

Ecology and Impacts of Infectious Diseases on California Hummingbirds

Lisa Tell DVM, Dipl. ABVP-Avian, Dipl. ACZM*
Holly Ernest DVM, PhD

School of Veterinary Medicine, University of CA, Davis
Department of Veterinary Sciences, University of Wyoming

*Diplomate American Board Vet. Practitioners-Avian,
Diplomate American College of Zoological Medicine

Avian Communities: Disease Ecology and Population Health

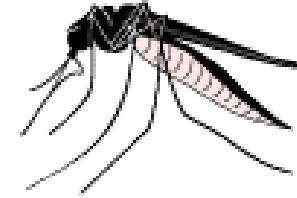


- ▶ **Disease prevalence = indicator of population health**
 - What is “normal” for a avian populations?
- ▶ **Key parameter for population viability assessment**
 - Which (how, when, why) disease agents change vital rates (survivorship and reproduction)?
- ▶ **Evaluation of ecological impacts**
 - “What if” scenarios – Which environmental actions will likely cause an effect to rates of disease in populations?
- ▶ **Assist with conservation planning efforts**
 - For populations at risk of decline, what actions can reduce disease-related losses in survivorship and reproduction?

Avian Vector Borne Diseases



- Vector Borne Disease Research
 - Model system for host-parasite interactions
 - Relevant to fields of ecology, evolution and conservation biology
- Hemosporidian Parasitism
- Viral Infections
 - West Nile Virus
 - Pox Virus



Avian Communities: Disease Ecology and Population Health WHY HUMMINGBIRDS?



- Provide critical ecosystem services by contributing to the overall ecological health of their habitats
- Serve as sentinel species that can provide indications of overall environmental health

HUMMINGBIRDS (Family Trochilidae)

- Despite their importance, little is known: disease ecology
- Several species threatened, endangered, or “of special concern”



California Hummingbird Species



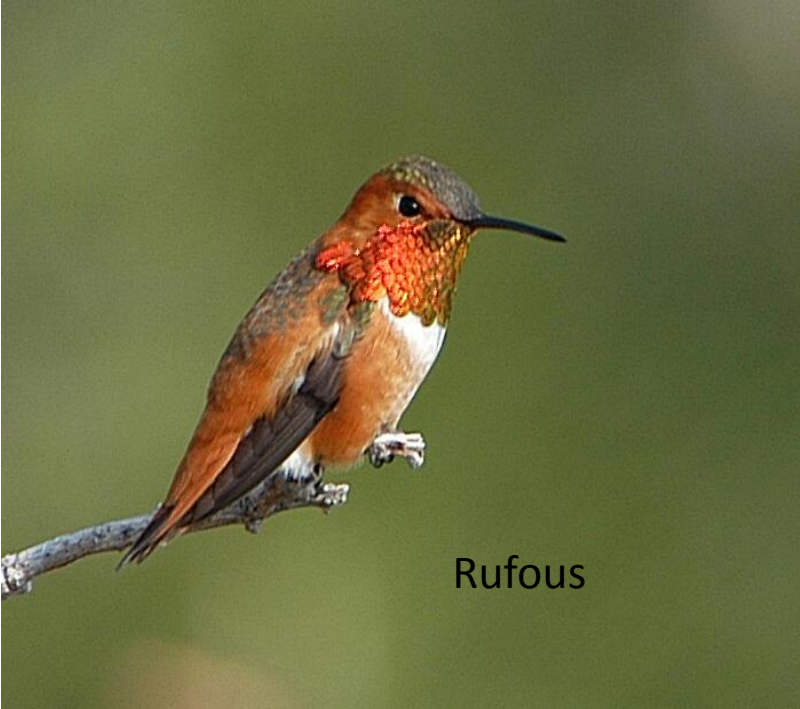
Anna's



Costa's



Black-chinned



Rufous



Allen's



Calliope

Hummingbirds: Specialized Research



=



1. Tiny!!!
2. Species ID
3. Specialized handling and sampling requirements
4. Assay methods need to be developed for sensitivity/small sample volumes

