

# Medical & Veterinary Entomology



Michael Riehle  
Department of Entomology

# What is Medical Entomology

**“The study of insects, insect-borne diseases, and other associated problems that affect human and public health.” (Also arachnids)**

**This can include:**

**Insects that transmit disease**

**Insects that bite, sting, blister, or irritate**

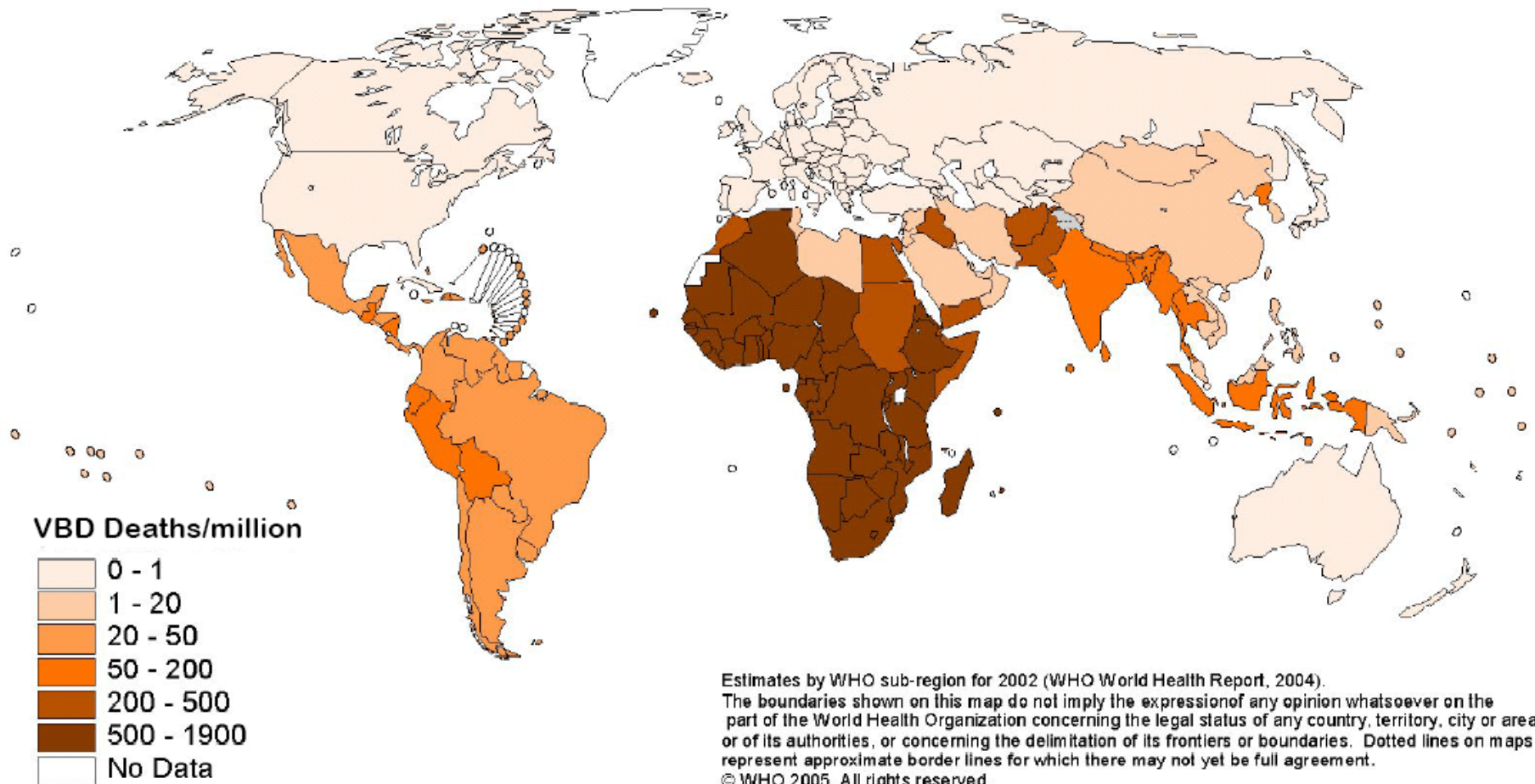
**Allergies to insects**

**Entomophobia and delusional parasitosis**

**Forensic entomology**

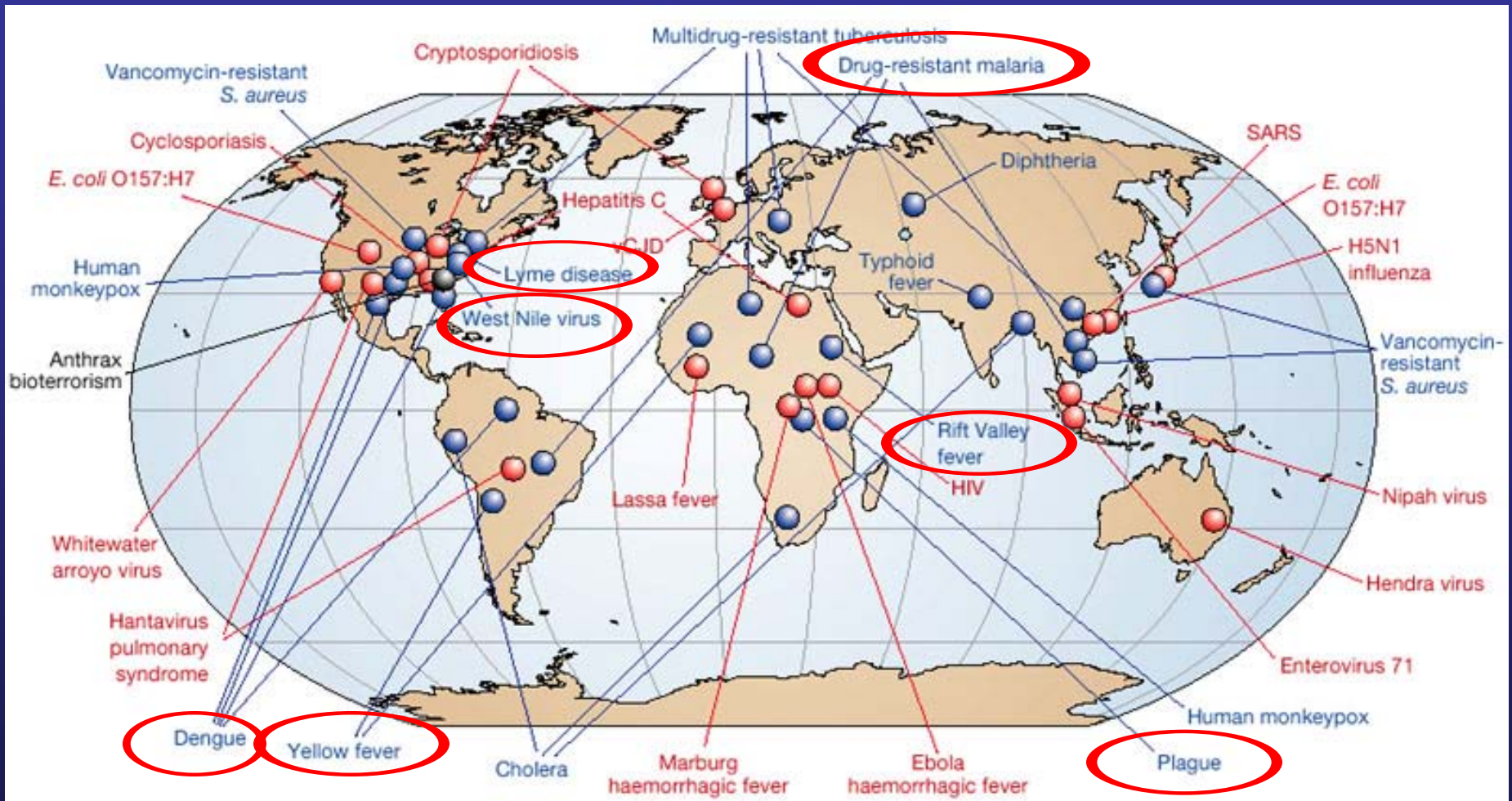
# Why study Medical Entomology?

## Deaths from vector-borne disease





# The Global Emergence and Re-emergence of Infectious Diseases



Red = newly emerging; blue = re-emerging/resurging; black = a 'deliberately emerging'.

