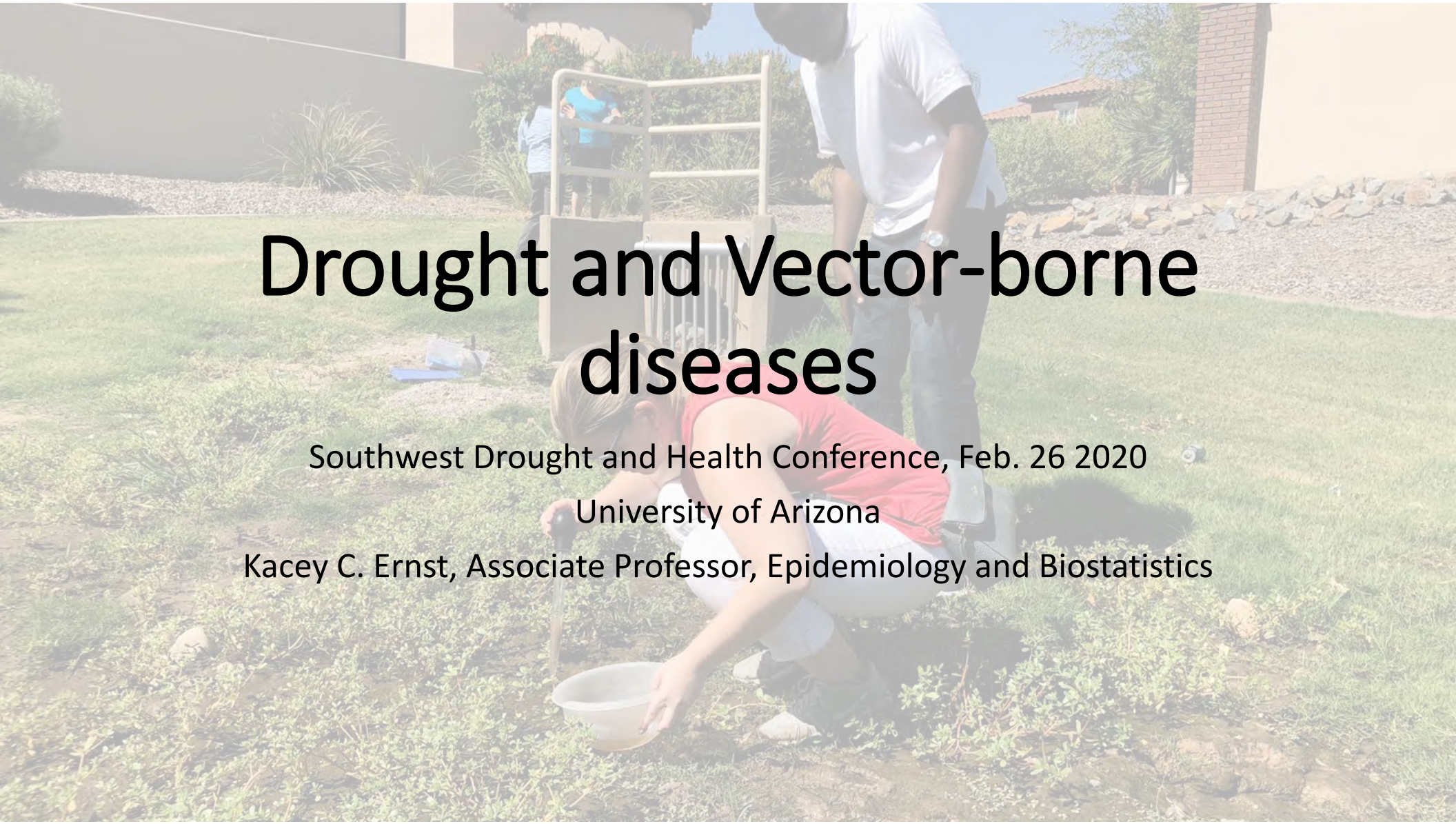


Drought and Vector-borne diseases

Southwest Drought and Health Conference, Feb. 26 2020

University of Arizona

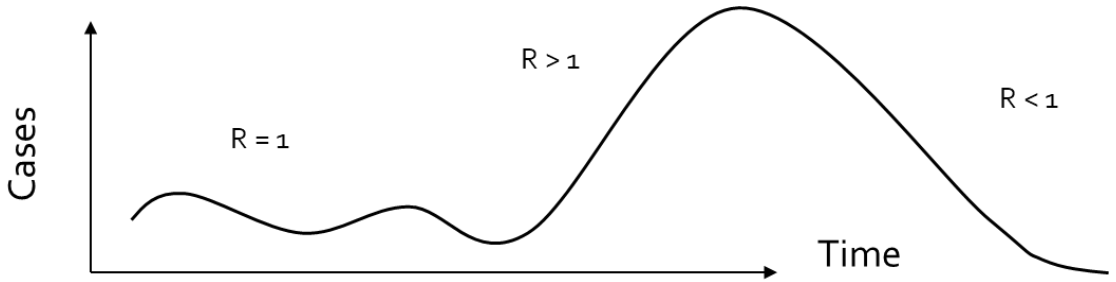
Kacey C. Ernst, Associate Professor, Epidemiology and Biostatistics

