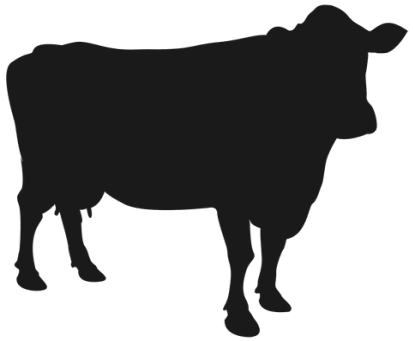
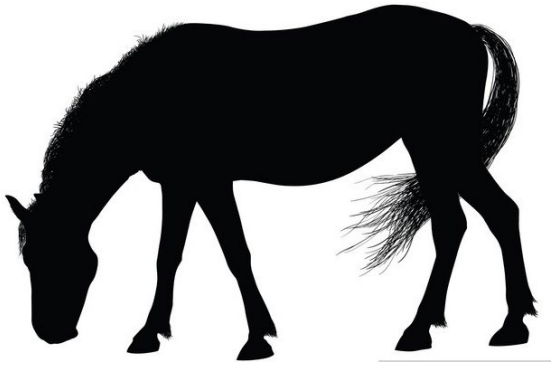
Large Animal Blood-borne Apicomplexans:

Theileria and *Babesia*

Species of *Theileria and Babesia* that infect cattle and horses



1. *Theileria orientalis* (Bovine Anemia)
2. *T. parva* (Africa, severe dz)
3. *T. annulata* (tropical/subtropical, severe dz)
3. *Babesia divergens* (Europe)
4. *B. bovis* (South, Central America, Cattle Tick Fever)
5. *B. bigemina* (South, Central America, Cattle Tick Fever)



<u>Equine Piroplasmosis</u>
1. *Theileria equi*
2. *Babesia caballi*

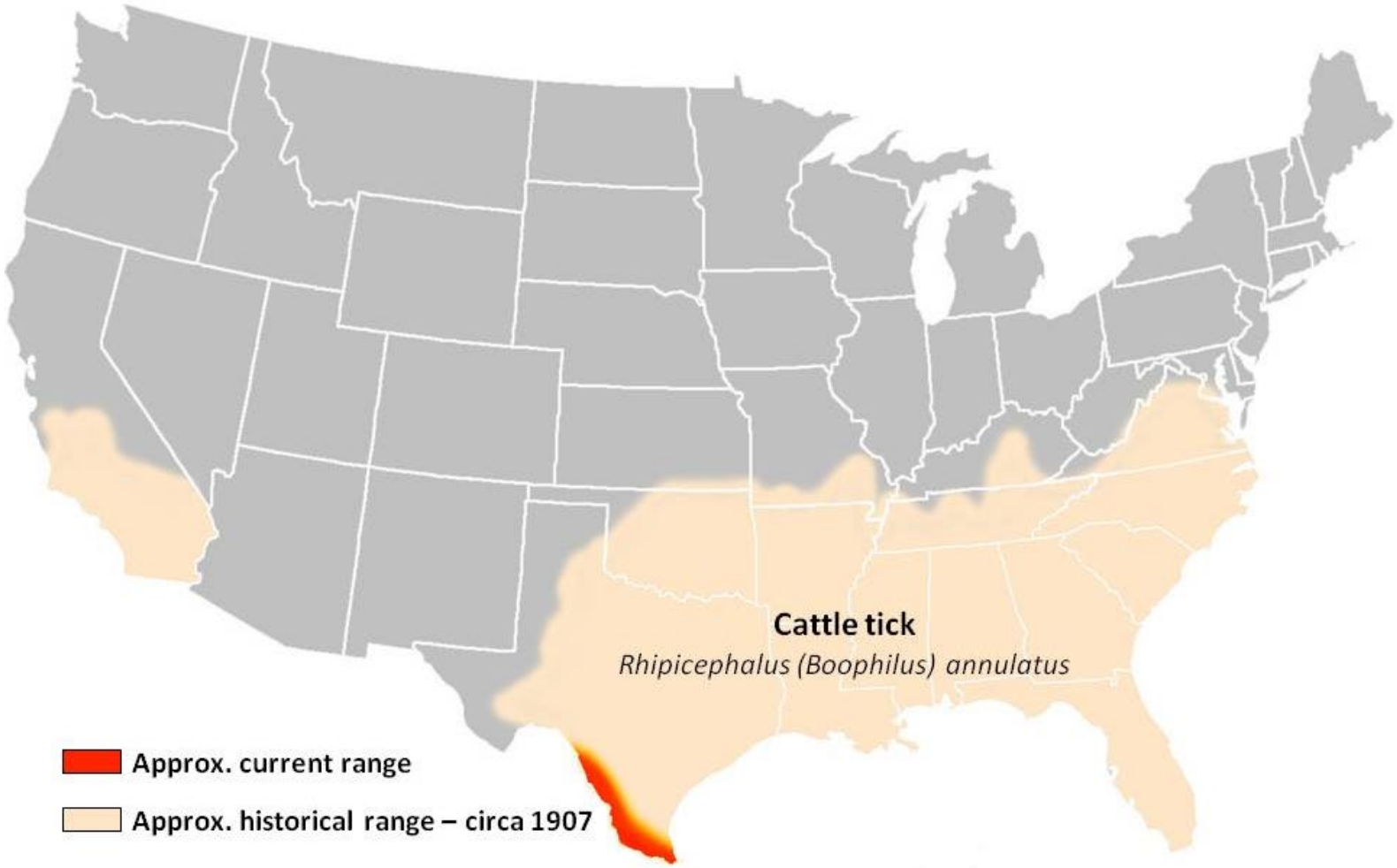
T. equi and *B. caballi* often co-infections

You are only responsible for knowing Bovine Anemia (*T. orientalis)* and Equine Piroplasmosis *(T. equi and B. caballi)*

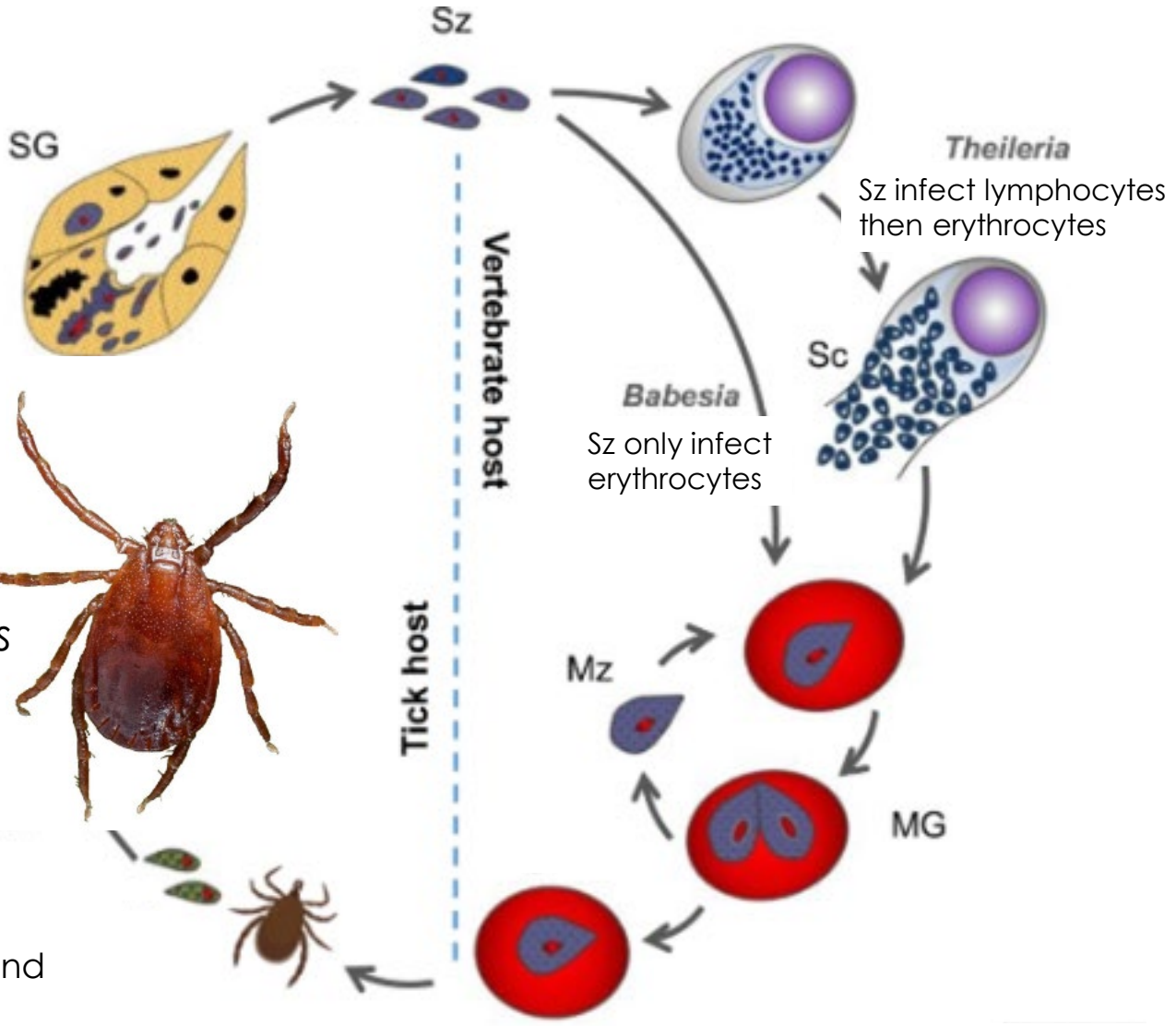
FYI: Eradication of Texas Cattle Fever (fever, anemia, and jaundice)

