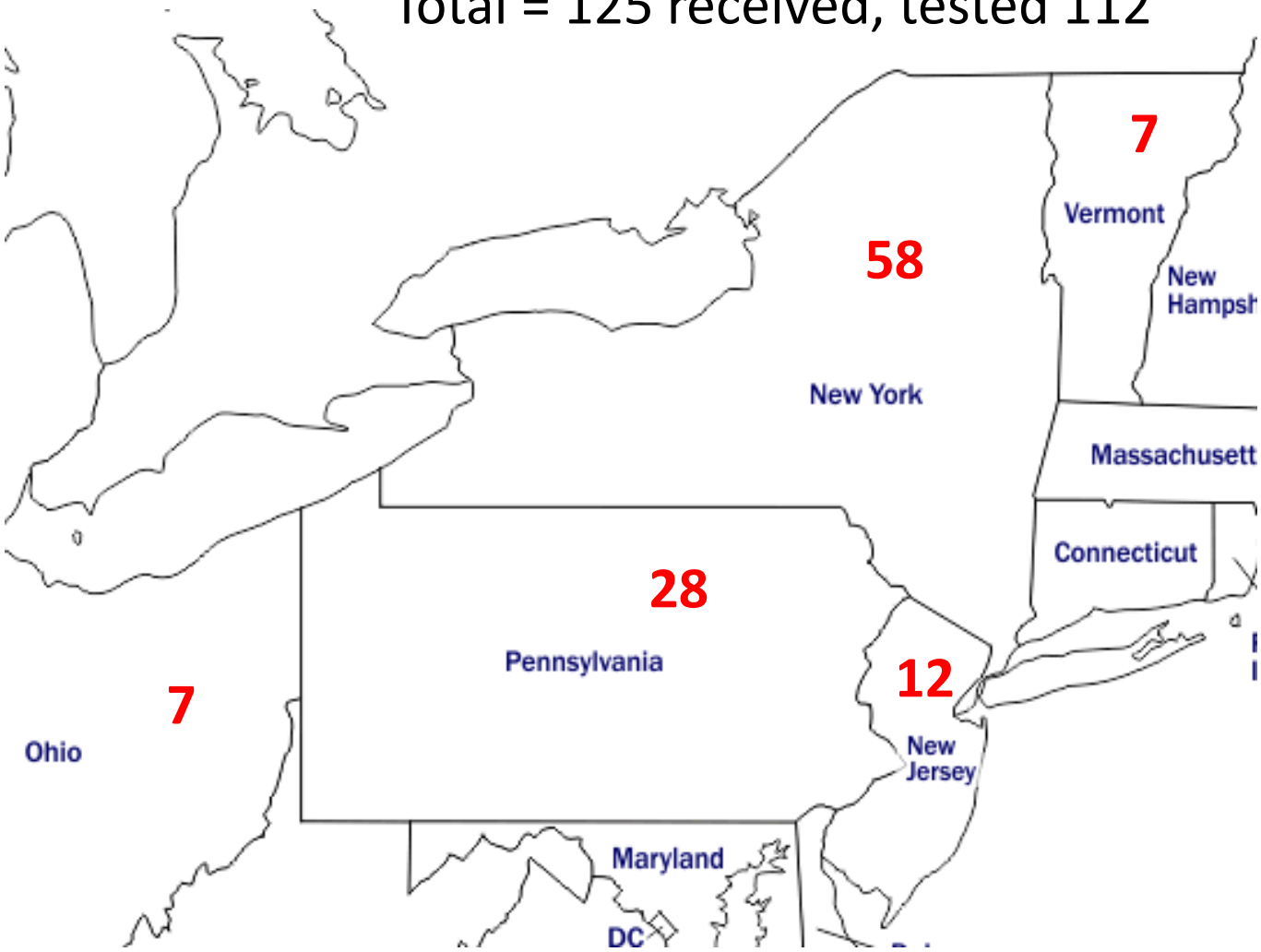
B) Big brown bats, *Eptesicus fuscus*

C) Adult *Carios kelleyi* wrestling

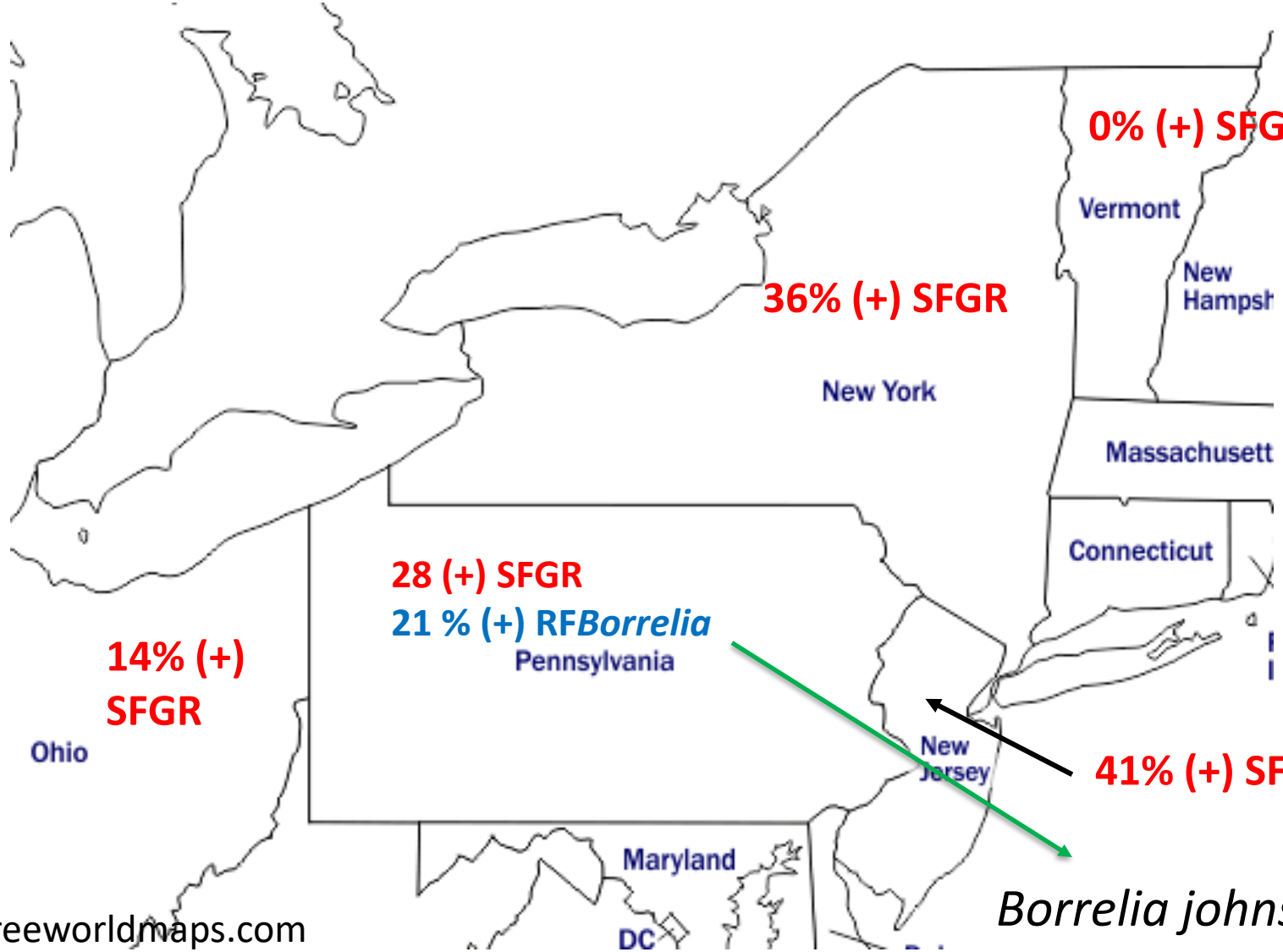
D) Larval *C. kelleyi* on bat guano

Results: *Carios kelleyi* received from each state

Total = 125 received, tested 112



Percentage of *Carios kelleyi* positive for Spotted Fever Group *Rickettsia* and Relapsing Fever *Borrelia*



www.freeworldmaps.com

Attacking the Tick Problem

Area-wide tick Control?