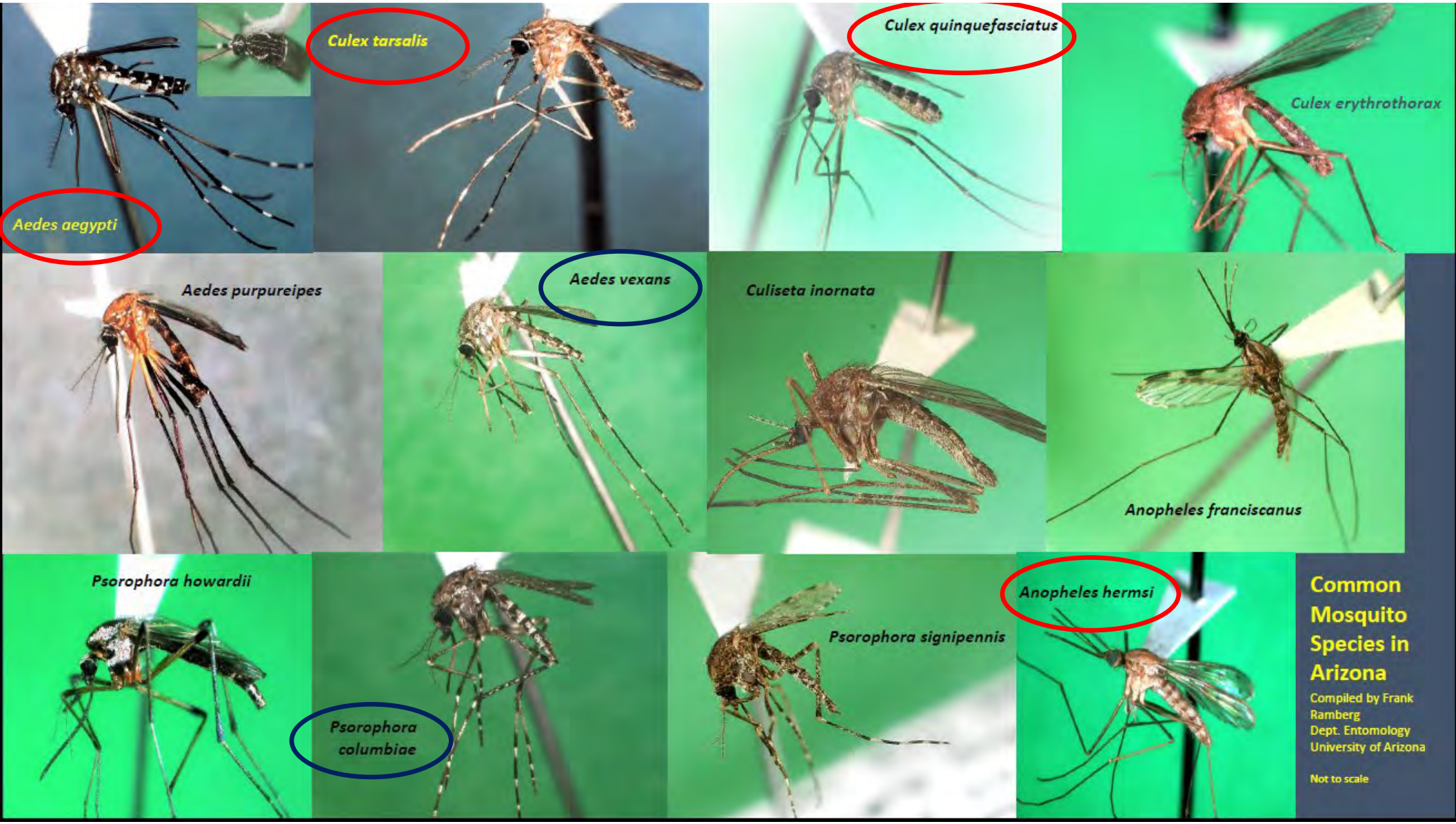
Potential for transmission

Reproductive number for mosquito-borne diseases (modification of the vectorial capacity equation)

$$R_0 = \frac{ma^2bc\,p^n}{(-\ln\,(p))r}$$

m: ratio of mosquitoes to humans
a: mosquito biting rate (on humans)
b and c: pathogen transmission efficiencies (human to mosquito and mosquito to human)
p: daily survival rate of mosquitoes
r: the recovery rate in humans (i.e., the reciprocal of the infective period of the human host)
n: the duration of the extrinsic incubation period (EIP).




Aedes aegypti
Culex tarsalis
Culex quinquefasciatus
Culex erythrothorax
Aedes purpureipes
Aedes vexans
Culiseta inornata
Anopheles franciscanus
Psorophora howardii
Psorophora columbiae
Psorophora signipennis
Anopheles hermsi
Common Mosquito Species in Arizona
Compiled by Frank Ramberg
Dept. Entomology
University of Arizona
Not to scale