Rhipicephalus (Boophilus) annulatus and microplus

(1-host tick) vector for *Babesia bigemina and B. bovis*

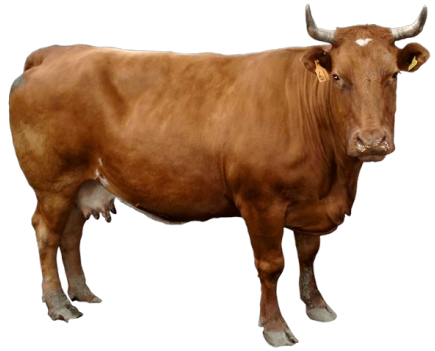


Indirect Life Cycle: *Theileria and Babesia*



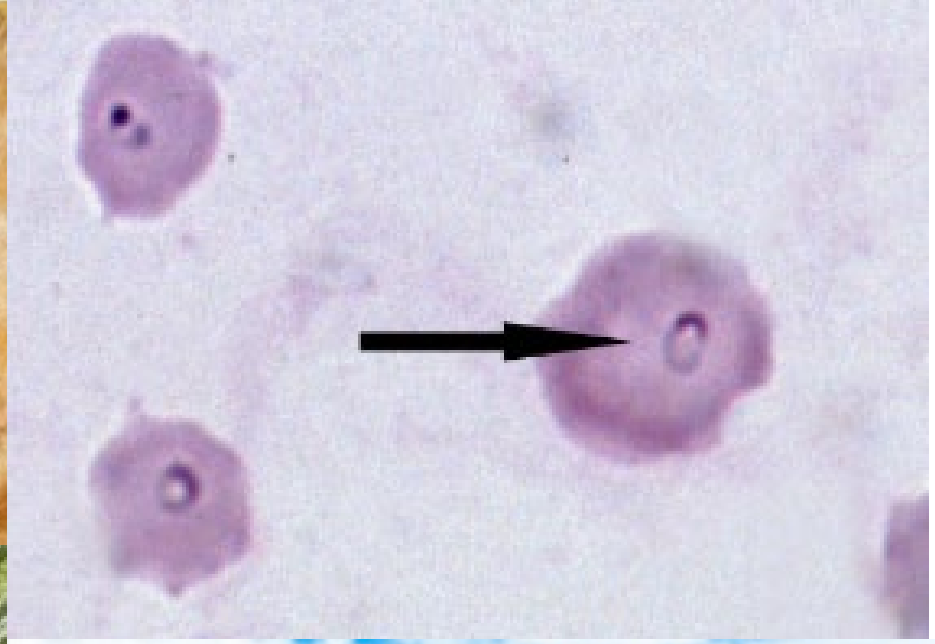
H. longicornis
(T. orientalis)

SG = salivary gland
Sz = sporozoite
Sc = schizont
Mz = merozoite



Theileria orientalis

Theileria equi
Babesia caballi



Theileria orientalis

- Virulent genotype Ikeda
- Bovine Anemia
- Indirect Life Cycles
  -Tick-borne disease

Learning Objectives: Bovine Anemia (*Theileria orientalis* Ikeda)

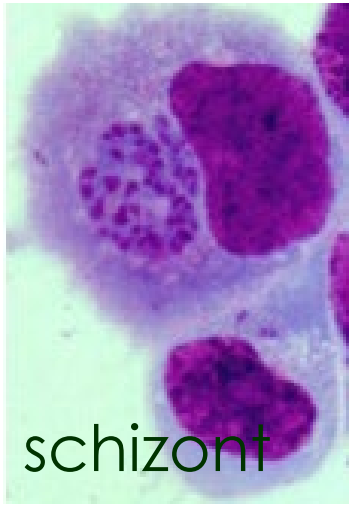
1. Life cycle: know that it is an indirect life cycle and the specified life cycle details.
2. Transmission: know how *T. orientalis* Ikeda is primarily transmitted in the U.S.
3. Pathogenesis: understand what host cell *T. orientalis* Ikeda infects and how it causes bovine anemia
4. Clinical signs: know the specified common clinical / laboratory findings for bovine anemia.
5. Diagnosis: know the 3 ways we can diagnose T. *orientalis* Ikeda
6. Management: Understand how to manage cattle infected with *T. orientali* Ikeda in the U.S
7. Epidemiology: know that Anaplasmosis is a differential and the risk factors for bovine anemia in the U.S.

“FYI” = won’t be tested on

Theileria orientalis

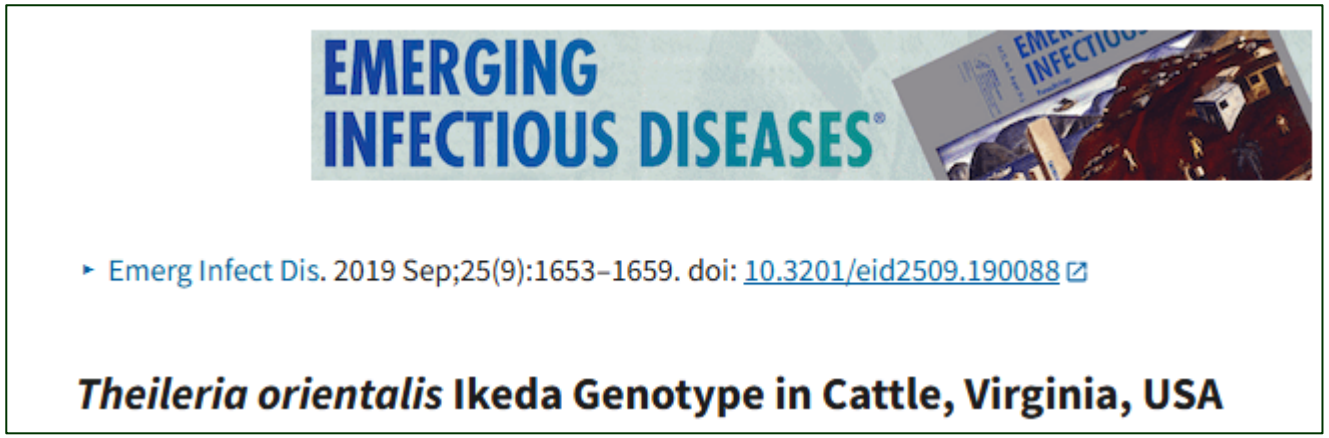
Blood-borne, tick transmitted piroplasm


piroplasm


schizont

Infects both erythrocytes and lymphocytes
schizonts in lymphocytes
piroplasms in erythrocytes