…and landscape management around the home

Personal Protection

1. Skin protection such as DEET, Lemon-eucalyptis oil, Picairdin.

2. Permethrin products such as Duranon® and Permanone® (ON CLOTHING ONLY).

3. Tuck Pants into socks.

4. Tick check.

Acknowledgments

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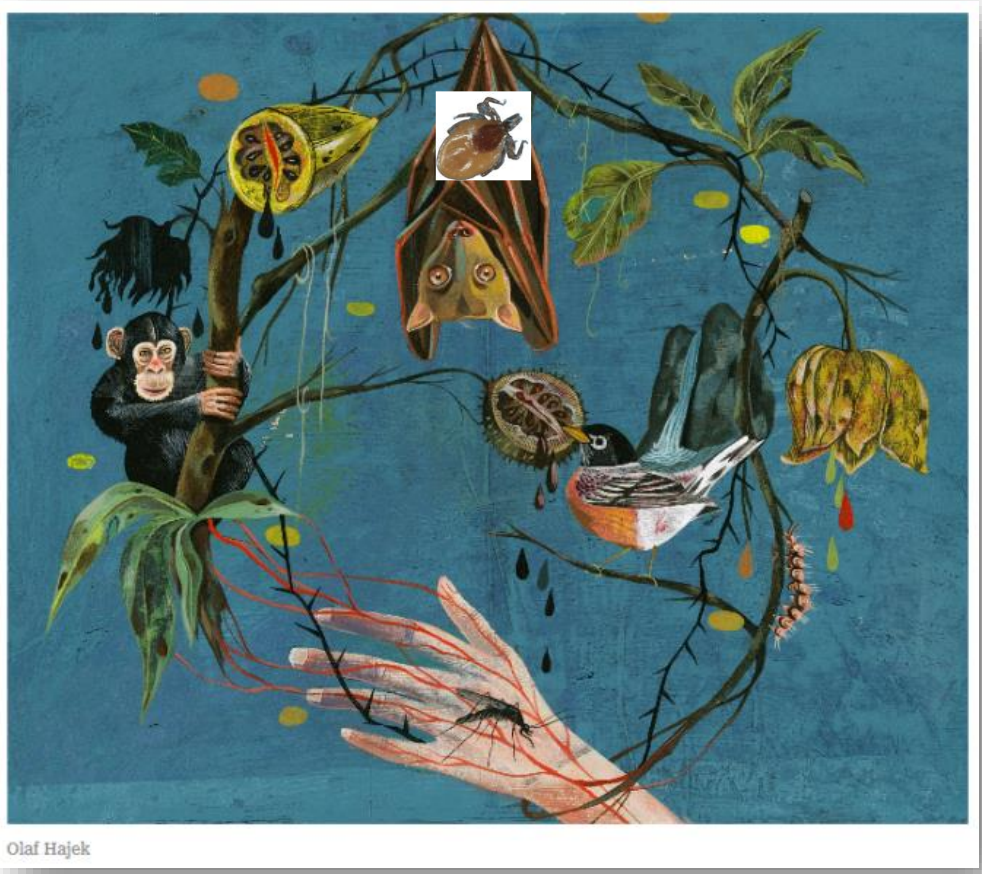
NJDOH-PHEL



Bat Tick Network:
Mackenzie Hall - NJDEP-F&W
Victoria Campbell - Wild Things Sanctuary
Steph Stronsick - PA Bat Rescue
Risa Pesapane - Ohio State
Cheryl Sullivan - UVM

Questions ?

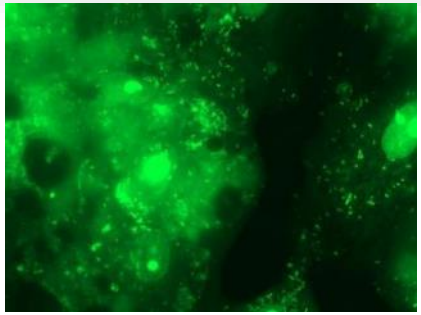
Extra slides

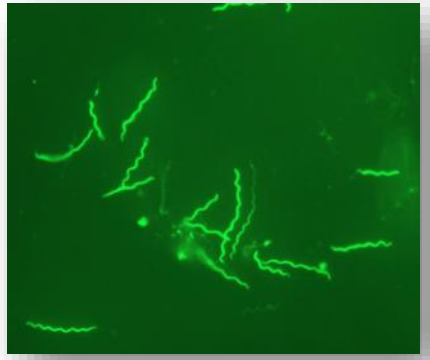
The first case of *Ixodes scapularis*
(blacklegged tick) feeding on bats in the north America.

Ixodes scapularis (Ixodida: Ixodidae) Parasitizing an Unlikely Host: Big Brown Bats, *Eptesicus fuscus* (Chiroptera: Vespertilionidae), in New York State, USA

James L. Occi,[1] Victoria M. Campbell,[2] Dina M. Fonseca,[1,5] and Richard G. Robbins[3,4]

Summary





What to do???

Tuck pants into socks
I
CKS

BLAST results of Concatenated sequences of *glp*Q, 16s rRNA and *fla*B of Relapsing Fever *Borrelia* isolate from *Carios kelleyi* from Pennsylvania