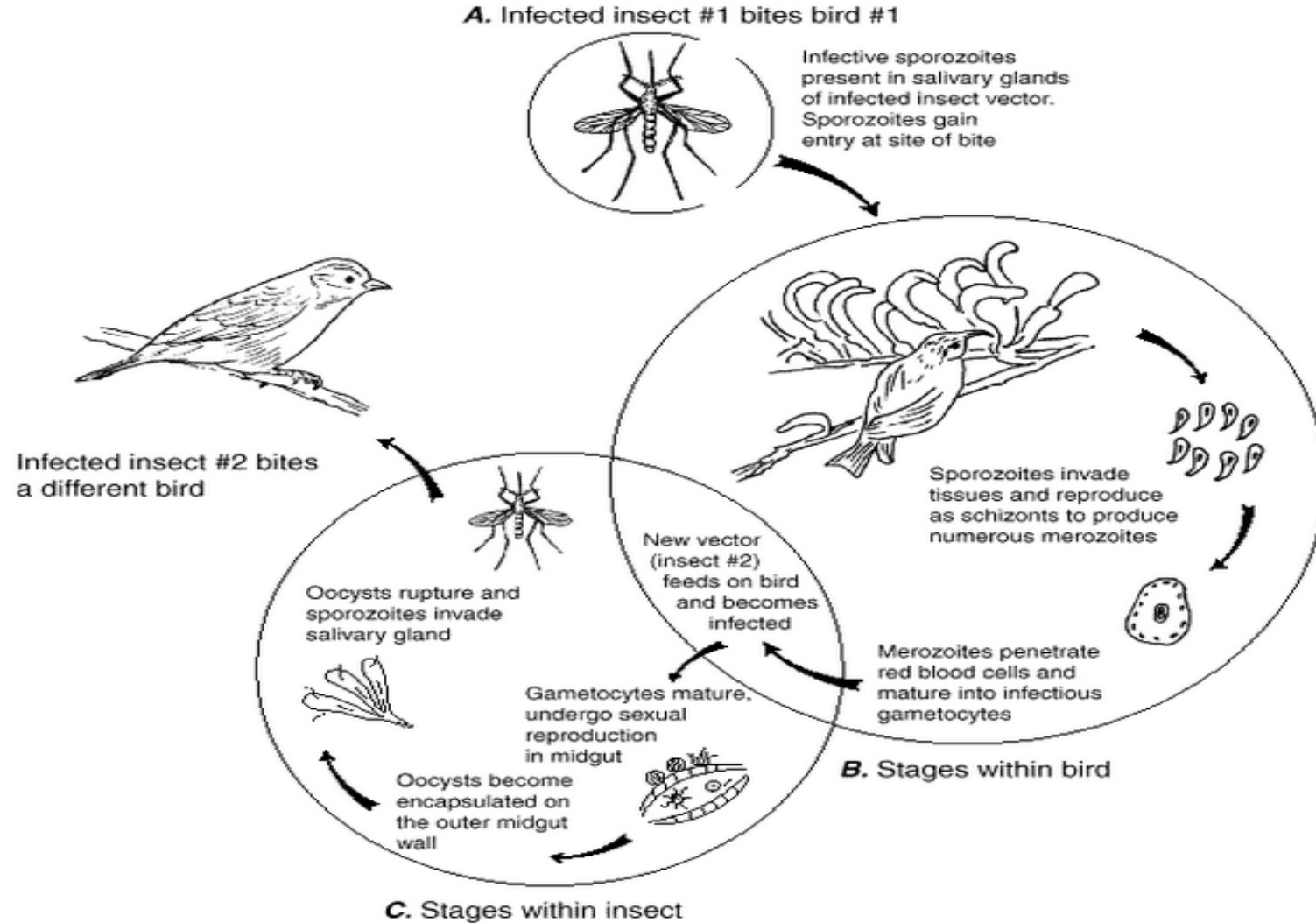


Photo courtesy of Shannon Skalos

Avian Vector Borne Dz: Haemoparasitism



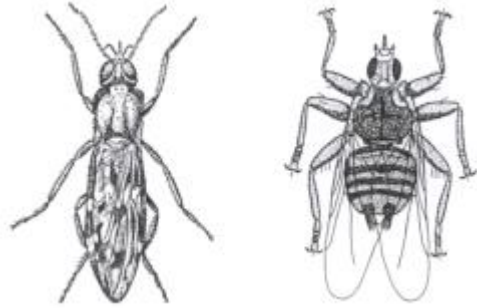
Source: http://wildpro.twycrosszoo.org/S/00Ref/bookref36_fieldmanualofwildlifediseases/24/B36Fig24-1.gif



