Public Tick IPM Working Group  
January 9th, 2019

Please send additions, omissions or other corrections to neisner@ipminstitute.org

The Working Group meets via conference call on the second Wednesday of each month at 1:00PM CT (2:00PM EST). The following notes are for January 9th, 2019

Roll
1. Gloria Kim, Limiting Lyme
2. Brittany Campbell, Pest World
3. Chris Stelzig, Entomology Society of America
4. Maria Diuk-Wasser, Columbia University
5. Kirby Stafford, Connecticut Agricultural Experimental Station
6. William Nicholson, CDC
7. Kristin Garafalo, Dept of Health, New Jersey
8. Alicia Cashman, Madison Area Lyme Disease Support Group
9. Andrew Rosendale, Mount St. Joseph University
10. Julian Cooper, IPM Institute
11. Bob Maurais, Mainely Ticks
12. Rayda Krell, Western Connecticut
13. Mason Kauffman, Dutchess County
14. Jill Auerbach, Hudson Valley Lyme Disease Association
15. Michael Mrozinski, Pike County Office of Community Planning
17. Kyndall Dye, Harris County Public Health
18. Joellen Marie Lampman, Cornell
19. Monica White, Colorado Tick-Borne Disease Awareness Association

Agenda
1. Presentation by Andrew Rosendale
2. Additional updates, comments and announcements from Working Group members

A recording of this call is available by visiting this link:
https://global.gotomeeting.com/play/recording/aa71d843170e195383e42bc447addfbe5012b441f5dd815af446f47f7241c8a2

Presentation, Dr. Andrew Rosendale
1) Introduction
   a) Dr. Andrew Rosendale is an assistant professor at Mount St. Joseph University. His current research focuses on understanding how climate change may impact the distribution of vectors and the diseases they carry, identifying novel and effective ways of controlling pest insects, and surveying the ticks and tick-borne diseases in the Cincinnati area.
2) Presentation: What Bugs Ticks? Physiological and molecular responses to stress in ixodid ticks
a) Interested in environmental and physiological stressors when ticks are off the host. How do ticks survive extreme temps? Dehydration? Starvation?
b) In Cincinnati looking mostly at American Dog Tick *Dermacentor variabilis*
c) Interested in range expansion of ticks, ex. Gulf coast tick *Amblyomma maculatum* species distribution is changing but we don’t know enough about biology or physiology to understand how far north this species can travel.
   i) American dog tick
      (1) Vector: Rocky Mountain Spotted Fever, Tularemia, Ehrlichiosis
d) Ecophysiology of ticks
   i) Methods: At molecular level, responses of ticks to stressors. Use lab reared ticks, focus on adult life stage. Lab ticks allow for control of many different variables.
      (1) Receive engorged nymphs from Oklahoma state for experiments
      (2) Example experiment: dehydration treatment exposing ticks to 0% compared to 93% humidity
      (3) Use RNA seq, get full transcriptome, basic physiology, metabolic profiles, etc.
         (a) Can get robust readout of gene expression and see 497 differentially expressed genes but challenging because don’t have entire genome of the dog tick.
         (b) Findings: many pathways for breakdown of protein suggest ticks increase breakdown of protein
         (c) Dehydration increases protein breakdown
         (d) Dehydrated ricks show increased levels of activity
            (i) Potentially looking for humid location to restore water balance.
         (e) Dehydration energetics
            (i) Dehydration increases metabolic rate
            (ii) Dehydration reduces protein and lipid levels
               1. Most insects and arthropods conserve energy to avoid excess water loss.
               2. Extreme dehydration is “metabolically expensive”
      (4) What happens to ticks at different stages of dehydration?
         1. Starved ticks have higher water loss rates
         2. Starved ticks show reduced survival of dehydration
      (5) Dehydration Summary
         1. Biochemical and molecular responses to dehydration likely improve tolerance of dehydration.
         2. Mechanisms for recovery from dehydration is a major component of response.
         1. Adequate energy reserves are critical for survival.
   ii) Starvation Tolerance in Ticks
      (i) Mosquitos can go a few days, bed bugs a few months. Ticks can go several months to several years between bloodmeals. Want to understand how.
      1. Methods: RNA seq and basic physiology, behavioral assays
      2. Energetics:
         a. Starvation reduces energy reserves
            i. Lipid and glycogen quickly reduced
            ii. Protein catabolism with prolonged starvation
         b. Metabolic rate:
i. Overall low metabolic rate. Surprisingly went up with starvation. Ticks may be turning things “on” in an effort to more actively find their next host.

ii. RNA seq data shows that in starvation there are many changes in gene expression throughout the starvation process.

iii. One interesting trend is many of the changes occur within the first 12 weeks.

iv. Slight increase in O$_2$ consumptions with starvation

(b) Energetic pathways:

i. Many changes related to energetics, lipase activity, etc.

ii. Surprisingly DNA replication, transcription, translation were turned on

iii. May be trying harder to find next host

(c) Autophagy

i. General increase in autophagy-related genes as starvation progressed

(d) Behavior

i. Increased activity and host-seeking behavior in starved ticks.

ii. Almost aggressive seeming behavior.

iii. Used activity monitor to quantify this effect.

iv. Stimulated by host cues (weighing tick)

v. Question assay: observed that starved ticks would assume position more quickly.

(e) Chemoreceptors

i. No change in gustatory receptors

ii. Ionotropic receptors increased expression

(f) Preparation for feeding

i. Immune response: 205 upregulated genes

(g) Salivary gland proteins

(2) Starvation conclusions:

a. Starvation tolerance:

i. Canonical process of consuming lipid first and then protein reserves.

ii. Inherently low metabolism adequate for survival.

iii. Increase in activity and host-seeking behavior.

b. Starvation resistance is likely a critical factor for how ticks respond to climate change

i. Relationship between nutrient reserve and environmental conditions

ii. Important epidemiological considerations

(3) Thermal stress

1. Dog tick larvae survive low temperatures.

2. Multiple adaptive responses to improve cold hardiness.

3. Freeze-intolerant.

4. Is there any relationship between species distribution and thermal characteristics?

a. Most variation in low temp survival

b. Thermal optimum 30-40 degrees C for activity and metabolic rate, 20 degrees C preferred.

(4) Future Directions:
1. Pesticides: permethrin. Want a better understand of how efficacy of pesticides is influenced by dehydration, etc.

(5) Questions:
   (i) How do changes in land use effect tick distribution?
   1. Dr. Rosendale: Short answer, we really don’t know but I would guess it is more than one factor. Perhaps a combo of climate change and land use. Likely species dependent. With the gulf coast tick, I find them in the field, but that land use has not changed recently, so I don’t think that would be a huge contributor for that species. Since it is a historically southern species, I would guess that a movement North would be due to warmer temperatures. I am now comparing survivorship between dog tick and gulf coast tick to see the difference.

These notes are for a Working Group call on January 9th, 2019. Future calls will continue to fall on the second Wednesday of each month at 1 PM Central time.

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