From Morens *et al* (2004) Nature 430, 242

# **We can divide the medically important effects of insects into direct and indirect effects**

## **Direct Effects – Host Reactions**

**Mechanical reactions (dermatosis, dermatitis, itching)**

**Exsanguination (loss of blood, annoyance)**

**Myiasis (fly larvae invading living tissues)**

**Toxin & Paralysis (envenomization)**

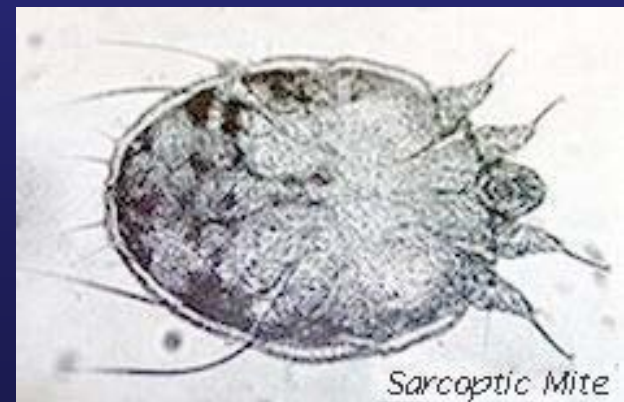
**Allergic reactions (anaphylaxis)**

# Mechanical reactions (dermatosis, dermatitis, itching)



Chigger and Chigger bites

# Mechanical reactions (dermatosis, dermatitis, itching)



**Mange**



## Texas Woman Claims to Have Found Mythical 'Chupacabra'



Is It Bigfoot Or Just A Mangy Bear?  
10-29-07





# Myiasis (fly larvae invading living tissues)



**Botfly**

# Toxin & Paralysis (envenomization)



# Toxin & Paralysis (envenomization)



**Fire Ant**



**Brown Recluse**



# Allergic reactions (anaphylaxis)



**US prevalence 0.4 – 0.8% of bee allergies**

**50-200 deaths annually**

**However, this is less than deaths caused by penicillin allergies or lightning strikes**

# Indirect Effects – Disease Transmission

Three things are required for vector-borne disease transmission

1. A competent arthropod vector



2. A susceptible host

3. A pathogen



# Indirect Effects – Disease Transmission

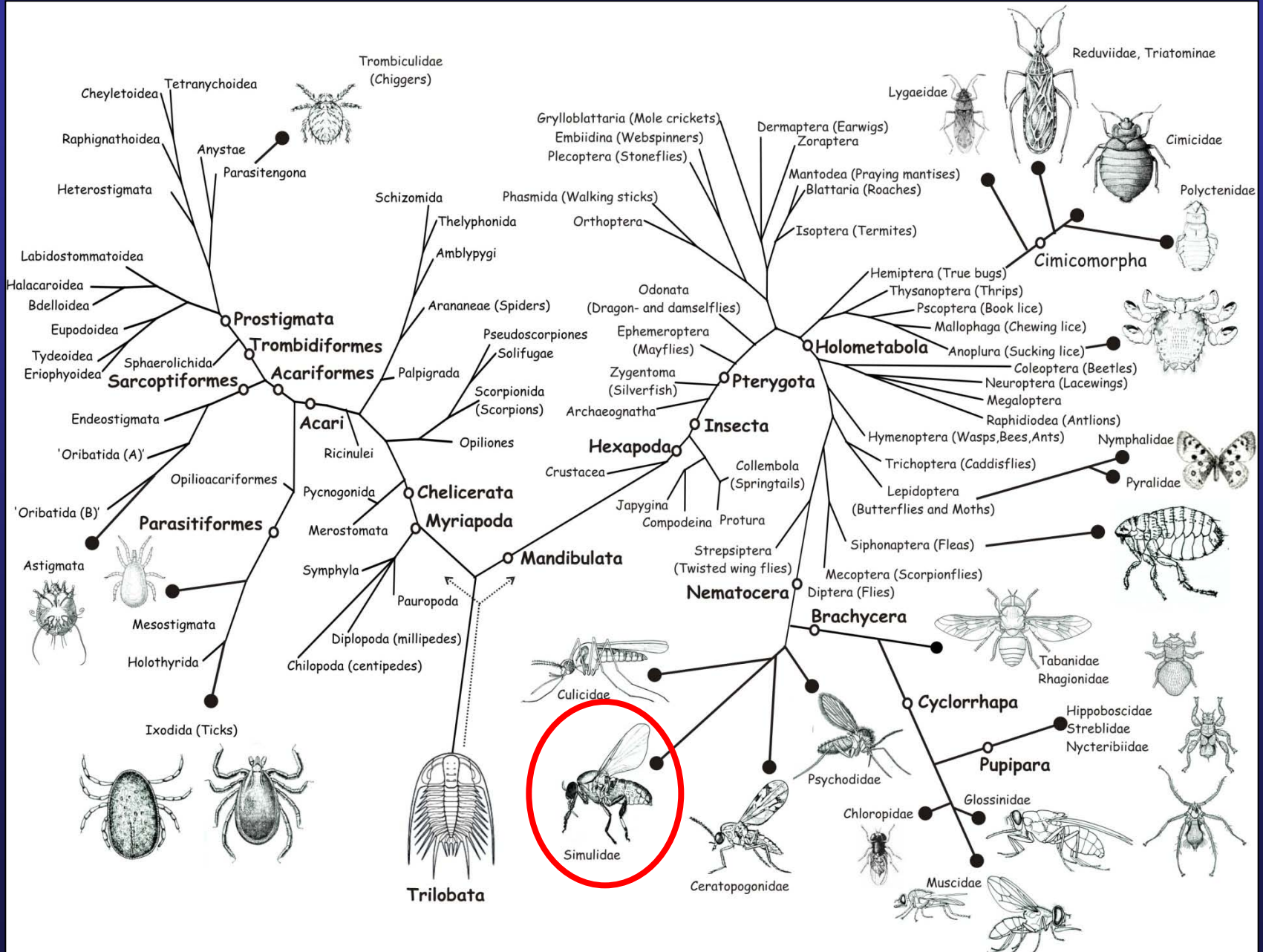
## Mechanical vs Biological transmission

**Mechanical transmission** occurs when the parasite is transmitted between hosts without amplification or development within the vector, usually by contaminated mouthparts.

**Biological transmission** occurs when the parasite has an obligate developmental or amplification period within the vector.



# Bloodfeeding Arthropods



# Black Flies (Simuliidae)



**Vector of Onchocerciasis (River Blindness)**

# Onchocerciasis (River Blindness)

## *Onchocerca volvulus*



- Cause by a filarial worm
- Adult worms live in Subcutaneous nodules (females live for more than 14 years) Males migrate between nodules
- Females produce 1000 mf per day which migrate to the Skin
- Mf taken up in the blood meal of a blackfly
- ~18 million infections leading to more than 0.5 million cases of blindness



# Onchocerciasis (River Blindness) Pathology



**Adults form large nodules, but microfilaria cause the pathology**

**Large numbers of microfilaria can cause intense itching, lesions, loss of skin elasticity, and if they invade the eye, blindness.**

**Some villages experience >15% blindness**



# Tabanid flies (Tabanidae)



**Vector of Loiasis (Loa Loa) and Tularemia  
(Rabbit Fever)**



# *Loa loa* - the tropical eye worm



**Biologically Transmitted**

**Migrating nematodes can cause pain and irritation**



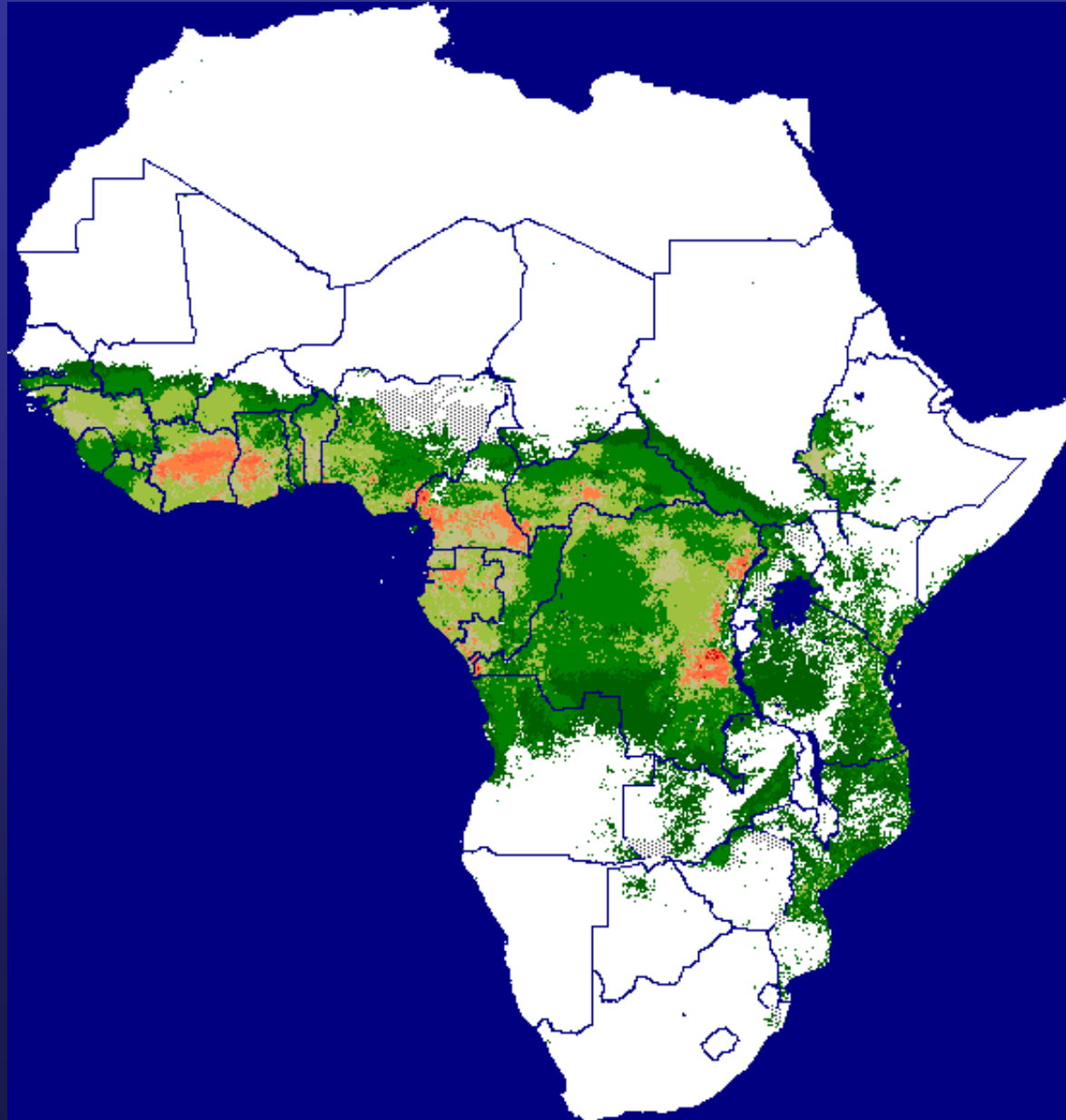
# Tsetse flies (Glossinidae)



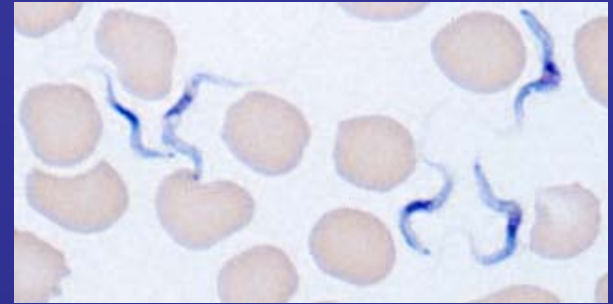
**Vector of African trypanosomiasis (sleeping sickness) and nagana**



# Distribution of all tsetse flies



# African trypanosomiasis



Major epidemics occurred in the late 19<sup>th</sup> century killing 750,000 people between 1896 and 1906.

50 million people in 38 countries are at risk.

25,000 new infections annually.

Thousands of deaths annually



# Last decade had many raging epidemics throughout subSahara

## Plagues of old reclaim continent



Tribune photos by Nancy Stone

10-year-old Dousa, 10, and his father, Paul Khamis, are patients at a hospital in Ibbra, Sudan, built for people with sleeping sickness. Dousa was severely malnourished when he first arrived because he wasn't awake long enough to eat properly.

Health care is regressing, life expectancy is going down.

Sleeping sickness, once vanquished, is killing again.

And in a post-Cold War world, few appear to care.

# The New York Times

Copyright © 1997 The New York Times

NEW YORK, FRIDAY, JULY 18, 1997

At \$1.00 the greatest New York newspaper

## Epidemic Rakes Sudan; Among Century's Worst



- WORLD
- U.S.
- LOCAL
- WEATHER
- SPORTS
- BUSINESS
- SCI-TECH
- POLITICS
- TRAVEL

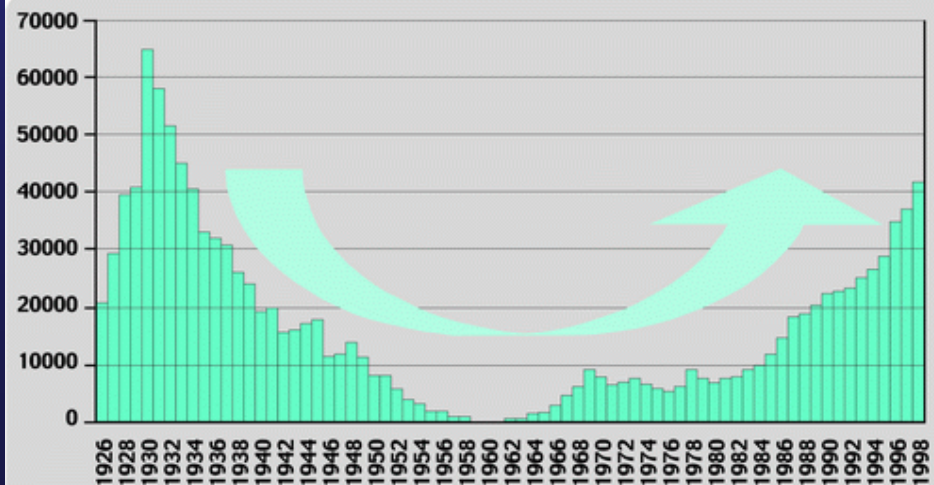
### Battling the deadly bite of the tsetse fly

February 28, 1998  
Web posted at: 2:08 p.m. EST (1908 GMT)

(CNN) — On the African continent, in the narrow band between the 15th parallels that bookend the equator, a tiny fly is jeopardizing the lives of 55 million people and could be responsible for one of the largest epidemics of this century.