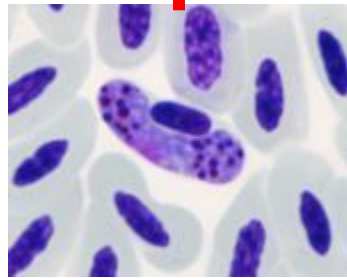
The complex general life cycle of hemosporidian parasites begins with (A), an infected insect biting a susceptible bird. Separate infectious and developmental stages occur in (B), the bird host, and (C), the insect vectors.

Haemoparasitism Vectors

Blood-Sucking Dipteran Insects



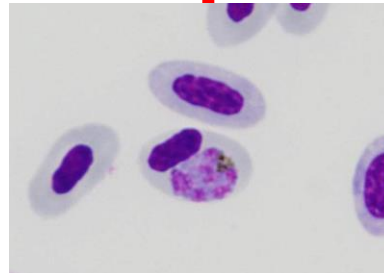
Biting Midges
(Ceratopogonidae)
Louse Flies
(Hippoboscidae)



Haemoproteus spp.



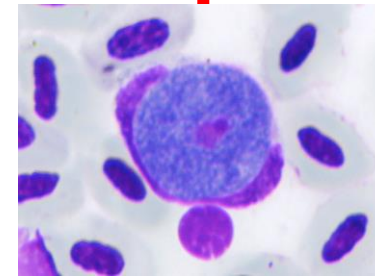
Mosquitoes
(Culicidae)



Plasmodium spp.



Blackflies
(Simuliidae)



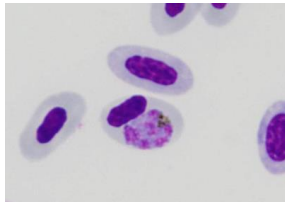
Leucocytozoon spp.

Hummingbirds: Haemoparasitism



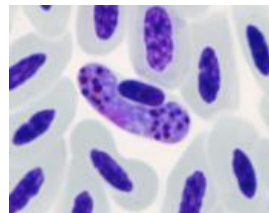
Very little known about hummingbird hemoparasites!

- Described blood parasites (literature)



- *Plasmodium relictum*
- *P. cathermerium*
- *P. rouxi*

} Found in
several bird families



- *Haemoproteus archilochus*
- *H. trochili*
- *H. witti*

} Found only in
hummingbirds

Recent publication describing *Leucocytozoon*

Haemoparasite Research Study



- Identify the prevalence of Haemosporidian blood pathogens found in CA hummingbirds — *Plasmodium*, *Haemoproteus*, and *Leucocytozoon*
- Distinguish potential novel strains of hemoparasites in hummingbirds
- Generate a phylogenetic tree to elucidate the evolutionary relationship of the identified hemoparasites