***T. orientalis* Ikeda genotype** (virulent strain) detected in cattle the U.S., transmitted by an invasive tick *Hemophysalis longicornis*



FYI *Theileria orientalis* Taxonomy

Theileria orientalis consists of a group of very similar (same?)organisms

T. sergenti (Japan)
T. buffeli (Austraila)
T. orientalis (worldwide)

} spp. debated → All are ***T. orientalis*** (genotype variations)

Major Piroplasm Surface Protein (MPSP) used to classify these genotypes, correlates with virulence

<u>Major MSPS types</u>

Ikeda → **anemia, Australia, Japan, NZ, US**

Buffeli
Chitose } low virulence (US and other countries)

Transmission: *T. orientalis* Ikeda

Haemaphysalis longicornis
(Asian Long-horned Tick)

- Invasive sp. from Australia – Asia region
- Emerging problem (primarily for livestock)
- **Vector for *Theileria orientalis* Ikeda**
- Feed on other animals (including dogs)
- Do not prefer humans
- Parthenogenic (females clone themselves)

All you need to know from this slide is that ***H. longicornis* is the vector for *T. orientalis*.**

Haemaphysalis longicornis –swarming “mob” behavior

Pathogenesis: *T. orientalis* Ikeda

Direct destruction of erythrocytes (hemolytic anemia)
multiple asexual cycles and destruction of RBC
Immune system removes RBC

Lymphocytic schizonts can be found transiently in other tissues but not typically in the peripheral blood.

Schizonts do not play a major role in pathogenesis unlike which other tick-borne disease?

Clinical signs: *T. orientalis* Ikeda

Severity of disease varies based on infective dose and host health (fatality rate 3 – 90%)

Acute Phase
Fever, pale mm, anemia, icterus, lethargy, weight loss, labored breathing
+/- hemoglobinuria in severe cases

Chronic Phase
Subclinical infections persist
Relapses with stress or immunosuppression
Weight loss and decreased milk production

Diagnosis: *T. orientalis* Ikeda

Parasite visualization

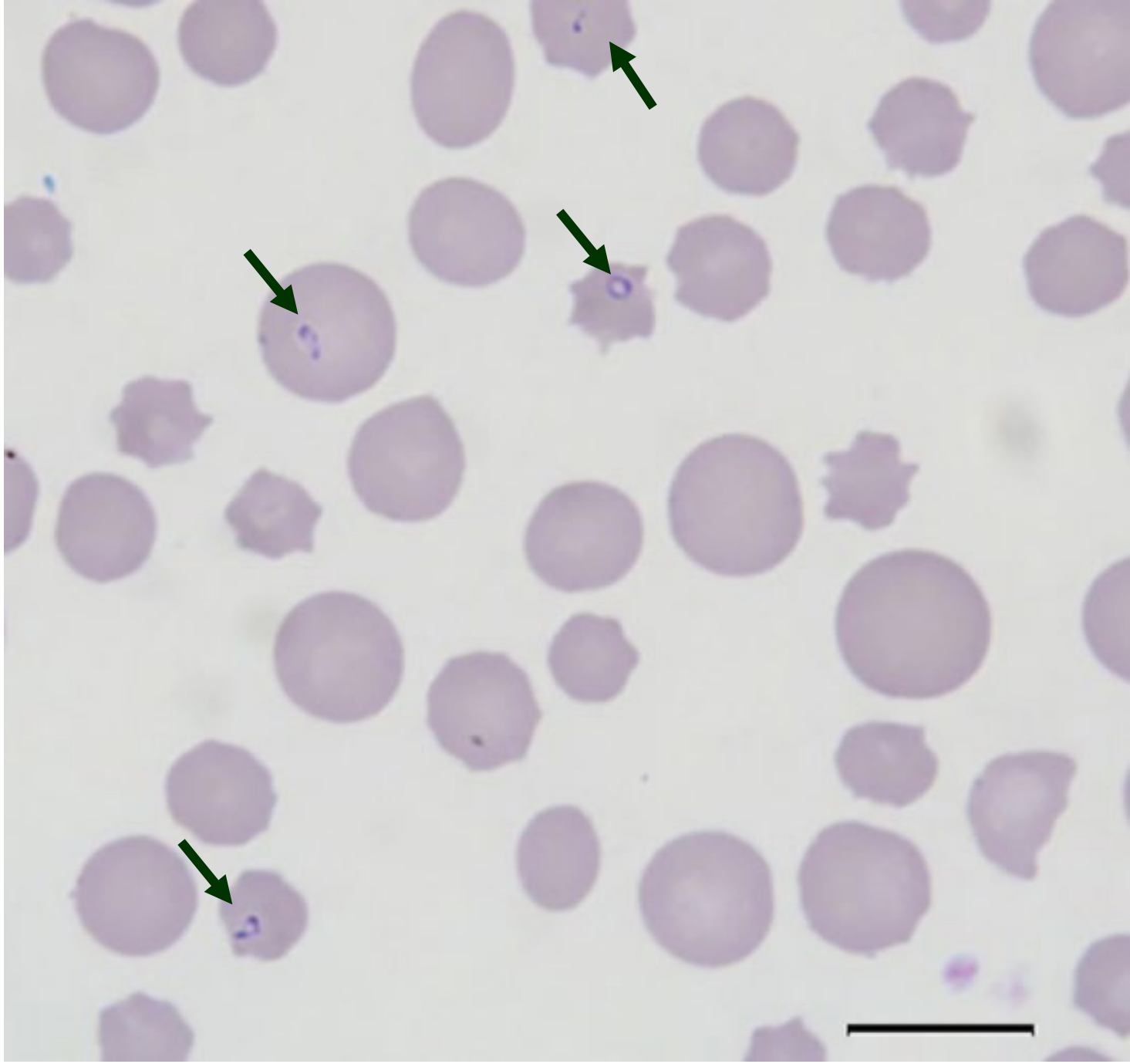
Serology

-ELISA and IFA

PCR

-Most sensitive

-Differentiate from less virulent *T. orientalis* strains already in the US



Oakes, Vanessa J., et al. "Theileria orientalis Ikeda genotype in cattle, Virginia, USA." *Emerging Infectious Diseases* 25.9 (2019): 1653.

Management: *T. orientalis* Ikeda

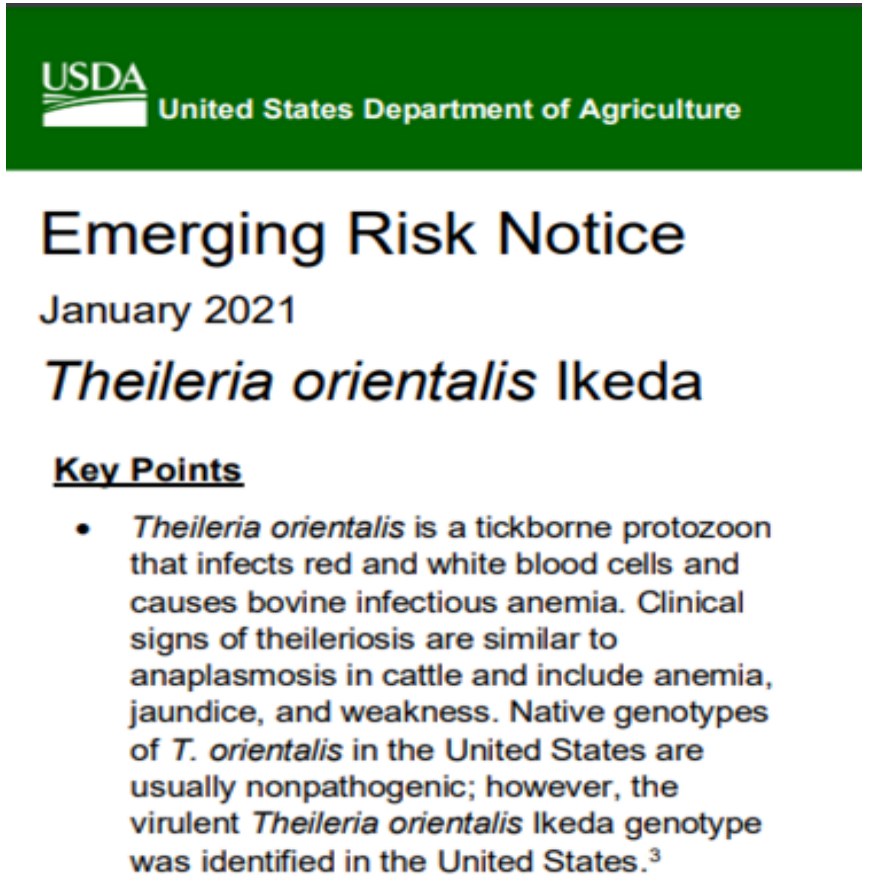
Treatment:
No cure, recovered cattle are carriers