Other potential vectors of regional interest

Brown Dog Tick: Rocky Mountain Spotted Fever*

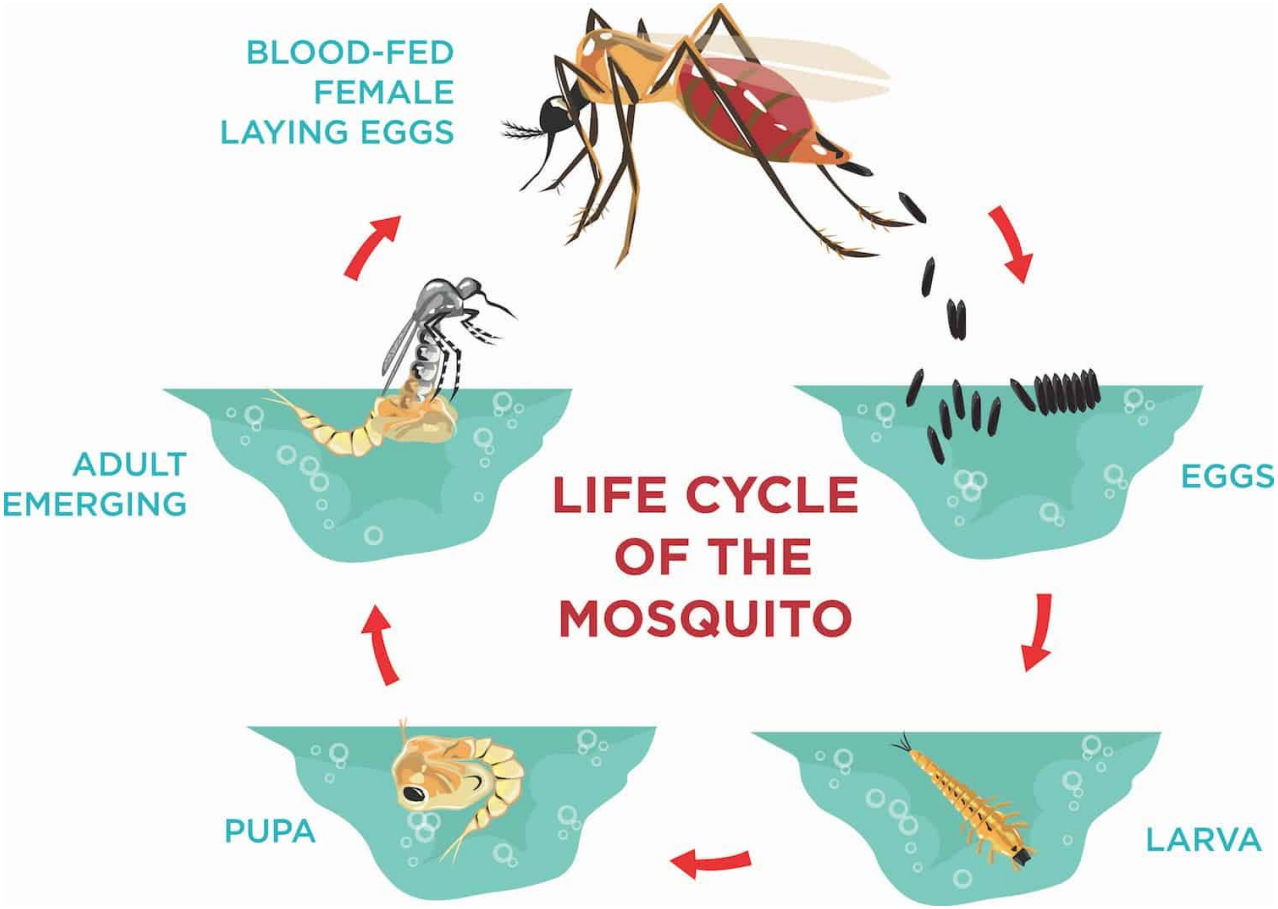
Fleas: Plague disease*

Triatome (kissing bug): Chagas disease$

* Transmission documented in Arizona

$One case study of possible local transmission

Mosquito life-cycle

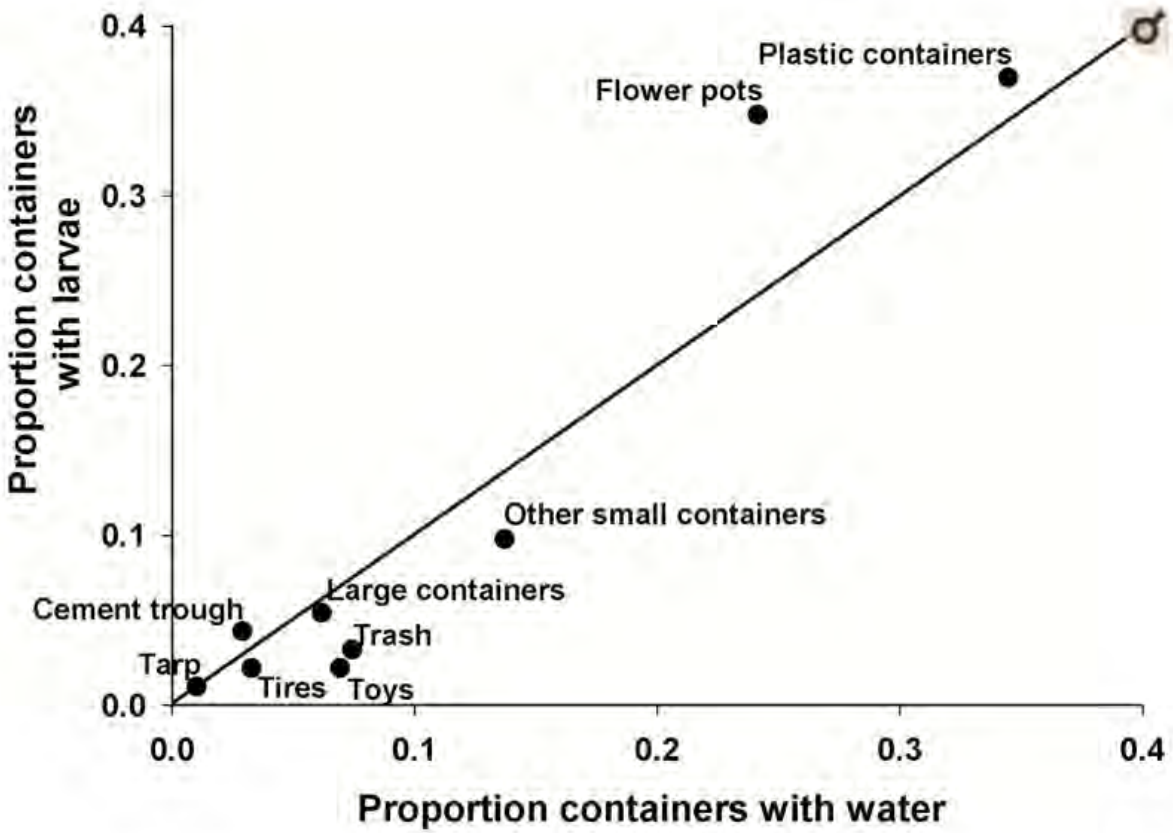


Oviposition sites

Precipitation Driven

Anthropogenic water sources

Flower pot saucers – number one suspect



Co-benefits and inadvertant consequences- water management

- Drought – water storage – dengue fever
- The case of Australia, Honduras, Brazil

Drought blamed for upsurge in dengue fever in Brazil

Beebe NW et. al.(2009) PLoS NTD 3(5).