**Study Lead: Sarah Bahan, Veterinary Student
University of CA, Davis**

**Collaborator: Dr. Ravinder Seghal
San Francisco State University**

Hummingbird Haemoparasite Research

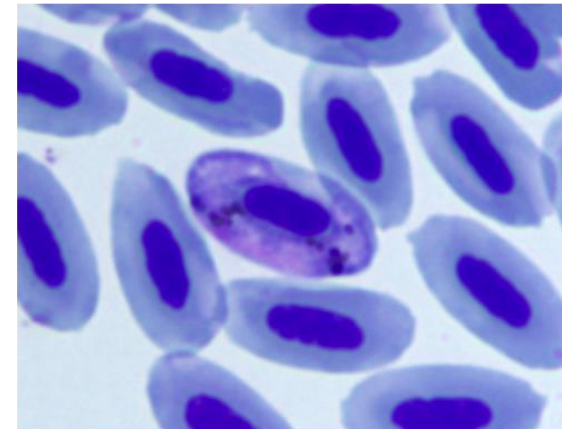


- **January 2012-August 2013**
- **Northern CA Banding Sites (n=3)**
- **Hummingbirds (n=300)**
 - *C. anna* 68% and *A. alexandri* 32%
- **Sample Collection: Toenail clip**
- **Blood Smear**
 - Coverslip Technique
 - Staining Method: Wright-Giemsa
 - Microscopic Assessment
- **Blood Sample**
 - Molecular Testing (PCR)
 - Previously described method (Seghal)

Hummingbird Haemoparasite Research: Preliminary Results



- 4.2% of total individuals screened by PCR tested positive for *Haemoproteus* or *Plasmodium*
- *Haemoproteus*: identified in 17.7% of the blood smears, as well as a *Trypanasome* in a single bird

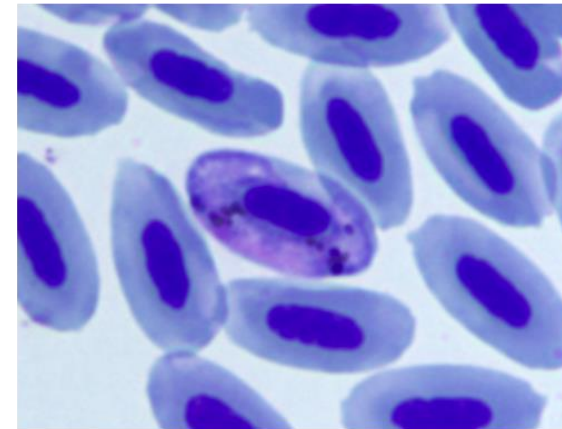


Haemoproteus infected erythrocyte
(Black-chinned adult hummingbird;
under oil at 1000x)

Hummingbird Haemoparasite Research: Preliminary Results



- Black-chinned hummingbirds: significantly higher prevalence of hemoparasitism than Anna's (p-value = 1.32×10^{-6})
- Adults (after-hatch year): significantly higher prevalence of hemoparasitism than juveniles (hatch year) (p-value = 0.003)
- Neither sex nor geographical location had a significant effect on prevalence of hemoparasitism

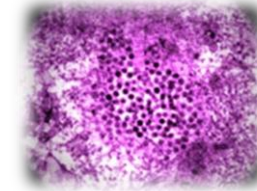


Haemoproteus infected erythrocyte
(Black-chinned adult hummingbird;
under oil at 1000x)

Vector Borne Avian Viral Infections: West Nile Virus



- Flavivirus –an **ArBovirus**
 - Blood sucking insect transmission
- First discovered 1937 Uganda; reported Western hemisphere (NY State) in 1999
- Mosquito vector: birds as reservoir hosts
- Many species of birds can become infected
- Severe weakness and depression, ataxia, circling, and convulsions
- Detection: rising ab titers, histopathology, virus isolation, DNA probes