The narrow arc along the equator ventures through 36 sub-Saharan nations, 22 of which are among the most underdeveloped in the world. In every land, the tsetse fly thrives.

Number of deaths from sleeping sickness





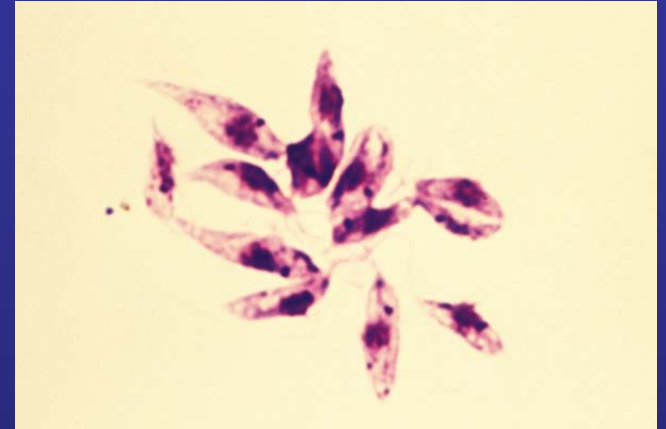


# Sand flies (Psychodidae)



**Vector of leishmaniasis, sand fly fever,  
Oroya fever**

# Leishmaniasis



**Protozoan parasite**

**Two forms cutaneous and visceral**

**Threatens 350 million men, women and children in 88 countries around the world**



# Clinical manifestations of leishmaniasis



Cutaneous leishmaniasis  
caused by *Leishmania major*



Visceral leishmaniasis  
caused by *Leishmania donovani*

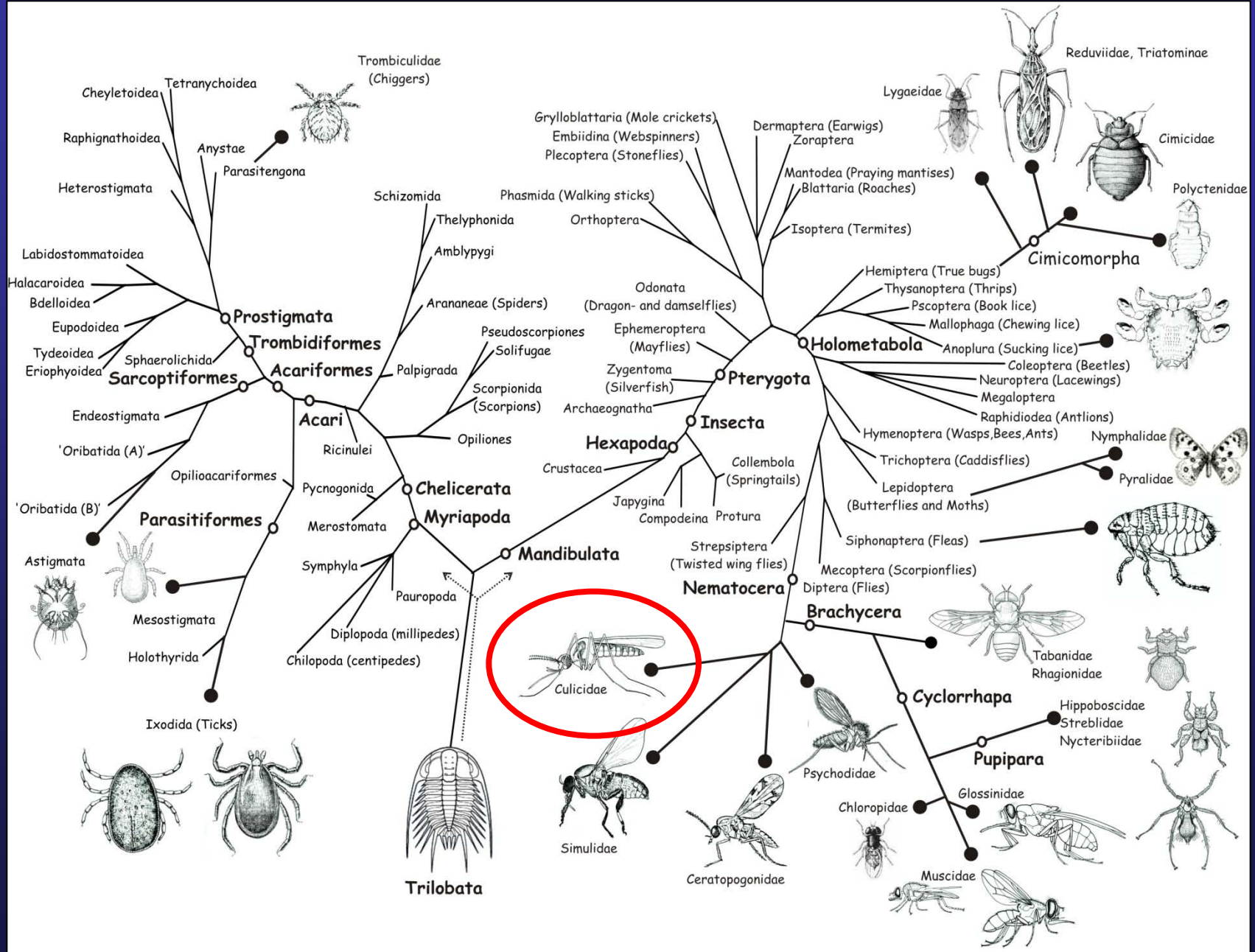


Mucocutaneous  
leishmaniasis caused by  
*Leishmania braziliensis*

Canine leishmaniasis  
caused by *Leishmania infantum*



# Bloodfeeding Arthropods



# Mosquitoes (Culicidae)



## Vector of:

Viruses – yellow fever, dengue, Rift Valley fever, myxomatosis, eastern equine encephalitis, western equine encephalitis, Venezuelan equine encephalitis, St. Louis encephalitis, LaCross encephalitis, Japanese encephalitis, West Nile encephalitis, Murray Valley encephalitis, Chikungunya fever, O'nyong nyong fever, Ross River fever (~250 mosquito-borne, ~100 cause human disease)

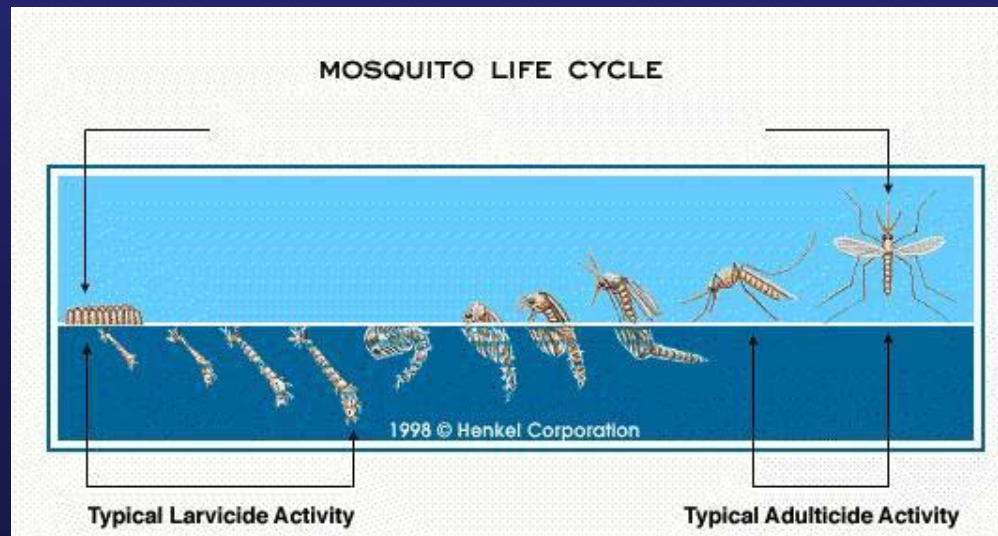
Protozoans – Malaria

Filarial nematodes – Wuchererian filariasis, Bancroftian filariasis, dog heartworm



# Mosquitoes (Culicidae)

- 3000 species world-wide
- ~150 in North America and ~50 in Arizona
- Only females consume blood and thus transmit disease
- Holometabolous life cycle with immature stages being aquatic



# Malaria (*Plasmodium*)



**1.6 billion people at risk**

**300-500 million new cases annually**

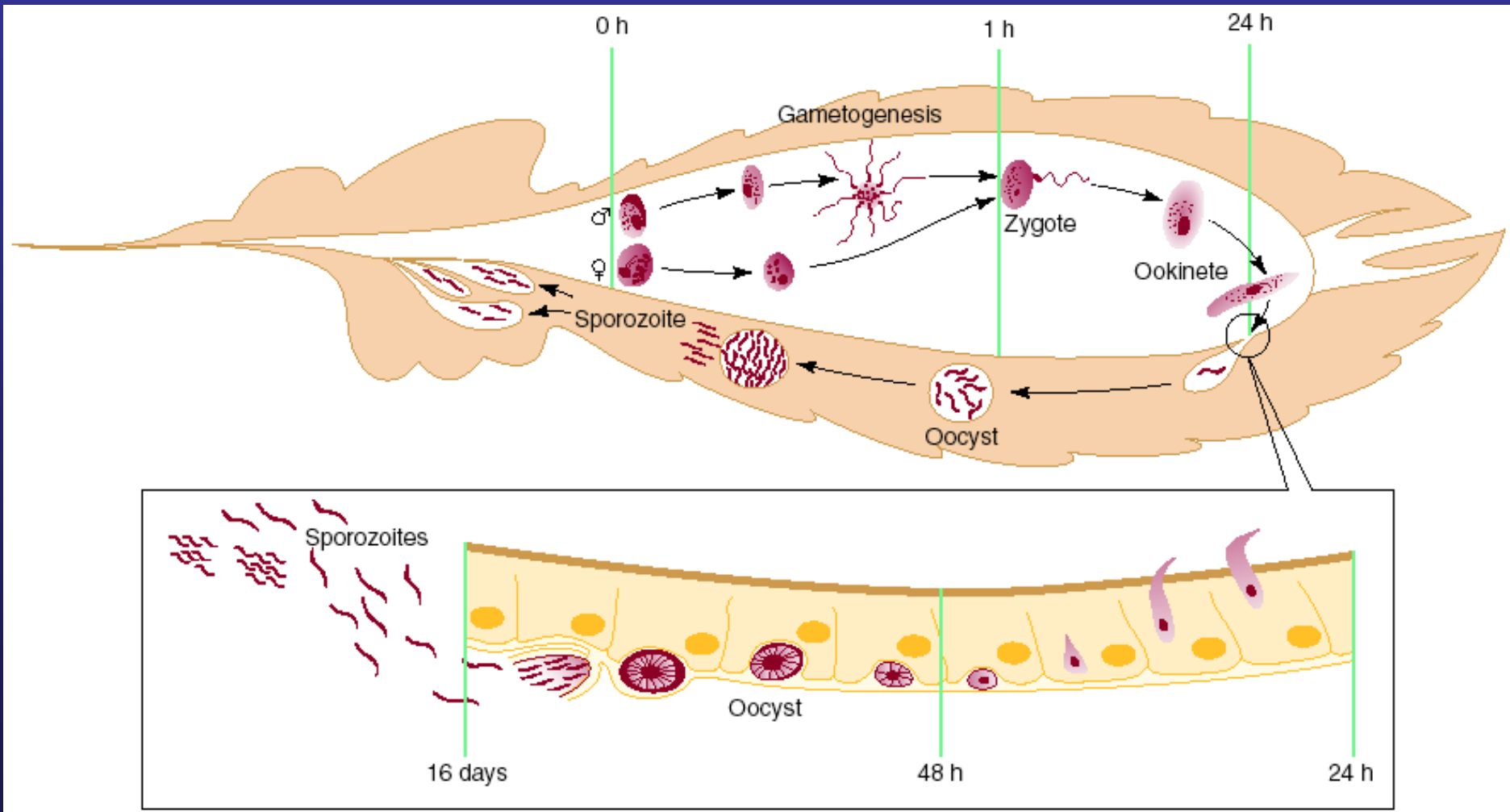
**1-3 million deaths annually, mostly children**