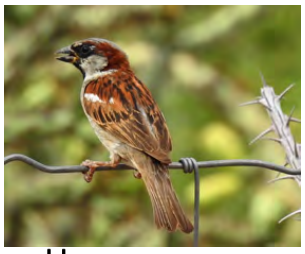
Drought – West Nile virus

- Factors contributing to WNV activity vary by region

Paull S. et. al., Proc. R. Soc. B, 2017

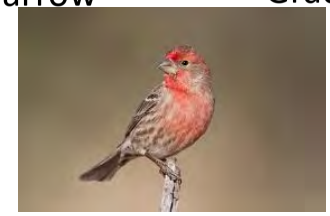
More than just mosquito abundance

West Nile Virus and Drought

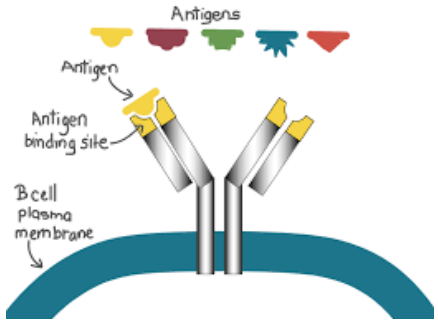


House sparrow

Grackel



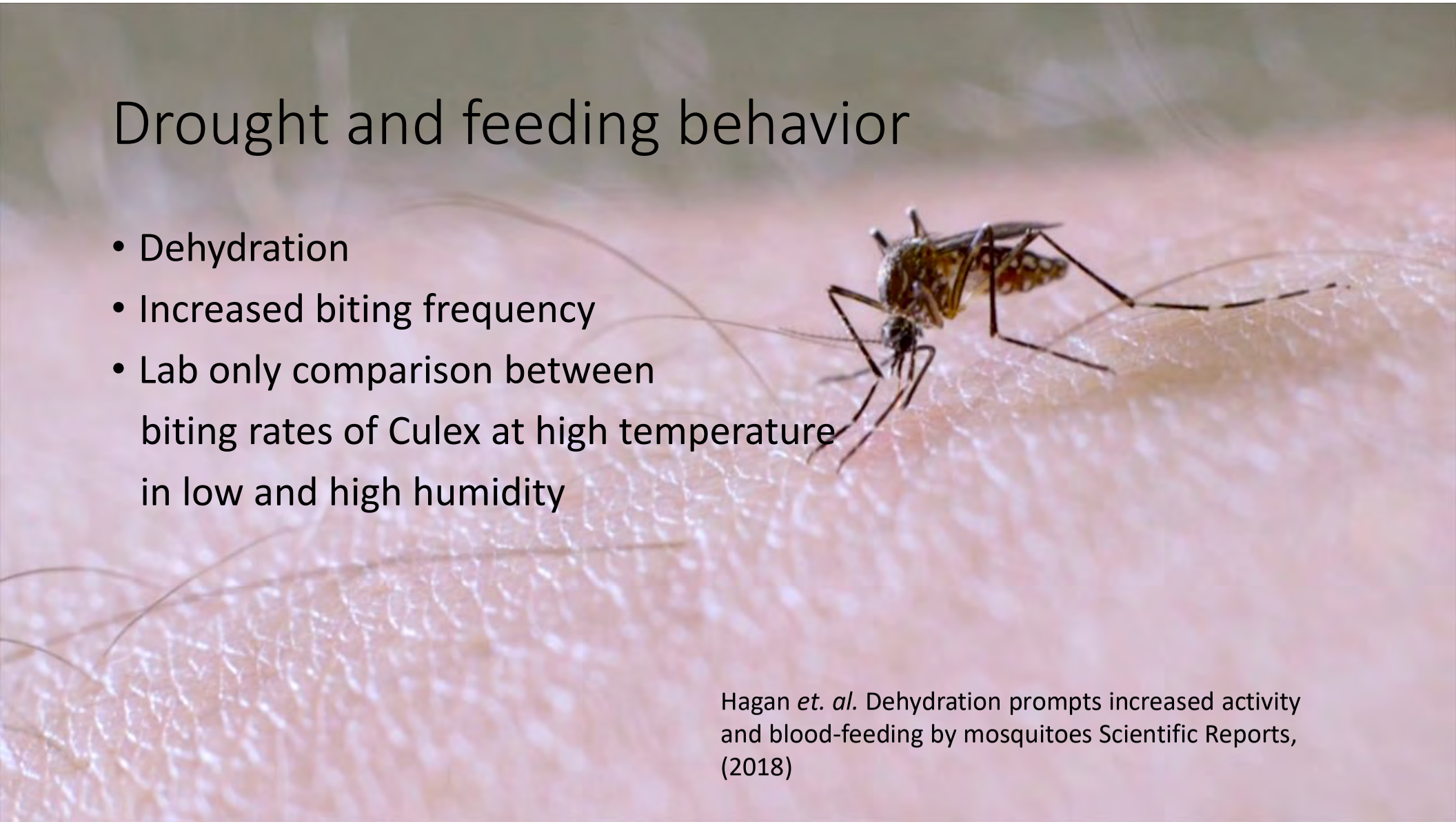
House finch



Paul S, et. al, PRSB 2017; Johnson BJ et.al., JME 2013; Shaman et.al. JME 2005;

Drought and feeding behavior

- Dehydration
- Increased biting frequency
- Lab only comparison between biting rates of Culex at high temperature in low and high humidity



Hagan *et. al.* Dehydration prompts increased activity and blood-feeding by mosquitoes Scientific Reports, (2018)