Herd Management:
No approved vaccine

Reporting:
National Reportable Disease
https://www.aphis.usda.gov/livestock-poultry-disease/surveillance/reportable-diseases

Prevention:
- biosecurity (testing new cattle, inspect for ticks)
- tick control (chemical control)
- environmental (limit cattle exposure to deer, wooded environment, mow parameter, brush free pastures)

https://www.aphis.usda.gov/sites/default/files/theileria-orientalis-ikeda-notice.pdf



USDA United States Department of Agriculture

Emerging Risk Notice

January 2021

Theileria orientalis Ikeda

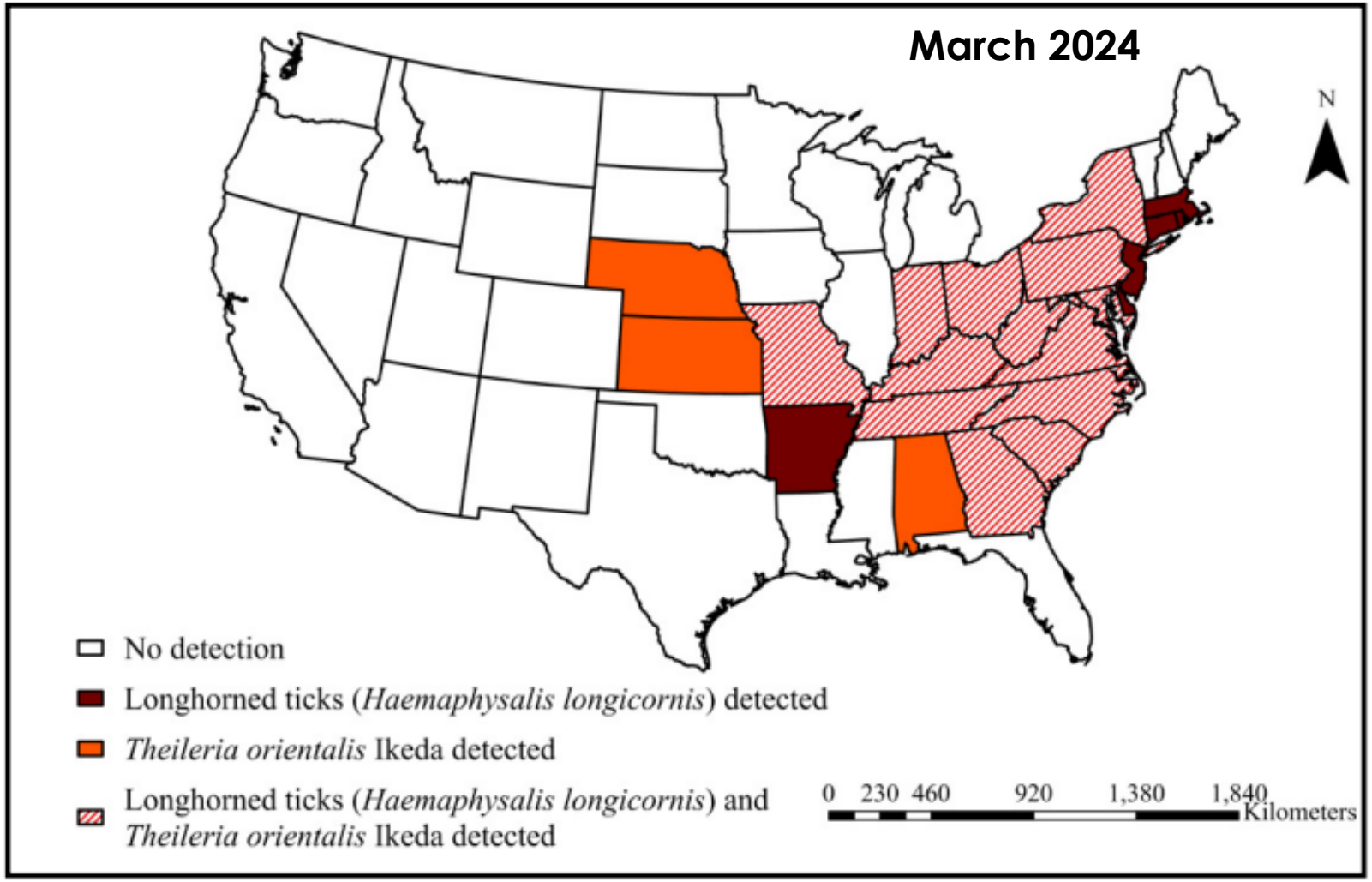
Key Points

- *Theileria orientalis* is a tickborne protozoon that infects red and white blood cells and causes bovine infectious anemia. Clinical signs of theileriosis are similar to anaplasmosis in cattle and include anemia, jaundice, and weakness. Native genotypes of *T. orientalis* in the United States are usually nonpathogenic; however, the virulent *Theileria orientalis* Ikeda genotype was identified in the United States.[3]

U.S. Epidemiology: *T. orientalis* Ikeda

Geographic distribution

- Normally in Asia, Australia, New Zealand
- In US, eastern states and expanding westward
  - movement of infected, asymptomatic cattle
  - could other tick species be competent vectors??



https://utia.tennessee.edu/publications/wp-content/uploads/sites/269/2024/08/W1255.pdf

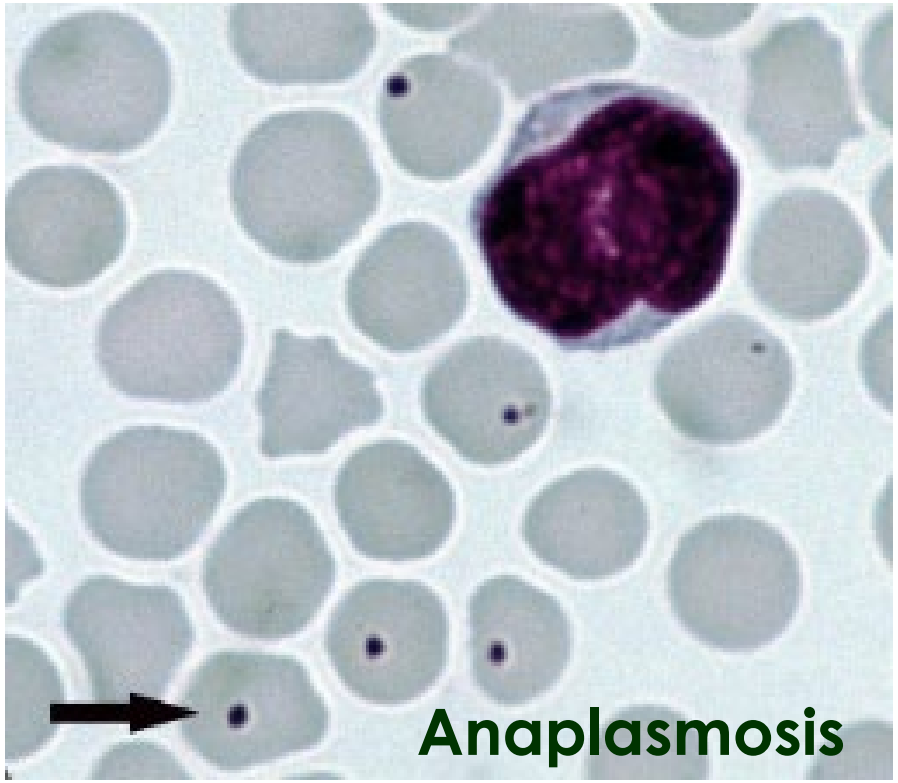
U.S. Epidemiology: *T. orientalis* Ikeda

