Rocky Mountain Spotted Fever: Tick Biology and Control

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Overview

• Summarize tick biology and the role of ticks as disease vectors

• *Rhipicephalus sanguineus* as a vector for spotted fever group rickettsiae

• Environmental and behavioral measures for prevention, management, and control of ticks and RMSF
Introduction to Tick Biology

• Over 850 species worldwide, approximately 80 in the United States
  – 25 species in Arizona
• Divided into three families
  – Ixodidae (hard ticks)
  – Argasidae (soft ticks)
  – Nuttalliellidae (“primitive” ticks)
• Approximately 12 species are of public health or veterinary interest in the US
  – Four known to be of public health concern in Arizona
Generalized Tick Life Cycle

- **Eggs**: Hatch
- **Larva**: Feed, Develop, Molt
- **Nymph**: Feed, Develop, Molt
- **Adult**: Feed, Develop, Lay Eggs
Pathogen Transmission in Tick Populations

- **Transovarial transmission**: transfer from one generation to the next through the egg
  - Spotted fever group rickettsiae
  - Tick-borne encephalitis virus
  - Colorado tick fever virus

- **Transstadial transmission**: transfer from one life stage to the next through blood meals
  - Lyme borreliae
  - Ehrlichia organisms
  - Anaplasma organisms
  - Babesia parasites
Generalized Tick Life Cycle

- **Eggs**
  - **Transovarial**
  - **Acquisition, Transstadiadial or Delivery**

- **Larva**
  - **Acquisition, Transstadiadial, or Delivery**

- **Nymph**
  - **Acquisition, Transstadiadial or Delivery**

- **Adult**
  - **Acquisition or Delivery**
Blood Feeding Strategies

• Soft ticks attach for longer periods as larvae, but then use a feed-and-hide strategy (feed time <= 30 minutes)
  – Spend most of their life cycle off host
• Ixodid ticks attach strongly for longer periods (multiple days)
  – Can need from one to three hosts to complete life-cycle
• Vary from host specific feeding to feeding on a wide array of vertebrate species
• Feeding strategy effects disease transmission
Survival Time Between Feedings

• Soft ticks:
  – Larvae: Need to feed immediately to transform to nymphal stages
  – Nymphs: Need to feed within days-weeks to move between nymphal instars (up to 8) and adult
  – Adults: Can survive years between blood meals

• Ixodid ticks:
  – Larvae: 1 month – 15 months
  – Nymphs: 4 months – 20 months
  – Adults: 4 months – 30+ months
Ecologic Needs for Tick Survival

- Correct humidity
- Temperature
- Available hosts
- Hiding spots for molting and egg laying
- Predation
- Natural diseases
- Pathogen induced mortality
Ticks and tickborne diseases are seasonally distributed

Peak of disease activity corresponds with peak of tick activity
(especially the life stages most important for transmission)
RMSF Vectors
The Primary U.S. Tick Vectors of RMSF

*Dermacentor variabilis*
American dog tick

*Dermacentor andersoni*
Rocky Mountain wood tick

Photos and maps courtesy of CDC
### Dermacentor variabilis  
**American dog tick**

- Three host tick
- Dogs are preferred hosts, but also feed large mammals (deer, cattle, raccoon, humans, etc.) as adults
- Feed on small mammals (mice, squirrels, chipmunks, etc.) as nymphs/larvae
- Prefers wooded, shrubby, long grasses
- Susceptible to desiccation in high temperatures/low humidity

### Dermacentor andersoni  
**Rocky Mountain wood tick**

- Three host tick
- No preferred host. Feed on large mammals (deer, cattle, sheep, humans, etc.) as adults.
- Feed on small mammals (ground squirrels, chipmunks, etc.) as nymphs/larvae
- Brushy vegetation that attracts small mammals
- Larvae prefer cool soil and high relative humidity
The Primary Arizona Tick Vector of RMSF

*Rhipicephalus sanguineus*
Brown dog tick

Photos and maps courtesy of CDC
Rhipicephalus sanguineus
Brown Dog Tick

- Three host tick – needs 3 feedings to complete lifecycle
- Primarily feeds on dogs in all life stages
  - Humans and other species are incidental hosts
- Requires a dog to find a mate
- Can live in a variety of climates
- Good survival rates with low humidity and high temperatures (33% survival at 50° C – Yoder et al, 2006)
- Peridomestic – capable of living indoor and outdoor
Brown Dog Ticks in the Human Environment

Photos courtesy of CDC and “Biology and ecology of the brown dog tick Rhipicephalus sanguineus” Filipe Dantas-Torres [link](http://www.parasitesandvectors.com/content/pdf/1756-3305-3-26.pdf)
**Rhipicephalus sanguineus**
Brown Dog Tick

- Transovarial transmission of RMSF
- Ticks are the primary hosts of *Riccesttsia rickesttsii* and transmit to their offspring
- Animals play minimal role as reservoir
  - Spirochete unlikely to transmit from hosts because it is an intracellular pathogen
- Capable of laying up to 4000 eggs
- Can complete life cycle in as little as 93 days if hosts available and environmental conditions are favorable
The Role of Dogs in RMSF