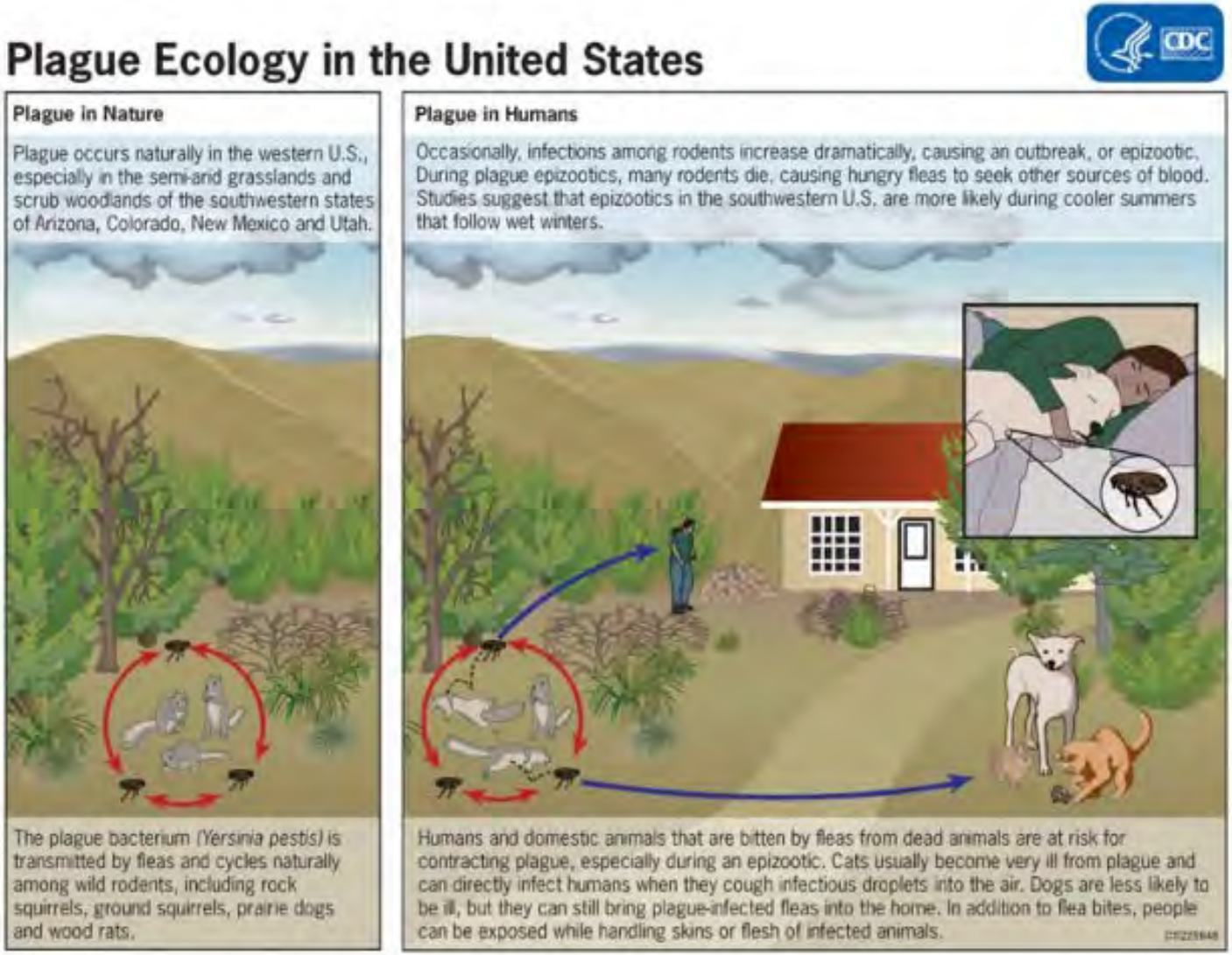
Rocky Mountain Spotted Fever and the Brown Dog Tick

- Resistant to dessication
  - Compared to other tick species (e.g. Lone Star Ticks)
- BDT has an extremely hard cuticle that helps protect it from desiccation
- Can “drink from the air" by excreting a hydrophilic solution from its salivary glands
- May seek peridomestic environments when not on host to avoid dry air