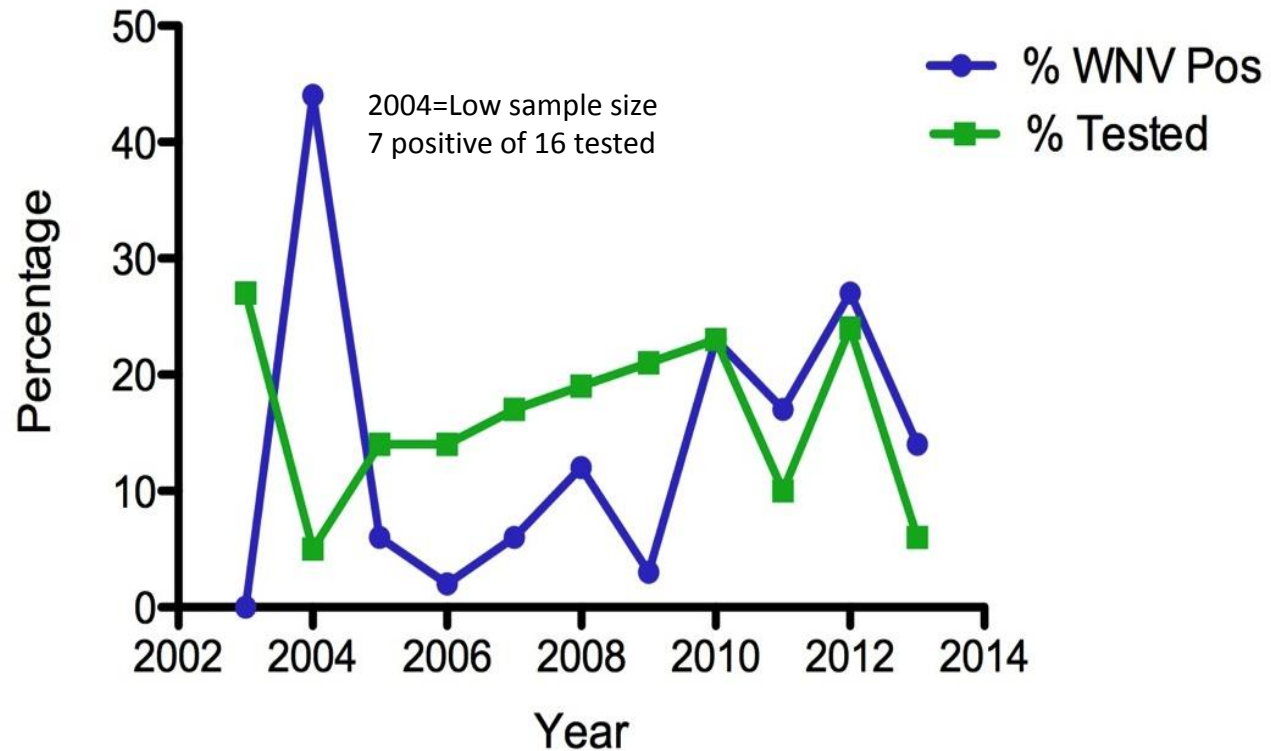
WNV Particle

Photo: Natl Inst. Health

Hummingbirds: West Nile Virus



- California Department of Public Health Surveillance
- Hummingbird deaths reported
- Carcass submission and PCR testing



Data courtesy of CA Dept. Public Health

Hummingbirds: West Nile Virus



- Future Efforts
 - Compare to other closely related species (swifts)
 - Compare to susceptible avian species
 - Evaluate resident versus migrating populations
 - Evaluate for geographic differences
 - Evaluate impacts of global warming

Yellow-billed Magpie

Very high % of
WNV-positive tested dead birds in California

Photo: Tom Greer



Vector Borne Avian Viral Infections: Avian Pox



- Pox viruses exist in numerous avian orders
- Examples: canary, poultry, pigeon, falcon
- Susceptibility: varies widely among birds
- Forms: Dry (cutaneous) or diphtheritic (wet)
- Transmission- Insects and traumatic induced lesions; break in epithelium necessary for infection



Hummingbirds: Avian Pox



Journal of Wildlife Diseases

October 2013, Volume 49, Issue 4, pp. 978-985

Characterization of avian poxvirus in Anna's hummingbird (*Calypte anna*) in California, USA

Godoy LA, Dalbeck LS, Tell LA, Woods LW, Colwell RR, Robinson B, Wethington SM, Moresco A, Woolcok PR, Ernest HB

- Avian Pox Virus
 - n=5 birds; 9 lesions
- Histopathology and PCR Dx



Photo courtesy R. Colwell

Hummingbirds: Avian Pox



- **Field Implications**
 - Needs portal of entry
 - Fomites?
- **Future Assessment**
 - Vector for hummingbird dz
 - Prevalence of disease
 - Geographic distribution
 - How climate change might impact disease prevalence
 - Limited food sources/feeder availability



Concluding Remarks



- Unique biology and ecosystem services
- Genetics and disease studies focusing on conservation efforts
- Develop novel approaches for disease monitoring
- The future is exciting!