**Both the mosquito and the parasite have developed resistance to insecticides and drugs respectively.**

**In malaria endemic countries up to 40% of the public health expenditure goes to treat malaria.**

**The annual “cost” of malaria, in both direct and indirect costs, is ~\$1.8 billion**

# Malaria (*Plasmodium*) Life cycle in the mosquito





# Lymphatic filariasis

*Wuchereria bancrofti*  
& *Brugia malayi*

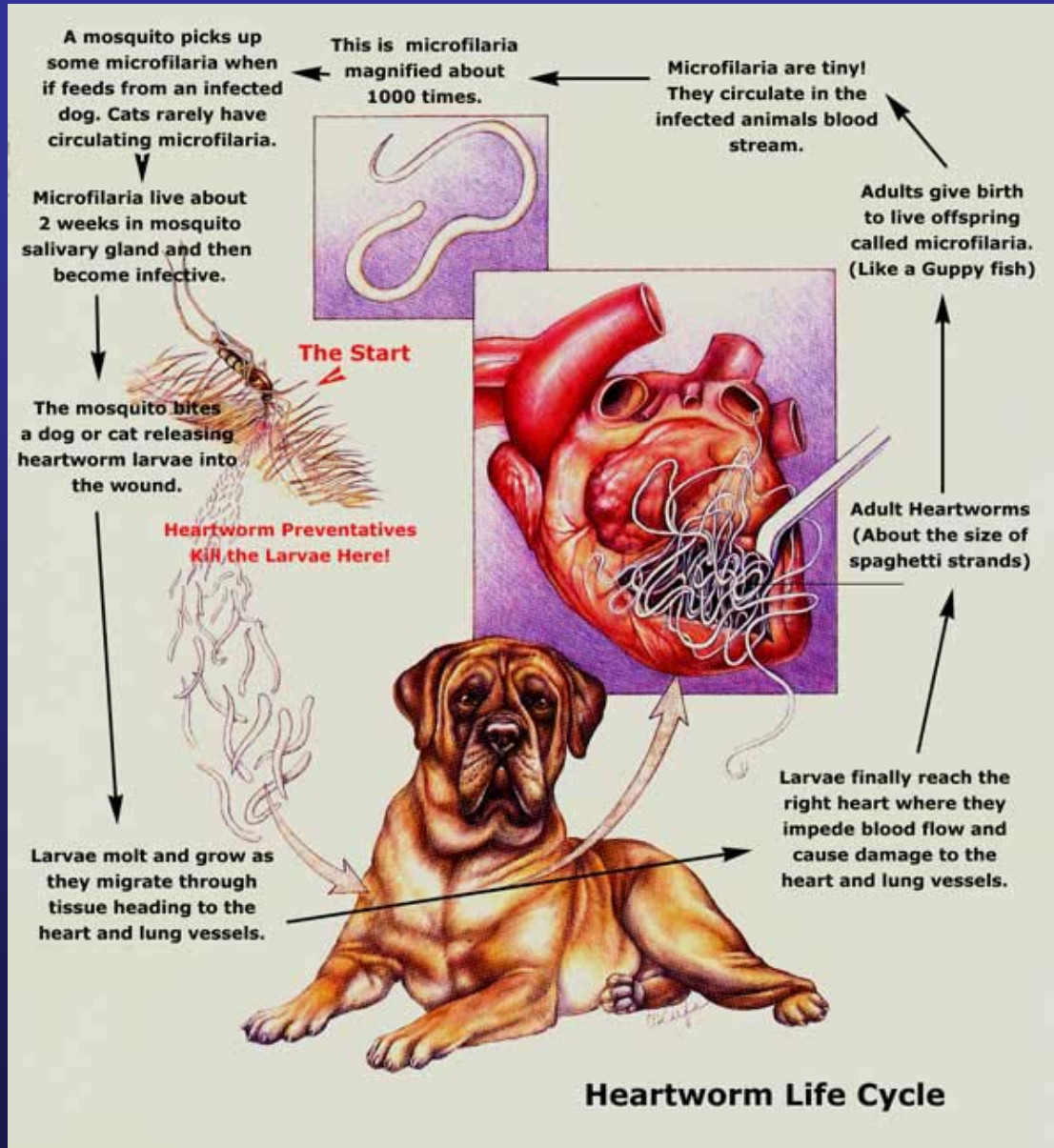
**1.2 billion people at risk**

**120 million infections per year**

- Adults live in lymphatic vessels for 5-10 years or more (reproductively active for 4-6 years).
- Female releases 50,000 or more microfilariae a day, which circulate in the blood to be transmitted by blood feeding mosquitoes.
- Microfilariae circulate in the blood for 1-2 years, and are only found in peripheral circulation at night.