Brown Dog Tick: Rocky Mountain Spotted Fever*

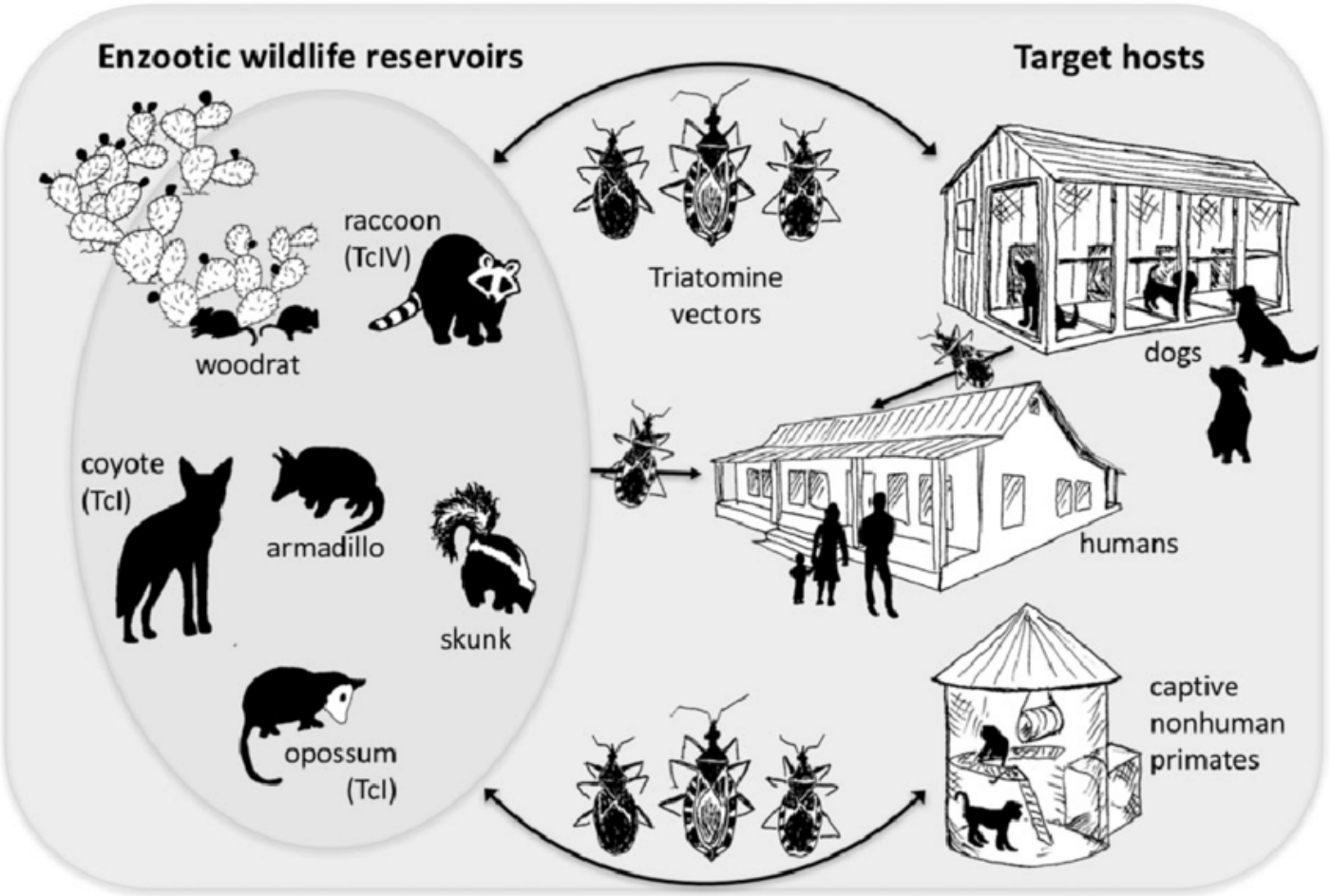
Plague

- Recent evidence suggests – prairie dogs more susceptible to fleas during drought (Eads et. al., Journal of Mammology, 2016)
- Plague activity in Europe is synchronous with drought between 1300-1800. (Yue et.al. STE, 2020)



Triatome and Chagas

- Some indication of shifting habitats during dry periods
- Little known about our specific species
- Not thought to be very competent vector



Summary

- Dynamics between vector-borne diseases and drought are complex and relate to:
  - Host immunity
  - Immature and adult habitat preferences
  - Ability to survive desiccation
  - Changes to feeding habits
- Ecology of each vector-pathogen-host(s) dynamic is needed
- However, evidence suggests increasing frequency of droughts may drive higher VBD risk parameters