Risk factors

- Naïve cattle more susceptible to severe disease
- Immunocompromised (stress, young)

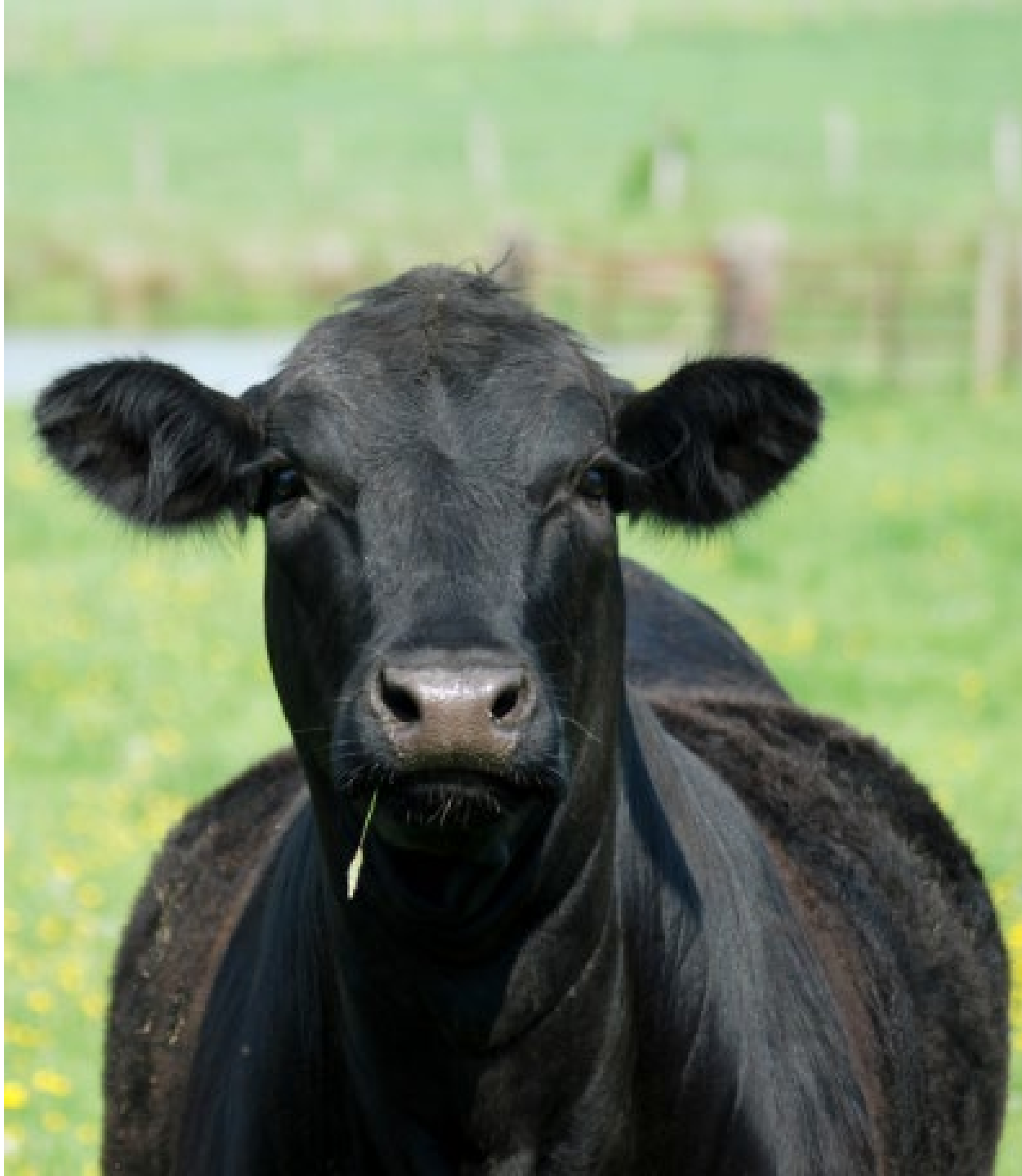
Differential Dx = Anaplasmosis

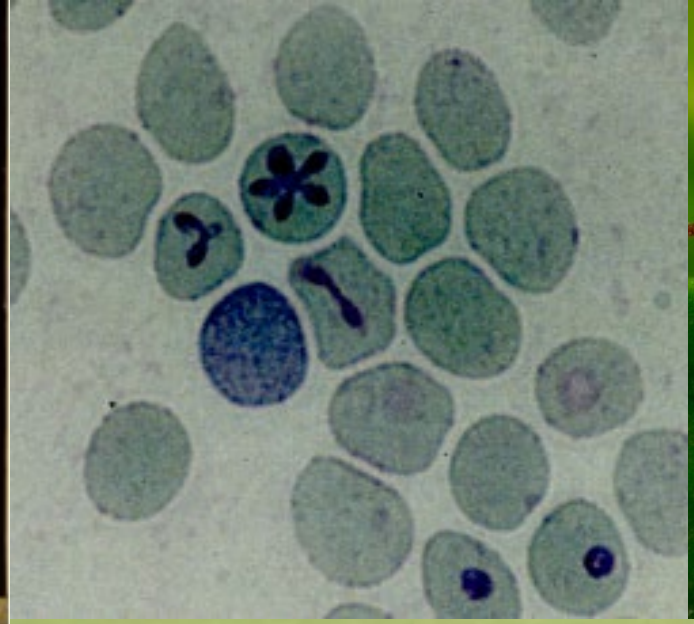
Not Zoonotic



T. orientalis Ikeda Take-Home Points

- Emerging US disease in cattle
- *H. longicornis* tick transmission
- Acute anemia
- Chronic asymptomatic infections
- PCR best way to definitively diagnose
- No Treatment
- Biosecurity and prevention is key





Equine Piroplasmosis

- *Theileria equi* and *Babesia caballi*
- Foreign Animal Disease
- Indirect Life Cycles
  -Tick-borne disease

Learning Objectives: Equine Piroplasmosis

1. Life cycle: know that equine piroplasmosis is caused by *Theileria equi* or *Babesia caballi,* both pathogens have an indirect life cycle and the specified life cycle details.
2. Transmission: understand how these 2 pathogens can be transmitted to horses.
3. Pathogenesis: understand the specified mechanisms of pathogenesis.
4. Clinical signs: know the specified clinical / laboratory findings for equine piroplasmosis.
5. Diagnosis: understand how to diagnose equine piroplasmosis and which is the best method
6. Management: understand how to manage equine piroplasmosis in the US.
7. Epidemiology: understand the risk factors in the US and that it is reportable