- Dogs cannot transmit RMSF, but they are preferred host.
- Dogs develop RMSF and can die from disease.
- Recovered dogs are immune to reinfection.
- Free-roaming dogs spread ticks into nearby homes and yards.
- New puppies (especially sick ones) may increase the number of infected ticks due to higher probability of having circulating rickettsiae in blood.
The Role of Dogs in RMSF

• Seropositivity in dogs and human risk
  — In general, no human cases have occurred in communities where canine seropositivity is ~5%
  — Human cases observed in communities where canine seropositivity is >50%
  — Threshold for human cases somewhere in between
  — Canine seropositivity has been observed prior to first reported human cases in some reservations
Prevention of RMSF
Personal Prevention

• Proper use of EPA approved products

• Skin Applications
  – DEET (20%+)
  – Picaridin
  – Oil of Eucalyptus
  – BioUD

• Clothing Applications
  – Permethrin (Permanone)
  – BioUD
Personal Prevention

• Routine tick checks and removal
  – The shorter the attachment time the lower the probability of transmission
  – RMSF transmission unlikely to occur in less than 6 hours

• Ticks should be removed using fine tipped tweezers
  – Hands should be gloved or tissue used to grasp tick
  – Tick should be flushed down toilet, not thrown in trash
Tick Control and Management in the Environment

• Management of habitat
  – Reduce tick survival
  – Reduce suitable host habitats

• Management of free living ticks
  – Reduce number of ticks in the environment seeking hosts

• Management of host population
  – Reduce the number of ticks in the environment by reducing the number of available hosts
Management of Habitat

• Decrease tick harborage
  – Decrease outdoor storage, clean up debris
  – Skirt houses to exclude animals

• Decrease harborage of molting ticks
  – Caulk openings, cracks, crevices

• Reduce moisture
  – Reducing weeds and mowing areas allows sun to dry areas and reduce tick survival
Management of Free-living Ticks

• Apply pesticides to areas where ticks are likely to be found
  – Places where dogs sleep
  – Under decks and porches
  – Cracks and crevices

• Use products that are effective for ticks and are safest for people and animals

• Apply often and in the right season
  – Focus on early spring tick emergence
  – In AZ climate reapply every 3-4 weeks in heavily infested areas

• Use appropriate chemicals for area being treated
  – Different products for indoor and outdoor use
Seasonality of Ticks and Treatment Timing in AZ

Treatment times in AZ: One time per month March - October

US Seasonality
AZ Seasonality
Indoor Treatment

• Treat cracks and crevices, edges
  – Do not treat food preparation areas
• Available products
  – Dusts and powders
    • Dessicants/scarification
    • Dessicants+chemical pesticide
  – Sprays
    • Pyrethrins
    • Pyrethroids
Outdoor Treatment

• Treat tick infested areas and animal sleeping areas
  – Do not treat groundwater or areas where runoff could occur

• Available products
  – Sprays
    • Pyrethrins, Bifenthrin, Permethrin, Lambda-Cyhalothrin, Carbaryl
  – Granules
    • Pyrethrins, Bifenthrin, Permethrin, Lambda-Cyhalothrin
  – Dusts
    • Permethrin, Deltamethrin, Carbaryl
Management of Host Population

• Reduce host (dog) contact with vector
  – Topical tick treatment
  – Tick collars

• Prompt removal of ticks
  – Prevents infection and illness
  – Treat ill animals with long-acting tetracyclines

• Reduce the transport of ticks from one area to
  – Keep dogs in fenced, escape proof yards
  – Safely tie-out dogs in areas without fences
  – Spay and neuter dogs
  – Removal of unwanted and uncared for dogs
Management of Ticks on Dogs

• Sprays/dips
  – Effective, but not long lasting (<2 weeks)
  – Products of various chemical classes
    • Organophosphates
    • Carbamates
    • Pyrethrins
    • Pyrethroids
Management of Ticks on Dogs

• Topicals
  – Pyrethrins
  – Permethrin, Permethrin + Pyriproxyfen
  – Fipronil
  – Fipronil + Methoprene
  – Fipronil + Methoprene + Amitraz
  – Metaflumizone + Amitraz
  – Selamectin
Management of Ticks on Dogs

• Collars
  – Tetrachlorvinphos
  – Tetrachlorvinphos + (S)-methoprene
  – Propoxur
  – Amitraz
  – Amitraz + Pyriproxifen
  – Deltamethrin
  – Flumethrin
Effective Tick Control Targets All Life Stages

- Eggs
- Free-living stages
- Parasitic stages
Resources

ADHS RMSF Website:
http://azdhs.gov/phs/oids/vector/rmsf/ticks.htm

CDC RMSF Website:
http://www.cdc.gov/ticks/

Tick Control Handbook (CT Ag. Extension)
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Questions?

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