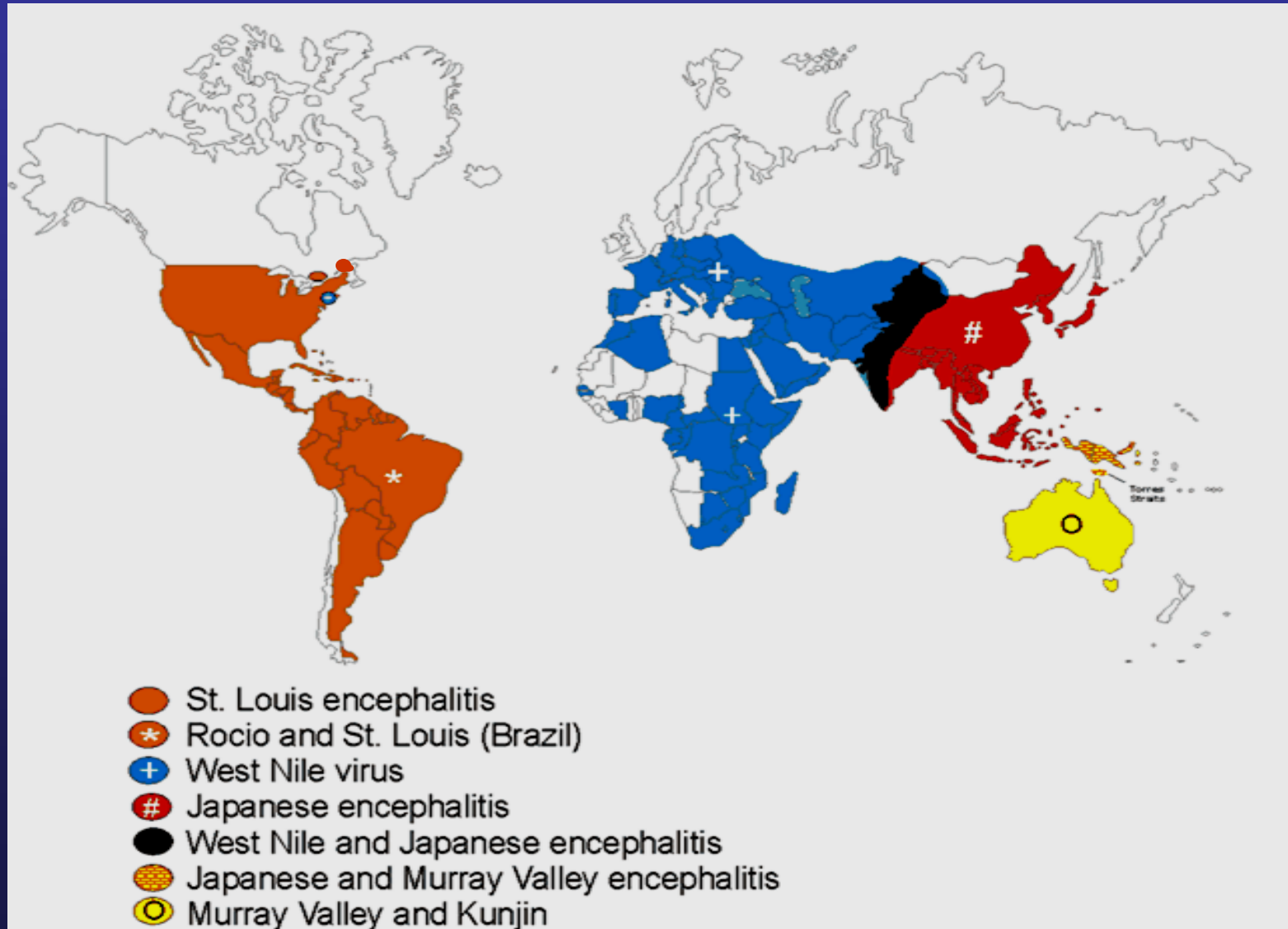


# Dog Heartworm



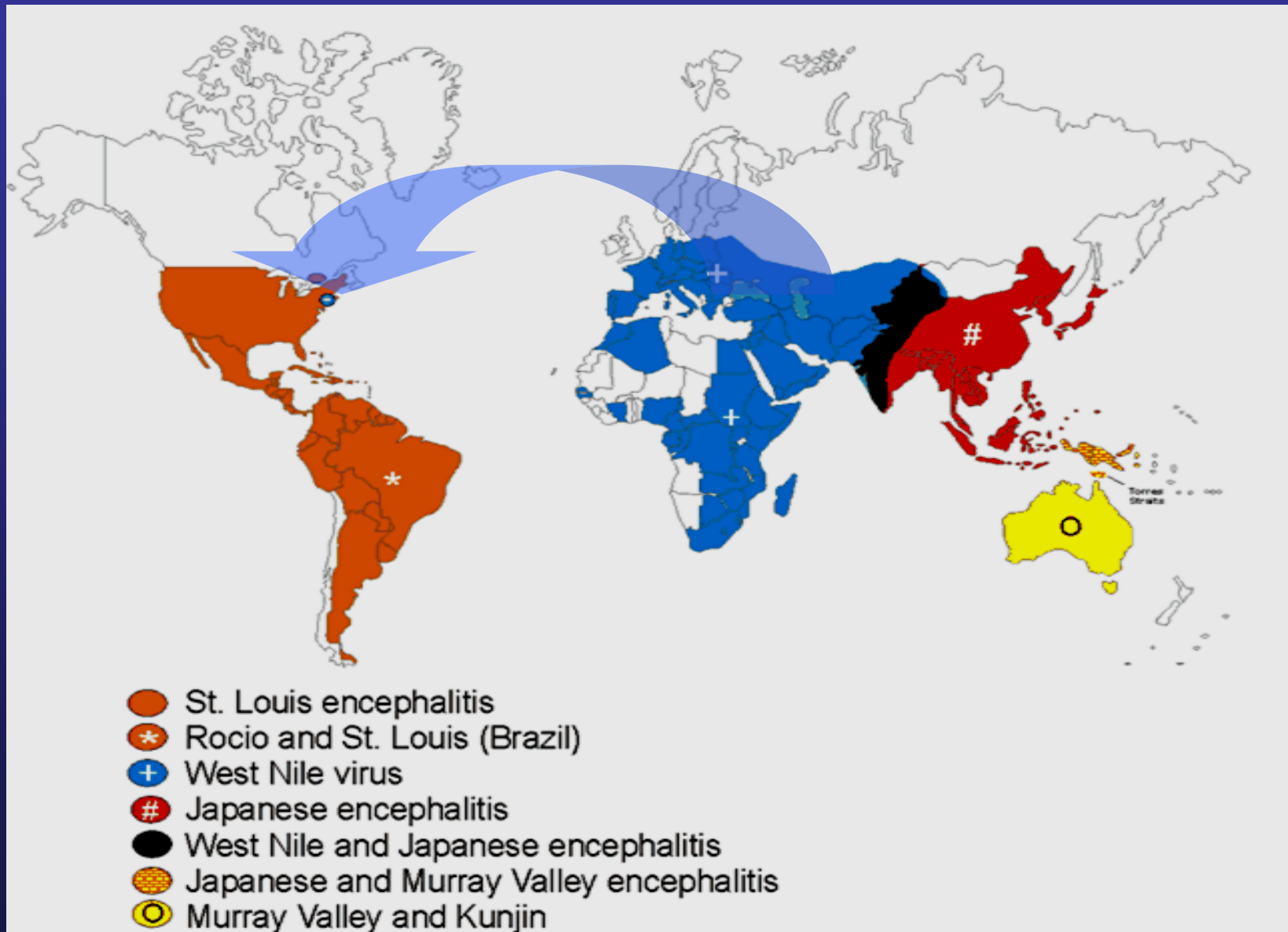
# Mosquito-borne Viruses Encephalitis

In 1998.....







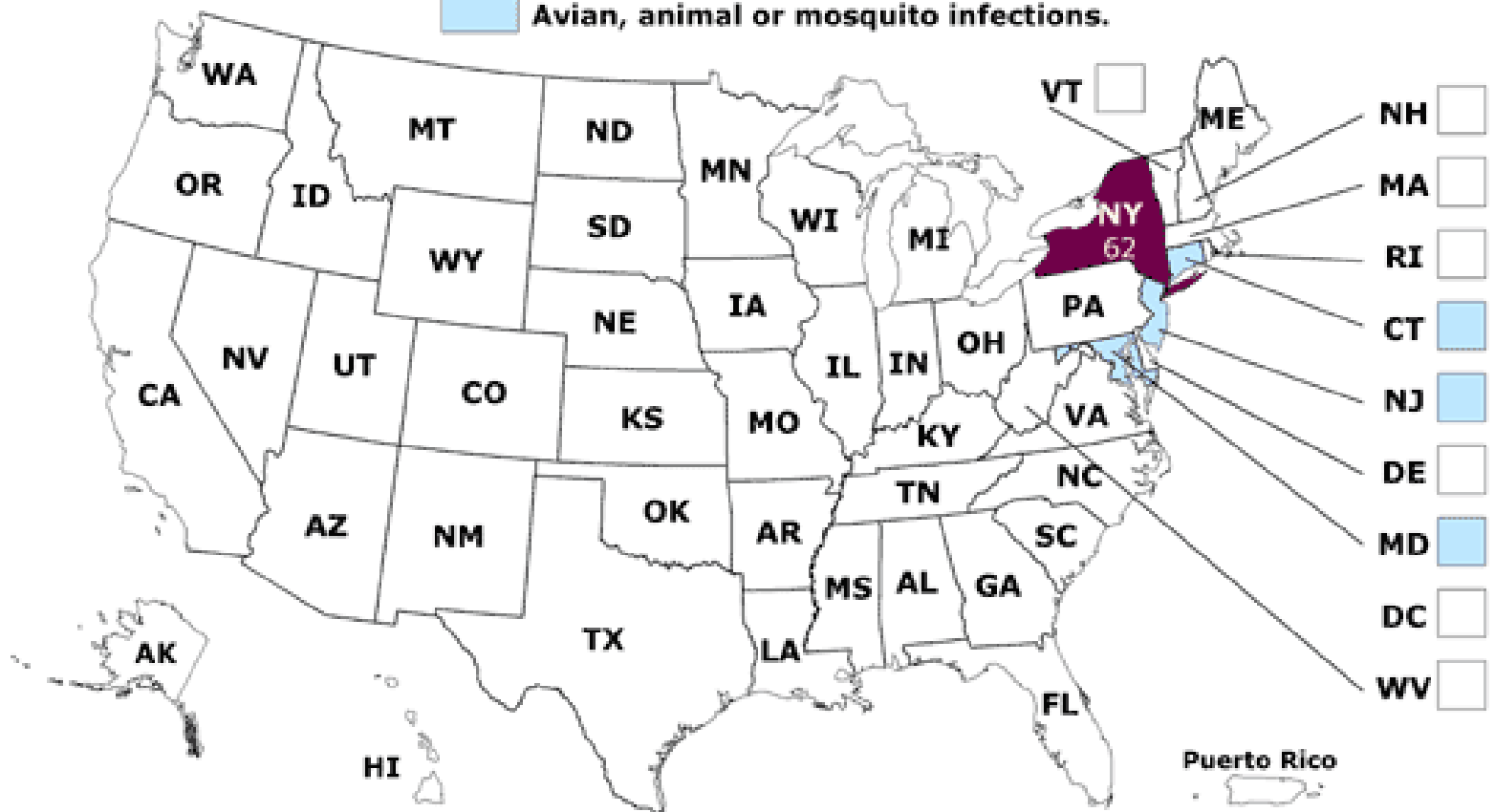
In 1999.....



# West Nile Virus 1999



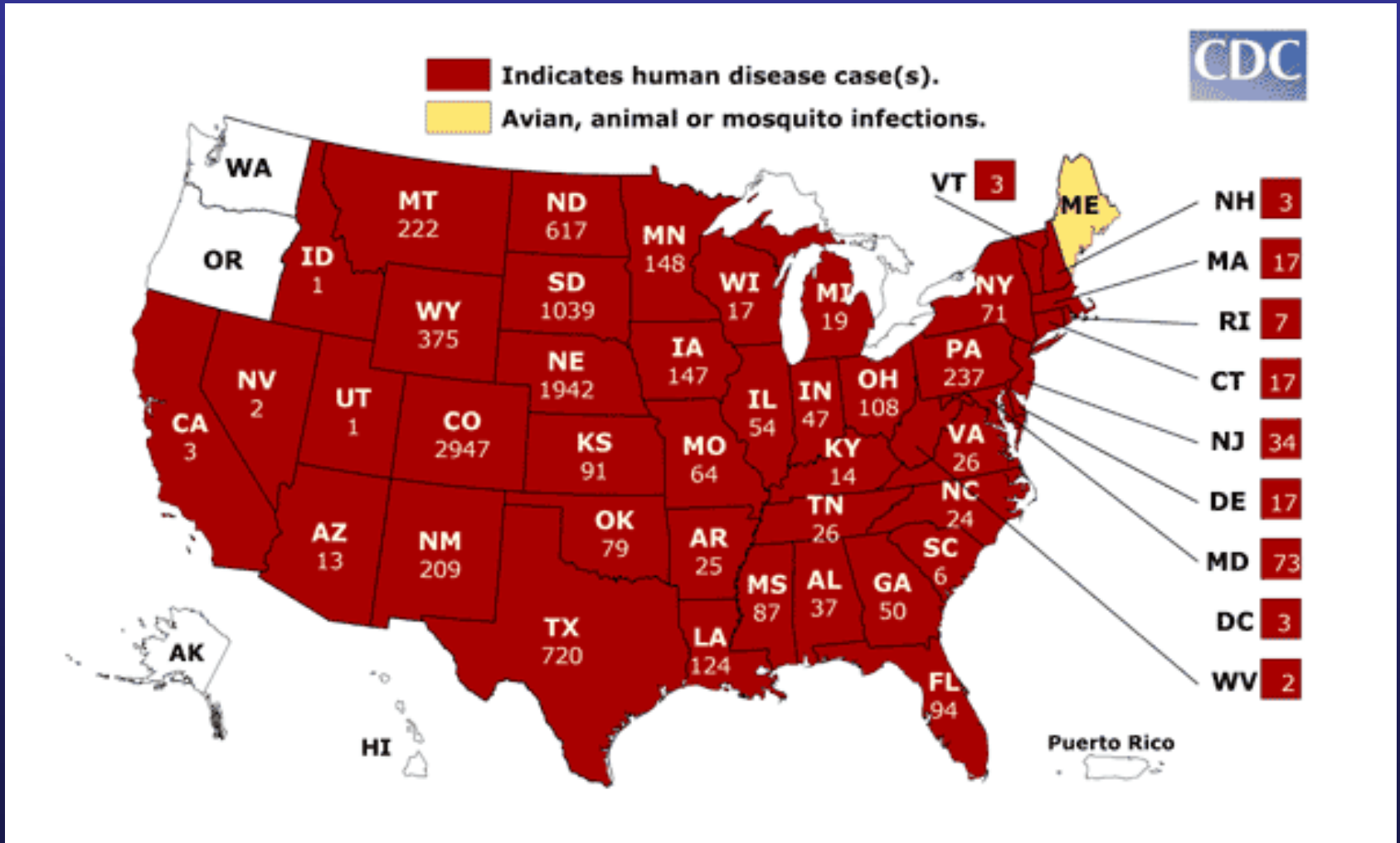
 Indicates human disease case(s).  
 Avian, animal or mosquito infections.