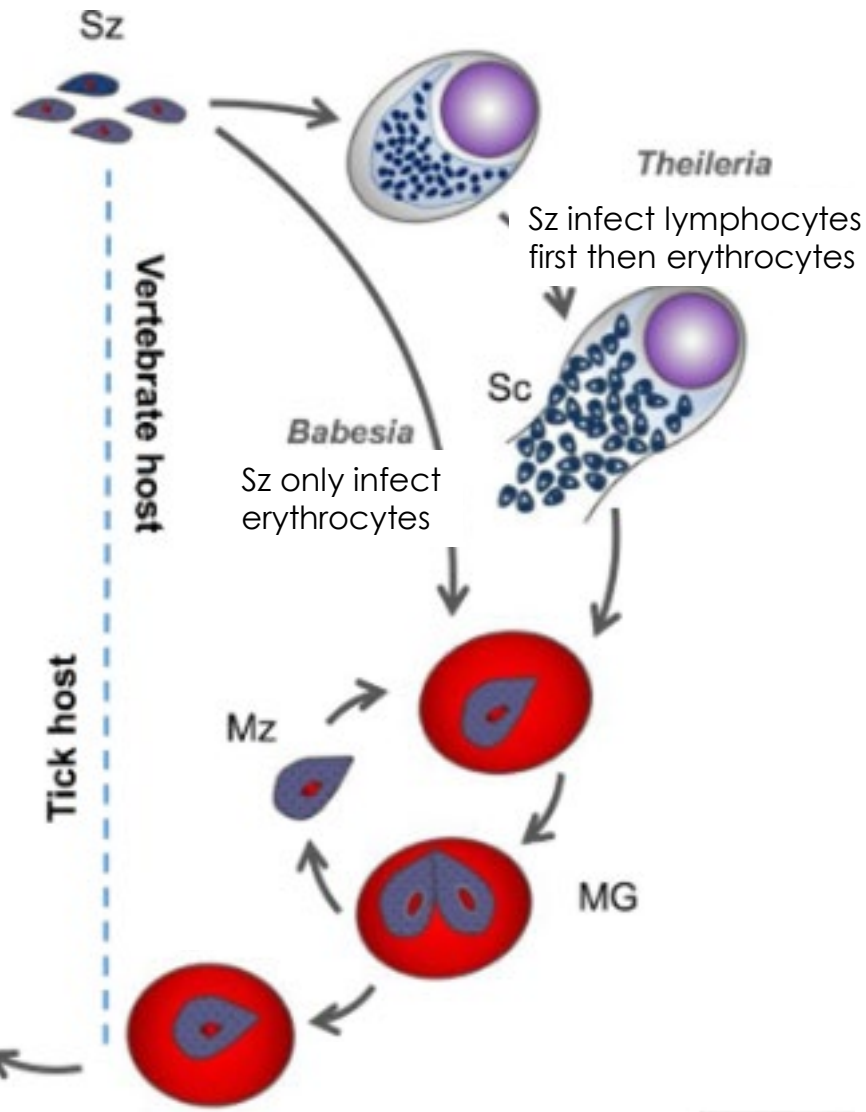
“FYI” = won’t be tested on

Indirect Life Cycle: *Theileria equi and Babesia caballi*

Many tick spp. transmit
T. equi and B. caballi:

FYI: U.S. tick species
Dermacentor variabilis
Rhipicephalus microplus
Amblyomma cayjennense

Dermacentor variabilis



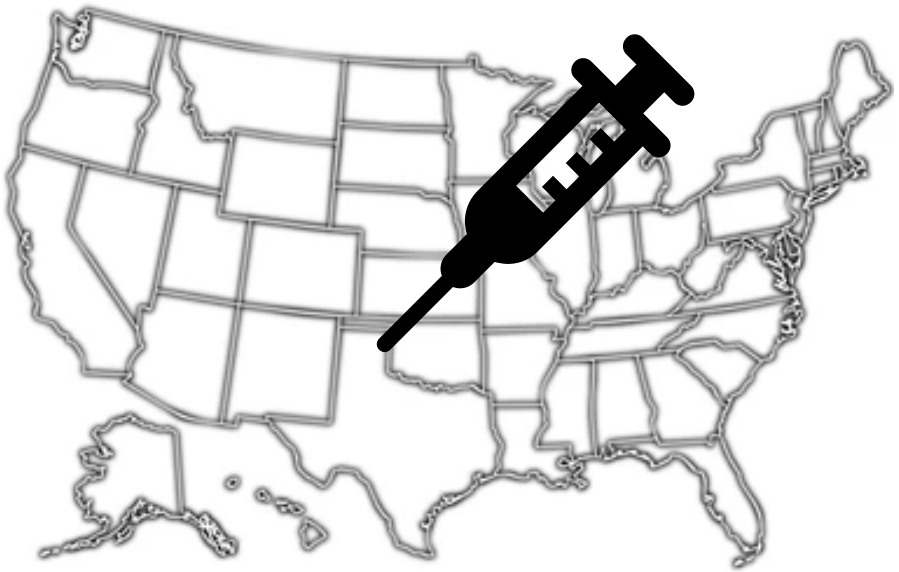
Horses
Donkeys
Mules
Zebras

SG = salivary gland
Sz = sporozoite
Sc = schizont
Mz = merozoite

Transmission: Equine Piroplasmosis

<u>*T. equi* and *B. caballi* can be transmitted by:</u>

1. **Ticks**
2. **Iatrogenic (blood transfusion or contaminated needles)**
   -contaminated needles most common in US
3. **Transplacental** (*T. equi* only)



Onyiche, ThankGod E., et al. "A review on equine piroplasmosis: epidemiology, vector ecology, risk factors, host immunity, diagnosis and control." *International journal of environmental research and public health* 16.10 (2019): 1736.

Pathogenesis: *T. equi* and *B. caballi*

Direct destruction of erythrocytes (hemolytic anemia)
multiple asexual cycles and destruction of RBC
Immune system removes RBC

B. caballi do not form schizonts
T. equi lymphocytic schizonts do not play a major role in *T. equi* pathogenesis

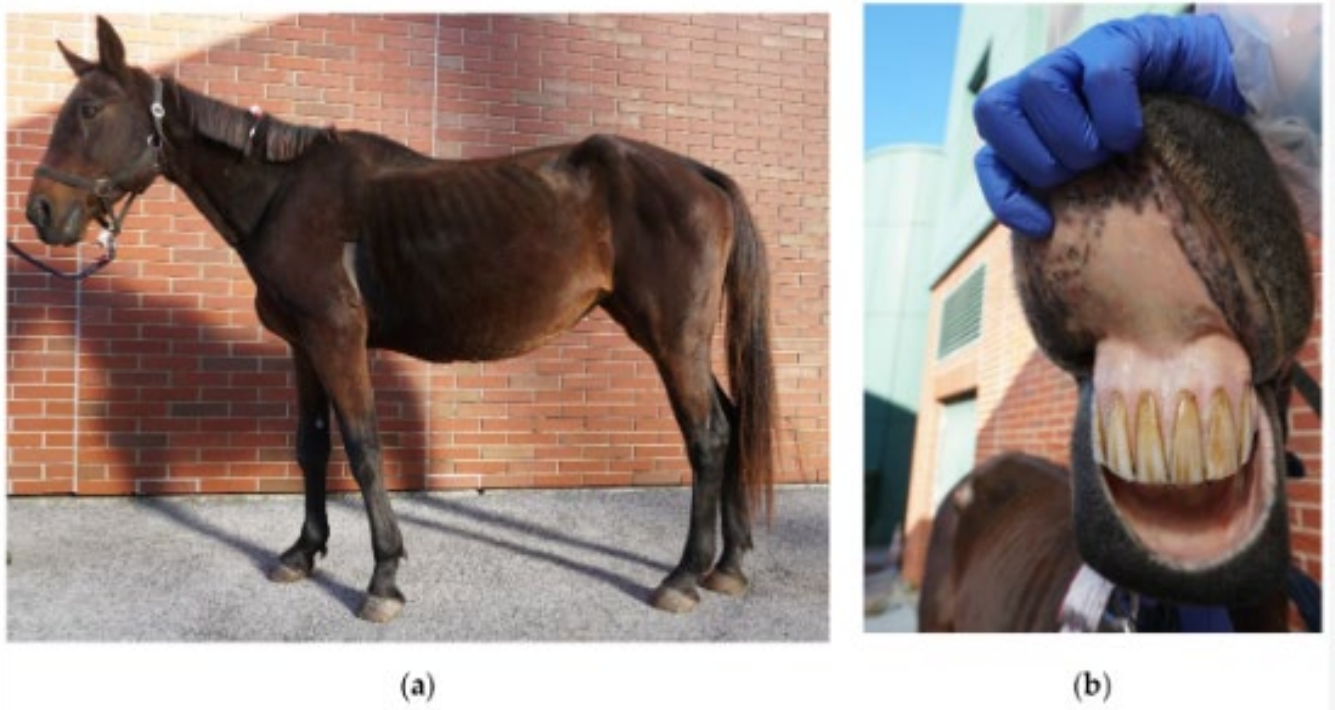
History and Clinical Signs: Equine Piroplasmosis

T. equi results in more severe clinical disease than *B. caballi*.

Acute Phase
Fever, pale mm, inappetence, weight loss, edema, splenomegaly, +/- icterus, +/- hemoglobinuria
Anemia
Thrombocytopenia

Chronic Phase
Weight loss
Poor performance
Subclinical infections (endemic countries)

Figure 1. (a) Clinical presentation of the diseased mare with poor body condition and (b) pale mucous membranes.