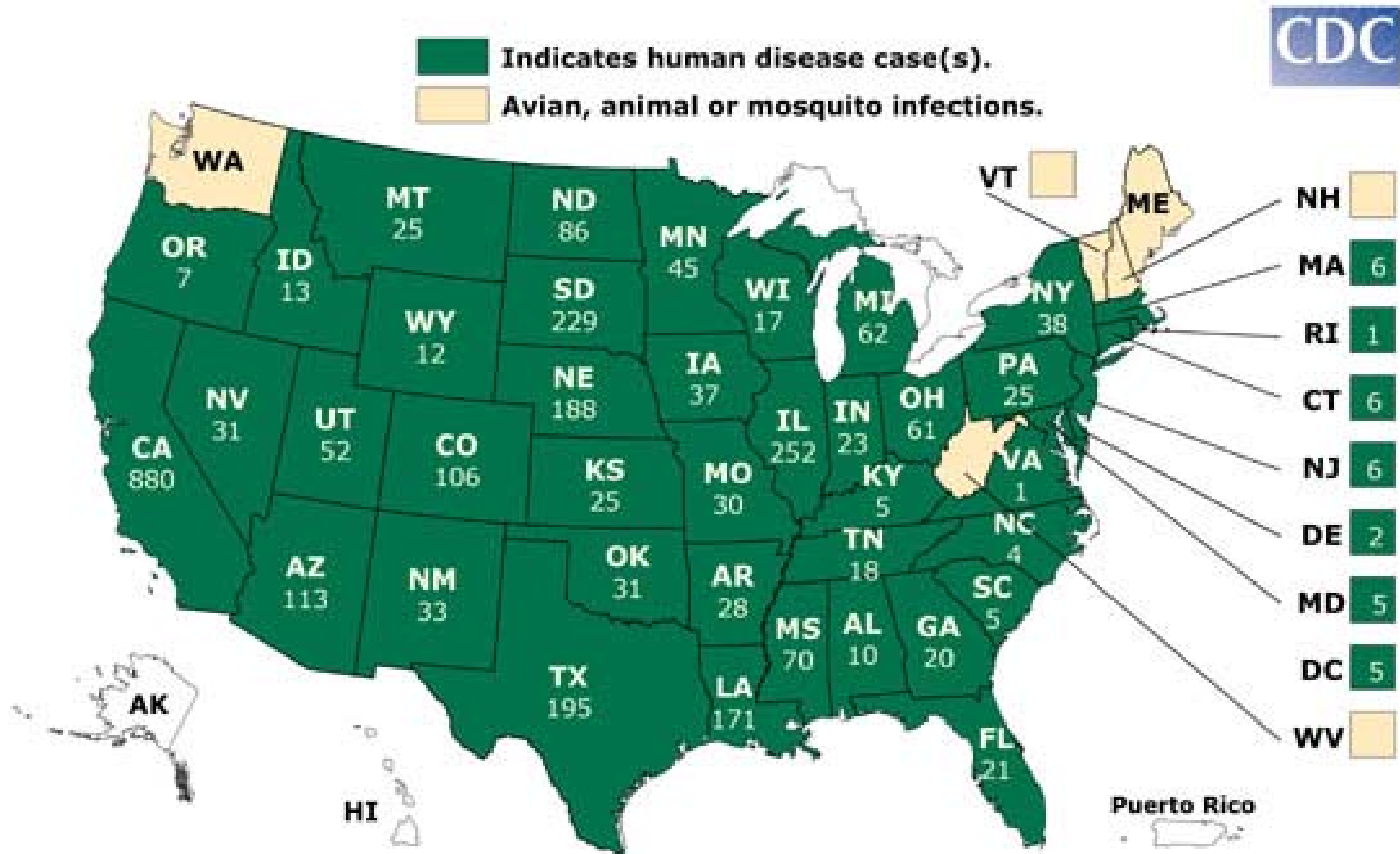






# West Nile Virus 2003

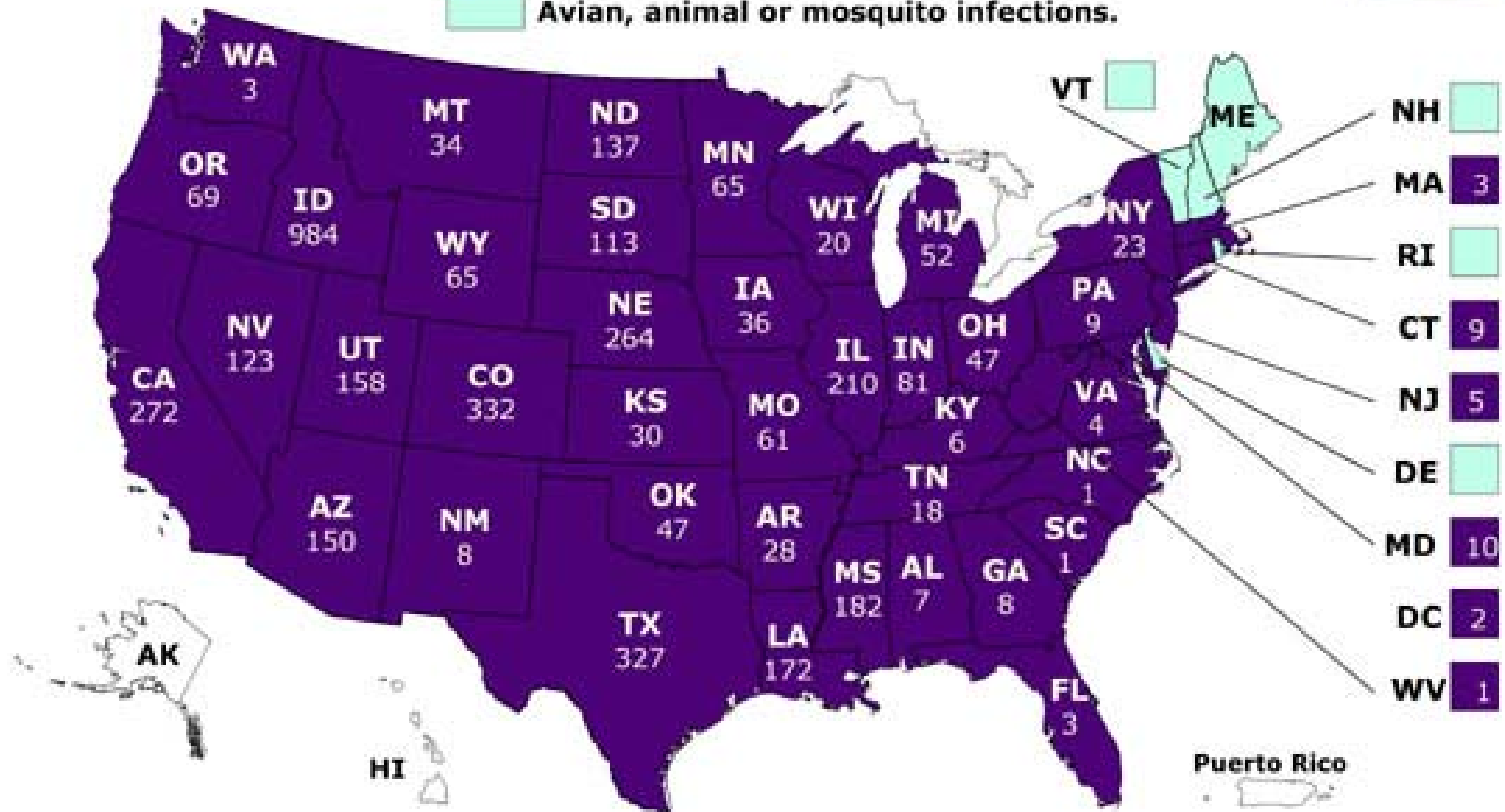


# West Nile Virus 2005



# West Nile Virus 2006

 Indicates human disease case(s).  
 Avian, animal or mosquito infections.



# Mosquito-borne Viruses

## Dengue & dengue haemorrhagic fever



Transmitted by *Aedes aegypti* (found in Tucson)

Two forms dengue and dengue haemorrhagic fever

Dengue fever is a flu-like illness. It can be quite painful, but rarely fatal.

Dengue hemorrhagic fever is a severe, often fatal, complication of dengue fever.

Four dengue serotypes (Den1-4) exist.

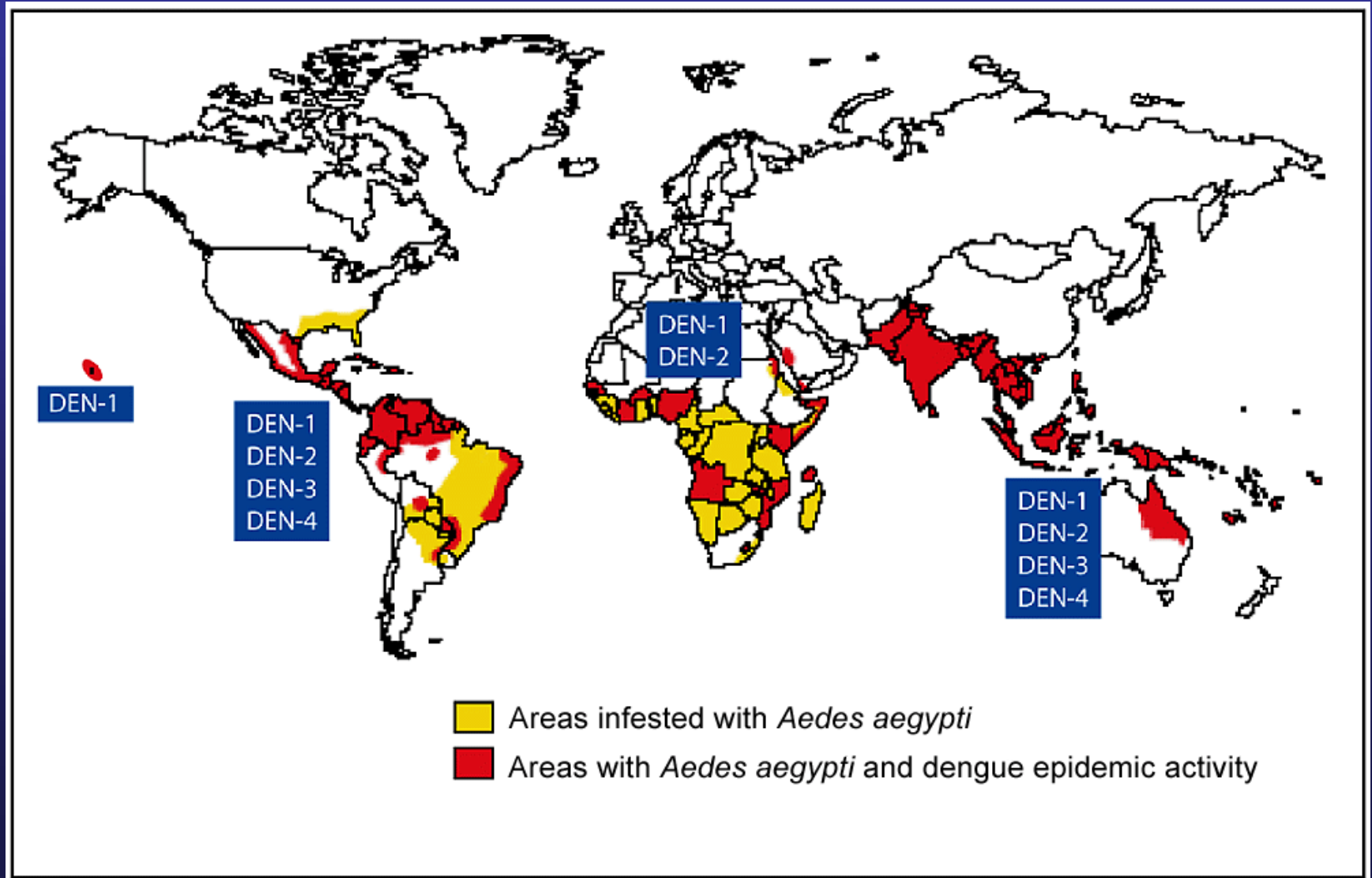
DHF can occur when a person previously infected with dengue is infected with a new serotype





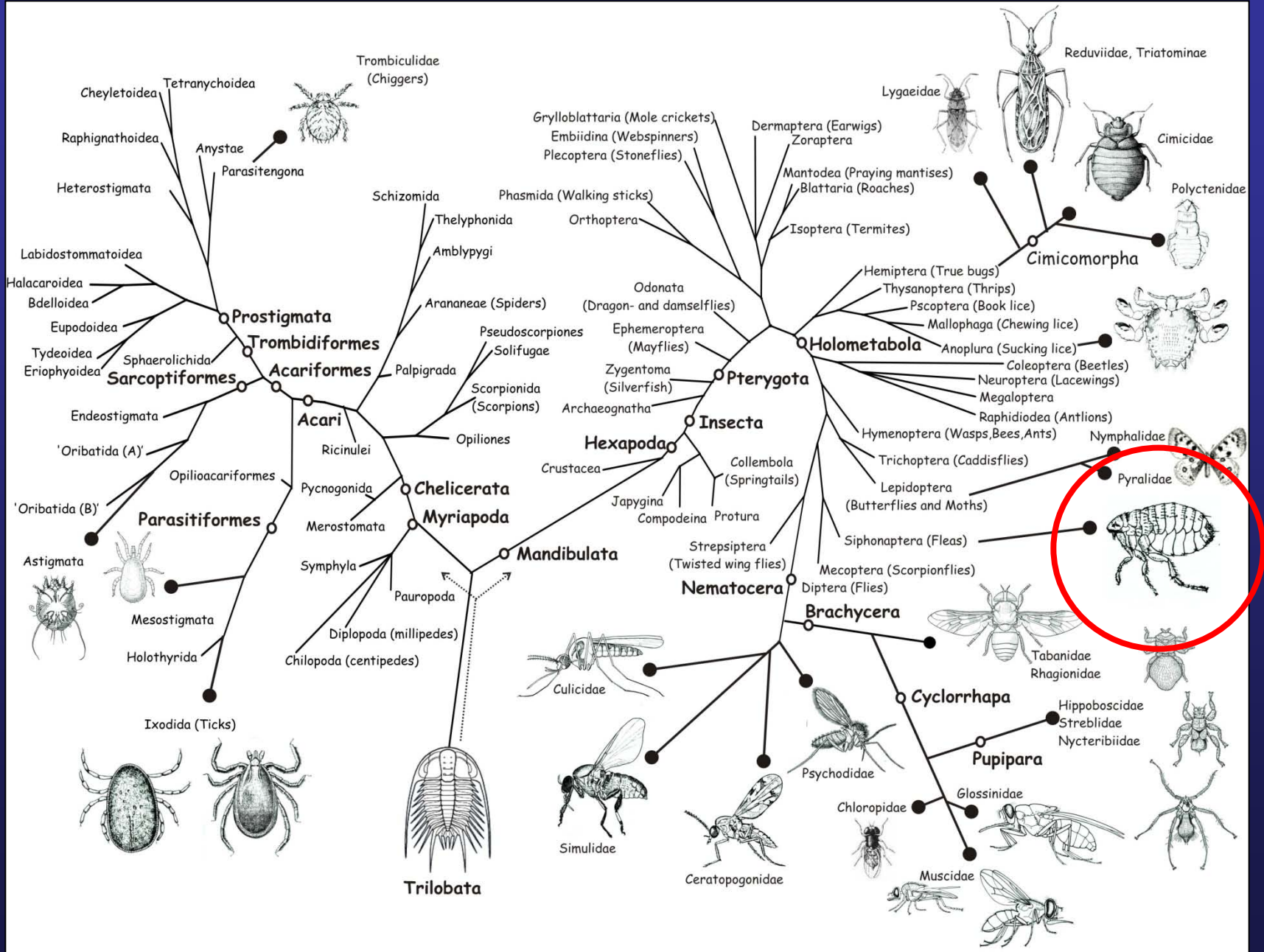
# Mosquito-borne Viruses

## Dengue & dengue haemorrhagic fever



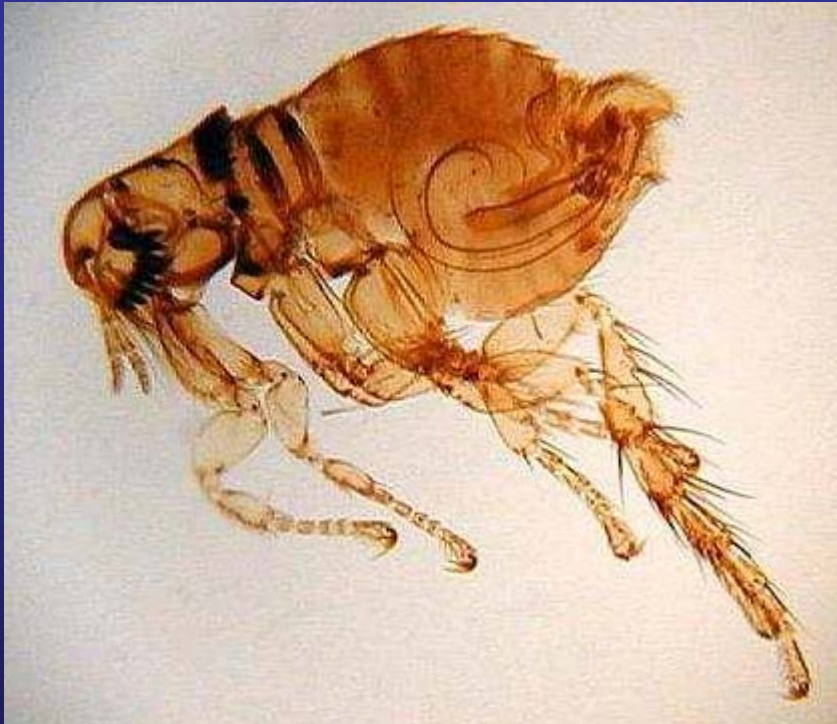


# Bloodfeeding Arthropods





# Fleas (Siphonoptera)



**Vector of plague**



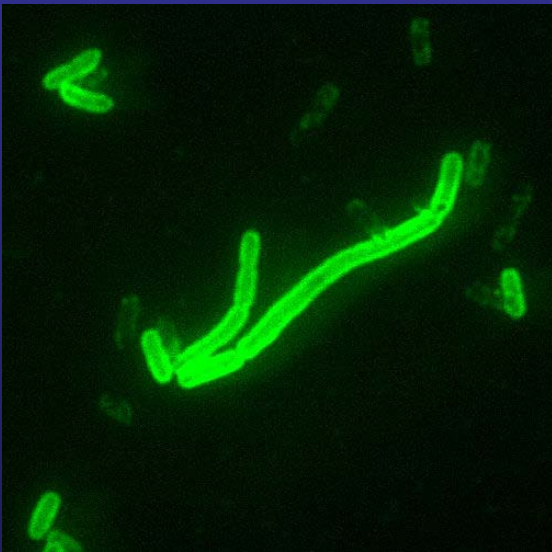
# Plague (*Yersinia pestis*)

Human infection most often occurs when a person is bitten by a rat flea.

Initial symptoms are chills, fever, diarrhea, headaches, and the swelling of the infected lymph nodes, as the bacteria replicate

If untreated, the rate of mortality for bubonic plague is 30–75%

early treatment with antibiotics reduces the mortality rate to 4 to 15%



# Flea-borne diseases - plague



Arizona did not have any human plague cases from 2002-2007

In September of 2007 a woman in Apache County contracted plague by a flea bite. She recovered.

In November 2007, a wildlife biologist at Grand Canyon National Park contracted and died of plague.

# Flea-borne diseases - plague



**A 37 year old biologist was found dead at his residence.**

**The biologist was working with radio collared mountain lions.**

**One week before his death a radio collar indicated a dead lion.**

**He recovered the lion, brought it back to his garage, and performed a necropsy with no PPE.**

**Went to the doctor and was diagnosed with a respiratory illness.**

**He was told to return to the hospital if the symptoms got worse.**

# Flea-borne diseases - plague



The biologist failed to show up for work and co-workers found his body the next day.

His roommates were out of town and he was unable to call for help.

What happened to the carcass?

The hind-quarters were used as bait in a mountain lion trap by the biologist.

The front quarters were never found.

Analysis of the *Y. pestis* in the biologist and carcass were identical.

Viable bacteria was found at the site of the animals death 24 days later.





# Kissing Bugs (*Reduviidae*)



**Vector of American trypanosomiasis  
(Chagas disease)**

**Geographic distribution of  
*Trypanosoma cruzi*  
(Chagas disease)**

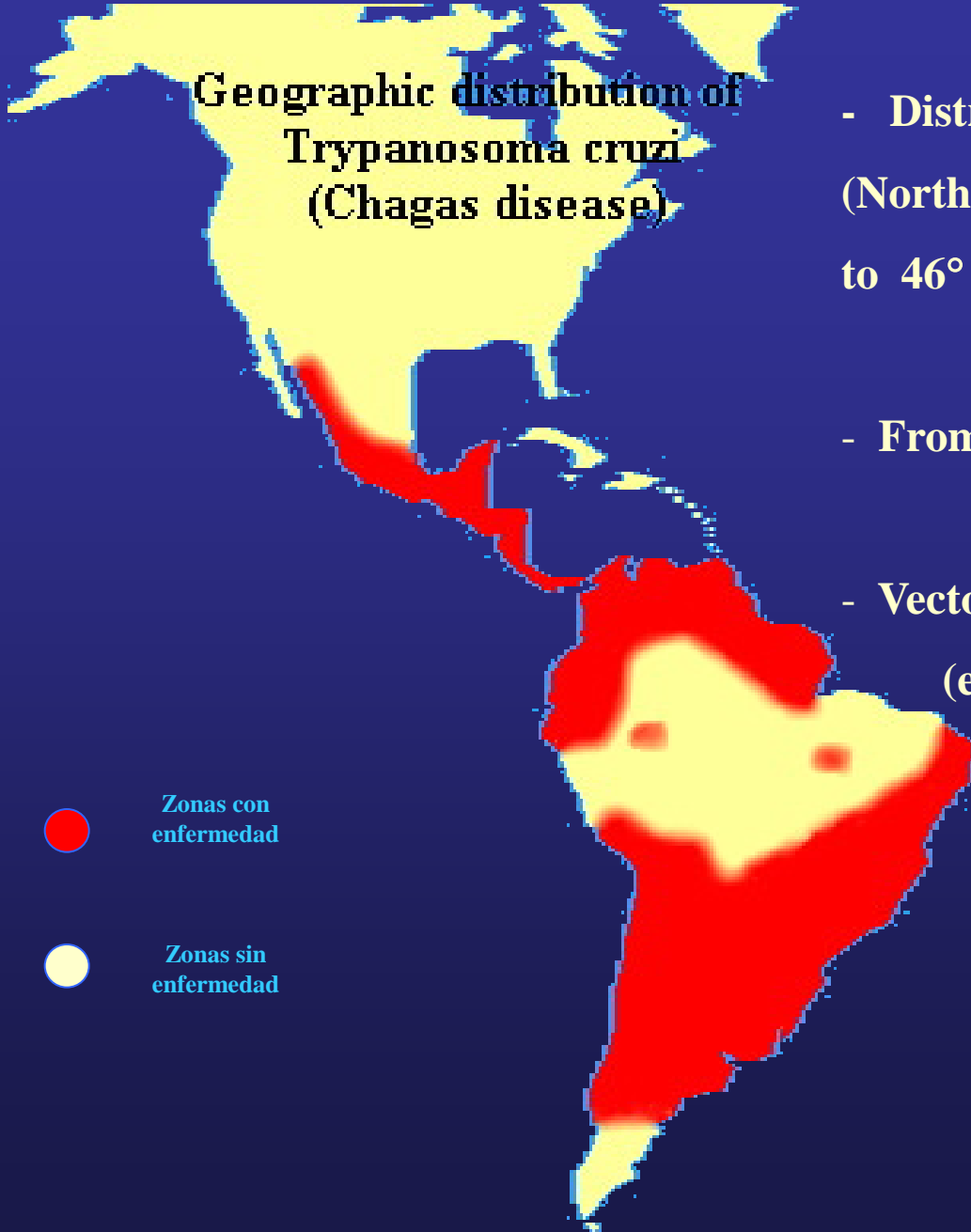
- Distribution from latitudes 42° North (North of California) to 46° South (So. Argentina and Chile).
- From 18 to 20 millions infected.
- Vector borne disease of greatest importance (economic impact and prevalence) in the Americas