Pathogens **2021**, *10*(3), 298; https://doi.org/10.3390/pathogens10030298

Diagnostics: Equine Piroplasmosis

Blood smear (fast, less sensitive)

Serology (ELISA, IFA)

-good for chronic infections

-ELISAs differentiate between species

PCR

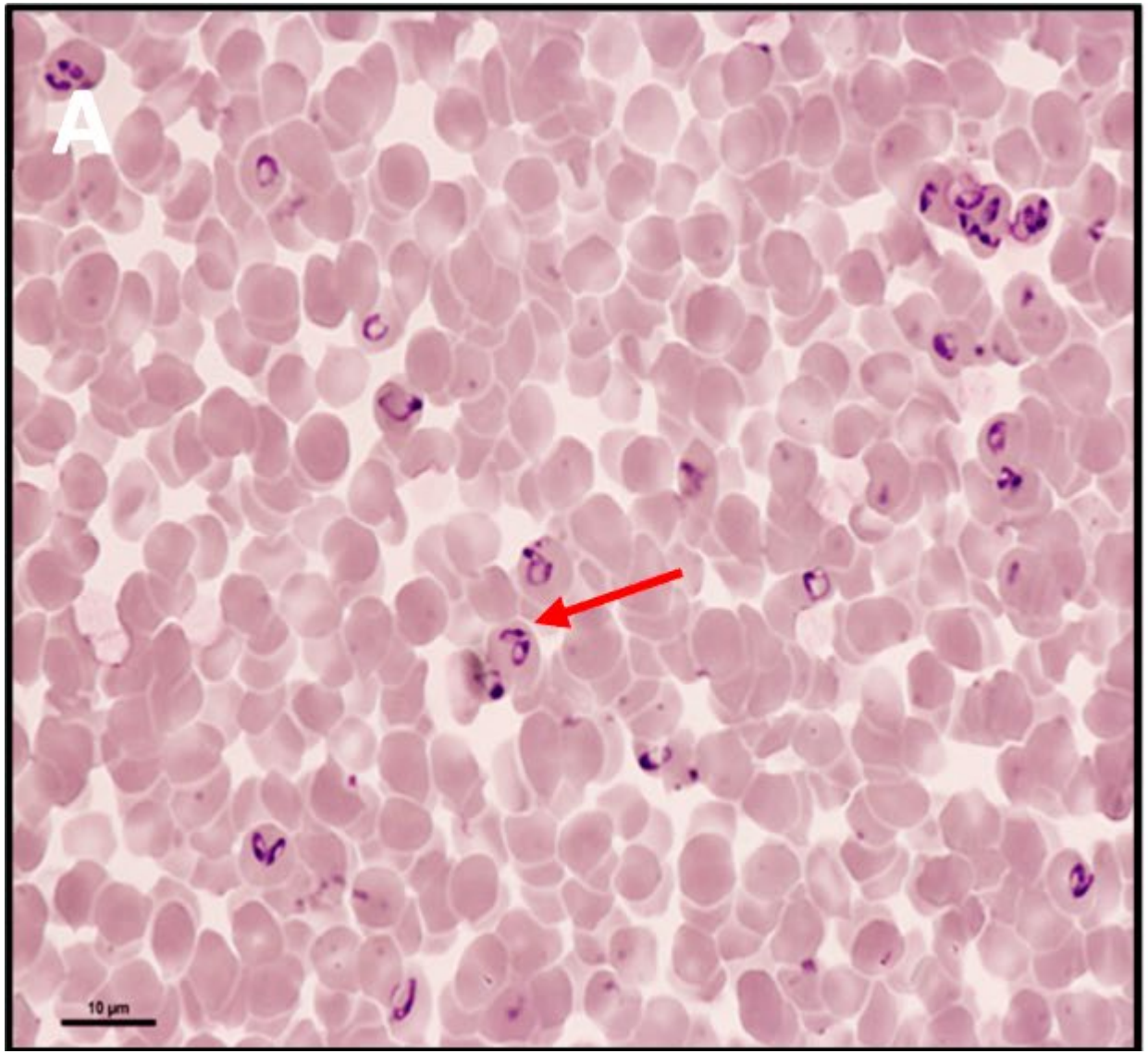
-good for acute and chronic infections

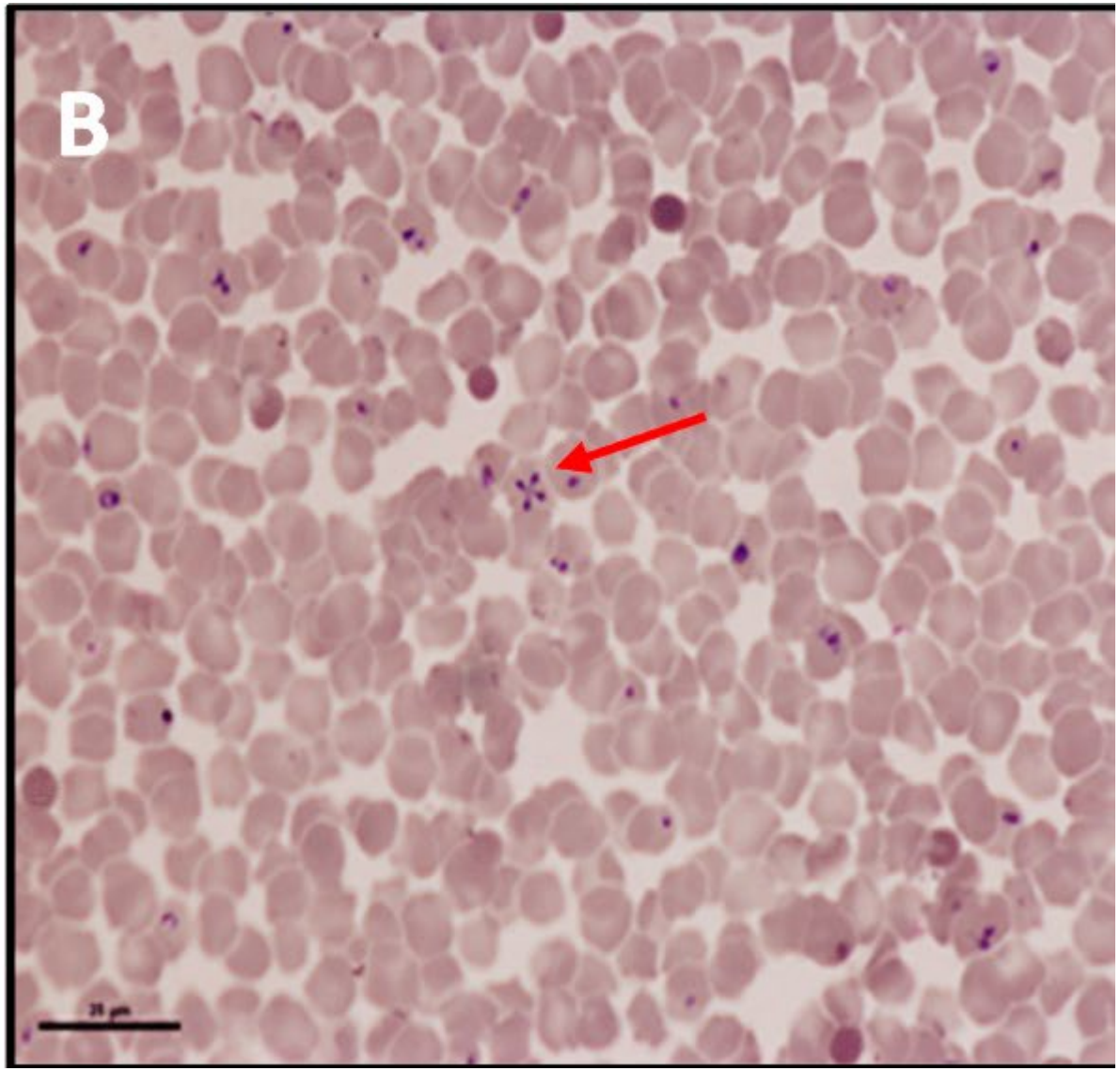
-differentiate between species

Horses imported into the U.S. should be tested for *T. equi* and *B. caballi*

Babesia caballi

Theileria equi





Management: Equine Piroplasmosis

Treatment (nonendemic countries):
Imidocarb dipropionate injections may help and reduce reservoir status
USDA-approved treatment program

Management:
No approved vaccine
Subclinical, chronically infected have life-long immunity

Prevention (used in nonendemic countries):
Biosecurity (testing new horses, inspect for ticks)
US, Canada require seronegative results to import (exceptions for sports)
Quarantine
Tick control

Epidemiology: Equine Piroplasmosis

- World-wide
- Not Zoonotic

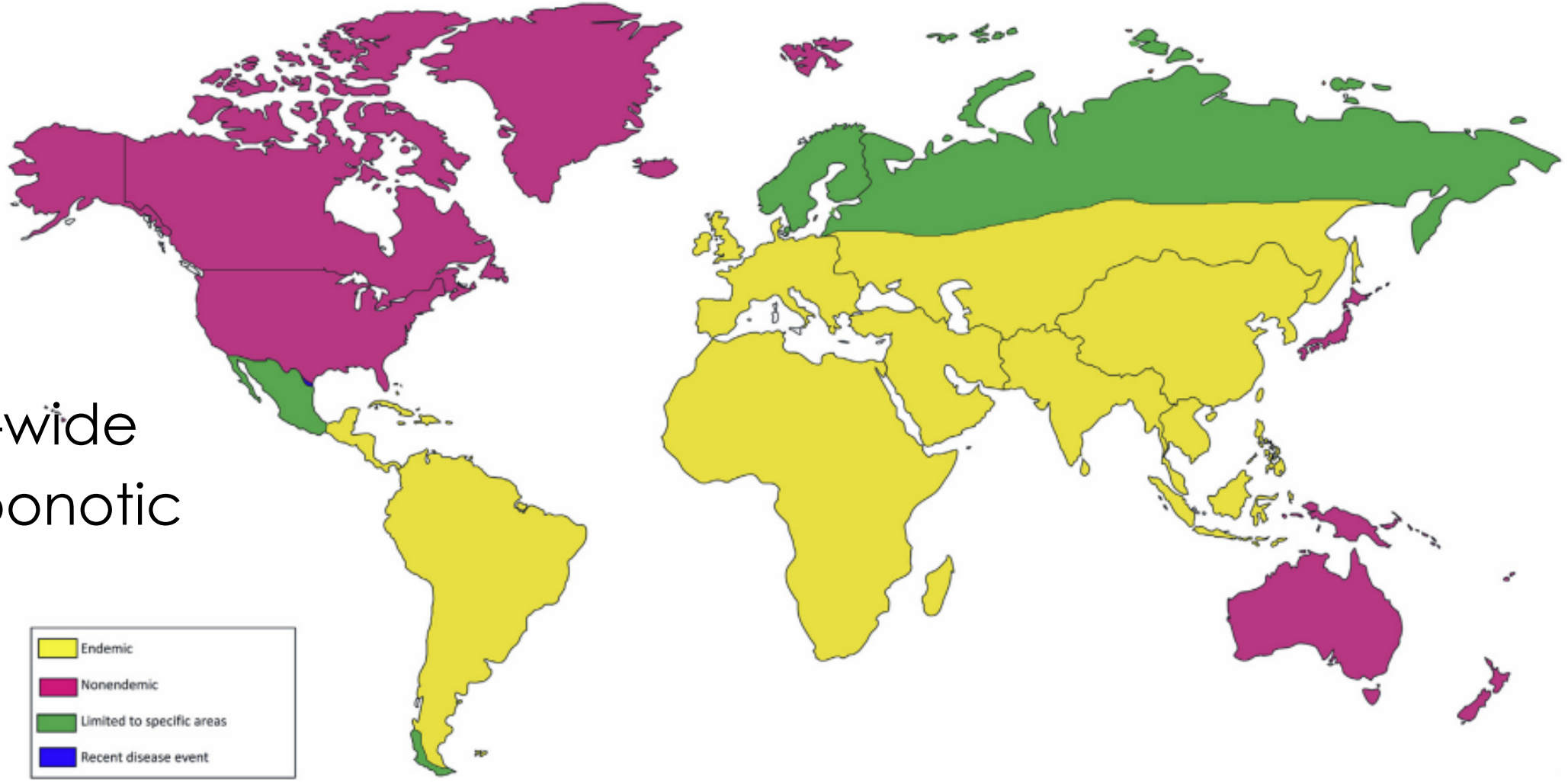


Fig. 2. General representation of the global distribution of equine piroplasmosis.

Management: Equine Piroplasmosis United States

National Reportable Disease
https://www.aphis.usda.gov/livestock-poultry-disease/surveillance/reportable-diseases

USDA Oversight:

- The USDA monitors equine piroplasmosis through import regulations, testing, and surveillance.

Quarantine Zones:

- Horses testing positive are quarantined and either treated, permanently restricted, or euthanized if necessary.

Outbreak Response:

- Tick control, movement restrictions, and testing of at-risk populations.

Epidemiology in US: Equine Piroplasmosis

FYI: Large outbreaks reported in US:

Texas (2009)

- 292 horses on a ranch
- Tick transmitted

Florida 2008

- 20 horses in 6 counties T. equi+
- Horses imported from Mexico not tested
- Iatrogenic transmission

Risk Factors (horses in US) (know this)

- Importation from endemic countries
- Unregulated racing events
- Quarter Horse racehorses

2021 EP Cases by State: 36 EP-infected horses found in 7 states (Jan-Dec 2021)

State Found	# *T. equi*-positive	# Dual infected with EIA	Risk Group
Florida	1	0	Andalusian originally from Spain, illegally moved from Mexico
Georgia	1	0	QH racehorse
Iowa	2	0	QH racehorses
Louisiana	2	1	QH racehorses
Oklahoma	1	0	QH racehorse
Tennessee	8	6	QH racehorses
Texas	21	8	17 QH racehorses in several clusters; 4 horses (1 Andalusian, 3 QH saddle horses) illegally moved from Mexico
Total	36	15	31 QH racehorses; 5 horses illegally moved from Mexico

Scoles, Glen A., et al. "Equine piroplasmosis associated with Amblyomma cajennense ticks, Texas, USA." *Emerging infectious diseases* 17.10 (2011): 1903.

Short, Michael A., et al. "Outbreak of equine piroplasmosis in Florida." *Journal of the American Veterinary Medical Association* 240.5 (2012): 588-595.

Equine Piroplasmosis Take Home Points

- *Babesia caballi* and *Theileria equi* cause hemolytic anemia in equids
- Primarily tick or iatrogenic transmission
- Asymptomatic infections in endemic countries
- PCR and serology to diagnose
- Imidocarb dipropionate treatment in nonendemic countries
- Biosecurity is key
- Imported and Quarter Horse racers at risk

Have Questions?

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