Zonas con enfermedad



Zonas sin enfermedad





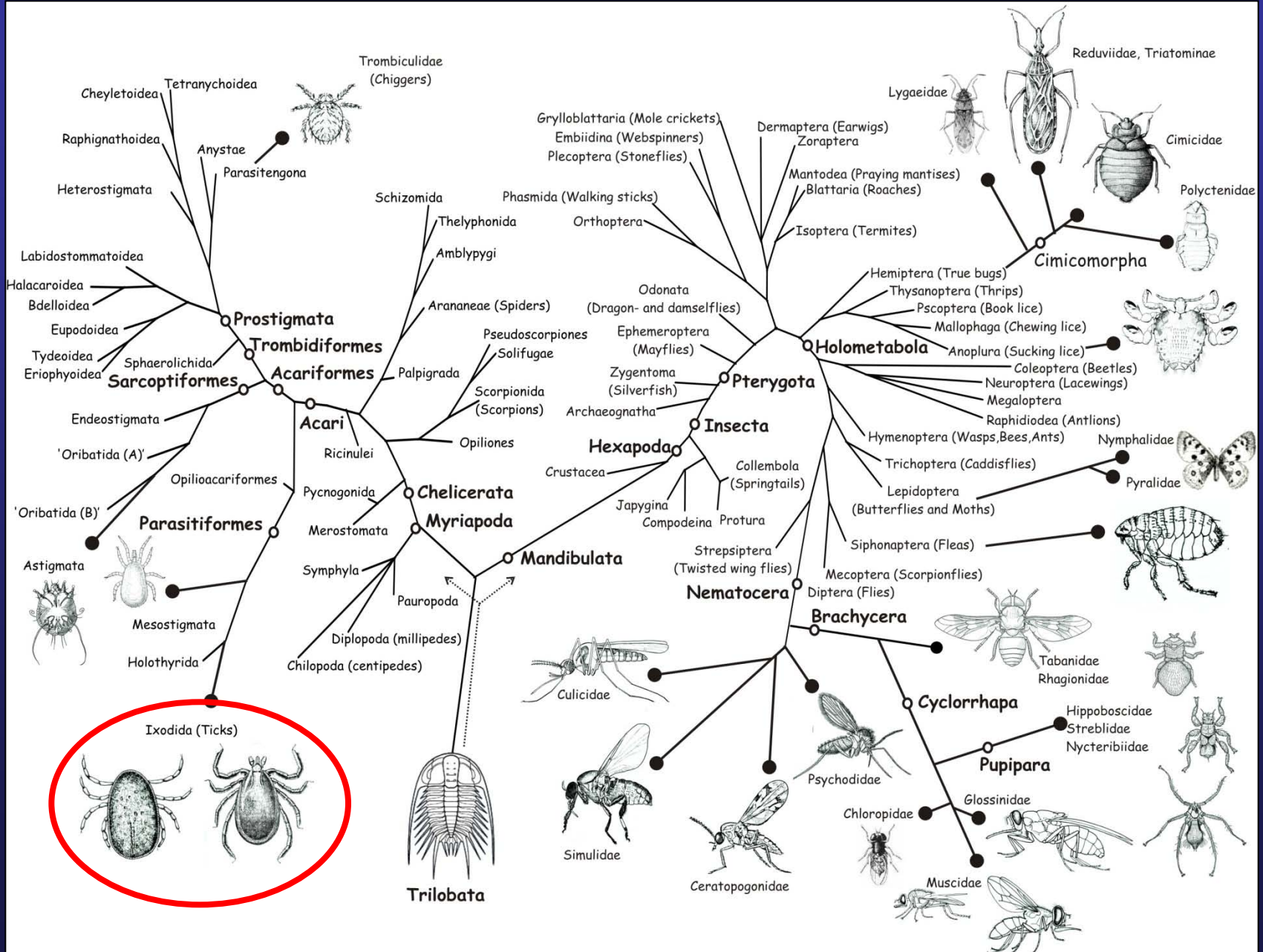


# Lice (Phthiraptera)

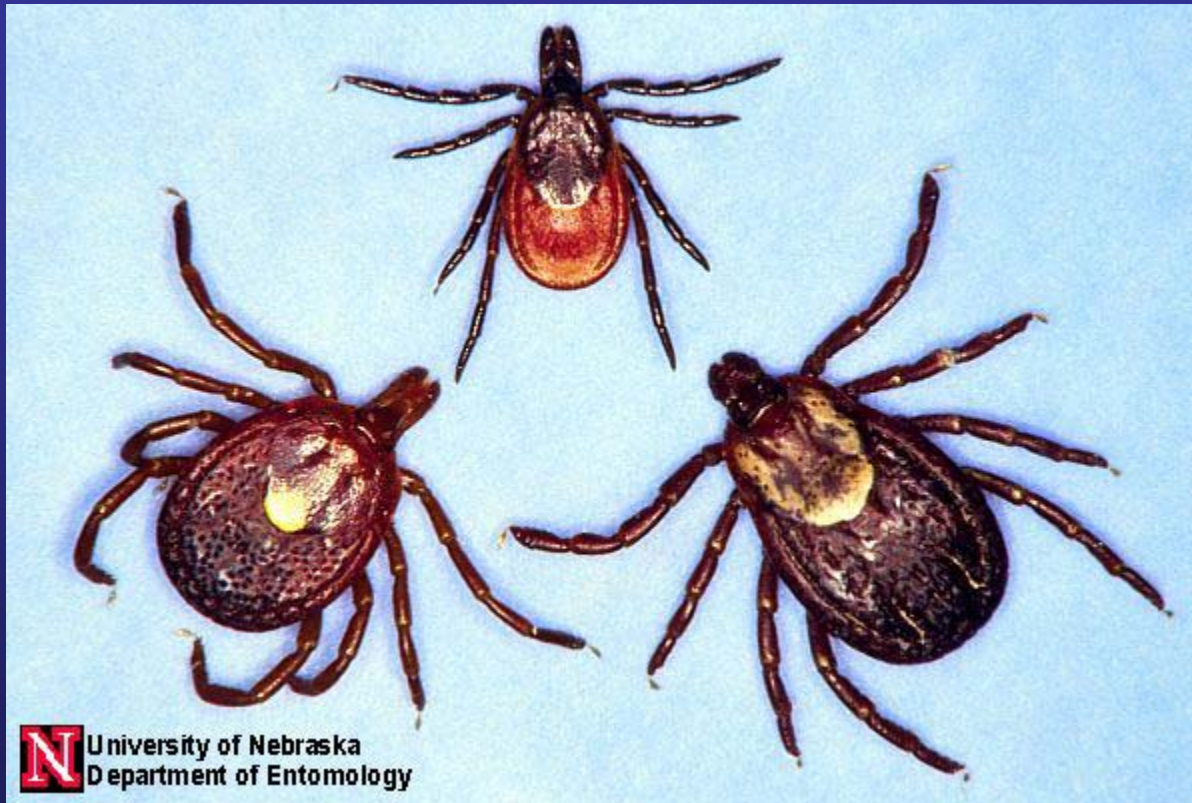


**Vector of epidemic typhus, trench fever,  
louse-borne relapsing fever**

# Bloodfeeding Arthropods



# Ticks



**Vector of Lyme disease, Rocky Mountain spotted fever, tick-borne ehrlichiosis, babesiosis**



# Rocky Mountain spotted fever



Caused by *Rickettsia rickettsii* bacteria

Symptoms include a sudden fever (which can last for 2 or 3 weeks), severe headache, tiredness, deep muscle pain, chills, nausea, and a characteristic rash

Without prompt medical care, kidney failure and shock can lead to death

Rocky Mountain spotted fever affects about 800 persons in the United States each year

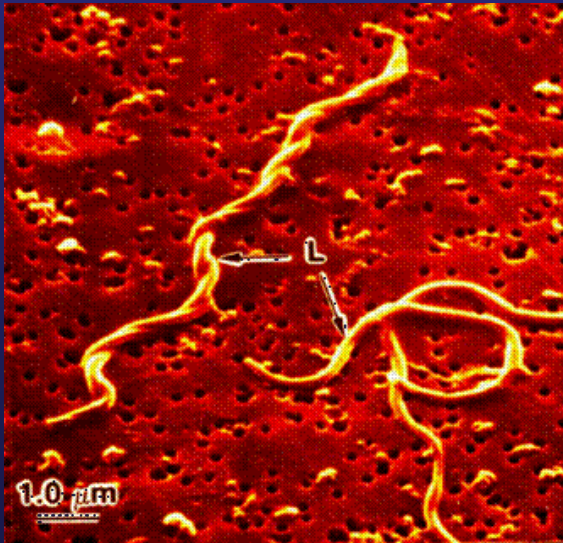


# Lyme disease



Caused by *Borrelia burgdorferi*, a spirochete bacteria

Typical symptoms include fever, headache, fatigue, and a characteristic skin rash called erythema migrans.



If left untreated, infection can spread to joints, the heart, and the nervous system.

# Tick-borne paralysis

**Symptoms of tick paralysis generally begin from five to seven days after a tick becomes attached, beginning with fatigue, numbness of the legs and muscle pains.**

**Paralysis rapidly develops from the lower to the upper extremities and, if the tick is not removed, is followed by tongue and facial paralysis.**

**The most severe complications may include convulsions, respiratory failure and, in up to 12% of untreated cases, death.**

**Treatment involves simply removing the feeding tick(s).**

# **Delusional parasitosis**

**A mistaken belief that one is being infested by parasites such as mites, lice, fleas, spiders, worms, bacteria, or other organisms**

**Stimulant drug abuse (particularly amphetamine and cocaine) can lead to delusional parasitosis**

**People suffering from these conditions may scratch themselves to the extent of serious skin damage and bleeding**

# Forensic Entomology

Insects can provide an objective estimate of the time of death as well as other valuable information concerning the circumstances surrounding the victim's demise





# **A shameless plug for the Medical/Veterinary entomology course**

**A detailed look at:**

- Vector-parasite interactions**
- Disease pathology and treatment**
- Control strategies – new and old**
- The evolution of bloodfeeding**
- Insecticide and drug resistance**
- And much more!**

**ENTO 457 and EIS 557**

**T/Th at 9:30-10:45 AM – Spring 2010**

**Space still available!**